Reconciling Carbon Pricing and Energy Policies in Developing Countries

Integrating Policies for a Clean Energy Transition
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Context: A Pathway toward Decarbonization

At the 21st Conference of the Parties, 193 countries recognized the urgency of addressing climate change and limiting the rise in global temperatures to well below 2°C Celsius. Achieving the overarching climate stabilization goal of the Paris Agreement includes the efforts of reaching global net-zero emissions in the second half of the century. As part of the agreement, more than 180 countries made their individual commitments in form of the Nationally Determined Contributions (NDCs) submissions, thereby demonstrating their contribution to the global effort.

Addressing the global climate change challenge requires full participation of all countries to drastically reduce GHG emissions generated by energy sector, including those associated with energy production and consumption in low- and middle-income countries. Since the likelihood of meeting a 2°C temperature goal requires global GHG emissions to be reduced by 40 to 70 per cent below 2010 levels by 2050 (IPCC 2014) and given that developing countries, mainly middle-income ones, currently account for almost two thirds of global emissions, a rapid transition to a low-carbon development path in these countries will be critical for achieving these goals. The importance of climate informed policies and actions in the energy sector is equally critical for the success of these global efforts since the sector is currently accounting for 65 per cent of emissions in these countries, a share that would grow substantially in the future if no policy action were to be taken. To put it bluntly, without a major effort to reduce emissions from the energy sector developing countries, the world will fail to meet the emission targets it has set, regardless of action taken elsewhere.

The High-Level Commission on Carbon Prices has reaffirmed the indispensable role that carbon pricing has as part of any cost-effective emission reduction strategy (Carbon Pricing Leadership Coalition 2017). In general, carbon pricing refers to various types of instruments, including carbon taxes, cap-and-trade schemes, other indirect policies such as the removal of the fossil-fuel subsidies, or adjustments in existing instruments in view of internalizing carbon costs into the decisions made by investors, firms, government and consumers. While historically high-income countries have been leading the way in testing and implementing these instruments, an increasing number of low- and middle-income countries is looking at the use of carbon pricing as part of their overall climate and energy policy mix.

Even though the pace at which the carbon pricing instruments are being introduced globally is faster than ever, their design and implementation does not come with no challenges. In fact, carbon pricing instruments in low- and middle-income countries can be often seen as contentious – by raising concerns over industrial development, energy access and energy security, for instance - for which reason their introduction must be carefully considered in the context of countries’ energy sectors. Given the complexity of energy systems and a number of public, semi-public and private stakeholders involved, each facing multiple objectives, effective design and implementation of carbon pricing and other climate policies must attempt to maximize synergies and minimize tensions among these objectives., while supporting economic growth, development, innovation, and poverty reduction,

The focus of the Report Reconciling Carbon pricing and Energy Policies in Developing Countries is how the objective of reducing emissions can be pursued alongside the priorities reflected in the energy

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1 A greater than 66 per cent chance.
2 Figures are based on WRI CAIT for the 2013 total of non-Annex I countries including AFOLU.
3 In many cases, these efforts are supported by the Partnership for Market Readiness (PMR), a global program developed by the World Bank and several high-income countries.
policies of developing countries. The Report for Practitioners summarizes the Report’s main findings and is split into three parts:

- Part I examines interactions between climate and energy policies and related challenges and opportunities; some interactions are positive, some are negative.
- Part II focuses on the potential conflicts between carbon pricing on existing energy policy instruments, and the way to reconcile them through adjustments to either carbon pricing or energy policy instruments;
- Part III outlines the options for ensuring the full integration of carbon and energy policies and instruments to accelerate low-carbon development; and

Finally, the Conclusion includes a practical Roadmap for climate and energy practitioners, which translates the Report’s main findings into a set of actionable guiding principles. By providing a practical guidance to the practitioners, the Roadmap is expected to further facilitate the reconciliation of carbon pricing and energy policy and ultimately ensure their effective implementation.

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4 The more detailed core report is available at [to be completed upon core report release].
PART I:

Adding Carbon Pricing to Energy Policy: Points of Convergence, Conflict, and Inefficiency

Part I examines synergies and conflicts between carbon pricing and energy policy. It offers an overview of key energy policy objectives, and the instruments used to achieve them, before examining the historic evolution of each. It then maps potential convergences and conflicts between the objectives of energy policies and carbon pricing instruments, as well as potential unexpected effects and inefficiencies that can result from an inadequate integration.

1. The objectives and instruments of energy policy

Carbon pricing in the energy sector will almost always interact with a complex web of existing policy instruments affecting firm and consumer behavior. Given the importance of energy to fulfilling both human needs and supporting economic development, energy is typically one of the sectors of the economy most subject to intervention and regulation, in terms of both production and consumption. In addition, energy markets can be subject to both domestic and international shocks, the latter often contributing to significant energy price volatility.

When seeking to understand the possible implications of carbon pricing in the energy sector, the distinction between instruments and objectives is crucial. Objectives are what the policy aims to achieve, instruments are what it uses to reach the objectives. The objectives of a typical energy policy can be organized into two broad categories: those specific to the energy sector (such as energy security and access) and those which are not (such as inflation control). Objectives relate to long term goals and are slow to be established or revised, while instruments can be designed and redesigned more quickly.

Instruments are designed to try to ensure that the sector supports the delivery of energy policy objectives that unregulated markets alone will not provide. In particular, these incorporate:

- **energy markets regulations and instruments**: in the case of the power sector, this includes natural monopoly regulation, bidding processes, dispatch and price clearance rules, retail tariff regulation and so forth, all of which have the common goal of enhancing competition and maximizing the efficiency of energy markets in setting prices while protecting customers;

- **energy taxes, fees and levies**: surcharges imposed by government that increase the price of energy or an energy commodity to generate general budget or sector specific financial resources; and,

- **energy subsidies**: measures used by governments specifically targeting electricity, fuels or district heating, which results in reducing the net cost of the energy purchased, reducing the cost of energy production or delivery, or increase the revenues retained by energy producers (Kojima, 2017)
Other forms of energy policy instruments are quantity-based, command-and-control, or institutional.

5 Quantity instruments include quotas that define a minimum or maximum amount of energy product that can be produced, imported or consumed, for example on fossil fuel products and renewable energy (for example renewable energy standards). Command-and-control measures (such as efficiency standards for the energy performance of buildings, processes, and appliances) regulate energy use and/or emissions directly (for example SO\(_2\) emissions). Institutional instruments include nationalizing or privatizing elements of the energy sector, and creating new institutions (such as regulatory agencies) or changing their roles.

Instruments are tailored to the energy sector’s three main (traditional) objectives:

1. **energy independence and security**, which is an objective for fossil fuel importers in particular, and can be achieved using a variety of instruments. This objective is intended to limit geopolitical risk, to protect against market power of fossil-fuel producing nations, and to reduce exposure to volatile or high prices. There are several ways to try to achieve energy security and independence using energy policy instruments:
   - diversifying the energy mix
   - facilitating national production of existing energy resources;
   - mandating that refiners and resellers store a certain amount of energy at all times; and
   - improving energy efficiency, developing local renewable energy, or imposing fossil fuel quotas or import tariffs to reduce dependence on imported energy.

2. reliability of energy supply, which aims at adjusting production to match demand, including responding to unexpected events. In electricity markets, for example, in the short term this requires maintaining grid reliability and managing peak demand, and in the long term it requires ensuring adequate investment in future supply, so as to maintain a minimum capacity reserve.

3. **consumer protection and equity objectives**, which require ensuring that energy prices remain affordable and predictable. Creating universal energy access often requires intervention to ensure that low-income and otherwise marginalized groups have access to energy at affordable prices. Furthermore, in most countries, including many high-income countries, the geographical expansion of electrical services to facilitate universal access is supported by subsidies. These subsidies are sometimes delivered through geographic equalization of tariffs, meaning that consumers in densely populated urban areas cross-subsidize consumers in sparsely populated rural areas.

Countries have also attempted to use energy sector instruments to achieve non-energy sector objectives such as:

- **regional development**: Increasing rural-urban equity has often been an objective of national development policies, as has developing regional and local energy resources. The energy sector instruments used to achieve this include electricity tariff and oil price equalization (as described above), and reliefs on excise taxes on, for example, oil products, when purchased by consumers in remote regions;

- **industrial development**: In countries endowed with energy resources, the development of energy intensive industry activity near these resources can be a key vector of economic growth;

- **macroeconomic and fiscal objectives**: Energy policy can help achieve many macroeconomic and fiscal objectives such as creating a steady source of government revenue, through excise duty taxes on fuels;
improving the balance of payments, by promoting indigenous energy resources; and inflation control through energy price controls; and

- environmental protection: In recent decades, environmental protection has emerged as an energy policy objective, with instruments based on socio-environmental licensing processes, standards, fines and subsidies, and with increasing popularity of market-based instruments to reduce pollutants, such as taxes and cap-and-trade systems.

A collection of instruments aims to achieve these objectives and there are often trade-offs between instruments and, sometimes, between objectives themselves. Understanding these trade-offs, and how they differ between low-, middle- and high-income countries and between fossil fuel importers and exporters, is key to understanding where conflicts can occur when introducing carbon pricing instruments - and how these conflicts can be resolved.
2. Energy Policy Objectives and Instruments: A Comparison of High-with Middle- and Low-Income Countries

The development of energy policies across countries is determined by historical conditions, socioeconomic status, and politics. For example, today, energy policies in high-income countries are increasingly associated with environmental and climate objectives. However, historically these countries have variously emphasized different policy instruments in diverse ways to meet different objectives.

**TABLE 1. Relative Priority Afforded to Energy Policy Objectives in Low and Middle-Income Countries and High-Income Countries**

<table>
<thead>
<tr>
<th>Low and Middle - Income Countries</th>
<th>Priorities</th>
<th>High Income Countries</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macroeconomic objectives</td>
<td>+++</td>
<td>Macroeconomic objectives</td>
<td>0/+</td>
</tr>
<tr>
<td>Inflation control, balance of payments</td>
<td>+++</td>
<td>Inflation control, balance of payments</td>
<td>+++</td>
</tr>
<tr>
<td>Reliability of supply</td>
<td>+++</td>
<td>Adequate power capacity and reasonable price, market-based competition</td>
<td>+</td>
</tr>
<tr>
<td>Price affordability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redistributive objectives</td>
<td>+++</td>
<td>Consumer protection and redistributive objectives</td>
<td>+</td>
</tr>
<tr>
<td>(social, lifetime tariffs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural Access and regional policies</td>
<td>++</td>
<td>Rural Access and regional policies</td>
<td>+</td>
</tr>
<tr>
<td>Energy independence by development of national resources</td>
<td>++</td>
<td>Energy independence, security of supply</td>
<td>+</td>
</tr>
<tr>
<td>Industrial Competitiveness</td>
<td>++</td>
<td>Industrial competitiveness</td>
<td>++</td>
</tr>
<tr>
<td>Fiscal objective</td>
<td>+</td>
<td>Fiscal objective</td>
<td>++</td>
</tr>
<tr>
<td>Environmental and climate protection</td>
<td>+</td>
<td>Environmental and climate protection</td>
<td>+++</td>
</tr>
</tbody>
</table>

Source: Authors’ compilation.

The development of energy policies in high-income countries has generally followed three distinct phases:

1. from the end of WWII through to the end of the 1970s, governments intervened significantly focusing on economic and social development, energy independence, and price controls. This interventionist approach was designed to improve energy security, particularly among fossil fuel importers;

2. between the 1980s and 1990s, governments liberalized and privatized gas and electricity sectors. This was in part anchored in a preference for using market mechanisms to generate efficient economic signals and restricting government intervention to the prevention of market abuse and ensuring consumer protection; and

3. beginning in the 1990s, government involvement resurged to promote clean, low-carbon energy sources and energy efficiency.

Political and socioeconomic circumstances have also shaped low- and middle-income countries’ energy policies. The early history of low- and middle-income country energy policies saw significant government...
intervention. Low- and middle-income country governments nationalized large parts of their energy sectors, including national electricity systems, and subjected energy sectors to government planning relying on significant public financing. However, these models had become unsustainable in many countries by the end of the 1980s: public monopolies were no longer able to mobilize the financial resources to invest leading to frequent challenges such as electricity outages, undermining economic development.

Although the problems of nationalization made many low- and middle-income countries receptive to the liberalization of power sectors seen in high-income countries from the 1980s, the resulting reforms often culminated in quite different models being adopted. Privatization and fragmentation of public utilities, along with the arrival of foreign energy companies, helped attract some additional financing in low- and middle-income countries. However, many of these countries lacked the institutional structures and economic stability necessary to attract sufficient private investment to meet growing demand. The result was a range of models. While power sector structures exist, in general they are across a spectrum rather than in isolated models:

- most high-income countries have *liberalized power sectors* characterized by unbundled, segmented industrial structures, third party access to grids and distribution networks, wholesale market and energy retailers, and independent regulators to control market power and protect consumers.

- other high-income and many middle-income countries typically use either:
  - *hybrid models* with partial unbundling, auctioned long-term contracts for energy and/or capacity, regulated distribution monopolies and retail price controls; or
  - *single-buyer models* that are similar to the hybrid model except that a state-owned transmission and dispatching company buys all power from generating companies through power purchase agreements (PPAs).

- low-income, small countries typically continue to employ the *state-owned public utility model*, characterized by bundled vertical and horizontal public entities, and tariffs set by governments.

These differences can have significant implications for the impacts of carbon pricing and other climate instruments on other energy instruments and market outcomes.

A further divergence in energy priorities can be seen in the different approaches of fossil fuel importers and exporters. Fossil fuel exporters have generally maintained domestic prices below international levels to provide a competitive advantage for local industries, and improve social welfare. However, especially when products are priced below production costs, this leads to industrial inefficiencies and overconsumption of energy, although low prices could also lead to fuel shortages, black markets and higher prices paid by consumers. Despite these negative side effects, the removal of these subsidies has proved politically challenging to date.
Traditionally, low- and middle-income countries have prioritized development objectives over climate objectives, but differences in priorities within these countries have emerged recently. Historically, environmental protection has been perceived as an obstacle to economic growth and most developing countries have argued that mitigation efforts should not constitute an additional constraint on development. However, many developing countries have recently increased their emissions reduction ambition, as the impacts of climate change are increasingly felt and the costs of low-emissions technologies continue to fall. This has included several middle-income countries either considering, or adopting, carbon pricing including China, South Africa, Chile and Mexico. The experience of high-income countries in carbon pricing can be hugely valuable to these countries as they experiment with carbon pricing. At the same time, the experience in high-income countries did not require consideration of how to introduce carbon pricing and reduce emissions while fulfilling basic development objectives. Thus, applying lessons from the experience of developed economies to developing countries needs to be done with caution and nuance, especially regarding the interaction and integration of carbon pricing instruments with energy policy instruments.

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7 The reduction of air pollution, in particular in urban areas, has also gained growing importance to the point that it has become one new driver of energy policies in countries like China.
3. Climate and Energy Policy Objectives: Working in Harmony, or Not

Domestic energy prices are never determined by the simple interplay of market forces, and a range of energy policy instruments, such as those presented in Chapter Error! Reference source not found., will interact with any carbon pricing instrument. Price instruments, quantity instruments, and regulations directed at meeting energy policy objectives all tend to influence energy costs, prices and eventually the behavior of both investors and consumers. Similar types of instruments are also used to meet environmental and climate objectives. Energy and climate policies can either work in harmony or conflict.

Carbon pricing, or other measures to reduce emissions, can support the operation of energy policy instruments, or help meet energy policy objectives. Examples of this harmony include:

- **reducing fossil-fuel imports in net-importing countries, improving energy independence and security:** Carbon pricing creates incentives for energy efficiency and encourages the uptake of renewable energy both of which reduce the demand for fossil fuel imports.

- **improving regional development:** By increasing the cost of fossil fuels, carbon pricing makes investment in local renewable energy resources, and the associated industrial development this can bring, more attractive.

- **strengthening innovation policy:** The adoption of carbon pricing (or a carbon reduction target) is often accompanied by complementary policies to promote low-carbon and energy-efficient technologies. This incentivizes increased research, development and deployment (RD&D) and innovation in energy technologies.

- **increased health and environment co-benefits, and other support for other development objectives:** Reducing GHG emissions can create significant health co-benefits, particularly by lowering levels of airborne pollutants. Long-term climate policies may also incorporate bioclimatic housing, universal electricity access, the promotion of decentralized renewable energy sources in electricity (RES-E) production, and public transport networks.
Reciprocally existing energy policies can contribute to reducing carbon emissions. Several energy policies reduce the share of thermal fuel in the energy mix, increase the penetration of renewable supply, or reduce energy demand. These include: energy-efficiency programs aimed at reducing energy dependence; technology deployment policies, such as feed-in-tariffs (FiTs) or green certificate systems for renewable energy; RD&D support for new energy technologies; or environmental policies that regulate conventional pollutants from fossil-fuel power stations to improve air quality.

However, conflicts between energy and climate policies and objectives can arise. Some of the most challenging of these is when carbon pricing, including the removal of fossil-fuel subsidies, affects energy policy objectives such as competitiveness, affordability and redistribution:

- removing fossil-fuel subsidies, introducing carbon pricing or complementary policies that promote renewable energy sources or energy efficiency, can increase consumer prices and affect affordability. This can have the greatest burden on low-income households; in the case of energy price subsidies in particular, avoiding this burden is often the principal reason for their initial introduction.

- if the costs of carbon policies differ among countries, it may raise concerns that there will be impacts on competitiveness. Energy intensive industries, in particular, often raise the concern that such differentials could lead to the migration of output, investment or employment to countries with lower costs.

While carbon pricing and other climate policies can promote energy independence in energy importers, they may threaten energy policy objectives in fossil fuel exporters. Production subsidies are often used by exporters to encourage investment in national fossil fuel reserves, including to attract foreign investors, and

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(*) ex: regulation introduced by the US EPA under the Obama Administration to phasing out of carbon-intensive coal power plants
(**) ex: China; United States, 1959–73; France, 1928–80; Germany—oil and coal imports quotas, etc.)

Source: Authors

As discussed in the introduction, this report includes the reduction or removal of fossil fuel subsidies as a carbon pricing instrument, as this policy moves the effective carbon price on fossil fuel consumption to closer to the optimal.
increase export capacity. Countries with some reserves but that also rely on imports may similarly use production subsidies to limit their dependence on foreign energy and reduce exposure to external price shocks. Countries may also choose to provide tax reductions or subsidize fossil fuel production for employment purposes, as can be seen in the case of coal production in several European countries. The reduction or removal of such benefits as part of a carbon pricing policy and/or the imposition of a new carbon pricing instrument are in direct conflict with the initial objectives of these subsidies or tax exemptions.

The nature of interactions in the power sector will depend strongly on power market design. Carbon pricing will have very different effects in a liberalized power sector relative to a sector which is under higher government control. There are three key interactions between carbon pricing and a liberalized power market that reduce emissions which may be missing in systems with more government control:

- **merit order impacts**: When a carbon price is introduced in an hourly electricity market, it increases the variable cost of every CO2-emitting plant but with the greatest increases for higher emissions-intensity plants. This means plants with higher emissions-intensity may be replaced by lower emissions-intensity ones.

- **incentives to invest in low-carbon technologies**: Whenever the hourly market price is higher than a generator's marginal cost, the generator receives extra revenue, or ‘infra-marginal rent’ which should cover the capital investment costs of the plant. Therefore, carbon pricing in a liberalized market can send a price signal to investors encouraging them to choose lower- or zero-carbon plants. This can displace existing emissions-intensive technologies and lead to a market-driven transition to a low emission-intensity electricity system.

- **effects on retail prices**: If the cost of carbon pricing is passed-through to wholesale and retail electricity prices - as would be expected in a liberalized market - this price increase can lead to consumers reducing their demand.

At the same time, the introduction of carbon pricing in a liberalized market may have some important undesirable redistribution effects. These are noted in Box 1, and explored further in Chapter 6.
BOX 1. The Rent Transfer associated to Carbon Pricing in a Merit Order Dispatch System

In liberalized power markets, the addition of a carbon price will increase the clearing price paid to all bidders. As a result, higher electricity prices can have undesirable redistributive impacts from consumers to producers. In such markets, generators offer their capacity at a price that can recover their operating costs. Generally, the price offered by the final plant dispatched (the marginal unit) sets the hourly price for all generators used. A carbon price increases generation costs relative to carbon content. Higher emitting plants will bear the largest costs, potentially changing the merit order of dispatch. This leads to benefits such as an increased likelihood that low emitting plants will be called to dispatch more and attract investment in the long-term. However, all other plants will see their rent increases, including pre-existing conventional zero-carbon ones (hydropower and nuclear) and fossil-fuel based power plants in case the marginal plant is still a more carbon intensive one (i.e. existing gas power plants will be paid more in case the marginal plant is a coal-based one). In case the increase in wholesale prices is passed through to the customers, this will induce a transfer of the carbon rent to the generators.

In the case of free allowance allocation, the rent transfer will also benefit to the most polluting generators. This challenge was observed in the first phase of the EU ETS where all generators received free allowances which if surrendered as part of a decision to produce electricity had an ‘opportunity cost’ - the lost revenue from not selling the allowance on the carbon market. Given the absence of international competition, this ‘opportunity cost’ was incorporated into price bids by the industry and ultimately paid by consumers.

The prevention of such rent transfer requires a thorough understanding of the functioning of the local energy markets and an adequate design of the considered carbon pricing instruments, including the recycling of the associated carbon rent.

The efficiency of carbon pricing also depends on the extent to which global price volatility feeds through into domestic prices. Most economic models that anticipate changes in consumer or investor behavior in response to carbon pricing are (implicitly) based on stable fossil fuel prices projections. However, in a deregulated domestic market, international price volatility will feed through into domestic price volatility. In these cases, and when international and hence domestic prices are volatile, it is questionable whether a marginal change in energy prices due to carbon pricing will have a significant impact on consumers or investors. For instance, variation in the oil price of $100 per barrel – consistent with the price changes seen in the global oil market over the last decade – is equivalent to a variation of the price of the carbon contained in an oil barrel of $210/tCO2. Such an oscillation is a far greater price signal than any carbon price observed in OECD countries and even more than the limited $5-$20 carbon price currently considered in developing countries. By contrast, in countries with regulated energy prices, which limit exposure to volatile international prices, the introduction of carbon pricing might have a more predictable effect. This indicates that it is of paramount importance to carefully analyze possible interactions to anticipate undesirable effects or conflicts to be able to mitigate or overcome them. Options for addressing these conflicts are explored in Part II.
PART II:

Reconciling Carbon Pricing with Energy Policies in Developing Countries

Part II examines in greater depth specific cases where carbon pricing and existing energy policy instruments can negatively interact, and how these negative interactions can be addressed through adjustments to either carbon pricing or energy policy instruments. Fossil-fuel subsidies in low- and middle-income countries may deliver social and sector specific objectives, but they need to be reconciled with climate objectives by ensuring they are appropriately designed to target support and maintain emissions abatement incentives. In the power sector, policymakers must be aware of how market models and instrument design may influence the interactions with carbon pricing. At the same time, the introduction of carbon pricing may require the protection of low-income households from regressive impacts and measures to address concerns regarding the competitiveness of energy-intensive industries (EIIs).

4. Fossil-fuel subsidies: Exploring Ways to Reconcile the Policy Objectives with Climate Change

Fossil-fuel subsidies are often introduced with justifiable energy and development objectives in mind. Consumption subsidies can help redistribute resources towards the poorest households which helps explain why consumption subsidies are concentrated in middle- and low-income countries whereas high-income countries have largely phased-out consumption subsidies. Some low-income and vulnerable groups may simply not be able to meet basic energy needs without some form of consumption subsidy: this includes, among others, lighting to improve domestic life, prevent accidents and violence and safer and cleaner cooking. Similarly, production subsidies help promote energy independence, which is particularly important for net energy importers. Countries across income levels subsidize energy production.

Removing electricity lifeline tariffs can lead to increase in payment defaults and even fraud, while increasing tariffs could create social unrest.

Nonetheless, fossil-fuel subsidies are controversial for four key reasons:

- **fiscal and macroeconomic impact**: fossil fuel consumption subsidies can directly impact the public budget, diverting expenditure away from welfare and development policies. For example, in Iran, Uzbekistan, and Turkmenistan subsidies make up 20-25 per cent of GDP. For net-exporters, they also reduce potential export revenue.

- **environmental impacts**: subsidized fossil fuel prices encourage emissions-intensive behavior and investments. According to several studies, the full worldwide phase-out of fossil fuel consumption and
production subsidies could contribute to reducing global emissions and thus limiting global warming to below 2°C.

- **regressive redistributive effects:** Extensive empirical research suggests that fossil-fuel subsidies are often regressive in their impacts, disproportionately benefiting richer consumers within the country where they are introduced. In addition, they can sometimes increase the revenues retained by energy producers and suppliers.

- **stranded assets:** several studies conclude that compliance with efforts to keep the increase in global temperature below 2°C Celsius during the 21st century would mean that two-thirds or more of known fossil fuel reserves cannot be used (IEA 2012, McGlade & Ekins 2015). Production subsidies that encourage further fossil fuel exploration and development may therefore contribute to stranded assets and, when directed to listed companies, risk creating a so-called financial ‘carbon bubble’.

Although these are legitimate concerns, the removal of fossil-fuel subsidies risks creating significant challenges. Redistributive critiques can overlook the contribution of subsidies to satisfying the new needs of lower- and middle-income groups and not just the poorest households. For example, many low- and middle-income families rely on private individual or collective vehicle usage and have few if any other low-carbon options. Eliminating fossil-fuel subsidies would significantly impact their welfare and, at the same time, the lack of alternatives suggests that there would be little change in emissions. In addition, because the marginal utility of income decreases as revenue increases, lower-income individuals gain a higher proportional increase in welfare from subsidies than higher income groups. The difference in quality of life is enormous when subsidies enable low-income customers to first access to basic energy services such as lighting or cooking.

**Therefore, reforming fossil-fuel subsidies, or replacing them with other instruments, requires a careful analysis of specific circumstances.** There is no generic solution that can be applied to all developing countries, although the currently low level of international oil and coal prices offers a unique opportunity to reform subsidies, and test innovative solutions, with less political risk. Any reform needs to be targeted, nuanced and aware of the impacts to ensure that it is politically feasible and socially acceptable.

There are a number of options for reforming fossil-fuel consumption subsidies. It is key that any reform ensures that the original policy goals of subsidies are still taken into account, otherwise there can be backlash both from the public and policymakers. Reforms also need to be designed to minimize transaction costs and reduce the risk of fraud and corruption associated to ill-designed existing subsidy schemes. Three practical examples of deeper reform are:

- fossil-fuel subsidies can gradually be transitioned towards low-carbon alternatives in many countries until the falling costs of renewable energy technologies turn these affordable.

- in certain cases, subsidies can be phased-out in favor of more efficient redistributive mechanisms. Countries with existing, efficient cash transfer could phase-in an energy focused program at lower risk and cost. This was the case with Brazil and the *Bolsa Familia* initiative (see Box 2). In case subsidies are cross-subsidies and financed through tariff by other categories of customers, it might not be possible to divert financial flows out of the sector to channel them via cash-transfer programs. In such cases, improving the targeting by aligning eligibility criteria with best practice cash-transfer program might be preferable.

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9 The Energy Subsidy Reform Assessment Framework (ESRAF) World Bank program, supported by ESMAP, provides a framework to carrying out a comprehensive assessment of issues related to energy subsidies reforms in a country. It includes a series of ten technical guidance notes that highlight tools, methods and practices to underpin the assessment of Energy Subsidy Reforms (ESR) readiness and help design ESR reform plans (“ESMAP. In press. Energy Subsidy Reform Assessment Framework. Washington, DC.”).
new and innovative technologies such as smart meters, pre-payment meters and smart grids can allow for greater targeting of low-income households and vulnerable groups while incentivizing rational consumption. Pre-payment meters have a proven track record of encouraging energy savings by requiring consumers to pay for energy before they use it. Prepayment meters combined with lifeline tariffs and energy efficiency measures could be one effective way to meet social objectives while reducing fossil fuel consumption subsidies.

**BOX 2. Examples of Cash-transfer Programs in Brazil**

An alternative to reducing the energy bills of low-income households via subsidized prices is to provide them with earmarked cash to help them pay these bills. The advantage of this approach is that it does not distort overall energy prices and therefore removes the incentive to consume more. There are numerous examples of successful earmarked transfer programs as part of subsidy reform. One case is that of Brazil where early subsidy designs for LPG initially created perverse outcomes. To prevent the illegal use of subsidized LPG for transport and by industry, the price-based subsidy was replaced in 2002 by an LPG cylinder-refill voucher awarded to only low-income families. Similarly, lifeline electricity tariffs set in 2002 are no longer based on consumption after they were seen to benefit vacation houses. Since 2010 they have instead been aligned with the criteria of the “Bolsa Família” program, a cash-transfer poverty reduction program.

The experience of high-income countries provides some lessons for the reform of production subsidies in middle and low-income countries. In the EU, coal production was heavily subsidized to encourage regional development and energy independence. The movement away from these subsidies has been in part driven by new, stronger, climate objectives that have outweighed the contribution of coal to energy dependence and regional economies. The European experience suggests that an approach based that gradually re-direct subsidies to support transition plan in affected areas, such as infrastructure investment and retraining programs, can allow for a progressive phasing out without compromising development. At the same time, the experience of Norway, the US and Canada in continuing oil and gas production subsidies (through tax reliefs) while simultaneously introducing mitigation measures suggests that dependence on oil and gas continue too high and climate objectives cannot yet overcome energy security and independence policy objectives. The rapid development of low-carbon energy and the risk of stranded assets may trigger a move away from fossil fuel production subsidies, but this has not yet occurred.
5. Affordable Energy and Consumer Protection: Correcting the Regressive Effects of Carbon Pricing via Recycling

The implementation of carbon pricing instruments will have both direct income-distribution impacts and broader indirect impacts. Any mechanism which leads to higher energy prices will directly influence income distribution, particularly since low-income households spend a higher proportion of income on energy. However, the ultimate impact of carbon pricing on inequality and poverty cannot be determined by looking at the additional burden on households’ energy consumption budgets alone. It is important to also consider how governments use revenues generated from carbon pricing, and to adopt a broader macro-economic perspective (such as impacts on GDP, employment and national competitiveness) to capture the net redistributive impacts. Most studies on the utilization of tax revenues show that the distributional effects of a carbon tax are regressive, unless the tax revenues are recycled in a way that corrects that distributive effect.

Revenue-recycling mechanisms can reconcile carbon pricing instruments with household redistribution objectives, and even offer the possibility of achieving a ‘double dividend’ by increasing overall welfare. The design of revenue recycling mechanism and choice of recipients is largely a political decision that includes whether to:

- distribute revenues to all households or target only lower-income groups;
- provide compensation through direct monetary flows to households or through indirect mechanisms such as energy conservation measures that aim to reduce overall energy consumption (see below); and
- in the event of providing direct monetary flows, whether to provide this through reduced tax burdens or other measures. If a reduction in tax burden is considered, whether this should be through lower energy taxes, lower value added taxes or other tax reductions.

**TABLE 2. Measures Used to Mitigate the Regressivity of Carbon Pricing through Recycling**

<table>
<thead>
<tr>
<th></th>
<th>Direct Measures</th>
<th>Indirect Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Households</strong></td>
<td>– Energy check for low-income households</td>
<td>– Subsidies for investment in energy efficiency (thermal renovation, etc.)</td>
</tr>
<tr>
<td></td>
<td>– Reduction of excise duty on petrol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Reduction of VAT on other products</td>
<td></td>
</tr>
<tr>
<td><strong>Employers</strong></td>
<td>– Reduction of social security charges</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Reduction of corporate taxes</td>
<td></td>
</tr>
</tbody>
</table>

Source: Author’s compilation.

If carbon pricing replaces less economically efficient forms of taxation and if the revenue recycling mechanism is designed to offset its regressive impacts, carbon pricing can generate a ‘double dividend’: achieving both a reduction in emissions and an improvement in macroeconomic outcomes.

Alternatively, carbon pricing can provide a source of revenue to support government spending. The High-Level Commission on Carbon Prices (2017) notes that revenues from carbon pricing can strengthen social
systems, support investment in health and education and infrastructure, promote innovation and research and development (R&D). An integrated strategy considering these options alongside revenue recycling measures can play an important role in helping countries achieve the SDGs. Analytical techniques such as CGE modelling are essential to assess comprehensively redistributive effects and other macro-economic impacts and to improve the design of both the carbon pricing instruments and the recycling of the corresponding revenue.

Some policy measures can both complement carbon pricing and tend to reduce its regressive impacts, but policymakers need to consider funding modalities. Complementary climate policies, such as energy efficiency can have a range of redistributive effects - as they reduce household energy bills and thus the net regressive impact of carbon pricing. Since these measures are frequently introduced alongside carbon pricing, it is important to consider how the package of climate policies affect any redistribution objectives. However, financing for these complementary measures can occur in many ways including levies, general government spending (which may necessitate an increase in government deficits), or use of carbon pricing revenue; each of which will have different macro-economic distributional impacts.
6. Incorporating carbon pricing in different power sector models and preventing regressive impacts

The impacts of carbon pricing on consumer prices in the power sector vary significantly depending on how prices are regulated and how incentives are structured for utilities and end-users. The main features determining the effects of carbon pricing are:

- the type of regulatory arrangement and the incentive framework for future investment in generation capacity. This determines how carbon pricing influences a long-term shift investment toward low-carbon technologies.

- the type of hourly coordination of power producers. This determines how carbon pricing can induce a short-term shift in operation from fossil-fuel-based thermal plants to lower-carbon plants.

- the way in which market prices are set on the retail markets (in a market regime), or are regulated (in a regulated tariff regime). This determines the extent to which carbon costs are passed-through from generators, retailers and/or distributors to end-users and induce a change in consumers behaviors.

In a liberalized power market, the redistributive effects of carbon pricing depend on the instrument used, and many jurisdictions have, over time, succeeded in reconciling energy and carbon pricing objectives. There is a difference between, on the one hand, a carbon tax or an ETS where allowances are auctioned, and, on the other hand, an ETS with free allowances. All these result in higher wholesale and retail electricity prices as the cost of carbon pricing is incorporated. However, the first two options generate government revenue (the ‘carbon rent’) that can be redistributed to benefit consumers. By contrast, and as noted in Box I of Chapter 3, under an ETS with free allowances, the carbon rent tends to be captured by generators as wholesale electricity prices still increase despite generators receiving the value of freely allocated allowances. Mechanisms can be found, however, to redistribute these rents to consumers. For example, Californian regulators mandated utilities to recycle the value of emissions allowances directly to residential customers through ‘climate credits’. For many customers, especially low-income households, these recycled revenues were enough to offset the increased cost of energy consumption that resulted from the pass-through of the carbon price into tariffs.

In a hybrid power sector model, in which long term coordination relies on auctioned long-term contracts and short-term coordination on a cost-based dispatch, ETS design should be adjusted to ensure abatement occurs in both the short- and long-term, and price regulations need to ensure carbon price signals are transmitted to consumers. In the short-term, to ensure marginal plants are replaced with lower-emissions alternatives, the cost-based dispatching program should take account of the carbon cost. To ensure that carbon pricing has a long-term effect on investment in generation capacity, carbon price expectations should be integrated into the long-term planning and the auction-based long-term contract selection process, which characterize this model. Finally, to ensure that end-users have an incentive to reduce consumption and hence emissions, retail price regulations should ensure that regulated tariffs convey a carbon incentive.

Single-buyer and vertically integrated state-owned utility models present challenges given dispatch methodologies, especially for ETSs. In countries which have adopted single-buyer or vertically integrated utility models including supply arrangements (PPAs, politically designated emissions-intensive “must run” plants) that deviate from economic dispatch, the distortive effects of power purchasing agreement (PPA) provisions, or the political
designation of some emissions-intensive plants (such as those which ‘must-run’), reduce the effectiveness of all forms of carbon pricing. ETSs, which require a large number of operators for a liquid market to facilitate price discovery, are particularly difficult to introduce. In these cases, command-and-control measures, such as including carbon costs in the centralized dispatch decision criteria, incorporating carbon costs in investment and planning criteria, or mandatory phasing-out of most polluting plans and phasing-in clean alternatives on the basis of a social cost of carbon can help ensure that carbon price incentives induce short- and long-term abatement.
7. Mitigating the Concerns of Negative Impact of Carbon Pricing on Domestic Industries’ Competitiveness

Carbon pricing can cause concerns over a loss of competitiveness, particularly for trade-exposed EIs in developing countries. While fears over competitiveness and carbon leakage have a mixed empirical basis, and can often be driven by political economy considerations, maintaining industry competitiveness after introducing carbon pricing remains a key policy objective. This reflects both energy policy considerations — many of the EIs that may face a negative competitiveness impact from carbon pricing are also targeted by energy policies — and broader macroeconomic and development objectives.

Competitiveness concerns are more likely to be legitimate and significant in low- and middle-income countries due to differences in economic structures and priorities. In the EU, the six industrial sectors that account for the most emissions are responsible for approximately only two per cent of GDP, and less than one per cent of total employment. By contrast, in many low- and middle-income countries, EIs are responsible for a large share of GDP and employment, reflecting that these countries are often dominated by export-oriented, manufacturing industries. For example, in China and India, EIs contribute close to ten percent of GDP (Grubb et al. 2011). Differences in cost structures between these countries can also make competitiveness impacts from carbon pricing more acute in low- and middle-income countries than in high-income countries. In the former, energy costs are a much larger component of overall product costs than in the latter. For example, a carbon price of $50/tCO2e could increase the final price of cement by 75 per cent in India but only 22 per cent in Europe.10

Conditional tax exemptions, tax differentiation and compensation measures can be used to address competitiveness concerns. Pure carbon tax exemptions fail to reconcile competing objectives — placing all emphasis on avoiding competitiveness concerns and no emphasis on reducing emissions. They can also lead to high welfare losses as more mitigation effort needs to be borne by sectors which are not exempt.11 A better option can be to make carbon tax exemption contingent on meeting certain mitigation objectives — for instance a commitment to implement energy conservation measures — as was done with the UK’s Climate Change Agreement (CCA) and Climate Change Levy (CCL) mechanism. This provides greater flexibility while ensuring mitigation objectives are met. Tax differentiation — allowing sectors considered to be at risk of competitiveness concerns — and compensation measures to reduce labor costs, such as labor subsidies, are comparatively more efficient and less costly than exemptions, but are still likely to result in some loss of economic welfare.

Methods of mitigating adverse competitiveness impacts in low- and middle-income countries need to account for national circumstances. Table 3 summarizes measures to mitigate redistributive effects and expected competitiveness impacts for different carbon pricing instruments. Further research is needed to discern where competitiveness concerns and leakage are likely to be most prominent, and to carefully design mitigating measures tailored for national circumstances and transition plans for impacted industries.

10 This also reflects differences in the carbon intensity of fuels.
### Table 3. Redistributive Effects and Competitiveness: A Comparison of Carbon-pricing Designs, and Examples of Mitigation Measures

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Coverage</th>
<th>Carbon Price Pass-through</th>
<th>Potential Carbon Rent Transfer</th>
<th>Ways to Mitigate Effects on Competitiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon tax</td>
<td>Possibly all sectors</td>
<td>Carbon tax, passed through in final energy prices, is paid by regulated sectors</td>
<td>Appropriation by state budget</td>
<td>Reduced rate, rebates for certain energy uses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Recycling via labor tax and/or corporate tax reduction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Border taxation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Exemption in exchange for energy-efficiency programs</td>
</tr>
<tr>
<td>ETS with auctioned allowances</td>
<td>Emitting industries</td>
<td>Cost of auctioned allowances passed through to customers’ prices for all covered sectors (including in wholesale energy prices, in the case of the power sector)</td>
<td>Appropriation by state budget</td>
<td>Recycling of proceeds to compensate for cost burden</td>
</tr>
<tr>
<td></td>
<td>Possibilities to also cover transportation fuels*</td>
<td></td>
<td></td>
<td>Partial free allowances for exposed sectors where the impact on competitiveness is significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Increased flexibility of allowance redemption rules</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Subsidized energy-efficiency programs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Partial offsetting allowed</td>
</tr>
<tr>
<td>ETS with free allowances</td>
<td>Same as above*</td>
<td>No pass-through in the case of industries exposed to foreign competition</td>
<td>No carbon rent</td>
<td>Possibility of taxation of carbon rent and return via grants to the consumers, or shift to auctioning for sectors not exposed to international competition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pass through of carbon market value into prices in industries not exposed to foreign competition (e.g. electricity)</td>
<td>Appropriation by producers e.g. power generators</td>
<td></td>
</tr>
</tbody>
</table>
PART III:

Reconciling Carbon Pricing with Energy Policies in Developing Countries

Part III goes beyond the reconciliation discussed in Part II to propose options based on a paradigm in which carbon and energy policies and instruments are fully integrated. Historically, energy policies have constantly evolved to incorporate new and changing policy objectives. A similar transition needs to occur in relation to energy and carbon pricing. A fully integrated carbon and energy policy approach helps to avoid overlaps and the creation of competing objectives. It also opens the possibility of using full energy price signals (energy market price plus energy taxes plus carbon pricing) to orient economic agents toward low-carbon solutions, rather than only relying on an incremental carbon charge added to existing final energy prices.

Indeed, several high-income countries have begun the transition from the parallel development of standalone carbon-pricing instruments on one side and energy policies on the other towards full integration. Developing countries do not necessarily have to introduce instruments in the same sequence as did high-income countries—in fact, they would do well to avoid the pitfalls of this path. The purpose of this part of the report is to highlight several specific, practical options that promote a more integrated approach.

8. Integrating Carbon and Energy Taxes

There is a strong case for integrating carbon and energy taxes. An integrated pricing system combining energy taxes and carbon pricing would transmit a clearer and stronger signal for investors to allocate resources to low-carbon opportunities and for consumers to adjust their behaviors.

At present, energy tax systems often send a strong but incongruent signals regarding carbon content. Looking at energy tax levels as expressed per ton of CO\(_2\) equivalent reveals that these levels are quite high, frequently above $150/tCO2 or even $200/tCO2 in high-income countries. These rates are significantly higher than those typically considered for a carbon tax. However, energy tax levels are often based on physical quantities (for example, liters) or energy content. This can result in an uneven implicit pricing of emissions that does not align with the objective of reducing emissions, for example, taxation levels of oil products in the EU translated from €/MJ to €/tCO2 range from €164/tCO2 in transport, to only €11/tCO2 for electricity generation and consumption, and the average tax rates vary significantly between countries. Modulating energy tax levels according to the carbon content of the energy product could create a strong signal for economic agents to choose low-carbon options, and eliminate incentives that encourage them to choose more-carbon-intensive options.

There are multiple other ways to integrate carbon and energy instruments consistent with an integration of carbon and energy policy objectives, but this must be preceded by a systematic mapping of the various energy and market instruments in place and how these could be potentially reconciled. This is likely to be more of a challenge for carbon market instruments than for tax instruments due to the detailed technicalities that affect a wide range of parties. Nonetheless, identifying market mechanisms that can be (re-)designed to jointly serve both carbon-mitigation and other energy-specific policy objectives is an important step that is ideally done at the country level for each energy subsector. This is discussed further in Part IV.

With this mapping in place, one approach involves commoditizing the low-carbon content of some energy as being an ‘attribute’ that provides an ‘ancillary service’. In this framing, traded energy products would have a low-emissions attribute, that delivers ‘environmental ancillary services’. Market mechanisms can then be designed to price the delivery of these services, thus generating an opportunity to connect energy markets with carbon markets.

White Certificates, Green Certificates and Brown Certificates are an example of desirable and achievable markets integration, which can help achieve multiple energy and climate objectives more efficiently. Several countries have implemented market mechanisms in the forms of three tradeable certificates. These require covered entities to reach a quantitative target by a certain date but allow the possibility to trade certificates among regulated entities or with third parties to enable them to comply with the obligation at the lowest cost. Three main tradeable certificate schemes are in use:

- **white**: where certificates designate an amount of energy savings and are aimed at promoting energy efficiency;
- **green**: where certificates designate an amount of renewable energy and are aimed at promoting the development of local renewable energy sources; and
- **brown**: where certificates designate GHG emission reductions, such as in an ETS.

White and green certificates are typically implemented as energy policy instruments, while brown certificates are a climate change policy instrument. However, as demonstrated by many CDM methodologies, converting energy savings or renewable energy into emissions reduction involves just one step: they are just “one emissions factor” apart. Nonetheless, these mechanisms have generally been implemented with no or limited coordination, generating inefficient overlaps.

On one side, white and green certificates undermine the efficiency of carbon pricing instruments, particularly ETSs. White and green certificate schemes happen to force additional abatement from energy efficiency or the use of renewable energy that would not otherwise be necessarily delivered by the ETS, reducing the gap for regulated entities to meet their ETS cap and therefore reducing the ETS liquidity and price. This introduces a risk that the ETS price might fail to incentivize low-carbon solutions not covered by the white and green certificates.

On the other side, an ETS might not deliver the energy policy objectives aimed at by white or green certificates. While energy conservation and renewable energy usually deliver emissions reductions, the
reciprocal is not always true: emissions reduction targets can sometimes be more easily met by switching from coal or fuel oil to gas than by investing in energy conservation or renewable energy.

Addressing these issues requires a minimum level of coordination. The lack of coordination induces both inefficiencies and additional transaction cost for entities regulated by multiple schemes. One approach could be to clearly separate the scope of these instruments so that they target different abatement sources. For instance, an ETS could focus on mitigation options that are responsive to carbon price (the “center” of MAC curves\(^\text{12}\)) and the other schemes focus on other technologies (i.e. the “left side” of MAC curves for white certificates). However, depending of the structure of the energy and industrial sectors, the goals targeted by the different mechanisms can be more intermixed than such a simplified approach can account for.

An alternative integrated solution to the interaction challenge might be achieved through combining the different schemes to create a multi-use certificate. White and green certificates are strongly correlated with emissions reductions. Reciprocally, many mitigation options relate to energy savings or renewable energy. In such cases, and subject to adequate regulation, it is possible to convert brown certificates into green or white certificates and reciprocally. A common framework covering issues such as certification; measurement, reporting and verification; the operation of registries; and trading could capture on one side (i) the GHG emission reductions created by white and green certificates and on the other side (ii) the energy savings of renewable energy generation associated to GHG mitigation activities. Ultimately, this would allow white or green certificates to be used for compliance with their own targets (energy efficiency and renewable energy respectively) as well as to contribute to an overall emissions target, and reciprocally, for mitigation options associated with brown certificates to also contribute to the compliance of energy savings or renewable energy targets. Eventually, the liquidity of the integrated market mechanism will be higher than for three separate competing ones, thus improving global efficiency.

\(^\text{12}\) MAC curves were popularized by McKinsey at the end of the 2000s. They provide a graphic representation of abatement potentials as well as costs and benefits for a set of technical mitigation measures at a given date. Measures are ranked according to their net economic costs, from the ones that come with highest net benefits on the left to the measures that come with the highest net positive costs on the right.
10. Balancing Pricing and Non-Pricing Instruments to Support an Effective Transition to Low-Carbon Energy Sources

Even fully integrated carbon and energy pricing instruments are unlikely to be sufficient and will require the complementary use of non-pricing instruments. There are a range of non-price market sector issues that can prevent price signals from being efficient in inducing a shift toward less-carbon-intensive fuels, technologies, and behaviors. These barriers include:

- **Planning, regulatory and logistic gaps**: current planning and regulatory frameworks have often been shaped around existing centralized technologies and tend to limit or even block the penetration of disseminated low-carbon technologies, including through inappropriate logistics to access consumer's markets. A typical example is the difficulty to explore renewable energy potentials that are located in areas not connected to the existing grid.

- **Split incentive along the decision chain**: this issue, also known as the “principal-agent” problem is frequent in the housing sector where landlords and construction decision makers are usually not interested in future costs to be supported by tenants: while the later would be willing to respond to energy/carbon price signal and invest in more efficient insulation or space heating/cooling systems, he has no say to the decision. Reciprocally, the formers are not exposed to the energy/carbon price signal.

- **Lack of local capacity and experience with low-carbon technologies**: low-carbon technologies are not always readily customized to the national circumstances of low- and middle-income countries and businesses and banks often lack experience with such technologies.

- **Incomplete and under-funded financial markets**: energy infrastructure is capital-intensive – and low-carbon energy infrastructure even more so. Financing is already a major barrier in many low- and middle-income countries and, as energy demand grows, and the low-carbon transition becomes more intensive, financing needs will grow further. Indeed, according to the IEA, $4.9 trillion will be needed in non-OECD countries between 2015 and 2025 for developing countries to shift quicker toward a less-carbon-intensive path.\(^\text{13}\)

A range of measures exist to address each of these barriers. As the High-Level Commission on Carbon Prices (2017) notes, combining carbon pricing with a package of other measures in a consistent way to address market and government failures can increase the effectiveness and decrease the required carbon price. Such a package could be composed of the following measures:

- **Adjustment of the planning and regulatory frameworks**: the rapid innovation in the renewable energy and the information technology sector is bringing to an end the cycle of growing economies of scale and regulated natural monopolies. This requires substantial adjustments of the existing planning and regulatory frameworks to scaling-up the penetration of low-carbon technologies.

\(^{13}\) Under the ‘New Policies Scenario’ that includes the energy-related components of the INDCs. This compares with US$2.9 trillion for OECD countries.
• **Command-and-control measures**: this includes the use of standards to exclude specific technologies, and force the penetration of best available technologies or efficiency measures – especially to overcome the principal-agents bottlenecks - and the direct funding of targeted R&D projects.

• **A shadow carbon price**: this is a price on carbon that is integrated into cost-benefits analyses and impact assessments. It can be used by governments or the private sector and can help to orient planning and investment towards low-carbon options and mobilize low-carbon financing.

• **Long and short-term planning exercises**: pursuing lowest-cost mitigation in the short-term can lock-in emissions-intensive infrastructure and activities in the long-term. Modelling of emissions pathways and marginal abatement cost curves can help create a cost-effective low-emissions trajectory that avoids lock-in.

• **Institutional capacity building**: many low- and middle-income markets lack the necessary skills in labor and management to procure and run low-carbon energy technologies and projects. Measures such as targeted training can help to build necessary capacities to both finance and operate a range of low-emissions technologies.

• **Measures to enable financial flows**: these are financial measures to stimulate capital-intensive, long-term and low-carbon investments. Scaling-up low-carbon investment will require attracting a share of the large capital markets and thus up-grade them to asset class. This includes a series of measures and instruments to de-risk projects, including: enhancements and revenue guarantees, first-loss provisions, cornerstone stakes; contract standardization to reduce transaction costs and the development of liquid markets for low-carbon energy infrastructure financing instruments like green bonds and listed “yield co”-type funds.

Table 4 presents some of the most important instruments across different sectors.

**TABLE 4. Indicative Range of Complementary Non-Pricing Instruments beyond Carbon and Energy Pricing**

<table>
<thead>
<tr>
<th>Instruments</th>
<th>Energy</th>
<th>Industry</th>
<th>Building and Appliances</th>
<th>Transportation and Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial regulation</td>
<td>Policies to remove financial barriers, soft loans and risk-sharing arrangements (credit-enhancement mechanisms, etc.)</td>
<td>Policies to remove financial barriers, soft loans and risk-sharing arrangements</td>
<td>Soft loans and grants</td>
<td>Policies to remove financial barriers, soft loans and risk-sharing arrangements</td>
</tr>
<tr>
<td>Command-and-control regulations</td>
<td>Phasing out of coal plants</td>
<td>Emissions performance standards</td>
<td>Thermal performance standards on new buildings</td>
<td>Performance standards on fuel consumption of vehicles</td>
</tr>
<tr>
<td></td>
<td>Emission performance standards</td>
<td></td>
<td></td>
<td>Prohibition of old and high-emissions vehicles</td>
</tr>
<tr>
<td></td>
<td>Obligations on suppliers to provide green/clean electricity</td>
<td>Requirements for operation licensing</td>
<td>Obligation of thermal renovation on public buildings</td>
<td></td>
</tr>
<tr>
<td>Technology development support</td>
<td>Public support for RD&amp;D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rating and labelling programs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tax relief on final use equipment</strong></td>
<td>Tax relief on energy-efficiency measures</td>
<td>Direct subsidies for thermal renovation</td>
<td>Direct subsidies for clean cars</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tax credit for energy-efficiency actions</td>
<td></td>
<td>Tax credit for clean vehicles</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors’ compilation
Conclusion

Designing an appropriate policy package that integrates energy and carbon pricing and non-pricing instruments can enable a cleaner development path for low- and middle-income countries. In fact, their effective integration can be a way to pursue a win-win solution for addressing both development- and climate-related challenges, while still offering an opportunity to deliver the infrastructure and capital needed for a transition to a faster, low carbon development. Such win-win path is illustrated in Figure 3.

**FIGURE 3. Progressing Faster on a Cleaner Development Path**

The integration of climate and energy policies requires the involvement and cooperation of a wide range of stakeholders, including climate and energy practitioners, as well as the application of knowledge and experience specific to each of the markets. The climate community rightly so emphasizes the importance of decarbonization of the energy sector in low- and (especially) middle-income countries, and the role that carbon pricing can play in this effort. That said, carbon pricing should not be seen a silver-bullet applied to a blank slate, for which reason a guidance from the energy community is needed to ensure that potentially negative interactions are curtailed and synergies are maximized when carbon pricing is added to an existing energy policy landscape.

In this regard, the following five steps could help facilitate their interaction and ensure effective implementation:

1. **Build Country-specific Mapping of Energy Policy Objectives and Instruments.** Knowledge and careful consideration of the specific sector policies, government objectives and national (economic and social)
circumstances are necessary prerequisites for designing an appropriate policy package, particularly one that reconciles potential pressure points between energy policies and carbon pricing. As such, a thorough and comprehensive mapping of all sectoral objectives, and the policies and instruments used to achieve these objectives is needed. For instance, mapping of energy market instruments requires a deep understanding of technicalities that involve several agents acting under a set of detailed rules and operational processes in effect in each of the different energy sub-markets (i.e. power, gas, liquid and solid fuels). The typologies of countries, policy objectives, energy markets structures and instruments proposed in this report are aimed at facilitating such country specific mapping.

2. **Analyze Interactions Between Carbon Pricing And Energy Policy Instruments.** Based on the review of existing energy policy and instruments, the next step consists in mapping the interactions between these and the different types of carbon pricing instruments, using the lessons learnt from the international experience. This interplay can cause both synergies and conflicts. The outcome of these interactions highly depends on the national circumstances, in particular how these are translated into the national energy policy objectives. The generic inventory of possible interactions presented in this report, combined with the typologies mentioned above can guide practitioners in identifying potential conflicts.

3. **Design Reconciliation Options, and Develop Comprehensive, Integrated Policy Packages.** Once tensions and inconsistencies are identified, reconciliation options can be creatively envisioned. The report detail lessons and limits of the experience of high income countries in adjusting carbon pricing instruments and existing energy policy instruments to mitigate conflicts or designing creatively integrated carbon and energy pricing instruments to maximize synergies.

As the influence of pricing instruments to shift investment and behaviors towards low-carbon alternatives is limited by market failures, comprehensive policy packages combining pricing and non-pricing instruments should be put together. The latter range from shadow carbon pricing in government planning and investment decisions; targeted skills and training, information dissemination and R&D programs; command and control regulations and technology standards, and financial instruments to de-risk low-carbon investments and attract capital markets.

4. **Build Tools To Assess Policy Packages and Instruments Designs.** The analysis of reconciliation options and policy packages requires an understanding of their impacts and trade-offs. This can be achieved by using modelling tools that help outline the potential impact of different policy interventions\(^\text{15}\), including both bottom-up and top-down economic modelling exercises. Modelling would need to be done at and between multiple levels including economy-wide, electricity markets and specific sector-focused models. Top-down models, such as computable general equilibrium models, provide a view of macroeconomic feedbacks, while bottom-up models are more appropriate for examining specific interactions and mechanisms.

Such an approach can be replicated beyond the energy policies to other sectors, such as agriculture, transport and industries\(^\text{16}\). Designing an appropriate policy package that integrates carbon and other sectors pricing and non-pricing instruments can generate double dividends: it can provide a win-win solution for addressing both development and climate-related challenges while still offering an opportunity to deliver the infrastructure and capital needed for a rapid transition to low carbon development.

Not all quantitative or qualitative impacts can be dealt with in economic models; the ones that cannot include, among others, administrative feasibility and institutional capacities, extra transaction costs.

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15 This could be based on using existing modelling approaches such as World Bank ‘Checklist for Developing Post 2020 Mitigation Pathways’ (https://openknowledge.worldbank.org/bitstream/handle/10986/21877/EPEP_eBook.pdf) and calibrating them to national circumstances.
16 Brazil is implementing such multi-sectoral approach with the support of the PMR, covering the following sectors: power, gas and liquid fuels, agriculture, planted forests and 7 industries (aluminum, steel and pig iron, cement, lime, glass, paper and cellulosics, and chemicals).
(infrastructure, operating costs, and human resources) to enable public agencies to implement the regulatory measures foreshadowed in the policy packages. The modeling approach should therefore be completed by a broader Regulatory Impact Assessment (RIA)\textsuperscript{17}.

Both approaches combined can provide a more complete picture of policies interactions and the potential impact of reconciliation options. This can, in turn, help policy-makers to estimate the impact of both existing policies and reconciliation measures, as well as broader policy packages.

5. **Political Dialogue to Ensure Buy-in and Help Facilitate Implementation.** Adoption and implementation of various instruments requires political dialogue that helps build understanding of how proposed approaches tie in with national policies and development objectives, while developing reconciliation options builds on such political considerations and is largely a product of technical dialogue among practitioners, including specifically examining the issues around. These critical issues, including the impact of carbon pricing on competitiveness and trade exposed energy intensive industries, the removal or reduction of fossil-fuel consumption subsidies and the reform of fossil-fuel production subsidies are presented in a separate Annex. There are examples from existing initiatives of effective stakeholder consultation and use of guidelines for political dialogue.

Table 5 summarizes these steps and points to specific chapters of the core report for further insight and guidance.

\textsuperscript{17} For more details and guidance see: http://www.oecd.org/gov/regulatory-policy/ria.htm
### TABLE 5. Synthesis of Steps Forward

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<th>Explanation</th>
<th>For Further Information Refer to:</th>
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<tbody>
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<td>Country-specific Mapping</td>
<td>Careful consideration of national circumstances is needed for the successful reconciliation of climate and energy policies. In turn, this requires mapping of sectoral objectives, policies and instruments. The typologies of countries, instruments, objectives and energy market structures provided in this report can help to facilitate such mapping.</td>
<td>Country typology (Preamble)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Energy objectives and instruments (Chapters 1 and 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Climate policy objectives and instruments (Chapter 3)</td>
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<td></td>
<td></td>
<td>Energy market structure (Chapters 2 and 7)</td>
</tr>
<tr>
<td>Analyze Interactions</td>
<td>Mapping and understanding the interactions of climate and energy policies, including synergies and conflicts, are critical. The interaction will inherently depend on national circumstances. The generic inventory of possible interactions presented in this report, combined with the typologies mentioned above, can guide practitioners in identifying potential conflicts.</td>
<td>Synergies and conflicts (Chapter 3)</td>
</tr>
<tr>
<td>Design Policies</td>
<td>After synergies and trade-offs are understood, reconciliation options can be crafted. This report provides several potential instrument and policy packages for reconciling climate and energy policies. Some are based on the empirical experience of OECD countries, while others are more innovative.</td>
<td>Reform of Fossil-fuel subsidies (Chapter 4)</td>
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<td>Revenue recycling (Chapter 5)</td>
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<td>Measures to address competitiveness (Chapter 6)</td>
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<td>An adjustable carbon-energy tax (Chapter 6)</td>
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<td>Separation or integration of certificates (Chapter 9)</td>
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<td>Shadow carbon pricing (Chapter 10)</td>
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<td>Command-and-control regulations (Chapter 10)</td>
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<td></td>
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<td>Financial instruments for incentivizing low-carbon investments (Chapter 10)</td>
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<tr>
<td>Assess Policies</td>
<td>Instruments and policy packages to reconcile climate and energy policies need to be carefully scrutinized. These could either be newly built or expand on existing approaches (see the next column). This would require both top-down (computer-generated equilibrium models) and bottom-up quantitative modeling. This should be complemented by a Regulatory Impact Assessment (RIA).</td>
<td>Existing modeling approaches such as the World Bank’s ‘Checklist for Developing Post 2020 Mitigation Pathways’ could be used 18</td>
</tr>
<tr>
<td>Political Dialogue</td>
<td>Implementation the reconciliatory policies presented in this report will require political dialogue and buy-in. This is particularly true of ‘critical issues’ such as EII competitiveness and fossil-fuel consumption and production-subsidy reform. The next column provides a number of illuminating cases of effective political and technical deliberation.</td>
<td>The FASTER Principles 19</td>
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<td>High-Level Commission on Carbon Prices 20</td>
</tr>
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Source: Authors

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20 [https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/59244eed17bfff0ac256cf16/1495551740633/CarbonPricing_Final_May29.pdf](https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/59244eed17bfff0ac256cf16/1495551740633/CarbonPricing_Final_May29.pdf)
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Main Report
Reconciling Carbon Pricing and Energy Policies in Developing Countries

Integrating Policies for a Clean Energy Transition
### Main Report

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Introduction

Meeting the Goals of the Paris Agreement: A Developing Challenge

At the 21st session of the Conference of the Parties (COP21) in Paris, December 2015, 193 countries agreed to the Paris Climate Agreement. This post-Kyoto treaty establishes the long-term goal of limiting global temperature rise to 2° Celsius. This is to be done by reaching global net zero emissions by the end of the century. As part of the agreement, more than 190 countries submitted their Intended Nationally Determined Contributions (INDCs) by 18 April 2016. Many of these have now become formalized as Nationally Determined Contributions (NDCs) for the 181 countries that have ratified the agreement. For the first time in the history of international negotiations on climate change, the vast majority of developing countries took quantified pledges to contain the growth of, or even reduce, their absolute domestic greenhouse gas (GHG) emissions. Many of these countries have since ratified the Paris Agreement, which includes provisions to periodically revise and enhance the ambitions of pledges, starting in 2018.

While developed economies bear the largest share of responsibility for past GHG emissions, stabilizing global GHG concentrations at levels that would prevent global temperature to increase beyond 2° Celsius requires the participation of developing countries.

Stabilizing GHG atmospheric concentrations at around 450 parts per million carbon dioxide equivalent (CO₂e) would be consistent with the objective of trying to limit warming below 2°C. This would require global GHG emissions to be reduced to at least 50 percent below 2000 levels by 2050 (IPCC 2007). This would entail absolute emission reductions of about 30–40 gigatons of carbon dioxide equivalent (GtCO₂e)/year by 2030.

Emissions from Annex 1 countries, which made international commitments to reduce GHG emissions under the United Nations Framework Convention for Climate Change (UNFCCC), have already plateaued, at around 20 GtCO₂/year since 2010. Even if Annex I countries reached net zero emissions, the world would still fail to meet the goals of the Paris Agreement. The global mitigation challenge requires that developing countries manage to shift to a low-carbon development path, and soon. As no less than two-thirds of global emissions are from fossil fuels, there is no solution to global climate change without drastically reducing the net CO2 emissions generated by energy production and consumption in the developing world.

However, there is a general concern that the policy instruments required to achieve such a result can hinder and divert resources away from economic development. How can efforts to mitigate carbon emissions be reconciled with development? Can the objective of reducing emissions be pursued alongside the priorities reflected in the energy policies of developing countries? These questions are the focus of this report.

Putting a price on carbon is one of the main instruments that countries have used or considered to reduce emissions. The growing interest in carbon pricing was evident in the launch of the Carbon Pricing Leadership Coalition at COP21, which was supported by 74 countries, 23 subnational jurisdictions, and more than 1,000 companies and investors. This follows almost two decades testing and implementing carbon-pricing instruments,

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21 As of the 5th of October 2018.
22 32 GtCO₂/year in 2010 and 36.3 GtCO₂/year in 2015 (Global Carbon Budget 2016).
mainly in high-income countries. An increasing number of developing (low-income) and emerging (middle-income) countries are considering carbon pricing instruments. Some, such as Mexico and South Africa, are already implementing carbon-pricing to achieve the mitigation goals articulated in their NDCs. An illustration of this effort is the Partnership for Market Readiness (PMR), a global program supported by the World Bank and 13 contributing OECD economies. The PMR aims to support about 20 emerging economies to assess, prepare, and implement carbon-pricing instruments.

