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Thailand: Clean Energy for Green Low-Carbon Growth

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for Green Low-Carbon Growth

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Foreword

The concept of green growth recognizes that environmental protection can be a driver for economic development rather than an economic burden. Economic growth can be sustained without compromising the environment and natural resources.

Given Thailand's remarkable growth and rapid urbanization, the green growth model represents a fantastic opportunity for Thailand to redefine its long-term growth strategy and make tremendous gains on several fronts; increasing energy efficiency and decreasing its energy dependence and imports and pre-empting the costs of future expensive retrofitting. Many countries around the world, particularly in Asia, have already introduced significant measures to achieve green growth as part of their strategies in the global competition for economic progress. Similarly, in an effort to get onto a sustainable development path, Thailand's National Economic and Social Development Board's 11th Five-Year Plan (2011–2015) has put green growth and low-carbon society as one of the central themes.

Drawing on international experience in green growth, this report presents effective policy instruments for transforming urban areas into green livable low-carbon cities. The report also proposes policy options, financing mechanisms, and institutional frameworks to help the Thai government achieve its energy efficiency and renewable energy targets.

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Abbreviations

ADEME	French Environment and Energy Management Agency
AE	alternative energy
AMI	advanced metering infrastructure
BMA	Bangkok Metropolitan Administration
BMCL	Bangkok Metro Company Limited
BMR	Bangkok Metropolitan Region
BMTA	Bangkok Mass Transit Authority
BTS	Bangkok Transit System
CHEEF	China Energy Efficiency Financing Project
CHUEE	China Utility-Based Energy Efficiency Program
CICC	Inter-secretarial Commission on Climate Change, Mexico
CMLT	Commission for the Management of Land Traffic
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
DEDE	Department of Alternative Energy Development and Efficiency
DLT	Department of Land Transport
DOE	Department of Energy, United States
DPT	Department of Public Works and Town and Country Planning
DSM	demand-side management
EE	energy efficiency
EEDP	Energy Efficiency Development Plan
EEPS	energy efficiency portfolio standard
EEU	Energy Efficiency Utility
EGAT	Electricity Generating Authority of Thailand
EMS	energy management system
NSCCM	National Strategy on Climate Change Management
ENCON Act	Energy Conservation and Promotion Act
ENCON Fund	Energy Conservation Promotion Fund
EPA	Environmental Protection Agency, United States
EPPO	Energy Policy and Planning Office
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
ESCO	energy service company
FACTS	Flexible Alternating Current Transmission Systems
GDP	gross domestic product
GEF	Global Environment Facility
GGS	Green Growth Strategy

Abbreviations

GHG	greenhouse gas
GJ	gigajoule
GWh	Gigawatt Hour
HEPS	High Energy Performance Standards
IBRD	International Bank for Reconstruction and Development
IFC	International Finance Corporation
IMCSD	Inter-Ministerial Committee on Sustainable Development, Singapore
kgoe	kilogram of oil equivalent
km	kilometer
km^2	square kilometers
ktoe	thousand ton of oil equivalent
kW	kilowatt
kWh	kilowatt-hour
L	liter
LAOs	Local Administrative Organizations
LEED	Leadership in Energy and Environmental Design
LRT	light rapid transit
m^3	cubic meters
M&V	measurment and verification
MEA	Metropolitan Electricity Authority
MEPS	Mandatory Energy Performance Standards
MJ	megajoules
MJ/m^2	megajoules per square meter
MLPD	million liters per day
MNRE	Ministry of Natural Resources and Environment
MOEN	Ministry of Energy
MOF	Ministry of Finance
MOT	Ministry of Transport
MOU	memorandum of understanding
MRT	mass rapid transit
MW	megawatt
NDRC	National Development and Reform Commission, China
NEPC	National Energy Policy Council
NESDB	National Economic and Social Development Board
NESDP	National Economic and Social Development Plan
NMT	nonmotorized transport
NO_X	nitrogen oxide

Abbreviations

NSI	National Strategy Institute, Republic of Korea
OECD	Organisation for Economic Co-operation and Development
ONEP	Office of Natural Resources and Environmental Policy
OPM	Office of the Prime Minister
OTP	Office of Transport and Traffic Policy and Planning
PEA	Provincial Electricity Authority
PECC	Special Program on Climate Change, Mexico
PCGG	Presidential Committee on Green Growth, Republic of Korea
$PM_{2.5}$	particulate matter less than 2.5 micros in size
PPP	Polluter Pays Principle
PPP	purchasing power parity
PV	photovoltaic
R&D	research and development
RE	renewable energy
REDP	Renewable Energy Development Plan
RMB	Renminbi (China's currency)
SEMARNAT	Climate Change office, Mexico
SMEs	small and medium enterprises
SO_2	sulfur dioxide
SO_X	sulfur oxide
SPP	small power producer
TA	technical assistance
tce	tons of coal equivalent
tCO_2	tons of carbon dioxide
tCO_2e	total carbon dioxide equivalent
TGO	Thailand Greenhouse Gas Management Organization
THB	Thai Baht
THB/L	Thai Baht per liter
toe	ton of oil equivalent
TOKYO-ETS	Tokyo Emissions Trading System
ug/m^3	micrograms per cubic meter
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UN-HABITAT	United Nations Human Settlements Programme
URMAP	Urban Rail Transportation Master Plan
VSPP	very small power producer

Executive Summary

Key messages:

- **Thailand needs to avoid the high-carbon growth path of many developed countries and, instead, take a low-carbon growth path.** A green low-carbon growth path is in Thailand's own interest as it can simultaneously tackle local environmental degradation, global climate change, and energy security challenges. It can also position Thailand as a regional leader in green, sustainable growth.

- **Green low-carbon growth in Thailand could focus on the following four pillars:**
  1. Maintaining rapid economic growth while adjusting the country's economic structure toward a less energy- and carbon-intensive economy
  2. Achieving greater urbanization while shifting toward green livable low-carbon cities
  3. Meeting the huge thirst for energy while transforming the energy sector toward one of high energy efficiency and widespread diffusion of low-carbon technologies
  4. Improving quality of life while shifting toward a resource-efficient and sustainable lifestyle.

- **Changes in the economic structure toward an innovation-driven, high-tech, and service-sector-based economy is a key driver to reduce energy and carbon intensity in Thailand.** Despite the government's efforts, Thailand's economic structure has shifted over the last decade toward dominance of the energy-intensive industrial sectors-a main reason for the rising energy intensity.

- **Building green livable low-carbon cities requires a holistic multisector approach to integrate compact urban form, green buildings and renewable energy supply, sustainable transport, and efficient water and waste management.** Bangkok's carbon dioxide emissions per capita are already high compared to the leading developed cities. Higher density and more mixed-use urban design can substantially reduce energy demand and emissions. Urban public transport is the key to improving green mobility. Green buildings require strengthening enforcement of building codes.

- **To greatly improve energy efficiency and achieve the goals of the Energy Efficiency Development Plan (EEDP), Thailand needs to increase the use of pricing and fiscal measures and performance-based energy-saving targets.** The government has actively adopted policies and financing mechanisms to promote energy efficiency, but energy intensity has not changed much over the last decade. The government is committed to reducing energy intensity by 25 percent from 2005 to 2030, among which the transport and industrial sectors offer the largest energy savings. Containing energy growth in the transport sector requires mandatory fuel economy standards, fuel taxes and road pricing, and public transport infrastructure. Industrial-performance-based energy-saving targets can be more effective than the current input-based energy managers program. Finally, the Standard Offer approach can be an innovative and cost-effective way to scale-up the Energy Conservation Promotion Fund.

- **To scale-up renewable energy and achieve the goals of the Renewable Energy Development Plan (REDP), balancing food and energy security is the key.** Currently, renewable energy (RE) for power and heating is largely on track to meet the REDP target, thanks to the RE adder scheme. But providing technical assistance and increasing access to financing for small power producers are important to make the proposed investments a reality. The alternative fuels for transport are lagging behind the RE target. Biofuel targets may need to be reduced to minimize the impacts on food security. Biofuel policies should proceed with caution and be part of a portfolio of policy measures to reduce oil consumption in the transport sector. In the medium term, future scale-up of RE would need to focus on cost reduction and grid integration.

- **A national champion and effective institutional coordination are key to successful implementation of green growth and energy conservation.** Green low-carbon growth and energy conservation require concerted efforts and effective coordination of multiple ministries and agencies at the national, sectoral, and local levels. A national champion with clear mandates, high-level authorities, and adequate resources should lead the multisector efforts, with clear roles and responsibilities across the key sectors and between the central and local governments.

Thailand is at a crossroad on its development path. Its key challenge is to avoid embarking on the high-carbon growth path followed by some developed countries, and instead take a low-carbon growth path. In an effort to turn the climate change crisis into an opportunity, one of the central themes of the 11th Five-Year Plan (2011–2015) prepared by Thailand's National Economic and Social Development Board (NESDB) is fostering a low-carbon society and green growth. To that end, green low-carbon growth has been adopted as a means to protect natural resources, mitigate environmental damage, and create new green jobs.

The overall objective of green growth is to sustain economic growth without compromising the environment and natural resources. The concept of "green growth" changes a development model treating environmental protection as an economic burden into a model that recognizes environmental protection as a driver for global and national economic development.

The window of opportunity is closing fast, and urgent action is required to transform the country toward a green low-carbon growth path. The scientific evidence about climate change and its negative impacts on growth in most countries is now largely accepted. The long lives of energy capital stocks (for example, power plants, buildings, roads) mean that investments over the next decade will largely determine emissions through 2050. Delaying action would lock the country into a high-carbon infrastructure and would require more costly retrofitting and premature scrapping of existing capital stocks in the future. However, such lock-in effects also offer an opportunity to build efficient low-carbon technologies into new infrastructure.

The remarkable growth and rapid urbanization have led to twin energy challenges in Thailand-environmental sustainability and energy security. Greenhouse gas emissions in Thailand rank 20th in the world and 5th in East Asia. The carbon and energy intensity of Thailand is several times higher than in leading developed countries, although its emissions per capita and historical emissions are still low compared to industrialized countries. Thailand's energy mix is dominated by fossil fuels. In addition, Thailand is already a net energy importing country and is expected to import 60 to 70 percent of its energy needs by 2030 under a "business as usual" scenario. Therefore, it will face growing energy security concerns.

A green low-carbon growth path is in Thailand's own interest as it can simultaneously tackle local environmental degradation, global climate change, and energy security challenges. Thailand's strong linkages with neighboring Southeast Asian countries in areas of trade, energy, transport and logistics present Thailand with an ample opportunity to position itself as a regional leader who can influence other countries to grow in a responsible and sustainable way.

Four Pillars for Green Low-Carbon Growth in Thailand: Achieving the 11th National Economic and Social Development Plan (NESDP)

Green low-carbon growth in Thailand could focus on the following four pillars:

1. Maintaining rapid economic growth while adjusting the country's economic structure toward a less energy- and carbon-intensive economy
2. Achieving greater urbanization while shifting toward green livable low-carbon cities
3. Meeting the huge thirst for energy while transforming the energy sector toward one of high energy efficiency and widespread diffusion of low-carbon technologies
4. Improving quality of life while shifting toward a resource-efficient and sustainable lifestyle.

Adjusting Economic Structure Toward a Less Energy- and Carbon-Intensive Economy

Changes in the economic structure toward an innovation-driven, high-tech, and service-sector-based economy are a key driver to reduce energy and carbon intensity in Thailand. These changes also help prepare to transform Thailand into a high-income country. However, despite the government's efforts, Thailand's economic structure over the last decade has shifted further toward dominance of the energy-intensive industrial sectors—a main reason for the rising energy intensity in Thailand. Japan and the Republic of Korea have demonstrated that shifting their economic structure from energy-intensive industries to high-tech and innovative industries was a key factor in increasing their gross domestic product (GDP) from US$3,000 per capita (middle-income) to US$11,000 per capita (high-income) in only a decade. Continued efforts toward rebalancing Thailand's economic structure to less energy-intensive, higher-value-added activities during the 11th NESDP period would be critical to achieving a less energy- and carbon-intensive society.

Transforming Urban Areas into Green Livable Low-Carbon Cities: Multisector Approaches

The speed and scale of urbanization in Thailand presents an unrivaled opportunity to build low-carbon cities today and to attract the best talent and long-term investments needed to create new jobs in the higher-value-added and less-resource-intensive industries. Green livable low-carbon cities can be built based on the following four key principles:

1. **Compact urban form:** Smart planning-that is, higher density, more spatially compact, and more mixed-use urban design that allows growth near city centers and transit corridors to prevent urban sprawl-can substantially reduce energy demand and CO_2 emissions.

2. **Efficient and clean energy:** Cities can drive down carbon emissions by sustaining demand-side energy efficiency measures in buildings, combined with renewable energy distributed generation:

    a. ***Renewable energy distributed generation:*** Increasing the share of renewable energy (RE) in a city requires not only on-site RE generation (such as rooftop photovoltaic (PV) panels, solar water heaters, and geothermal heat pumps), but also the purchase of green electricity to cover the gap, which can also spur large demand for green electricity. Mandatory requirements for the share of RE in cities have proven to be an effective policy instrument, which need to go hand in hand with financial incentives, such as tax credits, subsidies, and shorter permit approval periods. In addition, mandatory off-take of distributed generation and an adequate tariff level for RE generators are essential for self-generators to access the grids.

    b. ***Green buildings:*** Thai cities need to strengthen enforcement of building codes and pilot near-zero-emission buildings that combine energy efficiency (EE) measures with on-site solar and biomass power and heat generation.

3. **Sustainable urban transport:** Reducing energy growth in the urban passenger transport sector is regarded as a high-priority area, but also the most difficult one, because it involves multiple stakeholders. It requires the integration of a three-legged approach: (a) transforming vehicles (through fuel economy standards and the promotion of fuel-efficient vehicles of hybrid, plug-in hybrid, and electric cars); (b) transforming fuels (ethanol, biodiesel, and natural gas); and (c) transforming mobility (urban planning and mass transit). Fiscal policies such as a fuel tax and road pricing are also critical to reducing vehicle-kilometers travelled.

4. **Efficient water and waste management:** Cities can manage water resources efficiently and minimize waste by conserving water use and reducing waste generation on the demand side, and increasing efficient water supply such as wastewater treatment and wastes recycling and disposing on the supply side.

Tapping Energy Efficiency Potential: Achieving an Energy Efficiency Development Plan

In the short term, the first step is to increase energy efficiency, which is the largest and lowest-cost source of emission reductions in Thailand. Despite the policy frameworks and financing mechanisms that the government has put in place to promote EE in Thailand, energy intensity has not changed much over the last decade. This is largely due to the increasing share of energy-intensive industries in the economic structure and little improvement in energy efficiency at the sector level. The transport sector is among one of the most energy intensive, mainly due to the high level of motorization, heavy dependence on road transport, and a lack of fuel economy standards.

The government's Energy Efficiency Development Plan (EEDP) commits to reducing energy intensity by 25 percent from 2005 to 2030. The transport sector offers nearly half of the energy savings, followed by the industry and building sectors.

Effective policy is the key driver to achieve the goals of the EEDP. The government can consider strengthening mandatory regulations and increasing the use of fiscal measures to complement the existing voluntary measures and input-based approaches by:

- ***Improving energy efficiency in the transport sector:*** Implementing strict fuel economy standards will make the biggest difference in improving transport energy efficiency, followed by a fuel tax and road pricing policies (for example, increased vehicle registration fees, congestion charges, and high parking fees), and public transport infrastructure.

- ***Improving energy efficiency in the industrial sector:*** The current input-based mandatory energy managers program should be changed to output-based mandatory industrial energy performance targets. The energy managers program has not achieved its intended results, because the designated factories or buildings do not have mandatory targets on energy savings, and there is no penalty when energy savings are not achieved. Instead, mandatory specific enterprise energy saving or energy performance targets for top energy-intensive enterprises can be more effective to achieve energy savings, particularly when combined with penalties for noncompliance and financial incentives for exceeding the target.

- ***Improving energy efficiency in the building sector:*** Strengthening enforcement of building codes requires a strict compliance enforcement system by accredited third parties with clear rewards and penalties, sufficient resources and capacity building for enforcement, and close coordination among relevant agencies. The government buildings should lead by example with targets for energy savings and emission reductions.

Achieving the goals of the EEDP requires a substantial amount of financing. The Energy Conservation Promotion Fund (ENCON Fund) has made substantial contributions to increasing access to financing for energy efficiency and renewable energy. The report introduced successes and lessons learned from international experience on energy efficiency financing (see details in Annex 4). Learning from international experience, the ENCON Fund can adopt the following recommendations intended to better leverage public funds and achieve higher energy savings:

- ***Adopting a Standard Offer approach that can be managed by a competitively selected performance-based Energy Efficiency Utility:*** The ENCON Fund can provide a Standard Offer of energy-saving subsidies to energy users or ESCOs by "purchasing" energy savings using predetermined and pre-published rates (Thai Baht per kilowatt-hour [THB per kWh]), once they deliver verified energy savings. This approach provides transparency and certainty on subsidies of energy savings to ESCOs, which can help ESCOs generate energy efficiency projects quickly and increase access to commercial financing. To this end, the government can competitively select an Energy Efficiency Utility as the fund manager and sign a time-bound, performance-based contract with them to achieve specified energy savings.

- ***Providing a partial risk guarantee for ESCOs:*** A partial risk guarantee can be effective to enhance credits and mitigate the perceived risks for ESCOs, in order to increase bank confidence.

- ***Continuing Energy Efficiency Revolving Fund:*** The future of the Energy Efficiency Revolving Fund might target ESCOs and building energy efficiency market. It can also serve as a reward, linked with the industrial energy performance targets to reduce energy intensity in the industrial sector.

Successful implementation of these policy measures requires a strong national champion and effective institutional coordination. To achieve the goals of the EEDP, concerted efforts are needed to effectively coordinate multiple ministries and agencies at the national, sectoral, and local levels. A national champion with clear mandates, high-level authorities, and adequate resources should lead the multisector efforts, with clear roles and responsibilities across the key sectors and between the central and local governments. Concrete action plans are also needed to implement the 11th NESDP. The government could consider the following specific recommendations:

- ***Establishing a national institutional champion—two potential models:*** (a) strengthening the role of the Department of Alternative Energy Development and Efficiency (DEDE). DEDE has demonstrated strong leadership in the areas of energy efficiency and renewable energy, and should be given higher-level authority among relevant ministries for developing, coordinating, and overseeing EE policy implementation. Currently, because DEDE is under the Ministry of Energy, it does not have higher authorities to effectively coordinate with other key ministries, such as the Ministries of Industry, Interior, and Transport, to ensure that the EEDP targets will be met; or (b) creating a new dedicated Energy Efficiency Agency. This new agency would be responsible for implementing the EEDP. It requires a level of authority above all the key ministries, adequate resources, the ability to engage multiple stakeholders, independence in decision making, and credible monitoring of results.

- ***Holding regular National Energy Policy Council (NEPC) meetings.*** The NEPC needs to meet on a more regular basis so that the Prime Minister and other Ministers can update information and better coordinate energy efficiency policies.

- ***Setting clear roles and responsibilities at the sector and local levels.*** Since actual energy efficiency measures will be implemented at the sector and local levels, it is recommended that the national target should be disaggregated at both the sector and local level, in consultation with sector and local authorities based on their energy efficiency improvement potential. Subsequently, proper incentives for exceeding the targets and penalties for noncompliance should be implemented.

Scaling Up Renewable Energy: Achieving the Renewable Energy Development Plan

Thailand needs to change the trend from an increased role for coal to an increased role for renewable energy. Thailand's current plan to expand the role of coal in the future will lead to costly environmental degradation and expensive long-term lock-in effects. To get onto a more environmentally sustainable energy path, Thailand needs to ramp up its renewable energy use.

Renewable energy for power and heat are largely on track to meet the Renewable Energy Development Plan (REDP) target, but alternative fuels for transport are lagging. The government's REDP set a target of achieving 20 percent of final energy demand from renewable by 2022. Renewable for heating is on track to meet the target. While renewable for power accounts for less than 2 percent of total power generation, thanks to the attractive tariffs under the RE adder scheme, the total proposed investments under the small power producer (SPP) and very small power producer (VSPP) scheme have already far exceeded the RE target, particularly for solar PV and wind power. Alternative fuels for transport-both biofuel and natural gas vehicles-are the only subsector that lags behind the RE target.

The SPPs and VSPPs need technical assistance and access to financing to make the proposed RE investments a reality. Specifically, the government might consider:

- Applying more stringent due diligence criteria and requiring project readiness before a Power Purchase Agreement is signed

- Setting aside a portion of grant funds to provide technical and financial advisory services and project preparation grants to SPPs and VSPPs

- Providing partial risk guarantees and mezzanine financing from the ENCON Fund to help SPPs and VSPPs increase access to commercial financing.

Biofuel policies need to coordinate energy and transport policies with agriculture, forestry, and land-use policies to manage the competing demands of water and land for food. In Thailand, molasses and cassava are the primary feedstock for ethanol, and palm oil is the primary feedstock for biodiesel. There are a number of risks to food security from expanded biofuel production, such as increases in the prices of tapioca and palm fruits, reduced corn production, decreased cooking oil supply, and potential competition of land for food production by expansion of palm oil plantations. As biofuel production and consumption expand, government subsidies and various financial incentives may not be sustainable. Therefore, it is recommended that:

- Biofuel policies and targets may need to be reduced to minimize the impacts on food security.

- Regulations on land use and food security need to be implemented to ensure that threats to food security are avoided and increased greenhouse gas emissions and biodiversity losses are mitigated.

- Biofuel policies should proceed with caution and be part of a portfolio of policy measures to reduce oil consumption in the transport sector. The government should increase research and development expenditure in second-generation biofuel that do not compete with land and water for food and forest. Finally, biofuel is not a panacea. There is a wide range of options, such as vehicle fuel economy standards, a fuel tax, public transport, electric vehicles, and walkable cities to enhance energy security, reduce transport energy intensity, and lower emissions.

In the medium term, future RE scale-up would need to focus on (a) cost reduction through adjusting the feed-in tariffs downwards periodically, improving efficiency and performance, and building a local manufacturing industry; and (b) grid integration, particularly in wind-concentrated areas.