Developing countries can learn many lessons from the vast experience of high income countries in how to design and implement carbon-pricing instruments. Yet, several legitimate questions need to be answered for developing countries to be able to design and implement carbon-pricing instruments satisfactorily. One set of questions relates to the interaction of carbon-pricing instruments with existing sector policies, instruments, and markets. This is particularly relevant for energy production and consumption. Moreover, does this interaction facilitate the achievement of the expected reductions of emissions, or, does it undermine the effectiveness of these instruments? These questions are addressed in Part I of this volume.

Part II considers a number of questions that follow from Part I. First and foremost, how can emissions reductions strategies, particularly pricing, be reconciled with existing energy objectives in developing and emerging countries?

Part III goes a step further and considers a new, integrative approach to both energy and climate policy. We put forward several pricing and non-pricing instruments that can be merged together to create an effective package of energy and climate policies. By integrating climate considerations into the development of energy policy, and vice versa, a more sustainable and holistic outcome can be achieved.

In conclusion, the report proposes a roadmap for climate and energy practitioners of the developing world, which translates the report’s main findings into a set of actionable guiding principles. By providing a practical guidance to the practitioners, the roadmap is expected to further facilitate the reconciliation of carbon and energy policies and ultimately ensure their effective implementation.

Meeting the goals of Paris requires developing countries to combine their pre-existing development and energy objectives with ambitious emissions reductions. This report outlines the pitfalls and ways forward in addressing this challenge.

This report draws on the experience of countries from the Organisation for Economic Cooperation and Development (OECD) to distil lessons for non-OECD developing countries. While this is the predominant framing, we understand that the distinction between countries is often more complex and nuanced. To remedy this we will also, where necessary, draw on the Climate-Energy Typology outlined below, in addition to the OECD/non-OECD division.

The Climate Energy Typology

The climate-energy typology situates countries across a range of different metrics. It is designed to augment the current OECD/non-OECD split throughout the report with a more nuanced approach. The climate-energy typology aims to strike the balance between aggregation and detail. It is not intended to capture idiosyncratic features that apply in individual countries, but to draw out main characteristics common to a type. The typology provides a simple yet effective guide to understanding what issues will be pertinent to, and which responses are more likely to be applicable for, countries with shared characteristics and policy approaches.
Where necessary, the typology will draw out specific points for countries within or across types – such as for the OECD, Organization of the Petroleum Exporting Countries (OPEC) and Least Developed Countries (LDCs).

The proposed climate-energy typology shown in Figure 1 consists of six main categories along two dimensions:

1. Three categories of income: low, medium and high.

2. Two categories of fossil fuel trade: net importers and net exporters.

Within the six main categories, a range of different electricity market structures might be present. Electricity market structure can influence the interactions between policies, may underlie differences in views between energy and climate communities, as well as shape the options to reconcile differences. Although Figure 4 only shows how middle-income, net importers may have different electricity market structures this is just for expositional ease; in practice, all six country types can have different power market structures.

**FIGURE 4.** Climate-Energy Typology enables a clear distinction between groups of countries while...
The net trade position of fossil fuels strongly influences the objectives and implementation of energy and climate policies. For example, energy exporters are generally more likely to have higher levels of subsidies for production and consumption of fossil fuels (Bárány & Grigonytė 2015) or may use fossil fuel production as a major taxation source. Fossil-fuel energy exporters may also face greater challenges if the world pursues rapid decarbonisation. In contrast, net importers may implement policies that shield them from international energy price volatility, with the trade-off of greater fiscal budget volatility.

The degree of interactions between energy and climate policies correlates with the typology: the level of income and net trade of fossil fuels influence pressure points and different views on effective policy design. Carbon pricing mainly exists in high-income countries, while there are plans for more recent adoptions and pilots occurring in middle-income countries such as South Africa, China and Kazakhstan. The relative importance of reduced air pollution and competitiveness varies across income groups, and the net trade position for fossil fuels influences policies, and interactions between policies, for improving energy independence and overall energy investment.
PART I:

Adding Carbon Pricing to Energy Policy: Points of Convergence, Conflict, and Inefficiency

Carbon pricing is a tool to reduce greenhouse gas emissions, many of which are from energy. In doing so, carbon pricing necessarily interferes with existing energy policy instruments and their objectives. To analyze the interactions that may result, we begin by characterizing the instruments used for each energy policy objective in Chapter 2. Chapter 2 takes a historical look at the evolution of these objectives and instruments. In Chapter 3 we map out potential convergences and conflicts between the objectives of energy policies and carbon-pricing instruments. But before we can understand the synergies and conflicts of energy and climate, we must first comprehend the instruments and objectives that underlie energy policy.
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1.1. An Overview of Energy Policy Objectives and Prioritisation

There are a variety of objectives that energy policy seeks to fulfill. However, before analyzing objectives, it is crucial to distinguish policy objectives from policy instruments. Objectives are an overarching policy goal, whilst an instrument is a tool used to achieve one or more objectives. For example, reducing greenhouse gas emissions is a policy goal, whilst carbon-pricing is an economic instrument used to achieve this goal in a cost-effective manner. Every policy uses instruments to achieve its objectives. Specific policy objectives can be pursued by a variety of instruments and a single instrument can often meet multiple objectives.

Distinguishing objectives from instruments is important due to differences in flexibility. Objectives are slow to be established or revised, but instruments can be designed and redesigned quite quickly. For example, a sub-optimal outcome might be addressed by recalibrating an instrument to correct or avoid an undesirable side effect. In contrast, objectives are far slower to change in terms of form or priority.

The objectives of a typical energy policy can be organized into two broad categories: those specific to the energy sector (such as energy security and access) and those which are not (such as commercial balance and inflation control). Below is a brief list of objectives for these two categories.

- Objectives specific to the energy sector:
  - Provide energy security23
  - Provide energy independence (by limiting fuel imports and developing internal resources);
  - Ensure reliable supply at reasonable prices;
  - Extend access to new energy sources;
  - Protect affordable access to energy for low-income groups.

- Objectives that extend beyond the sector:
  - Promote the economic competitiveness of energy-intensive industries (EIs) and industrial development;
  - Protect and promote the development of regions;
  - Provide environmental protection;
  - Pursue macroeconomic and fiscal objectives.

These two groups of objectives can be in conflict, pitting market promotion against redistributive equity and leading to second-best compromises. In such cases, a prioritization of goals is drawn on. The relative importance of objectives has transformed due to changes in social values and theoretical approaches. For example, the criticism of public ownership and tight central regulations in the 1980s and 1990s led to the liberalization of energy industries.

23 We use the IEA definition of energy security as “the uninterrupted availability of energy sources at an affordable price”.
Energy policies and their prioritization have evolved due to external and internal factors. Changing perceptions of geo-economic vulnerability in the newly globalized economy are one external factor. An internal factor is the level of socio-economic development: above a certain threshold of development, energy access and basic energy needs have already been achieved.

While every country has its own unique background and circumstances, there are some commonalities in how energy objectives are prioritized. Frei’s (2004, 2011) hierarchy of energy policy priorities provides one way of understanding this pattern of prioritization. The hierarchy, provided below in Figure 5, starts with access to commercial energy, then moves to the topics of supply security, energy costs and prices, environmental issues, and social acceptance. Frei (2011: 761) writes, “These objectives are not subject to trade off, but to a hierarchy that requires satisfying lower-order needs before addressing the higher-order ones. The political weight of an issue is vastly different whether the issue is environment, economics or security in the higher order ones. It is not a normative hierarchy, but history tell us that going against it may lead to policies beyond political feasibility.”

**FIGURE 5. Key Objectives in Energy Policy, Ranked in Order of Priority**

![Hierarchy of Objectives](image)


The hierarchy of objectives suggests that some basic objectives will always be prioritized and pursued first, regardless of national circumstances. However, it does not provide an insight into how these objectives can be met, or if prioritization can be avoided by simultaneously achieving objectives. To understand these aspects, we turn to an exploration of energy instruments.

### 1.2. An Overview of Energy Policy Instruments

From an economic theory perspective, instruments designed to pursue energy policy objectives are aimed at compensating for market failures, correcting market imperfections, and redistribution. They can also be designed to encourage innovation through incentives for the development of new technologies and new activities to accelerate learning processes, and by creating favorable conditions for industrial, economic, and social development.
1.2.1. Price Instruments

Energy policies have used most of the same economic instruments that are also used by other sectors, such as agriculture, water and sanitation, railways, and the postal system. These are price, quantity and institutional instruments. Eventually, all these instruments either directly or indirectly shape final energy prices.

**Energy Taxes**

Energy taxes are one pricing instrument used to achieve a variety of objectives. An energy tax is a surcharge imposed by government that increases the price of energy, or an energy commodity. Examples of this include import tariffs on oil and other energy commodities, taxes on oil products. The taxes accrue to government and provide an additional source of revenue. Energy taxes are particularly prevalent due to the revenue they can provide. An energy product is easy to tax since (i) it is an essential product and its demand is relatively inelastic and (ii) the tax is easy to collect (which minimizes the cost of increasing fiscal revenues). Hence, some national governments heavily tax motor fuels\(^{24}\), taking advantage of the inelasticity of the demand.

The theoretical justification for energy taxes is that they ensure:

- **Secure supply and the protection of the economy against oil shocks.** These two objectives are used to justify import tariffs and taxes on oil products, which reduce imports in net importer countries; however, a quota system could also be used for this purpose (see below);

- **Optimal use of scarce nonrenewable resources.** The scarcity of nonrenewable resources implies a rent to be shared between the government (as an owner of the resource) and investors. However, this poses a risk to future generations if their interests are not considered in today’s consumption decisions, thus leading to the depletion of the resources. The main objectives of taxation at the upstream level are to ensure a fair distribution of the wealth accruing from resource extraction while encouraging investment in and optimal economic recovery of the resources (Nake 2011);\(^{25}\)

- **Environmental protection,** including the mitigation of climate change, and;

- Financing of infrastructure development to prevent congestion.

**Energy Subsidies**

Energy subsidies are measures used by governments targeting electricity, fuels or district heating, which results in reducing the net cost of the energy purchased, reducing the cost of energy production or delivery, or increase the revenues retained by energy producers (Kojima, 2017). This includes both direct measures such as social tariffs, as well as indirect methods such as tax reliefs and fiscal concessions.

\(^{24}\) An excise duty (or excise tax) is an inland tax on the sale of specific goods within a country that covers a quantity and not a value. Excise taxes are distinguished from customs taxes, or duties, which are taxes on imports.

\(^{25}\) There are a variety of tax types: a royalty payment on gross revenue for the right to use another property for the purpose of gain (with two versions, a per unit fixed charge on a specified volume, and an ad valorem tax); a resource rent tax; and income tax (on the corporate and not on the oilfield or project level). There are also two different legal regimes, concessionary and contractual, which have some implications for taxation.
Governments have used energy subsidies to pursue various energy policy goals, such as:

- Energy independence, or limited energy dependence—achieved by increasing the domestic production of oil, gas, or coal, or, in other cases, developing new technologies that do not rely on fossil fuels;
- Social objectives and consumer protection, and;
- Environmental protection, for example, by providing subsidies for clean technologies.  

Whilst subsidies can meet a variety of goals, they do also have a fiscal cost. Subsidies require governments to either forgo potential revenue, such as in the case of tax breaks, or directly outlay finance for subsidization.

**Price Controls and Tariff Regulation**

Price control measures include regulating prices, setting price ceilings, providing subsidies, and establishing a fund to smooth prices over time. When governments keep domestic prices below market levels for one or more types of fuel, they pay the difference. This can be done directly through budgetary transfers to oil refinery companies from the fund, or indirectly, through lower corporate taxes to compensate companies for financial losses (Kojima 2012).

Governments also regulate public utility monopolies through tariffs. They do so by ensuring that tariffs reflect (i) the long-term cost of development of generation capacity and grids, which are needed to satisfy increasing energy needs, and (ii) the cost of public service obligations (social tariffs, urban-rural cross subsidies, rural electrification, and so on). However, the absence of safeguards in the exercise of governments’ regulatory powers has allowed some developed countries (Italy and France during the 1980s, for example) to define tariffs below costs when fuel prices increase rapidly. In many developing countries, it became a general practice in the 1970s to establish tariffs at a level systematically below costs, whatever the situation.

Governments use price controls to:

- Control inflation (a macroeconomic objective);
- Support EIIIs (competitiveness), and;
- Protect consumers (redistribution, social equity), particularly in a context of volatile international prices.

**1.2.2. Quantity Instruments**

Quantity instruments include measures such as quotas and command-and-control measures (including standards for the energy performance of buildings, processes, and appliances). In the absence of such quantity instruments, energy prices would be different, and often lower, at least for the energy products targeted by quantity control.

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26 For instance, the adjunction of end-of-pipe desulfurization units to power plants and renewables support.
27 The issue of subsidies is more thoroughly analyzed in chapter 4.
28 The fund is financed during a low-price period by revenues corresponding to the difference between the reference price of the smoothing formula and the international price.
Quantity instruments can be used to meet energy objectives such as:

- Energy independence and consumer protection through the control of imports, and;

- To develop new energy technologies. This can contribute to multiple objectives such as energy security and environmental protection.

### 1.2.3. Institutional Means

One way of achieving energy objectives is by changing the institutional landscape that underlies energy development, production, delivery and consumption. Such institutional change includes a multitude of different approaches such as nationalizing the power sector, privatizing energy sector companies and infrastructure, and changing the rules and regulations that underpin an electricity market.

Institutional means are used by governments:

- To mobilize capital resources and coordinate the development of energy industries and their infrastructure for the purposes of energy security, and;

- To promote national research and development in partnership with private firms and innovators.

This can be done for a multitude of purposes including energy independence, energy security and environmental protection. It is worth noting that energy policies have used most of the same economic instruments—price instruments, quantity instruments, or institutional means—that are also used by other sectors, such as agriculture, water and sanitation, railways, and the postal system. Eventually, all these instruments do participate—sometimes directly, sometimes very indirectly—in the formation of final energy prices.

### 1.3. Objectives Specific to the Energy Sector, and Corresponding Instruments

In this section, we examine how the instruments outlined above have been applied to achieve energy policy objectives. Tables 1.1a and 1.1b summarizes the findings of this section by overviewing the various objectives and corresponding instruments of a typical energy policy in the OECD countries.

#### 1.3.1. Energy Independence and Energy Security

Energy independence is an objective of most countries, particularly importers, for several reasons. First and foremost, such independence limits geopolitical risk. This is key as most energy exporters are in unstable, conflict-prone regions. Energy independence also protects these nations’ economies against the monopolistic market power of the Organization of the Petroleum Exporting Countries (OPEC), among others. In doing so it reduces investors’ and consumers’ exposure to volatile and high oil prices. It also mitigates macroeconomic effects on inflation, on the balance of payments, and eventually on economic growth. There are three primary ways to achieve energy independence using energy policy instruments.
Three Ways to Limit Energy Dependence: Storage, National Resource Development, and Import Limits

The objective of limiting dependence can be achieved through three primary strategies. The first is done by mandating that refiners and resellers store a certain amount of energy at all times, and developing strategic storage capacity for governmental agencies or oil companies with an obligation to serve the national interest. Such an arrangement can be financed by a small tax on oil products. This approach involves a combination of different instruments including taxation, government expenditure and direct regulation.

A second strategy is to help develop national production of existing energy resources. This can be performed with the aid of fiscal incentives such as indirect subsidies like tax breaks. An extension of this approach is to protect national production which is costlier than imports at international prices. A long-term approach to reducing dependence lies in deploying technologies independent of imported fossil fuels and improving energy efficiency in industries, buildings, and transportation. Examples of this include the promotion of nuclear technology by many countries during the 1970s and 1980s, and, more recently the subsidization of renewable energy sources for electricity (RES-E) in the power sector and biofuels in the transportation sector. These goals can be achieved through subsidies under different forms, and by standards and regulations. Such regulatory approaches include establishing a mandatory percentage of biofuels content in vehicle fuels, setting a mandatory percentage of RES-E in the power generation mix, and creating minimum energy-efficiency performance standards for processes and appliances. Thus, this strategy involves a combination of different instruments including regulations and subsidies.

A third way to limit imports is by imposing quotas or import tariffs. The US used a quota system during the 1950s-1971 to protect against the risk of cheap oil imports from newly exporting countries in the Middle East (Gordon 2011). The mandatory oil import program established by the Eisenhower administration set imports at a specific percentage of expected consumption. Quotas were initially allocated based on historical levels of imports per refinery. Imports to the west coast of the US were set at the difference between expected consumption and expected domestic production in the region. The program led to conflicts between consuming and producing states over the level of imports, and between potential importers over the quota of allocations. The massive rise in world oil prices in 1971 led to the end of this quota system (Gordon 2011: 78).

29 Governments can eventually consolidate their relations with oil- and gas-exporting countries by leveraging their public oil and gas companies and signing some special contracts at higher prices than the international price. This was done by France, Italy, and Spain with some Gulf countries, and Algeria and Libya, around 1980. The additional cost of these special contracts is to be reimbursed to national oil and gas companies by the public budget.
### TABLE 1.1a Typical Energy Policy Objectives and Instruments Used in High-Income Countries: Supply Independence and Security

<table>
<thead>
<tr>
<th>Energy Objectives</th>
<th>Goals and Programs</th>
<th>Explicit Subsidies from the Public Budget or Consumers</th>
<th>Tariffs, Regulations, Price Controls</th>
<th>Taxation</th>
<th>Quantity Instruments and Flexibility (Cap and Trade)</th>
<th>Other Instruments and Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy independence</td>
<td>Development of national resources</td>
<td>Support to national resources development: tax rebate</td>
<td>Import tariffs (envisaged in the US in the 1970s)</td>
<td>Import quotas (for example, US until the 1970s)</td>
<td>Creation of national oil and gas companies</td>
<td></td>
</tr>
<tr>
<td>Limitation of dependence on imports</td>
<td>Strategic storage</td>
<td>Subsidy to costly production (coal)</td>
<td>Tax for financing storage</td>
<td></td>
<td>Protection of home-based energy companies</td>
<td></td>
</tr>
<tr>
<td>Development of national energy sources and technologies</td>
<td>Nuclear programs (1960s, 1970s, 1980s)</td>
<td></td>
<td></td>
<td></td>
<td>Creation OF THE IEA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RD&amp;D program on RES, clean coal, etc. (1975-90)</td>
<td></td>
<td></td>
<td></td>
<td>Investment by regulated monopolies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RES deployment (1990 on)</td>
<td>Support to RES (direct subsidies for investment, production subsidy from a FIT paid by a levy)</td>
<td>Levy to pay the cost of RES-E support</td>
<td>Green obligation (renewable portfolio standards, renewable certificates and obligations, and so on)</td>
<td>National R&amp;D laboratories</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EE programs</td>
<td>Subsidy to EE investment besides standards/labels</td>
<td></td>
<td>Certificates, obligations</td>
<td>RD&amp;D funding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Standards on processes, buildings</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: EE = energy efficiency; FIT = feed-in-tariff; IEA = International Energy Agency; OECD = Organisation for Economic Co-operation and Development; RES = renewable energy sources; R&D = research and development; RD&D = research, development, and demonstration.

Source: Authors' compilation.
### TABLE 1.1b Typical Energy Policy Objectives and Instruments Used in High-Income Countries: Supply Reliability and Affordability

<table>
<thead>
<tr>
<th>Energy Objectives</th>
<th>Goals and Programs</th>
<th>Explicit Subsidies from the Public Budget or Consumers</th>
<th>Tariffs, Regulations, Price Controls</th>
<th>Taxation</th>
<th>Quantity Instruments and Flexibility (Cap and Trade)</th>
<th>Other Instruments and Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reliability of supply at reasonable cost</strong></td>
<td>Adequate production and generation capacity, in accordance with demand levels</td>
<td>After market liberalization, installation of a remuneration mechanism to ensure adequate capacity (security of supply)</td>
<td>Before liberalization, cost-reflective tariffs (cost plus regulation)</td>
<td></td>
<td></td>
<td>National and regional power companies</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Power market structure and regulations:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Before 1990, regulated public utility regime (investment; least-cost planning, cost-plus tariff)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>After liberalization, establishment of a market regulatory framework and institutions (transaction clearinghouses, etc.), long-term arrangements for capital-intensive investments</td>
</tr>
<tr>
<td><strong>Consumer access and protection, redistributive objectives</strong></td>
<td>Satisfaction of basic energy needs, universalization programs</td>
<td>Social tariffs and line tariffs in utility regimes (electricity, gas, LPG); tariffs below costs in developing countries</td>
<td></td>
<td></td>
<td></td>
<td>Mechanisms to smooth the prices of oil products</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>After liberalization: regulated residential tariffs in electric and gas markets and social, street lighting tariffs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>After liberalization: to regulate wholesale prices from heritage assets (Canadian provinces, France)</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: LPG = liquefied petroleum gas; OECD = Organisation for Economic Co-operation and Development.

Source: Authors’ compilation.
<table>
<thead>
<tr>
<th>Energy Objectives</th>
<th>Goals and Programs</th>
<th>Explicit Subsidies from the Public Budget or Consumers</th>
<th>Tariffs, Regulations, Price Controls</th>
<th>Taxation</th>
<th>Quantity Instruments and Flexibility (Cap and Trade)</th>
<th>Other Instruments and Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial</td>
<td></td>
<td>Before 1990, special contracts for EII (cross-subsidies)</td>
<td>Less taxation of oil and gas in industries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>competitiveness of EII</td>
<td></td>
<td>Exemption of RES-E levy for EII</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial and innovation policies</td>
<td></td>
<td>Subsidies for energy innovations (nuclear, RES, clean coal, and so on)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>National preferences for local manufacturers in firms' procurement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional and rural policies</td>
<td></td>
<td>National subsidy to costly coal mines</td>
<td>Cross-subsidies through the geographical equalization of regulated prices</td>
<td>Discounts for irrigation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Excise tax reliefs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macroeconomic objectives</td>
<td></td>
<td>Better balance of payments through import reduction</td>
<td>Same tools as for dependence control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fiscal objectives</td>
<td></td>
<td>Inflation control</td>
<td>Price control after oil price spikes</td>
<td>High excise duty tax on motor fuels</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Budget equilibrium</td>
<td>A formula to smooth prices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market promotion to improve efficiency</td>
<td></td>
<td></td>
<td></td>
<td>After 1990, shift to a market regime in electricity and gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Globalization (free trade)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: EII = energy-intensive industry; OECD = Organisation for Economic Co-operation and Development; RES = renewable energy sources; RES-E = renewable energy sources for electricity generation. Source: Authors’ compilation.
The tax-quota-subsidy “trilemma”

To control imports amid low international prices, net importing countries face a “trilemma”: should they (i) tax energy imports, (ii) limit and auction import quotas, or (iii) subsidize national production (Griffin and Steele 1980; Percebois 1985; Gordon 2011)?

Import Taxes versus Quotas

Both import taxes and quotas can be set to a theoretically optimal level for energy independence. The drawback of the tax system is that it encourages oil exporters to increase the international price by an amount equivalent to the tax, up to a level where the demand of imported oil would be the same as the one targeted by the independence policy. The result is that revenues end up in exporters’ coffers rather than those of the importing state. Thus, as a general heuristic, quotas will often be preferable to taxation.

Import Taxes versus National Production Subsidies

Rather than taxing or restricting imports, countries can instead subsidize the national production of energy. The macroeconomic consequences of the two instruments are not the same. In the case of the subsidy, the taxpayer supports the charge while the consumer continues to benefit from the low international price. There is a transfer from the taxpayer to the consumer.

In the case of a tax on oil imports, the consumer carries the burden of the independence policy. Consumption diminishes as well as the consumer’s economic surplus. This is to the benefit of national producers, who are then able to secure a larger share of the reduced market. This oil import tariff also offers revenues to the public budget and potentially allows the reduction of other taxes. Theory suggests that when the price elasticity of demand is low, the losses of consumers’ surplus are more important than the sum of the gain of surplus by national producers and the fiscal gains by taxpayers (Percebois 1985: 291).

Overall, each of these systems can work in practice, but have costs and benefits. Import taxes are a simple tool, but can be gamed by exporters. Production subsidies have the benefit of directly promoting longer-term energy independence, but to the cost of taxpayers. Ultimately the choice of instrument will largely depend on the national circumstances of the country in question.

Energy Security: Ensuring a Reliable and Affordable Supply

Energy security incorporates notions of both energy reliability and general affordability. It has both short-term and long-term dimensions. A short-term aspect could be maintaining grid reliability and managing peak demand, whilst a long-term issue may be ensuring adequate investment in future supply. Across the short and long term, a match between generation capacity (supply) and demand is needed.

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30 In theory, by referring to the collective preference for energy independence and to the supply function of local energies, one could determine the optimal rate of independence and thus the maximum acceptable cost for marginal local production. It is also theoretically possible to determine the corresponding total import quotas or the optimum import tax level to be applied to oil imports. This is determined by the difference between the international price and the cost of the marginal local producers.

31 After the countershock of oil prices in the mid-1980s, an import fee was envisaged in some OECD countries whose national oil production covered a large share of domestic needs. The goal was to protect local producers and encourage exploration, despite costs being higher than international oil prices.

32 The concept of price elasticity reflects how much a consumer will reduce (or increase) consumption when the price of the product consumed increases (respectively decreases) on one unit. The price elasticity is the tangent of the demand function of the current price.
Before the wave of liberalization in the 1980s and 1990s, the power sector’s objective of matching capacity to demand was achieved through two means: (i) the optimization-based planning of monopolistic utilities; (ii) tariff regulation based on the “cost plus” principle. Planning aims for the forecast of growth in demand whilst tariff regulation intends to ensure a reasonable capital cost, since no risk premium must be charged. Vertical integration and a service monopoly were supposed to suppress price and volume risks, and thus limit capital costs. The regulation of utilities by an energy ministry would then ensure affordable gas and electricity tariffs and geographical price equalization. This rested on the assumption that governments would prioritize the interests of consumers over vested social and economic interests, particularly Ells.

Since 1985, OECD countries have been harshly criticized on the inefficiencies of regulated monopolies, public ownership, and public regulation. These criticisms are anchored in the economic theory of public choice and supported by a new belief in the virtues of the market. Eventually, the criticisms led to the introduction of competition in the gas and electricity industries, both at the wholesale and retail levels. This was conducted to lower prices for consumers by improving productive efficiency and creating market pressure. This liberalization model has since been extended to emerging and developing economies, amid growing disenchantment with the poor performance of state-owned public utilities and their limited investment capacity. However, proponents of liberalization did not foresee the obstacles to attracting private sector finance for capital-intensive generation equipment at the scale needed to satisfy growing demand (see section 2.3).

1.3.2. Consumer Protection and Equity

**Consumer Protection through Price Controls**

Consumer protection is by nature a political objective which seeks to appease the consumer preferences for low and predictable prices. It also attempts to ensure that affordability is maintained in the context of volatile energy prices. This makes consumer protection especially important for energy importers.

After the first oil shock of the 1970s many countries implemented price controls on oil products to keep price levels under international prices. This was done to the detriment of oil companies revenues. In net importing countries such as the US, the idea was to also limit the rent capture achieved by national producers. The control on oil prices in the US established by the 1974 Energy Act relied on entitlements to internal low-priced oil (Gordon 2011: 79). Under this system, transfers among refiners smoothed out differences in supply sources. Refiners whose use of the lower-priced domestic production of crude oil was above average had to make payments that were transferred to those with below-average access to these low-priced resources. This exchange was intended to make the weighted average of domestic and imported crude oil prices the same for every refiner.

Direct energy price controls among western and southern European countries were suppressed during the 1980s leading to a new, less stringent price control practice. Meanwhile, some countries, mostly outside of the OECD, developed a price-smoothing formula to transparently control the effects of oil price hikes on motor fuel prices. In other countries price smoothing is conducted on the post-tax price, by “buffering” the excise duty to avoid reimbursing companies.
Ensuring Universal Access, and Other Redistributive Objectives in the Power Sector

Creating universal energy access often requires intervention to ensure that low income, and otherwise marginalized groups, have access to energy at a relatively low cost. This is often not achieved simply by market operation and needs instruments targeted towards low income groups and redistribution.

Before the liberalization seen in the 1990s, regulated electricity and gas tariffs aimed to improve the access of small, low-income customers to electricity. In some cases, this was simply a “lifeline” connection to meet only basic needs. This implied cross-subsidies in various residential consumer segments.

In the power sector, some countries decided to maintain some regulated tariffs, including the so-called last-resort tariff, to protect residential consumers against the price volatility observed in short-term markets.

Initially in some countries and regions with important hydroelectric or nuclear assets (France, Québec), governments decided to regulate the prices of electricity produced in these ways and align them with their historic cost value. For instance, in France the historic operator was obliged to sign a special long-term contract with a consortium of major electricity-intensive industrial consumers. The contract enshrined a fixed price aligned with the nuclear plants’ historical costs, which were much lower than prices on the newly implemented market.

In developing countries, redistributive objectives keep pace with productive and allocative efficiency. In most countries, including some developed ones, the geographical expansion of electrical service to ensure universal access remains based on direct subsidies. Subsidies are used to finance investment in distribution lines, and frequently on implicit cross-subsidies for the geographic equalization of tariffs, especially between densely populated urban areas and sparsely populated rural areas. Such cross-subsidization sometimes persists decades after universal access is achieved to finance capacity upgrades and prevent the degradation of access (voltage drops) as rural demand increases alongside economic welfare and development in these areas. This is even the case for developed countries such as France.

The costs of underpricing electricity tariffs for households and EIIs have been considerable, and not balanced by the compensatory charging of higher rates for other consumer groups. Such underpricing over long periods undermines the ability of public utilities to finance their investments. This forces them to rely on public debt, making them directly dependent on macroeconomic and fiscal government policies. Reforms of the 1990s sought to correct these underpricing practices since they created a major barrier to private investment. Yet, such practices continue to some degree in many countries.

1.4. Objectives that Reach Beyond the Energy Sector, and Associated Instruments

1.4.1. Regional Development

Rural-urban equity has been a traditional objective of national development policies. This is reflected in the electricity and gas industries, first within the concession area of utilities, and later at the national scale, as electricity utilities were nationalized. In many cases, attempts to keep prices equal across rural and urban areas were a natural outgrowth of previous practices of financing rural electrification. Regional development policies have also promoted relatively equal prices for oil products across regions, states, and provinces, despite differences in the cost of transport, storage, and delivery. Rural-urban equity has also been pursued through reliefs on excise taxes on oil products, benefitting remote regions.
This focus on rural-urban equity is often complemented by a desire to promote development in specific regions or localities. For example, one region may have fallen behind others in terms of socioeconomic development and thus needs to engage in new sectors to replace lost jobs, or to improve international competitiveness. Such practices are evident in Europe were the direct subsidization of expensive coal production in some members aim to maintain industrial activities in formerly active coal and steel regions (see Chapter 4 for an in-depth analysis of this case).

1.4.2. Industrial Development

In countries endowed with energy resources the development of industry activity near these resources is a key vector of economic growth. Energy production can create export revenue opportunities, generate local economic activity and create demand for upstream manufacturing. The goal of promoting industrial development is particularly pressing in emerging countries endowed with oil resources. We observe this priority in Brazil, where the public oil company Petrobras plays a key role in the development of the country’s capital goods, shipbuilding (via offshore platforms), and construction industries.

Until the 1990s governments in the OECD countries were keen to consolidate national manufacturers of equipment procured by the energy sector. This was pursued by imposing requirements that electricity and gas utilities purchase a quota of national content. Typical requirements involved hydro turbines, electromechanical equipment, nuclear reactors, liquefied natural gas (LNG) shipments, and offshore oil techniques. This is a form of subsidization where foreign technologies might be cheaper.

Attempts to consolidate national manufacturers of equipment continue today in the promotion of renewable energy. This is particularly true of solar and wind in Germany and Spain. For the first-mover countries, RES-E subsidy policies aim to boost the development of national innovators. Globalization is challenging the achievement of that objective, a dilemma evident in the race to promote photovoltaic (PV) technologies. The entry of Chinese producers with numerous comparable economic advantages into the international market has bankrupted some German, Spanish, and US solar firms.

1.4.3. Macroeconomic and Fiscal Objectives

Energy policy can help achieve several general macroeconomic and fiscal objectives such as controlling inflation, maintaining a balance of payments equilibrium and creating a steady source of government revenue:

Inflation control. Energy price controls were used in the OECD countries to contain inflation. Their use decreased around 1980, at the start of the wave of liberalization. Controls remain important in developing countries facing high inflation rates and importers facing oil price volatility.

Balance-of-payment equilibrium. For importers, the reduction of energy imports can achieve a number of significant macroeconomic goals. This include reducing the “energy bill,” improving the balance-of-payments deficit and reducing the vulnerability of the economy to oil price shocks. This has can be done in ways which also reduce emissions, such as the promotion of energy efficiency, RES-E, biofuels, and nuclear power. For exporters in search of currency to import goods, or to preserve their balance of payments, oil production taxation and royalties have been used to encourage further exploration and production.

33 This is in tension with the international rules of the World Trade Organisation (WTO).
34 In the 1990s and 2000s, research and development (R&D) and economies of scale allowed the accelerated reduction of the production costs of solar photovoltaic (PV) technology, leading to a race in which countries tried to stay ahead of others in reducing their production cost and thus develop and keep their national PV industry globally competitive.
Revenue source. Governments often use excise duty taxes on motor fuels as a source of revenue. An advantage of such taxes is that the price elasticity of demand is low even as the tax works surprisingly well as an incentive for consumers to choose efficient motor cars. Proceeds from motor fuel taxation amount to around 8–10 percent of the budgetary resources in Western European economies.

1.4.4. Environment Protection

In recent decades, environmental protection has emerged as an energy policy objective. In the first phase of the high-income countries’ environmental policies (from the end of the 1960s until 1980), the policies were based on standards, fines, subsidies. Market-based instruments, namely tax and cap-and-trade systems, have become increasingly popular since 1980. Environmental taxation has generally been introduced under the conditions of budget neutrality. For instance, in Germany the ecological tax reform introduced in 1999 had two objectives: the reduction of GHG emissions and the reduction of statutory pension contributions to reduce labor costs and to increase employment (Beuemann and Santarius 2006). In other countries, such as Sweden, environmental taxation coincided with fiscal reform, especially to lower corporate and labor taxes (Hammar and Akerfeldt 2011).

An understanding of energy policy instruments demonstrates that new environmental objectives and instruments such as carbon pricing are not implemented into a blank slate. There are already a plethora of energy instruments and objectives that influence economic behavior and consumption in the energy sector. These all need to be considered when implementing new objectives and instruments such as emissions targets and carbon pricing. Box 1.1 provides a summary of the different energy instruments and objective covered in this chapter.

**BOX 1.1 Chapter 1 Summary**

This chapters contains some central theoretical ideas that provide the basis for the analysis in further chapters:

- Energy policy instruments are used to achieve energy policy objectives. These include pricing, quantity and institutional instruments.

- Energy policy aims to achieve several energy policy objectives including energy independence, energy security, and consumer protection and equity. Across most countries these objectives exist in a hierarchy in which basic objectives such as energy security must be met before others are pursued.

- Other objectives exist that go beyond the energy sector. These include environmental protection, regional and industrial development, as well as macroeconomic and fiscal benefits.

- These objectives are attainable through applying a collection of instruments. However most of these have trade-offs, often with other the operation of other instruments, or the achievement of other objectives. Understanding these trade-offs is key, and is the focus of coming chapters.

- Numerous objectives and instruments already govern economic behavior in the energy sector. Carbon pricing is not introduced into a void and needs to be aware of pre-existing energy policies.

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35 Subsidies were used for a variety of purposes including for river protection, land conservation, and agriculture.
36 Also, referred to as Emissions Trading Systems (ETSs) when dealing with air pollutants.


References


2. Energy Policy Objectives and Instruments: A Comparison Across the Climate-Energy Typology

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2.3.1 The Historical Evolution of Consumer Protection in the OECD Power Sectors

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The Single-Buyer Model

The State-Owned Public Utility

2.3.3 Power Sector Models and the Climate-Energy Typology
Energy policies are not frozen in time. Technologies evolve, resources change, and societies express new concerns and priorities. Socioeconomic disparities—and resulting differences in consumer demands—prompt divergent energy needs. Because interactions between energy and carbon policies are, for the most part, found in the high-income countries, analyzing policy decisions and outcomes in these countries may be instructive for developing countries. It must be noted, however, that any lessons learned may not apply. Policy makers must always focus on the local context and its unique needs.

The chapter focuses first on energy policies in the high-income countries, which are increasingly associated with environmental and climate policies and a move away from energy-pricing instruments. It then examines the trajectory in developing countries whose energy policies are centered on economic and social development—in particular, the satisfaction of basic needs at affordable prices. In these countries, energy policies are still focused on energy pricing, and are not yet really concerned with environmental protection. In particular, we will examine the power sector and how organizational and regulatory reforms have differed across countries of different income levels. The effects of carbon-pricing can differ depending on the power sector models in effect.

2.1. The Evolution of Energy Policies in High-Income Countries

Energy policies in high-income countries have gone through three distinct phases:

- First, a period of significant government intervention focused on economic and social development, energy independence, and price controls. This lasted through the 1970s (1945–80);

- The second occurred during the 1980s and 1990s and was dominated by the privatization and liberalization of the gas and electricity sectors to increase competition;

- The third, is a resurgence of government involvement to promote clean energies and energy efficiency, but with a reliance on market-based instruments (Finon 1994; McGowan 1996). This began in the 1990s and continues today. In each phase, policy instruments, including energy pricing, were used differently, as illustrated in Table 2.1.

Note that this analysis and the respective phases is based on a necessary generalization. There is a great deal of differentiation between the approaches of different high-income countries. While there are points of nuance which we will highlight, the general patterns we have identified are relatively accurate.
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>Priorities</td>
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<td>Priorities</td>
<td>Instruments</td>
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<td>Energy independence and security</td>
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<td>Subsidies</td>
<td>+/-</td>
<td>Subsidies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Import quotas</td>
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<td></td>
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<tr>
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<td>+</td>
<td>Utility regime</td>
<td>0</td>
<td>Market regime</td>
</tr>
<tr>
<td>Competitiveness</td>
<td>+</td>
<td>Tax rebate</td>
<td>++</td>
<td>Market regime</td>
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<td></td>
<td></td>
<td>Underpricing</td>
<td></td>
<td>Rebate for industries</td>
</tr>
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<td>Macroeconomic objectives (control of inflation, balance of payments)</td>
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<td>Subsidies (see energy independence)</td>
<td>0</td>
<td>Price control</td>
</tr>
<tr>
<td>Fiscal objectives</td>
<td>+</td>
<td>High excise duty on motor fuels in Europe</td>
<td>+</td>
<td>Effective carbon rates, including high excise duty on motor fuels.</td>
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<td>Consumer protection and distributional objectives</td>
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<td>Cross-subsidies</td>
<td>+</td>
<td>Residential prices regulation</td>
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<td></td>
<td></td>
<td>Oil price smoothing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural and regional policies</td>
<td>+</td>
<td>Cross-subsidies</td>
<td>+</td>
<td>Cross-subsidies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(geographical equalization)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial objectives</td>
<td>++</td>
<td>Implicit subsidies by public procurement</td>
<td>0/+</td>
<td>RD and deployment subsidies (RES, CCS etc.)</td>
</tr>
<tr>
<td>Environmental protection</td>
<td>0</td>
<td>Standards</td>
<td>+</td>
<td>Taxation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cap-and-trade standards</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Regulatory instruments e.g. renewable energy targets.</td>
</tr>
</tbody>
</table>

Note: R&D = research and development; RES = renewable energy source. The symbols ++, +, 0, and – indicate the level of importance of each policy objective during each phase of the energy policy, with 0 being least important.

Source: Authors’ compilation.
2.1.1. A Period of Public Intervention, 1945–80

The electricity and gas sectors have essentially been monopolies since the end of the 19th century. Their monopoly power was maintained by charging regulated tariffs and had public service obligations. Gas and electricity were natural monopolies. Accordingly, governments commissioned public utilities to extend grids for energy access and invest in additional generation capacities.

After the end of World War II, energy policies in the OECD promoted national energy production. They prioritized investment in large-scale energy infrastructure and high-risk oil and gas field development. The objective was to control inflation and to protect consumers through price controls and tariff regulation. In several countries, energy policies were conducted through (i) nationally owned firms and (ii) indicative planning, by which the government seeks to match future energy production, imports and transportation capacities against consumer demand. This was seen in European countries such as France and the UK. Public energy companies working with national manufacturers were open to innovative policies that focused on new technologies. This included, electromechanical technologies, nuclear plants, new oil and gas exploration, and novel transport technologies. Innovation coupled with nationalization allowed for the development of efficient electricity systems. The resulting rapid economic growth led to a doubling of the power demand every seven to ten years (Chick 2007). Natural gas and liquefied natural gas (LNG) infrastructure was developed in Europe and Japan to transport and distribute gas imports.

The US was an exception. Compared to Europe it had more private firms involved in the development of oil and gas production and infrastructure. Consequently, US regulation of private utilities was more robust, which ensured adequate investment and reasonable tariffs in the gas and electricity sectors.

To manage its oil dependence, the US government regulated oil imports using a system of import quotas, which were auctioned. In some countries (the UK, France, Italy, and Belgium, for example), governments controlled their oil-import dependence by promoting national companies. In others, such as France, governments imposed a trading monopoly, which set aside shares of crude oil and oil product imports for importing companies.

Countries such as the UK, Netherlands, Norway, Australia, and Canada also encouraged the development of newly discovered resources. They did so by establishing favorable fiscal regimes and embarking on joint ventures with foreign oil companies. The development of national resources was viewed as economic development, even in economics that were already quite diversified outside its primary sectors (Mitchell 1999). In countries such as the Netherlands and Norway, exports were managed by a public firm, acting on behalf of the government, to control the capture and allocation of oil and gas rents. In some cases, such as in the US, exports were either forbidden or subject to special government authorization.

In the 1960s and the 1970s, fossil fuel importers, such as France, established economic development and competitiveness as policy objectives. Successive administrations encouraged reliance on cheaper fuel oils over coal for electricity generation, industrial use, and domestic heating, and lowered taxes on heating and heavy fuel oils. In many countries, price controls were enforced from the first oil shock of 1973 until the mid-1980s (and until the 1990s, in some countries, for motor fuels). Energy price controls kept inflation in check to protect consumers and support energy-intensive industries (EIs). But eventually many European electricity and gas companies ran into deficit.

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37 A natural monopoly is defined as the situation of an industry where the lowest production cost is achieved when all the production (or delivery) of a particular good or service is concentrated in a single firm. In such a case, even a perfect competition between several firms would necessarily lead to higher production (or delivery) costs.
At the same time, motor fuel excise taxes become a major source of income in European countries. Gradual increases made the taxation levels acceptable as long as some low-productivity sectors, such as fishery and agriculture, were given tax relief.

OECD governments made energy security a priority in response to the first global oil crisis in 1973. The crisis, coupled with the emerging power of OPEC, motivated energy importers within the OECD create the IEA. The agency was designed as an institution to help cooperatively manage energy security and their strategic oil storage. After the collapse of oil prices in 1986, governments used a mix of taxes and protectionist measures to maintain fuel prices. These efforts were often used to support existing or emerging energy alternatives and the first energy-efficiency measures, which, in turn, also benefited from subsidies.

In summary, this interventionist approach was designed as a hedge against energy vulnerability, particularly for importers. It was dominant for almost four decades after World War II. A changing global context saw the decline of this approach, and the rise of the second phase of energy policy in OECD: privatization and liberalization.

2.1.2. Privatization and Market Liberalization in the 1980s and 1990s

The 1980s saw a decline in interventionism in the OECD countries and rise of privatization. In 1986 there was a sharp decrease of global oil prices due to the erosion of the OPEC’s market power. Energy security became less of a priority, and the goal of increasing the efficiency of the power sector entered the political agenda. Free market advocates in the OECD, and their criticism of the regulation and national ownership of energy companies, became increasingly prominent. The critics instead pushed for the privatization and liberalization of the power sector. These ideas were spread globally through international organizations such as the OECD, European Commission, IEA, World Bank, and International Monetary Fund (IMF). In the EU, the achievement of the Single Market was an opportunity to challenge the public utility monopolies, which were viewed as barriers to exchanges between countries. The advocacy of these international institutions eventually led to the creation of policies in which the government’s role was reduced.38 This was enabled by technological development. Improved information technologies in the 1980s and 1990s enabled physical trading between energy generators, traders, retail suppliers, and consumers. Power sector activities, once vertically integrated, were unbundled, and only transmission and distribution (T&D) grids remained legal monopolies. As privatization and competition took root, governments surrendered control of energy firms.

The OECD governments also removed controls on the rent derived from the exploitation of hydrocarbon resources. Coal subsidies had gradually decreased in the EU countries beginning in the 1990s. The unbundling of energy suppliers and transmission networks, along with the advent of consumer choice39, enabled competition in the electricity and gas industries. Control of long-term energy dependency was no longer a sufficient priority to maintain public research, development, and demonstration funding at high levels. The low price of oil led to energy independence dropping priority as an objective. In response, support for both energy efficiency and research development and demonstration was decreased.

38 Finon (1994) quotes Nigel Lawson, the British minister in charge of energy in 1982: “the task of a government is (...) to set a framework, which will ensure that the market operates in the energy sector with a minimum of distortion and the energy is produced and consumed efficiently. The free market approach could achieve security of supply more cheaply than voluntary action, which carried too high an opportunity cost relative to other desirable economic goals.”
39 The ability of consumers to freely choose among suppliers.
Energy price controls and tariff regulations ceased to be the major instruments of energy policy during his period. Instead, price controls on most fuels were generally dropped. This shift was more pronounced in countries and regions that had rapidly liberalized their gas and electricity sectors, and where regulated tariffs focused increasingly on residential consumers.

The new regulatory objectives were the promotion of competition wherever possible, and the protection of the consumer whenever necessary. Although the level of consumer protection continued to vary between countries, the general belief was that market competition and private ownership encouraged the highest efficiency and the greatest benefit to consumers. Subsectors that are natural monopolies, such as transmission and distribution, established price-cap regulation and service quality norms to encourage grid companies to improve their efficiency. At the retail level, regulated tariffs for small consumers remained. Residual public service obligations, such as social tariffs, and service quality norms were placed under the scrutiny of regulators.

Power sector privatization and liberalization were the product of changing economic circumstances and theoretical beliefs. The next change in OECD energy policy was driven not by economic ideas or conditions, but by environmental ones.

2.1.3. 2000 onwards: A Focus on Environmental and Climate Protection

Recent increases in government intervention suggests a new understanding among high and middle-income countries of the need for environmental protection. Increasing evidence of environmental degradation has played a role in driving government action. Increasing scientific concern of acid rain and ozone depletion in the 1980s and climate change in the 1990s demonstrated the market failures of modern industries. This spurred some governments to internalize the externalities of energy production (Anderson 1994). The current style of intervention differs from the earlier, postwar era methods. Interventions increasingly focus on market-oriented instruments, such as pricing tools (Finon 1994). This shift reflects the same predominant belief in the market that underpinned the phase of privatization. The market, not government control, is seen to be the most efficiency and cost-effective medium for achieving environmental goals. The preference for market-based instruments can be seen in the adoption cap-and-trade instruments for controlling sulfur dioxide (SO₂) and nitrogen oxide (NOx) emissions in the electricity and refinery sectors in the US, Australia, and New Zealand.

European climate policies launched after 1990 initially relied on direct carbon-pricing instruments, such as carbon taxation. In the 2000s, a carbon dioxide (CO₂) cap and trade was added. This was partly inspired by the experiences of successful SO2 cap and trade system used in the US to address acid rain. Carbon taxes were first discussed in individual European countries sometime around 1990, but the issue was addressed at the EU level for the first time in 1995. There were some positive outcomes including carbon taxes in Finland, 1990; Sweden and Norway in 1991; Germany under the form of an ecotax in 1999; the UK in 2003; Switzerland and British Columbia in 2008. But there were also political failures: France failed to pass a carbon tax in 1990, 1999, and again in 2013; the EU failed to pass a similar tax in 1995; the US Clinton administration was unable to pass a tax related to fuels’ energy content (the BTU tax) in 1993; and more recently in 2014 a carbon pricing
system was abolished in Australia. These attempts have been opposed because they will distort international competitiveness, have a negative impact on households, and increase social inequalities (Ekins 1999).

Carbon policy objectives have also justified government intervention in the form of increasing support for clean technologies. Instruments such as tax credits, production subsidies via feed-in-tariffs (FiTs), and/or renewable obligation certificates have been used to promote biofuels, RES-E and combined heat and power (CHP) units. A number of environmental and climate policies rely on quantity instruments to mitigate effluent discharges and/or atmospheric emissions. These incentivize the development of clean energy technologies without directly or explicitly influencing energy prices. The electricity suppliers can then choose to allocate the corresponding cost across different market segments in a nontransparent way. Because they mitigate emissions without influencing energy prices, these nonprice regulations often attract greater political support.

Along with direct carbon pricing governments have also pursued climate change objectives through policies that often capitalize on synergies between energy and climate policies. In the EU, positioning climate objectives as a top priority has led to greater support for energy policies that were originally designed to reduce energy imports, and conserve exhaustible resources, such as energy efficiency measures and renewable energy targets. Some of these policies are ‘no regrets’ measures which result in a net economic benefit, regardless of their mitigation potential. These measures have been paired with carbon pricing to form a more complete policy package. This has occurred in both at the state level through countries such as New Zealand and the EU, and sub-nationally in jurisdictions such as California. Such policies have also become central emissions reductions tools in countries which lack carbon pricing, such as the US.

The three phases of energy policy in OECD countries have been shaped by forces such as theoretical beliefs, environmental pressures and economic circumstances. The same factors have also guided energy policy in developing countries. Indeed, these countries also experienced phases of interventionism and liberalization. But important differences in socioeconomic status and development priorities has led to some divergences in energy objectives.

2.2. An Overview of Energy Policies in Developing Countries

The differing energy objectives in developed and developing countries, particularly in terms of environmental protection, can be understood by considering Frei’s (2004, 2011) historic hierarchy of energy priorities mentioned in Chapter 1. As noted, it is not a normative hierarchy, but “history tells us that going against it may lead to policies beyond political feasibility.” These objectives are prioritized in a logical sequence and are not interchangeable. More basic needs must be satisfied (energy access and reliability) before other objectives can be addressed. Alternatively, other objectives must be achieved in a way that helps achieve these basic needs.

2.2.1. Policy Objectives in Developing and Developed Countries: A Comparison

In developing countries, the paramount objective of energy policies is economic and social development (Madlener 2009). The overriding priority is still the satisfaction of basic needs through energy security, even in several emerging countries, such as India, Indonesia, and the Philippines. Many, if not all conventional energy policy objectives such as consumer protection and energy independence derive from these higher-level objectives. As demonstrated in Table 2.2, this is the central difference in the energy policy objectives

42 For instance, in the United States, the U.S. Energy Policy Act of 2005, reinforced by the subsequent Energy Act of 2007, provided subsidies to produce grain-based ethanol, complemented by a mandate of biofuel share in gasoline composition. In parallel it established a subsidization scheme for production using renewable energy sources for electricity (RES-E), based on tax credit for renewables and a system of loan guarantees for large-sized low-carbon projects (solar, carbon capture and storage [CCS], new nuclear).
of developed and developing countries. However, Table 2.2 is notional and important variations exist in both groups. Both emerging countries such as China, Brazil, and Costa Rica as well as low income economies such as Ethiopia and the Gambia have comparatively strong mitigation policies (Climate Action Tracker, 2017). Similarly, some OECD countries have relatively weak emissions reductions policies and appear to allocate far less importance to environment and climate objectives.

### Table 2.2 A Comparison of Energy Policy Objectives in Developing Countries and OECD Countries

<table>
<thead>
<tr>
<th>Developing Countries</th>
<th>Priorities</th>
<th>OECD Countries since 1995</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic development</td>
<td>+++</td>
<td>Macroeconomic objectives</td>
<td>0/+</td>
</tr>
<tr>
<td>Macroeconomic objectives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation, balance of payments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability of supply</td>
<td>+++</td>
<td>Adequate power capacity and reasonable price, market-based competition</td>
<td>+</td>
</tr>
<tr>
<td>Price affordability</td>
<td>+++</td>
<td>Consumer protection and redistributive objectives</td>
<td>+</td>
</tr>
<tr>
<td>Redistributive objectives</td>
<td>+++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural and regional policies</td>
<td>++</td>
<td>Rural and regional policies</td>
<td>+</td>
</tr>
<tr>
<td>Industrial objectives</td>
<td>++</td>
<td>Industrial objectives</td>
<td>+</td>
</tr>
<tr>
<td>Energy independence by development of national resources</td>
<td>++</td>
<td>Energy independence, security of supply</td>
<td>+</td>
</tr>
<tr>
<td>Environmental and climate protection</td>
<td>+</td>
<td>Environmental and climate protection</td>
<td>++</td>
</tr>
</tbody>
</table>

Note: OECD = Organisation for Economic Co-operation and Development. The symbols ++++, ++, +, and 0/+ indicate the level of importance of each policy objective in the two types of countries, with 0/+ being least important.

Source: Authors’ compilation.

Development indicators help to demonstrate the critical challenges that low and middle-income countries face (see Table 2.3). Many still live in global poverty despite global levels declining significantly since the 1990s. In 2010 1.2 billion people still lived on less than $1.25 per day: 400 million in India, 400 million in Sub-Saharan Africa, and 230 million in China. In India, 25 percent of the population lacks access to electricity. In some Sub-Saharan African countries, the rate is as high as 75 percent. A major symptom of poverty is the inability to satisfy basic needs. Worldwide, 840 million people suffer from hunger, 2.5 billion have no sanitation, and 863 million live in urban slums. Expanding access to modern energy is therefore among the highest policy priorities. Once basic access is achieved, ensuring that the cost is affordable continues to be a shared policy objective. In very poor countries, energy products for basic needs are generally underpriced and subsidized by the government, or are cross-subsidized by wealthier consumers of the same or another energy or fuel. For example, in Brazil, for many years the price of liquefied petroleum gas (LPG) was cross-subsidized by a tax on motor fuel.
Table 2.3 Critical Development Indicators in Emerging and Less Developed Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>GDP per Capita (PPP$ 1,000)</th>
<th>Per Capita Emission (tCO2)</th>
<th>Population below $1.25/day (%)</th>
<th>Rate of Electrification (% total)</th>
<th>Slum Population (as % Urban)</th>
<th>% Access to Sanitation Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>0.8</td>
<td>7.6</td>
<td>2.1</td>
<td>5.3</td>
<td>11.8</td>
<td>99.8</td>
</tr>
<tr>
<td>Brazil</td>
<td>5.2</td>
<td>11.2</td>
<td>1.2</td>
<td>1.9</td>
<td>6.1</td>
<td>99.3</td>
</tr>
<tr>
<td>South Africa</td>
<td>5.8</td>
<td>10.5</td>
<td>7.0</td>
<td>7.4</td>
<td>13.8</td>
<td>84.7</td>
</tr>
<tr>
<td>India</td>
<td>0.9</td>
<td>3.5</td>
<td>0.6</td>
<td>1.4</td>
<td>32.5</td>
<td>75.3</td>
</tr>
<tr>
<td>Indonesia</td>
<td>2.8</td>
<td>7.9</td>
<td>0.9</td>
<td>2.0</td>
<td>16.2</td>
<td>80</td>
</tr>
<tr>
<td>Cameroon</td>
<td>1.5</td>
<td>2.3</td>
<td>0.2</td>
<td>0.3</td>
<td>39.9</td>
<td>48.7</td>
</tr>
<tr>
<td>Mali</td>
<td>0.7</td>
<td>1.6</td>
<td>0.04</td>
<td>0.04</td>
<td>50.4</td>
<td>72.9</td>
</tr>
<tr>
<td>Benin</td>
<td>0.8</td>
<td>1.6</td>
<td>0.1</td>
<td>0.5</td>
<td>36.2</td>
<td>24.8</td>
</tr>
</tbody>
</table>

Note: GDP = gross domestic product; PPP = purchasing power parity; tCO2 = metric tons of carbon dioxide.
Source: Mags.un.org database.

The emphasis on meeting basic needs through ensuring supply and extending energy access has led to a common set of instruments being used across most developing countries. These instruments and their corresponding objectives are displayed below in Table 2.4. The use of these instruments has followed a similar pattern of nationalization and privatization that OECD countries experienced, but with important differences.

Table 2.4 Instruments of Energy Policies in Emerging and Developing Countries

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Degree of Priority</th>
<th>Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic development</td>
<td>++</td>
<td>Protection of the investments required to match rapid demand growth</td>
</tr>
<tr>
<td>Macroeconomic objectives:</td>
<td></td>
<td>Financing by public banks</td>
</tr>
<tr>
<td>Inflation, balance of payments</td>
<td></td>
<td>Price control to protect against crude oil price change</td>
</tr>
<tr>
<td>Reliability of power supply and reasonable prices</td>
<td>++</td>
<td>Reform of utility regime and public ownership in the 1990s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(attribution of foreign and private investors)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Toward cost-reflective tariffs</td>
</tr>
<tr>
<td>Energy independence by development of national</td>
<td>++</td>
<td>Central role of national companies</td>
</tr>
<tr>
<td>resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Related macroeconomic objectives:</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>limitation of import expenses, export revenues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redistributive objectives</td>
<td>++</td>
<td>Subsidized prices of energy for basic needs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Administrative control of oil products price</td>
</tr>
<tr>
<td>Rural and regional policies</td>
<td>++</td>
<td>Cross-subsidies (geographical equalization of tariffs)</td>
</tr>
<tr>
<td>Industrial objectives</td>
<td>++</td>
<td>Price below international prices in oil- and gas-producing countries and net importers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsidized electricity prices</td>
</tr>
<tr>
<td>Environmental and climate protection</td>
<td>0</td>
<td>Reluctance to adopt energy and carbon taxation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Promotion of renewables (biofuels, RES-E) in some emerging countries</td>
</tr>
</tbody>
</table>

Note: RES-E = renewable energy sources for electricity. The symbols ++, +, and 0 indicate the level of importance of each policy objective in the two types of countries, with 0 being least important.
Source: Authors’ compilation.
For decades, strong and coordinated public policy actions were the primary means to pursue the goals of supply security and expansion of energy access. Since these undertakings had to be funded by the public budget, it made them unsustainable in the long run. By the end of the 1980s, low tariffs, an increasing deficit, a lack of financing investment, and several decades of poor management had rendered this model ineffective, which led to a wave of privatization and market reforms in the 1990s. However, the market liberalization that was already taking hold in the OECD countries had to be adapted to the weak institutional environments of these developing economies, especially the least-developed countries (LDCs), which were characterized by weak regulation by public authorities and low rates of private investment.

Despite some partial successes of market-oriented reforms in the 1990s, public control remains dominant in the energy sector in many developing countries. Traditional energy price controls continue to be a policy tool and have not significantly evolved. Electricity tariffs are frequently kept below the average costs, and in some countries, domestic oil and natural gas prices are subsidized because they are set at levels below their local production costs.

Environmental protection in general, and the mitigation of climate change in particular, have not yet gained significant political legitimacy within the energy sector in most developing countries. Very recently, in anticipation of the 2015 Paris Climate Conference, emerging and developing countries made voluntary commitments to control the growth of their greenhouse gas (GHG) emissions, either in terms of carbon intensity or of absolute emissions. China adopted carbon intensity targets, and in 2015 committed to peak its emissions by 2030. It also started developing some regional, pilot cap-and-trade programs. Mexico and South Africa announced GHG emissions reduction targets for 2020 and 2030 and adopted a modest carbon tax. However, these initiatives are not coordinated with energy policies. China has adopted separate energy targets that overlap with carbon emissions intensity targets, and are driven in large part by conventional policy considerations of energy security and independence, and by local environmental considerations (air pollution). Brazil, probably the only emerging economy to significantly reduce its absolute GHG emissions (by 50 percent between 2004 and 2015), was able to achieve these cuts by reducing deforestation, not by reducing GHG emissions.

Therefore, despite recent commitments to reduce nationwide emissions, the hierarchy of energy policy objectives in developing countries, especially the least advanced ones, is still almost the inverse of the hierarchy observed in developed countries—particularly when it comes to the role of governing energy industries and climate change considerations. However, it is worth noting that the present forms of public intervention in developing countries are similar to those observed in the OECD countries during their phase of rapid economic and social development until the mid-1970s. Therefore, considering the new post-Paris context and the commitment to implementing NDCs, one can thus expect that the objective of mitigating CO2 emissions will also soon climb-up the ladder of energy policy priorities in developing countries.

2.2.2. 1950s–1980s: A Period of Government Intervention,

In the 1950s and 1960s economic and institutional barriers limited investment in capital-intensive energy equipment and infrastructure. Consequently, energy sectors in developing countries were nationalized during this time. The move was recommended by international donors based on the experience of public companies in Europe and Canada. Such nationalization aimed to finance and operate the national electricity systems. Major funding was necessary to make commercial energy affordable in medium and small cities, rural areas, and burgeoning suburban slums. Government planning and public utility initiatives relied on significant public financing. There was a limited role for the private sector in this new expansion and inclusive development phase. This approach had successes early on, but by the end of the 1980s had become unsustainable. Public companies were no longer able to mobilize financial resources to invest in production, transmission
infrastructure, and distribution networks. In many cases, even basic maintenance was compromised, and technical capacity began to deteriorate. This led to frequent outages and inhibited economic development. Ultimately it undermined the original objectives of promoting economic development and ensuring energy security.

2.2.3. Liberalization and Privatization in the 1990s

The problems of nationalization made developing countries receptive to the wave of liberalization and privatization that had taken hold in OECD countries. These markets reforms were promoted by the World Bank and the IMF as “structural adjustment” and “sectorial reform.” Under this new model, classic energy policy objectives and traditional policy instruments were subordinated to the drivers of economic growth.

The privatization and fragmentation of public utilities, along with the arrival of foreign energy companies, helped attract new financing. Fresh funding was found for power plants via power purchase agreements (PPAs), oil and gas fields, and even coal mines (in the case of Colombia and Indonesia). But transposing the free-market model from mature OECD energy industries to the still-expanding power sectors of developing countries was not enough to attract sufficient investment to meet the growing demand of urban and industrial centers and rural areas. Most of these countries were considered unsafe for international investors, and national private sector investors were still limited. Both developed and developing countries have experienced liberalization of the power sector, but energy market reforms have differed significantly. These differences are due to developing economies needing to make major investments respond to the growth in demand and lacking the institutional capacity to enforce the regulations needed to attract private investors. The different trajectories are important to understand since they determine the way carbon pricing could affect energy price settings. This has implications for both energy investors and consumers, and ultimately for energy emissions.

2.2.4. Powerful Incentives to Maintain Price Controls

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2.2.5. Powerful Incentives to Maintain Price Controls

Since 2003, oil price hikes have led exporter and importer emerging and developing countries to retain their price controls. (Kojima 2012). They have introduced a range of policies to keep domestic prices low including direct price regulation, price ceilings, universal or targeted price subsidies, freight cost equalization, and export restrictions. Alternatively, they have established a fund associated with a price-smoothing formula. When governments keep domestic prices below market levels for any fuel, they usually finance the price gaps by paying the difference directly or indirectly to oil refinery companies, lowering corporate taxes, or reducing excise duties during the spikes in oil prices. However, as the extreme price hikes persisted (see Figure 6), the cost of price protection became prohibitive. Governments gradually reduced subsidies for the different fuels without phasing them out completely. A complete phase-out would have been politically unfeasible.