Strengthening a National Champion and Institutional Coordination: Key to a Successful Implementation of Green Growth

It is essential to strengthen a national champion with the highest level of authority to lead and enhance effective institutional coordination to ensure successful implementation of green growth. The following recommendations are offered for the government's consideration:

- An Inter-Ministerial Committee on green growth could be set up, chaired by the Prime Minister, to demonstrate commitment and leadership from the highest level of authority. The Committee needs to meet regularly and frequently. The Secretariat should be housed in the NESDB, to lead not only the development but also the implementation of the green growth agenda. NESDB should be given a high-level authority and a sufficient budget to effectively coordinate with key sector ministries such as the Ministries of Energy, Environment, Finance, Interior, and Transport.

- The national green growth policy and strategy should take a holistic approach focusing on the most cost-effective interventions and sectors to achieve national green low-carbon growth objectives.

- Clear roles and responsibilities are assigned across the key sectors and between the central and local governments.

CHAPTER 1

The 11th National Economic and Social Development Plan: A Path to Green Low-Carbon Growth

In an effort to turn the climate change crisis into an opportunity, one of the central themes of Thailand's National Economic and Social Development Board's 11th Five-Year Plan or NESDP (2011–2015) is creating a low-carbon society and green growth. To that end, green growth has been adopted as a means to protect natural resources, mitigate environmental damage, and create new green jobs.

The Low-Carbon Society Strategies in the upcoming 11th National Economic and Social Development Plan focus on three areas:

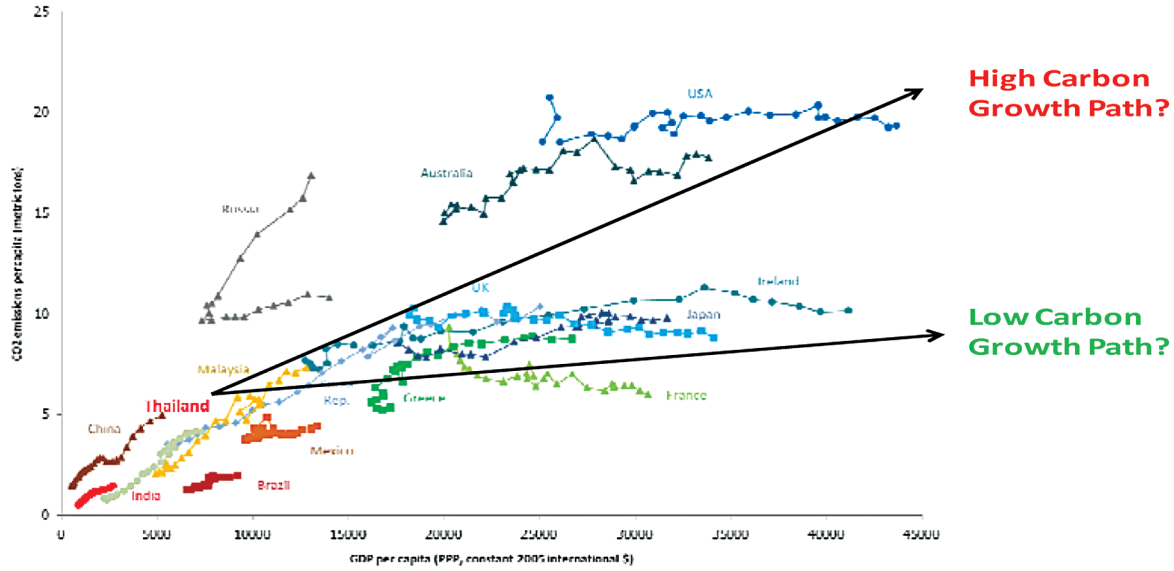
- Sustainable management of natural resources and the environment, which targets conservation of natural resources, a paradigm shift in consumption behaviour, ecological efficiency, urban infrastructure management, climate change adaptation, and natural resource governance;
- Balance and security of food and energy
- Fostering a creative economy and its enabling factors, to promote economic structural adjustment.

However, the concept of *green low-carbon growth* in Thailand is still being defined by policy makers to make the concept best fit local challenges and circumstances.

Thailand's shift toward a green growth development path is driven by a set of internal and external challenges that increasingly pose threats to continued economic growth. Thailand's sustained growth in recent decades has resulted in huge economic benefits and successful poverty reduction. However, natural resource depletion, environmental degradation, energy security, and inequality are growing concerns that increasingly constrain both continued economic growth and political and social stability. The government is finding it more difficult to respond to emerging challenges because the public consensus to continue with the past economic model has been eroding, while a new development direction has not been clearly articulated. A lack of public trust that the benefits of development will be equally shared and that the costs of environmental degradation will be fairly borne is a key development dilemma that needs to be addressed in order for the country to move on a sustainable growth path.

As a member of the global community, the country is also facing several threats, including the global financial crisis and climate change. In addition, Thailand emits a significant amount of greenhouse gas (GHG). According to the latest data from the U.S. Department of Energy's Energy Information Administration, Thailand's energy sector emitted 254 million tons of CO_2 in 2008, thus ranking 20th in the world and fifth in East Asia (after China, Japan, the Republic of Korea, and Indonesia). Due to its continued economic growth, Thailand's GHG emissions increased steadily at 3 percent per year during 2004–2008. The key challenge for the country is to avoid embarking on a high-carbon growth path (figure 1.1) and instead take a low-carbon growth path.

Figure 1.1 Thailand should avoid the high-carbon growth path



Source: Authors, adapted from NRC 2008 based on data from World *Development Indicator 2009.*
Note: Emissions and GDP per capita are from 1980 to 2005.

The window of opportunity is closing fast, and urgent action is required to transform the country toward green low-carbon growth. The scientific evidence about climate change and its negative impacts on growth in most countries is now largely accepted. The long lives of energy capital stocks (for example, power plants, buildings, roads) mean that investments over the next decade will largely determine emissions through 2050. Delaying action would lock the country into a high-carbon infrastructure and would require more costly retrofitting and premature scrapping of existing capital stocks in the future (Wang and others 2010). However, the inertia also offers an opportunity to build efficient low-carbon technologies into new infrastructure, since half of the energy stocks needed in developing countries by 2020 have yet to be built (McKinsey Global Institute 2009). *Time is of the essence.*

Green growth represents a crucial opportunity for the country to redefine its long-term growth strategy. While the concept needs to be further defined and articulated, green growth should imply a growth strategy that is more balanced, sustainable, and inclusive, and which allows the country to promote economic structural adjustments, meeting development needs and addressing rising development challenges. The NESDP will provide a platform for policy makers and the public to define and articulate green growth in the Thai context. A clearly articulated green growth plan will provide a conceptual and policy framework to drive policy responses in an integrated and systematic manner, including setting targets and performance indicators as well as priorities and institutional arrangements.

This chapter (a) defines the key characteristics and indicators for green low-carbon growth, (b) proposes four pillars for green low-carbon growth in Thailand, (c) recommends regulatory (or quantity-based) and fiscal (or price-based) policy measures to achieve green growth, and (d) suggests improved institutional coordination for successful implementation.

1. Defining and measuring green low-carbon growth

1.1 Defining green low-carbon growth

The emergence of the concept of "green growth" over the last several years changes a development model from treating environmental protection as an economic burden to a model that recognizes environmental protection as a driver for global and national economic development. The concept of green growth has gained momentum as the world has been searching for solutions to multiple global challenges. Green growth also responds to calls to refocus societies on achieving qualitative growth rather than simple quantitative growth, by measuring success based on traditional quantitative economic indicators, such as gross domestic product (GDP) (OECD 2009).

The recent financial and energy crises spurred private sector interest and high-level political commitment to green growth as one mechanism for economic recovery and job creation. The need to stimulate economic recovery through public spending, compounded by the need to make more progress toward the achievement of climate change and other environmental targets, motivated the interest in green growth. This situation is quite different from when environmental authorities advocated, often in vain, a better integration of environmental objectives into development strategies (OECD 2009).

The overall objective of green growth is to sustain economic growth without compromising the environment and natural resources. Green growth is difficult if not impossible to define universally, however, despite extensive research, because it depends on various factors that include stage of development, economic structure, resource endowment, and energy intensity and mix. For example, in low-income countries, the priority is to meet basic energy and water needs. In middle-income countries, green growth usually means addressing emerging environmental and resources problems as the economy grows. And in higher-middle-income or high-income countries, green growth provides an opportunity for innovation and job creation (box 1.1).

Based on a review of international literature from middle- and high-income countries, green growth has the following characteristics:

- Sustaining economic growth
- Reducing environmental damage, including local pollution and GHG emissions
- Relying on energy-efficient and low-carbon energy resources and production technologies
- Minimizing waste and inefficient use of natural resources
- Building sustainable urban infrastructure of compact urban form and public transport
- Promoting innovative green technologies and creating new job opportunities
- Educating and increasing the awareness of citizens to adopt resource-efficient consumption patterns.

Green low-carbon growth will not only improve environmental sustainability but will also bring additional benefits for development that include (a) enhanced energy security, (b) less traffic congestion, (c) more livable cities, and (d) greater competitiveness from higher productivity, which can help justify its cost and increase the appeal of green policies.

Box 1.1 Selected Definitions of Green Growth

Definitions of green growth generally include the concepts of improving energy security and health, and viewing environmental protection as a driver for economic growth and as essential for long-term economic and environmental sustainability. Selected specific definitions follow.

The Organization for Economic Co-operation and Development (OECD) defines green growth as "Promoting economic growth while reducing pollution and greenhouse gas (GHG) emissions, minimizing waste and inefficient use of natural resources, and maintaining biodiversity. The OECD Ministerial Council issued a Green Growth Declaration in 2009 that gave a mandate to the Organization to develop a Green Growth Strategy (GGS) to be presented to Ministers in 2011" (OECD 2009, 2010).

The United Nations Economic and Social Commission for Asia and Pacific (ESCAP) says "Green growth is a policy focus for the Asia and Pacific region that emphasizes environmentally sustainable economic progress to foster low-carbon, socially inclusive development to achieve real progress towards sustainable development and poverty reduction. The green growth approach seeks to harmonize the two imperatives of economic growth and environmental sustainability by promoting "fundamental changes in the way societies produce and consume…" (ESCAP 2006).

Korea defines green growth as "growth achieved by saving and using energy and resources efficiently to reduce climate change and damage to the environment, securing new growth engines through research and development of green technology, creating new job opportunities, and achieving harmony between the economy and environment" (Korean PCGG 2010).

Sources: OECD 2009, 2010; ESCAP 2006; Korean PCGG 2010.

1.2 Setting indicators for green low-carbon growth

Indicators at the economywide and sectoral levels are important when designing green growth policies and measuring progress toward green growth. Comprehensive economywide indicators provide the big picture on progress toward greener growth and thus should go beyond traditional indicators for economic growth such as GDP, and should account for environmental damages and depletion of natural resources. The adjusted net national income,[1] which is an extended measure of national income and particularly sensitive to changes in the environmental and natural resources, is an example of such an indicator.

Based on a review of international literature on green growth indicators from middle- and high-income countries (Annex 1), the following sectoral-level quantitative indicators are recommended for consideration by Thai decision makers:

[1] Net national income is defined as GDP minus net factor payments abroad, minus depreciation of produced assets, minus depletion of natural resources, minus pollution damages.

- ***Air quality and carbon emissions:*** Annual daily mean concentration against ambient air quality for particulate matter less than 2.5 micros in size ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxide (NOx) (micrograms per cubic meter [ug/m^3]), carbon dioxide (CO_2) emissions per capita (ton carbon dioxide equivalent [CO_2e] per capita), and CO_2 emissions intensity (ton CO_2e/million US$)

- ***Energy:*** Energy consumption gigajoule (GJ) per capita, energy intensity megajoules (MJ) per US$, share of renewable energy, and building energy consumption per square meter (MJ/m^2)

- ***Transport:*** Percentage of citizens walking, cycling, or taking public transport to work, length of public transport networks (km), and automobile fuel economy (km/liter)

- ***Water and sanitation:*** Water consumption per capita (cubic meter [m^3]/person), water system leakage (share of water lost in transmission), population with access to improved sanitation (share of population with direct connection to sewerage), and share of wastewater collected and treated

- ***Wastes:*** Municipal waste production (kilograms [kg]/person), and waste recycling rate

- ***Land use:*** At the national level, national forest areas (square kilometer [km^2]); at the city level, population density (persons per km^2), mixed land use of housing and jobs proximity, and green space per capita (sum of public parks, recreation areas, greenways, waterways, and other protected areas accessible to the public)

- ***Green technologies and innovation:*** Public spending on green technology research and development (R&D), patents in green technologies, share of global green technology product market, and number of green jobs.

Some of these indicators can be measured at the national level (such as carbon emission and energy), while others can be measured at the municipal level (such as transport, water, and wastes). Comparing key indicators for green growth between Thailand and other leading countries in the world is useful to better understand where Thailand and Thai cities stand in the international context (table 1.1). The international benchmarks can also help Thailand set its own targets to achieve green growth.

Table 1.1 shows that carbon intensity and energy intensity in Thailand are several times higher than those in developed countries, although its CO_2 emissions and energy consumption per capita are relatively low. This demonstrates a huge potential to improve energy efficiency and reduce energy intensity in Thailand. The share of nonfossil fuel in the power mix is also low in Thailand, which illustrates the need to increase the share of renewable energy in the energy mix.

At the city level, CO_2 emissions per capita in Bangkok are already high compared to the leading cities in the world, and are several times higher than the national average. In particular, the length of public transport networks and population density, two key determinant factors to transport emissions (see figure 2.2 in chapter 2), are low compared to the Asian regional average. The good news is that air quality in Bangkok has improved significantly over the last decade. The international comparison also shows the need to improve wastewater treatment, access to sanitation, and waste disposal in Bangkok.

Table 1.1 Comparison of Selected Green-Growth Indicators, Thailand and Selected Countries

Category	Key Green Growth Indicators	Thailand or Bangkok	Developed Countries
CO_2	CO_2 emissions per capita (tCO_2e/capita)[a]	Thailand: 4.3 (Bangkok: 10.7[b])	• Sweden: 5.4 (Stockholm: 3.6[b]) • Korea, Rep.: 9.4 (Seoul: 4.1[b]) • Japan: 9.6 (Tokyo: 4.9[b]) • Singapore: 7.9[b] • United States: 20.5
	CO_2 intensity (tCO_2e/million US$)[a]	Thailand: 1,121	• Sweden: 108 • Denmark: 192 • Japan: 280 • United States: 428 • Korea, Rep.: 465
Energy	Energy consumption per capita (GJ/capita)[a]	Thailand: 68	• Korea, Rep.: 107 • Denmark: 162 • Japan: 177 • Sweden: 237 • United States: 326
	Energy intensity (MJ/US$)[a]	Thailand: 17.8	• Denmark: 2.8 • Sweden: 4.7 • Japan: 5.2 • United States: 7.2 • Korea, Rep.: 9.3
	Share of nonfossil fuel in power mix[a]	Thailand: 8.1%	• Sweden: 97.4% • Japan: 40.8% • Korea, Rep.: 38.3% • United States: 28.7% • Denmark: 22.0%
Transport	Superior public transport networks (trains, light rail, subway, and bus rapid transit km/km^2)[c]	Bangkok: 0.04	• Tokyo: 0.14 • Singapore: 0.21 • Seoul: 0.94
Air quality	Daily suspended particulate matter levels (ug/m^3)[c]	Bangkok: 48.1	• Tokyo: 33.1 • Seoul: 55.0 • Singapore: 56.0
Water and sanitation	Water consumption per person (liters/person/day)[c]	Bangkok: 340	• Singapore: 308 • Seoul: 311 • Tokyo: 320
	Population with access to sanitation	Bangkok: 51%	• Singapore and Seoul: 100% • Tokyo: 99.4%
	Share of wastewater treated[c]	Bangkok: 12%	• Tokyo and Singapore: 100% • Seoul: 82%
Wastes	Share of waste collected and disposed[c]	Bangkok: 63%	Tokyo, Singapore, Seoul: 100%
Land use	Forest area (% of land use)[a]	Thailand: 28.4%	• Japan: 68.2% • Sweden: 67.1% • Korea, Rep.: 63.5%
	Population density (people/km^2)[c]	Bangkok: 3,607	• Tokyo: 5,947 • Singapore: 7,025 • Seoul: 17,289

Sources: (a) World Bank 2009a

2. Achieving Green Growth

There are three steps needed to achieve green growth: (a) lay out a vision, (b) implement effective policies, and (c) enhance institutional coordination.

2.1 Laying out a vision: Four pillars for green low-carbon growth in Thailand

Green growth policies will require an integrated strategy that effectively combines economic, environmental, and social policy objectives covering demand and supply aspects, both economywide and at the sector level, to ensure coherence in policy design and implementation and to maximize the synergies among different policy actions (OECD 2010). The first step is for governments to lay out a vision and set concrete objectives. Box 1.2 presents examples of green growth objectives and strategic areas in OECD, Korea and Singapore.

Box 1.2 Objectives and Strategic Areas for Green Growth in Korea and Singapore

The OECD's Green Growth Strategy focuses on three critical pillars of propoor green growth: (a) encouraging sound natural resources management and governance, (b) shaping climate-resilient growth, and (c) promoting low-carbon growth (OECD 2010). The strategy suggests the overall framework for achieving green growth stems from (a) removal of barriers to green growth; (b) promotion of a trajectory shift from a conventional economic growth path; (c) labor market support for the transition to a green economy to mitigate negative distributional impacts; (d) strengthening of international cooperation including financing mechanisms for global public goods such as climate change, biodiversity, and technology transfer; and (e) measuring progress toward green growth.

Korea's Green Growth Strategy clearly states as its objective "to become the world's 7th green power by 2002, and the 5th by 2050," through 10 policy directions to achieve the following three objectives:

1. ***Mitigation of climate change and energy independence*** through three policy directions: (a) mitigating GHG emissions, (b) reducing fossil fuel use and enhancing energy security, and (c) adapting to climate change.

2. ***Creating new engines for economic growth*** through four policy directions: (a) developing green technologies, (b) promoting green industries, (c) advancing industrial structure, and (d) developing a structural foundation for the green economy.

3. ***Improvement in quality of life and enhanced international standing*** through three policy directions: (a) greening the land, water, building, and transport infrastructure; (b) bringing the green revolution into the daily lives of its citizens; and (c) becoming a role model for the international community as a green growth leader.

Singapore's Sustainable Blueprint has the following four strategic objectives:

1. ***Boosting resource efficiency*** through (a) a policy of pricing energy appropriately; (b) boosting energy-efficient industry designs, processes, and technologies; (c) building capabilities in renewable energy; (d) promoting resource-efficient buildings; (e) promoting public transport; (f) expanding water supply and improving water efficiency; (g) minimizing waste upstream; and (h) enhancing land use planning.

2. ***Enhancing the urban environment*** through policy areas such as (a) reviewing air emission standards, (b) adopting new technologies, (c) pricing pollution, (d) improving water quality in waterways and reservoirs, (e) improving transport links, and (f) conserving urban biodiversity.

3. ***Building capabilities*** through a policy of (a) investing in R&D, and (b) facilitating international sharing of knowledge.

4. ***Fostering community action*** by promoting community efforts and industrial efficiency.

Sources: OECD 2009, 2010; Korea PCGG 2010; Singapore Ministry of the Environment and Water Resources and Ministry of National Development 2009.

Thailand continues to face local and global environmental sustainability challenges and energy security concerns to meet its growing energy needs that fuel rapid economic and social development. Furthermore, the country's development and its energy needs will be shaped by an unprecedented expansion of the domestic market driven by fast urbanization and rising incomes, and an uncertain outlook for global markets emerging from the financial crisis.

Recognizing key variables that determine GHG emissions helps identify policy levers for low-carbon growth. GHG emissions can be decomposed as follows:

$$\frac{GHG\ Emissions}{capita} = \frac{GDP}{capita}(Wealth) \times \frac{Energy}{GDP}(Energy\ Intensity) \times \frac{GHG}{Energy}(Energy\ Mix).$$

Wealth increases with economic growth, so policy levers for low-carbon growth should focus on a reduction in energy intensity and a shift in the energy mix toward low-carbon energy resources. The energy intensity of a country depends on a variety of factors, including the economic structure, climate, population density, transport infrastructure, energy efficiency, and way and quality of life. A reduction in energy intensity will target these factors.

Therefore, it is recommended that green low-carbon growth in Thailand focus on four pillars:

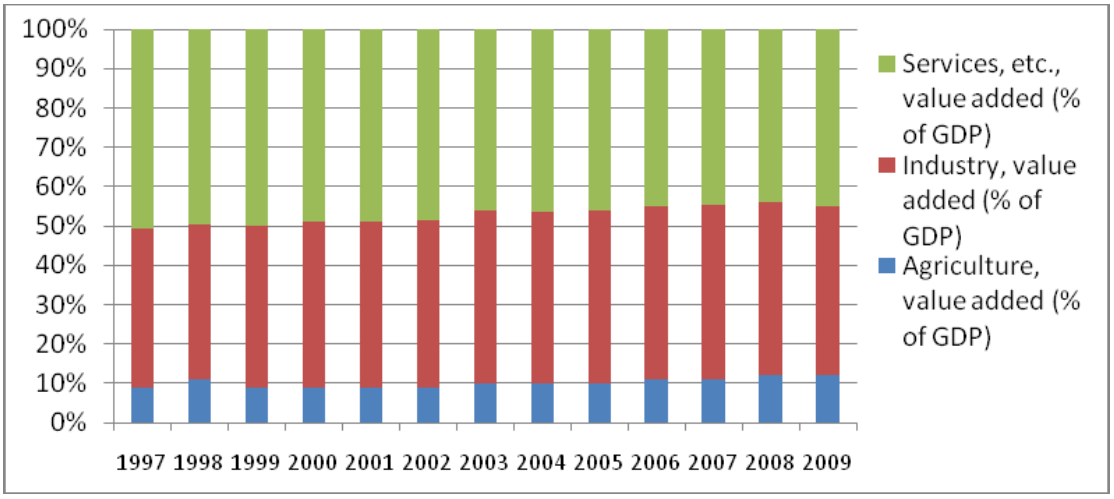
1. Adjusting the country's economic structure toward a less energy- and carbon-intensive economy
2. Promoting green livable low-carbon cities to seize the momentum of rapid urbanization
3. Scaling up energy efficiency and renewable energy to meet the country's thirst for energy in a sustainable way
4. Shifting consumers' behaviour and lifestyle toward resource efficiency.