FIGURE 6. The Price Smoothing of Oil Products in Brazil, 2001–11

To avoid such dilemmas, some Southeast Asian and Latin America countries, such as Indonesia, Thailand, Brazil, Chile, and Colombia, adopted a transparent price-smoothing formula. The target price is usually a moving average of past and future prices with high and low prices set in a band around this number. Usually, such mechanisms smooth consumer prices when the international price is above a reference price. This maintains oil product prices above the international price when the international price falls below the reference price. When the price is high, the gap is financed through one of two ways. Chile and Colombia make use of a dedicated fund. Others use the national budget by lowering the excise duty. When the price is low, the fund is replenished by a tax increase.

2.2.6. The Specific Case of Energy Exporters

While supply security is a key objective for energy-importing countries, maintaining secure revenues is the overriding concern for hydrocarbon-producing countries. It was this concern that led to the creation of the
OPEC in 1960. Initially the OPEC’s objective was to raise oil prices. Over time its function shifted to maintaining a safety net to ensure prices stayed above a minimum level, thus guaranteeing sufficient revenues to finance government spending in oil-exporting countries. The increasing demand of rapidly growing economies since the mid-1990s has led to energy markets becoming increasingly integrated. The once-comfortable margin of production capacity over global demand has begun to dry out. In response, oil prices reached their highest levels ever in the 2000s, a situation that was further aggravated by high volatility. Such uncertainties coupled with high prices have led several oil-producing countries, such as Venezuela, Bolivia, and Russia, to renationalize their oil and gas sectors to ensure greater control.

Resource-rich energy exporters represent a unique situation because their governments use oil revenues to subsidize the economy and finance their social and development objectives. This provides no incentive for the development and diversification of local industries, and leads to the excessive appreciation of the national currency. This effect is known as “Dutch disease,” and tends to affect countries where a significant share of export revenue is based on natural resources. However, maintaining low domestic prices for locally sourced energy products could provide a comparative advantage if used to support local industries and social welfare. Nevertheless, such practice can also have negative side effects. These include industrial inefficiencies and overconsumption of energy products. Despite these negative side effects, the removal of these subsidies is politically unfeasible. The domestic political stability of many exporters is largely built on subsidization.

2.2.7. 1990s onwards: Development Remains the Priority in the Face of Climate Change

Historically, environmental protection has been perceived as an obstacle to economic growth, until the point at which a society feels the ill effects of pollution on economic and social development. Most developing countries have argued that mitigation efforts should not constitute an additional constraint on their development. This has underpinned a refusal to adopt legally binding emissions reduction commitments and an insistence on making their mitigation contingent on international support.

However, some developing countries have begun to embrace emissions reductions as the impacts of climate change are increasingly felt and the cost of low-emissions technologies continues to fall. Most countries which are considering or adopting carbon pricing tend to be middle-income states. This is the case with emerging economies such as China, South Africa, Chile and Mexico. These countries have experienced significant economic development over the past 20 years which has enabled them to pursue more ambitious cost-effective climate change policies.

For most less-developed countries, the priority remains to reduce poverty. Although some low-income countries such as Ethiopia and Bhutan are undertaking substantial emissions reductions programs. For most low-income countries, ensuring economic development and successful mitigation and adaptation depends on developing credible international financial and technological.

2.3. The Special Case of the Power Sector: Diverging Sector Reforms

As mentioned earlier, the power sector once had, and in some segments still has, the characteristics of a natural monopoly for transporting and delivering electricity. Historically, a single power company has been awarded the right to connect and to supply all customers in each territory. These customers are, in effect, captive to a monopoly and must be protected by strong regulations. Consequently, most power sectors have a tradition of imposing consumer protection mechanisms that include price controls as well as public service obligations
(PSOs). Such PSOs include geographical service extension to rural areas, and obligations to deliver electricity to any connected “citizen,” delivery quality standards, supply reliability. Regulations in the power sector have consequences, both for the competitiveness of the industry and the affordability of its services. The introduction of competition at the wholesale and retail levels complicates the regulation of the power sector. It now involves a sophisticated mix of policy instruments aimed at the simultaneous pursuit of several policy objectives, including competitiveness, real-time supply reliability, capacity adequacy, and affordability. The characteristics of the power prices seen on hourly markets (which are aligned to the variable costs of the marginal plants that clear the market on each hour), induce volatility, influence variations in fuel price, and thus increase the risk that the high, fixed up-front costs of baseload technologies will not be recovered. Establishing long-term arrangements that involve risk sharing and guarantee revenue is crucial for the market to direct investments toward the most socially efficient technology mix. It is also key in creating sufficient investment in capacity for power production to be able to respond to peaks in demand and extreme events.

In understanding how introducing carbon-pricing instruments in the power sector might affect the practices of both the power industry and its various categories of customers, requires a careful understanding of two key aspects. First, the complexity of the signals that existing regulations are already sending to these agents. Second, how the new carbon-pricing instruments might interfere with this sophisticated mix of pre-existing instruments and eventually send blended signals to agents.

In recent decades, the regulation of the power sector has dramatically evolved in the OECD countries. Today, most functions in the sector are privatized. A once vertically integrated structure has been split into competitive segments such as generation, transmission, distribution, and commercialization. One exception is infrastructure used for physical T&D, which remains a natural monopoly. The aim of decades of reform has been to improve the sector’s economic efficiency by introducing as much market competition as technology allows. In the OECD countries, mature markets, technological surprises and slow growth in demand have enabled this to happen. Yet this liberalized, segmented model has limitations. For example, it does not necessarily provide independent private agents with a long-term incentive to collectively build an optimal technology mix. Such a mix requires investing in capital-intensive technologies that are competitive in terms of their levelized cost of energy (LCOE) (Finon and Roques 2013). This may not pose a problem when the need for new investment is limited by slow growth in demand. But in two critical situations, the challenge is more acute. First, those with decarbonizing power sector which need new, low-carbon technologies. Second are those economies in need of new capacity. This second need, seen most in countries outside the OECD, will now be considered.

Many stakeholders in developing and emerging countries are disenchanted with the historically poor performance of state-owned public utilities. Thus, has led to a perceived need for new investments in (i) generation and grids to keep pace with rapid demand growth, and (ii) distribution to expand access to the poor and across rural areas. Yet, despite a shared motivation to move away from inefficient public monopolies, power sector reforms in developing countries have been quite different from high-income countries. These differences can be clearly seen in the market structure, the degree to which the electricity supply industry’s functions have been unbundled and the retail market opened. Another two areas of difference are the level of private participation and the development of an effective and independent regulator. While power sector regimes in developing countries are diverse, none follows the standard model seen in most high-income countries.

All the various models observed are aimed at improving the technical and economic performance of the power sector to best serve the consumers’ interest. Each model will interact differently with
the introduction of a carbon-pricing instrument. While important lessons can be derived from the experiences of high-income countries with carbon pricing in place, it is essential that variations in sector structure and regulations be taken into account when considering how these lessons may or may not apply to developing and emerging economies.

The next subsection characterizes the market regime in the OECD countries and focuses on consumer protection. This is followed by an overview of the organizational models and regulations adopted in emerging and developing countries.

2.3.1. The Historical Evolution of Consumer Protection in the OECD Power Sectors

In the OECD countries, consumer protection has been one of the main policy objectives guiding the regulation of utilities. Until the 1990s, electricity companies were awarded a supply license for a given service area. This effectively granted them a legal monopoly in that area. In exchange, a tariff regulation and various PSOs were imposed on them. They were asked to provide service to rural areas, offer lower rates to low-income families, hold to standards over the continuity and quality of supply, and mitigate power outages by developing adequate capacity and networks to keep pace with growth in demand. In compensation, tariff regulations imposed by governments ensured that producers recovered all production, network, and PSO costs with a fair and reasonable return on capital. This is called a “cost plus” or “rate of return” regulation. Simultaneously, power companies are supposed to minimize the long-term costs of the system by avoiding excessive capacity and optimizing their technology mix. For this reason, regulators weigh the investment projects proposed by utilities against electricity growth forecasts before authorizing them.

Tariff structures have typically reflected political objectives such as economic and social development. In the 1950s and 1960s tariffs in the US were divided into progressively less expensive blocks with the aim of easing the development of new power uses (Chick 2007). This model was consistent with the cost cuts enabled by improved technical efficiency and economies of scale. But an increase in fuel prices in the early 1970s as well as an increasing focus on environmental protection prompted some US states to shift to a combination of lifeline tariffs and blocks of progressively more expensive rates. This combined the objective to protect low-income citizens with a new incentive for large consumers to manage their consumption above 10,000–20,000kWh.

Reforms toward a Decentralized Model of Market Competition

Toward the end of the 1970s, public utilities’ inefficiencies, such as overcapacity and overemployment, came under strong criticism, and privatization and competition were seen as the solutions. The main characteristics of the resulting power sectors are summed up in Box 2.1.

43 For the first block, the tariff was lower than the average cost to subsidize low-income households with low consumption rates.
Beyond this common set of principles, there is a wide range of industrial structures and market types in the OECD countries. Most European countries, Australia, and New Zealand have adopted a decentralized design with a market exchange. The US model is mainly an obligatory pool based on hourly bid prices, complemented by bilateral financial transactions aimed at guaranteeing a price for both parties. Competition on the retail markets has been introduced stepwise. Although, some countries have maintained a regulated tariff for households. This is typically offered by incumbent distribution companies. This regulated residential tariff competes with the market price offered by independent retailers.

The liberalization of electricity markets has two objectives. First, to improve the productivity of electricity generators, grid companies, and suppliers by introducing competition. Second, to transfer to consumers, through lower prices, part of the efficiency improvements. The reforms open consumers’ choices and eventually lower retail prices. In parallel, an independent regulatory authority ensures there is a level playing field for competitors, regulates network access, protects consumers, and monitors the implementation of PSOs. Due to these reforms, PSOs are now legally established in most OECD countries. These include social tariffs, obligations to purchase RES-E and CHP electricity, and obligations to finance energy-efficiency improvements on the demand side.

A ‘last-resort’ tariff offered by incumbent suppliers is maintained for residential consumers who might choose to return to their former supplier in case their new supplier increases its prices, or goes bankrupt. This tariff is therefore the price to beat by entrants. In general, the energy portion of the regulated tariff is aligned with the wholesale price, which is averaged over a specific period. So, retail prices and last-resort tariffs fluctuate alongside fuel prices. This determines wholesale hourly prices on the exchange, and will logically continue to do so if a carbon price is introduced.
Protecting Consumers after Liberalization: Introducing Carbon Pricing in Diverse Contexts

Consumer protection, particularly against high prices, is an important feature of regulatory supervision of power markets. Protection mechanisms directly influence the final price signal that a carbon-pricing policy will target. In general, it is difficult to judge whether liberalization has lowered the prices paid by consumers or improved the quality of the service provided. Retail price evolution in industrial and residential segments depends on (i) the initial stock of generation plants and its technology mix at the time of liberalization; (ii) the market design (mandatory pools in the US are different from the decentralized markets, complemented by a power exchange, seen most often in the EU); and (iii) the price regulation of T&D. In general, assessments of the reforms made in the EU countries have not provided conclusive evidence on the evolution of prices and consumer protection (Fiori and Florio 2013). Several observations can be made:

- First, there is evidence (from the UK, Spain, and Chile, among others) that, after reforms, some vulnerable groups, such as pensioners and low-income households are more adversely affected by price rebalancing than consumers with higher incomes (Ugaz and Waddams-Price 2003). This effect is particularly noticeable if it occurs alongside a reduction in general income. Adjustments can be made to correct this. For instance, the introduction of new legislation in the UK during 2001 gave regulators in the electricity sector a specific remit to account for the needs of low-income households. The breadth of the rebalancing and subsequent adjustments depends to a large extent on the specific political economy. Most importantly, how governments view redistribution issues or want to repeal cross-subsidies;

- Second, there are two different attitudes among governments and regulators in countries that decide to maintain social tariffs and/or regulated tariffs offered by incumbent suppliers. Most regulators prefer to pass the "spot price" changes in tariffs on to residential consumers. But some governments, for instance, in France from 2000 to 2015, have ordered the electricity regulator to maintain tariffs at a level aligned with the accounting costs of the historic operator. This means that retail tariffs could be set well below the wholesale price, which prevents the entrance of new operators and thus competition with historic operators of various segments of the retail markets. Such an approach can also be observed in some US states and jurisdictions, particularly in California.

These differences, which are anchored in regulatory history, are also observed in the way carbon pricing has or has not been passed on through retail prices and tariffs. This is particularly pertinent for countries that have adopted ETSs based on the free allocation of permits to power producers (see section 5.3, Chapter 5).

2.3.2. Power Sector Reforms in Emerging and Developing Countries

In the 1990s in developing countries, international donors and local reformers (advised by international consulting firms) aimed to restore the technical and economic performance of debilitated state-owned integrated power systems (which were unable to meet growing demand) in the interest of consumers. Their recommendations were strongly influenced by earlier experiences of liberalization in the OECD countries, especially the British reforms (see, for instance, Teplitz-Semblitski 1990; Millan and von der Fehr 2003).

The resulting reforms started unbundling country’s electricity sectors into segments, privatizing state-owned companies, introducing independent regulations to attract private investors, and improving systems’ operating efficiency. In the early 2000s, it was observed that while demand for power was continuing to increase, the

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45 For an insightful overview of the reforms in developing countries, see Besant-Jones (2006: 164). For a historical view of the reforms in emerging countries, see Heller and Victor (2009).
sector reforms had not been able to achieve their core objective of ensuring reliable electricity supply at reasonable and affordable prices. Several crises resulted, including the so-called apagão (the “big shutdown”) in Brazil in 2001. Greater investment was needed to counter the challenges being faced. Unfortunately, risk management in the new market-oriented regime was not adequate to attract this.

Consequently, in several developing countries, newly implemented market regimes were reformed again in the 2000s to create safe and stable regulatory environments for investors to build large power plants through long-term contracts between new and existing producers and retailers (Finon 2006). In countries where a fully liberalized market regime had not yet been achieved, reforms were put on hold, and power sector structures were frozen at the stage where they were. Most countries retained a supply monopoly and significant public-sector involvement. That is, they froze in the single-buyer model. This was done alongside some private ownership in the form of IPPs with PPAs signed with public companies). Their models can be categorized based on the degree to which generation, transmission, supply/commercialization, and distribution functions had been unbundled (vertical segmentation) and competition introduced in generation and supply (horizontal segmentation). Figure 7 illustrates this categorization.

**FIGURE 7. Relation of Power Generation and Supply Structures to the Degree of Market Competition**

![Diagram illustrating power generation and supply structures and market competition](image-url)

Note: Genco = generation company; Transco = transmission company, Distco = distribution company (grid+ retail); IPP = independent power producer; PPA = power purchase agreement. The figure lists model types, ranging from the conventional fully integrated public monopoly on the bottom-left to the most de-integrated, fully privatized competitive market on the top-right. The blue arrow illustrates the second-stage reform in the 2000s, which partly reversed the liberalization trend toward a hybrid model.

Source: from Besant-Jones 2006; Roques and Finon, 2017

The three main power models found in developing countries today are detailed below; these are, namely, the hybrid model, the single-buyer model, and the still-present, conventional, integrated state-owned public utility model.

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46 For more on the investment barriers in reformed power sectors, see Finon (2006).
The Hybrid Model

It is difficult to reform the electricity industry by imposing a new market design at the wholesale and retail level when the main objective is to quickly develop new capacity to catch up with growth in demand. Since, in power markets, hourly prices are determined by short-term marginal costs (the operation costs of the latest generation plant being dispatched), power generation investors are exposed to price variability that discourages them from investing in new plants. It is uncertain whether they can recover their fixed costs when hourly prices are aligned to short-term marginal costs. After a series of crises characterized by large shortages and sky-rocketing electricity prices, particularly in the Latin American countries, several countries adapted their power sector models to focus on the development of new capacity and an efficient technology mix. This was done by developing long-term contracts at fixed prices. Contracts between generators and suppliers/distributors (which keep their supply monopoly) allow for the transfer of risk to the latter. This change reduces the risks for investors, particularly for technologies with high up-front costs, such as hydraulic plants. Such a change also influences the development of low-emissions technologies which are for the most part capital intensive with large fixed costs.

**Box 2.2 The Main Characteristics of the Hybrid Model**

- Partial unbundling.
- Auctioned long-term contracts (capacity and energy, energy, or capacity only).
- Short-term coordination by a cost-based dispatch manager.
- Regulated distribution monopolies.
- Obligation imposed on suppliers/distributors to contract ex ante with generators to secure 100 percent of their load.
- Regulations to ensure that industrial and domestic tariffs reflect costs.

Source: Authors’ compilation.

Short term coordination is needed in addition to this long-term term. Such coordination is achieved through a program that uses the variable cost data submitted by each power generator to automatically determine which plants are to be dispatched. The participating plants are required to report their available supply capacity to the market operator one day in advance and are remunerated at a price aligned to the variable cost of the last plant to be dispatched.

This new market architecture which relies on long-term contracts depends on the existence of retail monopolies that can play the role of credible counterparts to power generation investors. To ensure the credibility of retailers, the regulation mandates them to sign contracts to cover their full customers’ load in the mid and long term. This reduces risks for investments in generation. These contracts cover both capacity and fuel costs, which are indexed to the prices calculated by the market operator. Thus, generation companies can respond to the challenge of investing in due time and with an efficient technology mix that excludes new capital-intensive hydropower plants. Downstream, the retail prices are regulated to reflect costs, including those of long-term contracts. Large consumers are free to purchase from any generator but are also obliged to sign long-term contracts to generate sufficient long-term incentives for power generation investments.

This model is called a hybrid because it combines some market-based elements with those of the traditional, monopolistic structure. The primary characteristics of this model are summarized in Box 2.2. Strong public regulations palliate market failures of investments and protect customers.
Differences in this model can be observed across countries (Moreno and others 2010). For instance, in Brazil, the sector relies on a central broker, which organizes auctions for mid- and long-term contracts with existing and new units for energy and capacity, and then transfers these contracts to the retailers. In Chile, there is a decentralized process of tailormade supply contracts, purchased by distributors obligated to use forward contracts to cover their forecasted loads. In Colombia, a central auctioning system generates long-term contracts for a fixed capacity payment between the generators and the transmission system operator. In both Brazil and Chile, the role of the spot market is reduced to the marginal adjustment of supply and demand among the distributors and free consumers; energy contracts are either indexed to the spot price or are option contracts guaranteeing the level of energy payment.

### The Single-Buyer Model

In many countries, a market structure based on a single-buyer model was initially adopted as an interim measure in anticipation of a fully competitive market. The main traits of this model are outlined in Box 2.3. This model was used in China, Thailand and several Eastern European countries among other. In many cases, such a model is still in place. Under this model, a state-owned transmission and dispatching company buys power from generating companies through PPAs negotiated individually with each producer, and then sells all electricity at a single, pooled, average wholesale price to the distribution utilities. Long-term PPAs (generally 10 years or more) and short-term PPAs (one year or less) are covered by “take-or-pay” provisions guaranteed by the state.

The retail price for end consumers is regulated by adding a T&D charge to the wholesale price. In parallel, large consumers that meet specific eligibility criteria, mostly based on purchase minima, can buy their electricity directly in a free wholesale market.

### BOX 2.3 Key Characteristics of the Single-Buyer Model

- Only one buyer present.
- PPAs.
- Short-term coordination between generators through specific provisions embedded in the PPAs (fuel cost reference, eventual “take-or-pay” rule); in certain cases, economic dispatching based on merit order.
- Regulated wholesale price for bulk purchases by regulated distributors.
- Regulated distribution monopolies.

Source: Authors’ compilation.

There are two versions of the single-buyer model, depending on the degree of the unbundling and privatization of the generation assets of former public utilities:

- In the first, the former national utility has been partially unbundled (for example, some regional distributions have been divested, transmission has been legally unbundled, and some generation assets have been separated), but remains as the single purchasing agency. This is the case in South Korea, Thailand, Indonesia, and a few jurisdictions of India;

- In the second, the unbundling of ownership is for the most part complete. The purchasing national or regional single buyer agencies are independent transmission grids, as in China.
There are several ways to ensure the short-term coordination of various producers (private and non-divested plants of the former public monopoly). In certain cases, there is an economic dispatching system among the contracting power plants. The generation capacities of independent producers are called upon in the order of their production costs. However, in some countries, PPAs transfer all the risk to the buyer via a take-or-pay provision. In this case, whatever the fuel cost of the IPPs, the electricity they generate must be dispatched as per the conditions specified in the contracts. For instance, for a coal plant, even if the price of coal increases and its variable cost is higher than the variable cost of gas plants (CCGTs), the coal plant will still be dispatched during the yearly time period specified in the contract. These rigidities can affect the design of efficient carbon-pricing schemes.

The regulation of retail tariffs can be difficult if the regulator or the government does not ensure that they reflect the single buyer’s procurement expenses. Indeed, in some countries, when fuel prices increase, the single buyer cannot be compensated for increases in the IPP payment, triggered by an indexation provision regarding the energy component that is contained in the PPA (Besant-Jones 2006: 63).

The State-Owned Public Utility

The conventional model of a state-owned, integrated monopoly has persisted, with modifications, in some countries. This is most often due to political barriers to reforms, as is the case in South Africa and some Indian states. Its persistence can also occur because existing market models cannot be easily downsized to suit the small size of the economy. This is particularly the case in LDCs. As Besant-Jones (2006) states, “unbundling the generation and distribution segments of the power supply chain into tiny entities would not make sense in these systems, because economies of scale and scope would be lost without gaining the benefits of competition.” Ultimately, “the public sector will remain an important source, and often for the medium term the main source, of investment for a power market where country and market risks deter private investors.” In these contexts, the modification consists mainly in the improvement of public regulation and the suppression of the generation monopoly to allow for the entrance of IPPs. As Besant Jones notes: “many developing countries do not offer the necessary conditions for attracting substantial amounts of private investment to (eventual) power markets. Many of them have attracted substantial investments by independent power producers, but only by giving contractual protection against most noncommercial risks to these producers”. In this context, PPAs with provisions for price indexation and volume offer strong protection and guarantees to investors. This transfers risks to the state-owned utility.

In this model, the dispatch is organized by the state-owned utility. It combines the mandatory offtakes from IPPs and the rest of the required supply in merit order from its own plants. The retail prices remain regulated by a ministry, and rarely by a regulatory authority, which, if present, remains under the authority of the ministry. Industrial and domestic prices are set at the government’s discretion, with a focus on inflation control and consumer protection, particularly when international oil prices are rising. In jurisdictions where carbon pricing is used, the issues of whether to pass the carbon price on through electricity rates is rarely brought up.

2.3.3. Power Sector Models and the Climate-Energy Typology

There are some general patterns in what power sector structures are employed by different categories of countries. This general dispersion of the different models is depicted below in Figure 8. The liberalized power sector model tends to be concentrated among high-income countries. Both the hybrid and single buyer models tend to be dispersed across a number of categories but are most prevalent among developed and
emerging economies. The state-owned public utility model is generally preferred by low-income countries. As mentioned above, this tends to suit their lower levels of institutional capacity. Energy import and export levels do not significantly impact the choice of power sector model.

**FIGURE 8 Sector Model Across Country Income Levels**

These patterns not suggest any form of economic determinism: greater economic development does not automatically lead to a liberalized power sector. It simply reflects the shared political, historical and socioeconomic conditions of different groups of countries. Moreover, power sector structures exist across a spectrum and not in isolated models. Generally liberalized power sector markets in high-income countries may at times have higher levels of regulation. Nonetheless, this general pattern of power sector structures is important to consider when discussing the impact of carbon pricing and other climate policy instruments on energy policy.

Both the power sector structure typology and other key lessons from Chapter 2 are presented in Box 2.4.

**BOX 2.4. Chapter 2 Summary**

- The development of energy policies across countries is determined both by historical conditions, socio-economic status, and predominant economic theory.
- The evolution of energy policy objectives in developed, emerging and developing economies present historical similarities. A key point of difference is current socio-economic statuses, and subsequent differences in priorities today.
- The four different power sector models differ across country categories. Most developed economies have liberalized models, whilst developing countries tend to rely more on the state-owned public utility model.
- Traditionally, developing and emerging economies have maintained development as an overriding priority despite the threat of climate change, while high income economies have now inverted relative priorities. However, recent commitments taken in Paris indicate that GHG mitigation is gaining importance as an energy policy objective in emerging and developing countries.
- Both current energy policies and power sector structures have important implications on the effects of a carbon pricing.
References


3. Climate and Energy Policy Objectives: Working in Harmony, or Not

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3.1.2 Quantity Instruments

3.1.3 Command-and-Control Instruments

3.1.4 A Need for Supplementary Policies

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Energy Independence: Reduction of Fossil-fuel Imports in Net Importing Countries

Energy Security: Increasing the Effectiveness of Energy-efficiency Measures

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3.4.4 Unexpected Redistributive Effects of the EU-ETS in the Power Sector

3.5 The Context of High Oil-Price Volatility

3.6 Concluding Remarks
The Brundtland report in 1987 (World Commission on Environment and Development 1987) laid the groundwork for the convening of the 1992 Rio Earth Summit and focused political attention towards the issue of climate change. Since then, the international community has responded, leading to a series of national and international commitments to reduce GHG emissions in many member countries. Countries that were part of the OECD grouping during 1992 were placed in ‘Annex I’ under the UNFCCC and designated as developed countries. These Annex I countries have been responsible for the majority of emissions reduction commitments, and are also obligated to support developing country actions through financing and technology provision.48

While developing countries action is required to reach the goals of the Paris Agreement, it is widely recognized that Annex I countries are responsible for the majority of historical emissions. Thus, for almost two decades, it was primarily Annex 1 countries that experimented with policy instruments meant to mitigate carbon emissions. The Paris Agreement largely removes this distinction and requires both developing and developed countries to put climate action pledges, or NDCs. The experiences of Annex I countries provide an opportunity to observe the interaction of climate instruments and objectives and instruments previously implemented in the energy sector (as presented in Chapters 1 and 2).

This chapter first presents the policy instruments that most Annex 1 countries have considered as they pursue the policy goal of controlling and reducing GHG emissions. It then offers an inventory of observed points of convergence and conflict between these new instruments, meant to mitigate carbon emissions (including carbon pricing), and existing energy policy objectives and instruments.

3.1. Policy Instruments for Carbon Reduction

When policies to control carbon, emissions were developed in the 1990s, the policy instruments considered were similar in nature to existing energy policies. The three broad categories are (i) price instruments, (ii) quantity instruments, and (iii) command-and-control regulations. These instruments aimed to either directly reduce GHG emissions or promote activities that indirectly reduce them, such as energy conservation. An overview of these different instruments is provided in Table 3.1.

3.1.1. Price Instruments

Price instruments directly modify price signals perceived by economic agents such as consumers and suppliers interested in estimating their return on investment. For many price instruments, such as taxes, the theoretical intention is to remedy a market failure by internalizing the external cost of carbon. That is, ensuring that the current and future social costs of emissions are reflected in their current market value. This category of instruments includes taxes, subsidies, and the suppression of subsidies.

**Taxes:** The most direct form of carbon pricing is the carbon tax, which establishes the price to be paid for the emission of one unit of GHG. This is usually quantified as a $ price per ton of carbon dioxide or CO₂ equivalent. A carbon tax can be applied either in specific sectors or the entire economy. Once the tax base has been defined, an efficient tax rate takes into account two economic considerations. First, if the primary goal of the tax is to achieve a target of emissions reductions, the level of the tax should be aligned to the marginal cost of the reduction. Second, to ensure consistency across sectors, the carbon tax should reflect the specific carbon content of different fuels that can be used for the same purpose (heating, transportation, industrial processes, and so on).

48 Countries who are responsible for financing and technology transfer are generally part of ‘Annex II’. This is a grouping that is similar to Annex I, but excludes economies in transition such as Belarus and the Russian Federation.
Subsidies: Subsidies can be implemented through direct payments, tax rebates (including carbon tax rebates when such taxes are in effect), and production price support. In recent decades in high-income countries, direct subsidies have been used mainly to support the RD&D of low-carbon technologies. Such technologies usually take the form of renewable energy or other emissions mitigation approaches. The deployment of these technologies benefits from implicit subsidies based on mechanisms that avoid any new charge on the public budget or fiscal revenue shortfall. Such mechanisms include feed-in-tariffs (FiTs) which are financed by a tax on electricity sales paid by some or all power consumers, as well as any obligations related to renewables or energy-efficiency certificates. Subsidies supporting renewable energy and low-carbon technologies constitute a point of convergence between energy policies and climate policies (which is detailed below).

Suppression of fossil-fuel subsidies: A complementary measure to subsidizing low-carbon and mitigation options is to tax fossil fuels according to their carbon content. Currently, many fossil-fuel producers and consumers across most country categories benefit from subsidies. Ending fossil-fuel subsidies is thus an alternative to taxation, or a possible first step towards it. Since subsidies are also implemented as an energy policy instrument, their removal raises a possible conflict between energy policy objectives and emissions reduction objectives. This issue will be explored in-depth in Chapter 4.

3.1.2. Quantity Instruments

The most commonly used quantity instruments to control emissions are “cap-and-trade” schemes. A cap-and-trade scheme, also referred to as an Emission Trading System (ETS), establishes a limit, or a ‘cap’, on the volume of GHGs that can be emitted by specified sources. A central regulatory entity then issues and allocates the sum of these caps through emissions allowances or ‘permits’. Each source is then required to remit emissions permits in a volume inferior to its actual emissions. In an ETS, permits can be traded among sources and sometimes among other parties participating in the carbon market, such as banks.

Different from a carbon tax, which generally covers the entire economy, an ETS often only applies to large emitting sources related to energy extraction, transformation, and consumption. This includes energy-intensive industries (EIIs), manufacturing industries, and some segments of the transportation sector such as aviation and marine bunkers. Small sources are generally not included because of the technical difficulties and high transaction costs associated with their monitoring and control. However, an ETS can also indirectly cover GHG emissions from small sources, such as individual or collective vehicles, by assigning caps on entities such as fossil fuel distributors. For example, this is done in California for oil product distributors. It is noteworthy that despite a sometimes-polarized debate between supporters of taxes and supporters of the ETS, it is not uncommon for both mechanisms to be implemented in complementary ways. A cap-and-trade mechanism can, for instance, be complemented by applying a carbon tax in uncovered sectors.

ETSs can be linked across national boundaries, creating an international carbon market. This can have numerous benefits such as lower cost abatement, greater political commitment and increased market liquidity. Yet it can also have drawbacks, most importantly the loss of regulatory control by individual governments. Linking carbon markets may impact both the negative impacts of carbon pricing highlighted in this report, and influence the ability of policy-makers to reconcile climate and energy policies. These important topics require further attention, but are outside the scope of this report.
Both carbon taxes and ETSs as carbon pricing instruments are policy signals. When combined with the long-term goals of the Paris Agreement and NDCs the implicit and explicit price of carbon will rise over time.

3.1.3. Command-and-Control Instruments

Command-and-control instruments include mandatory norms, standards, and technology bans. These specify either a mix of technologies to be used (technology standards) or the maximum authorized GHG emission rates, (performance standards, technology bans) determined in accordance with the policy objective of controlling emissions. In the UK and the US, these instruments are used in the power sector to improve the performance of existing equipment, and limit GHG emissions from new equipment to the level of the best-performing combined-cycle gas turbine (CCGT) power plant. Investors' decisions are thus oriented either toward the best-performing CCGTs, or, for coal plants, toward projects that use CCS. Recent US Environmental Protection Agency (EPA) regulations also seek to reduce the emissions of existing equipment by imposing obligations on existing power generation plants.

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49 This is 450 grams (g) of carbon dioxide (CO₂)/kilowatt-hour (kW/h) as per the UK standard, and 1,000–1,100 pounds (lbs) of CO₂/megawatt-hour (MWh) as per the U.S. Environmental Protection Agency (EPA).

50 See the EPA's website: [http://www2.epa.gov/carbon-pollution-standards](http://www2.epa.gov/carbon-pollution-standards).
### Table 3.1 Instruments of Carbon-Mitigation Policies

<table>
<thead>
<tr>
<th>Instruments</th>
<th>Energy Supply</th>
<th>Energy Consumption</th>
<th>Building and Housing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Price instruments</strong></td>
<td>Taxes, often economy-wide</td>
<td>Carbon taxes</td>
<td>Carbon or energy tax</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waste disposal tax</td>
<td>Excise duty aligned on carbon content</td>
</tr>
<tr>
<td>Subsidies</td>
<td></td>
<td></td>
<td>Congestion charge</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vehicle tax</td>
</tr>
<tr>
<td>Subsidies removal</td>
<td>Removal of subsidies benefiting production or imports of fossil fuels</td>
<td>Removal of subsidies supporting the use of fossil fuels</td>
<td>Removal of subsidies supporting the use of fossil fuels</td>
</tr>
</tbody>
</table>

**Fossil Fuels**

<table>
<thead>
<tr>
<th>Quantity instruments</th>
<th>Quotas and tradable permits</th>
<th>Cap and trade/ETS</th>
<th>Cap and trade/ETS</th>
<th>Inclusion of fuel distributors in cap-and-trade schemes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline and credits</td>
<td>Carbon credits under the CDM, other offset mechanisms</td>
<td>Carbon credits under CDM, other offset mechanisms</td>
<td>Car manufacturers weighted average norms (CAFE) and tradable certificates</td>
<td>White certificate obligations (tradable certificates)</td>
</tr>
<tr>
<td>Obligation and credits</td>
<td>Green certificates obligation (tradable certificates)</td>
<td>White certificates obligations (tradable certificates)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Command and control**

| Emissions standards for new plants | Technology bans | Environmental compensation | Fuel standards | Building codes |
| High emissions technology ban | Renewable portfolio standards | | Vehicle standards | Standards and labels for appliances |
| CCS regulation | | | Regulatory restrictions to encourage modal shifts | Mandates of energy suppliers |
| | | | Urban planning and restriction | Mandate to insulate existing buildings and residences |

Note: CAFE = Corporate Average Fuel Economy; CCS = carbon capture and storage; CDM = Clean Development Mechanism; CHP = combined heat and power; CO2 = carbon dioxide; ETS = Emission Trading Scheme; RES = renewable energy source; RES-E = renewable energy sources for electricity; RD&D = research, development, and demonstration.

Source: Authors’ compilation, based on table 15.2, IPCC WG III (2014).

Command-and-control policies may be extended to include technology bans, such as a moratorium on the development of high emitting plants. The Canadian province of Ontario decided in the late 1990s to phase out coal-fired power plants. This was done without a conventional cost-benefit assessment to internalize GHG
emissions by putting a price on carbon. Instead, it relied on a program to replace coal plants with gas plants and introduce mechanisms to promote renewable energy.

3.1.4. A Need for Supplementary Policies

Carbon pricing through a carbon tax or ETS is usually acknowledged as a central element of a cost-effective climate policy. But it is important to note that often a strong carbon price can fail to effectively encourage low-cost mitigation decisions and even win-win measures with short payback periods, such as many energy-efficiency measures. This is because a series of market failures prevent a rational response from economic agents, as would be predicted by economic theory. Barriers have been widely discussed in case studies conducted in many countries and include information barriers, skill limitations and financing bottlenecks.

Consequently, governments adopt supplemental policies in addition to existing carbon-pricing instruments to address these barriers. In several high-income countries energy-efficiency policies in transport, industry, and construction, as well as policies to promote renewable energy were initially designed to pursue conventional energy policy objectives. But they are now increasingly attached to climate policy objectives. Some observers even propose methodologies and merit-order criteria to build and apply an effective mix of instruments that include both pricing and non-pricing instruments.

**FIGURE 9 Well-designed Carbon Policy Mix**

An example of a phased policy package approach is advocated for by Matthes (2010) and Hood (2011, 2013) and highlighted in Figure 9. They propose that policies to unlock the cost-effective energy-efficiency potential on the left-hand side of the abatement cost curve should be considered first. Once these policies have unlocked precise barriers, these energy-efficiency measures are profitable by themselves due to energy savings and do not need the internalization of any carbon value. Responsive carbon-pricing mechanisms and technologies supporting cost-reduction policies can then be implemented. In this phase, an emphasis is
placed on decreasing the investment risks associated with the innovative low-carbon technologies needed for long-term decarbonization. This targets the highest cost abatement opportunities located on the right-hand side of the curve.

3.2. Convergence of Carbon Pricing and Existing Energy Policies

Carbon policy instruments, in particular carbon pricing, can have both positive and negative interactions with the various objectives pursued by energy policies. The nature of these interactions partly depends on governments’ economic and social priorities, as reflected in their existing energy policies and instruments (as described in chapters 1 and 2). Based on a review of existing policy and instruments,51 the next sections of this chapter propose a map of interactions between those related to (i) energy and (ii) carbon. Synergies and positive interactions are first discussed and then trade-offs and negative interactions are examined.52

3.2.1. The Contribution of Carbon Pricing to Energy Policy Objectives

The implementation of carbon-pricing instruments overlaps with a variety of energy policy objectives. There are two ways to look at positive interactions. The first is to observe the improved effectiveness of an energy policy when a carbon-pricing instrument is added to it. The second is to consider how effective climate policy can contribute to the achievement of policy goals in other areas.

Energy Independence: Reduction of Fossil-fuel Imports in Net Importing Countries

Carbon pricing creates incentives for energy efficiency and the uptake of RES-E, both of which reduce the demand and need of imported fossil fuels. Carbon pricing also encourages manufacturers to cut their carbon emissions through the improvement of processes, technology and fuel substitution, and innovation. These measures concern not only direct energy consumers but also consumers of products with a high carbon content, such as aluminum and steel. High and foreseeable carbon pricing also creates incentives for consumers to use products and services with lower carbon content, and for industry to create products meeting such demand. High carbon and energy taxes incentivize manufacturers to develop and sell more energy-efficient products.

Energy independence for importers is also improved by reducing fossil-fuel subsidies. Aligning oil and gas prices to international prices also contributes to decreasing imports by reducing their consumption.

Energy Security: Increasing the Effectiveness of Energy-efficiency Measures

Carbon pricing increases energy savings by increasing the final price paid by customers, thus reducing payback periods for investments in energy efficiency. In addition, the higher energy prices resulting from carbon pricing partly reduce the level of policy intervention, because a higher energy price reduces the rebound effect frequently observed in energy-efficiency programs.53 As a result, less additional capacity has to be built on the supply side, thus strengthening the supply-demand balance.

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51 See, in particular, Table 1.1, “Energy Policy Objectives and Instruments in OECD Countries,” and Table 3.1, “Instruments for Carbon Mitigation Policies.”
52 Trade-offs and negative interactions will be analyzed more thoroughly in succeeding chapters, in Part 2 of the volume. These are considered alongside ways to reconcile conflicts.
53 A rebound effect is observed when the reduction of the energy bill that results from energy-efficiency measures generates an incentive for customers to increase their energy consumption by using more efficient devices or purchasing additional ones, thus neutralizing the initial energy savings.
This supplementary effect can serve objectives outside the energy sector. One example is the fiscal objective of reducing the budgetary burden associated with certain energy policies. For instance, the higher energy prices resulting from the introduction of carbon pricing can reduce the subsidies needed in energy-efficiency programs, providing a bonus on top of energy prices, which is otherwise financed by the budget or a tax. The same is true for renewable energy support policies.

**Regional Development Policies: Supporting the Development of Local Natural Resources**

Fossil energies are global commodities, while most low-carbon renewable energy sources are local ones. By increasing the cost of fossil fuels, carbon pricing makes investment in local renewable energy resources more attractive. This can aid the development of many regions, and thus further an objective of many energy policies.

**Industrial and Innovation Policies: Amplifying Energy Innovation Policy**

In developed and emerging economies, the adoption of a carbon reduction target is often accompanied by complementary policies to promote low-carbon (renewable, CCS, and so on) and energy-efficient technologies. This provides a strong incentive to increase research and development (R&D) and innovation to support national firms developing green technologies.

**Health and Environment Co-benefits**

As detailed in chapter 1, environmental protection has been progressively integrated in energy policy objectives. Mitigation actions can further objectives in other areas such as health. Such contributions are frequently referred to as “co-benefits.” Actions to reduce GHG emissions can have significant health co-benefits, particularly by lowering levels of air-borne pollutants. One illustration of this is the increasingly ambitious nature of China's climate policies, which are largely motivated by local air pollution concerns (Lowi Institute for International Policy 2014).

**Other Development Objectives in Least-developed Countries (LDCs)**

Climate policies can also contribute to the development goals being pursued in developing countries. While the reduction of GHG emissions might not be perceived as a priority in LDCs, policies that seek to mitigate climate change can be better implemented through a co-benefits approach. This is illustrated in Table 3.2 (Mathy 2014), which uses UN Millennium Development Goals (MDGs) as a proxy to characterize and classify these co-benefits. In the short term, policies may address the use of climate-friendly technologies such as solar-lighting alternatives to kerosene lamps and gasifier cook stoves. Longer-term policies may address more comprehensive approaches such as bioclimatic housing, universal electricity access, the promotion of decentralized RES-E production, and public transport networks.
Table 3.2 Development and Carbon Objectives in LDCs: Examples of Co-benefits

<table>
<thead>
<tr>
<th>Area</th>
<th>Measures</th>
<th>Millennium Development Objectives</th>
<th>GHG Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>Promote bioclimatic building technique</td>
<td>Reduce people living in slums</td>
<td>Limit GHGs from new housing</td>
</tr>
<tr>
<td>Food</td>
<td>Improve agricultural efficiency from farm to fork</td>
<td>Reduce number of people suffering malnutrition</td>
<td>Limit GHG emissions from agriculture</td>
</tr>
<tr>
<td>Electricity</td>
<td>Develop decarbonized, decentralized electricity generation and electricity efficiency</td>
<td>Reduce people with no or insufficient access to lighting that are distant from the grid</td>
<td>Limit potential GHG emissions from new electricity generation</td>
</tr>
<tr>
<td>Sanitation</td>
<td>Develop efficient or improved sewage networks</td>
<td>Reduce number of people without sanitation and reduce water-borne diseases</td>
<td>Limit GHGs from effluents</td>
</tr>
<tr>
<td>Transport</td>
<td>Develop and improve public transport networks</td>
<td>Broaden access to mobility and improve public health in cities</td>
<td>Limit GHG emissions growth from vehicles</td>
</tr>
<tr>
<td></td>
<td>Develop sustainable mobility schemes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: GHG = greenhouse gas.
Source: Mathy 2014.

3.2.2. Contribution of Existing Energy Policies to Reducing Carbon Emissions

Some energy policies that act in the same sectors over the same time frame as carbon-pricing instruments can also reduce carbon emissions, even though that isn’t their original intent. These are typically energy policies that reduce the share of thermal fuel in the energy mix, increase the penetration of renewable supply, or reduce energy demand. These energy policies that reduce carbon emissions include:

- Energy-efficiency programs aimed at reducing energy dependence. These focus on overcoming barriers to cost-effective investment in energy savings, such as lack of access to financing, split incentives between those making investments (for example, landlords) and those paying energy bills (renters), a lack of information (like that gained from energy audits) and expertise etc. These energy-efficiency policy instruments can contribute to GHG reductions if the energy saved would have come from fossil fuel sources;

- Technology deployment policies, which drive the development of new energy options reducing energy dependence. For example, FiTs or green certificate systems for renewable energy, or underwriting nuclear investment. In the case of net importers, the supported technologies can reduce fossil-fuel imports and thus emissions;

- RD&D support for new energy technologies, which will prepare for the replacement of conventional technologies with lower emissions alternatives. These technologies will eventually have a critical impact on emissions;

- Environmental policies that regulate conventional pollutants from fossil-fueled power stations to improve air quality can also have indirect impacts on GHG emissions;

- Energy taxes, particularly on fossil fuels such as oil and coal. These are often designed to create a new, reliable revenue stream for governments (this will be covered in greater depth in Chapter 8). While these taxes are often justified on other grounds, they act as a de-facto carbon price. Adding a carbon price to existing energy taxes influences the final price signal received by the consumer and to further reinforce the penalty placed on emissions. There is the important caveat that a drop in the market price can cause emissions to go the opposite way to what was intended when the carbon price was introduced.
These energy policies address market failures that prevent the development and adoption of low-carbon technologies that cannot be overcome by energy pricing or carbon pricing alone. These market failures include:

- The results of market imperfections. Such imperfections include a lack of consumer information, various engrained energy use habits, and split incentives, as mentioned above;

- The externalities of RD&D and learning by doing. The commercial adoption of innovative low-carbon technologies requires a cost decrease. This in turn often requires significant amount of investments;

- Existing barriers to investment in low-carbon technologies. Such barriers include the intensive use of capital for these technologies.

Policies to address these market failures are sometimes called supplementary policies. However, if evaluated solely based on their reduction of GHG emissions, these energy policies generally cost more than the end carbon price.\(^{54}\) From a broader cost-benefit perspective, however, they do contribute to policy objectives beyond emissions reduction. These policies are therefore economically justified and consistent with carbon pricing, as long as their additional benefits exceed the difference between the marginal abatement cost (MAC) and the carbon price.\(^{55}\)

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\(^{54}\) The MAC of such policies depends on the carbon content of the energy displaced. This is because in the MAC calculation, the cost is divided by the avoided emissions. The same measure can appear very costly in terms of the MAC in a hydropower-dominated energy system, where the volume of emissions reduced would be insignificant, but very cheap in a coal-dominated energy system.

\(^{55}\) This might be the case in the construction of a metro line that would displace tens of thousands of cars in a congested area.
### Table 3.3 The Interactions of Carbon and Energy Policy in Net-Importing Countries

<table>
<thead>
<tr>
<th>Policy Objectives</th>
<th>Possible Positive Interactions</th>
<th>Possible Negative Interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy independence</td>
<td>The amount of fossil fuels consumed will probably decrease as prices rise because of carbon pricing and/or the reduction of subsidies.</td>
<td>Less support for the development of national fossil-fuel resources and production.</td>
</tr>
<tr>
<td>Relief from import dependence</td>
<td>Imports will likely fall with the adoption of renewable energy and energy conservation measures resulting from carbon pricing. This accompanies the development of national low-carbon resources.</td>
<td></td>
</tr>
<tr>
<td>Development of national energy sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability of supply at a reasonable price</td>
<td>In the case of a volatile carbon price, investment may suffer as uncertainty rises.</td>
<td>The large-scale development of intermittent renewable energy may affect overall system reliability.</td>
</tr>
<tr>
<td>Consumer protection and redistributive objectives (affordability)</td>
<td>A lack of subsidies for fossil-fuel consumption may be felt particularly by low-income households.</td>
<td>The final cost and price of energy may rise due to carbon pricing.</td>
</tr>
<tr>
<td>Environment protection</td>
<td>Convergence of carbon mitigation and reduction of local pollution.</td>
<td></td>
</tr>
<tr>
<td>Competitiveness of energy-intensive industries (EIIs)</td>
<td>Energy prices may increase because of carbon pricing.</td>
<td>Energy cost increase by alignment of fossil-fuel prices to the international price.</td>
</tr>
<tr>
<td>Industrial and innovation policies</td>
<td>Increase of RD&amp;D efforts in innovative low-carbon technologies, deployment support of RES-E and smart grid technologies (that is, facilitating embedded power generation based on decentralized renewable energy and so on), and accelerating medium- to long-term decarbonization.</td>
<td></td>
</tr>
<tr>
<td>Regional and rural policies</td>
<td>Regional development benefiting from the promotion of local renewables.</td>
<td>Possible conflict of existing land uses with the expansion of biofuel crops.</td>
</tr>
<tr>
<td>Macroeconomic objectives</td>
<td>Recycling of additional fiscal revenues resulting from proceeds of carbon tax and carbon permits auctioning.</td>
<td>Potential negative impact of carbon constraints on growth and employment.</td>
</tr>
<tr>
<td>Fiscal objectives</td>
<td>Convergence of energy taxation and carbon taxation (harmonization of excise duty on fuels with their carbon content).</td>
<td></td>
</tr>
</tbody>
</table>

Note: RD&D = research, development, and demonstration; RES-E = renewable energy sources for electricity.

Source: Authors’ compilation.
3.3. Carbon Pricing and Existing Energy Policies: Unexpected Effects and Conflicts

While there are numerous synergies between climate and energy policy, there are also conflicts. The exact nature of conflicts will depend on country circumstances. For instance, the potential interactions for net-importing countries is summarized in Table 3.3. Ordinarily, carbon prices are passed on to the price of energy products as well as intermediary goods such as steel and cement. This means conflicts can emerge since carbon pricing tends to increase energy prices whilst energy policies generally try to foster competitiveness and ensure affordability. Moreover, carbon pricing in the power sector could have unexpected, perverse consequences. For instance, the carbon rent on power sector could be passed onto consumers.

Carbon-pricing policies could also entail the removal of fossil-fuel subsidies, which could conflict with the energy objectives that underpinned the initial use of such subsidies. Similar conflicts can emerge between former energy policy objectives and the promotion of new renewable energy through subsidies (that is, FiTs). This is because the cost of such subsidization of low-emissions alternatives is usually paid by the consumers, sometimes through a tax. The following section presents some potential conflicts with the energy policy objectives presented in Chapters 1 and 2.

3.3.1. Negative Effects of Climate Policies on Competitiveness, Affordability, and Redistribution Objectives

Carbon pricing and the removal of fossil-fuel subsidies can have negatives impacts on energy policy objectives such as competitiveness, affordability and redistribution.

Impact of Carbon Pricing on Energy Prices at the Consumption Stage

Carbon pricing makes carbon-intensive energy sources more expensive, incentivizes a shift to lower-emitting equipment in the existing capital stock, and encourages the long-term substitution of fossil fuels by investing in low-carbon equipment. But if the price of the displaced fossil-fuel energy was initially lower than the cost of lower emissions energy sources, then the price of energy will rise. If carbon policies differ among countries, then there may be impacts on competitiveness. Theoretically, such impacts could take the form of higher production costs at EIs and the migration of investment to other countries with lower costs.

Suppressing Subsidies for Fossil-fuel Consumption

The subsidization of the consumption of motor fuel, fuel oil, and natural gas has been seen to support economic development, the mobility of goods and persons, and social equity. While such subsidies may seem excessive in several exporting countries (for instance, Venezuela), they do not exist solely in such countries. Suppressing fossil-fuel subsidies for climate-related purposes conflicts with the redistributive objective that led to their initial implementation, unless they are replaced by other redistributive instruments such as targeted social tariffs and/or cash transfers for poor consumers. These issues will be explored in-depth in Chapter 4, as will the complex topic of what qualifies as a subsidy.
Complementary and Supplementary Policies

The costs of complementary, or supplementary, energy policies that promote low-carbon energies or energy efficiency are either supported by the public budget with tax credits or direct subsidies, which are financed by electricity consumers via levies on each traded kilowatt-hour (kWh). Another way is increasing energy retail prices by forcing energy suppliers to comply with complementary policies such as green certificate obligations. Eventually, each of these approaches involves increased costs to consumers and can undermine energy price affordability.

3.3.2. Conflicts between Carbon Pricing Policies and Energy Independence and Security

While carbon pricing can be aligned with energy independence in countries dependent on oil, gas, or coal imports, it can lead to the opposite effect in countries with fossil-fuel reserves, since the development and use of these resources can then be penalized.

Negative Effects of Carbon Pricing and the Subsidization of National Fossil-fuel Production on Energy Independence

Production subsidies are used by exporters to encourage investment in national fossil fuel reserves and increase export capacity. Importing governments use production subsidies for the purpose of limiting their dependence on foreign energy and thus limit their vulnerability to external price shocks.

Countries may also choose to subsidize fossil fuel developments for employment purposes. One example of this is the subsidization of coal production in several European countries, a case study that will be explored in Chapter 4. The removal of these subsidies and/or the imposition of carbon pricing are in direct conflict with the initial objectives of these subsidies.

Negative Effects of Complementary Policies to Promote Renewables on Supply Reliability

Supplemental mitigation policies sometimes carry negative impacts on conventional energy policy objectives. The large-scale deployment of variable RES-E in the power system, pulled by nonmarket mechanisms such as FiTs or renewable energy obligations, require more technical flexibility than existing equipment can provide. In most cases, the way current power markets are designed leaves them unable to send adequate price signals to invest in flexible resources (see, for instance, Gross et al. 2006). The capacity of a system to deal with exceptional situations, such as large demand peaks and generator failure, may be altered, due to the presence of large variable RES-E capacities. RES-E heavy systems require greater reserve margins, which may be insufficient during such events. The lack of appropriate incentives to invest in peaking units is amplified when power prices are volatile, typically when the full pass-through of international fossil-fuel prices and/or carbon prices is enforced.
3.4. The Case of Liberalized Power Sectors

As noted above, the impact of carbon pricing on existing energy policies depends on national circumstances. Such circumstances include the structure and the regulatory system of the countries’ energy industries. Different issues will arise depending on whether prices are set by regulation or the market. As outlined in chapter 2, power sectors have evolved differently in the OECD and developing countries. Carbon pricing will have very different effects on a liberalized power sector in comparison to sector which is under a greater degree of integration and government control. Yet in both cases, even in the case of sectors that have undergone liberalizing reforms, regulations still have a decisive influence on the prices set on exchange markets (Grubb and Newbery 2008). The power industry is characterized by physical constraints restricting the liquidity of commercial transactions at various points where congestion occurs regularly in power systems, thus limiting the physical flows between zones. Liberalized markets therefore require the enforcement of numerous rules to create fair competition while at the same time generating short-, medium-, and long-term investment incentives.

Introducing carbon pricing in these sectors is not an easy task, and numerous ripple effects can generate unexpected results. This is particularly the case with rent allocation and capture. This section is not exhaustive, but instead aims to explain the most basic effects resulting from the central principle of merit-order price setting. This is present to some extent in most power systems. However, in some systems in developing countries, the contractual considerations of independent power producers (IPPs) largely overshadow that principle.

To start, we will present a brief description of merit-order price setting on an hourly basis for wholesale electricity transactions. We will then present the consequences of introducing carbon pricing on the wholesale market, and describe the effect of this introduction on the retail market.

In hourly based, liberalized wholesale markets, the generators who want to compete offer their generation capacity at a price that is sufficient to recover their short-term operating costs. The units participating in the competition are called along the merit order of their price bids. That is, corresponding capacities are dispatched starting with the lowest-price offer, moving up to more expensive offers until demand is met. Under normal conditions, the offer price of the last unit to be dispatched, which is called the “marginal” unit, sets the hourly market price, which is then paid to all generators that have been dispatched, irrespective of their initial offers. The accumulation of hourly surplus that results from the difference between each price bid—aligned to operating costs and the spot clearing prices—are intended to cover the capital costs and the fixed operating costs of the plants, as well as the short-term operating cost.\(^\text{56}\)

In many markets, gas-fired generators generally set this spot clearing price because the gas price per unit of electricity generated is usually higher than the coal price per unit (see left side of Figure 10). The introduction of carbon pricing is intended to change this price hierarchy and prompt the substitution of higher-emitting for lower-emitting plants on the hourly markets. As a result, the average wholesale cost is expected to increase in the following way.

\(^{56}\) Besides the core principle presented here, the generators can have tactical or strategical reasons to offer bids that differ from their short-term operating costs. Such deviations are not considered here.
Carbon pricing increases the sourcing costs of suppliers who buy part of their bulk energy on the power exchange. Generally, they purchase the remaining part through direct forward contracts, which include a price index based either on the electricity spot price (or equivalent) or on fuel prices. This index would be increased in accordance with the carbon price. Consequently, carbon pricing should increase retail prices, although the increases are not direct or easy to predict, as we will see further below.

### 3.4.1. The Effects of Carbon Pricing on Hourly Electricity Prices

The complex way that carbon pricing affects the price of electricity on hourly markets and helps to promote lower-emitting equipment is illustrated on the right side of Figure 10. On each hourly electricity market, the clearing price is generally determined by a thermal plant. When a carbon price is introduced at the generation stage, it increases the variable cost of every fossil-fuel plant. However, the increases are greater for higher emitting plants. Consequently, coal plants with the highest emissions become the marginal plants, as can be seen in Figure 10.

In the merit order, the plants with the highest emissions are replaced by lower-emitting ones and the clearing price is increased from price 1 to price 2, as indicated in Figure 10. If the demand is such that coal plants become the marginal equipment during a part of the year, the annual average price then increases. But because the coal plants are pushed outside the hourly merit orders, and are only partially dispatched, the emissions of the entire set of market players decreases.

It is important to note that if the international price of coal falls sufficiently, the reduction of the corresponding operating cost can compensate for the carbon price if it is unchanged. This was recently the case in the EU-ETS. Coal plants continue to displace gas plants because the carbon price on the ETS market does change, despite increasing demand for coal plant permits. This is in large part due to the design of the EU-ETS, which does not easily allow adaptation to macroeconomic fluctuations and an oversupply of permits. In such cases, emissions are not reduced.

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57 The strong development of shale gas in the US, which is a local market, displaced large quantities of coal, leading to a decrease of international coal prices. This made coal-fired plants again competitive against CCGTs in Europe. Consequently, several new CCGT plants had to be decommissioned.

58 However, the long-term goal of the EU-ETS is now clearly decarbonization of the power sector, and the introduction of renewable energy has reduced the revenue of both coal and gas plants. Whilst there may be unexpected effects in the short-term, the incentives to invest in long-term low-carbon generation are significant.
3.4.2. Long-Term Effects: Incentives to Invest in Low-Carbon Technologies

Whenever the hourly market price is higher than a generator’s bid, the generator receives an extra revenue. This is referred to as the “infra-marginal rent” in academic literature since this generator is not the marginal one. The sum of these extra revenues should cover the capital investment costs of the plant. Therefore, carbon pricing is intended to send a price signal to investors encouraging them to choose lower or zero emissions plants, which will benefit from higher infra-marginal rents on the hourly markets. The anticipation of these higher hourly surpluses should attract investors to invest in low-carbon technologies. This displaces existing emissions intensive technologies and lead to a market-driven transition to a low-emissions electricity system. Of course, any protective mechanisms aimed at maintaining the viability of carbon-intensive assets could undermine the pace of such a transition.

Power plants are long-lasting investments, and the evolution of wholesale prices are not easy to predict. It depends on the initial technology mix, which determines the annual number of hours during which CCGTs and coal plants are effectively the marginal plants on the hourly markets. In systems with a large share of zero-carbon technologies (that is, hydropower or nuclear plants), hourly prices would increase only when the demand is high enough for fossil plants to be dispatched. In this case, the effect of carbon pricing on the average price is much smaller than in a thermal-based system. This is because, most of the time, the hourly marginal plant does not rely on fossil fuels, and is thus not affected by carbon pricing.

In an energy mix where zero-carbon plants are not dominant, the marginal plant is most often a thermal one. In this case carbon pricing may increase the average annual price. Moreover, when a system dominated by hydropower or nuclear power is fully integrated with one dominated by thermal plants markets become more sensitive to carbon pricing. This is the case in Norway, Sweden, France and Austria.

3.4.3. Effects on Retail Prices

To the extent that carbon pricing drives up the average annual wholesale electricity price, it should also increase consumer retail prices. A price signal is sent to electricity consumers, who will respond by reducing their consumption, depending on their price elasticity. Price elasticity might vary from one group of consumers and be influenced by the time and the nature of their use.

However, consumers do not have control of the technology chosen for generating the electricity they consume. Their response is not based on their awareness of the carbon price but rather on the change in the total price. The final price seen by consumers is not purely influenced by the carbon price. It contains several other components such as transmission and distribution (T&D) costs, as well as taxes, levies, or rebates, some proportional to the supply cost, and others fixed, such as the connection fee. As an illustration, the electricity price paid by final consumers in Brazil in 2012 included 10 different taxes, levies, and other charges. This was in addition to generation and distribution costs, which represented roughly 41 percent of the final bill, effectively paid for by residential consumers in the southeast region, who consumed above 200 kilowatt-hours (kWh)/month (Associação Brasileira de Distribuição de Energia Elétrica 2015). In thermal-dominated systems any variation in the international price of fossil energy, if passed along to the retail price, will generate a response from customers. A fall in prices can offset the effect of carbon pricing. For consumers benefiting from long-term contracts59, when carbon pricing is phased in, the consumer does not receive the carbon price signal. Instead, the price increase is absorbed by the retailer, who cannot pass it on to the consumer. This may be the case for large categories of customers, or where rigid tariff structures are in place.

59 For example, a guarantee that they will pay the same electricity price for a number of years.
3.4.4. Unexpected Redistributive Effects of the EU-ETS in the Power Sector

Carbon-pricing mechanisms differ between countries and these differences can shape the resulting effects in an economy. For instance, in the case of an ETS, if free GHG-emissions allowances are allocated to power generators an undesirable redistributive effect can occur. This happened during the first phase of the EU-ETS. An ETS based on free allowances differs substantially from both a carbon tax and an ETS where allowances are auctioned with respect to how the carbon rent is shared among different economic agents. When any of these three systems of carbon pricing is applied to the power sector, electricity price bids by generators on hourly markets are aligned with the fuel cost, plus the market value of allowances, or the value of the carbon tax per unit of CO2 emitted per MWh. A distribitional issue is raised by the system of free allowances. When the allocation of allowances is free, which is the case during ‘grandfathering’ allocation, the real cost of allowances is not passed through in the prices bid by competitors. Instead, it is their “opportunity cost.”

The generators compare the costs and benefits of using an emissions allowance to generate and sell power from fossil-fuel-based plants with the alternative of selling this allowance on the ETS market (in which case they neither generate nor sell the corresponding power on the hourly market). Since a thermal-power generator can get immediate revenue by selling an emissions allowance, it might decide to use the allowance to generate power only if by doing so it can get adequate revenue; these generators therefore tend to incorporate that opportunity cost into their price bids. Since the marginal plant is usually one of these fossil-fuel-based thermal power plants, the clearing price is thus increased by a value corresponding to the carbon price (the value of the allowance on the carbon market). All power plants whose bids were below the clearing price receive that additional value—not only the fossil-fuel-based ones, which had received the allowances for free, but also those power plants without emissions (that is, nuclear, hydropower, and so on). As a result, they all benefit from additional revenues. Eventually, this price increase is paid by the end customers, thus characterizing a rent transfer from the customers to the generators, equal to the value of the free allowances on the carbon market.

It is important to note that if electricity were an international commodity exchanged on a global market (such as cement, chemical products, and so on), the producers would be forced to match the prices of their foreign competitors in countries where no such carbon-pricing mechanism had been implemented. They would thus use the free allowances to compete on a fair basis. However, since the power industry is not exposed to international competitors and all national competitors receive free allowances, they can internalize the value of the free allowance as an opportunity cost of power generation and pass it along to the end consumer. The electricity price increase by an ETS with free allowances results in a transfer of the carbon rent to producers. This is not the case with carbon taxation or an ETS that auctions allowances. The problem is exacerbated by the fact that not only non-emitting generation units receive this rent but also emitting plants, at least during the period before their replacement by clean units.

These distributional effects in the case of an ETS with free allowances raise the question of affordability for small consumers—and, for EIIs, the question of whether a rent transfer to electricity producers is acceptable. EIIs thus must pay both a direct carbon cost for their fossil-fuel use and an indirect cost for their electricity use. The effects of the carbon pricing described above are largely specific to power sectors governed by the market. This is the case for most high-income countries which use carbon pricing. These effects, particularly the distributional ones, can be quite different in countries where electricity market reforms differ structurally from high-income countries. For sectors that remain highly regulated with weak market competition means that the impacts of carbon pricing will largely depend on the regulations in place. This will be discussed further in Part 2 of this volume.

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60 The experience of sectors not exposed to international competition with countries that don't impose carbon constraints is different from the sectors that are exposed.
3.5. The Context of High Oil-Price Volatility

The efficiency of a carbon-pricing mechanism depends to a large degree on the energy-pricing policy, particularly its degree of liberalization, which determines how sensitive internal prices are to global price variations.

The theoretical and intuitive justification for introducing carbon pricing is that investors and consumers will respond to price signals and adjust their consumption decisions and investment to reduce their direct or indirect GHG emissions. The concept of price elasticity enables different kinds of economic models to test such responses and anticipate the level of emissions reductions that can be expected from a certain level of carbon pricing, whether the mechanism is a carbon tax or cap and trade. However, most economic models are based on oil price projections, which are considered stable price signals to which investors and consumers will respond. In reality, these prices are often volatile. If a country has opted for deregulating prices, its energy prices can then be as volatile as international market prices.

Oil prices have demonstrated high volatility over the past seven years. They decreased from a peak of $145 in July 2008 to $35 per barrel in February 2009, they then rose for several years at an annual average price of higher than $100–$110 per barrel. The price then fell from $110 in 2013 to around $55 per barrel in 2015. However, the combustion of one oil barrel leads to less than half a ton of GHG emissions expressed in CO2 equivalent (more precisely, 0.43 tCO2/barrel). This means that a variation in the oil price of $100 per barrel is equivalent to a variation in the carbon price of $210/tCO2.

The fluctuation of oil prices mentioned above implies a change in the carbon price from $337/ tCO2 to $81/ tCO2: that is, a reduction of $256/tCO2. Such variations are significantly larger than the carbon price used in many high-income countries. It is even larger when compared to carbon prices being considered in low and middle-income economies. Chile is considering a $5/tCO2 carbon tax and South Africa a tax around $10/tCO2.

While theoretical models anticipate a response from investors and consumers to an additional carbon price, the signal may be neutralized or lost underneath oil and fossil fuel price volatility. Assuming the introduction of a carbon price of $10/tCO2, if oil prices were to decrease by $50 per barrel (a drop equivalent to $105/tCO2), the carbon price would not lead to a net increase of the final price felt by customers; it would simply reduce the oil price drop from $50 to $45. Therefore, consumption might increase, along with associated emissions.

What can be expected from investors in the energy sector if energy prices are so volatile? Investors are averse to uncertainty. It is questionable if a marginal change in energy prices due to a carbon price would significantly alter their decisions in the context of large fossil fuel price volatility.

However, in countries where energy prices are regulated, with limited exposure to price variations, prices signals can be very stable. This constitutes a very different environment for introducing carbon pricing.

This brief analysis demonstrates that carbon pricing should not be thought of as a silver bullet. An approach based on a simple carbon price added on to energy prices might offer far fewer ways to effectively change the behavior of investors and consumers than an approach that addresses the totality of the energy signal. However, this would require policy makers to look at energy pricing and combine many policy objectives, including the reduction of emissions. Then, a new energy pricing system could emerge, allowing the use of the full energy price to promote the reduction of GHG emissions. This is an approach we will explore in the second part of this volume.
3.6. Concluding Remarks

It is essential to understand that energy prices are never determined by the simple interplay of market forces. Other factors such as (i) price instruments (which include taxes and subsidies), (ii) quantity instruments (obligation, quotas), and (iii) regulations (standards and market regulations) tend to influence private costs and prices. All these instruments affect the final energy price signals seen by customers and have been implemented to pursue specific policy objectives. Environmental and climate policies use the same set and categories of economic instruments that energy policies do. As a result, it can be expected that all public interventions using these different instruments for implementing carbon policies will have an impact on energy prices and tariffs. Such impacts may either be in synergy or conflict with existing energy policy objectives. An overview of the synergies and conflicts between climate and energy policies identified in this chapter is provided in Box 3.1.

History shows that neither policy objectives nor the set and design of instruments used to achieve these objectives are immutable. Understanding these evolutions is crucial since climate policy is not applied to a clean slate. The previous set and history of energy policies needs to be considered. In the next part, we will move from tracing the policy landscapes toward discussing solutions. We will discuss how the synergies between climate and energy policies can be maximized, and conflicts reconciled.

<table>
<thead>
<tr>
<th>BOX 3.1. Chapter 3 Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>The instrument available for climate policies are broadly similar to the types and categories of instruments used for energy policy.</td>
</tr>
<tr>
<td>Carbon pricing can have numerous co-benefits for energy policy. These include aiding energy independence, particularly for importers, providing a new source of government revenue and encouraging regional and industrial development and innovation. There can be significant co-benefits for other areas, such as health due to reduced air pollution.</td>
</tr>
<tr>
<td>Carbon pricing can also have several negative impacts on energy policies. These include undermining short-term energy independence for energy exporters, as well as trade-offs with energy security. Many of these negative interactions depend on the specific instrument used e.g. the allocation of free permits under an ETS can cause undesired redistributive effects.</td>
</tr>
<tr>
<td>Carbon pricing is not a silver-bullet. Both climate and energy policies should be considered together to maximize synergies and avoid conflicts.</td>
</tr>
</tbody>
</table>
References


http://www.abradee.com.br/setor-de-distribuicao/tarifas-de-energia/tarifas-de-energia#_ftn1.

UK Energy Research Centre, London.


PART II:

Reconciling Carbon Pricing with Energy Policies in Developing Countries

In Part I we analyzed how carbon pricing instruments might interact with a range of energy policy instruments, and how this interplay can cause both synergies and conflicts. In Part II, we will focus on possible conflicts between relevant objectives, and explore options for reconciliation through adjusting carbon pricing and energy policy instruments. We will draw lessons from recent attempts to overcome such conflicts, particularly in high income countries.

As was explained in part 1, two items should be differentiated: (i) the policy objectives, which reflect the sector’s development priorities, and (ii) the instruments adopted to achieve these objectives. While policy objectives are rarely in direct opposition, some instruments designed to achieve certain objectives could have negative side-effects on other objectives.

Therefore, the minimization of conflict—and the maximization of synergy—should be sought at the level of the instrument. Therefore, this part will focus on adjusting instruments, starting with pricing instruments in this part before moving to non-pricing instruments in Part 3. Here, we will scrutinize ways to reconcile environmental effectiveness of carbon pricing and energy independence (Chapter 4), affordability and consumer protection (Chapters 4, 5 and 6).

For the purpose of this report, we consider that the removal of fossil fuels subsidies is part of a carbon pricing policy. Indeed, there is a continuum from subsidies to taxes. Many subsidies that target certain energy products or categories of customers are financed by levies charged on others, which also affect price signals. Throughout history, countries have shifted from subsidies to taxes, and then in some cases from the new taxes to subsidies, for the same products and categories of customers. In some cases, tax exemptions have been granted for particular products or customers. Such tax exemptions have been classified as subsidies by certain authors (see IMF 2013, Coady et al. 2010). Price regulation instruments (such as price stabilization mechanisms) may be categorized as subsidies when regulated prices are below market prices, and as levies when regulated prices are above market prices.

For the sake of clarity, we will present the challenges of mitigating conflicts between carbon and non-carbon objectives for these two categories of pricing instruments separately (subsidies in Chapter 4 and taxes in Chapter 5).
4. Fossil-Fuel Subsidies: Exploring Ways to Reconcile the Policy Objectives with Climate Change Mitigation

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Fossil-fuel subsidies tend to increase the consumption of fossil fuels and thus increase emissions. They send a signal to economic agents that is contrary to the objective of carbon pricing instruments to reduce emissions. Such subsidies were not implemented to increase emissions, but for understandable policy objectives. The goal of this chapter is to explore options to reconciling the energy policy objectives behind subsidies and the objective of reducing emissions. Such goal requires first a structured analysis and understanding of the various objectives behind subsidies. To this end, energy subsidies may be mapped along three different dimensions: (i) the nature of the energy source, that is, renewable versus nonrenewable (mostly fossil fuels); (ii) the primary links of the production chain, that is, mainly production versus consumption, and; (iii) the level of development. Regarding this last comparison, as we saw in Chapter 2, differences between the current

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Note: It is important to note that the intention here is not to advocate for subsidies or subsidies maintenance. Certain subsidies might have been motivated initially by developmental goals but maintained beyond the achievement of such goals and should thus be removed. Certain subsidies might be considered ill-designed, inadequate or inefficient instruments to achieve such goals. Certain subsidies might reflect the capture of the government decisions by interest groups. This chapter does not pretend to provide a comprehensive analysis of energy subsidies nor of corresponding reforms needed. It intends to focus only on topics deemed to be relevant to facilitate the achievement of the new policy objective of reducing GHG emissions in a landscape of energy policy instruments, including subsidies, assuming that the developmental goals supporting these subsidies, as presented in chapter 1, are still deemed to be supported by the society in the considered countries. For a more comprehensive analysis of energy subsidies and guidance for energy subsidy reforms, please refer to specific literature, including: “Energy Subsidy Reform Assessment Framework” ESMAP, The World Bank. In press., Washington, DC.
conditions observed in developed and developing countries reflect, to a certain extent, differences observed across time in a single developed economy. Before delving into the particulars, it is worthwhile to explore energy subsidies as a whole.

4.1. An Overview of Energy Subsidies

According to the International Energy Agency (IEA) (2014), and setting aside for a moment the debate on how to define and measure subsidies, which will be discussed later, the structure of energy subsidies in the world has four dominant characteristics (see Table 4.1):62

First, fossil-fuel subsidies dominate, with a share of 80.5 percent in 2013. This equates to $450 billion out of $722 billion, including $344 billion for oil products, $94 billion for natural gas, and $12 billion for coal;

Second, fossil fuel subsidies in non-OECD countries dominate, at 76.3 percent of the total subsidies of these countries in 2013;

Third, the importance of subsidies in the non-OECD countries comes from their significant support of the consumption of fossil fuels. In 2013, such subsidies amounted to $548 billion (including subsidies for the electricity produced by fossil fuels) in the 25 countries that expended more than $1 billion, while the OECD countries had much lower subsidy levels ($32 billion). Though subsidies in the OECD countries represent a minor share of the global total, they are nevertheless significant: the subsidies for low carbon options were $142 billion in 2013, an increase of $82 billion from 2007;

Fourth, the subsidies in the OECD countries are concentrated at the production level, while those in the non-OECD countries are concentrated at the consumption level. When the OECD countries subsidize at the consumption level, it is mainly in the form of tax rebates or exemptions.

<p>| Table 4.1. Energy Subsidies in OECD and non-OECD Countries in 2013 (in $ billion) |</p>
<table>
<thead>
<tr>
<th>Crude Oil and Oil Products</th>
<th>Natural Gas</th>
<th>Coal</th>
<th>Electricity Consumption</th>
<th>Low-Carbon Options</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-OECD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top 25</td>
<td>314</td>
<td>94</td>
<td>10</td>
<td>130</td>
<td>548</td>
</tr>
<tr>
<td>OECD</td>
<td>30</td>
<td>—</td>
<td>2</td>
<td>—</td>
<td>142</td>
</tr>
<tr>
<td>Total</td>
<td>344</td>
<td>94</td>
<td>12</td>
<td>130</td>
<td>174</td>
</tr>
<tr>
<td>Note: The calculations refer to the IEA’s official estimations, using the price gap method based on a reference to international prices (OECD = Organisation for Economic Co-operation and Development; — Not available. Source: IEA 2014 (except for subsidies on fossil fuel in OECD countries, which is derived from GSI reports).</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

The structure of energy subsidies in the OECD countries has changed over time. Most abolished their energy price controls after the consolidation of social welfare at high levels and the liberalization of energy markets in the 1980s and 1990s. Energy subsidies in these countries generally no longer focus on consumption and pricing policies aimed at controlling inflation have almost disappeared. There are exceptions. For instance, in countries with high levels of energy taxation on oil products, where some support to low-productivity activities is still provided via tax rebates and exemptions. Indeed, most OECD governments have maintained rebates or tax exemptions on diesel for transportation, fisheries, agriculture, and, in certain cases, for horticulture. Tax exemptions on kerosene for international aviation and bunkers have been justified by the difference in

62 Note that this does not address the debate on how to define and measure subsidies. We will deal with this topic in section 4.2.
tax levels seen across countries. Some governments have also decided to retain internal taxes for domestic flights and waterway transport.

Energy subsidies in the OECD countries are now largely focused on energy production, mainly the promotion of new “clean” technologies ($142 billion). This includes grants for the research and development (R&D) of renewables, clean coal, nuclear (safety, new reactor types), and new processes, production subsidies to support the deployment RES-E and other low-carbon technologies; and subsidies to support energy-efficiency. While some fossil-fuel subsidies can be found in OECD countries, these are mainly at the production level—primarily in the oil and gas sectors ($30 billion) and marginally for coal production (only $2 billion).

Low and middle-income countries are focused on consumption-based fossil fuel subsidies. Egypt, Indonesia, the United Arab Emirates, Algeria, Iraq, Argentina (particularly natural gas), Mexico, Nigeria, and Uzbekistan subsidize fossil-fuel consumption at levels of $10 billion or more per year. In addition to its long-lasting existing coal and electricity subsidies, India has increased its subsidies of oil and gas consumption ($47 billion in 2013), despite its oil and gas dependence. Meanwhile, China, whose annual subsidies amount to less than $20 billion, has begun to reduce its subsidies to the coal and electricity sectors.63

Oil-rich, energy exporters have tended to be the largest users of consumption fossil fuel subsidies. Their significance has grown in the past ten or so years, as a result of a rise in oil prices ($120 per barrel [bl] in 2013 against $80/bl in 2007). Iran supplies the most subsidies, with $84 billion in 2013 (85 percent in oil and gas), followed by Saudi Arabia with $62 billion, Russia with $40 billion (mainly in natural gas and electricity), and Venezuela with $35 billion (IEA 2014, 321).

4.2. Subsidizing Energy Production: Energy Independence and Climate Policy

Historically, the main policy objectives supporting the subsidization of energy production have been energy independence and security. Such policies are not necessarily tied to fossil fuels, since the development of alternative energy sources also serves these objectives. The development of bioethanol in Brazil and nuclear energy in France in the 1970s and 1980s are examples of policies that were motivated by energy independence and security and supported low emissions energy sources. More often, such objectives justify subsidies for the national production of fossil fuels. These subsidies are now seen to undermine efforts to mitigate climate change.

The benefits and costs of energy production subsidies vary drastically across energy exporters and importers. In energy-importing countries that have few national oil and gas resources, the overall effects of carbon policies on energy security are expected to be positive (see Chapter 1). They can limit the vulnerability of consumers and their economies to high and volatile energy prices set by global commodity markets, and increase the security of supply. Reforms of fossil-fuel subsidies can create incentives to adopt energy-efficiency measures, and use lower emissions energy sources.

In fossil fuel exporters, the equation differs significantly: the suppression of subsidies for fossil-fuel production can hinder energy independence and national economic activity, as it would mean eliminating support of the national production of oil, gas, or coal. This debate has been developing for quite some time in the OECD countries, and their experiences—in particular how they address such potentially conflicting objectives—are illuminating.

63 The level of subsidies in India and in China in 2007 was, respectively, $20 billion and $25 billion (IEA 2008).
The experience of high income exporters and importers reveals some of the dilemmas in reforming fossil fuel production subsidies. The phasing out of subsidies of coal production in the EU, and the suppression of tax reliefs for oil exploration and production in the US, Canada and the UK are two informative cases.

4.2.1. Aiding the Transition: Lessons from Phasing Out Coal Subsidies in the EU

Subsidies of coal production in Europe were traditionally justified by EU member states as fulfilling the national objectives of limiting energy dependence and maintaining local economic activity in steel and coal producing regions. The subsidies needed to maintain these production levels steadily increased in the 1970s and 1980s, due to the rising costs of labor and social protection (pensions and social security) among coal miners. In 2000, the cost per miner was valued at about €30,000 in Spain and around €100,000 in Germany (De Moore 2001).

In line with its climate policy, in 2000 the EU decided to minimize subsidies of coal production. Maintaining the expensive domestic production of coal could no longer be justified by the goal of energy independence and security. In 2010, subsidized European coal contributed only 5.0 percent to the total EU energy mix, and the power generated using such coal contributed only 12.6 percent of total European power generation. Moreover, these subsidies depended on an exceptional regime that was seen to be violating articles of the EU Treaty on state aid. This regime has been revised by successive directives every ten years. The 2010 directive is aimed at a complete phase-out of subsidies within the decade.

Resistance to a decrease in coal subsidies has been strong in several EU countries. Initially the European Commission proposed October 1, 2014, as the date for state aid to be phased out. But Germany, Poland, Spain, and Romania succeeded in postponing the phasing out of their direct subsidies. In response, the Commission changed its proposal. The overall amount of aid granted by a member state is now to be gradually reduced, by 25 percent by 2013, 40 percent by 2015, 60 percent by 2016, and 75 percent by 2017. The closure of the last uncompetitive mines in Germany is scheduled for 2018. Spain, Poland, and Romania, meanwhile, have not yet decided to close their costly mines and still pursue a policy of subsidization. In Poland, the coal mining and energy production industry received an average subsidy of €2 billion per year between 2005 and 2012. Spain’s power generation companies are under a public service obligation to produce up to 23.4 terawatt-hours (TWh) per year from the mandatory purchase of coal by the 10 coal plants, and contract directly with mining companies for the volume and price of coal under their quotas. The coal industry, therefore, receives direct aid, principally in the form of transfer payments from the government, to compensate for the difference between its operating costs and the prices at which it sells its production to coal power plants.

Since 2012–13 policies have evolved a consequence of the economic crisis. Among austerity measures, the Spanish government cut subsidies to coal mining companies by 80 percent, from €300 million in 2011 to only €55 million in 2013. All support measures are to be terminated by 2018.

The European Commission endorses subsidies aimed at supporting transition, not continuous production. Its authorization of aid for direct production is conditional on (i) a firm closure plan over ten years and (ii) the implementation of energy-efficiency and renewable energy projects designed to fill the gap equivalent to the coal production decrease. Subsidies are also justified for the environmental restoration of sites and their economic reconversion (EU Council of Ministers 2010).

In the EU, the social consequences of an abrupt cessation of coal production would be significant. Instead they opted for a slow phase out of subsidies to promote a steady transition. The gradual closure of French
coal mines began in 1986, and was spread out over nearly 20 years. The last mine was closed in 2004. The European experience could be useful for developing countries with costly production supported by direct subsidies, or held captive to contracts with public electricity companies. It is important to balance the social benefits of such incremental change with its opportunity cost—that is, any profits that might be gained by closing production units faster, in particular by comparing savings to the additional cost of the production being maintained (UNEP 2008, 26).

The key lessons from the EU experience of phasing out subsidies for coal production can be summarized as follows:

• Despite the costs and the environmental impact of coal, its subsidization supports key energy policy objectives. There are also important political economy considerations. The production of coal was concentrated in a few key regions and incumbent industries that would be hard-hit by the quick termination of subsidies;

• The objective of mitigating climate change has changed the landscape: the benefits of maintaining costly coal production through subsidies for national and regional production are outweighed by coal’s effects on overall emissions. The falling price of renewable energy and gas has also made the subsidization of coal increasingly difficult to justify;

• An exit plan can be effective while also supporting the transition in impacted communities and regions.

4.2.2. Lessons from the Suppression of Tax Reliefs for New Oil and Gas Production in the US, Canada, and the UK

Developing domestic energy sources can have benefits for both importers and exporters. For a net importer, such development limits energy imports and buffers against frequent oil shocks. For an exporter, it offers an opportunity to create new sources of export revenue. While there are trade-offs with global mitigation objectives, several high-income countries have regularly provided support for the development of new oil and gas fields in pursuit of these benefits.

This is typically done by relaxing typical fiscal constraints. Such support was implemented after the first oil crisis of 1973, and when technical progress offered opportunities to develop new national resources (Mitchell 1999). Oil and natural gas benefited most from percentage depletion allowances; oil production benefited greatly from regulatory subsidies, such as those allowing higher-than-average regulated rates of return on oil pipelines. This support went beyond the relaxation of the national fiscal systems used to levy severance taxes, royalties, and special petroleum duties, and was granted regardless of the profitability of the fields in question.

The emergence of concerns regarding climate change has not prompted a decrease in tax relief support for the exploration and production of hydrocarbons in the US. In the US, a debate at the end of the 2000s centered on whether to eliminate tax preferences awarded to oil and gas companies—which cost around $3.4 billion in 2009—with the goal of conforming to the G20 recommendations on subsidies (Allaire and Brown 2009). But for an importer such as the US, the benefits of reducing oil imports by increasing national production are significant (Leiby 2007). Despite the opportunity cost associated with allocating fiscal resources for this purpose, tax reliefs on fossil-fuel production remained at a similar level in 2013 ($3.2 billion) (Dinan 2013).

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65 This was performed through percentage of depletion allowance, tax credits, exemptions from royalties, and other measures.
66 There are also economic discussions about the tax neutrality principle. The foregone revenue necessitates higher taxes on other activities to close the budgetary gap, and those tax gains further shift the mix of economic activity away from that determined in a free market (Allaire and Brown, 2009).
Similar approaches are prevalent in high income exporters. In Alberta, Canada, the development of unconventional oil production—that is, bituminous shale extraction, known to produce carbon dioxide (CO2) emissions—has benefited from tax reliefs. The process was excluded from Canada’s emissions reduction target in the Kyoto Protocol even before the country left the protocol in 2011. The balance between the perceived benefits of extraction and reducing emissions are reflected in policy. A new carbon tax in Alberta would charge an initial $20 per ton of carbon dioxide (tCO2) in 2017, to be increased to $30/tCO2 in 2018. The tax would be accompanied by an output-based subsidy to defend the international competitiveness of domestic firms. Some analysts forecast that this may compensate a number of oil sands facilities for the cost of the carbon tax (Tombe 2015). The UK presents another example of the tension between fossil fuel production and climate objectives. In 1993, the British government decided to change its taxation system to slow the decline of North Sea oil and gas production and protect its balance of payments (Kemp and Stephen 2007). In 1992 the government had acted to reduce domestic demand for fossil fuels by implementing a carbon addition to the excise duty tax on motor fuels. In the beginning of the 2000s, it considered introducing a climate-change levy and an Emissions Trading System (ETS) in industrial sectors. Yet it continued simultaneously protecting its North Sea Oil production.

The paradox between increasing domestic climate action and the continued economic promotion of fossil fuel exploration and development has both instrumental and political explanations. Instrumentally, the development of domestic energy sources has several economic benefits, particularly for importers. Politically, extractive industries tend to be economically and socially powerful incumbents. The continued government support of the fossil fuel industry in the above case studies was underlined by effective lobbying efforts. This can be exacerbated in the case of exporters with well entrenched, and often government supported, energy production industries.

It is worth noting that in the absence of a global agreement directly eradicates or limits the extraction of fossil fuels from the Earth, if one country refrains from developing new oil and gas production, this development will likely occur elsewhere—and imports will take the place of national production. At the end of the day, global emissions will remain unchanged. And, it could be argued, national production could just as well meet diminished demand as could imports. Thus, in the absence of such global agreement, reducing demand for fossil fuels appears as a more promising way to mitigating emissions.

From this perspective, it might still make sense for a country to develop its hydrocarbon resources to spur economic growth; domestic upstream sectors (oil services, equipment, shipbuilding, and so on), sales, and resources promise to improve the balance of payments. For a net importer, such development limits energy imports and buffers against frequent oil shocks. For an exporter, it offers an opportunity to create new sources of export revenue.

However, this perspective might change if countries start to anticipate that new investment in oil and gas national production may result in stranded assets. The use of production subsidies to encourage fossil fuel extraction and development are highly likely to be incompatible with the long-term goals of the Paris Agreement. Several studies conclude that compliance with efforts to keep the increase in global temperature below 2° C during the 21st century would mean that a significant share of known oil and gas reserves can never be extracted. For example, the IEA projects that no more than one-third of proven reserves of fossil fuels can be consumed prior to 2050 if the world is to achieve the 2° C goal, unless carbon capture and storage (CCS) technology is widely deployed (IEA 2012). A recent study in Nature Climate Change came to even more stark conclusion: half of oil reserves, a third of gas reserves and 80 percent of coal reserves need to remain unused to meet the goals of Paris (Mcglade and Ekins, 2015). Under this modelling the early use of CCS beginning in 2025 has little impact on the amount of ‘unburnable carbon’. The Bank of England is conducting an enquiry into the risk of fossil-fuel companies causing a major economic crash if future climate change rules render their coal,
oil, and gas assets worthless. This risk is being called the “carbon bubble” and is being taken increasingly seriously by various financial companies, including Citibank, HSBC, and Moody’s.67 This issue has also been discussed by the Financial Stability Board through the Task Force on Climate-related Financial Disclosures.

The transposition of this discussion to low and middle-income exporters is relevant, given that these countries have even more reason to develop and use their hydrocarbon resources to fuel energy development than the high-income countries where energy demand is already stabilized. Consider the case of Mexico. It has recently implemented a carbon tax as well as a suite of other climate policies under its 2013 National Climate Change Strategy. Yet is has also adopted new legislation to open its hydrocarbon resources to foreign companies, aiming to help the development of new resources with foreign private capital and technological resources (Godoy 2014). In some cases, countries will require continued use of fossil fuels to maintain energy independence and security. This may often be due to geopolitical circumstances, as is the case with Lithuanian use of natural gas to avoid dependence on Russia. In these cases, the use of fossil fuel production and import subsidies still reflects reasonable energy policy goals and national circumstances.

Overall, for countries of all incomes, both energy independence and emissions reductions are not mutually exclusive. The strategic importance of economic development opportunities and energy independence from the development of national resources does not oppose the rationale of internalizing the costs of GHG emissions from oil and gas production. Significant progress can be made by enforcing regulations to reduce emissions at the wellhead, or by implementing a series of other instruments, including fiscal ones. But ultimately internalizing the cost of carbon emissions at the level of consumption might be a more effective and efficient way to reduce emissions.

To summarize the analysis on energy production subsidies:

- The subsidization of new oil and gas production (via tax reliefs) works toward key objectives of domestic energy policy: increased energy independence and economic activity. These are priorities even in high income countries. The power of incumbent industries has also led to the continued subsidization fossil fuel production in the above case studies;

- Different from coal, projections of climate change have not yet changed the landscape for the development of oil and gas resources, even in high-income countries. There is still no immediate complete alternative to oil and gas, meaning that the key objectives of energy independence and energy security still depend on secured access to these fossil-fuel sources; to some extent, subsidies of national production still reflect the importance of these objectives—even in those high-income countries committed to fighting climate change. The benefits associated with the development of new oil and gas resources are still seen as more important than the carbon externalities;

- This might change if countries start to anticipate that new investment in oil and gas national production may result in stranded assets;

- Reducing energy demand through energy conservation, in particular for oil and gas products, is as important as replacing carbon-intensive supply sources with low-carbon ones, and can reduce emissions faster. In fact, unless subsidies of national oil and gas production lead to lower final prices than imports, the level of demand for fossil fuels—and therefore corresponding emissions—are not affected by such subsidies at

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the production level. At least in the short to medium term, eliminating such subsidies would only prompt a rise in imports to meet otherwise unchanged demand;

- It is also possible to accelerate the transition to low-carbon and/or neutral energy systems by using lower-emitting fuels whenever it is possible to replace carbon-intensive energy sources at the national level. For example, in the United States coal-fired power plants can be replaced by gas-fired combined-cycle gas turbines (CCGTs), and, in the longer term, RES-E and, possibly, CCS technology can be deployed on a larger scale;

- A series of policy instruments can be designed and used to generate and align incentives to achieve the twin goals of (i) accelerating lower/zero carbon energy penetration and (ii) reducing energy demand.

4.3. Subsidies to Energy Consumption: Reconciling Social and Redistributive Issues with Climate Change Mitigation

An earlier discussion of how energy policy objectives map to corresponding policy instruments highlighted how countries have subsidized energy prices for several social and economic reasons. These reasons include granting access to energy at affordable prices (particularly to meet the basic energy needs of low-income consumers), supporting the competitiveness of energy-intensive industries, promoting regional development (specifically rural areas that are expensive to serve), and, at times, controlling inflation. These various objectives can be broadly referred to as the redistributive objectives of energy policies, since corresponding subsidy mechanisms redistribute part of the costs incurred by beneficiaries to other categories of customers—or sometimes to taxpayers in general, when the difference between the real cost and the price is borne by the government budget. In short, these mechanisms redistribute part of a country’s wealth to beneficiaries, who pay less for the energy they consume than this energy’s cost to society.

As noted earlier, the majority of high-income countries have phased out most subsidies at the consumption level. At their present level of welfare and infrastructure development, all households have access to commercial energy, and in particular electricity, at an affordable cost when compared to per capita income. Given the slow growth of the demand in these countries since the seventies, the energy markets in these countries are considered as “mature”. This maturity was reached before climate change concerns became a predominant official policy issue.

As noted in Chapter 2, the difference in the socioeconomic development of high income countries relative to low and middle-income countries imply significant differences in the order of priority for their energy policies. This translates into a very different landscape for energy pricing policies, particularly subsidy practices. In developing countries, the priority is still the satisfaction of basic needs. Even in emerging middle-income countries where access rates are now very high, this goal has been achieved only recently. Ensuring that the poor can afford to meet their basic energy needs continues to be a commonly shared policy objective.

As poor people face many unserved priorities (food, health, transport, energy, education, etc.), they might not be able to allocate enough resources to pay for the minimum energy quantity required to meet basic energy needs, especially for the most fragile ones. Such basic energy needs include among others: (i) lighting: the

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68 As a matter of fact, total life-cycle emissions associated with national oil and gas production might be higher or lower than those associated with imported products, depending on the quality of the resources and associated upstream and midstream emissions.
69 Our Common Future, also known as the pioneer Brundtland report, from the United Nations World Commission on Environment and Development (WCED), was published in October 1987.
70 See, in particular, Table 2.3 in Chapter 2 of this volume.
absence of minimum lighting lead to safety issue both regarding risk of domestic accidents, in particular for kids and elders, and increased violence, in particular for women, and; (ii) cooking: affordable and clean energy for cooking is a necessary condition for proper nutrition in most countries and regions and reduce exposure to harmful indoor pollution.

Therefore, it is unsurprising that energy products for basic needs are still underpriced in these countries, and are either subsidized by the public budget or cross-subsidized by better-off consumers of the same energy product or by customers of another one.

Redistributive goals have led to extensive use of subsidies by both importers and exporters. There is a long-lasting practice of setting domestic prices below international prices and in exporters, subsidizing consumption by administered prices below production and distribution costs. In importers, consumer protection and inflation controls combine to justify the control of oil products’ prices against international oil price hikes, sometimes also working in the other direction by preventing domestic price drops in case of counter-shocks. This concerns not only products dedicated to satisfying basic needs (kerosene for lighting, liquefied petroleum gas (LPG) for cooking), but also motor fuels for transportation, heating fuels for industry, and electricity for various consumer groups. However, the prevalence of subsidies is being challenged.

Since 2009, several countries confronted with major public deficits are trying to reform subsidy practices. This reform has been advocated by international organizations, in particular the International Monetary Fund (IMF 2013a, 2013b), on the grounds of economic efficiency (especially the better allocation of resources) and mitigation by decreasing excessive energy consumption. While some countries have already reduced subsidies, in particular on electricity, moves to do so face significant political resistance.

Now that low and middle-income countries are embracing a climate change agenda, the challenge of combining the new objective of reducing emissions with their former energy policy objectives require a closer look at the rationale and consequences of removing such subsidies at the consumption level. High income countries can offer lessons, particularly since they phased out most consumption-level subsidies before looking to mitigate GHG emissions. While the experience of high-income countries is valuable; the challenge of balancing objectives must be viewed from the perspective of developing countries.

### 4.4. The Fossil Fuel Subsidy Debate

#### 4.4.1. The Critiques of Fossil Fuel Subsidies

Large-scale subsidies of fossil-fuel consumption are generally criticized for their (i) macroeconomic effects, (ii) contribution to energy inefficiencies and associated environmental impacts, (iii) illegitimate distributional effects, and (iv) incompatibility with long-term climate goals.

**Fiscal and Macroeconomic Impact**

Four critical aspects of the macroeconomic effects of subsidies are often noted by observers:

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• Fossil-fuel subsidies affect the public deficit. For instance, most price-smoothing schemes build up deficits if high prices last longer than expected, requiring budgetary transfers or large public loans. This involves significant fiscal costs that affect the business cycles of developing economies (Kojima 2012);

• They divert the use of public resources away from welfare objectives and long-term growth. The IEA points to the importance of total subsidies as a share of the gross domestic product (GDP)—a share that is, for example, around 20–25 percent in Iran, Uzbekistan, and Turkmenistan; and 10 percent in Egypt and Venezuela. The share of subsidies is often much larger than that of public spending on education and health (IEA 2014);

• For oil-rich countries, they reduce potential revenue. Removing subsidies would eventually generate an export potential for national oil, which implies new revenues for the public budget via the taxation of the national oil company.

Energy Inefficiency and Environmental Impacts

Subsidized energy prices generate inefficient behaviors and suboptimal equipment choices, which result in an allocative inefficiency (that is, fuel is overconsumed in the absence of incentives to choose more efficient cars, appliances, and industrial processes). The budgetary costs of subsidies have an opportunity cost for emissions reductions. For examples, subsidies reduce the public resources available to develop public transportation, which, in turn, would help decrease emissions. The cumulative emissions and environmental impacts of preferring subsidies can be significant.

Subsidies can also deter energy efficiency by increasing the payback period for more efficient equipment (IEA 2014: 327). For instance, in Saudi Arabia, where the gasoline price at the pump was $0.15 per liter in 2013 (compared with $0.97 in the US and $2.10 in Europe), it would take 18 years to recover the cost of upgrading to a vehicle that’s twice as fuel efficient. Removing subsidies and aligning internal prices with the international price would cut the payback to three years (considering the annual mileage of an average car in Saudi Arabia). Another example concerns lighting in the building sector of Middle Eastern oil-producing countries, where it accounts for more than 15 percent of lighting demand. The payback period for investment in lighting emitting diodes (LED) is almost 10 years on average across the region. It would be only around 1.5 years if electricity tariffs were to recover the full cost of supply (IEA 2014).

Inefficiency of Redistributive Effects to the Poor

Critics of fossil-fuel subsidies consider price controls an inefficient means of protecting the poor, curbing inflation, and achieving other objectives. The objectives may be admirable, but subsidies are not seen to be an effective of efficiency way of achieving them. They highlight the fact that subsidies at the consumption level are either (i) not well targeted since they generally do not distinguish among social groups (as with subsidies on motor fuels, kerosene for lighting, LPG for cooking); or are (ii) not properly designed (in the case of universal social tariffs or electricity lifeline rates, whose design generally allows higher-income groups to benefit from them, thus diverting these subsidized tariffs from their initial purpose). In the case of gasoline, the IEA argues that only 8 percent of the fossil-fuel subsidy reaches the poorest 20 percent of the population (IEA 2014: 318). There, the IEA proposes other direct forms of welfare support that lower overall costs.
In addition, delays in financial compensation to the agents of the supply chain of subsidized products can lead to fuel shortages on official markets and diversion to black markets, making consumers pay far in excess of the official subsidized price, eventually consuming less the subsidized products (Kojima, 2017).

### 4.4.2. Nuancing some of the Critiques

Many of these arguments reflect legitimate concerns, but they can sometimes overlook the key policy objectives behind energy subsidies. Some reports on the topic argue that fossil-fuel subsidies have many negative impacts and should therefore be removed. Others simply inventory fossil-fuel subsidies "regardless of their impact or of the purpose for which the measures were first put in place" (OECD 2013), and take no position on their removal.

The redistributive impacts of energy subsidies are one issue that requires a more nuanced approach. At first look, universal subsidies might target lower-income groups but end up mainly profiting higher-income groups, as lower prices encourage them to develop their consumption. Previous studies have found ample evidence of this occurring in practice. It might then be argued that such subsidies increase social inequalities. But this can overlook the contribution of these subsidies to satisfying the new needs of lower-middle-income groups, beyond the needs of the poorest 20 per cent.

Lower-middle-income groups can be significantly affected by the suppression of such a universal subsidy, whether it be for fuels or electricity. This is because their standard of living is near that of the poorest group. They represent a large share of the population in middle-income countries, and tend to be too quickly excluded from the poor category targeted by local programs to reduce extreme poverty reduction. Yet they are still very far from the level of welfare attained by developed countries when these decided to phase out consumption subsidies in the 1980s. In South Africa, for instance, the revenue of a middle-income household of four persons was between $180 and $544 per month in 2008. On this year the transport budget per month by an individual car at the current gasoline price of 0.87 $ per liter in 2008 (GIZ 2008) represents at least 15 percent of the family budget in the best case. While subsidies may be incentivizing transport use, it is necessary to ensure that low-emissions alternatives are available. This includes decarbonized fuels as well as public transport.

From a theoretical perspective, one can argue that because the marginal utility of income decreases as revenue increases, lower-income individuals gain a higher increase in satisfaction and happiness from subsidies than higher income groups. Conversely, satisfaction degrades much more for low-income groups when a subsidy is suppressed.

Moreover, when it comes to universal subsidies for motor fuels, these subsidies do not directly concern the 20 percent of people in lower-income groups, who usually cannot afford to own a vehicle, but rather lower-middle-income families. Given that public transportation infrastructure is insufficient in many cities, many such families depend on private vehicles. Aligning the internal price of gasoline to the international price would significantly impact the welfare of this group.

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72 Unlike social welfare programs in the OECD countries, programs in developing countries usually focus on extreme poverty, in particular the eradication of hunger.
73 “It should be better appreciated that the middle group in South Africa, comprising 4.2 million households [31% of households], is quite poor (receiving between R1,520 and R4,560 as their total household income per month for a household of four, in 2008 Rand) [$182–$547/month, using an exchange rate of $0.12 for 1 Rand]” (Visagie 2013).
74 Hypothesis: distance traveled of 1000 km per month with 9 l consumption per 100km.
75 Moreover, let us consider an individual who cannot satisfy his or her basic needs. This person will receive increasing marginal utility from additional income to the point where all his or her basic needs are met; that is, additional income beyond this level has decreasing marginal utility.
Last, but not least, if subsidies do not reach poor consumers because these consumers have no or only limited access to commercial energy networks, in particular in LDCs, removing the subsidies might not be the only, or the most appropriate, solution. It might be more important to extend the subsidy to nonconventional energy sources that can more easily reach marginalized populations. This is the case in Brazil, where conventional diesel-based generators, renewable-energy-based mini-grids, and stand-alone solar systems serving isolated populations in the Amazon region benefit from subsidies. These groups are charged tariffs similar to those of comparable income groups connected to a grid.

A second set of issues arise from the question of how to characterize a subsidy:

International price or national production costs? There is a substantial difference between exporters and importers. For an importer, the reference should be the marginal cost of supplying the national demand, which is usually the international price. For an exporter country the reference could be the average or the marginal cost of oil extraction. In an importing country, removing subsidies should not be done to the detriment of the legitimate policy goals of economic and social development. Self-interested exporters have legitimate reason to price oil products below the international market price. Doing so, however, does not prevent the possibility that negative environmental impacts will be internalized (any such internalization should also be applied to international prices). This argument also applies to importers where imports represent a minor share of national consumption. However, this case is more complex: an alignment of the internal price to the national production cost would affect national oil refiners that need to import some amount to uphold their market share. One solution, as adopted in the US in the 1970s, is to fix the internal price as a weighted average price reflecting the respective shares of imports and national production for supplying the national demand of refined products. Such a solution is quite easy to implement when there is only one national retail monopoly for oil products, as is still the case in numerous low and middle-income economies. The situation is more complex when there are several companies with different shares of imported oil, as seen under US price controls in the 1970s (for details, see Chapter 2).

International oil prices also result from speculation, not only market forces. When critics of fossil-fuel subsidies argue that the difference between international prices and internal prices should be considered a subsidy, they supposedly assume that international oil prices are set by an efficient and balanced demand-supply energy market, with no or limited financial speculation. The second point here is an important one rarely put forward: what is the effect of the financialization of oil and commodity markets since 2004? In that year the liquidity of the oil market more or less quadrupled, with no specific reasons related to the crude oil trade. In 2008, after the subprime crisis, speculators shifted in mass from financial markets toward commodities markets, and, as a result, oil prices skyrocketed up to $143/bl (Einloth 2009). Oil price fluctuations are now in great part the result of the speculative moves of the so-called "noncommercial traders", who are not driven by the same concerns and do not build their anticipations with real expertise as those in the energy business. The speculation not only increases the volatility of the oil prices but as usually on different financial and monetary market with bubbles, keep longer peak prices by the game of converging anticipations (Fatouh et Killian 2012). Evidence by econometric studies is shown by a number of econometric studies (for instance Morana, 2013). Wholesale criticism simply fails to embrace the reality of both international oil markets and the social realities of countries still struggling to promote development. In countries where a great part of the population’s basic needs is barely met, the objective of protecting against oil price hikes is not irrational.

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76 Exceptions can occur when the country has some national reserves whose production costs are very close to international prices. If the international price increases above that national production cost, then the marginal cost becomes national production cost.

77 For an overview of the objectives that have led many countries to apply subsidies at some point in their energy policy history, see Chapters 1 and 2.

These points do not challenge the need for reform but suggest that the removal of subsidies needs to be conducted in a careful manner. Not all subsidies are legitimate, or when legitimate, are correctly designed or implemented. Nor are that subsidies necessarily the most appropriate instrument with which to pursue a legitimate energy policy objective. However, ignoring or negating the policy objectives behind subsidies is not advisable. Such an approach can, rather than encouraging low emissions development, antagonize key stakeholders and decision makers. It is therefore essential to look for ways to reconcile conflicting objectives, or at least propose a balanced approach to addressing them.

Fossil fuel subsidies were designed with a clear social and development objective in mind. They can achieve these objectives, but often with perverse outcomes. Often there are other options which may meet these objectives without increasing emissions. It is a matter of determining when subsidies should be phased out, or substituted, and with what alternative instrument. Reform is needed, but it needs to be targeted, nuanced and aware of the impacts. The goal is to mitigate negative impacts on emissions without undermining other underlying policy objectives. Luckily there are options for reconciling these goals.

4.5. Reviewing and Reforming Consumption Subsidies

Reforming fossil-fuel subsidies, or replacing them with other instruments, requires a careful analysis of specific circumstances so that appropriate and acceptable solutions can be designed. For example, in a country that is using significant amounts of coal to satisfy basic needs (heating, cooking), would emissions be reduced faster by subsidizing the use of gas—another fossil fuel—than by removing coal subsidies altogether, if gas remains more expensive? In a country where renewable biomass offers a reliable alternative, subsidies should focus on such zero-carbon alternatives rather than LPG.

There is no one, generic solution that can be applied to all developing countries. The unilateral removal of fossil-fuel subsidies is no silver bullet if they are not replaced with other instruments that address the redistributive objectives. Such an action would put climate objectives in opposition to development priorities.

Often the greatest barrier to reforming subsidies is not meeting redistributive objectives, but ensuring political acceptance. Lobby groups and specific demographics will often oppose changes to subsidies which they benefit from. This varies across countries. For example, subsidy reforms in Yemen required a raise for military staff. The currently low level of international oil and coal prices offers a unique opportunity to reform subsidies, and test innovative solutions, with minimal political risk. Even so, such subsidies should not be simply erased without any further policy adjustment. In the many cases where subsidies reflect a legitimate social policy objective—and that of equity in particular—simply erasing them is not a sustainable option. As soon as international prices rise again, so will people’s demand for access to energy at equitable rates.

Several existing tools and methods may be used to map out exactly how existing redistributive instruments conflict with the new objective of controlling carbon emissions, conclusions should be viewed cautiously. Alternative redistributive instruments must be designed and implemented to support clean, sustainable development.

79 For more on these challenges, and in particular how social acceptance issues slow reforms, see the IEA’s analyses in the successive World Energy Outlook reports since 2011. Each report includes a special chapter on fossil-fuel subsidies with a section on the difficulties of implementing reforms.
80 In the case of liquefied petroleum gas (LPG) in cylinders.
81 For instance, renewable charcoal, solar heaters and cookers, ethanol gel, and so on.
4.5.1. Transitioning Subsidies from Carbon-intensive Fuels to Low-carbon Alternatives

In recent years, the cost of renewable energy has been falling, making it increasingly competitive with fossil fuels, particularly oil and coal (especially at the international prices observed before the recent drop). It is possible to consider a shift from consumption subsidies for fossil fuels to subsidies for low-carbon, renewable energy. Several distinct policy instruments may be required. For example, energy prices alone will not encourage people to replace electric, gas, or coal-based water heaters with solar ones. Instead, various efforts may be combined to promote social equity while mitigating the emissions associated with fossil fuels. The socioeconomic priorities of development require that redistributive mechanisms be expanded and adapted to the use of renewable energies—and not just that fossil-fuel subsidies be eliminated. This transition should make the phase-out of fossil fuel subsidies more socially and politically acceptable.

4.5.2. Smart Cash Transfers and Better Targeted Subsidies

An alternative to reducing the energy bills of low-income households via subsidized prices is to provide them with cash to help them pay these bills. The advantage of this approach is that it does not distort overall energy prices and therefore removes the incentive to consume more. Theoretically, customers will adjust their consumption to higher prices, even if they receive some cash compensation, the rationale being that they would prefer saving what cash they can than paying a higher energy bill.

However, it is important to remind that while subsidies do introduce price distortions, which increase consumption, this is actually the objective pursued by the policy regarding low-income households: to allow access to basic needs which would otherwise not be fulfilled quantitatively because of low-income constrains. As cash transfer are fungible and poor people face many unserved priorities (food, health, transport, energy, education, etc.), they might not be able to spare enough resources to pay for the minimum energy quantity required to meet basic energy needs, especially for fragile and dependent persons, who usually do not participate to the allocation decision, characterizing a principal-agent issue (i.e. lighting: absence of minimum lighting lead to safety issue both regarding risk of domestic accidents, in particular for kids and elders). In poor areas, increasing tariffs by eliminating lifeline tariffs can lead to increasing payment defaults, or even fraud, particularly in regions where fraud and payment default are already very high (i.e. above 30 percent).

Still, the design of cash-transfer programs can be improved. One case is that of Brazil where early subsidy designs for LPG initially created perverse outcomes. To prevent the illegal use of subsidized LPG for transport and by industry, the price-based subsidy was replaced in 2002 by an LPG cylinder-refill voucher awarded to only low-income families. However, in the case of lifeline electricity tariffs, direct cash-transfer was not an option. Indeed, there are other factors to consider. For instance, if social tariffs are subsidized via a cross-subsidy among customer groups, as this is the case for electricity in Brazil (and in many countries) or among energy products (as with oil and gas products), the actual monetary flow might not be easy to isolate and re-channel via a scheme outside the sector.

Also, national circumstances play an important role in deciding whether such a scheme makes sense or not. If the country already has an efficient cash-transfer program to reduce poverty, then a program focused on energy could be phased in at a relatively low marginal cost. Where no efficient, socially sound cash-transfer program exists, it might be difficult to create an efficient financial mechanism disconnected from energy billing. The long chain of administrative and financial processes involved can turn such a mechanism into an expensive one subject to error and fraud. In fragile states, where governance capacity is usually far weaker than the utility companies, this might simply be unrealistic.
Therefore, in many cases, when subsidies cannot be eliminated, the challenge is to offer clean alternatives and more access to energy efficient devices than to eliminate subsidies (which can be partially converted into targeted subsidies for lowering the price of efficient devices). Still, the targeting of subsidies, when these cannot be eliminated, can be improved to reduce opportunistic behaviors leading to additional energy consumptions and eventually emissions. Again, in Brazil, lifeline electricity tariffs set in 2002 are no longer based on consumption (after they were seen to benefit vacation houses). Since 2010 they have instead been aligned with the criteria of the “Bolsa Família” program, a direct cash-transfer poverty reduction program.

Net exporters constitute a special case, as the value redistributed from oil rents might exceed what is needed to achieve abatement of fossil-fuel prices. In such cases, the implementation of a universal minimum revenue financed with oil rents might be a preferable option. If an oil-exporting country opts to align internal fuel oil prices with international prices, the revenue effects could be compensated by implementing a universal regime of minimum revenue by redistributing the very significant increase in the oil rent collected by the state. In that case, the goal would not be to more than compensate the income effect of fuel-price increases, but to establish a universal minimum revenue.

This system was applied in Iran after 2010 in parallel with the progressive adjustment of internal price on international prices. This was accompanied by a compensatory transfer to households of up to $43 per person per month for each family. In 2012 this accounted for $3.8 billion per month. But the additional budget revenues were only $2.8 billion per month, which prompted the Iranian budget to help finance this measure, with recourse to loans from the central bank and the abandonment of other objectives revenue recycling, in particular in consuming industries (Hassanzadeh, 2012). A new round of price increases, coupled to a reduction in monthly cash transfers to households was initiated in early 2014. The Iranian experience suggests that such an ambitious system of universal cash transfer can have drawbacks. Domestic price increases could be rapidly eroded in real terms by domestic inflation. Moreover, an increase in international prices, or exchange rate depreciation may cause the resources of the program to be rapidly eroded (Guillaume et al. 2011).

The application of a minimum revenue deserves to be also discussed in the perspective of efficient management. This solution supposes that the revenues to be gained from aligning internal prices to the international market can be efficiently redistributed. But significant transaction costs, including for the handling of fiscal administration and social programs—not to speak of the risk of corruption and funds being diverted to the general budget—must be taken into consideration. Designing a long chain of measures to deliver a benefit is generally not the best solution for public policies.

4.5.3. Smart Meters and Smart Grids: Opening a Wide Range of Opportunities

Smart grid and smart meter technologies are quickly becoming more accessible to developing countries, and are an innovative option for reconciling energy and climate objectives in subsidy reform. A new generation of smart meters offers a variety of ways to better target the poor and to generate appropriate incentives to rationalize consumption. This can help contain demand peak periods – usually more carbon intensive - while maintaining redistributive tariffs. One of the simplest options is a pre-payment meter, used to pay for energy use in advance. This helps the poor manage their energy budget, and generates an incentive for more energy-efficient behaviors while furthering the social goal of equitable access. International experience indicates that

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82 According to a joint report of the World Bank, IEA, and OECD, in 2009 the share of subsidized gasoline prices in Venezuela was 94.2 percent, reducing the estimated final reference price from VEF 1.04 per liter to VEF 0.06 per liter (from $0.48/liter to $0.03/liter). See “The Scope of Fossil-Fuel Subsidies in 2009 and a Roadmap for Phasing Out Fossil-Fuel Subsidies”, prepared for the G20 summit in Seoul, November 11–12, 2010.
customers like prepayment options, particularly when they are combined with flexible payment methods utilizing information technology (IT) (for example, payment via cell phone). This can help make subsidy reform more transparent and politically acceptable. An example is the BONOLUZ program in the Dominican Republic which made use of smart cards to move to more targeted subsidies. Prepayment is also being used for grid-connected gas and water customers. High-income and industrial customers, meanwhile, rarely opt for prepayment.

The development of smart grids opens up a wide range of possibilities, particularly in better targeting subsidies. Smart grids provide the ability to communicate with far-off meters. This can be especially useful when combined with new data management systems that are being adopted by utilities worldwide. Meters can now be controlled either pre- or post-payment, and tariffs programmed (and reprogrammed, as needed) for specific customers. These functions can in turn be used to align the eligibility criteria for reduced energy tariffs with criteria used for other social programs. This has been done in several countries, including Brazil, to reduce the risk that universal subsidies benefit customers who do not need them.

Smart grids and smart meters allow distributors to send price signal variations to customers and encourage them to curtail usage during peak periods. The limitation is that complex, fluctuating price variations may not be easily deciphered by customers. Further innovations, like individual devices to manage home energy use, might still take time to reach the bulk of customers in developing countries. But these could significantly increase the capacity of customers to respond to price signals and thus reduce overall carbon emissions. In general, the costs of smart grids, smart meters, and smart energy management devices are dropping, making them increasingly feasible for energy companies to implement.

Overall, there are numerous options for reconciling climate and energy objectives during subsidy reform. The different approaches to reform, as well as the other central issues highlighted in this chapter, are outlined in Box 4.1. Blind elimination of subsidies can have many perverse outcomes, but targeted reform can ensure that the objectives of subsidies are better met while emissions are decreased. All the options discussed here, including transitioning subsidies towards renewable energy, using cash transfer programs, and making use of new demand management technologies, require a country specific approach. Subsidy reform requires nuance and caution, but the potential benefits for reducing both poverty and emissions are immense.

There is another promising method that makes use of carbon pricing to achieve the redistributive objectives of subsidies. That is revenue recycling, which will be discussed next in Chapter 5.

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83 The UK and South Africa pioneered prepayment meters (PPMs) and scaled them up over two decades, and can thus be looked at for lessons. When PPMs and associated policies are wisely designed, they can be welcomed by publics. In South Africa, for example, customers quickly lined up to shift to PPMs. For an overview of the South African case, see Van der Merwe (2011).
Fossil fuel subsidies were often instituted with justified objectives in place. Consumption subsidies were often done with the intent of redistribution, and production subsidies with the goal of energy independence.

Both consumption and production subsidies can have perverse outcomes, particularly in terms of increasing GHG emissions.

Regarding the production of coal, in several high-income countries the objective of mitigating emissions has already changed the landscape; subsidies are redirected to exit plans to support the transition of impacted regions.

Regarding the production of oil and gas, there is still no immediate complete alternative to these fossil fuels, meaning that the key objectives of energy independence and energy security still depend on secured access to fossil-fuel sources. To some extent, subsidies of national production still reflect the importance of these objectives—even in those high-income countries committed to fighting climate change. This might change if countries start to anticipate that new investment in oil and gas national production may result in stranded assets.

Reducing energy demand through energy conservation, in particular for oil and gas products, is as important as replacing carbon-intensive supply sources with low-carbon ones, and can reduce emissions faster; fossil fuel subsidies can be reformed by gradually moving subsidization programs towards supporting falling cost renewable energy sources and energy efficiency measures.

In developing countries, consumption subsidies for basic energy needs are still supported by strong social objectives.

Consumption subsidies for low-income beneficiaries can be either better targeted or substituted, in certain cases, by smart cash-transfer programs to reduce opportunistic behaviors and perverse incentive to increase consumption and emissions; new technologies such as smart grids and smart meters are expected to play an important role to help reconcile equity and climate friendly behaviors.
Appendix: Methodological Challenge in Defining Subsidies

The definition of a subsidy is a complicated topic. The first point of contention is the way the reference market price is chosen when determining the subsidy (see Figure 11). Should the basis for determining the reference be the price that would prevail in the absence of any government intervention? Should it be the international price, or the hypothetical price stemming from national producers’ production costs if the national market were a closed one? Evaluations by various international organizations[84] that have called for subsidy reforms use the “price gap” method, this method defines international market prices as reference prices and then compares these to local prices for fuels that could be exported, electricity being the exception. Under such an approach, any “underpricing” that results from a comparison with international market prices means a loss of revenue for local producers and the public budget, and leads to inefficient behaviors such as overconsumption and, eventually, a higher rate of emissions. However, it is worth to note that the “price gap” method raises a few substantial issues, a couple of which are briefly presented in Box 4.2.85

FIGURE 11. Widening of the Subsidy Concept

Another point of debate is whether any tax reliefs or exemptions applied to fossil-fuel production and consumption should also be considered subsidies. Even if they entail a loss of budgetary revenues, tax rebates and exemptions are not direct expenses; some might even see them as reducing a market distortion derived from a government intervention.

84 For a methodology of assessing subsidies, see, for example, UNEP 2003; UNEP and IEA 2008; and GSI 2009, 2010, 2014.
85 Note that the “price gap” estimates do not capture the various types of production subsidies from the state budget, including those that have no effect on consumer prices compared with international prices.
On the matter of tax rebates and exemptions in oil and gas resource development, the following two objectives are at odds: (i) encouraging investment in oil and gas resource development and (ii) oil rent sharing. Nake (2011: 411) underlines that the two objectives are not complementary:

“So, there is a difficulty of defining what is fair, of tracing a limit between an implicit subsidy and an efficient taxation for a low rate. As there is no objective yardstick for sharing economic wealth between the various parties involved in the petroleum activities, controversy will always exist between investors and the government. Tax rates too low can leave the owners of the resources (the government or the nation) a small and inequitable portion. Such a situation is unlikely to endure under political pressures. But if taxes rates are too high, investment can be discouraged in both new projects and new investment in existing operations.”

Hence, when a government wants to boost the exploration and production of oil and gas for energy independence and commercial reasons, it should play by the fiscal rules to encourage investors to develop new fields of hydrocarbons.

It is noteworthy that reports put out by the International Monetary Fund (IMF) and others go further (IMF 2013; Coady and others 2015) and argue that baseline costs and prices should consider external costs and benefits (that is, they should be economically optimal). A failure by the government to address a market failure involving an external cost could be considered a subsidy. This situation also arises when an energy product is not taxed at a “rational” level; for instance, the absence of a tax reflecting the external costs of gasoline use is a subsidy that adds to the gap between national and international prices (IMF 2013; Coady and others 2015).
BOX 4.2. The limits of the “Price Gap” Method of Estimating Subsidies

The usefulness of the “price gap” method is questionable as it tends to overestimate fossil fuel subsidies.

Consider the case of a net energy exporter. Here, a relevant reference price would be the total internal cost of each energy chain rather than international prices. This is logical since reference to the local production and supply cost acknowledges the benefits from the comparative advantage that oil and gas resources give to the country’s economy. This is also a widely-used method in the power sector, which deals with a commodity with little or no international exchange. In that context, a legitimate reference value for a possible subsidy is the average total electricity production and delivery cost. This can be based on the average energy efficiency of a country’s power plants.

When domestic prices are aligned with the local cost of production and supply, the oil rent is transferred to domestic consumers. When domestic prices are aligned with international prices, the transfer of oil rent is from consumers to the national oil company.

A state endowed with hydrocarbon resources may choose to benefit national consumers with prices lower than international ones to boost industrial development (through energy-intensive industries, EIs), to improve the living conditions of lower-income groups and the poor and for social stability. It seems logical that a state would choose to favor national consumers by defining cost-reflective prices and not let the total oil and gas rents go to producers, especially if these producers are foreign. It also seems reasonable that when national producers export, they extract a maximum rent from foreign consumers. To do the same for domestic consumers might appear unfair to consumers and thus to the government. A balanced political choice would be to set the price at the cost of production plus the reserve reproduction cost. If we refer to this principle, several oil-producing countries, such as Venezuela, Iran, Algeria, and Egypt, would still appear to price their oil products and natural gas below their costs.

This approach comes with a caveat for the net importing countries. Aligning the internal price with the national production cost would affect the oil product retailers and oil refiners who import into the domestic market. The solution could be to fix the internal price as a weighted average price, considering the share of imports required for supplying domestic needs if there is a national retail monopoly (as is the case in many emerging and developing countries). The situation is more complex when several companies with different shares of imported oil distort the competition. In the United States, this issue was managed in a complex way in the 1970s (Gordon 2011), when price controls were combined with entitlements to internal low-priced oil for refiners. This mechanism organized transfers among refiners: from those with above-average use of the lower-priced oil to those with below-average access. In this way, the system was supposed to make the weighted average of domestic and imported crude oil prices equal to the marginal cost to refiners (see section 2).

Source: Authors’ compilation.
References


Tombe, Trevor. 2015. “Here’s what we know—and don’t know—about Alberta’s carbon tax”, Macleans, November 23rd.


5. Affordable Energy and Consumer Protection: Correcting the Regressive Effects of Carbon Pricing via Recycling

5.1 The Direct and Indirect Redistributive Effects of Carbon-Pricing Instruments ...........................................88

5.2 Recycling Revenues from Carbon Pricing to Correct Regressivity: The Double Dividend ..................................................................................................................89

5.3 Complementary Policies that Aim to Promote Renewables and Energy Efficiency Also Have Redistributive Effects ......................................................................................................91

Because of the variety of policy objectives reflected in energy pricing—objectives that include, among others, making energy affordable and generating fiscal revenue—pricing choices will eventually have redistributive effects across customer categories. The nature and amplitude of these redistributive effects depend on the level of priority given to particular policy objectives. The effects tend to be neutral or somewhat regressive in high-income countries, and generally progressive in low-income countries. In emerging economies, the effects of fuel taxes are significant (Sterner 2012). The implementation of a carbon-pricing instrument in these countries would introduce a new cost that will eventually be distributed across customer categories. This constitutes the “burden sharing” involved in efforts to reduce emissions.

Mitigation is a process that will, in turn, have its own redistributive effects. Therefore, any carbon-pricing instrument introduced in developing countries will be assessed by energy authorities not only for whether it advances environmental goals, but also for whether it aligns with the social equity objectives of existing energy policies.

A climate policy, such as carbon pricing, that efficiently internalizes the future damage of climate change may not improve overall welfare if low-income people targeted by redistributive mechanisms, including social energy pricing, find themselves in a worse position after the implementation of such a policy. The legitimacy of a carbon-pricing instrument, and complementary policies, might be determined not just by its environmental efficiency, but also by distributional outcomes. Balancing these concerns is particularly relevant when designing compensation mechanisms.

Our purpose in this chapter is to look for ways to reconcile climate policies with the redistributive objectives of energy policy. The experience of some OECD countries shows that recycling the revenues derived from carbon-pricing instruments is needed to align these instruments with redistributive priorities. When done properly measures such as revenue recycling can more than offset the regressive redistributive effects of carbon pricing. But before we discuss potential solutions, the exact redistributive effects of carbon pricing need to be understood.

86 For a detailed discussion of the energy policy objectives commonly seen in developed and developing economies, see Chapter 1.
87 The rate of a progressive tax increases as the taxable amount increases. The term progressive refers to the way the tax rate progresses from low to high, with the result that a given taxpayer’s average tax rate is less than their marginal tax rate. In general, the rate of a progressive tax increases as the payer’s income increases. On the other hand, the rate of a regressive decreases as the amount subject to taxation increases. In terms of individual income and wealth, a regressive tax imposes a greater burden (relative to resources) on the poor than on the rich. In other words, the rate of a regressive tax increases as the payer’s income decreases.
88 Estimates of the distributional incidence of higher energy prices depend to a large extent on the indicator used. Distributional impacts appear to be higher when additional costs are measured as a percentage of total household expenditures rather than income; they are also higher if current income is considered instead of lifetime income.
5.1. The Direct and Indirect Redistributive Effects of Carbon-Pricing Instruments

The redistributive effects of carbon pricing can be quite complex and unexpected. For instance, the introduction of an Emissions Trading System (ETS) can have counterintuitive distributional consequences. As mentioned earlier in Chapter 3, during the pilot phase of EU-ETS emissions allowances were granted to power generators for free. This led to a significant net rent being transferred from final customers to power generators (this is further detailed in the next section). More intuitively, ETSs can also generate distributional effects in cases where allowances are sold through auctions. Hassett et al. (2009) predict that a carbon tax could be regressive in the US. They estimated the cost to the poorest decile to be about 3.74 percent. This was approximately four times the cost observed among the highest decile.

Most affected categories are difficult to determine and depend on the presence of non-energy-related redistributive policies, in particular social security programs. Blonz, Burtraw, and Walls (2012) show that social safety nets generally protect low-income households, leaving middle-income households vulnerable (see IPCC WGIII 2014).

The distributional effects of a carbon-pricing instrument will also depend on the mode of implementation. Carbon pricing differentiated by fuel, use, or sector, will have effects that are more difficult to assess than those of a single universal fuel tax. This is because the many possible substitutions among fuels are sometimes difficult to anticipate, as are their eventual redistributive effects.

Besides the direct redistributive effects of regressive or progressive taxation, it is important to note that the customer category that pays the carbon tax is not necessarily the one that bears the ultimate cost. The introduction of carbon pricing will also have macroeconomic impacts on employment, growth, and income. Most studies on the utilization of tax revenues show that the distributional effects of a carbon tax are regressive, unless the tax revenues are used directly or indirectly in favor of low-income households (Poterba 1991; Barker 1993; Hamilton and Cameron 1994; OECD 1995; Oliveira-Martins and Sturn 1998; Timilsina and Shrestha 2007). It is therefore important to assess redistribution from a macroeconomic perspective.

The ultimate impact of carbon pricing on inequality and poverty cannot be determined simply by looking at the additional burden it puts on households’ energy consumption budgets. The impact also depends on how tax revenues (or the revenue from the auctioning of allowances, in the case of an ETS) are used. This depends on (i) how these revenues are recycled into the economy, and (ii) the general macroeconomic effects induced by the combination of carbon pricing itself and the measures undertaken to recycle revenue. As a consequence, governments considering the introduction of carbon-pricing instruments have based their decisions partly on macroeconomic assessments of these instruments and how recycling measures might eventually impact income redistribution, the competitiveness of particular sectors, and overall economic growth. Eventually, the legitimacy of a carbon-pricing instrument is established not only on the basis of its environmental efficiency, but also on how it distributes any burden across customer categories. As we will see in the following section, this also applies to indirect carbon-pricing instruments, such as those used to promote renewable energy, either directly supported by the public budget or by certain categories of consumers (for instance, via a levy added to energy prices to subsidize renewables).