Maintaining rapid economic growth while shifting the country's economic structure toward a less energy- and carbon-intensive economy

Economic structural changes toward an innovation-driven, high-tech, and service-sector-based economy is a key driver to reduce energy and carbon intensity in Thailand. It also prepares for transforming Thailand into a high-income country. However, despite the government's efforts during the last Five-Year Plan period, the economic structure has not improved much. On the contrary, over the last decade, Thailand's economic structure had shifted further toward dominance of the energy-intensive industrial sectors- a main reason for the rising energy intensity in Thailand (figure 1.2).

Japan and Korea have demonstrated that shifting the economic structure from energy-intensive industries to high-tech and innovative industries is a key factor in increasing their GDP from US$3,000 per capita (middle-income) to US$11,000 per capita (high-income) in only a decade. The global financial crisis provides an opportunity to boost the share of the services sector, which will help achieve still high but more sustainable growth. Continued efforts toward rebalancing Thailand's economic structure to less-energy-intensive, higher-value-added activities during the 11th Fiscal Year Plan period would be critical to achieving a less energy-and carbon-intensive society.

Figure 1.2 Thailand's economy has not shifted toward less energy-intensive industries over the last decade



Source: World Bank 2009a.

Achieving greater urbanization while shifting toward green livable low-carbon cities

Cities are at the center stage of the action plan to get onto a green low-carbon growth path. The world's cities already consume more than two-thirds of global energy and produce more than 70 percent of CO_2 emissions (IEA 2008). Thailand is undergoing rapid urbanization, with the share of the population living in urban areas[2] growing from 18.5 percent in 2000 to 33.6 percent in 2009 (Thailand National Statistical Office 2010). This urbanization trend will be a defining driver of economic growth. The urban economy should generate enough jobs to absorb the additions to the urban workforce at steadily rising wages if the economy continues to grow at a robust rate, capital accumulation is sustained, and the scope for enhancing innovation and benefiting from agglomeration economies increases.

This speed and scale of urbanization presents an unrivaled opportunity to shift the type of urban growth and retrofit existing cities in a manner that is not only less energy- and carbon-intensive, but that would enable cities to compete globally to attract the best talent and long-term investments needed to create new jobs in the higher value-added and less resource-intensive industries. As mentioned in section 1.2, Bangkok already has a relatively high carbon emission per capita compared to the leading developed cities in the world. The transport sector already dominates Thailand's energy use and emissions, and is expected to grow faster due to rapid urbanization and the rise of the consumer class over the next two decades. Furthermore, Thai cities also need to improve water and waste management to improve the quality of life while minimizing waste and inefficient use of water resources.

Green livable low-carbon cities can be built based on the following four key principles (figure 1.3), (Wang and others 2011) (chapter 2 will discuss detailed policy instruments in these areas):

[2] Thailand's urban population is underestimated, because sanitary districts or towns (subdivided into urban and rural sanitary districts) are not counted as urban according to the Thai definition, even though some of these towns are quite large, with populations of more than 20,000 (Jones 2002).

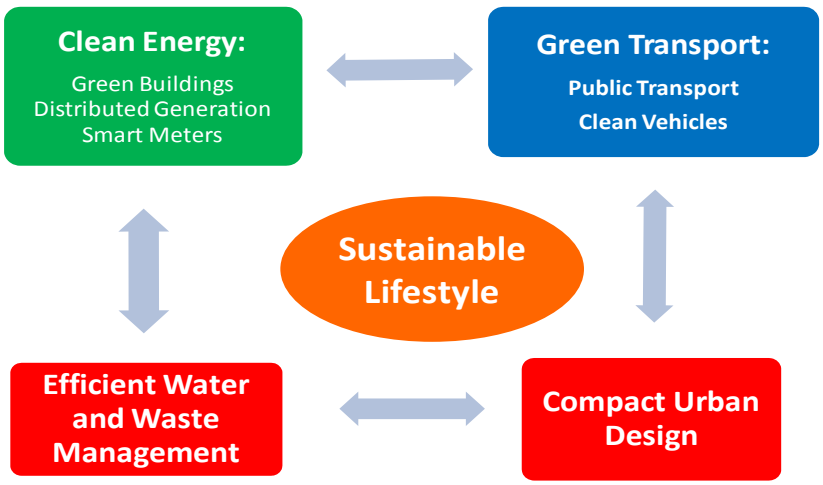
1. **Compact urban form:** Smart planning-higher density, more spatially compact, and more mixed-use urban design that allows growth near city centers and transit corridors to prevent urban sprawl-can substantially reduce energy demand and CO_2 emissions. A study in Toronto, Canada showed that a low-density suburban neighbourhood can have 10 times the carbon emissions per capita (13 ton/capita) compared to the high-density inner-city area with high-rise apartment buildings (1.3 ton/capita), largely due to the urban form (VandeWeghe and Kennedy 2007).

2. **Efficient and clean energy:** Cities can drive down carbon emissions by sustaining demand-side energy efficiency measures in buildings, combined with renewable energy distributed generation:
   - Renewable energy distributed generation: Increasing the share of renewable energy (RE) in a city requires (a) on-site renewable energy generation such as rooftop PV panels, solar water heaters, wind, landfill gas, and geothermal heat pumps, depending on resource availability in each city; and (b) the purchase of green electricity to cover the gap.
   - Green buildings: Thai cities need to strengthen the enforcement of building codes and pilot near-zero-emission buildings that combine energy efficiency (EE) measures with on-site power and heat generation from solar and biomass.

3. **Sustainable urban transport:** A World Bank study shows that energy use and emissions in the transport sector could be reduced by around 25 percent from the baseline in Bangkok by 2020. Improving fuel efficiency to meet future European Union fuel economy standards makes the biggest difference, followed by fuel tax and road pricing policy (for example, increased vehicle registration fees, congestion charges, and parking fees) and public transport infrastructure (Wang and others 2010).

4. **Efficient water and waste management:** Cities can manage water resources efficiently and minimize waste by conserving water use and reducing waste generation on the demand side, and increasing efficient water supply such as wastewater treatment and waste recycling and disposing on the supply side.

Figure 1.3 Green low-carbon cities require a comprehensive multisector approach

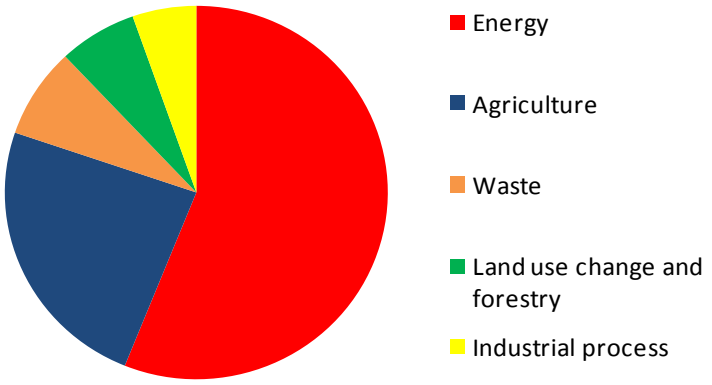


Source: Authors.

Quenching the huge thirst for energy while transforming the energy sector into one of high energy efficiency and widespread diffusion of low-carbon technologies

Energy demand in Thailand is expected to more than double over the next two decades. The remarkable growth and rapid urbanization have led to twin energy challenges in Thailand-environmental sustainability and energy security. The energy sector is already the largest contributor to GHG emissions in the country (figure 1.4). As mentioned, the carbon and energy intensity of Thailand is several times higher than in leading developed countries, and its energy mix is dominated by fossil fuels. In addition, Thailand is already a net energy importing country and faces growing energy security concerns.

Figure 1.4 Energy dominates greenhouse gas emissions in Thailand



Source: Carbon Dioxide Information Analysis Center; http://cdiac.ornl.gov/ftp/trends/emissions/tha.dat.

To address these two challenges, the first step in the short term is to increase energy efficiency in the building, industry, power, and transport sectors-the largest and cheapest source of emission reductions and fully justified by development benefits and future energy savings (Wang and others 2010). Chapter 3 discusses policy instruments, financing mechanisms, and institutional reforms needed to tap the remaining potential of energy savings in order to achieve the Thai government's Energy Efficiency Development Plan.

In the short to medium term, the second-largest source of emissions reductions comes from low-carbon technologies for power generation, particularly renewable energy. Chapter 4 discusses financing mechanisms, food and energy security, and grid integration to scale-up renewable energy in order to achieve the Thai government's Renewable Energy Development Plan.

Improving quality of life while shifting to a resource-efficient and sustainable lifestyle

Consumer lifestyle is a key determinant of future energy demand in Thailand. A less energy-intensive lifestyle in Japan, for example, results in an energy demand per capita of 4 tons of oil equivalent (toe), compared to 10 toe in the United States (CCICED 2009). With rising income and thus higher individual purchasing power, it is essential for the government and society as a whole to encourage a consumer lifestyle and behavior with a resource-efficient consciousness and low carbon footprint through tax and fiscal measures and intensified public education.

2.2 Policy matters

After the government lays out a vision and sets strategic objectives, effective policies, concrete implementation strategies, and action plans are needed to make them a reality. Generally, there are two types of policy instruments for green growth: (a) quantity-based regulations, such as cap and trade; and (b) pricing-based fiscal measures, such as taxes.

Policy instruments need to be tailored to the maturity and costs of technologies and national context. Mandatory regulations are perhaps more effective for many EE measures, while pricing-based financial incentives are critical to scale-up renewable energy.

Many EE measures are already financially viable for investors at current prices, yet are not fully realized due to many market failures and barriers. In particular, adopting EE measures in the building, industry, and transport sectors is a function of the preferences of, and requires action by, many decentralized individuals, energy demand is less responsive to price signals, and regulations tend to be more effective. However, weak enforcement of regulations is a concern in many developing countries. Therefore, pricing and fiscal policies should go hand in hand with regulations.

For RE, the number-one barrier is the incremental financial costs between RE and fossil fuels. Consequently, price-based policies that either put a price premium on RE or tax fossil fuels are most effective to scale-up RE (Wang and others 2010).

To increase the use of fiscal policies, Thailand is considering a *Fiscal Measures for the Environment Bill.* Such a bill is important to introduce the Polluter Pays Principle (PPP) for the first time by charging polluters taxes and fees if they do not undertake measures to mitigate pollution. Based on international best practices, the following is recommended for government's consideration:

- In principle, the tax rate should be slightly higher than the marginal abatement cost to provide incentives for polluters to undertake abatement measures.
- It would be desirable to identify the main types of air and water pollutants and polluting products and selection criteria, and then specify different tax rates for each pollutant and product. For air pollution, it would be prudent to start with environmental taxes on local air pollutants-particulates, SO_2, and NOx. But Thailand, as a middle-income country, can also consider adopting a carbon tax.
- Studies have found that the negative impact of environmental taxes on tourism is negligible as long as the per person tax rate is moderate (Edwards 2008). Most European countries and tourist destinations currently impose a tax of US$2 to US$10 per bed per day on tourists. However, a tourist tax collected through hotel charges or visa fees is usually more practical. And tourists are more willing to pay for an "environmental tax" than a general "tourism tax."
- For the Supervisory Committee, it is important to have a balanced representation of government officials and industries to avoid a high proportion of polluters represented that may result in a conflict of interest. In addition, the bill needs to explicitly state the criteria for reducing or exempting taxes and fees, thus limiting loopholes and political interference in the waiver process.
- It is important to specify how the monitoring, inspection, and enforcement will be undertaken and by whom, and to reserve a sufficient budget to cover their costs.