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89 For a more detailed review of methods used to assess the impact of a carbon tax on a national economy, see Analysis of the International Experience on the Use of Tax as an Instrument for Emission Pricing and Perspectives on Application in Brazil—Review of the Economic Literature around Adoption of Tax as an Instrument of Emissions Pricing, in particular section 3.1: “Methods to Assess the Impact of Carbon Tax on the Economy,” The World Bank (PMR 2013) for the Ministry of Finance of Brazil—on demand.

90 In addition, the capacity of households to alleviate such a direct burden varies across customer categories: richer customers usually have a better margin of adaptation (for instance, buying new equipment enables them to switch to cheaper fuels) than low-income ones.
Overall, the redistributive effects of carbon pricing vary across countries and are largely determined by the design of measures to recycle corresponding revenues (as shown by Fullerton, Heutel, and Metcalf (2012) and Sterner and Coria (2012)). OECD countries have valuable experiences with revenue recycling approaches. Revenue recycling and compensation can be used to protect low-income households as well as other categories, including Ells. This section will focus on low-income households.

5.2. Recycling Revenues from Carbon Pricing to Correct Regressivity: The Double Dividend

Revenue recycling can both offset the regressive impacts of carbon pricing and also provide broader positive macroeconomic impacts. Both outcomes will be dealt with in tandem. The wide variety of compensation measures to mitigate the direct, regressive impact of carbon pricing is seen in the first row of Table 5.1. These measures may involve direct monetary flows to households or indirect mechanisms aimed at reducing overall energy consumption to compensate for the higher energy cost and eventually reduce customers’ energy bills.

<table>
<thead>
<tr>
<th></th>
<th>Direct Measures</th>
<th>Indirect Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Households</strong></td>
<td>Energy check for low-income households</td>
<td>Subsidies for investment in energy efficiency (thermal renovation, etc.)</td>
</tr>
<tr>
<td></td>
<td>Lump-sum transfers/universal grants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduction of excise duty on petrol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduction of VAT on other products</td>
<td></td>
</tr>
<tr>
<td><strong>Employers</strong></td>
<td>Reduction of social security charges</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduction of corporate taxes</td>
<td></td>
</tr>
</tbody>
</table>

Note: VAT = value added tax.
Source: Author’s compilation.

As can be seen in Table 5.2, corrective measures are not limited to low-income customers but may also be used to counter any negative effects on industrial competitiveness or the development priorities often behind energy policies (this specific issue will be discussed in Chapter 7).

From an institutional point of view compensation measures can be organized in a variety of ways. While cash-transfer programs to reduce poverty are generally managed at the central government level, compensatory measures based on the recycling of proceeds from carbon-pricing schemes are not necessarily managed by governments. The US offers two examples of an ETS whose compensatory mechanisms were designed and enforced by the power sector regulators of the state in question. The Californian ETS opted for free allowances, while the Regional Greenhouse Gas Initiative (RGGI) ETS in nine Northeast and mid-Atlantic states auctioned allowances (see Table 5.2). Carbon-pricing mechanisms can thus be aligned with sector priorities through sector-specific regulations, even in the absence of relevant legislation and without having to channel the proceeds through the central budget. Such channeling would entail far more uncertainty and transaction costs.

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91 In the next section, we observe the way the Public Utility Commission of California (CPUC) creates a complex institutional channel by which the carbon rent of generators is extracted and redistributed to household consumers.
TABLE 5.2. Measures Used to Correct the Redistributive Impacts of Carbon Pricing: Examples from OECD Countries

<table>
<thead>
<tr>
<th>Scope</th>
<th>Direct Measures</th>
<th>Indirect Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EU ETS</strong>&lt;br&gt;Since 2005</td>
<td>Large industrial emitters and internal transports (airlines, bunkers)</td>
<td>Free allocations up to 2015 in the power sector&lt;br&gt;For indirect costs to EIIs, compensation up to 75%–85% through subsidies</td>
</tr>
<tr>
<td><strong>British Columbia</strong>&lt;br&gt;Since 2008</td>
<td>All activities with fossil-fuel emissions outside the sector</td>
<td>Carbon tax relief grant provided to commercial greenhouse growers, including those focused on vegetables and flowers, wholesale production, and tree seedlings.</td>
</tr>
<tr>
<td><strong>California ETS</strong>&lt;br&gt;Since 2013</td>
<td>Large industrial emitters&lt;br&gt;From 2015 onwards, fuel distributors and upstream natural gas suppliers</td>
<td>Transitional free allowances to compensate for competitiveness issues&lt;br&gt;Compensation for increased electricity prices by an energy-efficiency program</td>
</tr>
<tr>
<td><strong>New Zealand</strong>&lt;br&gt;Since 2008</td>
<td>Industry&lt;br&gt;Electricity not included</td>
<td>Transitional measures: a requirement to surrender only one carbon unit for every two emissions tons (a division of the allowance price by two)</td>
</tr>
<tr>
<td><strong>Québec</strong>&lt;br&gt;Since 2013</td>
<td>Power sector&lt;br&gt;Industrial establishments (fuel distributors in 2015)</td>
<td>Free allocation</td>
</tr>
<tr>
<td><strong>RGGI</strong>&lt;br&gt;Since 2008</td>
<td>Electricity sectors of nine Northeast and mid-Atlantic states in the US&lt;br&gt;Auctioning</td>
<td>No coverage of emitting sectors outside the power sector&lt;br&gt;Business efficiency and clean energy financing (21% revenue auctioning)</td>
</tr>
</tbody>
</table>

Note: EIIs = energy-intensive industries; ETS = Emissions Trading System; EU = European Union; OECD = Organisation for Economic Co-operation and Development; RGGI = Regional Greenhouse Gas Initiative.
Source: Authors’ compilation.

Understanding the macroeconomic consequences of revenue recycling schemes offers a systemic avenue to correct the regressivity of carbon pricing. Such a positive macroeconomic effect is called the “double dividend” of carbon pricing, where a decrease in carbon emissions goes hand in hand with improved economic efficiency through strategic use of revenues.92

A double dividend becomes possible when the burden of the carbon price does not fall entirely on labor and/or productive capital and is partially allocated to nonwage incomes. Such reallocation of the fiscal burden is frequently referred to as an environmental tax reform (ETR). Thus, the net cost of carbon pricing also depends on the structure of the tax system prior to its introduction. To a certain extent, the more distorted the preexisting taxation, the lower the welfare losses as carbon pricing replaces other “burdensome” taxes. As Carraro and

92 The term “double dividend” became popular after Pearce (1991) introduced it in “The Role of Carbon Taxes in Adjusting to Global Warming”. He suggested that a carbon tax could be implemented, and its revenues used to reduce the excess burden of preexisting distorting taxes. As Bosquet states: “the Environmental Tax Reform (ETR) shifts the tax burden from economic ‘goods’ to environmental ‘bads,’ from what is socially desirable, such as employment, income and investment, to what is socially undesirable, such as pollution, resource depletion and waste” (Bosquet 2000). In addition to the double dividend hypothesis, some authors have mentioned the possibility of achieving a triple dividend from an ETR. The triple dividend concept arises when a third economic benefit results from an ETR policy implementation, usually related to social welfare (Bovenberg and Ploeg 1998).
Soubeyran (1996) show, the gain in jobs is even greater when the labor market is rigid. These results have been confirmed by studies of several European countries (IPCC WG III 2001, section 8, p.54).

Another way to possibly generate a double dividend is by using carbon pricing as an instrument to recapture part of an oil-exporting country’s rent, by lowering demand for oil (Goulder 1994; Ligthart 1998). Thus, the regressive effect of carbon pricing can be partially or totally offset by the “double dividend”. That is, if the recycling mechanism is properly designed. This is an interesting result to be tested in the case of emerging economies, and involves two key questions: (i) what tax burden will be replaced? and (ii) where and how will the new revenues generated by the carbon-pricing mechanism be reinjected into the economy? Box 5.1 summarizes several assessments of the net redistributive impact of various carbon-pricing schemes in OECD countries. It illustrates the wide range of options available to governments.

**BOX 5.1. Recycling Carbon Tax Proceeds to Mitigate Regressivity of the Burden Sharing: Findings from OECD Countries**

The usefulness of the “price gap” method is questionable as it tends to overestimate fossil fuel subsidies.

Numerous studies have examined the impact of revenue recycling schemes in OECD countries:

- Two British studies in the 1990s looked at the distributional effects of climate policies. Barker and Johnstone (1993) investigated the distributional effects of a carbon-energy tax. Revenues are recycled through an energy-efficiency program and compared to lump-sum transfers. The results show that the burden of a carbon tax falls most heavily on low-income groups. At the same time, the potential gains to be realized by increasing energy efficiency to offset this regressive outcome are higher for these low-income groups. Symons et al. (1994) investigated of the potential of revenue recycling in the UK. They estimated that a carbon tax without recycling, or with recycling via a value added tax (VAT), would be significantly regressive. Conversely, recycling the carbon tax through a combination of VAT rate reductions and reforms directed toward poorer households results in favorable distributive effects;

- In the case of Ireland, O’Donoghue (1997) found that carbon taxation is generally regressive, but that recycling the carbon tax through a fixed basic income for all individuals allows the distributional effects to become almost neutral;

- Barker and Kohler (1998) evaluated the effect of a fixed carbon tax) for 11 EU member states, The policy had a goal of reducing emissions by 10 per cent below the baseline by 2010. They concluded that the changes would be weakly regressive for nearly all member states if revenues were used to reduce employers’ taxes, and strongly progressive if they were returned in a lump sum to households;

- A carbon tax was implemented in France in 2009. Combet and others (2010) compare two recycling modes: (i) the reduction of social charges and (ii) a universal grant (a flat-rate payment paid to all households). The study shows that recycling the tax proceeds of up to €300/metric ton of carbon dioxide (tCO2) in lower social contributions has far superior effects in terms of economic activity than in terms of social equity. It results in the creation of 870,000 jobs and an increase of 2.5 percent in gross domestic product (GDP).

5.3. Complementary Policies that Aim to Promote Renewables and Energy Efficiency Also Have Redistributive Effects

Complementary climate policies (see Chapter 3) can have a range of redistributive effects. Since these complementary measures frequently coexist with carbon pricing, their redistributive effects should also be taken into consideration. Assessing the redistributive effects of carbon pricing and revenue recycling usually relies on macroeconomic modeling, which uses the price-elasticity function to simulate the response of economic agents, including households, to price variations. The redistributive effects of complementary policies are primarily because they ‘force changes’ in price elasticities. As the impact of carbon pricing on household energy bills is reduced, these complementary measures tend to reduce the regressivity of carbon pricing. This points to the importance of considering the design of a carbon-pricing scheme in association with other measures that may not be, strictly speaking, economic instruments but are still relevant to long-term price elasticities (Timilsina and Shrestha 2002, 2007). Such measures have not always been considered complementary to carbon pricing and have often been designed independently to accelerate the penetration of non-fossil-energy sources (more commonly referred to as renewable energy sources) and energy conservation measures. But since these measures frequently coexist with carbon pricing, their redistributive effects should also be taken into consideration (as we will do later, focusing on the experience of the OECD countries).

Policies that seek to accelerate the development of renewable energies or the dissemination of energy conservation measures are in effect similar to a negative carbon tax. Such incentives must in the end be financed or foregone by someone, thus generating burden-sharing issues that are similar to those associated with carbon pricing. This is especially obvious when a subsidy allocated to promote such a measure is financed by a levy charged to particular customer categories.

Policies aimed at promoting RES-E and energy efficiency are now considered an integral part of EU climate policy. The cost of such RES-E and energy-efficiency policies raises concerns increasingly associated with the redistributive effects of carbon-pricing instruments. The levies charged on electricity bills to finance production subsidies paid to RES-E plants via FiTs in Europe eventually implied an increase in final electricity prices. These levies have become an important element of the energy taxes used to implement these complimentary climate policies. This makes the issues of burden-sharing, particularly between industrial and residential energy users, more important and politically sensitive.

The significance of financing complementary policies is increasingly evident in Europe. In 2014, the cost of the RES-E policy reached €23 billion in Germany, €10.5 billion in Spain, and €4 billion in France. Reports from the European Commission indicate that the levies for financing renewable energy sources and combined heat and power policies became more important than all other electricity taxes, including the VAT (see Figure 12 for households). Since 2013, the RES-E levy is more significant in Germany than the energy share of households’ electricity retail price.

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93 Such price elasticity derives from the notion of the demand curve, which represents how the demand for a product or a service evolves when the corresponding price changes. Typically, an economic agent will reduce their purchase of a good or service when the price of that good or service increases. Such price elasticities—embedded in macroeconomic models as stable and predictable functions—are essential to simulate the net redistributive effects of carbon pricing. Meanwhile, responses not related to price can also be induced from consumers. 94 This is also referred to as “positive carbon pricing,” since it results in a “positive” revenue paid to the agents implementing emissions abatement measures, while carbon pricing usually consists in charging the equivalent of a tax—a “negative revenue”—to agents generating greenhouse gas (GHG) emissions.
FIGURE 12. The Share of RES-E Levies in Household Electricity Bills, Selected EU Countries (2009–12)

Note: The share is calculated as a percentage of price for consumers with annual consumption between 2,500 and 5,000 kWh (excluding VAT).
EU = European Union; kWh = kilowatt-hours; RES-E = renewable energy sources for electricity; VAT = value added tax.
Source: Calculations of the European Commission’s Directorate-General for Energy, based on Eurostat and EU member state data.

FIGURE 13. Breakdown of the Electricity Retail Price for Residential and Large Industrial Consumers, 2012

Notes: GWh = gigawatt-hours; MWh = megawatt-hours; VAT = value added tax.
As shown in Figure 13, there are significant discrepancies among EU members regarding how the RES-E policy costs are to be distributed among households and industrial customers. For instance, in Germany, the levy paid by heavy electricity users (>10 GWh) is only €0.5/MWh, while it is set to €5.28/MWh for industrial businesses (less than 1 GWh) and to €58.4/MWh for other small industrial users, services, businesses, and households. The debate on the distributional effects of the German carbon policy focuses on the way industries should pay for the carbon policy cost, which includes both the costs of emissions allowances and the levy on renewable energy subsidies (Buchan 2014).

An alternative to charging a levy to finance RES-E policy costs is to transform this cost into public debt. The debt would then be paid for by future generations rather than present customers. Such a measure is being considered by some EU members. Italy and Spain have not allowed electricity regulators to charge the cost of RES-E development (through FiTs) to residential and industrial consumers. In these systems, the mandatory purchase of green electricity imposed on historic operators or grid companies is not compensated by monthly payments financed by levies. Instead, these agents receive public bonds that increase the public debt. It should be noted that such a mechanism cannot become permanent. Indeed, reforms were already under way in 2015.

As for carbon pricing, market instruments can be used instead of taxes, levies, and subsidies to enforce the mandatory purchase of green electricity. This is the case for tradable green certificates (or renewable portfolio standards) that US electricity suppliers are obligated to redeem every year. However, in such an arrangement, the burden sharing is determined internally by each retailer and is therefore relatively opaque.

A summary of the core lessons from this chapter are presented in Box 5.2.

**BOX 5.2. Chapter 5 Summary**

- The redistributive effects of carbon pricing are often regressive and in tension with existing energy policy objectives.

- Complementary policies aim at promoting renewables and energy efficiency also generate burden sharing issues.

- The recycling of carbon pricing revenue can offset regressivity and be designed to concur to the redistributive objectives of energy policies.
References


Organisation for Economic Co-operation and Development.


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This chapter examines the impact of carbon pricing on consumers across the four different power sector models outlined in Chapter 2. This analysis is based on an understanding of how different market structures and regulations translate into different ‘pricing screens’ along the production chain which alter the impact of carbon pricing, sometimes generating unexpected, undesirable results. This impact must be analyzed bearing in mind the importance of captive customers protection in a sector characterized by regulated natural monopolies. It is a general examination based on theoretical comprehension. Market regulations are diverse: a detailed and empirical understanding of the distributive effects and what carbon pricing design to use would require a specific national case study.

We saw earlier that nowadays, power sectors can be classified in four main models: (i) the market model, representing the most advanced stage of the market-based coordination of economic agents; (ii) the state-owned vertically integrated utility, which reflects strong command-and-control coordination; (iii) the single-buyer model, which enables some participation of the private sector; and (iv) the hybrid model, which mixes market features with substantial public intervention (for a detailed description of the four models, see Chapter 2).
In Chapter 3, we found that the effects of carbon pricing depend on three main determinants. First, is the principle used for dispatching power plants. This may either be market based or cost based. Second, is the development of risk-sharing arrangements. These may enable long-term capital-intensive investment, particularly in low-carbon plants. Third, is the degree to which the final price is regulated, often with the aim of addressing redistributive objectives.

These three determinants take very distinct forms in the four main power sector models.

The market-model is prevalent among high-income countries, but is either absent or partially implemented in most other countries. There are substantial differences in how the price is or isn’t passed on to consumers across power sector models, and therefore developing and developed countries. We will consider several options here.

The first section of this chapter focuses on power sectors that use a market model. It analyzes the distributional effects of carbon pricing via an ETS and discusses various methods used to control these distributional effects. The second and third subsections focus on the models prevalent in developing countries: the hybrid model, the single-buyer model and the vertically integrated state-owned utility model. These subsections explore how the potential effectiveness of carbon pricing is strongly constrained by the specific features of these models. Table 6.1 presents a synthesis of the main findings detailed later in this chapter.

6.1. Mitigating the redistributive effects of carbon pricing in power sectors that use a market model

In many middle- and high-income countries, power sectors operate under a market model and are covered by a carbon-pricing scheme.

The redistributive effects of carbon pricing in these power sectors depend on the type of instrument adopted. There is a difference between a carbon tax or an ETS with the auctioning of allowances, and an ETS with free allowances. The first two mechanisms result in an additional cost for the generators, which in turn increases the wholesale electricity price. The carbon rent is received as revenue and can be either retained in the public coffers or redistributed to benefit consumers. In the case of an ETS with free allowances, the carbon rent tends to be captured by the generators.  

Free allowances raise a distributional concern since the carbon rent may be transferred to fossil-fuel plants as well as low-carbon plants, via the pass-through of an “opportunity cost.” During the long transition period characterized by the progressive entries of low-carbon plants under the incentive of the carbon price which increases the anticipation of net revenues of these types of plants on the hourly markets. The power generators that have received free allowances may redeem them in the process of generating carbon-intensive power to sell on the hourly power market. However, these allowances can also be sold on the ETS. Thus, a fossil-fuel-based plant would decide to use the free allowances to generate power only if by doing so it could get at least the same net revenue that it could from selling the allowances on the market. Such plants therefore tend to incorporate that opportunity cost into their price bids. If their bids are not competitive and their plants are not dispatched, they can still sell the allowances.

Marginal plants are typically the fossil-fuel power plants that receive free allowances during the first years of the transition stage. Thus, the clearing price is increased by the value of those allowances on the carbon
market. Since all power plants that have bid below the clearing price receive this clearing price, the additional value is received not only by the marginal thermal plants that received the allowances for free, but also by all the non-emitting power plants that did not receive the allowances and were dispatched. Eventually, every single plant that has been dispatched will receive an additional rent. The rent is equivalent to the opportunity cost of the free allowances received by that marginal plant. As a result, all of them benefit from additional revenues. This hourly price increase is paid by the retailers which add it in its price offers to their customers.

6.1.1. The Experience of High-Income Countries with ETS: Avoiding the Capture of the Carbon Rent, but Weak Consumer Protection

There appear to be no reports on the capture of the carbon rent by power generators under countries with a ETS with free allowances. Such countries include the EU member states in the first two EU-ETS phases (2005–13), New Zealand since 2008, and Australia in 2012–13. However, this issue is relevant to the calculation of the regulated electricity tariffs that apply to captive residential consumers. In principle, these tariffs are aligned with the weighted average of the hourly wholesale prices observed on the three-month futures market. Should the regulators who observe these retailers’ sourcing costs refer to only this wholesale price, which includes the opportunity cost charged by the generators? Or should they calculate a hypothetical retail tariff by deducting the allowances’ opportunity cost from the average wholesale price? In Australia, subnational regulators in some states pointed to the carbon price as a factor pushing up retail tariffs. In all these cases, no provisions were taken to protect captive residential consumers from such rent transfer to power generators.

In the EU, the warnings came from the economist, who shortly after the EU-EYS implementation in 2005, alerted regulators, governments, and the EU Commission that power generators were accumulating “windfall profits” due to the allocation of free allowances. This new rent may have redistributive effects on not only the tariffs charged to households, but also the price of electricity input in energy-intensive industries. While the auctioning of allowances, or a carbon tax, would also affect the electricity price paid by these categories, it would not induce a rent transfer to the power generators. However, nobody suggested taxing the windfall profits of the generators during this early phase of the EU ETS. Economists only suggested that auctioning would address distributional concerns. Eventually, the political context shifted, and free allowances were replaced by full auctioning in the power sector, in the third EU-ETS phase (2012-2020). A minor share of the proceeds which is kept by the EU commission was used to support some EU low-carbon, innovative technology demonstration programs.

Interestingly, only the “upstream” rent capture has been addressed, but the “downstream” redistributive effects on prices and tariffs were not considered. This is surprising, given that consumer protection is a key energy policy objective in most EU member states. Now that the carbon rent is transferred to government rather than power generators, the increase in electricity retail prices induced by the EU-ETS has become acceptable among both politicians and publics.

96 Before the abolishment of the carbon pricing system in 2014 by a new cabinet.
97 See, for example, NSW Independent Pricing and Regulatory Tribunal (2012).
98 There is abundant economic literature on the carbon pass-through after the EU ETS implementation. Sijm (2005) and Sijm, Neuhoff, and Chen (2006) report that a significant percentage of the market value of free allowances is passed through to the wholesale electricity price on the German market, and substantially increases the profits of some companies. IPA Energy Consulting (2005) and Fezzi and Bunn (2010) find a similar cost pass-through in the UK and other EU countries.
6.1.2. The California Exception: Reconciling Carbon Pricing with Strong Consumer Protection

A cap-and-trade scheme came into force in the US state of California in January 2013. It initially covered only the electricity sector and emitting manufacturers, and was progressively extended to natural gas utilities and oil product distributors (see, for example, Durning and Bauman 2014).

Under this ETS, Californian utilities receive emissions permits for free. However, the California Public Utility Commission (CPUC) requires all private utilities\(^ {99} \) to sell these free allowances in an auction run by the Air Resource Board (ARB) of the Californian Environmental Protection Agency (EPA). Then, the same utilities must rebuy all the permits they need on the market and redeem these to cover their own emissions. This mechanism may seem convoluted but offers important benefits. One of them is to determine the market value of the emissions allowances, which will then be passed through in the tariffs. Passing this carbon price through to customers ensures that the price signal can play a role in molding their future consumption behavior. Meanwhile, the CPUC orders utilities to return all the proceeds of the sales of the free allowances to their retail customers. This is possible in the Californian system, because distributors have retained their retail sales monopoly.\(^ {100} \) They also remain partly vertically integrated, despite having been forced to sell half of their capacities under a divestiture mandate before 2000.\(^ {101} \)

In 2014 the CPUC ordered Pacific Gas and Electric (PG&E), the giant private utility that serves much of northern California, to redistribute “climate credits” to its residential customers. For the year 2014, this was done on customers’ April and October bills, via a grant averaging $35 for six months.\(^ {102} \) For many customers, especially low-income households, this cost abatement was enough to offset the increased cost of energy consumption that resulted from carbon pricing. And, since the compensation was after the fact, it did not eliminate the price signal informing customers of the environmental cost of their consumption—and thus maintained the incentive for them to lower it.

This creative solution is consistent with CPUC’s approach to consumer protection. For years, discounted power rates and energy-saving services have been offered to low-income families. Since climate credits are redistributed in flat amounts, regardless of how much power a household uses, they counter the regressive nature of carbon pricing. Eventually, climate credits provide a net gain to these low-income consumers, who also benefit from discounted rates.

This complex process of free permits, mandatory auctions, and mandatory climate credits has three main advantages. First, it prevents utilities from capturing the carbon rent, as would normally happen due to the pass-through of the opportunity cost of the free allowances. Second, it creates a solid carbon price reference to be reflected in the retail tariffs and thus provides a price incentive for customers to internalize the environmental consequences of their consumption. Third, it corrects the regressive nature of carbon pricing, preventing rent capture by power generators and preventing low-income customers from bearing the cost of their contribution to reducing the sector’s GHG emissions.

California’s use of climate credits contrasts with many OECD countries. Some high-income countries with carbon pricing have not used compensation to aid affected low-income consumers. However, there

\(^ {99} \) Invested-owned utilities or ‘IOUs’.  
\(^ {100} \) With some exceptions for large users.  
\(^ {101} \) Note that the permits allocated freely to independent producers appear to not be resold in the auctioning of the Air Resource Board (ARB).  
\(^ {102} \) http://ww2.kqed.org/news/2014/04/02/pge-climate-credit.  
\(^ {103} \) From a theoretical perspective, according to their price elasticity, customers would reduce their consumption as a result of the tariff increase induced by carbon pricing. This results in both a reduction of emissions, but also a loss of consumer surplus. The redistributive effects of climate credits compensate part or all of that loss.
are other exceptions. In Australia under the previous carbon pricing system, low-income families were overcompensated through lower income taxes and higher welfare payments (Jotzo, 2012). There are also other examples in the US. In the RGGI, the proceeds of auctioned allowances are used to reduce low-income tariffs and finance investment in the energy efficiency of low-income housing. Revenue is also used to finance energy conservation among local businesses, industrial facilities, and community buildings (RGGI 2014). These three examples demonstrate that innovative solutions can be found: emissions reduction and progressive redistribution can co-exist under a market model.

6.2. Potential Accommodation of Carbon Pricing in the Hybrid Model

As outlined in Chapter 2, the hybrid model is a combination of strictly framed competition among private agents and the direct participation of public authorities. The effects of carbon pricing in this model is largely determined by the design of the long-term contracts mechanism the economic dispatching (cost-based versus price bid-based), and the retail regulation.

6.2.1. Environmental Efficiency in the Hybrid Model: Two Distinct Time Horizons

Three different effects can be expected from introducing a carbon-pricing mechanism in the hybrid model. The first and most intuitive one is a reduction of consumer demand in case the carbon price is passed through to the final prices (for free consumers) and regulated tariffs (for captive customers). Depending on the carbon intensity of the power-generation matrix, this price signal will be felt by customers, and the consequent adjustment of demand will affect total power generation, including its fossil-fuel-based share. Second, an almost instantaneous substitution among existing generation plants competing at the margin may occur. Third, there will be a long-term redirection of investments toward less-carbon-intensive technologies. This is especially relevant for systems facing significant growth in demand. The second and third effects are potentially the strongest ones can be expected even in lower-emissions power systems.

Short-term Effects of Carbon Pricing on Emissions

Emissions will be abated quickly if high-emitting plants are replaced with lower emitting plants in the hourly operation of the system. Regardless of the carbon pricing instrument used, every time the marginal unit is a fossil-fuel plant, the price of carbon should be reflected in the marginal price calculated by the cost-based dispatching program. In countries with a bid price model, the bidders will normally include the carbon cost in the calculation of their bid prices. In other countries where a cost-based model is in place (Brazil, Chile, Peru, Argentina, etc.), the market operators would consider the current carbon price of the moment. While emissions could be reduced, some problems could occur.

A problem with the long-term contracts of the existing plants could emerge when carbon pricing is introduced. If there is no provision to revise the contracts in order to take into account the carbon cost for the reimbursement of variable costs when the plant is dispatched, the operation of these plants could become financially unsustainable if the cost is not passed through. The revision of the existing contracts is necessary in this respect to avoid early retirements of some equipment.

105 The contracts still make the plant’s operation mandatory once it has been dispatched by the system operator.
In the case of an ETS with free allowances or a carbon tax with free threshold, a problem could occur if the regulator decides not to pass through the opportunity cost in the wholesale price paid by the retailers and the end users. This issue is discussed below, in a subsection exploring distributive issues.

**Long-term Effects of Carbon Pricing on Emissions**

In the hybrid model, investors interested in the building of new generation plants may benefit from long-term contracts awarded via auction. These transfer the price risk to retailers and eventually to captive end-use customers due to cost-plus based tariffs.

In Brazil, the long-term contract on capacity and energy which is selected by the auctioning process guarantees a fixed remuneration on the variable cost part of the contract, which will be indexed on inflation and fuel price variations. These variations are thus passed through to distributors. This is the purpose of auctions, since investors can present risk-free power purchase contracts to their financiers. This creates conditions that enable the private sector to effectively invest, on time, in the desired generation capacity.

In Chile and Peru, where the mechanisms consist of decentralized auctioning by the distributors of contracts on energy, the generators bids should have to consider the expected carbon cost. If an ETS is introduced, the candidates to invest should anticipate the evolution of the carbon price on the long term which is uncertain. One function of the long-term contract would be to share the risks of the carbon price.

For carbon pricing to be effective in encouraging new investments in low-carbon technology, both the selection criteria used at auction and in the structure of the contracts awarded should allow for internalization of the carbon cost. Without this, the rules do not send a clear signal to potential investors regarding how different power generation technologies might be impacted by the new carbon-pricing scheme. This is particularly true for an ETS which intrinsically has a volatile price with significant long-term uncertainties. Correcting this would require adjusting both current selection criteria and proposed long-term contracts. This could be challenging in a complex auctioning mechanism such as in Brazil (see Box 6.1).
**BOX 6.1. Auctioned Power Contracts in Brazil: An Overview of their structures**

Under the Brazilian model, long-term contracts are awarded to future power generation plants via a two-stage auctioning process organized by the regulator (ANEEL) and the planning agency (EPE) (Tomaslquim, 2012). They are standard contracts. They are structured in two parts: (i) the energy portion (expressed in $/MWh), which is a financial option contract, and (ii) the capital portion (expressed in $/MW), which is a monthly fixed amount remunerating the available capacity.

All contracts, which are financial instruments, concern both MWh and guaranteed MW. Such contracts must be covered by Firm Energy Certificates (FEC); e.g. to sign a contract for 1000 MW the generator or trader must show that it possesses firm energy certificates that add to the same amount. FECs are issued by the regulator for each generator in the system, are rated in MWh/year and reflect its secured energy production capability. For hydro plants, the FEC corresponds to their (firm) energy production capability in dry years). These allow for firms to have different types of contracts and time-spans to cover different types of equipment (new plants with forward contracts of 15 years or more and existing ones of 1 to 3 years) and to stabilize their revenues. For example, new plants can have forward contracts of 15 years or more, whilst existing ones have contracts of 1-3 years. There are two types of types of contracts for new capacity generation:

- standard financial forward contracts, where generators bid an energy price $/MWh for the firm energy (aMW) offered;
- energy call options or “reliability options”. In the call option proposal, the retailer “rents” the plant from the investor, paying a monthly fixed amount $/MW for its availability and reimbursing the plant’s owner on its declared variable operating costs whenever the plant runs. The buyer is now responsible for any spot market transaction. Because spot prices tend to be low most of the time, this option contract is very attractive in Brazil.

For option contracts, generators bid not only on the option premium ($/MW) but also on the option strike price to cover its operation costs ($/MWh). One of the components to decide the auction winners is through the “Cost-Benefit Index” which is the Operation Marginal Cost (OMC). At the beginning of the process, the OMC is calculated for several scenarios by the system operator’s model. This is then received by auction participants to prepare their bids for the contracts for the two phases of the auction.

Bids are then compared on the basis of the expected benefit for consumers. The EPE is helped by the system operator market simulation model which calculates (i) the expected value of their reimbursements with the option strike price (in $/year), and (ii) the expected value of the short-term transactions at the spot market (in $/year). In short, the government estimates the plant usage and provides expected operation costs and spot market transactions incurred by the buyer. A single unit energy cost–benefit index in $/MWh of firm energy is then calculated for each technology. This is a benchmark for comparing bids on the option contracts.

- After the winners’ selection, every contract is fully indexed on fuel prices and inflation.
- To introduce a carbon pricing by an ETS would imply third changes in this complex market design: first to add long term expectations of carbon price into the calculation of the OMC by the system operator model during the auctioning process; second to add the futures’ carbon price to the indexation formula; and third to include the actual carbon price in the complex weekly programming of the cost-based dispatching. Indeed, the prices are calculated by the dispatching manager, also called the “market operator,” who uses a computational model to operate the system. Every week, this model calculates short-run marginal costs (measured in dollars per megawatt-hours [$/MWh]) in each region and for three different load blocks per week.
Variable costs should be fully indexed not only on the fuel price and inflation, but also on the ETS price. If such indexation is not implemented, a potentially significant price risk would be reintroduced. This might deter investors, especially in gas-fired power plants that will still be needed in the short-term for some countries before zero-emissions plants can cover 100 percent of the demand. This defeats the purpose of an auctioning system aimed at reducing risk to attract private investors, and potentially threatens energy security. Under such conditions, carbon pricing would be able to influence the investment choices of decentralized players who remain free, under the hybrid model, to choose what technology to invest in. Note that in the case of a carbon tax, no carbon price volatility is expected and therefore less flexibility is required.

In conclusion, in case an ETS is to be combined with a hybrid power sector model, some adjustments are required to reduce emissions:

- For the short-term effects of replacing a marginal plant with a lower-carbon one, the price of carbon should be reflected in the marginal price calculated by the cost-based dispatching program in countries with such a short-term market model;

- For the long-term effects on investment, the carbon price expectations should be integrated during the auction-based selection process into estimates of expected fuel-cost reimbursements. Moreover, the variable price should be fully indexed in the proposed contract, not only on the fuel price and inflation, but also on the ETS price.

### 6.2.2. Distributional Effects in the Hybrid Model

To ensure that end-use customers eventually internalize the environmental cost that their consumption generates, retail price regulations should guarantee that the carbon value reflected in distributors’ contractual sourcing is passed downstream in their respective regulated tariffs. If it is not, customers will not change their behavior: the impact of carbon pricing will only be felt by generators.

When passed through, in the case of a carbon tax or an auction-based ETS, the carbon rent would become government revenue. Consumer compensation would depend on how and if this revenue is recycled.

The situation is more complex in the case of an ETS with free allowances. If the opportunity cost of the carbon allowances received for free by generators is passed through into regulated tariffs, then the carbon rent would be potentially captured by the generators, transferred from customers. How can a regulator address such a situation? On one side, the strong priority that developing countries often afford to the protection of consumers, in particular captive low-income consumers—and to defending the productivity of energy-intensive domestic industry—would advocate for public authorities to take back this rent (consider the case of California, discussed earlier). Developing countries especially have low-income consumer protection as a priority. But, unlike most OECD countries, demand is still increasing in developing countries. Meeting this demand requires an increase in installed capacity and permanent investment. In this case, the carbon rent could also be oriented to finance future low-carbon investment. If an appropriate mechanism can be designed to force investors to reinvest this rent into low-carbon technology, then the long-term environmental efficiency of the carbon-pricing scheme at the generation level could become effective, despite the free allocation of allowances. It would also simultaneously help ensure medium- and long-term energy security. The key decision public authorities face when freely allocating permits is whether to prioritize consumer protection, or environmental efficiency and supply security, or a combination of the two.

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106 See sections 3.3 and 6.1 for a detailed description of this phenomenon.
In the case of an ETS or carbon tax there is also the risk of significant rent capture by existing hydropower plants. In the Latin American systems, where hydropower has an important share in the generation mix\textsuperscript{107}, carbon pricing can generate a supplementary rent on the benefits of hydropower producers during hours when the marginal plants\textsuperscript{108} are fossil-fuel-based ones. As explained earlier, the clearing price is defined by the marginal cost associated with the marginal plant, and is paid to all plants dispatched, including the lower-cost ones covered by the same dispatching rule. It can become a serious problem for these systems if fossil-fuel-based plants become the marginal units most of the year. This might be especially relevant in countries facing increasing environmental and social constraints on the development of new hydropower plants. Such issues can arise whatever the carbon-pricing mechanism chosen. A possible solution would be to tax the hydropower rent. An interesting precedent is the taxation applied on the rent of existing, written-down nuclear plants\textsuperscript{109} following market liberalization in several EU members.\textsuperscript{110} Such amortized plants have very low operating costs and make windfall profits when selling their power at the clearing price defined by the hourly power market. The proceeds of this taxation can then be redistributed to compensate for the regressive effect of the carbon price or to stimulate further low-carbon generation investment.

\section*{6.3. Constraint on the Effectiveness of Carbon Pricing by Strong Regulation in the Single-buyer and State-owned Vertical Utility Models}

As explained in Chapter 2, under the vertically integrated state-owned public entity model, all investments in generation, transmission, and distribution are decided and made by a single state-controlled public company. Ideally, prices are built as a direct function of all costs observed along the three stages of the production chain, such that these costs are covered and the system’s renewal and expansion can be self-financed.\textsuperscript{111} However, most of the time, this setup is not fully implemented. Other priorities, particularly ones motivated by politics, are considered in government investment and management decisions.

As explained in Chapter 2, in the single-buyer model, the private sector participates —mainly in production, through independent power producers (IPPs)—yet there is no market. All producers, whether public or private, can only sell their production to the single buyer, which is a public entity. In that model, the PPAs signed with the IPPs often include must-run provisions ensuring that the corresponding plant will be dispatched in priority. This is necessary to ensure investment profitability and a predictable stream of revenues to recover fixed costs. This is also the case in the state-owned vertical utility models in countries such as India and South Africa where some IPPs have developed independent capacities under PPAs. In both these models, dispatching may diverge significantly from a pure economic merit order and carbon pricing would not alter the off-taking of the production of emitting IPPs by the hourly dispatching.

There is no easy way to coordinate a market-based carbon pricing instrument these heavily regulated models. An ETS requires that a multiplicity of entities exchange their allowances on the market to ensure minimum liquidity. In the absence of substantial reform, both models imply the preservation of one utility or just a handful of them, thus preventing sufficient liquidity. In any country with an ETS, electricity operators are often

\begin{itemize}
  \item \textsuperscript{107} For example, 35-40 percent in Argentina, Chile and Colombia, 50 percent in Peru, and 85 percent in Brazil.
  \item \textsuperscript{108} The marginal power plant is the last one to be dispatched by merit order. Depending on demand, such a plant is called on to generate or not, and to sell its power or not. The "margin" of the power supply is therefore the place where the competition is the most intense in the system. Most marginal plants are flexible thermal plants, which burn fossil fuels and are therefore directly affected by the introduction of a carbon price.
  \item \textsuperscript{109} The "written-down" value of an asset is the value of the asset after accounting for depreciation or amortization. It is calculated by subtracting accumulated depreciation or amortization from the asset’s original value.
  \item \textsuperscript{110} Including Belgium and Germany.
  \item \textsuperscript{111} A complete theory for such optimized calculation was developed in the 1950s and the 1960s, in particular by the economists/engineers of French Utility Electricité de France (EdF), and is known as the Long-Term Marginal Development Cost Theory. See, in particular, Boiteux (1956).
\end{itemize}
the largest players besides industrial firms’ due to the limited sectorial coverage of most ETSs. A carbon tax might be more appropriate for these models with a small number of players.

6.3.1. The Restricted Efficiency of Carbon Pricing in the Single Buyer and Vertically Integrated State-owned Utility Models

Since the single-buyer and vertically integrated state-owned utility models have been maintained in many developing countries, which are still facing rapid expansion, their short- and long-term impacts on emissions are particularly important.

Constraints on Short-term Effectiveness

Whichever carbon-pricing instrument is chosen, it would be effective in shifting the production from the most emitting plants to less emitting ones if there is a real economic dispatch. If the dispatching is not based on merit order or if some emitting plants are considered “must-runs,” it would be difficult for carbon pricing to generate any significant abatement. In the absence of economic dispatching, the distortive effects of PPAs’ contractual provisions, or the political designation of some emissions intensive plants as ‘must-run’, might leave carbon pricing partially or totally ineffective in reducing emissions.

Still, there are ways to accommodate carbon-pricing schemes within such constraints. For an ETS this would involve allocation based on grandfathering. Establishing a tax-free threshold under a carbon tax is another option. However, unless PPAs are revised the problem of environmental inefficiency will persist.

Meanwhile it is possible for authorities to use a command-and-control approach to include a carbon cost in the centralized dispatching decision criteria and overrule existing rules. This would require a shift in priorities for many low-income countries.

Long-term Effectiveness Restrictions

The carbon-price signal cannot be effective in accelerating the replacement of high-emitting generators with low-carbon ones under an ETS with free allowances and a taxation with tax-free thresholds (Grubb et al. 2014, see Chapter 8). This is the reason why a progressive shift toward the auctioning of allowances has been programmed into most ETSs. A similar phasing out of tax-free thresholds is also typically considered in carbon-tax schemes. Importantly, this requires determining how such solutions can be made compatible with pre-existing planning and dispatching rules.

An alternative might be to opt for a command-and-control approach in which planning and investment decision criteria would be modified to align with carbon emissions reductions. It could be made by a program of old coal plants phase out and replacement by low or lower-emissions technologies.

Box 6.2 presents the nature of the challenges and preliminary options that could be considered, as illustrated by the single-buyer model in China.
The Strong Control of Possible Regressivity

ETSs, assuming appropriate design\textsuperscript{112}, present the advantage of easily preventing generators from capturing the carbon rent. Due to the tight control of both wholesale and retail prices and tariffs, the pass-through of the opportunity cost of the free allowances can be blocked. Thus, the transfer of the carbon rent from consumers to generators can be prevented. However, the price signal sent to energy-intensive industries to inform them of the cost of indirect emissions would also be lost.

In the case of a carbon tax with tax-free thresholds, such a risk of rent capture and transfer does not exist, since the tax exemption does not translate into any MWh cost-price that could be sold (unlike free allowances). However, the additional cost of the carbon tax applied beyond that threshold must then either be passed through to generators or they need to be compensated for it. Compensation could occur through the reduction of other taxes. In case of a pass-through, the possible regressive effects on low-income customers would need to be addressed. This could be done in a multitude of ways, including by designing a taxation of windfall profit and a recycling of its proceeds towards low-income customers.

Besides these theoretical speculations, one might also consider the long record of electricity tariffs not recovering costs. Given the traditional discrepancy between actual costs and regulated tariffs in most developing countries, nothing guarantees that this would not also affect the pass-through of the carbon cost from wholesale tariffs to final customer regulated tariffs. In a context where the priorities remain affordability and competitiveness, it is probable that the pass-through of the carbon cost will be limited. The eventual gaps may need to be filled using the same, costly budgetary transfers to the affected utilities.

\textsuperscript{112} That is, that dispatching is made consistent with carbon pricing and, if free allocation of permits is used then there are provisions to address the perverse side-effects.
6.4. Summary

A summary of Chapter 6 is provided in Table 6.1.

**TABLE 6.1. The Environmental and Distributional Impacts of Carbon Pricing in Various Power Sector Models: An Overview**

<table>
<thead>
<tr>
<th>Organizational and regulatory model</th>
<th>Regions and states</th>
<th>Effects</th>
</tr>
</thead>
</table>
| **Market model**                    | EU members, Australia, and several US states | Short-term effectiveness: Effective because the power exchange is based on hourly bid prices, including the carbon price  
Critical distributional effects:  
If there is an ETS with free allowances, the problem of emitting plants capturing the carbon rent can be corrected by shifting to the full auctioning of allowances or by redistributing the carbon rent to consumers  
The carbon rent can be transferred from final customers to existing low-carbon plants, in the case of a carbon tax or ETS, even if allowances are auctioned |
| Hybrid model                        | Brazil, Chile Colombia, Peru, Ontario, Canada | Short-term effectiveness: Possible if carbon costs are integrated in cost-based dispatching  
Long-term effectiveness: Possible if carbon pricing is reflected in the selection criteria, and long-term contracts are awarded to winning bidders for new capacity  
Critical distributional effects: See above, for the effects of the market model. |
| Single buyer #1                     | South Korea        | Short-term effectiveness: Possible if generators are dispatched by the single buyer according to merit order and the carbon price is considered  
Long-term effectiveness: Only if the carbon cost is internalized in the single buyer’s planning  
Critical distributional effects: Depend on how the carbon cost is passed through by the single buyer |
| Single buyer #2                      | Thailand, Indonesia, China | Short-term effectiveness: Very low if there are many IPPs that “must” be run  
Long-term effectiveness: Only if the carbon cost is passed through in the new PPAs  
Critical distributional effects: Mitigated by heavy regulation |
| Integrated state-owned utility, with some IPPs | South Africa, and several Indian states | Low compatibility with an ETS because of the monopolistic structure (the number of players is too small for the ETS to deliver benefits); a carbon tax is a more appropriate instrument in this context  
**Long-term effectiveness:** Depends on the integration of the carbon cost in the investment criteria of the integrated SOE, and on whether the carbon cost is passed through in the new PPAs  
**Short-term effectiveness:** Depends on the integration of the carbon cost in the dispatching process of the national/regional utility  
**Critical distributional effects:** There is a frequent disconnect between tariffs and actual costs; without full cost-recovery, it is unlikely that final tariffs will reflect carbon costs |

Note: ETS = emissions trading system; EU = European Union; IPP = independent power producer; PPA = power purchase agreement; SOE = state-owned enterprise.  
Source: Authors
References


7. Mitigating the Concerns of the Negative Impact of Carbon Pricing on Domestic Industries’ Competitiveness

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    7.5.3 Compensation versus Tax Reliefs .............................................................................................122

As noted in Part 1 of this report, defending the competitiveness of Energy Intensive Industries (EIs) is one energy policy objective that can clash with carbon pricing.

113‘Defending the competitiveness of domestic industry is certainly a policy objective whose scope is far broader than that of any energy policy. This is a policy objective that is driven by concerns over regional and national economic development, and, to a certain extent, also political economy. Meanwhile, the potentially negative impact of carbon pricing on competitiveness would concentrate on EIs, which are precisely the industries targeted by energy policies. As we will see in this chapter, many of the compensation measures that have been used and considered in some high-income countries are related to energy pricing, energy taxation, or energy conservation.

The potential impact of carbon pricing on competitiveness is central to both the political debate on emissions and any dialogue between policy makers and domestic industries. How the issue is addressed will in turn inform key policy decisions. Such decisions include whether to opt for a tax or an ETS, which sectors to regulate, and, in the case of an ETS, which method to use for determining emissions caps and allocating permits. Questions over compensations and revenue usage lie at the heart of the debate over carbon pricing design.

It should be noted that competitiveness protection is ultimately a short-term measure. It is an approach that needs to be balanced with the need for EIs to innovate and prepare for a low-carbon, competitive environment.

113 Variations in competitiveness can be understood in different ways, for instance, as variations in sector-specific trade balances or as variations in the relative prices of sector-specific exports (due to different caps levels and different scheme features). While various indicators measure competitiveness across sectors (or jurisdictions in a given sector), the most comprehensive index in the context of computable general equilibrium (CGE) modeling involves producers’ price indices (for exports) and consumers’ price indices (for domestic consumption). That is, a sector in one country will see its degree of international competitiveness diminish if the aggregate prices of the commodities it produces exceed those produced by foreign competitors. In the case of domestic consumption, a sector would lose its competitiveness if the aggregate prices of the commodities it produces exceed the aggregate prices of the same commodities imported from foreign countries (de Gouvello and Timilsina 2012).
Short-term misalignments between NDCs may make protection desirable, but meeting the long-term goals of Paris requires all industries to eventually decarbonize or undertake significant mitigation efforts. The evolution of EIIs towards lower emissions is necessary for them to avoid becoming relics of the past, or the target of trade measures. This need to transform in the long-term is a consequence not of carbon pricing, but of the long-term goal to reach net zero emissions.

In this Chapter, we will first examine how the potential impact of carbon pricing on competitiveness varies according to the type of carbon pricing considered, and then review compensation measures that have been implemented, mainly in OECD countries, and the methods used to test their effectiveness.

7.1. Energy-pricing Policies and the Competitiveness of Energy-intensive Industries

Before looking at the relative impact of carbon pricing, it is important to recall that, even in those OECD countries that have opted for market-based models for their power sector, defending EIIs has remained a clear objective of their energy policies. In such market-based models, large consumers such as EIIs directly procure their electricity from the market. Therefore, electricity prices are determined by market forces and not by governments. However, despite prices being determined by the market governments can still reduce the energy costs of EIIs by exempting them from energy taxes and levies, even if these levies are aimed at financing the potential additional cost of low-carbon power production by renewables (see Chapter 6). If EIIs are exempted from such levies then the cost will fall upon consumers and hinder redistribution objectives.

In the specific case of Germany, a recent study from Ecofys, Fraunhofer-ISI, and GWS (June 2015), which analyzes the role of these exemptions, shows that energy-intensive, large-scale consumers from the metalworking and chemical industries pay the lowest electricity prices in most of the 11 countries analyzed (10 high-income countries plus China). Most of these companies pay no, or significantly reduced, taxes and levies and low network charges (see taxes and levies in blue in Figure 14). By comparison, without the exemptions under the so-called special equalization scheme (DE in Figure 14), the electricity price paid by EIIs would be much higher than the electricity prices paid by comparable EIIs in other countries.

FIGURE 14. Electricity Prices for Electricity-intensive Industries in 10 OECD Countries plus China

<table>
<thead>
<tr>
<th>Country</th>
<th>Calculated electricity price [c€/kWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE</td>
<td>12</td>
</tr>
<tr>
<td>(DE)</td>
<td>7</td>
</tr>
<tr>
<td>NL</td>
<td>6</td>
</tr>
<tr>
<td>FR</td>
<td>5</td>
</tr>
<tr>
<td>UK</td>
<td>4</td>
</tr>
<tr>
<td>IT</td>
<td>3</td>
</tr>
<tr>
<td>DK</td>
<td>2</td>
</tr>
<tr>
<td>CA</td>
<td>2</td>
</tr>
<tr>
<td>US</td>
<td>1</td>
</tr>
<tr>
<td>KR</td>
<td>1</td>
</tr>
<tr>
<td>CN</td>
<td>1</td>
</tr>
<tr>
<td>JP</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: DE = German prices with privileges; (DE) = German prices without privileges; CA = Canada; CN = China; DK = Denmark; FR = France; IT = Italy; JP = Japan; KR = Korea; kW = kilowatt-hours; NL = Netherlands; OECD = Organisation for Economic Co-operation and Development; UK = United Kingdom; US = United States; c€ = Euro cents.

Source: Ecofys, Fraunhofer-ISI, and GWS 2015.

114 Canada, Denmark, France, Germany, Italy, Japan, the Republic of Korea, the Netherlands, the United Kingdom, and the United States.
115 As mentioned above (section 5.3), in Germany the levy paid by the large industrial consumers of the EIIs is €0.5/MWh, while it is set to €58.4/MWh for small businesses and households.
This study also estimated the potential impacts of increased electricity prices on the competitiveness of EIIs. It estimated that if the special equalization scheme were removed then product prices would increase by about 5 percent on average, exports in the metal and paper industry sectors would decline by 16–18 percent, and the production of these industries would decrease by 11–18 percent. This is based on the assumption that increased electricity costs in the value chain were fully passed on to product prices in the paper and nonferrous metal industries, Box 7.1 presents detailed findings of this study for a product (wire rods) of the steel industry.

**BOX 7.1. Tax Exemptions on Electricity Prices, and the Competitiveness of the German Steel Industry – assessment of the impact on the production cost of wire rods**

- In Germany, the steel industry, alongside most EIIs, benefits from the special equalization scheme (Besondere Ausgleichsregelung, BesAR) implemented under the German Renewable Energies Act (EEG). Figure 15 illustrates how the removal of the BesAR scheme would increase electricity prices and impact the production costs of steel wire rods using the Electric Arc Furnace (EAF), and thus affect the competitiveness of the industry at the product level. Electricity costs make up about 9 percent of product prices with privileges, and approximately 18 percent without. The production costs of wire rods were slightly higher than the observed market price without implementation of the BesAR at the time of the study.

- The impact of electricity prices on the industry’s competitiveness related to the production of wire rods was measured via changes in product prices, demand, and production. The analysis used an input-output model and a trade model to simulate the effect on product prices and production if the BesAR were to be abolished for only the steel industry. The modeling results indicate an increase in product prices of 3.3 percent for electricity-intensive companies in the sector and 1.5 percent for non-energy-intensive companies. This results in a 16 percent drop in exports, a 5 percent decline in domestic demand, and an approximately 18 percent reduction in total production. These higher costs may result in a higher burden for consumers. After the winners’ selection, every contract is fully indexed on fuel prices and inflation.

- To introduce a carbon pricing by an ETS would imply third changes in this complex market design: first to add long term expectations of carbon price into the calculation of the OMC by the system operator model during the auctioning process; second to add the futures’ carbon price to the indexation formula; and third to include the actual carbon price in the complex weekly programming of the cost-based dispatching. Indeed, the prices are calculated by the dispatching manager, also called the “market operator,” who uses a computational model to operate the system. Every week, this model calculates short-run marginal costs (measured in dollars per megawatt-hours [$/MWh]) in each region and for three different load blocks per week.

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116 It is, however, important to note that the overall macroeconomic balance might change due to the macroeconomic consequences of maintaining the same mitigation target. This may increase the burden placed on other sectors (see section 7.5)
7.2. The Impact of Carbon Pricing on Industrial Competitiveness

The implementation of a carbon-pricing scheme has a direct impact on industrial production costs, since any plants emitting GHGs must pay a carbon tax or purchase emissions allowances. It also may have an indirect impact when the energy sector is affected by the carbon-pricing scheme. Industrial energy consumers are likely to pay higher prices for their energy inputs, either because of the direct effects of carbon pricing on the prices of the fossil-fuel energy consumed, or because of the indirect effects of passing through the carbon costs borne by the power industry on to electricity prices. Figure 16 suggests that climate-related policies, including carbon pricing, would increase electricity costs for EIIs in Germany. The impact would be several times larger than the increase generated by other energy taxes and levies. Such increases in production costs encourage a short-term shift to, and long-term investment in, lower-emissions plants.

These effects have created competitiveness concerns for trade exposed EIIs. Competitiveness concerns are due to the difference in carbon policies across the world. Sectors that pay a carbon cost may feel increased pressure from any foreign competitors not exposed to a similar carbon cost. These foreign competitors can gain a comparative advantage, and an industry grappling with the implications of a new carbon-pricing instrument can then lose some of its market share.

Note: EAF = Electric Arc Furnace.
Source: Ecofys, Fraunhofer-ISI, and GWS 2015.
The magnitude of any potential loss depends to a large degree on the cost structure of the industry. Grubb, Hourcade, and Neuhoff (2014) highlighted that for most manufacturing industries the differences in the cost of labor and exchange rate variations far outweigh any additional costs induced by carbon pricing. Only a handful of carbon-intensive industrial sectors would see their competitiveness suffer due to carbon pricing. Figure 12 shows the relative impact (on total production costs) of direct and indirect cost increases in the UK, triggered by a carbon price of €20/tCO₂ of direct industry emissions and of €10 per MWh, the latter resulting from the share of fossil fuels in the energy mix of the power sector.

However, the potential impact of carbon pricing on the competitiveness of sensitive industries is likely to be more significant in developing economies. For example, in EU economies, the total sum of added value generated by the affected sectors is small. The six industrial sectors with the most emissions are responsible for approximately only 2 percent of GDP, and less than 1 percent of total jobs (Grubb, Hourcade, and Neuhoff 2014: 290). These sectors represent less than 1 percent of GDP in the UK (see Figure 7.2).

In contrast, in emerging economies EIs are responsible for a large share of national GDP and jobs. For example, in China and India, they contribute close to 10 percent of GDP (Grubb, Hourcade, and Neuhoff 2014: 291). This is because these economies are still dominated by the production of intermediary goods and export-orientated, manufacturing intensive industries. Because of differences in cost structure, the same carbon-pricing level can have a significantly greater impact in developing economies. For example, a carbon price of $50/tCO₂ could increase the final price of cement by 75 percent in India from $52/t of cement to $90/t. In Europe, the effect will be limited to an increase of 22 percent, from $175/t to $215/t.

Note: Sectors are ranked by the decreasing impact of carbon costs on production costs, from left to right. The carbon price is €20/tCO₂ and €10/MWh. CO₂ = carbon dioxide; EU ETS = European Union Emissions Trading System; GDP = gross domestic product; MWh = megawatt-hours; tCO₂ = metric tons of carbon dioxide.

Source: Hourcade and others 2007.
Despite a comparatively smaller impact, high-income governments have not dismissed the impact of carbon pricing on the competitiveness of their industries. Much of the concern has been driven by lobbying pressures by impacted industries. One argument is that if domestic industries lose out to competitors not covered by a carbon price then global emissions will be unaffected. The emissions reduced in one place will be compensated by an increase in emissions elsewhere. This idea is referred to as ‘carbon leakage’. Importantly, as more countries and jurisdictions adopt carbon pricing, leakage and losses in competitiveness should decrease. Yet even if such policies align completely across all countries, the risk does not totally disappear. This is because, as noted earlier, internal cost structures—and thus impacts—differ significantly.

Before detailing how high-income countries have implemented and adapted to carbon pricing, it is important to detail several differences between various types of carbon-pricing instruments. Different instruments have different impacts on competitiveness, and thus require different adjustments to mitigate these impacts.

7.3. Different Carbon-pricing Instruments, Different Effects

A carbon tax, an ETS with auctioning, or an ETS with free allowances will have different effects on international competitiveness. The differences between carbon taxes and ETSs in terms of regulation points are highlight in Table 7.1. This is in large part because of differences in how these instruments interact with existing energy regulations, especially in the power sector.

To understand these differences two issues, need to be interrogated. The first involves the regulation point: that is, the point at which the fossil-fuel chain intersects with a carbon-pricing scheme. If carbon pricing is applied to only final consumption, it will not affect competitiveness. This is true in the case of a carbon tax or an ETS, provided these instruments do not cover any intermediary energy consumed by industries. It is not feasible to extend ETSs to individual households or small and medium enterprises (SMEs) of the tertiary sector.

**TABLE 7.1. The “Regulation Point” and Competitiveness Effects: A Comparison of Two Carbon-pricing Instruments**

<table>
<thead>
<tr>
<th>Regulation Point</th>
<th>Carbon Tax</th>
<th>ETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producers</td>
<td>Trade distortions may affect export industries in the absence of similar regulations elsewhere. Possible trade distortions without global carbon pricing coverage. Current response: free allowances based on grandfathering, up to 95% of the baseline emissions.</td>
<td></td>
</tr>
<tr>
<td>Consumers</td>
<td>No trade distortion, even in the absence of worldwide carbon restrictions. No trade distortions even in the absence of the worldwide coverage of carbon restrictions. However, extending ETSs to small consumers, in particular households, is not realistic.</td>
<td></td>
</tr>
</tbody>
</table>

Note: ETS = emissions trading system.
Source: Authors’ compilation.

The second issue involves how the carbon rent is captured: whether by the state, or in the case of the power sector, by the power generation companies.

In this respect, an ETS with free emissions allowances clearly differs from a carbon tax or an ETS with auctioned emissions allowances. Indeed, as detailed in previous chapters, where free allowances are awarded to the power industry, the carbon rent is transferred from consumers to power generators. This problem is found
not only in the energy sector but in any sector not exposed to international competition.\textsuperscript{118} When an industry does not need to redeem its free allowances to remain competitive, it can instead sell them on the market. The producers receiving these free allowances internalize the corresponding opportunity cost, and pass it through to their clients (see Chapters 3 and 6). These customers end up paying an additional cost not borne by the producers in the first place, making it a pure rent transfer. This redistributive effect alters the final price of electricity paid by industrial consumers. This is particularly pertinent for trade-exposed EIIs. Meanwhile, in the case of an ETS with auctioned emissions allowances, the electricity prices paid by industrial consumers are also affected by an ETS with the auctioning of emissions allowances. In this case the carbon rent is not transferred to power generators, it is instead transferred to government, thus allowing the recycled proceeds of the auctioning to partly compensate the most affected industries (see Table 7.2).

7.4. High-income Countries’ Attempts to Mitigate Negative Effects on Competitiveness

There are several ways to limit carbon policy instruments’ undesirable effects on competitiveness. These include (i) border taxes, involving tariffs on imports and/or tax rebates on exports; (ii) mandatory emissions allowance purchases imposed on importers; and (iii) mandatory carbon product standards for imports (Wooders, Cosbey, and Stephenson 2009: 9–12). The first option has been widely discussed (see, for example, IPCC WG III 2001, 2014;\textsuperscript{119} Grubb, Hourcade, and Neuhoff 2014: Chapter 8), often in the context of the World Trade Organization’s (WTO’s) rules on trade and the environment.\textsuperscript{120} There appears to be relative agreement that, depending on design, such measures could be compatible with WTO rules. There has also been discussion of border carbon adjustments under the European Parliament and Commission and were part of the Waxman-Markey bill of 2009 in the US.\textsuperscript{121} Despite this, no high-income country with carbon pricing has implemented carbon border adjustments yet.

In practice protectionist measures have been overlooked in favor of adjusting the carbon pricing instrument. The following two subsections present international experiences in this matter for both ETS and carbon tax instruments. Table 7.2 presents a synthesis.

\textsuperscript{118} The case of the power industry differs to other industries such as steel. The former only serves the domestic market whilst the latter is largely globalized and exposed to international competition. To maintain competitiveness, the steel industry has to use and redeem its any free allowances to avoid an increase in its costs. Passing through a carbon cost to its clients would undermine its competitiveness against peers that do not bear a similar carbon cost. An industry that is not exposed to such international competition can afford to pass through the carbon cost, including the opportunity cost (in case the allowances were awarded for free).


\textsuperscript{120} Helm, Hepburn, and Ruta (2012) question the conventional view of a border tax on carbon products as a trade barrier. Instead, they argue, the absence of a carbon price comprises a subsidy to high-emissions production in nonregulated markets. Thus, it is this implicit subsidy, rather than the border tax (which is a correction of a market failure), that should be regarded as the distortion.

\textsuperscript{121} Also known as the “American Clean Energy and Security Act of 2009 (ACES)”. The bill passed the House of Representatives but was never tabled to the Senate.
### TABLE 7.2. Redistributive Effects and Competitiveness: A Comparison of Carbon-pricing Designs, and Examples of Mitigation Measures

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Coverage</th>
<th>Carbon Price Pass-through</th>
<th>Potential Carbon Rent Transfer</th>
<th>Ways to Mitigate Effects on Competitiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon tax</td>
<td>Possibly all sectors</td>
<td>Carbon tax, passed through in final energy prices, is paid by regulated sectors</td>
<td>Appropriation by state budget</td>
<td>Reduced rate, rebates for certain energy uses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Recycling via labor tax and/or corporate tax reduction</td>
</tr>
<tr>
<td>ETS with auctioned allowances</td>
<td>Emitting industries</td>
<td>Cost of auctioned allowances passed through to customers’ prices for all covered sectors (including in wholesale energy prices, in the case of the power sector)</td>
<td>Appropriation by state budget</td>
<td>Border taxation</td>
</tr>
<tr>
<td></td>
<td>Possibilities to also cover transportation fuels*</td>
<td></td>
<td></td>
<td>Exemption in exchange for energy-efficiency programs</td>
</tr>
<tr>
<td>ETS with free allowances</td>
<td>Same as above*</td>
<td>Pass through of carbon market value into prices in industries not exposed to foreign competition (e.g. electricity)</td>
<td>Appropriation by producers e.g. power generators</td>
<td>Recycling of proceeds to compensate for cost burden</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Partial free allowances for exposed sectors where the impact on competitiveness is significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Increased flexibility of allowance redemption rules</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Subsidized energy-efficiency programs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Partial offsetting allowed</td>
</tr>
</tbody>
</table>

Note: With allowances allocated to wholesale gasoline distributors (as in California).
Source: Authors’ compilation.

#### 7.4.1. Adjusting ETS Instruments

The competitiveness protection measures used in different ETSs are summarized in Table 7.3. In general, governments have preferred allocating free allowances to exposed sectors as a response. For example, in the EU ETS, permits have been allocated for free to “emissions-intensive, trade-exposed” industries until 2020. A similar solution was adopted in Australia under its previous carbon pricing scheme. New Zealand adopted a novel system that combined free allowances with a requirement that only one carbon unit be surrendered for every two tons of carbon emissions. This halved the carbon cost.

However, free allocation is far from an ideal solution. It eliminates the carbon price signal and can be criticized as an implicit subsidy for the benefited industries. For these reasons, several jurisdictions have opted for a progressive transition from free allocation to auctioning over a period of 10 to 20 years. The previously mentioned case of the EU is one example of this.
Another way to reduce the cost for affected industries is to allow for the use of carbon offsets. Offsets are emissions reductions made to compensate for emissions elsewhere. Offsets must be verified by an authorized third party and then become credits.

The offset is made by sectors not covered by an ETS and purchased by firms under the ETS to offset part of their compliance obligations. Usually, an ETS covers only part of an economy, namely those sectors where emissions are concentrated in a limited number of facilities that can be monitored at a reasonable transaction cost and that are managed by firms with the capacity to access and benefit from a carbon market. Other sectors—in particular those related to land use, such as agriculture, forestry, and farming—tend to be left out of the ETS scope.

When sectors not regulated by an ETS implement mitigation activities, any resulting emissions reductions verified by an authorized third party can generate a carbon credit which can be acquired by ETS regulated entities to offset (part of) their compliance obligations. If corresponding abatement costs are low, then industries regulated by the ETS can purchase these credits, which can be redeemed when their emissions exceed the cap. Thus, the credits function as emissions allowances, and reduce the cost of complying with the cap. It is worth noting that such offset mechanisms can also encourage nonregulated sectors to produce renewable energy, for instance, waste-to-energy, wood-to-energy, and other kinds of bioenergy that may over time become more competitive against conventional energy sources and more mature technologies.

Most ETSs allow for offsets to be purchased from international and domestic entities. The international offset market includes Clean Development Mechanism (CDM) and Joint Implementation (JI) projects under the Kyoto Protocol. Under the CDM offsets are purchased from developing countries which are not committed to emissions reduction under the Protocol.

7.4.2. Adjusting Carbon Taxes

All countries that have introduced carbon taxes have also implemented measures to address their impact on competitiveness, particularly for EIIIs. Such measures aim to accomplish one—or both—of two main objectives: (i) adjust the carbon tax itself, and (ii) enhance fiscal neutrality, that is, compensate for the introduction of a new carbon tax by reducing the fiscal burden imposed by other, preexisting taxes.

In almost all cases, several sectors are exempted from the carbon tax, or the tax is differentiated across sectors. Typically, households pay the full tax rate and export-oriented industries pay either nothing or a lower rate.

Concerns about the regressive effects and sectorial implications of carbon taxation have led to three types of responses (see details in Table 7.4):

- Carbon-intensive activities are exempted from the carbon tax up to an emissions threshold. In South Africa, this is up to 60-80 per cent of Emissions. Low-productivity activities, such as agriculture, forestry and fishery are often totally exempt. This is done as in Finland, Ireland, Japan, and partly in British Columbia;\(^\text{122}\)

- Tax rate differentiation across sectors or across uses. The former is practiced in South Africa and the latter in Sweden where industry sectors not covered by the ETS are eligible for a rebate of up to 30 per cent of energy used for heating;

\(^{122}\) British Columbia introduced a carbon tax in 2008 at an initial level of $10 and with an automatic growth of $5 per year until 2012; no exemption or relief was awarded to industry, transport, or residential sectors, although rebates were conceded to farmers for their fuel consumption.
Carbon tax reliefs subject to voluntary agreements to achieve energy-efficiency targets. One example is the 80 percent relief of the Climate Change Levy (CCL) in the UK before and after the EU ETS implementation.

The design of the carbon tax in South Africa, including widespread emissions thresholds, offers a model for emerging and developing countries looking to limit competitiveness effects. Importantly, the generalization of tax-free thresholds does not hamper the instrument's effectiveness, since the taxation of the remaining portion of emissions still encourages emitters to reduce their emissions.

**TABLE 7.3. Coverage, Mode of Allocation, and Correction of Distributional Effects in Selected ETSs**

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Mode of Allocation and Compensations</th>
<th>Correction of Distributional Effects on Industry</th>
<th>Offsetting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EU ETS since 2005</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power sector, iron and steel, cement, aluminum, ammonia, bulk organic chemicals, installations of thermal combustion over 20 MWh, domestic aviation</td>
<td>Grandfathering in the two first phases</td>
<td>Free allocations</td>
<td>Restrictions of the use of international offset credits by entities to up to 11% of their allocation in second phase of the system (2008–12)</td>
</tr>
</tbody>
</table>
| California ETS since 2013 | Allocation by free allowances of up to 95% of baseline | Transitional additional free allocations to compensate for competitiveness issues:  
• Industries' compensation through a subsidized energy-efficiency program  
• Customers receive compensatory check | Offsets limited overall (domestic and international) to 8% of an entity's compliance |
| Forestry, transport fuels, coal mining and imports, gas mining, geothermal energy, industrial processes, and synthetic gases and waste  (Electricity not included because obligation is on upstream sectors: coal, oil, gas, geothermal) | Allowances are allocated for free to the trade-exposed industrial sectors, forestry, and fishing  
Allowance auctioning may be considered in the future | Requirement to surrender only one carbon unit for every two tons of carbon emissions (division of the carbon cost by two) | No quantitative limit, but several qualitative restrictions related to the project generating the offset credits |
| Quebec since 2013 | Free allocation in first period | Free allocation | Offsets limited overall (domestic and international) to 8% of an entity's compliance |
| Electricity generators and industrial sites in all manufacturing sectors (more than 25,000 tCO2)  Inclusion of fuel distributors in 2015 | Decrease of free allocation by 1%–2% per year |  |  |
| Six Chinese ETS pilots since 2013–14 | Free quota on the first phases  Progressive phase-in of auctioning | Free allocation | Depending on the system, domestic offset credit limited to 5%–10% of an entity's allocated allowances or annual verified emissions |

Note: EIIs = energy-intensive industries; EU = European Union; EU ETS = European Union Emissions Trading System; MWh = megawatt-hours; tCO2 = metric tons of carbon dioxide.  

123 Although not an OECD country, the example of China’s ETS pilots have been added for information.
An alternative to adjusting tax levels or providing rebates is to compensate the associated costs via a fiscal abatement on labor costs or on corporate taxation. In some countries, such as Sweden and the Netherlands, the implementation of a carbon tax has been presented as an opportunity to reform the entire fiscal system and transfer taxation to “bad goods” rather than on labor or non-polluting inputs. In the Nordic countries, the carbon tax has generally been a substitute for an existing energy tax, particularly an excise duty on motor fuels.

While such efforts may succeed in making the carbon tax palatable to a voting public, they require detailed planning and analysis. Adjusting an entire taxation system is complicated, especially when considering the potential macroeconomic and fiscal results.

**TABLE 7.4. Carbon Tax Rebates and Exemptions: Examples from around the World**

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Coverage</th>
<th>Rebate and Exemption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>1990</td>
<td>All fuels and sectors: Motor fuels €60/tCO2; Fuel oils, natural gas, coal: €30/tCO2</td>
</tr>
<tr>
<td></td>
<td>First as an energy tax, followed by many changes</td>
<td>Agriculture</td>
</tr>
<tr>
<td>Ireland</td>
<td>2010</td>
<td>All fuels; All sectors not covered by ETS. €20/tCO2</td>
</tr>
<tr>
<td>Japan</td>
<td>2012</td>
<td>All fossil fuels; ¥289/tCO2 ($2.5)</td>
</tr>
<tr>
<td>Norway</td>
<td>1991</td>
<td>$4–$71/tCO2; Addition to existing energy tax</td>
</tr>
<tr>
<td>Sweden</td>
<td>Since 1991</td>
<td>All fossil fuels; All sectors</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Since 2001</td>
<td>Heating industrial processes, transportation fuels; Increase from $13/tCO2 in 2008 to $66/tCO2</td>
</tr>
<tr>
<td>UK</td>
<td>Since 2004</td>
<td>Industry; The CCL: £5.5–£10.5/tCO2</td>
</tr>
<tr>
<td>South Africa</td>
<td>Introduced in 2015</td>
<td>All direct stationary sources; Initial tax: $10/tCO2</td>
</tr>
</tbody>
</table>

Source: PMR 2013. Note: CHP = combined heat and power; CO2 = carbon dioxide; EIs = energy-intensive industries; ETS = emissions trading system; EU = European Union; LPG = liquefied petroleum gas; SMEs = small and medium enterprises; tCO2 = metric tons of carbon dioxide.
7.5. An Assessment of the Different Ways to Counter the Potential Effects of Carbon Pricing on Competitiveness

Similar to Chapter 5, which assesses measures aimed at correcting the regressive effects of carbon pricing, this subsection assesses the measures meant to contain carbon pricing’s negative impact on competitiveness, in particular the ones that have been implemented in practice and highlighted in the previous section. This requires an analysis of not only the direct effects on carbon costs, but also systemic effects, which depend on the macro-economic structure of the economy. There is a wealth of information to draw on, including work by the IPCC Working Group III which primarily relied on studies from general equilibrium models to examine how rebates or exemptions weaken the effectiveness of the carbon price signal. However, some studies have conflicting results, and many do not account for political economy dynamics.

7.5.1. Tax Exemptions

Findings from modeling exercises suggest that granting tax exemptions to the industry to offset the negative impact of carbon taxes on competitiveness would significantly increase the total carbon cost borne by the economy. In the case of Germany, Böhringer and Rutherford (1997) estimate that awarding exemptions to energy- and export-intensive industries would increase the cost of meeting a 30 percent CO2 reduction target by 20 percent. Jensen and Rasmussen (1998) reach a similar conclusion for Denmark: considering a national CO2 reduction target of 20 percent, the exemption of six production sectors that emit 15 percent of Denmark’s total emissions would imply a welfare loss of 1.9 percent and a carbon tax on the nonexempted sectors of $70/tCO2. The welfare loss would be only 1.2 percent and the required carbon price only $40/tCO2 without the exemption. Hill (1999) conducted a similar study for Sweden and found that the welfare costs of using exemptions are more than 2.5 times higher than a uniform carbon tax to decrease emissions by 10 percent. Babiker and others (2000) also conclude that the costs of tax exemptions would be high in the case of the US. The results from these studies of high-income countries are clear: tax exemptions lead to welfare losses and are not an ideal measure to address competitiveness concerns.

7.5.2. Tax Differentiation versus a Flat Tax

Tax differentiation appears to be preferable to tax exemptions, but more research is needed. Tax differentiation has been studied using a general equilibrium model by Bergman (1995), who compares its effects with those of a flat tax in the case of Sweden. In this study, the tax rate applicable to industrial firms is set to one-quarter the tax rate for non-industrial firms and households. Bergman estimates that tax differentiation would lead to slightly higher GDP losses than a flat tax. However, the purchasing power of the aggregated incomes of labor and capital would be significantly reduced. Based on this study, tax differentiation appears to result in less welfare losses than full tax exemption.

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124 We refer here in particular to IPCC WG III (2001): chapter 8, section 2.2.2. For the effects of various ETS designs on the competitiveness of an industry, we refer to Chen and Timilsina (2012).
125 It is worth noting that the ECOFYS, Fraunhofer-ISI, and GWS study referred to in section 7.1 includes the input-output-based macroeconomic simulation in addition to a simulation of the impacts of energy and climate taxes on EII’s competitiveness in Germany. This study suggests that, in the absence of the special equalization scheme (BesAR), total German exports in 2020 would be 0.3 percent, or €4.7 billion, lower. According to the study, withdrawing the BesAR scheme would lead to a reduction of GDP amounting to €4 billion, or 0.15 percent, in 2020. This would amount to a loss of up to 104,000 jobs by 2020, of which more than 70,000 would be in the manufacturing sector. The fact that these conclusions diverge from those of the Böhringer and Rutherford (1997) study illustrates that the topic is not consensual.
7.5.3. Compensation versus Tax Reliefs

Compensation and tax-reliefs are another two measures that have been studied and compared, although more evidence is needed:

- Compensation and subsidies. Böhringer and Rutherford (1997) as well as Hill (1999) consider labor subsidies that are adjusted to maintain a given employment target. Comparing labor subsidies with tax exemptions for energy- and export-intensive industries, they conclude that a uniform carbon tax combined with wage subsidy can achieve identical levels of both national emissions reduction and employment at only a fraction of the cost of tax exemptions;

- Carbon tax relief based on voluntary agreements on sectorial objectives. In the UK, the Climate Change Levy (CCL) has been complemented by the Climate Change Agreement (CCA), which involves individual commitments to reach a targeted reduction in exchange for a relief of 80 percent on the CCL levy. Through this implicit subsidization, the CCL-CCA package acts as an incentive to implement energy-efficiency actions, and the CCA eventually strengthens the effectiveness of the CCL (Ekins and Etheridge 2006). However, there is a risk of moral hazard and free riding since, even in the absence of a CCA, industrial firms might already be encouraged to invest in energy-efficiency measures under the CCL (Martin and Wagner 2009).

Compensation through measures that reduce labor costs appear to be more efficient than tax reliefs, even those associated with energy-efficiency programs. Overall, it appears that tax exemptions are the least desirable measure. Tax differentiation and compensation measures appear to be more appropriate instruments that can protect industries with a comparatively low loss of economic welfare. However, the evidence base for this area is thin and further research is needed. The sensitivity of results to the type of modeling and assumptions used highlight the need for governments to have thorough mastery and ownership over models before proposing—or deciding on—any related policy.

Other innovative measures to address leakage and competitiveness concerns exist. One example is the linkage of carbon markets to allay competitiveness concerns across trading partners by subjecting industries to the same carbon price. While these are interesting proposals, they require further analysis and are outside the scope of this report. The proposals to address leakage identified in this chapter are summarized in Box 7.2.
Box 7.2 Chapter 7 Summary

Carbon pricing can cause concerns over a loss of competitiveness, particularly for trade-exposed EIs, which are often supported by energy pricing policies. Fears over competitiveness and leakage have a mixed empirical basis and are partly driven by political economy considerations.

Competitiveness concerns are likely to be more legitimate and significant in developing countries due to higher relative impact on production costs and importance of EIs in their economies.

High-income countries have used the adjustment of ETSs, such as the free allocation of permits, and carbon taxes adjustments, such as tax exemptions, tax differentiation, rebates and compensation measures to address competitiveness concerns. Other measures such as carbon border adjustments have been discussed, but not implemented to date.

Regarding carbon tax adjustment options, studies suggest that tax exemptions are the least effective way to address competitiveness concerns. Tax differentiation and compensation measures are comparatively less costly, but will likely still result in some loss of economic welfare.

Further research is needed and these corrective measures need to be carefully modelled to account for national circumstances. This is particularly important for developing countries which are considering ways to ensure industry competitiveness under carbon pricing.
References


PART III:

Beyond Carbon Pricing: Integrated design of Carbon and Energy Policies and Instruments

In Part 2 of this volume, we saw that possible conflicts between carbon pricing and existing energy policies can be mitigated. Two ways to do so were discussed. First, policy makers may adjust the design of carbon-pricing instruments to prevent or limit undesirable effects that undermine the achievement of important energy policy objectives. Or, second, they may reform existing energy policy instruments, typically energy subsidies, that—though originally designed to pursue legitimate policy objectives—are incidentally generating incentives for the emission of greenhouse gases (GHGs).

Here, in Part 3, the proposal is to move one step beyond this corrective approach. We have seen that energy policies must evolve over time to address the emergence of new challenges, thus requiring the elaboration of new policy objectives and at times dropping outdated objectives inherited from a bygone phase of the industry. At the 21st session of the Conference of the Parties (COP21), which led to the international Paris Agreement, many developing countries committed to controlling the growth of their domestic GHG emissions. These commitments are reflected in the Nationally Determined Contributions (NDCs) that more than 180 countries elaborated, in many cases based on substantial national and multi-sectoral consultations.

While the corrective approach proposed in Part 2 is certainly relevant for those developing countries now designing carbon-pricing instruments similar to the ones previously implemented in the high-income countries, the challenges faced by developing countries today are quite different from those experienced by the former 15 years ago. As outlined in Part 1 of this volume, emerging economies seeking to reform their energy sectors must consider the dynamic growth of citizens’ demand for energy—not to mention their pressing need for basic services that remain unfulfilled. As a result, the energy policies in these economies are continually evolving to adjust to their dynamic contexts. Developing countries’ commitment to controlling their emissions is also very recent, and policy makers are still exploring options for how to implement them. Last but not the least, the past decade has seen the blooming of renewable energy, in particular wind and solar, and an evolution of grid systems prompted by information technology (IT) innovation. These circumstances create an opportunity to integrate carbon-mitigation objectives in the evolving energy policies of these countries, and to design policy instruments that support both these and existing energy policy objectives.

Interestingly, instruments with these dual objectives are also observed in OECD countries today, marking a transition from 15 years of the parallel development of stand-alone carbon-pricing instruments on the one side and energy policies on the other (a scenario that frequently resulted in overlapping, if not competing, objectives). In these countries, this recent trend is largely motivated by the unexpected results of stand-alone carbon-pricing instruments that were not integrated with energy policy instruments. In the European Union, it is now almost impossible to distinguish between energy and carbon policies.

As underlined in the present volume, developing countries do not necessarily have to introduce instruments in the same sequence as did high-income countries—in fact, they would do well to avoid the pitfalls of this path. Developing stand-alone carbon-pricing instruments separate from existing energy policy instruments has several drawbacks (see Chapter 3, Part 1). For instance, it is worth recalling the inefficiency of a carbon
tax (that, it might be noted, would necessarily be moderate in developing countries, for the time being), if
added as a top-up to volatile oil prices—and the unexpected distributive effects of an emissions trading
system (ETS) when its design does not take into account the complex rules of power markets. Developing
countries have an opportunity to learn from these experiences—and skip them in favor of an integrated, and
possibly more efficient, approach.

Against this backdrop, we propose several ways that developing countries can shape their own integrated
climate and energy policies and design corresponding joint policy instruments. Chapter 8 will explore how
to efficiently integrate carbon and energy taxes. Chapter 9 will introduce the idea of converging clean energy
and carbon markets. The tenth, and last, chapter will propose a move beyond pricing instruments to policy
instruments that can address barriers and market failures. In doing so these instruments can discourage
emissions while serving energy policy goals that cannot be achieved by a price signal alone. Related steps
include releasing investment financing constraints and regulatory lock-ins that limit the penetration of clean
energy options. These chapters together present a holistic policy approach to tackling energy and climate
objectives in an integrated fashion.
8. Integrating Carbon and Energy Taxes - The OECD Experience

Introduction: Using Energy Taxes to Discourage Emissions, the OECD Experience

Energy taxes always generate revenue. The relative inelasticity of certain segments of energy demand, particularly for motor fuels, has made energy taxes a very attractive fiscal basis for generating government revenue. 127 Since the majority of a nation’s emissions come from electricity generation and energy use, carbon...
taxes provide a similar opportunity to generate fiscal revenue. Both energy and emissions taxes represent an opportunity to generate a significant and stable source of revenue.

Considering this similar function, would it make sense to integrate the two taxes? Answering this is not as easy as it might at first seem. Today’s energy taxation systems have evolved over decades and reflect differences in fiscal traditions across countries, as well as across sectors and fuels within a country. As a result, these systems can be complex. This applies to both advanced economies and developing economies.

The question of coordinating carbon and energy taxes is quite new for emerging economies. The OECD countries, on the other hand, have already accumulated more than 15 years of experience in defining and testing approaches to combining both sets of taxes. Thus, OECD country experiences might help developing countries anticipate some of the challenges and possible solutions related to the introduction of one more tax in the energy-production chain.

In this chapter, we will first look at some relevant differences across the wide range of energy taxes in the OECD countries. These differences reflect variations in the energy policy objectives being pursued, and the relative weight of fiscal objectives. We will then review the experience of the OECD countries in progressively introducing a carbon objective to energy taxation, to make it more consistent with a newly introduced aim of curbing emissions. Finally, we will discuss the recent shift toward using tax proceeds to finance energy-based carbon-mitigation measures.

8.1. An Overview of Energy Taxes in OECD Countries

The OECD (2013a) report Taxing Energy Use: A Graphical Analysis provides a comprehensive review of energy taxation levels in all the OECD countries, both by fuel type and by energy use. This report provides the taxes’ observed levels and structures in terms of both euros per unit of energy (€/gigajoule [GJ]) and of carbon equivalent (€/ton of carbon dioxide [tCO2]).

8.2. Differences in Energy Tax Rates, by Type and Use

Fuel Taxes

In almost every country, energy products used in the transport sector are taxed significantly more, per unit of energy (GJ) and carbon content (tCO2), than those used for heating or industrial process use or for generating electricity. In the case of oil products, taxation levels range, on average, from €11.8/GJ (€164/tCO2) in the case of transport, to only €0.9/GJ (€11/tCO2) for electricity generation and consumption (see Tables 8.1a and b). Coal for industry is taxed even less, at €0.5/GJ (€5/tCO2). Natural gas is taxed at a more consistent rate across sectors.

The comparatively high taxes on transport fuels are not surprising given the importance of the fiscal resources that governments can collect due to their price inelasticity. Consequently, on average, 85 percent of all energy taxes are collected from the transportation sector, which consumes only 23 percent of the total energy used.

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128 In France, for instance, four different taxes apply on electricity, including a value added tax (VAT) that is applied on the final price of electricity and electricity-specific local taxes.

129 In Brazil, final electricity prices include 11 different taxes and levies.

130 Figures in the OECD (2013a) study, which represent the “revenues surfaces” generated by carbon tax level times CO₂ quantity for the different energy uses, illustrate that fact.
Regarding heating and process uses, in many countries energy products are taxed at higher rates when used for residential or commercial purposes than for industrial ones. Such differences are driven by the objective of not undermining the global competitiveness of domestic industries.\textsuperscript{131} There are, however, significant exceptions. In some countries, coal and gas are not taxed at all in the residential sector. In some cases, they are, but at a much lower rate than that applied to heating fuel or heavy fuel oil used in the industrial sector.\textsuperscript{132}

**TABLE 8.1a. Average Fuel Tax Rates, by Fuel Type and Use, OECD (€/GJ)**

<table>
<thead>
<tr>
<th>% of base</th>
<th>Oil Products</th>
<th>Coal</th>
<th>Natural Gas</th>
<th>Biofuels and Waste</th>
<th>Renewables and Nuclear</th>
<th>All Fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>34</td>
<td>21</td>
<td>25</td>
<td>5</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>Heating and process uses</td>
<td>34</td>
<td>1.7</td>
<td>0.5</td>
<td>0.7</td>
<td>0.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Electricity</td>
<td>42</td>
<td>0.9</td>
<td>0.7</td>
<td>1.2</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Total use</td>
<td>100</td>
<td>7.9</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>3.3</td>
</tr>
</tbody>
</table>

**TABLE 8.1b. Average Fuel Tax Rates, by Fuel Type and Use, OECD (€/tCO2)**

<table>
<thead>
<tr>
<th>% of base</th>
<th>Oil Products</th>
<th>Coal</th>
<th>Natural Gas</th>
<th>Biofuels and Waste</th>
<th>Renewables and Nuclear</th>
<th>All Fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>38</td>
<td>32</td>
<td>22</td>
<td>8</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Heating and process uses</td>
<td>37</td>
<td>24</td>
<td>5</td>
<td>13</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Electricity</td>
<td>36</td>
<td>11</td>
<td>14</td>
<td>14</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Total use</td>
<td>100</td>
<td>110</td>
<td>14</td>
<td>15</td>
<td>31</td>
<td>0</td>
</tr>
</tbody>
</table>


Note: €/GJ = euros per gigajoule; €/tCO2 = euros per ton of carbon dioxide; OECD = Organisation for Economic Co-operation and Development.

The same OECD report also points to the following trends in tax rates:

- Fuel oil used in agriculture, fishing, and forestry is often exempt from tax;
- International air carriers and airports are exempt from excise duties, and domestic air carriers benefit from tax reliefs.

The taxes applied to different fuels consumed for the same use also vary, often significantly. For instance, the tax rate on diesel for road use is typically lower than the comparable rate on gasoline, both in terms of energy (€10.5/GJ against €15.5/GJ) and carbon content (€142/tCO2 against €224/tCO2), even though diesel’s environmental impact is known to be more significant (see Tables 8.2a and b).

Some of the differences in taxation levels might reflect real differences in the relative priority afforded to policy objectives. For instance, defending competitiveness may be prioritized over more stringent application of climate-related objectives. In other cases, they might reflect political concessions to competing interest groups.

\textsuperscript{131} See Chapter 7 on mitigating the negative impact of carbon pricing on industrial competitiveness.

\textsuperscript{132} In France, for instance, coal and natural gas are exempted of tax in the residential sector for historical reasons.
**TABLE 8.2a. Average Effective Fuel Tax Rates, by Fuel Type and Use, OECD (€/GJ)**

<table>
<thead>
<tr>
<th>% of base</th>
<th>Gasoline</th>
<th>Diesel</th>
<th>LPG</th>
<th>Aviation Fuel</th>
<th>Biofuels</th>
<th>Natural Gas</th>
<th>All Fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road transport</td>
<td>53</td>
<td>34</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Other uses (aviation, agriculture, fishery)</td>
<td>10</td>
<td>4.4</td>
<td>4.4</td>
<td>0.3</td>
<td>1.7</td>
<td>0.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Total (in weighted average)</td>
<td>100</td>
<td>10.2</td>
<td>10.2</td>
<td>3.6</td>
<td>1.7</td>
<td>5.0</td>
<td>0.6</td>
</tr>
</tbody>
</table>

**TABLE 8.2b. Average Effective Fuel Tax Rates, by Fuel Type and Use, OECD (€/tCO2)**

<table>
<thead>
<tr>
<th>% of base</th>
<th>Gasoline</th>
<th>Diesel</th>
<th>LPG</th>
<th>Aviation Fuel</th>
<th>Biofuels</th>
<th>Natural Gas</th>
<th>All Fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road transport</td>
<td>53</td>
<td>34</td>
<td>1</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Other uses (aviation, agriculture, fishery)</td>
<td>10</td>
<td>15</td>
<td>60</td>
<td>4</td>
<td>23</td>
<td>—</td>
<td>5</td>
</tr>
<tr>
<td>Total (in weighted average)</td>
<td>100</td>
<td>223</td>
<td>137</td>
<td>56</td>
<td>23</td>
<td>71</td>
<td>11</td>
</tr>
</tbody>
</table>

Note: €/GJ = euros per gigajoule; €/tCO2 = euros per ton of carbon dioxide; LPG = liquefied petroleum gas; OECD = Organisation for Economic Co-operation and Development.

**Electricity Taxes**

Electricity is taxed in two ways: first, by taxing the fuels used to generate it and, second, by taxing the consumption of the electricity itself. In the OECD countries, the fuels used to generate electricity make up 38 percent of total energy use and 27 percent of energy-based CO2 emissions on average. But there are tremendous differences across countries. Some countries, such as Spain and Poland, subsidize the over-cost of domestic coal production used in electricity generation. Others tax the fossil fuels used in thermal plants (see Table 8.3) or just electricity consumption.

**TABLE 8.3. An Overview of Electricity Taxes in the OECD (number of countries)**

<table>
<thead>
<tr>
<th>Taxation at the Generation Point</th>
<th>Taxation at the Consumption Point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>Tax on fuels</td>
<td>5</td>
</tr>
<tr>
<td>No tax on fuels</td>
<td>2</td>
</tr>
<tr>
<td>Rebates/subsidies on fuels</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: OECD 2013a, table 7: 45.
Note: OECD = Organisation for Economic Co-operation and Development.

Among those who tax electricity at the consumption stage, some have already taxed the fuel consumed by thermal plants that generated the electricity (see Table 8.3). One anomaly can be observed in Spain, which subsidizes fuels consumed by thermal plants, while also taxing the end-user prices.

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133 It is noteworthy that where the consumption of electricity is taxed, the OECD report calculates an effective tax rate as if the electricity tax were an implicit tax on the underlying fuels used to generate it, according to the relative share of these fuels in the power generation mix. This calculation is made only for comparative purposes: taxing electricity consumption provides no signal of the differences among the environmental impacts of the various energy sources from which electricity may be generated.
Differences in Energy Taxes across Countries

Tax levels differ significantly by country, ranging from €0.25/GJ in the US to €6.58/GJ in Luxembourg for energy. For CO2, equivalent taxes range from €4.5/tCO2 in the US to €107.28/tCO2 in Switzerland.

The Western European countries have high average tax rates, due to a long-standing consensus to tax motor fuels at high levels. Gasoline taxes amount to around $c80/liter (l) (or €23/GJ) on average in the EU, against only $c18/l (or €5.2/GJ) in the US and Canada, and $c35/l (or €10.1/GJ) in Australia. Excise duties on gasoline and diesel are a very important source of revenue for the budgets of Western European countries and play a smaller role in this regard in the US, Canada, and Australia. Differences in the fiscal policies of European countries and other OECD countries result in sharp differences in the taxation of motor fuels (see Table 8.4).

**TABLE 8.4. Taxes on Oil Used for Road Transport in Selected OECD Countries (in €/GJ and €/tCO2)**

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>Canada</th>
<th>Australia</th>
<th>Spain</th>
<th>Japan</th>
<th>France</th>
<th>Germany</th>
<th>Sweden</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>€/GJ</td>
<td>1.2</td>
<td>1.9</td>
<td>7.7</td>
<td>10.8</td>
<td>13.3</td>
<td>13.3</td>
<td>16.0</td>
<td>16.8</td>
<td>20.3</td>
</tr>
<tr>
<td>€/tCO2</td>
<td>16.8</td>
<td>27</td>
<td>109.1</td>
<td>147</td>
<td>188</td>
<td>182</td>
<td>222</td>
<td>234</td>
<td>282</td>
</tr>
</tbody>
</table>

Source: OECD 2013a, annex B.
Note: €/GJ = euros per gigajoule; €/tCO2 = euros per ton of carbon dioxide; CO2 = carbon dioxide; OECD = Organisation for Economic Co-operation and Development.

To summarize, an analysis of energy taxes across the OECD countries reveals two main structural differences, to be considered when seeking to integrate a carbon-reduction objective in energy taxation:

- Significant differences in tax rates across energy types, uses, and countries signal that energy policy objectives play a significant role in energy pricing, particularly in the transport sector, with a focus on gasoline;

- Differences in energy taxation reveal a shifting balance between fiscal and other energy policy objectives.

8.3. Introducing Carbon Objectives into Energy Taxes

Looking at tax levels as expressed per ton of CO2 equivalent reveals that these levels are quite high, frequently above $150/tCO2 or even $200/tCO2. These rates are significantly higher than those typically considered for a carbon tax.

A similar observation can be made in emerging economies and developing countries, where motor fuels are mainly or exclusively taxed with fiscal objectives in mind (see Table 8.5). Indeed, many of the patterns of energy taxation in OECD countries are repeated among developing countries. Transport fuels are the most commonly taxed. Heating and process uses are taxed at much lower rates and are in many cases untaxed. Electricity is taxed at the level of generation if there is some fossil fuel generation, and hydropower production is taxed at the concession rate. The motive for focusing taxation on the transportation sector is the scale and buoyancy of the potential revenues, the relative ease of tax assessment and enforcement, and the low administrative costs and relatively small risk of evasion (see subsection 8.3). Given the small size of the carbon taxes being considered in developing countries (about $5/tCO2 to $10/tCO2), transportation fuel taxes (when also expressed per unit of carbon content) will remain far higher than any realistic stand-alone carbon tax for many years.
### TABLE 8.5. Energy Tax Rates, by Use, in Selected Emerging Economies

<table>
<thead>
<tr>
<th>2012 Rates</th>
<th>China</th>
<th>India</th>
<th>Brazil</th>
<th>South Africa</th>
<th>Argentina</th>
<th>Mexico</th>
<th>Chile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline</td>
<td>32 CNY/GJ</td>
<td>280 INR/GJ</td>
<td>-2.8 BRL/GJ</td>
<td>97–100 ZAR/GJ</td>
<td>80 ARS/GJ</td>
<td>10.8 MXN/GJ</td>
<td>7,000 CLP/GJ</td>
</tr>
<tr>
<td>Diesel</td>
<td>22 CNY/GJ</td>
<td>100 INR/GJ</td>
<td>-1.3 BRL/GJ</td>
<td>80 ZAR/GJ</td>
<td>50 ARS/GJ</td>
<td>8 MXN/GJ</td>
<td>1,900 CLP/GJ</td>
</tr>
<tr>
<td>Heating and process uses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating fuel oil</td>
<td>22 CNY/GJ</td>
<td>100–40 INR/GJ</td>
<td>-1.3 BRL/GJ</td>
<td>No tax</td>
<td>25 ARS/GJ</td>
<td>No tax</td>
<td>No tax</td>
</tr>
<tr>
<td>Natural gas</td>
<td>No tax</td>
<td>No tax</td>
<td>No tax</td>
<td>No tax</td>
<td>3 ARS/G J (ind.)</td>
<td>No tax</td>
<td>No tax</td>
</tr>
<tr>
<td>Coal</td>
<td>No tax</td>
<td>No tax</td>
<td>No tax</td>
<td>No tax</td>
<td>No tax</td>
<td>No tax</td>
<td>No tax</td>
</tr>
<tr>
<td>Power production and use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity*</td>
<td>Regulation No tax</td>
<td>Subsidies No tax</td>
<td>Hydro:4.8 BRL/GJ</td>
<td>Coal: 3 ZAR/GJ</td>
<td>Hydro: 2 ARS/GJ</td>
<td>No tax</td>
<td>Carbon tax on fuel power plants (2016)</td>
</tr>
<tr>
<td>LPG</td>
<td>No tax</td>
<td>No tax</td>
<td>No tax</td>
<td>No tax</td>
<td>Subsidy</td>
<td>No tax</td>
<td>No tax</td>
</tr>
<tr>
<td>Kerosene</td>
<td>No tax</td>
<td>No tax</td>
<td>No tax</td>
<td>No tax</td>
<td>Subsidy</td>
<td>No tax</td>
<td>No tax</td>
</tr>
<tr>
<td>Weighted average rate per GJ***</td>
<td>0.31 €/GJ</td>
<td>0.28 €/GJ</td>
<td>0.35 €/GJ</td>
<td>1.25 €/GJ</td>
<td>1.84 €/GJ</td>
<td>0.02 €/GJ</td>
<td>1.4 €/GJ</td>
</tr>
</tbody>
</table>

Source: OECD 2015.

Note: *The calculation of the Brazilian tax on transportation fuel is complicated by the price-smoothing process adopted by the Brazilian government in periods of high oil prices. In fact, the Contribuição sobre Intervenção no Domínio taxes are applied to the ex-refinery prices of gasoline, diesel, liquefied petroleum gas (LPG), aviation fuel, ethanol, and biodiesel, but in 2012 they were rated zero.

**Possible taxation of some fuels for electricity production (fuel oil in India, all fuels in Brazil, coal in South Africa, natural gas in Argentina, carbon tax in Chile) and taxation of hydropower in Brazil and Argentina.

***Weighed average rate in € per GJ are calculated in OECD (2015, annex B: 147).

ARS = Argentinian peso; BRL = Brazilian real; CLP = Chilean peso; CNY = Chinese yuan; GJ = gigajoules; INR = Indian rupee; MXN = Mexican peso; ZAR = South African rand.

As such, energy taxes could be considered de facto carbon taxes, since they both offer a price signal and meet a fiscal objective. The problem is that while energy tax levels—expressed in €/tCO2—are high, the signal they provide is not aligned with the objective of reducing emissions. These levels, which are usually defined based on physical quantities (e.g. kilograms), appear to be extremely uneven in terms of both energy and carbon content. This disparity is observed not only across countries but also more importantly across sectors, uses, and fuels within the same country. As a result, the potential role of energy taxes in reducing emissions is largely lost in sectors other than transportation. In some cases, when carbon-intensive fuels, especially coal, are taxed less than alternative fuels the result can be even the opposite of what is intended: more emissions than would occur in a scenario with no tax at all.134

Assigning energy tax levels according to the carbon content of the energy product being taxed therefore offers an important opportunity. It can not only generate a strong signal for economic agents to choose low-carbon

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134 Note that this perverse incentive can occur even in the absence of fossil fuel subsidies, even when carbon-intensive fuels are actually taxed rather than subsidized.
options, but also eliminate incentives to choose more carbon-intensive options. Adjusting energy tax levels to send a meaningful carbon price signal could face political resistance, as carbon pricing proposals often do. However, it also has substantial room for reallocation of the fiscal burden. As we will see below, the experiences of high-income countries in introducing a carbon consideration into energy taxes has varied, particularly concerning the balance between fiscal and climate objectives.

### 8.4. Using Carbon Taxes for Different Objectives: Examples from High-Income Countries

The explicit intention of carbon tax is usually to reduce emissions, but in some cases fiscal objectives appear to be a more important motivator. This can be seen in setting tax rates so low that they do not significantly influence consumer behavior. It is also evident in the capping of the progressive growth of the tax. Both the “ecotax” adopted in Germany in 1999, and the CCL adopted in the UK in 2001 are examples of this. In some cases, the tax has been applied to a subsector or use too limited to deliver significant emissions reductions, while still allowing for the generation of substantial fiscal resources.

The following three examples of carbon taxes reflected budgetary concerns more than they promoted emissions reductions:

- **In Ireland**, a carbon tax was implemented in 2010 to address fiscal deficits. It was not part of a larger tax reform but was instead intended as a revenue-generating policy instrument to complement the EU ETS. A carbon charge on mineral oil was added to a preexisting mineral oil tax. Power and heavy industries already covered by the EU ETS were excluded from the new charge.\(^{135}\)

- **In Chile**, a small carbon tax of $5/tCO\(_2\) on fossil fuels used in power generation was adopted in 2014. Its explicit objective was to finance expenses and investment in education, health, and innovation, in the context of a large budgetary deficit.

In France, after three political failures to introduce a carbon tax on fossil fuels in 1999, 2009, and at the end of 2013, a compromise was struck in 2014: an incremental increase in an existing excise duty on oil and gas products. The increase began with €7/tCO\(_2\) in 2014, followed by two subsequent increments up to €22/tCO\(_2\) in 2016. No further increases are envisaged. Even though this is an explicit carbon tax, because it is completely integrated into excise duties,\(^{136}\) any signal meant to change consumer behavior has been blurred.

In the beginning, it was perceived as a fiscal instrument to close the public budget deficit. It was neither accompanied by any reduction of other taxes, nor were the proceeds used to finance mitigation measures. Corresponding tax increments were also limited for some emitting industrial establishments to prevent rejection, particularly from the chemical industry. However, during the vote of the Energy Transition Act in July 2015, a provision was introduced among other amendments, which imposes a growth of the climate-energy tax toward a target of €100/tCO\(_2\) in 2030. This would include an incremental stage at €56/tCO\(_2\) in 2020. But if there is henceforth an effective carbon taxation in France, no reduction of other taxations accompanies the growth of the tax. This reflects the continued dominance of fiscal objectives.

In contrast, Northern Europe offers several examples of carbon taxes that explicitly seek to reduce carbon emissions. Sweden adopted a carbon tax in 1991, and progressively increased it from $40/tCO\(_2\) to $163/

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\(^{135}\) The tax base concerns petrol, heavy fuel oil, auto-diesel, kerosene, LPG, fuel oil, natural gas, coal, and peat. Originally set in 2010 at €15/tCO\(_2\), it was increased to €20/tCO\(_2\) in 2012 (see PMR 2013: 74–75).

\(^{136}\) In 2016, the carbon tax will represent 7.9 percent of the excise duty on gasoline, 12.4 percent on diesel, 43.1 percent on LPG, and 61.8 percent on heating fuel oil.
The intent was clear from the outset. The nation's carbon intensity has been reduced by 40.5 percent since 1990, and absolute emissions by more than 10 percent. Economic growth continued throughout this period. The carbon tax's effect was reinforced by a subsidized program to promote the use of non-fossil fuels in electricity (biofuel, waste, renewable energy sources [RES]), heating, and combined heat and power and district heating (CHP-DH) schemes, as well as energy-efficiency programs based on standards.

It is difficult to assess the extent to which these decreases in carbon intensity can be directly attributed to the carbon tax. But the purpose and political will underlying the tax were clear.

The case of the carbon tax in Switzerland is exemplary for featuring the flexibility needed to ensure that it does reduce emissions. In the Swiss case, the level of the CO2 levy is legally tied to its efficacy in achieving the desired CO2 reductions. The law governing the levy provides for automatic increases if predefined emissions reduction objectives are not met. As a result, the levy was raised from the initial level of 12 Swiss francs (CHF)/tCO2 in 2008 to 36 CHF/tCO2 in 2010. Further increases up to 120 CHF/tCO2 are possible from 2014 onwards (Hood 2011). The Swiss CO2 levy is intended as an incentive to promote energy efficiency and to shift toward cleaner fuels in heating and processes. The aim is not to raise revenue. Indeed, all levy proceeds are redistributed to the population and the economy.

### 8.5. Using Carbon Tax Proceeds to Finance Environmental Measures: Examples from high-income countries

As highlighted earlier, carbon tax revenue can be recycled to address redistributive objectives in relation to both industry and consumers. However, use of the revenue may not aid emissions reductions, especially if the tax rate remains too low. Allocating part of the proceeds to financing mitigation measures is one way to ensure that a carbon tax meets its environmental objectives. Since most emissions are energy based, channeling these resources toward energy programs that serve both energy policy and climate-related objectives is logical. For example, they can be used to finance energy-efficiency measures and to promote renewable energy sources for electricity (RES-E) and research, development, and demonstration (RD&D) for new technologies (carbon capture and storage [CCS], renewables, smart infrastructures, and so on).

In some cases, such as Switzerland, only a small portion of the carbon tax proceeds might be allocated to an environmental goal. In other cases, the tax has been specifically designed and earmarked for such measures. For example, a small but universal carbon tax, or a specific levy charged per MWh of energy generated or consumed, may be used to finance the over-cost of the renewable energy policy. As an illustration of this, in October 2012, Japan introduced a carbon tax that was not intended to create a direct price incentive. Government analysts soon decided that using the revenue raised by such a tax would be more effective in reducing emissions than the response to the incremental price signal itself. This was in part because Japanese energy prices were already very high and, consequently, the use of energy was already very efficient. There was limited room for further improvement on the demand side. The tax started at a level of Japanese yen (JPY) 289/tCO2 ($2.5/tCO2) and would increase gradually over the next three years (Hood 2013).

In certain European countries, levies applied on electricity to finance production subsidies and FiTs for RES-E plants became an important element of energy taxes, prompting significant increases in final electricity prices. In 2014, the cost of RES-E policy borne by electricity consumers reached €23 billion in Germany, €10.5 billion...
in Spain, and €4 billion in France. Several reports from the European Commission indicated that levies used
to finance RES and cogeneration policies had become larger than all other electricity taxes, including VAT.\textsuperscript{\textit{139}}

8.6. Gradually Adapting Energy Taxes to Meet Climate Objectives—
The Case of Europe

In the EU, the European Commission has had to face the double challenge of: (i) reducing disparities in tax
levels to level the field for competition and (ii) aligning energy taxes with new emissions mitigation objectives.

A 2003 EU directive defined parameters for energy taxes based on the energy content of fuels (see Table 8.6).
Then, in 2011, the EU Commission sought member states’ agreement on how to implement the rules, “which
aim to restructure the way energy products are taxed to remove current imbalances and take into account
both their CO\textsubscript{2} emissions and energy content (…) Existing energy taxes would be split into two components
that, taken together, would determine the overall rate at which a product is taxed. The Commission wants to
promote energy efficiency and consumption of more environmentally friendly products in the same time that to
avoid distortions of competition in the Single Market” (European Commission 2011). Given that every EU-wide
decision on a fiscal issue must be unanimous, the directive is not yet in effect. It has not been accepted by
the most recent EU members, which are large users of fossil fuels, particularly coal.

Regardless, the European Commission’s approach to aligning energy and carbon taxes offers an interesting
model for analysis. The Commission’s 2011 proposal aimed for a minimum tax on carbon and energy content.
This included both: (i) a single rate of €20/CO\textsubscript{2} for all sectors not part of the EU ETS; and (ii) a minimum rate
based on energy content. This double minimum would maintain a large gap between taxes on motor fuels
and all other fuels, for example, €392 per 1,000 l for diesel (motor fuel) and only €57.4 per 1,000 l for gas oil
(heating fuel) (see Table 8.6).

\textbf{Table 8.6. Proposed EU Taxes on Motor and Heating Fuels}

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel</td>
<td>€330/1,000 l</td>
<td>€390/1,000 l</td>
<td>20</td>
<td>9.6</td>
</tr>
<tr>
<td>Gasoline</td>
<td>€359/1,000 l</td>
<td>€392/1,000 l</td>
<td>20</td>
<td>9.6</td>
</tr>
<tr>
<td>LPG</td>
<td>€125/1,000 kg</td>
<td>€500/1,000 kg</td>
<td>20</td>
<td>9.6</td>
</tr>
<tr>
<td>Natural gas</td>
<td>€2.6/GJ</td>
<td>€10.72/GJ</td>
<td>20</td>
<td>9.6</td>
</tr>
<tr>
<td>Heating Fuels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoil</td>
<td>€21/1,000 l</td>
<td>€57.4/1,000 l</td>
<td>20</td>
<td>0.15</td>
</tr>
<tr>
<td>LPG</td>
<td>€0/1,000 l</td>
<td>€64.9/1,000 l</td>
<td>20</td>
<td>0.15</td>
</tr>
<tr>
<td>Heavy fuel oil</td>
<td>€13/1,000 kg</td>
<td>€67.8/1,000 kg</td>
<td>20</td>
<td>0.15</td>
</tr>
<tr>
<td>Coal</td>
<td>€0/GJ</td>
<td>€2.04/GJ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural gas</td>
<td>€0/GJ</td>
<td>€1.27/GJ</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Note: kg = kilograms; GJ = gigajoules; l = liters; LPG = liquefied petroleum gas.

\textsuperscript{\textit{139}} In Germany since 2013, the RES-E levy is larger than the wholesale electricity price seen on households’ electricity bills (in 2016, approximately €60/MWh against €30/MWh).
Economic theory might propose that aligning tax levels across all energy uses would be an optimal way to meet environmental and cost-efficiency goals. However, introducing a carbon component into a heterogeneous tax structure is itself a big step toward generating better price signals. In terms of allocating resources at the consumer level, energy demand for transport does not compete with space heating. Both uses are necessary, and there is little substitution elasticity. Thus, introducing a price signal to encourage a shift from a more-carbon-intensive option to a less-intensive option within the same sector will do the most to reduce emissions within that sector.

8.7. A Trend toward Progressive, Partial Integration

The experiences of high-income countries discussed above provide several examples of how to gradually integrate energy and carbon taxes over time:

- The trend is to align energy taxes with the carbon content of the fuel(s) when the prevailing policy objective is to change consumer behaviors. This trend also includes adjusting taxes on coal and natural gas used for heating uses in countries where such taxes are low or nonexistent. This is particularly important for sectors not covered by an ETS;

- The second trend is to use part of the proceeds of carbon-based taxes or levies to finance energy-related mitigation measures.

This process of integration is not necessarily seen in every high-income country. Exceptions exist when energy policy objectives—such as making energy affordable to consumer, promoting the international competitiveness of domestic industry, and supporting industry in regions vulnerable to energy policy changes—are difficult to reconcile with the high carbon tax levels required amid low price elasticity. In such cases, the feasibility of carbon taxes might depend on exemptions and rebates.

As we saw in a previous chapter, the political economy of most high-income exporters (such as Canada, and Australia) is not conducive to the development of significant fuel taxes. Similar constraints will probably be faced in low and medium income exporters. The same problem may even exist for importers with larger resources. Taxation is a policy instrument that is difficult to implement. In several countries, the introduction of carbon taxes has been accepted only where they are presented as an add-on to existing energy excise duties and/or paralleled by a decrease in another energy tax.

While the trend toward carbon taxes is clear, it is not seen everywhere, even in Europe. Competing energy policy objectives remain in place, as do interest groups.

8.8. Redirecting the Oil Rent to Climate Policy

Before the emergence of climate policy, oil-producing and oil-importing countries were in frequent debate. In some cases (for instance, in some European countries), excise duties and other taxes (including the VAT) more than doubled ex-refinery prices.

In a competitive market both sellers and buyers are price-takers and respond to the market price that results from their global interaction. However, seller collusion to reduce quantity can increase oil prices and in turn
exporter profits. This has been the case in the oil market since the establishment of OPEC. As noted earlier, limiting the effects of the monopolistic power of OPEC has been a central objective of importer energy policies.

The economic literature suggests one way to confront such a monopoly: to establish an import tariff or a tax on oil consumption. The rationale is that oil buyers can coordinate and form a monopsony and, through optimal import tariffs or taxes on consumption, can restrict their internal demand and their imports, and thus decrease international prices. These taxes limit the increase of exporters’ revenues by slowing the rise of consumption and limiting the pressure of the demand of major importers on global oil supply, thus reflecting the monopsonic market power of these countries (Griffin and Steele 1980; Percebois 1985).

From the perspective of oil-importing countries, this solution presents a double benefit. First, it lowers international prices. Second, it enables them to extract part of the rent from the oil exporters that have formed a cartel. According to Newbery (2010), the level of the tax will depend on the price elasticity of demand: the tax will be more important when the price elasticity is lower. This means that at a high price elasticity the tax is limited, but is much higher if short-term elasticity is lower.

The debate reemerged after climate policies and carbon pricing were added to existing excise duties. For oil-producing countries, carbon taxes lower both the demand in importing countries and the international market price. This decreases potential export revenue. Carbon revenues recovered by oil-importing countries constitute a portion of the oil rent. A carbon tax could thus be seen by exporters as a capture of the oil rent by importing countries. Since a carbon tax applies to all fossil fuels, the issue extends more widely, to the gas and coal markets.

These and related issues have been noted in international negotiations on climate change, and oil exporters have pushed for different international agreements to refer to producers’ need for compensation.

The addition of a carbon tax to the international oil price acts as a “monopsony premium,” and fulfills the objective of balancing the market power of oil-exporters. As this is done by capturing part of the oil rent and converting it into fiscal revenues, the carbon tax allows the redirection of part of that rent to carbon policies.

The combination of carbon and energy taxes can also help in generating a less volatile price signal needed by importing countries who want to both protect against oil price volatility and encourage low-emissions investments. In the case of an ETS, price floors and price ceilings can also be used in the same manner to help integrate the market carbon price signal with the energy taxes. This combination offers a chance to integrate emissions reductions objectives into energy policies, which is the intention of the proposal presented in the following subsection.

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140 A monopsony is a market configuration in which a unique purchaser of a product can exert market power over multiple sellers of the product, in the same manner that a monopolist can influence the price in a monopoly with one seller and several buyers.

141 On theoretical developments quoted in section 1, see Griffin and Steele (1980) and Percebois (1985).

142 Article 4.8 of the UNFCCC and Article 3.14 of the Kyoto Protocol are good examples of this.

143 Oil prices have demonstrated very high volatility over the past few decades. In the past seven years, oil prices have fallen from $145 to $35 per barrel. The combustion of 1 oil barrel leads to less than half a ton of GHG emissions expressed in CO₂ equivalent (more precisely 0.43 tCO₂/barrel). This means that a variation in the oil price of $100/barrel is equivalent to a variation in the carbon price of $210/tCO₂. Therefore, the variation of oil prices in the past seven years has resulted in a drop of the carbon price from $337/tCO₂ to $81/tCO₂, that is, a reduction of $256/tCO₂.

144 We expand here on the analysis of Paul Leiby (2007) regarding different elements of the social costs of oil supply for the U.S. economy to the carbon externalities.

145 As explained in a report of IPCC WG III (2014): “When permits are auctioned, there is a floor (reserve) price below which permits are not sold, and permits for immediate use are always made available at the ceiling price, even if sales have already reached the permit cap. To the extent the price is controlled by these limits, it is a tax. So, if the floor is set equal to the ceiling, cap-and-trade becomes a pure carbon tax.”
8.9. Lessons for Middle and Low-Income Countries

As the energy demand in most economies is relatively inelastic to price changes, energy taxes constitute a long-standing and significant source of fiscal revenue.

As noted earlier, many of the energy taxation patterns in developed economies are apparent in developing countries. Many emerging and developing economies have energy taxes and specific levies in place for fiscal purposes.\footnote{In the power sector of a number of countries, there are several fee concessions (hydraulic, urban network etc.) and specific levies collected at various stages of the electricity chain, in order to finance specific costs not reflected in the direct price. In Brazil, they are dedicated to financing some overcosts in other sectors than electricity, and to cross-subsidizing electricity prices between regions, between urban and rural areas, and so on; their sum amounts to a large share of energy taxes; see, for example, Brazil Fuel Subsidies, Working document, 2014.} Motor Fuels in particular are a significant source of revenue. This is true even in several very low-income countries where motor fuels are taxed much more heavily than most other goods and services (Smith 2005). In some cases, excise duties are added to ex-refinery prices. Even when the prices of refined products are set below international prices, and to the extent these prices exceed the average oil production and refinery costs of the country), these excise duties should be viewed as a tax, since they generate fiscal revenue. The use of energy taxes is a rational choice given their low administrative cost, significant potential for revenue and low risk of evasion.

The fiscal objective of energy taxes is the dominant one. In fact, environmental externalities have not been considered until recently. Newbery (2006) points out that “ordinary energy taxation is not related in a systematic way to environmental damages, and they do not meet minima consistency criteria for so doing.”\footnote{In any case an environmental tax could not cover the exact environmental cost for which it is implemented. The precision required is too difficult. This is particularly the case for the cost associated with a ton of carbon emitted.} It is only now that, in some OECD and developing countries, energy taxes are being designed to reduce both fuel consumption and the carbon emissions directly or indirectly generated in the production or use of energy products.

As noted earlier, energy taxation levels are high in terms of carbon content and have significant potential to reduce emissions. Realizing this potential would require adjusting existing energy taxes and mapping out and correcting their inconsistencies with the carbon-mitigation goal. The experience of several European countries demonstrates that this is feasible. Introducing a carbon component into an existing energy tax structure is a first step toward meeting a new carbon-mitigation objective. Such a component is also a powerful instrument for generating the fiscal resources needed for energy-based mitigation measures.

Introducing a carbon component into energy taxes does not necessarily require immediately aligning the equivalent carbon price for all energy uses across all sectors. As explained earlier, different segments of energy demand are quite independent. In terms of changing consumer behavior, introducing a price signal that encourages consumers to shift from more-carbon-intensive options to less-intensive options within the same segment is what really matters for reducing emissions. This also gives policy makers greater flexibility to balance both mitigation and other objectives.
There are numerous patterns in energy taxation across both developing and developed countries. This includes higher rates for transport, and generally high levels both in terms of carbon content and energy content.

Carbon taxes and energy taxes can both be used as a source for revenue and emissions reductions. Carbon taxes have been used for both reasons, whilst energy taxes tend to be employed as a fiscal tool.

Energy taxes, particularly for transport, are often significantly higher in terms of carbon content than carbon prices in use or under consideration. Accordingly, energy taxes have significant mitigation potential. However, this potential is not being fulfilled since the energy taxes are not modulated according to carbon content.

Integrating energy and carbon taxes can help redirect the fossil fuels rent to climate policies

The progressive integration of energy and carbon taxes can generate a stronger price signal than will a carbon tax alone, thus aligning more effectively consumers and investors behaviors with mitigation objectives while still fulfilling the objectives of the energy taxes. In the case of an ETS, price floors and price ceilings can also be used in the same manner to help integrate the market carbon price signal with the energy taxes.
References


9.1 Markets include policies and regulations

In energy markets, demand is defined by the customer. That is, a customer has energy needs and expresses willingness to pay to satisfy these energy needs, as reflected in price elasticities. In carbon markets, on the other hand, the demand for emissions reductions is initially determined by policy makers, not consumers. The determination is based on scientific evidence of the need to control greenhouse gas (GHG) concentrations. Tradable quotas of emissions, meanwhile, are arbitrarily defined to meet a maximum emissions target. The difference between the sum of these quotas and the baseline emissions generate demand for emissions reductions, which is the sum of the gaps between the individual quotas allocated to emitters and their own individual baselines. The gap of each emitter can either be filled by the emitter itself—by reducing emissions—or via an emissions trading system (ETS). Thus, while carbon markets are created by policy makers and regulators, carbon markets are created by policy makers and regulators, who impose obligations that generate demand, energy markets preexist policies and regulations.

Yet it is worth noting that even in the most liberalized countries, a series of regulations, institutions, and programs had to be implemented to ensure minimum conditions for energy markets to work efficiently, including prevent market abuses and internalize key externalities.¹⁴⁹

¹⁴⁸ The conversion of global GHG reduction needs, as determined by scientists, into quotas allocated to individual emitters is conducted in a complex political economy and involves negotiations and arbitrage at the international and national levels.

¹⁴⁹ Such regulations can be seen as tentative fixes to market imperfections. Such externalities include short term and long-term continuity of service, environment protection, social equity and affordability of basic needs, etc.
Proactive policies to generate market conditions involve, for example, specific bidding process and contractual arrangement to ensure the development of planned transport infrastructure in the power sector and in the gas sector to establish fair competition among suppliers willing to serve the same customers.

A good example of regulations used to internalize key externalities are environmental regulations. These policies force economic agents to internalize the cost of avoiding pollution and other environmental impacts. In addition, taxes or levies are often added on top of market prices to internalize other policy objectives. In some energy markets, quotas have also been used to serve specific energy policy objectives. Examples of such quotas are, on the supply side, the creation of the Organization of the Petroleum Exporting Countries (OPEC) cartel and, on the demand side, the system of auctioned oil import quotas in the United States in the early 1970s. Thus, even in countries who have opted for market instruments rather than administered prices, energy policies and instruments have always been designed and implemented either to enable market forces to interplay or to channel them so that particular policy objectives are internalized into the decisions of economic agents. Thus, policies and regulations play a major role in both energy and carbon markets.

That said, in countries where energy markets are liberalized and carbon trading has been adopted, the prices of both energy products and emissions are eventually determined by market forces. The challenge is thus to ensure that both energy and carbon market instruments can be jointly designed in such a way that market forces can converge. This will lead to efficient and low-cost achievement of both energy and climate objectives.

9.2. Mapping Market Instruments and Integration Needs

Following on the previous chapter, this section will focus on the integration of carbon and energy market instruments. It is interesting to note that carbon markets use a quota system, a type of instrument already used to internalize energy policy objectives into energy markets. In addition, since most carbon dioxide (CO2) emissions come from energy production or use, quota systems based on emissions and those based on energy are de facto quite close instruments.

In Chapters 3 (and, specifically, section 3.4) and 6 of this volume, we looked at the variety of interactions between carbon-pricing instruments and power markets. We observed unexpected effects that could undermine the goal of reducing carbon emissions and generate conflicts with existing energy policy objectives. Beyond mitigating conflicts, we believe that it is possible to add carbon reduction to existing energy policy objectives, and to design market instruments accordingly. The history of energy policies and instruments shows us that the process of (re-) defining relevant energy policy objectives and designing or reforming, accordingly, the most efficient energy policy instruments is permanent.

Integrating carbon and energy market instruments is certainly not an easy task, one that we do not attempt to address in full here. For instance, as certain energy markets are globalized, as is the case for oil and coal and to LNG to an extent, convergence can be sought at only the global level. Proposals for the global convergence of energy and carbon markets is outside the scope of this volume. Instead, we will focus on national policy instruments.

150 Examples of such types of infrastructure are power lines, transformers, gas pipes, gas processing units, oil ducts, etc., which connect energy producers to retailers or directly to final customers.

151 The example of “climate credits” in California, noted in Chapter 6, demonstrates that instruments can be designed creatively to simultaneously pursue both carbon mitigation goals and the protection of small customers.
Despite these challenges, it is possible to offer some preliminary considerations that may be used to frame a consistent approach in countries willing to integrate carbon and energy policies. Indeed, energy markets are subdivided into several subsectors (e.g. oil, gas, and coal) and submarkets (e.g. gasoline, diesel, kerosene, and fuel oil) for which different market mechanisms have been developed. These market mechanisms are in turn based on national circumstances. Table 1.1a in Chapter 1 provides an overview of such market instruments. For instance, the several market mechanisms seen in Brazil’s power sector include: (i) a variety of auctioning schemes to contract additional capacity of various types (from thermal plants; from large hydropower and wind-, solar-, and biomass-based plants) to serve captive customers, (ii) a spot market accessible to free customers, and (iii) the auctioning of distribution concessions, among others. Identifying market mechanisms that can be (re-)designed to jointly serve both carbon-mitigation and other energy-specific policy objectives must be done at the individual country level for each energy subsector.

Mapping the various energy market instruments and how they might be integrated with potential carbon market instruments is more complex than doing the same for tax instruments. Even though energy taxes can be complex, it is relatively easy to obtain an exhaustive list of them, including calculation rules and application points. In contrast, mapping market mechanisms requires an understanding of technicalities that involve several agents acting under a set of detailed rules and operational processes.

For instance, in the case of Brazil’s power sector, how could new capacity auctions be designed to integrate the low-carbon development objective? How could distribution concession contracts be adjusted at the time of their renewal to ensure that they include incentives for demand-side energy conservation and distributed generation based on renewables?¹⁵²

¹⁵² If the demand is defined as kilowatt-hour (kWh) consumption, competition should lead to the lowest kWh price. If demand is defined as final energy services (that is, space heating, refrigeration, air conditioning, cooking, water heating, clothes washing, ironing, dishwashing, television, computers, and so on), then competition should lead to the lowest price for satisfying these final needs, meaning that it should include energy-efficient devices and smart energy management meters (and adequate remuneration to the provider of such equipment). The development of smart meters, “big data,” and the almost infinite range of analytics that can be developed using this numerical information open up the possibility of redefining the role of concessionaires and other stakeholders (that is, retailers) and integrating the exploration of demand-side efficiency potential within the scope of market competition. This rationale can be extended to distributed generation. A simple example is the provision of efficient lamps to customers by a distribution company, who can then include the cost of the lamps as a separate item in electricity bills. Payments for the lamps can be spread over time, resulting in an immediate reduction of customers’ monthly electricity bills while providing suitable remuneration to the distribution company, thus providing a win-win solution.
Concerns have been on the rise about the security of supply, reigniting interest in capacity mechanisms (CMs) across the EU and beyond. This is due to many grids incorporating larger variable generation sources such as wind and, in some cases, losing flexible power generation capacity. CMs are market-based mechanisms aimed at incentivizing investments in new capacity and preventing the retirement of existing capacity required to meet a given reliability standard (Baker and Gottstein 2013). The challenge has been to design CMs that deliver the required security of supply but do not compromise other, parallel objectives, such as decarbonization. This is pertinent since some CMs are carbon intensive. For instance, the UK’s first capacity auction, which concluded on December 18, 2014, has led to large payments—estimated at £658 million ($966 million)—to the most polluting forms of electricity generation, including diesel- and coal-fired power (National Grid 2014).

The European Agency for the Cooperation of Energy Regulators (ACER) uses the taxonomy of CMs presented in Figure 17, based on whether they are quantity or price based, targeted or market wide, and centralized (purchased by system operators or governments) or decentralized (procured by electricity suppliers or consumers) (ACER 2013).

- Strategic reserves consist of existing generation capacity that are kept available to ensure the security of supply as a last resort. Payments are typically determined through a tender. In Germany, new strategic reserves have been established in the context of an increasing share of variable renewables in the power mix.

- Capacity obligation schemes are schemes under which suppliers and large consumers must contract a certain amount of capacity. The amount is determined by the system operator or regulator based on forecasted demand. A linked market for trading capacity certificates may be established under the scheme. France has plans for a capacity obligation scheme.

- Capacity auctions are centralized, quantity-based schemes in which system operators or regulators determine, typically a few years in advance, the level of capacity that will be required to meet forecasted levels of demand. This capacity is then procured through an auction that sets a price that is paid to all capacity providers that bid successfully in the auction. The UK has implemented a capacity auction scheme, and its first two auctions were held in 2014 and 2015.

- Capacity payments provide a fixed price to providers of capacity for their contribution to the security of supply. The price is determined by an independent body, while the providers of capacity determine the level of capacity they can provide based on those payments. Capacity payments have been in use in Spain since 1996 and in Greece since 2005.