Table 1.2 Summary of Policy Measures to Achieve Green Low-Carbon Growth

	Regulatory Measures (quantity-based policies)	Fiscal Measures (price-based policies)
Economywide	• Cap and trade	• Energy/carbon tax
Energy efficiency	• Economywide energy- efficiency targets • Energy-efficiency obligations • Industry energy-performance targets • Building codes and green building certificates • Mandatory requirements for retrofitting inefficient buildings • Appliance standards	• Tax credits • Investment subsidies, soft loans, and grants • Decoupling profits from sales • Time-of-use tariffs for power • Consumer rebates • Density bonus • Shorten permit approval period • Green mortgage • Consumer financing through increased utility bill or property tax
Renewable energy	• Mandatory purchase, open and fair grid access, including priority dispatch of renewable distributed generation • Renewable portfolio standards • Mandatory installation of solar water heaters • Voluntary purchase of green electricity • Grid code regulations for interconnection	• Feed-in tariff, net metering • Real-time pricing • Tax credits • Investment subsidies, soft loans, and grants
Transport	• Fuel economy standards • Low-carbon fuel standards	• Fuel taxes • Congestion tolls • High parking fees • Taxes based on engine size • Insurance or tax levies on vehicle miles traveled • Taxes on light trucks and SUVs
Water	• Drinking water quality standards • Wastewater treatment and disposal standards • Water works and system standards	• Metering and usage charges • Cost recovery tariff and pricing • Investment subsidies, soft loans, and grants for sludge treatment
Waste	• Waste classification and standards for waste collection, treatment, and disposal • Demand management for waste reduction	• User fees (e.g., fees charged to waste generators, product charges, packaging fees)

Source: Authors. For water and waste management, adapted from Suzuki and others 2010

2.3 Institutional coordination is the key to successful implementation

Achieving green growth requires a holistic multisector approach, with key sectors involving energy, the environment, land use, transport, waster, and water. Given that implementing green growth involves multiple ministries and agencies, it is essential to strengthen institutional coordination and to have a national champion to lead this important effort. Based on existing institutional arrangements in Thailand and international best practices, this report offers preliminary recommendations for improved institutional coordination for Thailand.

Existing institutional arrangements in Thailand

At the national policy-making level, the Office of the Prime Minister is responsible for overall climate change management in Thailand. A Secretariat has been set up in the Office of National Resources and Environmental Policy within the Ministry of Natural Resources and Environment (MNRE). The National Economic and Social Development Board (NESDB) is responsible for medium-term National Economic and Social Development strategies. The Fiscal Policy Office under the Ministry of Finance is responsible for fiscal policies. The roles and responsibilities of each agency are shown in table A2.1 of Annex 2.

At the sectoral level, a number of agencies are also involved. In particular, the National Energy Policy Council (NEPC), chaired by the Prime Minister and which includes ministers from line ministries (for example, Agriculture, Commerce, Energy, Finance, Industry, Science and Technology, and Transport), is responsible for setting national policies and strategies on energy, promotion of energy conservation, and management of the Energy Conservation Promotion Fund (ENCON Fund). Under the Ministry of Energy, the Energy Policy and Planning Office (EPPO) is responsible for setting overall energy policies and plans, and the Department of Alternative Energy Development and Efficiency (DEDE) is in charge of setting and implementing renewable energy and energy efficiency policies and promotion programs. The Ministry of Transport (MOT) is responsible for overall transport policies and the Office of Transport and Traffic Policy and Planning is in charge of overall transport planning including Master Plans for mass transit system in Bangkok and other cities. The detailed institutional arrangements in three major sectors (energy, transport, and urban) for green low-carbon growth are shown in table A2.2 of Annex 2.

International experience

Box 1.3 presents the international experience of institutional frameworks for green growth in Korea; low-carbon growth in China, India, and Mexico; and sustainable development in Singapore. These experiences reveal the following common features for successful implementation of green low-carbon growth:

- ***High-level commitment and coordination:*** In all the cases reviewed, an interministerial body was created, led by the highest level of authority (the President or Prime Minister of the country), involving key sector agencies responsible for formulating policies, strategies, and action plans for green low-carbon growth. The committee meets regularly and frequently, with the presence of the highest-level authority, as in China and Korea.
- ***The Secretariat is housed in senior ministries with high-level authority:*** The Secretariat of the interministerial body is either housed in an overarching coordinating agency such as the National Development and Reform Commission in China, or consists of key line ministries such as energy, finance, industry, transport, and water in Korea and Singapore. The Secretariat is given high-level authority to coordinate different ministries and should also have adequate resources, including staff and funding.
- ***An adequate budget:*** The government earmarks a substantial amount of funding to support the green low-carbon growth agenda and to turn strategy into concrete and operational actions, as in Korea.

- ***Legal framework:*** Korea also passed the Basic Law for Green low-carbon Growth to provide a solid legal framework for the Presidential Committee on Green Growth.

The coordinating body should also have core competencies for effective implementation including:
- The ability to work collaboratively with multiple public and private agencies
- The ability to leverage private-sector participation
- The ability to effectively engage with and influence a wide range of stakeholders
- A credible scheme for results monitoring.

Box 1.3 International Experience Regarding Institutional Arrangements for Green Low-Carbon Growth

Republic of Korea: The Korean Presidential Committee on Green Growth (PCGG) was created in February 2009 under the direct supervision of the President as the highest authority for deliberation, interministerial coordination, and public-private consultation, on green growth policies. It consists of 14 ministers and 36 private experts and is cochaired by the Prime Minister and President of the National Strategy Institute (NSI). It is supported by an Inter-Ministerial Secretariat consisting of senior elite officials and 12 Task Forces of officials and private experts. The PCGG coordinates with local Green Growth Committees created by local autonomous governments.

The Presidential Committee has prepared the 2009–2013 Five-Year Plan for Green Growth. With funding of US$83.6 billion, or 2 percent of Korea's GDP, this Five-Year Plan intends to turn the strategy into concrete and operational policy initiatives toward achieving green growth. In 2009, Korea allocated 80 percent of the US$38.1 billion economic stimulus package to green investments (UNEP 2010).

China: The Chinese government in 2008 issued a White Paper on China's Policies and Actions for Addressing Climate Change. It also committed to reducing carbon intensity by 40 to 45 percent from 2005 to 2020, dropping energy intensity by 20 percent from 2005 to 2010 in the 11th Five-Year Plan, and increasing the share of renewable energy to 15 percent of primary energy by 2020.

To further enhance the leadership on climate change, the Chinese government established the National Leading Group on Climate Change in June 2007. The Leading Group is headed by the Prime Minister, with 20 ministries and government agencies involved, responsible for formulating key strategies, polices, and measures to tackle climate change and coordination among agencies. The Secretariat of the Leading Group is housed in the National Development and Reform Commission (NDRC), and a special institution was established in the NDRC to organize and coordinate climate change work. The NDRC is responsible for developing and implementing the country's Five-Year Plans, and has the highest authority with a sufficient budget to coordinate key line ministries to address climate change.

India: The Indian government issued in 2008 a National Action Plan on Climate Change, which pledged that its per-capita greenhouse gas emissions will at no point exceed that of developed countries even as the country pursues its development objectives. An Advisory Council on Climate Change was created, chaired by the Prime Minister and housed in his office, and is responsible for coordinating national action for assessment, adaptation, and mitigation of climate change. The Council provides overall strategic guidance on mainstreaming climate change in development, identifies key intervention priorities, and monitors the implementation of these interventions.

Singapore: Singapore's Inter-Ministerial Committee on Sustainable Development (IMCSD) was established in 2008 to formulate a national strategy for Singapore's sustainable development in the context of emerging domestic and global challenges. The IMCSD is cochaired by the Minister for National Development and the Minister for the Environment and Water Resources, and includes the Minister for Finance, the Minister for Transport, and the Senior Minister of State for Trade & Industry.

Sources: Korea: Park 2010; Young 2009, 2010. China: China's Policies and Actions for Addressing Climate Change 2008. India: National Action Plan on Climate Change 2008. Mexico: National Strategy on Climate Change 2007. Singapore: Sustainable Singapore, Lively and Livable City." http://app.mewr.gov.sg/web/contents/ContentsSSS2.aspx?ContId=1292

Recommendations for green growth institutional arrangements in Thailand

Achieving green low-carbon growth requires a national agenda and the concerted effort of several ministries and agencies at the national, sectoral, and local levels. Therefore, a national champion with high-level authority to lead effective institutional coordination is critical to meet clearly defined national targets. The following recommendations are made for the Thai government's consideration:

- ***An Inter-Ministerial Committee on green growth could be set up, chaired by the Prime Minister.*** The NESDB is responsible for developing national economic and social development strategies, and green growth is one of the key pillars in the 11th Five-Year Plan. Therefore, the Secretariat of the Inter-Ministerial Committee should be housed in the NESDB, to lead not only the development but also the implementation of the green growth agenda in Thailand. To fulfil this mandate, the NESDB should be given high-level authority and a sufficient budget to effectively involve and coordinate with key sector ministries such as the Ministries of Energy, Environment, Finance, Interior, and Transport. The Inter-Ministerial Committee should meet often. The concrete green growth action plans under development for the national economic and social development plan led by the NESDB should be closely and clearly linked with the National Strategy for Climate Change Management led by the Ministry of Natural Resources and Environment, so that the green low-carbon growth agenda will be mainstreamed in the implementation of the 11th Five-Year Plan, as in Korea.

- ***The national green growth policy and strategy can take a holistic approach focusing on the most cost-effective interventions and sectors.*** Under the leadership of the NESDB and the Inter-Ministerial Committee, the national green growth policy and strategy should prioritize and focus on those most cost-effective interventions and sectors to achieve the green low-carbon growth objective. As a result, the targets and strategies in each key sector will be developed in a more strategic and systematic manner, in line with the national agenda.

- ***The roles and responsibilities for urban transport should be clarified among the key sectors and between the central and local governments.*** Institutional reform in the urban transport sector is one of the fundamental longstanding gaps hindering timely policy responses and an efficient policy-making process. The urban transport sector is currently characterized by overlaps in policy, regulatory, and operational functions, and between the central and local government. Coordination through a high-level central authority, such as the Commission for the Management of Land Traffic (CMLT), should be enhanced with a full-time secretariat agency, such as the Office of Transport and Traffic Policy and Planning. The CMLT should also be given authority to mandate institutional reforms. For example, targeted reform of strategic state-owned enterprises, such as the Bangkok Mass Transit Authority, can be directed by the CMLT to unlock key barriers to improving the bus sector. Coordination between local and national authorities also has to be sorted out. The Bangkok Metropolitan Administration and the Metropolitan Police can use the CMLT as a platform to coordinate traffic management, in which the local authority will take the lead, with enforcement support from the police. Because the local authorities often lack adequate technical and financial capacity to deliver these services (modern urban transport, waste management, energy efficiency) or to meet rising challenges like climate change, capacity enhancement at the local government level is a must.