Regardless of their efficacy, there are ways to reconcile CM market mechanisms with the decarbonization objective:

- In France, demand-side responses have been introduced and given priority over generation capacity, for instance, by allowing the former to request certificates over a longer time frame (up to a year prior to delivery, compared to three years for existing generation capacity).

- In the US, PJM (a regional transmission organization) has promoted the participation of a demand-side response in its capacity market in three ways. First, by enabling its participation in the wholesale electricity market and the CM. Second, by introducing different categories for demand-side response resources to the CM on the basis of when they can be deployed. Third, by adopting a differentiated auction process. Demand-side responses have helped to reduce the costs of meeting the reliability standard by an estimated 10–20 percent in 2014/15, delivering consumer cost savings of an estimated US$1.2 billion (Keay-Bright 2013). More recent reforms also allow demand-side response resources to submit aggregated CM offers together with other resource types, such as storage and energy efficiency.

Source: van der Burg and Whitley 2016.
BOX 9.2. Commoditization of specific attributes of energy products

An interesting concept—widely used in energy markets to incorporate requirements additional to that of delivering energy content—is that of ancillary services. Ancillary services are a technical refinement of requirements for achieving energy security, or more precisely, the reliable delivery of energy. In the power sector, ancillary services are defined by the Federal Energy Regulation Commission as “those services necessary to support the transmission of electric power from seller to purchaser, given the obligations of control areas and transmitting utilities within those control areas, to maintain reliable operations of the interconnected transmission system. Ancillary services supplied with generation include load following, reactive power-voltage regulation, system protective services, loss compensation service, system control, load dispatch services, and energy imbalance services.” In the gas sector, ancillary services are those needed for a reliable “delivery of natural gas to consumers, including, but not limited to, storage, pooling, balancing, and transmission.”

Besides their energy content, energy sources and products have different attributes that reduce or increase the need for these ancillary services at the system level. Such attributes can be priced according to their contribution to serving the demand for these ancillary services. Market mechanisms have been designed and established to put a price on the delivery of these services, including via commoditization (see the example of CMS in box 9.1). The notion of attributes and ancillary services can be extended to climate objectives. To the extent that a power system has to comply with a carbon objective, an energy technology with appropriate attributes delivers “ancillary” environmental services to the system to comply with that objective. Such attributes are clearly established in the Renewable Portfolio Standard in California, which defines the renewable energy credit as the quantification of such attributes. Interestingly, electricity sold as a commodity without such attributes is called “null power,” allowing demand-side response resources to submit aggregated CM offers together with other resource types, such as storage and energy efficiency.

Source: Authors
Another example, from high-income countries, is the challenge of designing capacity mechanisms (CMs) that are consistent with the objective of decarbonizing the power sector (see Box 9.1).

Naturally, there is a continuum of scenarios between (i) reforming existing energy policy instruments to include new climate objectives and (ii) designing new instruments that integrate carbon reduction in existing energy policy objectives. One way to design new market-based instruments has been to commoditize specific attributes of energy sources and projects that provide specific services in addition to their energy content (see Box 9.2).

9.3. Examples of Integration: Green, White, and Brown Certificates

Numerous countries, particularly high-income countries, have simultaneously implemented several market mechanisms to promote (i) energy efficiency, through tradable energy-saving certificates, also called “white certificates”; (ii) renewable energy, through tradable renewable energy certificates, also called “green certificates”; and (iii) GHG emissions mitigation, through tradable carbon credits (termed in this chapter as “brown certificates”). GHG emissions are often mitigated by implementing energy conservation activities or by replacing fossil fuels with renewable energy. And, reciprocally, when energy conservation activities or additional renewable energy are produced and used, carbon emissions are usually avoided. It is therefore a legitimate question whether simultaneously implementing an ETS and a white and/or a green tradable certificate scheme can be a source of redundancy and inefficiency.

We will briefly present these three mechanisms before exploring the reasons and consequences of their coexistence. Finally, we will discuss ways to ensure their efficient interaction, including via the integration of trading mechanisms.

9.3.1. Main Principles and Attributes of White, Green, and Brown Certificates

These three market instruments are based on the same two principles. First, an obligation imposed on some economic agents to reach a quantitative target by a certain date. Second, the possibility to trade certificates among regulated agents or with third parties to enable them to comply with the obligation at the lowest cost. A common trait of these instruments is the commoditization of the efforts required from the regulated parties.

The ETS instrument has already been discussed in detail in this volume. In a nutshell, an ETS is a “cap-and-trade” mechanism that establishes a limit (also called a cap) on the total volume of GHG emissions that can be generated by one or more sectors of the economy. A central authority then issues a number of tradable allowances (also called emissions permits) that does not exceed the level of the cap. Each allowance corresponds to one unit of emissions (typically one ton). Each source is then required to surrender one emissions permit for every unit of emissions for which they are accountable (World Bank 2016). In an ETS, permits can be traded among sources and sometimes among other parties participating in the carbon market, such as banks and other financial intermediaries. An ETS usually applies to only large emitting sources related to energy extraction, transformation, and consumption, such as energy-intensive industries (EII’s), manufacturing industries, and some segments of the transportation sector (for instance, aviation and marine bunkers). Small sources are generally not included because of the technical difficulties and high transaction costs associated with monitoring and controlling their emissions. However, an ETS can also indirectly cover GHG emissions from small sources (such as private or public transport vehicles) by assigning caps on entities such as oil product distributors (as in California).

153 That is, a maximum level of emissions, a minimum share of renewable energy, and a specified amount of energy savings.
A white certificate trading mechanism is a “baseline-and-credit” system (Bertoldi and Revezi 2006, Bertoldi and others 2010, Betz and others 2013, Giraudet and Finon 2015). Energy-efficiency targets are expressed as a percentage of the reduction of the energy supply (for suppliers) or consumption (for consumers). Reducing the energy needed requires achieving better performance in transforming or using the energy than continuing with the same practice. The improvement is therefore related to future performance, which is then compared to a counterfactual baseline that supposes the continuation of the status quo. Thus, the measure and certification of energy savings achieved involves the definition of this counterfactual baseline, which uses an approved methodology. Certificates, or credits, are then issued, which reflect the amount of energy saved. As baseline methodologies are generally too complex to elaborate and too costly to implement and verify, an alternative sometimes used is the notion of “deemed” energy savings. This simplifies the estimates of the savings being certified by using default values for the baseline. These energy credits, or white certificates, can then be traded among parties. Parties able to perform better than their obligation at a relatively low cost can obtain more certificates than they need. They can then sell these certificates to other parties for which compliance would require more expensive action. Transactions may occur on a trading platform and/or over-the-counter and are settled in a registry. This allows for the transfer of certificates to be tracked. Parties that do not comply with their obligation by the end of the period must pay a penalty.

The green certificate mechanism is neither a cap-and-trade nor a baseline-and-credit instrument, but a “floor-and-trade” mechanism. It requires that a minimum share (the “floor”) of the electricity that electricity retailers supply to their customers comes from renewable energy sources. Such an obligation regarding the origin of a part of their energy supply sources portfolio is also referred to as a “renewable portfolio standard” (RPS). In the case of non-compliance, they must pay a buy-out price, which is applied to the deficit amount. Renewable energy obligation targets are often set as a percentage of the total energy supplied in a given year from qualifying technologies. Green certificates are usually issued to renewable energy producers, who can sell them to energy clients who must comply with the RPS. In case the energy purchaser can exceed its obligation, and thus is above the “floor,” it can sell its excess green certificates to another party who has not yet met its mandatory target (and is thus still below the floor). Similar to the trading of white certificates, green certificates are traded on and/or off-exchanges, with transactions settled in a tracking registry.

9.3.2. Why Separate Mechanisms?

For climate specialists familiar with the variety of mitigation activities, it is a well-known fact that most emissions come from energy generation and use. A cap-and-trade system already generates obligations and incentives to develop renewable energy production and energy conservation activities. Therefore, for this community, white and green certificate schemes might appear redundant and should thus be eliminated if an ETS is already in existence.\(^{154}\)

Reciprocally, energy specialists stress that energy savings and the use of renewable energy reduces or displaces the use of fossil fuels and therefore avoids emissions. As such, sectors or entities who have already received energy-efficiency or renewable energy obligations and are regulated via white and/or green certificate schemes should be excluded from the scope of an ETS, or an ETS would be redundant with these schemes and would thus need to be eliminated.

The fact is that, while both viewpoints are right, the policy objectives being pursued by these different schemes are distinct. For instance, energy-efficiency and renewable energy policies are generally not implemented primarily for reducing emissions:

\(^{154}\) The same rationale (and thus the question of redundancy) also applies to the coexistence of white and/or green certificates with a carbon tax. As we focus on market instruments in this chapter, we will not further develop the topic of the coexistence and alignment of these instruments with carbon taxes.
• Energy efficiency can be a high priority as it contributes to energy security, the preservation of national resources, environmental sustainability, energy affordability, and competitiveness.

• The promotion of renewable energy sources contributes to building a renewable-energy-manufacturing industry, improving energy security by limiting the role of imports, and diversifying the energy mix to address local air pollution, which has become a severe issue in many cities and countries.

As a matter of fact, in most OECD countries energy-efficiency and renewable energy policies were implemented many years before carbon policies, as concerns about the policy objectives listed preceded the concerns on climate change. White and green certificates schemes were adopted in several countries as instruments to pursue these policy objectives. This preceded the use of carbon pricing, and carbon pricing did not replace these pre-existing instruments.

One reason is that carbon pricing is not sufficient to overcome market barriers and market failures which limit the spontaneous adoption of energy-efficiency measures, even if these appear to have negative marginal cost. Such barriers can include a lack of skills and information. An energy-efficiency obligations scheme will force regulated entities to find a solution to these issues so that they can comply with these obligations. Carbon pricing might not either provide sufficient or stable enough economic incentives for the deployment of renewable energy projects.

Moreover, it is possible to reduce emissions without reducing energy demand and/or increasing the share of renewables. Shifting fuels from coal or fuel oil to gas or nuclear electricity will reduce emissions without meeting the energy-efficiency or renewable energy target. Reciprocally, if the power sector matrix is already low carbon (being based, for instance, on large hydropower or nuclear capacity), electricity conservation activities will only marginally reduce emissions. Such observations demonstrate clearly that the targets assigned under white or green certificates can usually not be achieved fully through the implementation of only an ETS, although some cross-benefits generally do materialize. Therefore, the core differentiation of these mechanisms is the setting of targets that eventually reflect the specific objectives pursued by each scheme and thus legitimate their separate existence.

However, because of the cross-effects between the three mechanisms, the coexistence of these might also have a pragmatic justification: it creates reliability as well redundancy. If one of the mechanisms fails to enforce its target, the other may partially fulfill it, even if not primarily designed to achieve that target, thereby reducing the risk of failing to meet the objectives overall (Johnson et al. 2013).

9.3.3. Examples of White, Green, and Brown Certificates Coexisting in High-Income Countries

International experience shows that energy-efficiency, renewable energy, and emissions trading can coexist. Renewable energy certificate schemes with exchanges have been developed in some European countries as well as in some US jurisdictions (that is, RPS). Energy-efficiency certificate schemes are in place in numerous EU countries and have also been implemented in several US and Australian jurisdictions. Some of these have included trading functionalities with a possible exchange of energy-efficiency certificates. However, co-existence might in some cases involve intricate schemes, whose scope and interface are dynamic. Examples from the UK are shown in Figure 18 and Box 9.3.

155 For example, Sweden, Belgium, Poland, and the UK.
156 In some jurisdictions, it is currently being extended into a clean energy obligation with the inclusion of other low-carbon technologies (Paul, Palmer, and Woerman 2011).
157 California, New South Wales, Victoria, South Australia etc.
A review of international experience with coexisting market-based schemes (Johnson and others 2013), in high-income countries as well as China and India highlights a trend: coexisting trading systems usually focus on different sectors. Carbon-trading systems typically focus on industrial sectors and power generation, as in the case of the EU-ETS and the cap-and-trade program in California.

Renewable energy certificate schemes focus on electricity retailers. In the case of energy-efficiency schemes, there are two approaches. While most such schemes focus on small consumers, several (as in the UK, India, and China) also cover industrial sectors, thus potentially overlapping with an ETS. In energy-efficiency schemes focusing on small energy users, the obligation to comply with the target is imposed upstream, on the electricity retailers, since it would be far too complex and costly to impose it on a large number of small energy users.

158 While we use the word “retailer” here, other authors might use the word “supplier” or “distributor.” The correct term varies by country. We prefer to use the word “retailer” to make it clear that the regulated parties are the ones who sell the electricity to the final users, independent of their other functions, like developing and operating the distribution grid in the case of electricity or gas.
BOX 9.3. The Evolution of White Certificate Trading in the UK

An interesting concept—widely used in energy markets to incorporate requirements additional to that of delivering energy content—is that of ancillary services. Ancillary services are a technical refinement of requirements for achieving energy security, or more precisely, the reliable delivery of energy. In the power sector, ancillary services are defined by the Federal Energy Regulation Commission as “those services necessary to support the transmission of electric power from seller to purchaser, given the obligations of control areas and transmitting utilities within those control areas, to maintain reliable operations of the interconnected transmission system. Ancillary services supplied with generation include load following, reactive power-voltage regulation, system protective services, loss compensation service, system control, load dispatch services, and energy imbalance services.” In the gas sector, ancillary services are those needed for a reliable “delivery of natural gas to consumers, including, but not limited to, storage, pooling, balancing, and transmission.”

Besides their energy content, energy sources and products have different attributes that reduce or increase the need for these ancillary services at the system level. Such attributes can be priced according to their contribution to serving the demand for these ancillary services. Market mechanisms have been designed and established to put a price on the delivery of these services, including via commoditization (see the example of CMS in box 9.1). The notion of attributes and ancillary services can be extended to climate objectives. To the extent that a power system has to comply with a carbon objective, an energy technology with appropriate attributes delivers “ancillary” environmental services to the system to comply with that objective. Such attributes are clearly established in the Renewable Portfolio Standard in California, which defines the renewable energy credit as the quantification of such attributes. Interestingly, electricity sold as a commodity without such attributes is called “null power.”

Allow demand-side response resources to submit aggregated CM offers together with other resource types, such as storage and energy efficiency.

Source: Johnson and others 2013, Bowden and Rydger 2011.

Analyzing possible overlaps requires reviewing several distinct aspects of a scheme, including sectoral and fuel coverage as well as obligated parties.

The boundary of a scheme is defined by these aspects (see Table 9.1). Below, we present a few cases where three kinds of market-based schemes coexist.

- In the UK, the Energy Efficiency Commitment EEC and its successors (see Box 9.3)—are aimed at residential energy users only, especially low-income ones. The CERT can be traded bilaterally between obligated entities. The Renewable Obligations (RO), established in 2002 to meet with European Directives, imposes a renewable floor on energy suppliers, thus covering all electricity customers. As an EU member, the United Kingdom participates in the EU ETS, which replaced the domestic U.K. emissions system in 2005 and imposed emissions caps on all high-emitting installations in the power and heat generation and select energy-intensive industrial sectors (which were above a certain level of output). The overlap between the CERT and RO and the EU ETS is as follows: electricity generators must comply with GHG quotas under the EU ETS, and the electricity is then purchased by distributors, who also have to comply with the CERT and RO targets. The energy-efficiency, RO, and ETS schemes work independently, although all are expected to contribute to the national emissions reduction target. The energy-efficiency and RO schemes are regulated by the Office of Gas and Electricity Markets; the ETS and Climate Change Agreements (CCAs) are regulated by the environmental agency.

- Italy also participates in the EU-ETS. It has implemented renewable energy and energy-efficiency schemes to comply with the European Directives. The nation’s “white certificate” energy-efficiency legislation, the Titoli di Efficienza Energetica (TEE) system, implemented in 2005, imposes obligations on large electricity....
and gas suppliers to reduce the amount of energy consumed by the households they serve. Certificates can be traded to reduce the cost of compliance. The TTE may include projects from all sectors. In practice, most savings come from the residential sector. The EU-ETS and the TEE overlap, since both cover end-use energy consumption in EIIs. The TTE is regulated and administered by the Italian Authority for Electricity and Gas with the assistance of the Italian National Agency for New Technologies, Energy and Sustainable Economic Development, which certifies the energy savings. The market was managed for some time by the Gestore Mercati Energetici (GME), which also managed the Italian power exchange. After GME closed its carbon-trading platform, Italian market players conducted emissions exchanges with other European countries.

- In California, energy-efficiency programs date back to the 1970s. The point of regulation of the current energy-efficiency obligation (EEO) is the utility that supplies electricity or gas. All consuming sectors are included. Most electricity savings occur in the residential and commercial sectors. Most gas savings take place in the commercial and industrial sectors. The program is regulated by the Californian Public Utilities Commission (CPUC) and differs from several other EEO programs in that it does not include trading options. The RPS was introduced after the energy crisis in 2000 to diversify energy resources. It imposes an obligation on different kinds of energy retailers regulated by the CPUC to procure 33 percent of their annual retail sales from renewable energy sources by 2020. Thus, all customers and sectors served by these utilities are covered by the scheme. The retailers are obliged to buy renewable energy certificates (RECs) together with the renewable energy to comply with the RPS. The RECs can be traded on voluntary markets. The California Energy Commission (CEC) tracks the RECs and verifies the compliance of regulated entities with the RPS. Under California’s ETS, which came into effect in 2012, obligated parties are installations emitting more than 25,000tCO2e per year. Sectors covered include electricity generation (including imports), industries, and distributors of transportation fuels, natural gas, and some other fuels. The total coverage of the scheme is approximately 85 percent of California’s energy-based GHG emissions. The scheme is regulated by the Air Resources Board (ARB).

In these and other examples, energy-efficiency, renewable energy, and carbon certificates coexist but are largely autonomous. The energy schemes and carbon schemes are regulated by distinct authorities, with variable, but often limited, degrees of coordination. If coordination were to be introduced, one entry point might be trading. Most of these schemes include trading to introduce flexibility and reduce overall compliance costs. The degree to which trading can be used to comply with a scheme’s obligations, meanwhile, varies significantly.

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<td>Some EU members (UK, France, Italy, Denmark), US (California), India, China (for industry)</td>
<td>Some EU members (Italy, Sweden, Belgium), US (California’s RPS)</td>
<td>All EU members (UK, Germany, France), US (California), China (pilot schemes)</td>
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- **Nature of the scheme**
  - Baseline and credit (possible formulation in terms of carbon savings, as in the UK)
  - Floor and trade
  - Cap and trade

- **Sectorial coverage of obliged parties**
  - Electricity and gas retailers (EU), grid distributors (Italy), industrial consumers (India, China, UK)
  - Electricity suppliers, producers (Italy)
  - Emitters in power and industrial sectors, and oil products suppliers/importers (California)

- **Role of exchanges**
  - Marginal, except in Italy with third parties (obligation on grid distributors)
  - Limited to relations between developers, obliged retailers
  - Important (including with traders)

- **Penalty for noncompliance**
  - Different kinds of penalties; not always applied
  - Penalty equivalent to a price cap and opt-out price
  - High for deterring

- **Monitoring and verification**
  - Random verification on deemed measures
  - Easy verification (via transparency of the power market)
  - Heavy procedure (100% third-party verification)

- **Who pays?**
  - Levy (on all consumers)
  - Obliged parties’ customers
  - Buyers of industrial products

Source: Authors’ compilation.
Note: RPS = Renewable Portfolio Standard; OECD = Organization for Economic Co-operation and Development.

**9.3.4. Varying Importance of Trading**

In the case of coexisting schemes, the trading of certificates is almost always done separately for each scheme:

- In the renewable energy scheme, exchanges are most often between developers and obliged suppliers. An organized market may exist, but have a very minor role, given that the major obliged parties would prefer to opt out rather than adjust their certified quantity on the exchange;

- In energy-efficiency schemes allowing trade, exchanges between obliged suppliers are marginal. Exchanges with energy service companies (ESCOs) are developed only if the obliged parties are grid distributors unfamiliar with the new communication needed with consumers. That said, suppliers typically prefer to directly influence their customers’ consumption.

In ETSs, exchanges of allowances are a common practice, and corresponding markets are well developed, with active trading. So, the role of exchanges is not the same from one type of scheme to the other. Moreover, in both the cases of renewables and energy-efficiency obligations, the obligated entities have preferred vertical integration or long-term contracts as a way of hedging against the risk of price volatility on the market. In energy-efficiency schemes, there are opportunities for market participants other than the liable energy companies. However, the entries of ESCOs into trading schemes have mainly involved very simple deemed measures such as free compact fluorescent lamp (CFL) distributions. This is the case in Italy, and in Australia, where the significant trading activities of the New South Wales GGAS and the Victoria Energy Efficiency Scheme (VEET) are mainly fueled by ESCOs (Betz and others 2013). Trading is less important for certain schemes, particularly for green and white certificates. This does not mean, however, that when they coexist these schemes do not interact, and potentially undermine one another.
9.3.5. Effects of Coexisting Mechanisms

First, it is important to note that it is possible to reduce emissions without reducing energy demand or without increasing the share of renewable energy sources. The reciprocal, however, is rarely true. Indeed, switching from coal to fuel or fuel oil to gas reduces emissions. Such a switch may be the preferred option for both industrial and power generation sectors to reduce emissions. This is because shifting to renewable energy sources means changing the supply chain substantially. In the case of combustion this involves a series of challenges regarding the origin and reliability of the supply. It may also require technologies that are less mature and widely applicable than conventional fossil fuels. In the case of power generation, a shift to wind or solar energy, for example, means moving from a stable, predictable energy source to a more variable one. Moreover, scaling up solar or wind energy involves a series of obstacles (in particular regarding transmission, regulation, and so on), the overcoming of which does not depend on the purchaser. If the electricity retailer is only subject to an emissions cap and can choose between a generally cheaper, more available, and reliable offer of gas-based power supply and a still developing, limited, and uncertain renewable energy offer it can be expected that the energy user will prefer gas.

Switching from coal or fuel oil to gas does not require developing an innovative demand-side program to save energy and overcome the challenges associated with many energy-efficiency and renewable energy options. It is important to note that switching allows actors to comply with an emissions reduction obligation, and not with an energy-efficiency or renewable energy target. This is precisely why, in case energy conservation or the development of a local renewable energy source is defined as an energy policy priority, it is necessary to set energy-efficiency and/or renewable energy targets to force agents to tackle the specific challenges associated with this priority. An emissions reduction obligation would not, on its own, ensure the desired outcome.\footnote{In theory, one could also imagine that countries concerned by their dependence on oil or coal might adopt an energy policy aimed at promoting the switch to gas. This may also have short-term benefits for emissions reduction objectives.}

That said, saving energy overall and increasing the use of renewable energy does help to avoid GHG emissions. Of course, the emissions reductions will be limited if the energy matrix is already very clean. But if the share of renewable or other low-carbon energy\footnote{That is, nuclear energy or large hydroelectricity.} is already large, the GHG reduction target will already be low.

Where an entity has obligations to both reduce emissions and promote energy efficiency or renewable energy, the typical strategy involves two steps. First, take the necessary measures to comply with the energy-efficiency and/or renewable energy targets. Second, look for additional ways to meet the emissions cap after deducting the emissions reductions already delivered by the energy-efficiency and/or renewable energy measures. This might be done by implementing in-house mitigation activities or purchasing carbon credits from other parties.

In summary, the coexistence of energy-efficiency/renewable energy schemes and an ETS tends to encourage obligated parties to comply with GHG targets using a restricted set of technical options. These technical options would not be implemented on their own to reduce emissions. In this context, mitigation options might eventually be implemented, but only to complement the GHG emissions reductions already achieved via energy savings and/or the increased use of renewable energy (see Figure 19).

Consequently, the coexistence of energy-efficiency/renewable energy and ETS schemes reduces the quantity of emissions reductions that must be delivered by the ETS market. Thus, the demand for ETS allowances is reduced. In addition, the forced implementation of energy-efficiency/renewable energy measures supersede the principle of implementing least-cost mitigation options first. Instead low-cost abatement will be prioritized after the other required measures have been implemented, thus reducing the price of these credits. There is a risk that if the energy-efficiency/renewable energy schemes deliver too much of the abatement required
to meet the ETS cap. The ETS allowance price might be reduced to the point that it no longer provides a clear signal for investing in other low-carbon measures (Hood 2013). Another risk is an excess of emission allowances at the end of the compliance period, which, if banking\textsuperscript{161} is allowed, can further undermine the role of the ETS during the next compliance phase. If the energy-efficiency/renewable energy schemes deliver less than expected, pressure on the ETS market increases, raising allowance prices. If they deliver more than expected, allowance prices will fall. Such price uncertainty creates an additional risk for investors, and this type of uncertainty has been shown to delay investment decisions (IEA 2007).

In addition, in case the schemes are based on absolute targets, then the impact of economic circumstances concentrates on the ETS. This makes the ETS sensitive to economic conditions: a reduction of economic activity will trigger a reduction of emissions, but the amount of energy savings would be constant, thus further squeezing the role of the ETS (Hood 2011). Such a scissor effect might be reduced where obligations are output based.

**FIGURE 19. Impact of an Energy-Efficiency/Renewable Energy Scheme on the Role of an ETS**

Other unintended effects can occur where the energy-efficiency scheme and the ETS are not linked. For instance, emissions reductions associated with a decrease in electricity consumption that resulted from the energy-efficiency scheme can benefit power generators under an ETS—and they would thus benefit from an effort that they may not have been involved in. While a power generator might be willing to help end-users save energy and thus release some allowances, in many countries, a restructuring of the power industry has involved the unbundling of generation, transmission, and distribution, meaning that end-use energy efficiency is rather disconnected from power generation. A similar issue may arise in the case of a renewable energy scheme. While electricity retailers would need to reduce their supply from carbon-intensive energy sources, they will also see their emissions being reduced, thus allowing for the release of emissions allowances for trading.

This brief look at the interactions of white, green, and brown certificates thus underscores the importance of coordination.

\textsuperscript{161} Banking consists of reserving part of the carbon credits acquired during one compliance period for use during the following compliance period.
9.3.6. Separation or Integration?

Three distinct aspects of a scheme require a minimum level of coordination to prevent inefficient redundancies and undesirable outcomes: (i) the sectoral scope, including the definition of obligated parties in the regulated sectors, (ii) targets, and (iii) trading.

Coordination may be organized around two opposing approaches: separate the schemes to prevent any possible interaction, or integrate them. Although these two approaches can be combined, for the sake of simplicity we will focus on full separation and maximum integration.

Coordination by Separation

The first option for coordinating the three schemes is to define the obligated scope and entities in such a way that avoids overlaps between the different instruments. Then targets can be set up independently for each scheme, to the extent that relevant national goals can be achieved by focusing efforts on specific sector subsets. For instance, suppose that the objective of diversifying energy sources is mainly related to a concern about energy security in the power sector, as was the case in California after the 2000 crisis. In this case, the renewable energy scheme might be limited to the power sector and the ETS left to cover only direct emitting sources for other industries. Coordination here would mainly involve ensuring that there is no overlap between (i) the sectors and the obligated parties (and possibly fuels) regulated by energy-efficiency and/or renewable energy schemes and (ii) the ETS. However, this kind of separation can concentrate the burden of an ambitious target on a limited number of sectors or entities. This may make any burden excessive for some and hinder political feasibility.

- One way to maximize the efficiency of separate schemes is to list emissions reduction potential in merit order, using marginal abatement cost (MAC) curves, as shown by Matthes (2010) and Hood (2011). MAC curves are one of the most common ways to illustrate the costs of different emission-reduction options. MAC curves were popularized by McKinsey at the end of the 2000s. They provide a graphic representation of abatement potentials as well as costs and benefits for a set of technical mitigation measures at a given date. Measures are ranked according to their net economic costs, from the ones that come with highest net benefits on the left to the measures that come with the highest net positive costs on the right. MAC curves are powerful instruments as they allow the synthesis of a huge volume of data in a very visual and practical way, indicating the most economically attractive mitigation options for the considered planning horizon. Such curves often have three identifiable parts (see Figure 20):

- On the left side, a series of energy-efficiency measures, which present a negative MAC, imply that the discounted benefits are greater than the discounted costs. These are mostly energy-efficiency measures facing barriers that are not related to profitability. MAC studies usually provide a detailed list of these barriers;

- On the right side are innovation-intensive measures, which present high or very high MACs. This is often the case for new low-carbon technology or not yet commercially mature renewable energy technologies. Developing and promoting such potential usually requires relatively large incentives either at the financing stage or to increase revenues to reach the breakeven point.

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162 The MAC of a GHG abatement measure is defined as the following difference: discounted costs minus discounted benefits.

163 Such barriers include a lack of access to financing, a lack of sustainable business models to ensure that entities that master the relevant knowledge and skills can generate a profitable and viable business of it, atomization of the energy-savings potential across a large number of small and disparate players (for example, residential customers), behavioral inertia, implementation bottlenecks and other obstacles to achieving scale, lack of access to efficient alternatives (for example, no efficient mass transit), and so on.

164 Particularly when they are capital intensive, as many renewable energy technologies are.
In the middle, a wide range of relatively mature and competitive options can respond effectively to a carbon price signal.

**FIGURE 20. An Ideal Merit Order of Actions to Reduce Emissions**

![Figure 20](image)

Source: Matthes 2010.

Note: ETS = emissions trading system; RES-E = renewable energy sources for electricity.

The idea, then, is to target the left side of the curve with an energy-efficiency scheme, the right side with a renewable energy scheme, and the middle with an ETS.

This differentiation, applied carefully—to ensure that eligible measures under each scheme are consistent with the corresponding MAC categorization—can be useful to avoid overlaps and prevent undesirable and counterproductive interactions.

However, it is arguable that, depending on the country and the schemes’ implementation schedule, relevant goals are usually more intermixed than a simplified approach can account for (see Figure 21). Furthermore, the time horizon matters, particularly for developing countries that intend to introduce schemes in the near future. By this time many innovation-intensive technologies will become lower cost due to research and investment in front runner countries. In Figure 21, this would result in many of the renewable energy measures on the right quickly migrating to the left. This has previously been the case for onshore wind and small- and medium-scale photovoltaics.

Additionally, the same entity can possibly employ mitigation options belonging to each of the three segments. Measuring the results is cumbersome at best. For instance, an industry can simultaneously improve the efficiency of combustion and also introduce renewables into the fuel mix. The former reduces energy consumption and residual methane emissions. In such a case, it becomes impossible to disaggregate the three different
outcomes to allocate them quantitatively to distinct energy-efficiency, renewable energy, and additional GHG abatement measures.

**FIGURE 21. An Actual Order of Actions to Reduce Emissions**

![Diagram showing abatement potential vs. cost for energy efficiency measures, matured potential of incremental innovation, and innovation-intensive potentials in RES-E, low carbon options.](source: Matthes 2010. Note: RES-E = renewable energy sources for electricity.)

Such a blurring of the segments might not necessarily invalidate the option of establishing separate schemes. But the resulting interactions, particularly for trading, would require another layer of coordination. This would at least be the case for target setting to prevent double-counting.

It is also important to consider the future impact of renewable energy and energy-efficiency schemes when defining the cap trajectory of an ETS. This is to ensure that the price signal sent by the ETS stays an effective incentive to adopt lower-carbon technologies. Hood (2013) proposes a series of recommendations to accomplish this over time:

- Define a rolling cap, set annually and five years in advance to ensure a balance between medium-term flexibility and long-term certainty;
- Set moderate-length commitment periods with a well-understood mechanism to adjust the subsequent period’s cap for any significant surplus carried forward;
- Set limits on banking to avoid significant surpluses being carried forward, while still allowing early actions to be rewarded;
- Use flexibility mechanisms that automatically adjust auction volumes if emissions are significantly lower than forecasted;
- Use ceiling and floor price mechanisms to maintain coherence across scheduled reviews, since carbon prices should not diverge wildly from anticipated values.

165 Such as five years.
Integration: Benefits and Avenues

Green, white, and brown certificates are similar in many respects. This suggests that greater integration could be preferable and possible. Issuing white or green certificates is as almost identical issuing an emissions reduction certificate.

The CDM of the Kyoto Protocol has developed many methodologies to calculate and monitor emissions reductions associated with energy conservation activities and increases in the use of renewable energy.\footnote{As of August 23, 2016, the number of CDM-approved methodologies, including broad-spectrum-consolidated methodologies, amounts to 36 for emissions reductions from renewable energy and to 101 for emissions reductions from energy-efficiency improvements (http://www.cdmpipeline.org/cdm-methodologies.html1).}

One lesson from these CDM methodologies is that the bulk of the calculation and the monitoring requirements are related to the energy saved and the additional renewable energy generated and used.\footnote{Christophe de Gouvello, co-author of this report, participated in this process as a member of the Methodology Panel of the UNFCCC for the CDM for five years: from June 2002 to November 2007.} Converting the amounts of energy saved or renewables used into emissions reductions is quite straightforward, using emissions factors.\footnote{For electricity savings and electricity based on renewable energy, the energy displaced is converted into emissions reduction using a grid emissions factor. For electricity savings and electricity based on renewable energy, the energy displaced is converted into emissions reduction using a grid emissions factor.} Importantly, the calculation and monitoring requirements for issuing white certificates or carbon credits for the same energy-efficiency activities are mostly the same. The calculation of emissions reductions involves just one more step to convert the energy saved into emissions reduced. They are just “one emissions factor” apart.\footnote{This does not mean that calculating and monitoring the emissions factor for the first time is a simple operation. However, it is largely independent from the energy-efficiency or renewable energy activity itself. It is usually done and updated nationally on a sector wide basis by official entities. This depends on the evolution of the fuel mix of the energy system and is frequently made available online.}

When a white certificate is ready to be issued, there is little left to do to create an emissions reduction certificate. Issuing the emissions reduction certificate first makes the process even easier, since it is almost always necessary to calculate the energy savings achieved before calculating the emissions avoided.

The same holds true for green certificates and associated carbon credits. Once the additional renewable energy has been used, it can be multiplied by the emissions factor of the displaced energy to estimate the emissions avoided. This is the approach applied by the Voluntary Renewable Electricity (VRE) Program under California’s Cap-and-Trade Program, which automatically calculates the amount of emissions avoided by multiplying the quantity of renewable energy by an emissions factor.\footnote{The corresponding amount of emissions allowances can then be claimed to be retired from the ETS. The referenced default emissions factor is 0.428MtCO\textsubscript{2}e/MWh.} Once again, the reciprocal is even simpler, since issuing an emissions reduction certificate for a renewable-energy-based mitigation activity requires first calculating the amount of additional renewable energy that has been generated to displace the emitting source. Given this, integrating the different schemes seems a plausible option.

Multi-use Certificates

Exploring possible integration requires looking at several distinct dimensions of the different schemes: the setting of targets (jointly defined or not), the sectoral coverage (fully overlapping or not), the coverage of obligated parties (either final consumers or an upstream aggregator, that is, the energy supplier), the registries (one or several), the trading (one or several platforms), and the institutional setting (one or several regulatory entities).

The core question to be eventually answered is to what extent these different types of certificates are fungible. That is, to what extent a white or green certificate can be converted into a carbon credit and vice versa. Carbon credits are allowances to emit GHGs. An entity regulated under an ETS can obtain them either through the
initial allocation of allowances (quotas) or by purchasing emissions allowances from another party able to reduce its emissions.

A purchased carbon credit can be made equivalent to an energy-efficiency or renewable energy certificate only if this carbon credit is associated with energy savings or an amount of renewable energy. This association is only possible if the selling party has implemented a mitigation activity, based on energy-efficiency or renewable energy generation, that reduced a volume of emissions corresponding to the carbon credit being sold. If this is the case, then the equivalent energy-efficiency savings or renewable energy content can easily be established. It is then possible to decide that implementing a mitigation activity entitles the hosting party to associate a renewable or energy-saving content to a corresponding amount of emissions allowances.

Let's suppose that both an ETS and a white certificate scheme coexist. Then, the amount of energy savings to be associated with the emissions allowance being sold can be determined using the approved baseline methodology used for issuing the energy-efficiency certificates. In case the emissions allowance being sold is not associated with any energy-saving activity, this amount is zero. This way, at the time a carbon transaction is made, it is always possible to associate it with the corresponding value of a white certificate. And vice versa: each time a white certificate transaction is made, it is possible to associate it with the corresponding value of emissions allowances. Of course, the association of these two values should be regulated. The selling entity must indicate the energy-saving activity to which the carbon credit being sold is linked, and the value of the equivalent white certificate should be calculated using approved methodologies. Failure to do this would nullify the value of the equivalent white certificate.

The same rationale applies to the case of a coexisting ETS and a green certificate scheme. To the extent the selling party can associate the sale of a carbon credit with a renewable energy activity, a green certificate can then be associated with the sold carbon credit. Reciprocally, a green certificate transaction can be associated with a carbon credit. The same principles apply: if the allowance being sold cannot be associated with a renewable energy activity, the value of the green certificate should be zero.

It is thus possible to envision a multiuse certificate with several values: a carbon credit value, a white certificate value, and a green certificate value. The owner of such a multiuse certificate could decide to use it to comply with any of three targets: the emissions cap, the energy-efficiency target, and/or the renewable energy target.

When selling energy-efficiency or green certificates on a carbon-trading platform, what is purchased by the buyer is a carbon emissions allowance equivalent. This means that the seller should see its carbon allowances reduced accordingly. Thereafter it can no longer use these white or green certificates to comply with its energy-saving or renewable energy obligation. Both the GHG emissions allowances and the white certificate registries should be adjusted accordingly to prevent double counting.\footnote{Imposing targets for carbon emissions, energy savings, and renewable energy shares implies the need for linked registries. Each entity that has to comply with an emissions quota needs to have a registry where its emissions allowances are issued, transferred, and then balanced with its obligations at the end of the compliance period. The same applies to energy savings targets, green certificates and to renewable energy standards.}

Reciprocally, when the sale of a carbon allowance occurs on an energy-efficiency certificate or green certificate trading platform,\footnote{This supposes that the carbon credit being sold is associated with an energy-efficiency- or renewable-energy-based mitigation activity; if not, the value of the value of white (or green) certificate is zero and thus would not be sold on a white (or green) trading platform.} the seller cannot use it anymore to comply with its emission quota obligation. It cannot use any of the corresponding energy savings or renewable energy content to comply with its energy-efficiency or green standard obligation. And again, both the GHG emissions allowances and the green certificate registries should be adjusted accordingly to prevent double counting.
If the above-mentioned conditions are clearly established and met - that is, only approved methodologies are used for the conversion and the registries are operated simultaneously -, then the separate trading platforms can be merged. What eventually counts is that the traded certificates are correctly retired from the seller’s registries and accounted in the buyer’s registries.

In case the seller has an energy-efficiency obligation but not an emissions cap, and the buyer does have an emissions cap to comply with, the transaction, is similar to the sale of a CDM credit from a non–Annex 1 country\textsuperscript{173} to an Annex 1 country\textsuperscript{174}. The seller does not need to have a quota to generate an “offset” that can then be used by a regulated entity to comply with its obligation. A similar rationale applies to the reciprocal situation or to the transaction of a green certificate purchased for compliance under an ETS.

Allowing such “offset” transaction then allows for the sectoral scopes of the three policies not to fully coincide and still rely on a unified certificate scheme.

Considering that these schemes are instruments to achieve specific policy objectives, the three targets are supposedly aligned with the three policy objectives—that is, reducing demand so as to reduce the risk of an energy deficit, increasing the share of renewable energy sources to increase diversification and reduce dependency, and reducing emissions to comply with a GHG reduction commitment. Thus, one can assume that the three targets are set separately according to the relevant policy, as are the specific sectoral scope of each instrument.

Eventually, the integrated scheme brings together the three groups of regulated sectors, targeted by three policies, with only partial sectoral overlap. Ensuring the fungibility of the certificates across the sum of all the three sets of sectors promises higher liquidity and cost-efficiency. The methods used to establish the three national policy targets of each policy to be enforced on each of the three sets of regulated sectors and corresponding entities should be defined and revised jointly to ensure the flexibility and integrity. To ensure consistency and integrity, it is recommended that a common institutional framework be created to regroup the definition and approval of methodologies, the certification, the MRV, the operation of registries, and trading.

The multi-use certificate system and other primary concepts of this chapter are summarized in Box 9.4.

**BOX 9.4 Chapter 9 Summary**

Different market instruments can be combined to create a more efficient approach to achieving simultaneously energy and climate policies objectives. In all cases, mapping of existing instruments and national circumstances such as the power sector model, needs to be done first.

While a lack of coordination can generate conflicts and inefficiencies, market instruments can be designed creatively to integrate energy and climate policies objectives.

The commoditization of specific attributes of different energy products - a concept already used for balancing the supply and demand of ancillary services in the power sector – can be used to facilitate the integration of carbon and energy market instruments.

White certificates for energy efficiency, green certificates for renewable energy and brown certificates (emissions permits) are an example of desirable and achievable markets integration, which can help achieve multiple energy and climate objectives more efficiently. Integration can be achieved through combining the different schemes to create a multi-use certificate. Before certificates become fungible changes to institutional settings such as registries would be required.

\textsuperscript{173} A developing country with no mandatory target under the former Kyoto Protocol.
\textsuperscript{174} A country with a mandatory target under the former Kyoto Protocol.
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10. Balancing Pricing and Non-Pricing Instruments to Support an Effective Transition to Low-Carbon Energy Sources

10.1 The Need for Nonpricing Instruments When Scaling Up Low-Carbon Technology

10.2 Filling Regulatory and Logistics Gaps that Prevent Low-Carbon Energy Options from Accessing Consumer Markets

10.2.1 Without Appropriate Access to Markets, the Potential Energy-Development and Global Benefits of Clean Energy Projects Cannot Be Achieved

10.2.2 Access to Markets Requires Filling Regulatory Gaps in the Power, Gas, and Automotive Fuel Sectors

10.2.3 Market Access Requires Appropriate Infrastructure Planning and Policies to Overcome Logistics Bottlenecks

10.2.4 The Benefits and Limits of Using a Shadow Carbon Price to Orient Public Planning and Investment

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10.3 Fill Local Capacity Gaps that Prevent the Adoption of Low-Carbon Energy Options

10.3.1 The Dissemination of Technical Information Is Needed for Even Mature, Clean-Energy Technologies

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10.7 Designing Pricing and Non-Pricing Policy Packages for Faster, Cleaner Development
10.1. The Need for Nonpricing Instruments When Scaling Up Low-Carbon Technology

In Chapters 8 and 9, we saw that there are promising avenues for integrating carbon- and energy-pricing instruments. Chapter 8 discussed the integration of carbon and energy taxes and chapter 9 dealt with the integration of carbon and energy market mechanisms. This integration opens the possibility of using full energy price signals to orient economic agents toward low-carbon solutions, consistent with other energy policy objectives, rather than only relying on a carbon charge added to existing energy prices.

However, even full price signals are not always sufficient to induce economic agents to adjust their decisions to the desired policy objectives—in this case, a shift toward less-carbon-intensive fuels, technologies, and behaviors. This is because there are other market failures beyond a market’s inability to integrate carbon externalities in energy prices (Fay et al. 2015). These market failures prevent investors and customers from adjusting their decisions in accordance with policy objectives. These specific market failures are referred to as ‘adoption barriers’. Many thorough theoretical and empirical analyses conducted over decades strive to understand the non-adoption of different low carbon options. Such analyses were conducted even before reducing GHG emissions became a policy goal, and have pertinent lessons to offer.\footnote{For example, the state of California began implementing energy-efficiency measures in the mid-1970s, including building code and appliance standards with strict efficiency requirements.}

An exhaustive review of such studies is beyond the scope of this chapter. Our focus here is to offer a simplified categorization of the adoption barriers. The categories and examples presented here draw from empirical studies conducted by the World Bank over the past decade, among others. We find that adoption barriers are of two main types: (i) a lack of access to technology and (ii) a lack of access to the finance.

One example of an adoption barrier is the difficulty of individuals to reduce their consumption of fossil fuels from their individual cars and motorcycle in some cities of the developing world. Passengers have no choice but to use their cars where mass transit systems (bus rapid transit [BRT], subway trains, and so on) are nonexistent or insufficient, passengers have no choice but to use their cars, even if this forces them to wait in traffic jams for long periods. Mass transit infrastructure is highly capital intensive and the development of this low-carbon option is difficult to finance. This often leads to very low-price elasticities and limited responses to price signals.\footnote{An interesting acknowledgment of such limited effect of price signal to overcome adoption barriers preventing the implementation of low-carbon technologies is the following requirement imposed by the Executive Board of the CDM: project proponents shall demonstrate that the project eligibility to the CDM, which mainly translates into additional carbon-price based revenues, is determinant for the mitigation activity to be implemented. The project is not accepted if it cannot demonstrate that these potential additional revenues will enable the project to overcome the identified barriers. See CDM Executive Board (2009): “If the CDM does not alleviate the identified barriers that prevent the proposed project activity from occurring, then the project activity is not additional.”}

Thus, overcoming market failures requires non-pricing instruments in addition to, or in place of, pricing instruments. It is important to note that the implementation of non-pricing measures is required for more than GHG mitigation measures. While theoretical and practical efforts have allowed the scope and effectiveness of price-based markets to expand over the past decades, including in the production and use of energy, non-pricing measures remain common practice in support of a variety of policy objectives across sectors and countries. In the case of urban transport, fuel-efficiency standards and urban transport planning are examples of non-pricing measures used by governments to reduce emissions from polluting cars.
The effect of non-adoption barriers has been observed by multiple studies conducted in several developing countries. Most of these studies involved empirical investigations, mobilizing local and international technical experts to identify commercially available low-carbon energy options and find out why they were not more broadly disseminated. Since most of these technologies had already been implemented and thus were economically viable in these contexts, it might be assumed that market failures prevented their adoption and thus were responsible for their unused technical potential (see Box 10.1).

**BOX 10.1 Inventory of Opportunities for Low-Carbon Development Projects in Brazil**

From 2008 to 2010, the World Bank, BM&F-BOVESPA, the São Paulo–based Brazilian stock exchange, and a consortium of Brazilian firms (ICF International Brazil and FIDES) conducted a first attempt to inventory the potential of low-carbon development projects in Brazil. These projects can contribute to achieving Brazil’s voluntary national commitments, future energy supply and/or supplying offsets to Annex 1 countries. The study team used as a starting point the public assets of low-carbon activities already submitted to the CDM. At that time, more than 7,500 project proposals had been submitted for validation by private and public companies all around the world in a variety of sectors covered by 130 approved CDM methodologies. Data on these proposals enabled the identification of the types of entities, and corresponding sites and facilities, that could implement the 130 corresponding mitigation activities. Using existing databases of industrial facilities and other potential project sites in Brazil, the study team estimated the number of similar low-carbon development projects that could be implemented in Brazil in similar facilities. Such investments would both reduce GHG emissions and contribute to development, for instance, by delivering additional energy supply.

This methodology was first applied in Sub-Saharan Africa. There, it was used in 44 countries to guide the consideration of 22 low-carbon technologies and allowed to pre-identify more than 3,200 low-carbon energy projects to provide potentially 740 mTCO2 per year and more than 170 GW of additional power-generation capacity, that is, more than twice the region’s current installed capacity. In the case of Brazil, 61 kinds of technologies/activities were looked at in five different sectors; more than 18,000 potential emissions reduction projects were preidentified (along with the power utilities, breweries, cement and paper factories, steel industries, rural producers, and transport companies and many other types of facilities that could implement these technologies), with an abatement potential of up to 4 billion tCO2 in 10 years and an additional generation capacity (for the energy-related projects) of around 450 GW. Whenever possible, the study also looked at investment requirements associated with the considered projects.

In many cases, non-pricing measures unlock an alternative for economic agents. This can enable a more effective response to price signals. Thus, pricing and non-pricing instruments are complementary. Policy packages may combine both types of instruments efficiently. Such packages might, for example, be designed to achieve a carbon-mitigation objective alongside a preexisting set of other energy policy objectives. Here again the nascent experience of the OECD economies may be very useful to developing countries seeking to achieve voluntary targets in an efficient way. This chapter will thus present several such experiences. As noted previously the lessons learned cannot be applied in a homogenous way but need to account for national circumstances.

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177 A few years ago, the World Bank conducted a study of the existing potential of low-carbon energy projects in Sub-Saharan Africa (de Gouvello, Dayo, and Thioge 2008). The team visited 12 countries and investigated 22 low-carbon technologies that had already been implemented in other parts of the world, analyzing their energy-saving potential and the barriers that prevented them from being implemented in Africa. The World Bank conducted a similar study in Brazil, with the collaboration of BM&F-BOVESPA (the São Paulo Stock Exchange), focusing on 61 low-carbon technologies (World Bank and BM&F-BOVESPA 2010). The Bank also conducted a series of national low-carbon studies in Mexico, Brazil, Colombia, India, Indonesia, and Poland, among others. Most of these studies involved empirical investigations, mobilizing local and international technical experts to identify commercially available low-carbon energy options and find out why they were not more broadly disseminated. To access the series of low-carbon country studies conducted by the World Bank, see ESMAP (Energy Sector Management Assistance Program): [http://www.esmap.org/LowCarbonDevelopmentStudies](http://www.esmap.org/LowCarbonDevelopmentStudies).

178 In these studies, market failures included both failure to internalize carbon benefits and other types of barriers (detailed in this chapter).
10.2. Filling Regulatory and Logistics Gaps that Prevent Low-Carbon Energy Options from Accessing Consumer Markets

The first series of barriers to the use of low-carbon options, particularly for developing countries, relates to the regulatory framework and logistics systems formed around existing technologies. Existing energy technologies have economic and spatial features that might differ from low-carbon options. Accordingly, economic regulations are not necessarily adapted to the new technologies. One good example is the power sector. For decades, economies of scale have prevailed in energy generation. This has led to the spatial concentration of large power generation plants using energy products, mainly fossil fuels, near the main consumption centers. To bring this energy to individual customers, transmission and distribution (T&D) grids were built. Since T&D costs grow with distance, the power grid started developing multipolar, center-to-periphery patterns. As technology progress allowed for greater economy of scale, the electricity network progressively expanded. This interconnected first larger centers and then smaller, more distant ones and eventually penetrating rural, low-density areas. This pattern is still incomplete in the poorest countries or where the populations are the most dispersed, such as the Amazon region.

This technical system, presented here in a simplified manner, has peculiar economic proprieties: it is very capital intensive and it is a natural monopoly. Building multiple parallel grids to offer customers their choice of supply would be too costly. To ensure competition, the power sector must be regulated both to prevent the abusive market power of monopolistic concessionaires and to warrant them long-term exclusivity to ensure that they can recover their heavy investment. Serving rural areas involves high and costly T&D losses since small customers have limited capacity to pay, thus requiring a certain level of price equalization and cross-subsidies between urban and rural markets. Additionally, electricity is very difficult and costly to store, and the power sector needs the development of sophisticated planning, dispatching, and tariff regulations.

Rapid innovation in the renewable energy sector suddenly brought this cycle of growing economies of scale to an end. Small does not mean costlier anymore. Distant rural areas do not need to wait for decades for the grid to reach and serve them, and basic needs can be served by decentralized PV systems without inducing T&D costs. Renewable energy is far less concentrated and frequently dispersed over wide areas, but can serve nearby small loads directly. It can also be easily stored as the current capacity of existing batteries roughly matches the needs of small generation capacities and loads. In many cases, the development of renewable energy does not correspond to a natural monopoly. Cross-subsidies from urban to rural areas can no longer be justified based on high T&D investment costs. The exclusivity of service awarded to a concessionaire is put in question. Time-of-use pricing and dispatching are no longer needed.

The regulatory frameworks in place do not reflect these new realities. While modern technologies allow for developing the large generation capacity of wind, solar, and biomass, their localization is rigidly determined by the geography of the resource. They cannot adhere easily to the geography of large customer centers, and they do not always coincide with the geography of the T&D network inherited from the former center-to-periphery model. Thus, new needs for transmission lines and local wheeling have appeared. This requires a new regulatory framework and new investment mechanism to complement the infrastructure. This background helps us understand the barriers detailed below, which need to be addressed to enable the greater implementation of low-carbon options.179

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179 For a more thorough discussion of the spatial economics of grid expansion, see de Gouvello (1993). For an analysis of the technological lock-in effect induced by the regulatory framework associated with grid-based electrification, see de Gouvello (1996). For an econometric parametrization of the relative competitiveness of the grid versus decentralized photovoltaic systems, see de Gouvello and Maigne (2002).

For the share of low-carbon energy to grow in the energy matrix of developing and emerging countries, a minimum requirement must be set. Once energy is produced, it should be able to access consumer markets in a sustainable manner. Today, more than 60 sugar mills are distributed across 21 countries in Sub-Saharan Africa. They represent more than 660 MW. This is additional generation capacity that could be made available if 67 cogeneration projects were implemented using technology similar to the tens of bagasse-based cogeneration units existing in the Brazilian sugar industry. These projects could abate 2.4 MtCO$_2$ per year (de Gouvello, Thiuye, and Dayo 2008). To date, only a few of them have been developed. For fossil-fuel-based energy processes in the region’s existing industrial facilities the cogeneration potential is also large. It has been estimated that more than 350 projects that could deliver more than 17,000 MW to these countries—potentially abating up to 72.9 MtCO$_2$ per year (de Gouvello, Thiuye, and Dayo 2008).

Excess electricity production is often created because cogeneration systems are usually sized to ensure that the industry’s heat demand is satisfied. It is therefore imperative that industrial companies aiming to implement cogeneration systems can sell the excess generation. Otherwise, they are unlikely to produce more than they need, preferring the simpler solution of generating heat only.

The market-access issue does not affect the clean-energy projects built onto existing large power plants. This includes adding a second cycle to open-cycle gas turbines (OCGT) to upgrade them into a CCGT. It is a serious concern for nonconventional, power-generation plants. This problem is valid not only for sugar mill cogeneration, as discussed above, but for many other forms of renewable-energy power generation, including biomass, wind, and small hydropower plants. In Sub-Saharan Africa alone, the potential power generation from biomass residues is estimated at more than 1,700 projects (from agriculture, forest and wood-industry residues, landfill gas, Typha, and Jatropha) that add more than 70,000 MW equivalent to the region’s current installed capacity. Since such clean-energy options are generally dispersed and of small or medium size (5–50 MW), they require access to existing local markets.

For more capital-intensive indivisible clean-energy options existing local markets are usually too small to absorb the energy generated by these large projects. This includes the recovery and use of flared gas during oil production. Instead, such projects require either access to the international gas market or the development of the domestic gas market.

In all cases, ensuring local and international market access requires overcoming soft (regulatory gaps) and hard (logistics bottlenecks) barriers.

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180 In 2008, in Sub-Saharan Africa, only two cogeneration units were using high-pressure boilers (Le Gol in Reunion Island and Belle Vue in Mauritius), compared with several in Brazil.

181 This upgrade allows for the recovery of vented heat and enables the generation of more power from the same quantity of fossil fuel used, thus reducing emissions intensity. For instance, in 2008 in Sub-Saharan Africa, the potential was estimated at 200 projects, totaling more than 5,500 MW and an abatement capacity of up to 36 MtCO$_2$ based on the performance of the Azito and Ciprel OCGT in Côte d’Ivoire and countries’ specific grid emission factors (de Gouvello, Thiuye, and Dayo, 2008). In Brazil in 2010, the mitigation potential was estimated at 1.5 MtCO$_2$ per year for 16 projects, totaling 1.2 GW of additional capacity and potentially (World Bank and BM&F-BOVESPA 2010).
10.2.2. Access to Markets Requires Filling Regulatory Gaps in the Power, Gas, and Automotive Fuel Sectors

In the case of the power subsector, market access means that independent power producers (IPPs) must be able to sell electricity at an acceptable price by being able to bid on a wholesale trading pool, or through equitable regulated purchase tariffs (for example, in the case of a monopolistic public utility), or more generally through power purchase agreements (PPAs) to a distribution company or distant consumer (wheeling).

Unfortunately, in many developing countries too small to implement a liquid competitive wholesale market, purchase tariffs are nonexistent, PPAs are poorly designed, and regulators do not allow the wheeling of excess power production through existing national grids. In short, key missing elements in the regulatory framework of the electricity sector prevent clean-energy-based IPPs from accessing the market. Fair purchase tariffs for the diverse types of clean energy generated by IPPs and sound frameworks for PPAs between industries and power utilities must be established.

Appropriate purchase tariffs are needed for renewable intermittent power-generation options. For example, cogeneration uses seasonally available agricultural residues and wind-farm output depends intrinsically on wind variability. Traditionally, public utilities have been reluctant to buy energy from such intermittent sources since it requires a more flexible generation capacity. The nonpermanent nature of these options triggers complex questions regarding how the electricity generated should be remunerated. Additionally, the issue of integrating such local energy production was often ignored by sectoral authorities until recently. But the electricity generated has a real value that can contribute to narrowing the supply-demand gap. Various tariff and contractual formulae have been tested and adopted in several countries.

Low-carbon distributed energy resources (DERs)\(^\text{182}\) are also expected to play a more prominent role in the power sector. Technological innovations are enabling the emergence and proliferation of a range of low-carbon DERs. New information communication technologies (ICTs) can increase the efficiency and precision of data collected on the usage and operation of the entire power system. This allows for more sophisticated and effective demand response (DR) options. Innovation allows for multidirectional power flows across distribution networks, enabling the development of micro grids and on-site distributed generation (DG).

Electricity storage technologies are also progressing quickly both for short-term applications\(^\text{183}\) and for periods of day-into-night, which is essential for PV-based generation. Storage can drastically reduce the need for peaking and mid-merit capacity, and ensure better use of other capital-intensive power plants. It could eventually affect the plant mix substantially, allowing for a much higher penetration of variable resources (IEA 2016a).

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\(\text{182}\) DERs design a suite of new technologies that allow consumers to reduce their needs for external supply coming from concentrated generation via the grid, thus delivering cost savings for the system. They include demand response options through which consumers temporarily or permanently reduce their demand for energy, and distributed generation by which consumers become local energy producers.

\(\text{183}\) For a few seconds to a few hours.
The role of distribution grids is changing, with network operations moving from a passive role to the center of the energy transition process. Grids will shape the future deployment of DERs such as solar PV, electric vehicles, micro gas-fired turbines, distributed storage, and demand response.

- Active operation of distribution networks can enable reductions in or the postponement of network investments. If the regulatory frameworks for distribution networks fail to evolve, this opportunity may be lost.
- New network regulations are needed to establish a smart distribution network. New regulations should also enable the creation of market platforms where DERs can participate, while keeping a neutral role vis-à-vis competition.
- Decisions to refurbish the distribution grid, affecting the where and when of distribution, and the degree of its automation, should be taken only at the local level. Network regulation therefore needs to give balanced negative (cost-efficiency) and positive (technology investment) incentives to distribution network operators and owners.

Source: IEA 2016a, chapter 8.

The technological innovation and diffusion of low-carbon DERs can bring new services and actors into the market. As DERs penetrate the network, traditional consumers will be able to control their demand, potentially becoming net suppliers to the utilities. Conversely, utilities will be able to control loads and distributed generation. This allows for supply and demand matching in a low-cost, reliable way.

Roles and responsibilities in the power supply chain will also change, especially those in the distribution and retail sectors. This reflects new conditions whereby consumers will be increasingly able to store and manage energy and adjust peak consumption, as well as produce and sell excess energy to the grid. A recent IEA report, “Re-Powering Markets—Market Design and Regulation during the Transition to the Low-Carbon Power Systems” (IEA 2016a), presents one of the most detailed analyses available to date regarding the need for evolving power markets regulations to enable a low-carbon transition. It provides a thorough review of requirements for the future scaling up of both DR and DG (see Boxes 10.2 and 10.3).

This transformation has already started in more advanced power systems such as in the US and EU. Although the corresponding regulatory framework are not yet stabilized. For this transition to happen and for DERs to be able to function in developing countries, local regulators will have to adapt regulatory frameworks to the transformative changes that will emerge with the use of ICTs in distribution.

Switching from coal or fuel oil to natural gas can enable emissions reductions. For such substitution to be scaled up, natural gas needs to be able to access the industrial market at the scale needed. Market conditions also need to be competitive enough for maximizing the competitiveness of gas against more carbon-intensive fuels.
BOX 10.3 Demand Response Programs: Key Challenges

- Demand response programs can play a role in the decarbonization of the power system by decreasing demand when the system is tight, and by adjusting the timing of power consumption to when supply from low-carbon resources is more abundant.

- Large consumers already respond to prices by participating directly in wholesale electricity markets. They buy their expected consumption in advance and respond to price variations by reselling on short-term markets.

- Smart meters and progress in automation technologies increasingly enable smaller consumers to be price responsive. Dynamic pricing options, such as critical peak pricing (CPP), are a straightforward way to tap into this potential.

- To date revenues from participation in the wholesale energy markets are rarely sufficiently abundant or predictable to cover the (fixed) cost of investing in the equipment needed to develop demand response.

- Another option is to treat demand response as generation, and “dispatch” it on wholesale electricity markets. Direct participation of demand response aggregators in capacity markets has been effective in kick-starting demand response in several markets, such as the US regional transmission organization, PJM.

- Treating demand response as generation requires complex market rules, with the need to define a baseline of consumption against which demand response can be assessed. Defining the correct level of remuneration is difficult and can be controversial.

- The protection of data to safeguard consumer confidence is an additional and important prerequisite for the significant deployment of demand response.

Source: IEA 2016a, chapter 6.

Even in countries where a gas sector already exists, several barriers related to inadequate regulatory frameworks can prevent gas from reaching industrial customers. Such barriers can be complex and need to be analyzed thoroughly in each national context to determine the appropriate policy instruments needed. Often this will involve crafting new legal and regulatory frameworks. New frameworks and legislation will also be needed to address the risks associated with gas, such as methane leakage. Box 10.4 illustrates the specific case of Brazil.

In this regard, the recovery and use of associated gas (AG) is no exception. Since AG is generally considered waste output in the production of crude oil, in many countries little or no relevant regulation has been developed regarding its use. AG ownership rights are either unclear or nonexistent. Additionally, many production contracts provide no rights for the downstream sale or commercialization of AG and prevent recovery of the costs incurred to harness AG output for productive uses. In this context, it is often difficult to attract the required local and international investment to develop gas infrastructure to a level that can significantly reduce flaring.184

Such gaps in the regulatory framework are evident in other energy subsectors, preventing the implementation of other types of clean-energy projects. This is the case for biofuels which cannot be blended with fossil fuels.

fuels without acceptable definitions of technical specifications and licensing procedures.\textsuperscript{185} In the absence of such regulations, biofuels are barred from the market and potential investors cannot expect revenue from their sale.

**BOX 10.4** Market Barriers to Specific Industrial Uses of Gas in Brazil

In Brazil, the potential of replacing industrial use of coal or fuel oil with natural gas is significant. Shifting from fuel oil to natural gas for thermal purposes represents a 26 percent reduction of CO\textsubscript{2} emissions; and from coal to natural gas, a 44 percent reduction (see table A.1 in the annex to this volume). However, the development of the gas market (a requirement for such substitution to take place), both to make gas more competitive and to increase its offer, has been hampered. Although the sector was opened to competition in 1995, players other than Petrobras still face significant challenges to accessing the market.

The following examples show the barriers to market access. A producer wanting to sell natural gas would have in theory three main options: (i) sell to a distribution company at the city gate; (ii) sell to a free consumer; and; (iii) have the gas consumed on a vertical integrated facility (“self-consumption”). To reach the market, it would have to process the natural gas and inject it into the transport network. It would be difficult to transport the gas in the short term to a Natural Gas Processing Unit (NGPU), since all the existing facilities are exclusively owned by Petrobras. This includes both upstream pipelines and NGPUs. Even if it can work around this issue in the medium term, the producer would have to access the transportation network. Currently, Petrobras has already booked all the capacity in the long term. There is no additional capacity available to be contracted on a firm basis in the market. In addition, the short-term products are scarce and there is no transparent information on how much capacity is available on either a consistent or interruptible short-term basis. Finally, whether it intends selling to a free consumer or consuming its own natural gas, the supplier would have to pay a tariff to the distribution company, regardless of whether the distribution network is being used or not.

Besides barriers to physically reaching the market, the producer would face difficulties finding a buyer willing to buy the natural gas. This is due to the non-interruptible and variable profile production of a gas field. Since the producer is envisaging only one buyer for its production, providing a set reference quantity in the contract would be too risky. The producer is thus tied to a production curve that cannot be controlled. Imbalances between the quantity produced and demanded by the contract cannot be mitigated in the short term. Therefore, the supplier would have no mechanism to accommodate or to contract the flexibility required and neither would the consumer.

The same holds true in the case of liquefied natural gas (LNG) imports. The agent would have to build import capacity (the LNG terminal and the regasification unit) and access the transport network to reach the final consumer. The full volume of natural gas imported would either must be sold and consumed at the same time (sold on a long-term basis) or be stored until it is fully demanded by the buyer. It would ultimately face the same problem: a lack of contracting options. The most common solution used around the world is the take-or-pay contract: the producer bears the price risk, and the buyer bears the quantity risk. In Brazil, however, the buyer would not have the means to manage such quantity risk, so the standard solution is not possible.


10.2.3. Market Access Requires Appropriate Infrastructure Planning and Policies to Overcome Logistics Bottlenecks

Some potential clean-energy projects are in places already well connected to the energy transport infrastructure. In the power subsector, examples include the addition of a second cycle to an open-cycle power plant, cogeneration from fossil fuels or industrial biomass residues, and energy-efficiency measures (for example, switching to compact fluorescent lamps and more efficient industrial equipment and household appliances). But in many cases, when added generation capacity is to be installed, the transmission capacity of the existing

\textsuperscript{185} Such as biodiesel and bioethanol.
grid is insufficient to carry the additional power to the market. In many other cases (typically agriculture, forest, and wood-industry residues), the primary energy resource is dispersed and distant from the grid. This implies a dual logistics challenge: constructing high- or medium-tension transmission lines to bring power to the market and, in the case of dispersed biomass, collecting and transporting it to the transformation facility. Regarding power evacuation, if clean energy project developers bear the total investment cost and financing of the construction of transmission lines, the added burden is likely to render the project unfeasible. It would prove unattractive to nonconventional players whose core businesses are unrelated to energy. Instead, development of the required infrastructure can be undertaken as part of the overall transmission system’s planning and development. It is common practice to charge consumers tariffs calculated to reflect systemwide development costs, including the distribution and transmission of investments for which they are responsible. Based on this, an alternative is that investment in transmission lines required to evacuate clean energy186 is borne collectively by the sector and then charged back to the generators and consumers through tariffs. This arrangement requires appropriate planning of both clean-energy grid development and transmission and an appropriate cost-sharing policy. Many countries lack the requisite planning capacity to achieve this objective.

Another key bottleneck to fuel switching from coal or fuel oil to gas or to the capture and market distribution of flared associated gas is the high investment cost of energy transport infrastructure. In many fossil fuel exporters, the local markets where natural gas can be used are either too small or located in dispersed areas far from oil and gas-producing fields. This makes heavy investments in T&D infrastructure necessary. For the domestic energy market to play a significant role in the gas flare-out strategy, the required gas T&D infrastructure must be in place. A related issue is the inertia of local gas markets. Fuel switching by the power sector can serve as the catalyst for using gas in other sectors of the economy. This was demonstrated in Nigeria, where the power sector acted as the anchor for demand for gas and a catalyst for boosting its use in the country’s economy. A country’s requirements for natural gas for power generation can serve as the driving force for extending its gas network.

Lack of transport systems also inhibits the development of biomass-based clean energy. For example, collection of biomass residues from agriculture and forest and wood-processing industries, usually located in remote areas, is often barred by poor transport infrastructure, rendering the residues unrecoverable.

Electrification is a key strategy for decarbonization and the existence of a mature infrastructure network associated with fossil fuels bars the scaling up of alternatives, for instance, electric vehicles (OECD 2015a).

In summary, overcoming such logistics bottlenecks requires adequate policy design and planning the development of the production-transport-distribution market gas chain. Planning is the initial critical step to formulating infrastructure development programs that can allow for the redistribution of investment costs to bearable levels.

### 10.2.4. The Benefits and Limits of Using a Shadow Carbon Price to Orient Public Planning and Investment

An estimated 60–80 percent of developing and emerging country infrastructure investments are still in the hands of the public sector, which have a different incentive structure to the private sector (Fay and others 2015). Infrastructure decisions are often driven by development and social concerns rather than strictly economic ones (say, a desire to integrate the country through a transport network or to promote the development of lagging regions). As a result, one cannot expect a carbon price to automatically incentivize the required changes in infrastructure investments and technologies. More targeted policies may be required. An easy technique to
start internalizing carbon benefits in public decision making is to mandate the use of a shadow carbon price. Defining a shadow carbon price is a complex process, affected by many uncertainties, theoretical debates, and delicate political economy issues. Thus, the result is rarely perfect from a theoretical perspective. However, this is a first step to internalizing a collective preference for mitigating climate change at the upstream planning stage. Those governments, firms, and institutions that have adopted a shadow price for carbon typically have used values ranging between $20 and $60 in 2015, with central figures usually around $25 to $40 (see Figure 22) and increasing over time. The World Bank Group introduced a similar shadow price for use in its project assessments (World Bank 2014).

**FIGURE 22. Examples of Shadow Carbon Prices Increasing over Time**

![Graph showing examples of shadow carbon prices increasing over time.](image)

Source: Fay et al. 2015.

Note: EIB = European Investment Bank; IEA = International Energy Agency; WBG = World Bank Group.

10.2.5. Planning Short-Term Mitigation Targets while Enabling Longer-Term Ambitious Decarbonization Goals

Logically lowest-cost mitigation options should be prioritized. Corresponding costs are often measured as the cost differential of using low-carbon options relative to a baseline alternative. Using a baseline option as a benchmark is a practical way of ensuring that sectoral policy objectives are already taken care of. The decision processes can then focus on selecting the least-cost option to meet these objectives and mitigation targets. As noted in Chapter 9, MAC curves are a very useful instrument for identifying lowest-cost options.

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187 The shadow price of carbon (SPC) is a value used by government and firms to internalize the cost of carbon emissions in their decisions. It is usually defined using estimates of the social carbon cost as a reference. The social cost of carbon is "the value of the climate change impacts from 1 ton of carbon emitted today as CO₂, aggregated over time and discounted back to the present day; sometimes also expressed as value per ton of carbon dioxide" (IPCC 2007).
and crafting cost-efficient mitigation policy. Accordingly, the World Bank has developed the MACTool, aimed at helping governments build their own MAC curves (see Box 10.5).

Fay and others (2015) point out that the simplicity of these curves comes with an important limitation. MAC curves do not provide information on the length of time it would take to implement the mitigation measures plotted in the curve. This is especially relevant for harmonizing short- and longer-term planning aimed at achieving an increasingly ambitious level of decarbonization. One of the bottlenecks, among others, that determine the pace of implementation is the slow capital turnover. The average lifetime for energy-consuming equipment ranges from an estimated 7 years (for lightbulbs) to more than 35 years (Williams and others 2012). This is particularly important for coal-fired power plants, as some 40 percent of them are now less than 15 years old (Davis and Socolow 2014). This can lead to a phenomenon known as ‘carbon lock-in’: infrastructure decisions today can determine emissions trajectories decades into the future.

**BOX 10.5 MACTool: A User-Friendly Software for Building Marginal Abatement Cost Curves**

The World Bank has developed the MACTool to help governments compare the costs and benefits of emission-reduction options that can be used to build low-carbon scenarios at a national or subnational level.

As inputs, the MACTool uses the key sociotechnical parameters of a set of large mitigation measures and macroeconomic variables. For instance, technology options to produce electricity are characterized by the required capital and operation expenditures, as well as by their lifetime, energy efficiency, and type of fuel used. Physical constants, such as the carbon intensity of each fuel, are factored in. The user must also specify at least one scenario on the future macroeconomic variables of interest, such as the price of fossil fuels and the future demand for electricity. The user must also provide scenarios of future penetration of low-carbon technologies and measures, in both a baseline and at least one emission-reduction pathway (ESMAP 2012).

As outputs, MACTool computes the amount of GHG emissions saved by each measure during the past year in tCO2/year. The cost is also provided in dollars/tCO2. This is then illustrated with two figures: a MAC curve and an abatement wedge curve. The latter shows when each option would be deployed and how the different mitigation interventions add up over time. It also estimates the incentives needed to make those options attractive for the private sector by calculating a break-even carbon price. This also helps governments assess the total investment needed to shift toward low-carbon growth.

A first version was developed with the support of the Energy Sector Management Assistance Program (ESMAP) by de Gouvello and Maestle. A more sophisticated one, which can integrate policy options and the time dimension, has been developed under the leadership of Grzegorz Peszko and Victor Loksha, with the contribution of Adrien Vogt-Schilb ([https://esmap.org/MACTool](https://esmap.org/MACTool)).

Source: Authors compilation

Short-term planning exercises aimed at achieving early mitigation targets have several time constraints to consider. For example, what initial steps should be taken to enable more ambitious longer-term targets? Failing to consider this leads to the “tortoise and rabbit” paradox, as stated by Fay and others (2015). Opting for only rapid low-cost, short-term marginal changes in the economic system without immediately starting on slower, costlier structural measures causes delays. This can prevent the longer-term, ambitious mitigation targets from being achieved on time (Vogt-Schilb, Hallegatte, and de Gouvello 2014).
10.3. Fill Local Capacity Gaps that Prevent the Adoption of Low-Carbon Energy Options

Development of clean-energy projects frequently requires the operation and use of modern technologies that are not always readily available in developing countries. Such technology transfer requires selected capacity-development activities that depend on the clean-energy potentials targeted. These activities range from R&D to training and information dissemination.

10.3.1. The Dissemination of Technical Information Is Needed for Even Mature, Clean-Energy Technologies

In many developing countries, sustainable clean-energy development is hindered by a lack of knowledge, information, capacity, and effective communication on the development of clean-energy technologies. This includes the necessary background data and inventory of potential energy sources and financial options. The effects of such gaps in decision making are exemplified by the lost potential of cogeneration. Most small- and medium-sized industries of the developing world ignore the opportunity for improved profitability and competitiveness provided by the cogeneration option. The technical facts, rarely captured in the decision-making process, are that the best thermal efficiency from a stand-alone system is about 55 percent, compared with a minimum of 85 percent from today’s more advanced combined heat and power (CHP) systems.\(^{188}\)

Similarly, industries’ lack of information on more energy-efficient alternatives (for example, efficient electric motors, steam and cooling systems, and lighting), that are theoretically attractive based on energy savings, contributes to their ongoing use of inefficient devices. Even technologies widely used in more advanced economies are not commonly applied in many developing countries. This is the case with mechanical recompression for waste-gas power generation in oil refineries.

Distorted perceptions about cleaner-energy options can also prevent clean-energy development. For example, in addition to a lack of information on coal mine methane (CMM) sources, lack of interest in investing in CMM projects is impeded by the perceptions of many coal industry officials and mine operators who view CMM as a safety hazard rather than a valuable energy resource. In the case of the agro-industry and wood-processing industry, a similar perception persists regarding industrial biomass residues.\(^{189}\) Such residues are viewed as a waste-disposal issue. At best, they are partially burned in an inefficient manner to generate a limited amount of process heat to eliminate an undesirable by-product. Yet, there is an enormous potential for agricultural and agro-industrial processing. Not only can some of these processes decrease electricity consumption, they can also result in additional net power production.\(^{190}\) This is also the case regarding the blended cement versus the energy-intensive ordinary Portland cement option.

The first step toward engaging potential developers of clean-energy projects who currently run inefficient facilities or waste bioenergy is to provide them with information on these technologies. One approach might be to jointly organize technology-focused information campaigns with equipment and technical-services providers, targeting the specific technologies that match the region’s available clean-energy potentials and the decision makers of corresponding companies.

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188 In such countries as Brazil and India, the commercial dissemination of CHP began more than 20 years ago.
189 For example, sugarcane bagasse, groundnut shell, rice husk, and palm fiber.
190 Cumulated potential generation capacity from bagasse, agricultural and agro-industrial residues, and the forest and wood-processing industry.
10.3.2. Training Is Needed to Fill Technical Skills Gaps Related to Mature, Clean-Energy Technologies

A significant share of GHG emissions is derived from inappropriate maintenance schemes in industry. This is part caused by a labor force that lacks adequate skills. For example, the primary barrier to implementing industrial steam-system, energy-efficiency improvement projects are a lack of adequate repair capacity. That is, when steam traps malfunction, they are not immediately repaired or replaced. This causes condensates to be released routinely into drainage lines, and results in the loss of considerable amounts of enthalpy.

Clean-energy development often requires training operators and building their capacity and skills to use clean-energy technologies. It is important that the staff responsible for the operation and management of the energy-related equipment be trained in its use so that countries can build national capacity for clean-energy technology applications. If based on the traditional turnkey approach of imported technology, scaling up and efficiency will be limited.

10.3.3. R&D is Needed to Enable Clean-Technology Efficiency and Sustainability

Relative to more advanced economies, many developing countries have limited capacity to adapt technologies to local resources. For example, biomass products usually require drying and size reduction to become usable fuel. In other applications, it may be necessary to carbonize the biomass (use it to produce charcoal) before it can be used as fuel for domestic and commercial end-uses. At the extreme end is the gasification route, which requires intensive technical know-how. The equipment required to capture the full energy potential of local biomass is not readily available in the developing world. This is particularly true of LDCs, many of which are rich in biomass. As a result, R&D activities are required to adapt efficient pre-use transformation solutions and combustion equipment to the specific characteristics of each type of local biomass residue.

Local research is required not only to get the most from local clean-energy potential at the lowest costs, but also to ensure the sustainability of its use. Biomass residue is one of the most attractive clean-energy potentials in poor countries because of its numerous potential benefits for both the local energy sector (for example, reduced dependency on high-priced petroleum products) and the economy (for example, new income-generation activities). For biomass residue environmental and social impacts assessments are particularly important. In subsistence farming practices, agricultural productivity is particularly sensitive to the amount of post-harvesting residues left on the farm. Key functions of residues on such farms include protection against soil erosion, reduced compaction resulting from heavy rains, moisture conservation (thereby reducing the need for irrigation), maintenance of a more even soil temperature, and weed-growth prevention. The expanded use of residues for energy may grossly affect farming activities. Therefore, it is critical that agricultural research be conducted to strike an optimal balance between the use of residues as a fuel and their alternative utilization.

10.4. Command-and-Control Technology Regulations to Exclude Inefficient Technologies

From a theoretical perspective, command-and-control instruments are usually considered to be inefficient. They fail to put a price or opportunity cost on the negative externality and provide no intrinsic mechanism for ensuring that environmental targets be attained at the smallest economic cost (de Serres, Murtin, and Nicoletti 2010). However, under specific circumstances, they might still be justified or even be the only effective options
available. For example, Coria and Sterner (2011) describe some of the conditions that may motivate the use of technology regulations:

- The technical and ecological information is complex;
- Crucial knowledge is available to the government rather than the polluter;
- Polluters are unresponsive to price signals and investments have long-run irreversible effects;
- The standardization of technology holds major advantages;
- Of only a few competing technologies available, one is superior;
- Monitoring costs are high and whilst monitoring emissions is difficult, monitoring technology is easy.

When one, or some, of these conditions are met, the imposition of direct regulations may be the desirable approach. According to Coria and Sterner (2011), this is presumably why technology regulations are still frequently used.

Another situation, known as the principal-agent problem, cannot be addressed with pricing but can be conveniently solved by technology regulations. For instance, landlords are reluctant to invest in energy efficiency if it is the tenant who eventually pays the heating bill. Such bottlenecks are usually solved by technology regulations, particularly performance standards (Fay and others 2015).

National energy-efficiency standards and labeling (EESL) programs have been in existence since the 1970s and now operate in more than 80 countries around the world, covering a wide range of appliances and equipment in the commercial, industrial, and residential sectors. According to the 2016 Annual IEA 4E Report, while the design and coverage of EESL programs vary according to national circumstances, they provide the cornerstone of most national energy-efficiency and climate change mitigation programs (2016b). EESL programs use one or more of the following complementary tools to improve the energy-efficiency performance of appliances and equipment:

- Energy labels enable consumers to make an informed choice at the point of purchase, either by showing the comparative performance of all appliances (rating labels) or by identifying the best-in-class products (endorsement labels);
- Minimum energy performance standards (MEPS) provide a level playing field in competitive markets by removing the worst-performing products.

According to the IEA 4E report, “the most mature national EESL programs covering a broad range of products are estimated to save between 10 percent and 25 percent of national or relevant sectoral energy consumption. In all of the EESL programs reviewed, the national benefits outweighed the additional costs by a ratio of at least 3 to 1, i.e. EESL programs deliver energy and CO2 reductions while also reducing total costs.”

Appliances and equipment covered by EESL programs have not only significantly improved in efficiency over the past 20 years, but have also become cheaper to purchase because of mass-scale production. Another

191 Other barriers might include non-rational behaviors and (biased) risk perceptions from consumers (who are not doing a cost-benefit analysis before they buy a car) and investors (who do not like to invest in new sectors); such barriers, which are not necessarily easy to document, are also possible justifications for non-price policies.

192 4E stands for Energy Efficient End-use Equipment.
IEA report reviewed the experience with energy-efficiency regulations for electrical equipment (IEA 2007a) in Europe, the US, and Japan, covering 59 types of equipment distributed in 10 end-use categories (see Table 10.1). The study concluded that all products have experienced a decline of between 10 to 45 percent in real prices, while energy efficiency increased by 10 to 60 percent over the various study periods. See the case of refrigerators in the US in Figure 23.)

TABLE 10.1 Major Electrical Appliance Categories

<table>
<thead>
<tr>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Space heating</td>
</tr>
<tr>
<td>2 Space cooling</td>
</tr>
<tr>
<td>3 Water heating</td>
</tr>
<tr>
<td>4 Refrigeration</td>
</tr>
<tr>
<td>5 Lighting</td>
</tr>
<tr>
<td>6 Cooking</td>
</tr>
<tr>
<td>7 Laundry (and dishwashing)</td>
</tr>
<tr>
<td>8 Home entertainment</td>
</tr>
<tr>
<td>9 Information and communication technology (ICT)</td>
</tr>
<tr>
<td>10 Other</td>
</tr>
</tbody>
</table>

Source: IEA 2007a.

FIGURE 23. Average Energy Consumption and Prices of Refrigerators in the US


Energy performance standards are even more decisive in the building sector. This is because the principal-agent issue mentioned above plays a very strong role in the decision-making process regarding the quality of the construction and improvements. In addition to the misalignment of the split incentive between landlords and tenants, construction decision makers are usually not interested in future costs. Developers have to be competitive to sell buildings to future occupants or users and will not have to pay future bills. Accordingly, they tend to disregard the incremental investment cost that will reduce future energy consumption. Building

193 For more details, including equipment, countries, and periods considered, see IEA (2007a).
occupants, who pay the energy bills, are rarely involved in the building design (IEA 2007b). Such asymmetry between builders and occupants is not specific to energy performance, and building codes are not a new invention. Building codes or standards for new buildings address several concerns, such as construction safety, fire safety, and occupants’ health. One of the earliest examples of regulations for buildings is Hammurabi’s law from Mesopotamia, established around 1790 BC (IEA 2007b).

Besides building codes, countries have frequently adopted energy standards to revise and strengthen energy efficiency requirements. This is particularly done for energy systems related to space heating, space cooling, and air quality.

Buildings are usually constructed to be used for many decades or, in some cases, for more than a hundred years. This eventually makes building codes and building energy-efficiency standards essential for ambitious, long-term mitigation.

**FIGURE 24. Impact of Codes on Heating Energy and Total Building Energy Demand (Indexed to 1975)**

As the construction market is under constant change, countries regularly revise their building codes and energy standards. In the building sector, examples of new products included are low-energy windows, condensing gas boilers, highly efficient heat pumps, PV components, passive solar house-heating system units etc. Energy-efficiency requirements are one of the drivers for these changes in the markets, as they enable faster learning curves, reduce the price gap between the market and the next generation of efficient technologies, and facilitate increasing energy-efficiency requirements over time.

Several studies have analyzed the average energy impact of the improvement of codes along time. Figure 24 presents a synthesis of some of these studies and shows steady progress toward greater efficiency. In the US, residential buildings that were code compliant in 2015 were 43 percent more energy efficient than comparable code-compliant buildings from 1975 through to the mid-1980s. For non-residential buildings, the efficiency gain is 45 percent. In parallel, the “best-in-class” residential building line has also continually improved ahead of the building standards, as illustrated in the case of Germany (see Figure 10.3).
10.5. Financial Instruments and Measures to Make Long-Term, Capital-Intensive Low-Carbon Energy Investments Attractive for Capital Markets

Energy infrastructure is capital intensive. Low-carbon energy infrastructure is even more so. Conventional fossil-fuel-based energy equipment has relatively high operational costs. This results from the consumption of the corresponding commercial fuels as intermediary products, whose prices cumulate extraction, processing, and transport costs. Many low-carbon energy alternatives use directly available local renewable natural resources. As a result, they do not require the purchase of commercial intermediary energy products. For obvious reasons, the same also applies to energy conservation alternatives. Consequently, most of the costs of low-carbon solutions are up-front investment costs. While operation and maintenance (O&M) costs of conventional fossil-fuel-based plants are relatively high, most of the time they are still competitive because the share of up-front investment cost in their total cost is far lower than for renewables (see Table 10.2). For instance, for a gas-fired plant with a 50-year lifetime, $1 of gas purchased in year 50, discounted at 5 percent, would account for just $0.09 in present value at the time of plant construction. In addition, no money must be borrowed to finance the purchase of gas for future years of electricity production.

Building a renewable energy plant is like building a fossil energy plant—plus buying up-front all the fuel that the fossil plant will use over its lifetime (Timmons, Harris, and Roach 2014).

### TABLE 10.2. Capital Cost of Renewable and Nonrenewable Electricity Sources (*)

<table>
<thead>
<tr>
<th>Nominal Capacity (MW)</th>
<th>Capital Cost ($)</th>
<th>Assumed Capacity Factor (%)</th>
<th>Capital $/Expected kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas: combined cycle</td>
<td>620</td>
<td>917</td>
<td>90</td>
</tr>
<tr>
<td>Coal: advanced pulverized fuel</td>
<td>650</td>
<td>3,246</td>
<td>90</td>
</tr>
<tr>
<td>Hydroelectric: conventional</td>
<td>500</td>
<td>2,936</td>
<td>75</td>
</tr>
<tr>
<td>Wind: onshore</td>
<td>100</td>
<td>2,213</td>
<td>25</td>
</tr>
<tr>
<td>Biomass combined cycle</td>
<td>20</td>
<td>8,180</td>
<td>90</td>
</tr>
<tr>
<td>Wind: offshore</td>
<td>400</td>
<td>6,230</td>
<td>35</td>
</tr>
<tr>
<td>Solar: photovoltaic</td>
<td>150</td>
<td>3,873</td>
<td>20</td>
</tr>
<tr>
<td>Solar: thermal electric</td>
<td>100</td>
<td>5,067</td>
<td>20</td>
</tr>
</tbody>
</table>


Note: (*) For comparing sources with different capacity factors, the author defined $/expected kW as $($/kW)/ (capacity factor), or the capital cost to produce the same amount of electricity as one kilowatt of capacity running continuously. kW = kilowatts; MW = megawatts.

Even for conventional energy infrastructure, however, the financing of the investment is a major barrier in developing countries. As the energy demand still grows at a substantial pace in these countries, the financing for the energy supply is substantial. According to the IEA, $4.9 trillion will be needed in the non-OECD countries over the 2015–25 period ($2.9 trillion for the OECD countries) under the “New Policies Scenario,” which includes the energy-related components of the NDCs\(^{194}\) (2015b).\(^{195}\) According to SE4ALL, the annual investment required for universalizing energy access and doubling the share of renewables in the energy mix by 2030 is even higher, amounting for $1.0 trillion–$1.2 trillion per year. The estimated financing gap compared to the current 2012 level ranges from $654 billion–$862 billion per year (SE4ALL 2015).

Though these financing needs are considerable, the need for such a large additional volume of equipment compared to the existing one gives more room for developing countries to shift quickly toward a less-intensive

\(^{194}\) INDCs submitted by national governments by October 1, 2015, to the Secretariat of the UNFCCC as pledges for COP21.

\(^{195}\) In contrast, $2.9 trillion would be required for the OECD countries.
carbon path. However, as most energy infrastructure investments are long term, missing the opportunity to make that shift would generate a lock-in of carbon-intensive trajectories for decades to come.

- The three main sources for financing infrastructure investments are (OECD 2015b; IEA 2014):
  - Direct investments from governments, companies, and households;
  - Loans from public and private banks;
  - Capital markets (through equity and bonds).

In most developing countries, while the public-sector heads long-term investment in infrastructure in general and in energy, either via state-owned companies (SOEs) or via public banks, it is no longer able to tackle the size of the challenge. The private sector is thus essential to meet the energy investment needs in full. Indeed, the transformational change toward a low-carbon energy sector will need to mobilize mainly private sector investment and finance (Corfee-Morlot and others 2012; IEA 2014).

As a result of the 2008 financial crisis, banks are facing restrictions due to the changes in prudential regulation, particularly Basel III and post–BASEL III local regulations. In many countries, the banking system is undergoing a process of capital adjustment, which significantly impacts the availability of long-term funds from banks. Therefore, alternatives to financing through traditional banking markets should focus on the third source of financing, that is, capital markets, particularly institutional investors such as insurance firms, pension funds, and sovereign funds (World Bank 2016).

Financial resources available in capital markets are still several orders of magnitude larger than the investment volume needed (see Figure 25). Attracting a small portion of these large capital pools would thus be more than sufficient to finance the required energy investments.

**FIGURE 25. Assets Held in the 20 Largest Economies plus the Euro Area**

Notes: MUNFI: Monitoring Universe of Non-Bank Financial Intermediation; OFIs: other financial institutions.

196 For a detailed case study regarding long-term financing issues and options for energy infrastructure in Brazil, see World Bank and FGV (2016).
There are, however, several challenges to attracting these large investors. Institutional investors with long-term liabilities, like pension funds insurers and sovereign funds, are also looking for long-term asset classes. Since most energy investments have long maturity periods, it would be natural for institutional investors to incorporate such investments in their portfolios. However, their investment in energy projects remains minimal compared to the scale of their assets. A survey conducted by the OECD on “Institutional Investors and Long-term Investment” found that out of the nearly $8 trillion managed by 69 large pension funds and public pension reserve funds, infrastructure investment in the form of unlisted equity and debt was $72.1 billion in 2012. This represented only 0.9 percent of the total assets managed by these funds (OECD 2014a).

The reason is that often these investments do not qualify as asset class for these investors. That is, the risk-return profile of most long-maturing, capital-intensive infrastructure investments in developing countries are not attractive enough for these risk-adverse investors. These projects’ risks therefore need to be precisely identified and mitigated (see Table 10.3).

In addition, and as noted in earlier subsections, existing policies tend to collectively favor investment in conventional, mostly fossil-fuel-based investment (see Table 10.4). The scaling-up of private financing toward low-carbon investment will not happen spontaneously. Improving the economics of the projects via pricing instruments, including carbon pricing, will not be sufficient. A series of complementary measures needs to be taken to de-risk these projects and level the playing field.

### TABLE 10.3. Mapping Risks of Energy Projects in Developing Countries

<table>
<thead>
<tr>
<th>Stage</th>
<th>Risk / Risk</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Environmental and Social</td>
<td>The risk of damage to the environment or adverse impact on local communities</td>
</tr>
<tr>
<td>Build</td>
<td>Land purchase and Site</td>
<td>The risk of acquiring title to the land to be used for a project, the selection of the site, and the geophysical conditions of that site</td>
</tr>
<tr>
<td>Build</td>
<td>Design</td>
<td>The project has not been designed adequately for the purpose required</td>
</tr>
<tr>
<td>Build</td>
<td>Resource or input</td>
<td>Interruption or cost overrun in the supply of the required resources</td>
</tr>
<tr>
<td>Construction</td>
<td>Construction</td>
<td>Labor disputes, commissioning, quality assurance standards, defective materials, subcontractor disputes / insolvency, cost overruns</td>
</tr>
<tr>
<td>Build</td>
<td>Performance / Price</td>
<td>Risk that the asset is not able to achieve the output specification metrics and at the expected price</td>
</tr>
<tr>
<td>Completion</td>
<td>Completion</td>
<td>Risk of not commissioning the asset on time and on budget</td>
</tr>
<tr>
<td>Operation</td>
<td>Force majeure</td>
<td>Unexpected events beyond the parties’ control; delays that prohibit performance</td>
</tr>
<tr>
<td>Operation</td>
<td>Strategic</td>
<td>Change or conflict in shareholding of private partner</td>
</tr>
<tr>
<td>Operation</td>
<td>Inflation</td>
<td>Unexpected increase in the project costs</td>
</tr>
<tr>
<td>Operation</td>
<td>Disruptive technology</td>
<td>Displacement by a new technology</td>
</tr>
<tr>
<td>Operation</td>
<td>Regulatory / Change in law</td>
<td>Law changes that affect the ability of the project to perform, including the price to comply with the new law and changes in taxation</td>
</tr>
<tr>
<td>Operation</td>
<td>Political</td>
<td>Government intervention, discrimination, asset seizure, or expropriation, public sector budgeting</td>
</tr>
<tr>
<td>Operation</td>
<td>Insurance</td>
<td>Unavailability in insurance for a particular risk</td>
</tr>
<tr>
<td>Operation</td>
<td>Exchanged and Interest rate</td>
<td>Fluctuations in currency and interest rates over the life of a project</td>
</tr>
<tr>
<td>Operation</td>
<td>Maintenance</td>
<td>Maintaining the asset; complying with appropriate and regulatory standards</td>
</tr>
<tr>
<td>Operation</td>
<td>Demand</td>
<td>Availability both in volume and quality of the resources as well as the demand for the product or service</td>
</tr>
</tbody>
</table>


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An asset class is a group of instruments that have similar financial characteristics and behave similarly in the financial marketplace. The two main asset classes in securities are equities (stocks) and fixed income (bonds).
Table 10.4. Issues Limiting the Attractiveness of Long-Term Capital-Intensive Low-Carbon Energy Investments for Institutional Investors

<table>
<thead>
<tr>
<th>All long-term infrastructure investment</th>
<th>Financial market policies</th>
<th>Financial incentives across the financial system favoring short-termism (remuneration practices, fiscal measures, performance appraisal)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Potential unintended consequences of financial regulations on long-term financing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barriers to the deployment of innovative financial instruments for new types of investors (for example, institutional investors)</td>
</tr>
<tr>
<td>Investment policies</td>
<td></td>
<td>Regulatory barriers to international investment (for example, limits on foreign ownership, restricted access to land, local content requirements)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of transparency, insufficient investor protection and intellectual property rights protection, weak contract enforcement enterprises, and independent producers of clean energy</td>
</tr>
<tr>
<td>Sector-specific regulations</td>
<td></td>
<td>Lack of stability of regulatory framework, government interventionism changing rule of the game</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Additional disadvantages for low-carbon, capital-intensive energy options</th>
<th>Fiscal policies</th>
<th>Environmentally harmful subsidies and incentives (for example, fossil fuels)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tax policies that unintentionally favor carbon-intensive behavior (for example, company cars)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Competition policies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of level playing field regarding internalization of carbon benefits of low-carbon options and/or carbon cost of fossil fuels (including in public procurement)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of open and competitive infrastructure markets (for example, in the electricity sector)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Market designs and regulatory rigidities that favor carbon-intensive infrastructure investment in the energy sector</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of a level playing field in the power sector for existing fossil-fuel-producing state-owned enterprises and independent producers of clean energy</td>
</tr>
</tbody>
</table>

Source: Adapted from OECD (2015)

To attract institutional investors to a low-carbon project, it is thus necessary to improve its risk-return profile and move this into the investment asset class.

Financial instruments can be established to achieve that goal. These aim at de-risking and enhancing the credit rating of these projects or of any project developers willing to take debt or issue bonds. These instruments can be designed to improve the risk profile of individual projects or to aggregate large set of projects and thus benefit from a diversified portfolio (see Box 10.6).

A variety of financial market products can be tailored and introduced to increase the liquidity of these assets. An OECD report, “Aligning Policies for a Low-carbon Economy,” presents a series of specific actions that can be taken by governments to facilitate investment of institutional investors in low-carbon infrastructure, including low-carbon energy investments (OECD 2015a):²⁹⁸

- Clarify the risk profile of low-carbon energy investments. Strengthening requirements for institutional investors to provide information on these investments, following internationally agreed definitions, would enhance monitoring and understanding of these investments;

- Create risk-mitigation financing tools. Facilitating the development and application of risk-mitigation financing tools could result in more appropriate allocation of risks and their associated returns. They

²⁹⁸ The recommendations proposed in the OECD (2015a) are based on Annual Survey of Large Pension Funds and Public Pension Reserve Funds (OECD 2014b) and Mapping Channels to Mobilise Institutional Investment in Sustainable Energy (OECD 2015b).
could include credit enhancements and revenue guarantees, first-loss provisions, cornerstone stakes, and tools targeting challenges at all stages of the project life cycle;

- Promote market transparency and standardization. This could include improving data on performance, risks, and costs of low-carbon energy investments across available channels;

- Reduce transaction costs. The costs associated with managing low-carbon energy infrastructure investment could be eased by supporting efforts to standardize contracts and project evaluation structures, and by creating aggregation and “warehousing” facilities;

- Develop liquid markets for low-carbon energy infrastructure financing instruments. These could be for debt in the form of green bonds, and for equity in the form of listed “yield co”-type funds. They could be tailored to investor risk profiles across the project life cycle and developed in cooperation with investors;

- Build confidence. Developing a national infrastructure strategy, including a road map and project pipeline, would make investors feel more confident in the governments’ commitment to low-carbon energy infrastructure.

**BOX 10.6. A Low-Carbon Development Facility to Achieve a Specific Abatement Target**

The principle of the proposed Low-Carbon Development Facility (LCDF) is to leverage limited public resources to channel large amounts of cheap financing from the global financial market toward low-carbon development projects.

At a global scale, the LCDF would provide a large amount of low-cost financing (for instance, $100 billion per year at LIBOR+10) for scaling up avoidance of emissions in non–Annex 1 countries while fueling their development. The avoided emissions could be up to 10 GtCO2e/year in 2030. However, the same concept can also be applied at a national level.

The LCDF would be capitalized by an initial equity. By applying best-practice portfolio risk management tools, the LCDF would then be able to leverage this initial capital by issuing AAA Green Bonds to finance low-carbon development projects in non–Annex 1 countries, usually rated BBB or less. For BBB projects, the financial savings would then amount to around $3/tCO2 or more. As a result, large amounts of emission reductions could be achieved in non–Annex 1 countries at a cost of around $1/tCO2 only or less, without overflowing future carbon markets with cheap offsets that would jeopardize more structural, long-term mitigation efforts.

The LCDF could be consistent with the considerable methodological assets developed under the CDM. That is, projects could use the measuring, reporting, and verification (MRV) methodologies of the CDM to measure the environmental performance of the LCDF.

A model has been developed to simulate the financial and environmental performance of the LCDF concept, allowing for different low-carbon project portfolio profiles to be tested. Using the detailed (3,000+) CDM projects database built by the UNFCCC secretariat, the model provides a tool to build a portfolio of technology- and country-specific projects using a credit-rating matrix of rating agencies. The model allows either the determination of the volume of initial equity needed to achieve a determined abatement target by a specific date in a specific jurisdiction (or group of jurisdictions) or determination of the volume of abatement that can be achieved for a specific initial equity in the same jurisdictions.

Source: de Gouvello, Zelenko, and Ambrosi 2010.

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199 A yield co is a publicly traded company that is formed to own operating assets that produce a predictable cash flow. Separating volatile activities (e.g. R&D, construction) from stable and less-volatile cash flows of operating assets can lower the cost of capital. These companies are commonly used in the energy industry, particularly in renewable energy, to protect investors against regulatory changes.
10.6. A Quick Overview of Policy Packages in the High-Income Countries

As explained above, price signals, although important, are not sufficient to induce investment decisions in low-carbon equipment and infrastructures. There is a need for complementary measures to address other market failures than carbon externalities, such as lack of information, dynamic externalities of learning in low-carbon innovation processes, and incomplete financial markets with respect to risk management associated to low-carbon investments and to the internalization of collective goods related to energy policy objectives (such as reduction of energy dependence, limitation of the exposure to international prices volatility, exhaustion of local resources, dynamic externalities of economic development, and so on).

System transformation requires a proactive role from governments and other agencies to drive non-incremental change with instruments for energy efficiency and technology developments, provision of networks, adjustments to the energy market design, enforcement of rules to govern land-use changes associated to biofuels, and so on. Another justification of specific policies to promote clean-energy technologies is to prevent carbon leakages that can result from asymmetric carbon regulation and pricing between countries, which can alter the competitiveness of industries and hamper countries’ welfare, as shown by Fischer, Greaker, and Rosendahl (2014).

Some of these non-pricing measures are new; a number of them are actually energy policy instruments that need to be adjusted either to correct contradictory messages or to positively orient the energy sector and consuming industries toward a less-carbon-intensive path.

What is eventually required for an efficient and effective shift from a BAU development path to a low-carbon one is a balanced pricing and non-pricing policy package adapted to the specific circumstances and ambition of each country.

Here again, the high-income country experience can be useful to middle and low-income countries willing to achieve voluntary emissions reduction targets efficiently. Table 10.5 presents an overview of the mix of pricing and non-pricing instruments used for implementing these policy packages.

Among key differences, the infrastructures of both developing and emerging countries are still being developed and may still have time to limit the fossil-fuel lock-in from which the OECD countries are suffering. Therefore, there might be an opportunity for a convergence between development and mitigation policies in various sectors.

Below are some lessons that can be drawn from the experiences of high-income countries in designing such policy packages.


In the EU member states, renovation policies were stimulated by the proactive actions of the European Commission, including the Energy Efficiency Directive (2012). This directive required member states to establish a long-term strategy to mobilize investment in the renovation of the national stock of residential and commercial buildings, both public and private, with an obligation of an annual renovation rate of 3 percent of all public buildings owned and occupied by central governments. Moreover, the Renewable Energy Directive

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200 This subsection summarizes findings from BPIE (2013).
(2009/28/EC) introduced measures to increase the share of energy from renewable sources in new and renovated buildings.

The existence of a long-term renovation framework provides the necessary investment predictability for building owners and investors to lead the sustainable building transformation. Member states have been improving the regulatory, administrative, and investment environment, including mandatory renovation requirements at national or local levels, mechanisms that simplify the investment environment, and tailormade economic support measures to overcome the barrier of high up-front capital and owners’ purchasing power.

Grants and direct subsidies are used more than other financial instruments. Fiscal instruments such as VAT rates and tax credits\(^{201}\) are widely used but not to the extent of grants\(^{202}\). The same for “energy performance contracting,” which has been around since the 1980s and which, unlike the previously mentioned schemes, normally relies on private financing. Fiscal instruments are followed by preferential loans and now by innovative financing measures through the help of external funding.

In Germany, financial measures and mechanisms to support building retrofit have been adopted. This includes the successful “KfW Energy-efficient Refurbishment Program,” with the KfW public banks. It finances corresponding measures, both at low interest rates and in the long term. The support can take the form of either a low-interest loan or a nonrepayable grant. The level of support is dependent on the chosen refurbishment standard. For instance, a “KfW efficient building 55”\(^{203}\) receives a soft loan plus a high subsidy of 12.5 percent.

In the UK, an important financial support program is the “Green Deal” program launched in January 2013. This program aims to fund energy-saving upgrades for buildings without any up-front costs. Instead, the costs are added to the energy bills and recouped over time, like a loan over a 25-year period. Unlike many other building improvement initiatives, the “Green Deal” is not dependent on people’s income and the loans are available to everyone.

These experiments show the importance of financing capital-intensive investment through decentralized, private low-carbon investment, together with command-and-control regulations.

10.6.2. Reducing Emissions from Private Transport: Combining Performance Standards and Taxation\(^{204}\)

Performance standards are commonly used for cars and other light-duty vehicles. Currently, 32 high-income countries have imposed performance standards on light-duty vehicles (including Canada, the EU countries, Japan, the Republic of Korea, and the US\(^{205}\)) following by Brazil, China, India, and Mexico, with five studying performance standards for heavy-duty vehicles. Fiscal incentives are also successfully used to improve the fuel performance of cars, such as fee-bate programs in European countries or scrappage schemes for old cars. The advantage of a fee-bate measure is that it could be self-financed, the revenue from taxing low-performing cars serves to pay the subsidy to high-performing cars.

\(^{201}\) For instance, sales tax incentives to promote market penetration, or tax rebates given in recognition of energy saving investments.

\(^{202}\) Among which there are possible grants from the energy suppliers submitted to an obligation of energy-efficiency certificates by advising and investing among their customers. This is convenient in the thermal renovation of housing in countries such as the UK where cavity wall construction allows standardized and cheap interventions in insulation.

\(^{203}\) That is, 55 percent of the comparable new building.

\(^{204}\) For the automotive sector, the IEA had calculated in 2008 that to meet the 450 parts per million (ppm) scenario, it is appropriate to limit the average emissions of new cars sold in Europe to 80g CO\(_2\)/km by 2020 and about 60g CO\(_2\)/km by 2025 (2008, World Energy Outlook).

\(^{205}\) In the US, the CAFE standards are imposed on car manufacturers. They are defined as the average fuel economy to be achieved by a given fleet of vehicles in a given model year, expressed in miles per US gallon (mpg), of a manufacturer’s fleet of current model year passenger cars or light trucks produced for sale in the US.
Performance standards can constitute a low-cost instrument if car manufacturers are given enough time to adapt their vehicles when announcing new performance regulations. In the US, the EPA estimates the social benefits of the Corporate Average Fuel Economy (CAFE) standard to range from $78 billion to $1.2 trillion ($2010) depending on the value considered for the social cost of carbon (EPA/Department of Transportation, 2012).

10.6.3. Long-Term Risk-Sharing Arrangements for Scaling Up Low-Carbon Generation in the Power Sector

As seen earlier in this volume and stressed by the OECD (2015), in highly liberalized power systems, a market’s design may limit its ability to guide future low-carbon investments, even when a carbon-pricing mechanism has been established. This is for three main reasons, which eventually translate into high risks for such investments: (i) the alignment of the price of the hourly electricity market with the variable cost of the marginal plant; (ii) the carbon price’s lack of stability; and (iii) the capital intensiveness of low-carbon technologies with high up-front costs per kW and long construction times.

Regulators who observed that the risks allocation was not optimal agreed that new market arrangements should be designed to guarantee the recovery of fixed costs. This would de-risk investment and transfer part of the risk to governments and/or consumers. This meant new arrangements that would align revenues on the full cost of the technology instead of relying on the sum of hourly marginal prices on the wholesale market. This meant a departure from pure market coordination.

These arrangements cover a wide array of solutions, ranging from FiTs, which guarantee revenues for many years to investors, to fixed-price, long-term contracts auctioned by the regulator. Some countries and subnational jurisdictions adopted a RES-E obligation (or a clean-energy obligation) placed on electricity suppliers, which incited them either to build their own RES-E plants or to establish contracts with project developers who would only invest based on long-term, fixed-price contracts. The scaled-up use of the corresponding low-carbon technologies supposed to result from such arrangements requires that the government set an ex ante and ex post quantity control to contain the overall cost of the policy instruments. This can quickly inflate.

The recent British electricity market reform combines (i) the auctioning of long-term contracts for large-sized, low-carbon plants; (ii) FiTs for the small-sized RES-E; (iii) a floor price designed as flexible carbon tax integrated into the emissions trading system (ETS) design, and; (iv) stringent emissions norms for new fossil-fuel plants.

In Germany, the decarbonization transition, which is mainly based on RES-E in the power sector, opted first for long-term FiTs, now replaced by contractual feed-in-premiums allocated via auctions to mid- and large-sized plants. This is in alignment with the recommendations of the European Commission in the matter of state aids (European Commission 2014).

While departing from pure market coordination, these arrangements present two advantages. First, they de-risk investments in RES-E, nuclear, and CCS equipment of different sizes, making them bankable. Second, they significantly lower capital costs, eventually enabling investment decisions.

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206 For light-, medium- and heavy-duty vehicles directly targeting CO₂ emissions at the projected net present value of mitigation benefits over the next 40 years from three vehicle standards.

207 The reference social cost of carbon will depend on the discount rate used e.g. 5 percent, 3 percent, 2.5 percent.

208 This subsection builds mainly on OECD (2015: chapter 7) and Finon (2013: 1–16).

209 See Chapter 3, section 4, for further details.

210 RES-E, a commonly used acronym, stands for Renewable Energy Sources for Electricity.
In the US, before 2014, the main instruments used to be (i) a tax credit per kWh produced from wind power and nuclear, and (ii) per kW for PV; and (iii) an obligation of a minimum share of renewables imposed on suppliers. The recent US EPA’s Clean Energy Plan adopted in 2014 to control the power sector’s CO2 emissions is now based on an obligation to limit total emissions below an absolute cap defined separately for each state: this cap should decrease progressively to 70 percent of the 2005 emissions by 2030. Each state is free to choose among different instruments: a clean-energy obligation (a generalized RPS), a baseline and credit mechanism at the plant level (standard and tradable performances certificates), or a cap-and-trade system.

These three examples, while all focused on new capacity to be installed, still demonstrate the variety of policy packages adopted in high-income countries. Interestingly, results have been positive in all these countries, as shown in Table 10.5. It is important to note that cost-containment measures have been introduced by lowering the support awarded to the different eligible technologies, imposing specific quotas to limit annual development, or controlling the capacity volumes to which long-term contracts were awarded via auctions.

**TABLE 10.5. Scaling Up RES-E in Selected Developed and Emerging Economies (RES Power Capacity in gigawatts [GW] w/o Hydro)**

<table>
<thead>
<tr>
<th>Instruments</th>
<th>US</th>
<th>EU</th>
<th>Japan</th>
<th>China</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruments</td>
<td>Tax credit per megawatt hour and RPS (obligation)</td>
<td>FiTs</td>
<td>FiTs</td>
<td>FiTs</td>
<td></td>
</tr>
<tr>
<td>Auctioned contracts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green certificates obligation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity in 2004</td>
<td>22 GW</td>
<td>50 GW</td>
<td>10 GW</td>
<td>5 GW</td>
<td>4 GW</td>
</tr>
<tr>
<td>Capacity in 2013–14</td>
<td>67 GW wind power + PV</td>
<td>120 GW wind power + PV</td>
<td>21.5 GW wind power + PV</td>
<td>138 GW wind power + PV</td>
<td>25 GW wind power + PV</td>
</tr>
<tr>
<td>12.5 GW biomass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objectives 2020–30</td>
<td>152 GW (2030)</td>
<td>230 GW</td>
<td>165 GW</td>
<td>500 GW (high scenario)</td>
<td>160 GW (2022)</td>
</tr>
</tbody>
</table>

Note: FiTs = feed-in-tariffs; GW = gigawatts; PV = photovoltaic; RES = renewable energy source; RPS = renewables portfolio standard.

Eventually, most high-income countries have designed complex policy packages that try to balance a series of pricing and non-pricing instruments. An indicative range of the complementary instruments used in high-income countries is provided in Table 10.6. These packages increasingly merge the energy and mitigation objectives, as illustrated by the case of Sweden (presented in Box 10.7).
In addition to participating in the EU-ETS, Sweden has progressively introduced a carbon tax. In 2015, this tax reached the high level of €123/tCO2 for services and households, and €40/tCO2 for industries not covered by the EU-ETS. The climate-energy tax levels on fossil fuels are significantly higher in Sweden than in other countries, especially for non-vehicle fossil fuels.

A series of complementary programs have been implemented over the years. These programs, as identified by IEA evaluation reports (2004; 2008; 2013), are:

- A direct grant program to municipalities and businesses to adopt non-fossil fuels in district heating boilers and cogeneration, with the Climate Investment Program (KLIMP);
- A policy of promoting district heating (DH), particularly for office buildings. DH now covers 80 percent of the tertiary sector’s space-heating needs. The combined share of biofuels, wood pellets, and waste now amounts to 68 percent of the DH energy consumption;
- Thermal performance standards and a financing program to support thermal renovation of buildings;
- Performance standards for vehicles combined with a vehicle taxation based on emission rates;
- Support for the improvement of biofuels and wood production;
- A full tax exemption on biofuels;
- A green certificate obligation mechanism imposed on power suppliers to support the development of electricity production from renewables.

As a result, Sweden was able to contain the growth of its national emissions whilst growing the economy. Between 1990 and 2013, their GDP increased by 61 percent, while emissions increased by only 23 percent.

### TABLE 10.6. Indicative Range of Complementary Instruments Used in Climate Policy Packages in High-Income Countries

<table>
<thead>
<tr>
<th>Instruments</th>
<th>Energy</th>
<th>Industry</th>
<th>Building and Appliances</th>
<th>Transportation and Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial instruments (beyond carbon pricing)</td>
<td>Subsidies to district heating (district heating/combined heat and power) and biomass use; RES-E production or investment subsidies (FiTs, financing); tradable white and green certificates</td>
<td>Tax relief on energy-efficiency measures</td>
<td>Direct subsidies for thermal renovation</td>
<td>Direct subsidies for clean cars</td>
</tr>
<tr>
<td>Financial regulation</td>
<td>Policies to remove financial barriers, soft loans and risk-sharing arrangements (credit-enhancement mechanisms, and so on)</td>
<td>Policies to remove financial barriers, soft loans and risk-sharing arrangements</td>
<td>Soft loans and grants</td>
<td>Policies to remove financial barriers, soft loans and risk-sharing arrangements</td>
</tr>
<tr>
<td>Technology development support</td>
<td>Obligations on suppliers to provide green/clean electricity</td>
<td>Requirements for operation licensing</td>
<td>Obligation of thermal renovation on public buildings</td>
<td>Biofuel blends mandate</td>
</tr>
</tbody>
</table>

Source: Authors’ compilation.

Note: CAFE = corporate average fuel economy; CHP = combined heat and power; DH = district heating; ETS = emissions trading system; FiTs = feed-in-tariffs; OECD = Organisation for Economic Co-operation and Development; RD&D = research, development, and demonstration; RES-E = renewable energy sources for electricity.

### 10.7. Designing Pricing and Non-Pricing Policy Packages for Faster, Cleaner Development

Designing an appropriate policy package that combines pricing and non-pricing instruments can help reconcile carbon and development policies and speed development. Figure 26 illustrates that opting for a low-carbon development path can be a way to pursue a win-win strategy. Under a BAU scenario, infrastructure projects, particularly conventional energy projects, are facing a series of restrictions that reflect the imperfect business environment in developing countries, limit infrastructure investments, and eventually hinder economic growth (moving from A to B).

It is important to overcome the market failures and barriers that prevent the implementation of low-carbon energy projects, some of which, such as attracting financing, also apply to conventional fossil-fuel-based alternatives.
Addressing the constraints detailed here, with a special focus on low-carbon infrastructure investment, can give the former a comparative advantage over the latter and eventually enable an economy to grow faster (from A to C) while simultaneously avoiding GHG emissions. This is especially true if needed investments benefit from additional carbon revenues and/or a share of concessional funding from international sources. The different non-pricing instruments discussed in this chapter are summarized in Box 10.8.

**FIGURE 26. Progressing Faster on a Cleaner Development Path**


Note: BAU = business as usual; CO2 = carbon dioxide; GDP = gross domestic product.
BOX 10.8 Chapter 10 Summary

- Non-pricing measures are required to overcome market failures, particularly non-adoption barriers which prevent the scaling-up of low-carbon options and facilitate fossil fuel-based technology lock-in; in the absence of market solutions, this requires proactive government policy in implementing non-pricing instruments.

- Adoption barriers include regulatory and logistic gaps that prevent low-carbon options to access consumers’ markets; lack of access to information, skills and local R&D to enable an efficient and sustainable use of clean technology; lack of access to financing for capital intensive low-carbon investments; principal agent problem leading to the misallocation of costs and benefits.

- Non-pricing instruments include: the use of shadow carbon pricing in government planning and investment decisions; targeted skills and training programs as well as information dissemination and R&D programs; command and control regulations and technology standards to help phase-out inefficient and emissions-intensive technologies.

- Scaling-up low-carbon investment will require attracting a share of the large capital markets and thus up-grade them to asset class; a series of measures and instruments needs to be implemented to de-risk projects, including: enhancements and revenue guarantees, first-loss provisions, cornerstone stakes and tools targeting challenges at all stages of the project life cycle; standardize contracts and project evaluation structures to reduce transaction costs; develop liquid markets for low-carbon energy infrastructure financing instruments like green bonds and listed “yield co”-type funds.

- Pricing and non-pricing instruments can be combined to create effective policy packages. Numerous high-income countries, including Sweden, have crafted such packages.

- Overall an appropriate policy package can lead not just to cleaner development, but quicker development.
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Conclusion and Practical Steps Forward

The integration of climate and energy policies requires the involvement and cooperation of a wide range of stakeholders, including climate and energy practitioners, as well as the application of knowledge and experience specific to each of the markets. The climate community rightly emphasizes the importance of decarbonization of the energy sector in developing countries, principally in middle-income ones, and the role that carbon pricing can play in this effort. That said, carbon pricing should not be seen a silver bullet applied to a blank slate, so guidance from the energy community is needed to ensure that potentially negative interactions are curtailed and synergies are maximized when carbon pricing is added to an existing energy policy landscape.

In this regard, the following five steps could help facilitate the interaction of carbon pricing and energy policies and ensure effective implementation:

1. **Build Country-specific Mapping of Policy Objectives and Instruments.** Knowledge and careful consideration of the specific sector policies, government objectives and national (economic and social) circumstances are prerequisites for designing an appropriate policy package – particularly one that reconciles potential pressure points between energy policies and carbon pricing. As such, a thorough and comprehensive mapping of all sectoral objectives, and the policies and instruments used to achieve these objectives, is needed. For instance, mapping of energy market instruments requires a deep understanding of technicalities that involve several agents acting under a set of detailed rules and operational processes in effect in each energy sub-market (i.e. power, gas, liquid and solid fuels). The typologies of countries, policy objectives, energy markets structures and instruments proposed in this report are aimed at facilitating such country-specific mapping.

2. **Analyze Interactions Between Carbon Pricing and Energy Policy Instruments.** Based on the review of existing policy and instruments, the next step consists of mapping the interactions between those related to (i) energy and (ii) carbon, using the lessons learnt from the international experience. This interplay can lead to both synergies and conflicts. The outcome of these interactions depends largely on the national circumstances – in particular how these are translated into the national energy policy objectives. The generic inventory of possible interactions presented in this report, combined with the typologies mentioned above, can guide practitioners in identifying potential conflicts.

3. **Design Reconciliation Options, and Develop Comprehensive, Integrated Policy Packages.** Once tensions and inconsistencies are identified, reconciliation options can be creatively envisioned. The report details the lessons and limitations of the experience of high-income countries in adjusting carbon-pricing instruments and existing energy policy instruments to mitigate conflicts, or designing creatively integrated carbon- and energy-pricing instruments to maximize synergies.

As the influence of pricing instruments in shifting investment and behaviors towards low-carbon alternatives is limited by market imperfections, comprehensive policy packages combining pricing and non-pricing instruments should be developed. The latter include shadow carbon pricing in government planning and investment decisions; targeted skills and training, information dissemination and R&D programs; command-and-control regulations and technology standards; and financial instruments to de-risk low-carbon investments and attract capital markets.

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212 These five steps are not necessarily strictly sequential. For instance, the development of tools mentioned in step 4 can be initiated early, although the use of them is aimed at assessing the packages developed in step 3.
4. **Build Tools to Assess Policy Packages and Instrument Design.** The analysis of reconciliation options and policy packages requires an understanding of their impacts and trade-offs. This can be achieved by using modeling tools that help outline the potential impact of different policy interventions,\(^{213}\) including both bottom-up and top-down economic modeling exercises. Modeling would need to be undertaken at and between multiple levels, including economy-wide, electricity markets, and specific sector-focused models. Top-down models, such as computable general equilibrium models, provide a view of macroeconomic feedbacks, while bottom-up models are more appropriate for examining specific interactions and mechanisms.

Such an approach can be replicated beyond the energy policies to other sectors, such as agriculture, transport and industry.\(^{214}\) Designing an appropriate policy package that integrates carbon and other sectors' pricing and non-pricing instruments can generate double dividends: it can provide a win–win solution for addressing both development and climate-related challenges, while still offering an opportunity to deliver the infrastructure and capital needed for a rapid transition to low carbon development.

Not all quantitative or qualitative impacts can be dealt with in economic models; those that cannot include, among others, administrative feasibility and institutional capacities, and extra transaction costs (infrastructure, operating costs, and human resources) to enable public agencies to implement the regulatory measures foreshadowed in the policy packages. The modeling approach should therefore be completed by a broader qualitative assessment of non-quantitative impacts, i.e. regulatory and institutional changes needed.\(^{215}\)

Both approaches combined can provide a more complete picture of policy interactions and the potential impact of reconciliation options\(^{216}\). This can, in turn, help policymakers estimate the impact of both existing policies and reconciliation measures, as well as broader policy packages.

5. **Political Dialogue to Ensure Buy-in and Help Facilitate Implementation.** Adoption and implementation of various instruments requires political dialogue that helps build an understanding of how proposed approaches tie in with national policies and development objectives. Developing reconciliation options builds on such political considerations and is largely a product of technical dialogue among practitioners. These critical issues, including the impact of carbon pricing on competitiveness and trade in exposed energy-intensive industries, the removal or reduction of fossil-fuel consumption subsidies, and the reform of fossil-fuel production subsidies, are presented in a separate Annex. There are examples from existing initiatives of effective stakeholder consultation and use of guidelines for political dialogue.

Table 11.1 summarizes these steps and points to specific chapters of the core report for further insight and guidance:

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\(^{213}\) This could be based on using existing modeling approaches such as World Bank ‘Checklist for Developing Post 2020 Mitigation Pathways’ (https://openknowledge.worldbank.org/bitstream/handle/10986/21877/EPEP_eBook.pdf), and calibrating them to national circumstances.

\(^{214}\) Brazil is implementing such a multi-sectoral approach with the support of the PMR, covering the following sectors: power, gas and liquid fuels, agriculture, planted forests and seven industries (aluminum, steel and pig iron, cement, lime, glass, paper and celluloses, and chemicals).

\(^{215}\) For instance, performing a Regulatory Impact Assessment (RIA). For more details and guidance on RIA see: http://www.oecd.org/gov/regulatory-policy/ria.htm

\(^{216}\) This combined approach is being tested in Brazil with the support of the Partnership for Market Readiness.
### TABLE 11.1. Five-Step Roadmap for Reconciling Climate and Energy Policies

<table>
<thead>
<tr>
<th>Step Forward</th>
<th>Explanation</th>
<th>For Further Information Refer To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country Specific</td>
<td>Careful consideration of national circumstances is needed for the successful reconciliation of climate and energy policies. In turn, this requires mapping of sectoral objectives, policies and instruments. The typologies of countries, instruments, objectives and energy market structures provided in this report can help to facilitate such mapping.</td>
<td>Country typology (Preamble). Energy objectives and instruments (Chapters 1 and 2). Climate policy objectives and instruments (Chapter 3). Energy market structure (Chapters 2 and 7).</td>
</tr>
<tr>
<td>Mapping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analyze Interactions</td>
<td>Mapping and understanding the interactions of climate and energy policies, including synergies and conflicts, is critical. The interaction will inherently depend on national circumstances. The generic inventory of possible interactions presented in this report, combined with the typologies mentioned above can guide practitioners in identifying potential conflicts.</td>
<td>Energy and carbon policy interactions (Chapter 3).</td>
</tr>
<tr>
<td>Design Policies</td>
<td>After synergies and trade-offs are understood, reconciliation options can be crafted. This report provides several potential instrument and policy packages for reconciling climate and energy policies. Some are based off the empirical experience of OECD countries, while others are more novel.</td>
<td>Revenue recycling (Chapter 5). Measures to address competitiveness (Chapter 6). An adjustable carbon energy tax (Chapter 8). Separation or integration of certificates (Chapter 9). Shadow carbon pricing (Chapter 10). Command and control regulations (Chapter 10). Financial instruments for incentivizing low-carbon investments (Chapter 10).</td>
</tr>
<tr>
<td>Assess Policies</td>
<td>Instruments and policy packages to reconcile climate and energy policies need to be scrutinized. These could either be newly built or expand of existing approaches (see the further information column). This would require both top-down (computer-generated equilibrium models) as well as bottom-up quantitative modelling. This should be complemented by a Regulatory Impact Assessment (RIA).</td>
<td>Existing modelling approaches such as the “Checklist for Developing Post 2020 Mitigation Pathways” (World Bank 2017) could be used.</td>
</tr>
<tr>
<td>Political Dialogue</td>
<td>Implementation the reconciliatory policies presented in this report will require political dialogue and buy-in. This is particularly true of ‘critical issues’ such as EII competitiveness and fossil fuel consumption and production subsidy reform. The ‘further information’ column provides a number of illuminating cases of effective political and technical deliberation.</td>
<td>The FASTER Principles (OECD &amp; World Bank Group 2015). High-Level Commission on Carbon Prices (Stiglitz &amp; Stern 2017).</td>
</tr>
</tbody>
</table>

Source: Authors’ compilation.

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# Annex 1

Carbon Dioxide Emissions Coefficients by Fuel

## TABLE A.1. Carbon Dioxide Emissions Coefficients by Fuel

<table>
<thead>
<tr>
<th>Fuels</th>
<th>Kilograms CO2 per Million Btu</th>
</tr>
</thead>
<tbody>
<tr>
<td>For homes and businesses</td>
<td></td>
</tr>
<tr>
<td>Propane</td>
<td>63.07</td>
</tr>
<tr>
<td>Butane</td>
<td>64.95</td>
</tr>
<tr>
<td>Butane/propane mix</td>
<td>64.01</td>
</tr>
<tr>
<td>Heating and diesel fuel (distillate)</td>
<td>73.16</td>
</tr>
<tr>
<td>Kerosene</td>
<td>72.3</td>
</tr>
<tr>
<td>Coal (all types)</td>
<td>95.35</td>
</tr>
<tr>
<td>Natural gas</td>
<td>53.07</td>
</tr>
<tr>
<td>Gasoline</td>
<td>71.3</td>
</tr>
<tr>
<td>Residual heating fuel (businesses only)</td>
<td>78.79</td>
</tr>
<tr>
<td>Other transportation fuels</td>
<td></td>
</tr>
<tr>
<td>Jet fuel</td>
<td>70.9</td>
</tr>
<tr>
<td>Aviation gas</td>
<td>69.2</td>
</tr>
<tr>
<td>Industrial fuels and others not listed above</td>
<td></td>
</tr>
<tr>
<td>Flared natural gas</td>
<td>54.7</td>
</tr>
<tr>
<td>Petroleum coke</td>
<td>102.1</td>
</tr>
<tr>
<td>Other petroleum and miscellaneous</td>
<td>72.62</td>
</tr>
<tr>
<td>Coal by type</td>
<td></td>
</tr>
<tr>
<td>Anthracite</td>
<td>103.7</td>
</tr>
<tr>
<td>Bituminous</td>
<td>93.3</td>
</tr>
<tr>
<td>Subbituminous</td>
<td>97.2</td>
</tr>
<tr>
<td>Lignite</td>
<td>97.7</td>
</tr>
<tr>
<td>Coke</td>
<td>114.12</td>
</tr>
<tr>
<td>Other fuels</td>
<td></td>
</tr>
<tr>
<td>Geothermal (average all generation)</td>
<td>7.71</td>
</tr>
<tr>
<td>Municipal solid waste</td>
<td>41.69</td>
</tr>
<tr>
<td>Tire-derived fuel</td>
<td>85.97</td>
</tr>
<tr>
<td>Waste oil</td>
<td>95.25</td>
</tr>
</tbody>
</table>

Note: Coefficients may vary slightly with method of estimation and across time. Btu = British thermal units; CO2 = carbon dioxide.

Source: US Energy Information Administration (EIA 2016) estimates.
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