CHAPTER 2

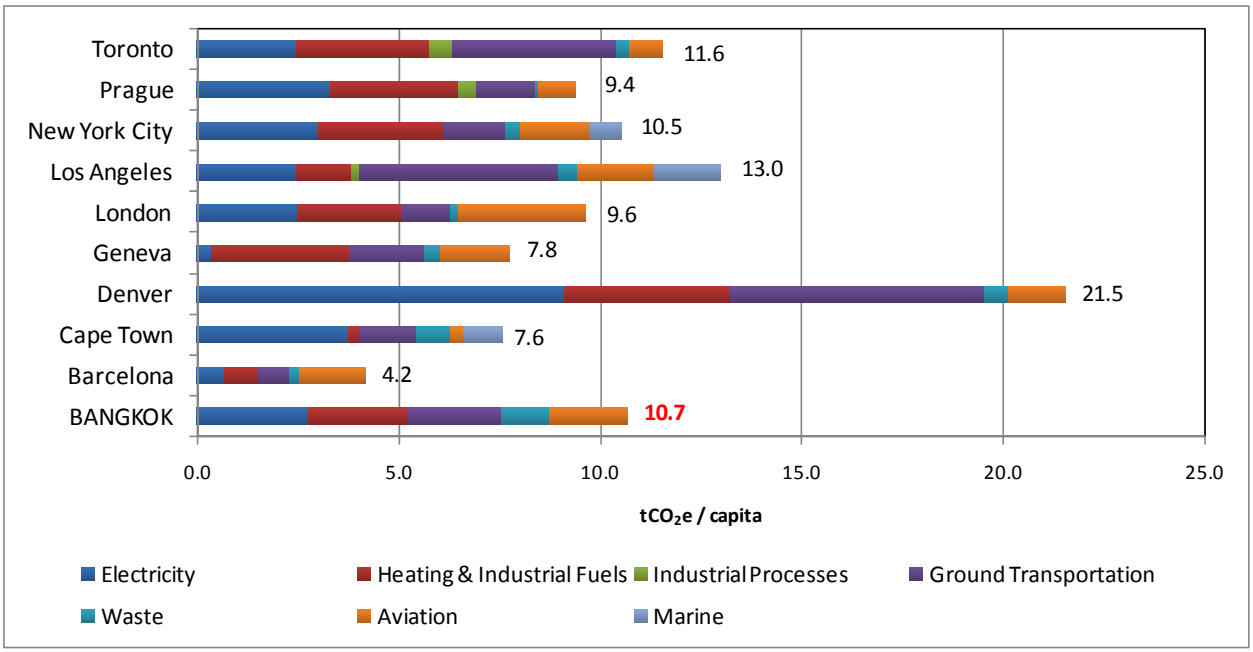
Transforming Urban Areas into Green Livable Low-Carbon Cities

1. Bangkok has a high CO_2 emission per capita but has launched climate change plans

1.1 Bangkok's CO_2 emissions per capita are already high

Per capita carbon dioxide (CO_2) emissions in Bangkok are already high compared to leading cities in the world and are more than double the national average of those cities (figure 2.1). It is essential that Thai cities avoid embarking on a high-carbon growth path as the urban population rises. The bulk of emissions in Bangkok comes from the power, industrial, and transport sectors (Kennedy and others 2009). This emissions distribution is representative of two important characteristics of Bangkok: (a) power generation is dominated by fossil fuels and is mainly used for lighting and air conditioning; and (b) industry and transport dominate energy consumption, while much of industrial activity takes place in zones outside Bangkok city center.

Figure 2.1 Bangkok already has a relatively high GHG emission per capita, dominated by power, industry, and transport

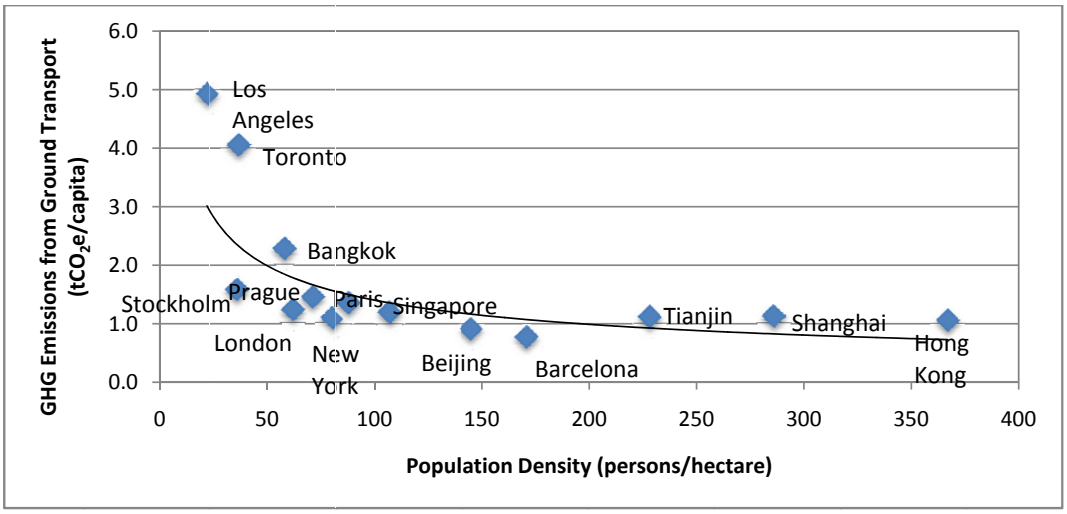


Source: Kennedy and others 2009

Note: The data for this figure are based on a study conducted by Kennedy and others published in 2009. For Bangkok, the data are for 2005 and the city population is taken to be 5,658,953. The value of 10.7 tCO_2e/capita differs from the Bangkok Metropolitan Administration's estimate of 7.1 tCO_2e/capita due to differences in calculation methodologies. The methodology of Kennedy and others reported emissions from the following sources: (a) electricity consumed within the city, (b) fossil fuels consumed within the city (as well as rice husk, bagasse, and wood), (c) industrial processes and products use within the city, (d) waste generated in the city, and (e) aviation and marine fuels loaded onto planes and ships. For more on the methodology used by Kennedy and others 2009, please see Kennedy and others 2010.

Bangkok's relatively high transport emissions result from an urban form with low population density and short public transit networks. In major global cities, both population density and the length of the transit system are inversely proportional to transport emissions (figure 2.2). For example, in Los Angeles urban sprawl combined with a small transit system promotes the use of personal vehicles, which increases transport emissions significantly. Smart urban form and sustainable transport development in Thai cities are the key determinant factors to reduce emissions in the transport sector.

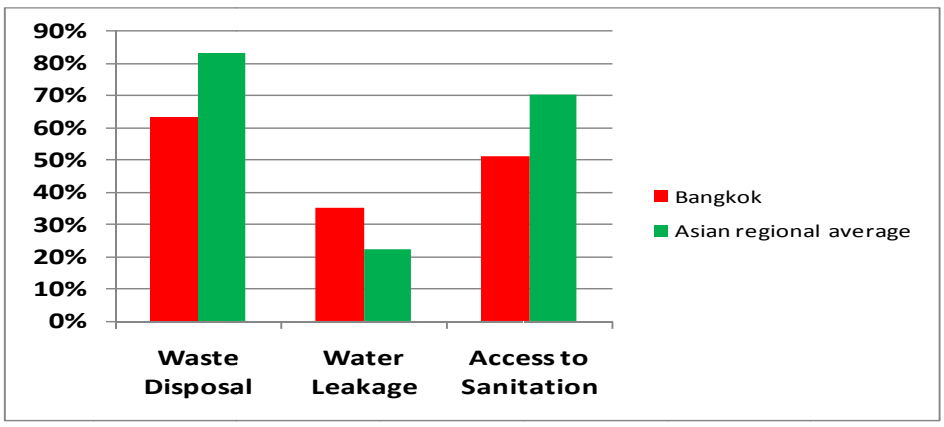
Figure 2.2 Population density is inversely proportional to transport emissions



Source: Sugar, Kennedy, and Leman 2010.
Note: tCO_2e = total carbon dioxide equivalent.

In addition, Bangkok also ranks low on water and waste management compared to the Asian regional average. The city generates more wastes (535 kg/person) than the regional average (375 kg/person) and collects and disposes of only 63 percent of it compared with the regional average of 83 percent (figure 2.3). Furthermore, Bangkok consumes more water (340 liters/person/day) than the Asian regional average (278 liters/person/day), with higher water system leakage (35 percent) compared to the regional average (22 percent), and has a lower-than-average access to sanitation (Economist Intelligence Unit and Siemens. 2010a).

Figure 2.3 Water and waste management in Bangkok is lower than the Asian regional average



Source: Authors based on data from Economist Intelligence Unit and Siemens. 2010a.

1.2 Bangkok has launched climate change action plans

The Bangkok Metropolitan Administration has launched its Action Plans on Global Warming Mitigation with a target of reducing the city's emission by 15 percent below the projected emission level in 2012. The Action Plan contains the following five initiatives.

Initiative 1: Expand Mass Transit and Improve Traffic Systems. The objective is to reduce GHG emissions from vehicle traffic. Three Action Plans under this initiative are to expand the mass rail transit system, improve the public bus system, and improve the traffic system. A 2009c World Bank study on urban transport in Bangkok estimates that 46 percent of person trips made each day in the Bangkok Metropolitan Region (BMR) are by private motorized modes, 3 percent are by rail mass rapid transit (MRT), 37 percent are by bus, and 14 percent are by walking and other nonmotorized transport (NMT) modes. An MRT master plan called the Urban Rail Transportation Master Plan was updated in 2011.

Initiative 2: Promote the Use of Renewable Energy. The objective is to increase the proportion of biofuels usage by promoting the use of biofuels (that is, gasohol and biodiesel) and other low-carbon emission fuels such as compressed natural gas.

Initiative 3: Improve Electricity Consumption Efficiency. The objective is to reduce electricity usage in Bangkok by improving the energy efficiency of buildings and conducting an electricity conservation campaign.

Initiative 4: Improve Solid Waste Management and Wastewater Treatment Efficiency. The objective is to increase efficiencies in solid waste management and wastewater treatment.

Initiative 5: Expand Park Areas. The objective is to increase CO_2 absorption by planting more trees in the Bangkok metropolitan area on both public and private property and in neighbouring provinces.

2. Policy instruments to promote green livable low-carbon cities

Green livable low-carbon cities require a holistic multisector approach to integrate energy efficiency, clean energy technologies, green transport, compact urban design, and efficient water and waste management. In this regard, the world's first city-level carbon cap-and-trade system in Tokyo presents a good example (box 2.1). This section briefly introduces key policy measures in the energy, transport, water, and waste sectors.

Box 2.1 Tokyo Emissions Trading System: The World's First City-Level Carbon Cap and Trade

Launched on April 1, 2010, Tokyo's cap-and-trade program, the Tokyo Emissions Trading System (Tokyo-ETS), targets large-scale commercial and industrial facilities (that is, buildings and factories) that consume more than 1,500 kilolitres of crude oil equivalent in fuels, heating, and electricity each year. The facilities are subject to an absolute emissions cap: 6 percent below 2000-level emissions during the first compliance period (2010–14), and 17 percent below 2000-level emissions during the second period (2015–19). To reach their cap, facilities are encouraged to use energy efficiency measures, or they may purchase offsets. Emissions must be reported each year and verified by a third party registered with the Governor of Tokyo. Program compliance is mandatory, with strict penalties imposed on those who fail to meet commitments.

Implementation of the Tokyo-ETS required political commitment and institutionalization. Building on a voluntary emissions reduction system launched in 2002, legal standing was granted in 2008 when the Tokyo Metropolitan Assembly incorporated the Emissions Trading System into the "Tokyo Metropolitan Environmental Security Ordinance". The cap-and-trade program was prepared and organized by the Tokyo Metropolitan Government. The program required numerous institutional procedures, including specific methodologies for calculating and verifying emissions, a registration system for third-party verification agencies, a system for annual emissions reporting, and disciplinary procedures for noncompliant facilities.

The success of the cap-and-trade program's implementation can be attributed to five key drivers:

- Reporting is mandatory.
- Political support from the Governor of Tokyo made emissions reduction legally binding.
- Input from all stakeholders was used in the program's development.
- The reporting system is simple.
- Third-party auditing is required.

The launch of Tokyo-ETS represents an important first step toward the development of a global city-level carbon cap-and-trade system. Using their expertise, the Tokyo Metropolitan Government has proposed both a national and a regional cap-and-trade program to the Government of Japan. The long-term goal of Tokyo-ETS is to extend the program to all of Japan and encourage other cities to adopt cap-and-trade programs.

Sources: Padeco 2010; Tokyo Metropolitan Government 2010.

2.1 Efficient and clean energy

Renewable energy distributed generation: To increase the share of renewable energy in a city requires (a) on-site renewable energy generation such as rooftop PV panels, solar water heaters, wind, landfill gas, and geothermal heat pumps, depending on resource availability in each city; and (b) the purchase of green electricity to cover the gap.

Integrating renewable energy distributed generation such as rooftop solar panels in buildings and electric vehicles provides an innovative and integrated approach to meeting the growing energy demand in a sustainable way in urban areas. Mandatory requirements for installation of solar water heaters in new buildings, for example, have proven to be an effective policy instrument in Rizhao, China, where 99 percent of households in the central district installed solar water heaters. Such mandatory requirements for the share of renewable energy in cities would be more effective if they were combined with financial incentives. For example, the city government can reward those developers and building owners who meet the renewable energy requirements with a tax credit, subsidies, a density bonus (that is, offering developers the option of building greater height and/or floor areas if green building standards are met), and/or a shorter permit approval period. Finally, mandatory off-take of distributed generation and an adequate tariff level for renewable energy generators and/or net metering policies are essential for self-generators to access the grids (Wang and others 2011).

Purchase of green electricity is important for those cities where the on-site renewable energy supply is relatively limited within city boundaries. Developing green electricity schemes and or promoting imports of renewable electricity are essential to achieve a low-carbon energy mix and can spur large demand for green electricity.

Green buildings: Green buildings present one of the most cost-effective mitigation options. Green buildings, however, do not necessarily cost more, and incorporating sustainable design features into construction can attract more customers and be profitable. Studies show that the implementation of energy-saving standards increases property costs by 5 percent to 10 percent, and not the average of 17 percent widely quoted by developers (Jing and Yu 2008). Copenhagen, the greenest city in Europe, offers a role model (box 2.2).

Bangkok can improve its eco-building policies, since it currently has only a partial code for efficiency standards in new private buildings and has no mandatory green standards for its public buildings. Bangkok might also consider mandating the use of efficient light bulbs and appliances to promote electricity conservation (Economist Intelligence Unit and Siemens. 2010a).

Box 2.2 Copenhagen: A Role Model for Achieving a Low-Carbon City

Low carbon emissions: Copenhagen, with a population of just over half a million, has a per capita CO_2 emission of 5.38 tons, which is much lower than the overall EU-27 average of 8.46 tons. The low per capita CO_2 emissions is largely attributable to the city's low energy intensity, which, at 1.4 megajoules (MJ)/US$, is significantly lower than most global leading cities. Not resting on its past success, however, the City of Copenhagen rolled out the Copenhagen Climate Plan 2009, which aims to reduce CO_2 emissions by 20 percent from 2005 to 2015. The City also set an ambitious target of becoming carbon neutral by 2025, which, if realized, would make Copenhagen the first carbon-neutral city in Europe.

Clean energy supply: Copenhagen has made a considerable effort to transform its energy mix to green. As a result, the share of renewable energy consumed by the City is 18.8 percent. Going one step further, the City relies on a greener energy mix to meet 75 percent of emissions reductions in the newly adopted climate plan, including substituting biomass for coal in power stations, increasing reliance on geothermal power, renovating the district heating network, and building new wind farms.

Improving energy efficiency of buildings: A key driver of the significant decline in CO_2 emissions over the last decade is the City's efforts to improve its energy efficiency. The annual energy consumption of residential buildings is around 554 megajoules per square meter (MJ/m^2), one of the lowest in Europe. Nearly all buildings are connected to the district heating system and 97 percent of city heating is supplied by waste heat. The City plans to realize 10 percent of its emissions reduction target through building energy efficiency projects.

Promoting greener transport: Copenhagen has a highly accessible public transport network. Consequently, 68 percent of its residents walk, cycle, or take public transport to work. The City plans to achieve 10 percent of its targeted emissions reduction from the transport sector. To reach this goal, the City has proposed a variety of measures including improving public transport and bicycling service, encouraging car pooling, switching vehicle fuel to hydrogen and electricity, and imposing road pricing.

Source: The Copenhagen Climate Plan; http://www.c40cities.org/docs/ccap-copenhagen-030709.pdf.

2.2 Green mobility

Transport accounts for more than one-third of final energy consumption in Thailand, the second-largest energy consumer. In particular, the BMR consumes 47 percent of gasoline and 44 percent of diesel. Reducing energy growth in the urban passenger transport sector is regarded as a high priority area, but also as the most difficult area, because it involves multiple stakeholders. It requires integration of a three-legged approach: (a) transforming vehicles (through fuel economy standards and the promotion of fuel-efficient vehicles of hybrid, plug-in hybrid, and electric cars); (b) transforming fuels (ethanol, biodiesel, and natural gas); and (c) transforming mobility (urban planning and mass transit). In addition, fiscal policies such as a fuel tax and road pricing are critical to reduce vehicle-kilometers travelled.

Transforming vehicles and fuels can be relatively straightforward if the will is there. Policy direction from the central government, such as the promotion of biofuels and alternative fuels, has been the key driver for these transformations. However, improving mobility has long been a major challenge for Bangkok, as for other big cities, because such transformation involves not only policy but also complex institutional arrangements for implementation.

Since the 1990s, the city has made remarkable progress in improving mobility thanks largely to the completion and operation of several major expressways and mass rail transit lines, the adaptive travel behavior of commuters (such as choice of travel time based on real-time traffic information), the contribution to traffic management by a large number of traffic supervisors employed by private developers, and a significant share of motorcycles in the traffic mix, which are more traffic-efficient.

High fuel prices and the removal of gasoline subsidies in recent years have also added to the favourable situation. Nevertheless, mobility remains a key issue for the city in terms of moving people more efficiently, maintaining the city's competitiveness, and reducing energy consumption and GHG emissions. Bangkok has a long way to go to catch up with the transport performance of best-practice cities like Hong Kong and Singapore and to contribute significantly to the national green growth agenda. The challenge is that the recent achievements may be quickly eroded by continuing growth.

Currently, the need to develop a well-functioning public transport system to alleviate traffic congestion and improve mobility is well recognized by policy makers. The government strategy focuses on the expansion of the MRT system. However, the MRT alone will not be enough to fully address future traffic challenges. MRT service coverage will be limited for many years. A well-functioning MRT system requires good accessibility and supporting road-based public transport systems to feed the system. Efforts on other fronts, such as bus service improvements, public transport modal integration, pedestrian accessibility improvement, and road pricing are equally important. All these will contribute not only to the improvement of transport system performance, but also to energy savings if they induce a shift away from personal vehicles to public transport.

While several measures could be taken to improve mobility, institutional fragmentation in the urban transport sector is the key impediment preventing concerted efforts being taken. This institutional fragmentation is fundamentally characterized by overlapping distribution of transport responsibilities between levels of government (for example, central vs. local government) and functional distribution between policy and management functions and transport operations. Such institutional arrangements make it difficult to effectively plan and implement an optimal transport system and integrate transport services and management, since responsibilities fall under different authorities. Several reform proposals have been put forth to devise a new institutional arrangement that aims to address institutional and regulatory issues, such as bringing public transport management under a single authority, with a clear policy framework, performance criteria, and reporting mechanisms to ensure that such authority is held responsible for the sound functioning of the public transport system. What is crucial, however, is the strong political commitment to push forward with the reform agenda.

Urban road pricing is another potential fiscal measure to reduce motorized transport. Thailand has not employed demand management to curb road use due to the country's strong and dominant road and car culture, to which the use of demand management could potentially cause a political backlash. Currently, there are three main types of user charges on motorists in the country: (a) tolls for the use of expressways and motorways, (b) taxes and charges on vehicles including related license fees, and (c) taxes and levies imposed on fuels. The first is a road usage charge and applies to controlled-access roads or expressways. The others are not related to the use of specific roads. No additional charges are applied to motorists in the BMR.

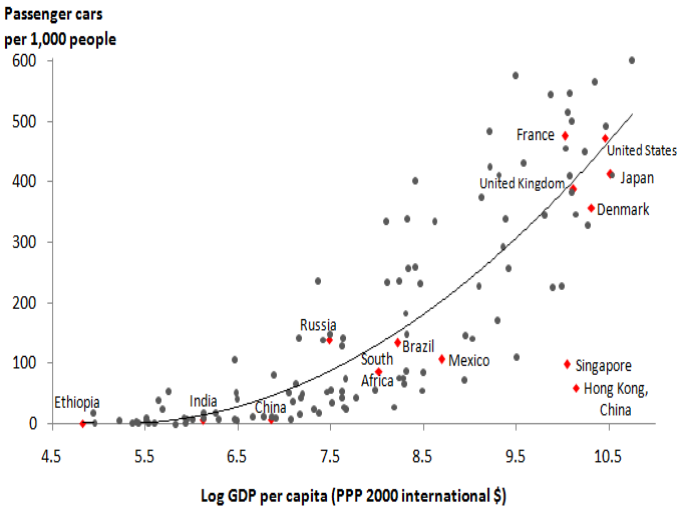
The current system of road use charges does little to moderate the use of vehicles during congested times and in congested locations. The annual vehicle registration fees in Thailand are also very low. By comparison, the registration fees in developed countries, such as Australia, the United

States, and Europe, are several times higher. There is scope to increase charges and modify the structure of current vehicle registration fees and charge regimes (World Bank 2009c). This could start with a review of the existing legislation governing the administration and use of heavy vehicles (Land Transport Act) and passenger vehicles *(Motor Vehicles Act)* under the Department of Land Transport. A more comprehensive pricing scheme would allow the public to recover the average cost that motoring imposes on the community at large, which includes the cost of providing roads and environmental and social costs. Given the current institutional capacity, the introduction of a comprehensive road pricing policy targeted at the BMR to improve traffic efficiency is not foreseeable in the near future. However, successful implementation of congestion pricing in Singapore (box 2.3), London, and Stockholm has proved that it is possible and should be considered by developing cities like Bangkok.

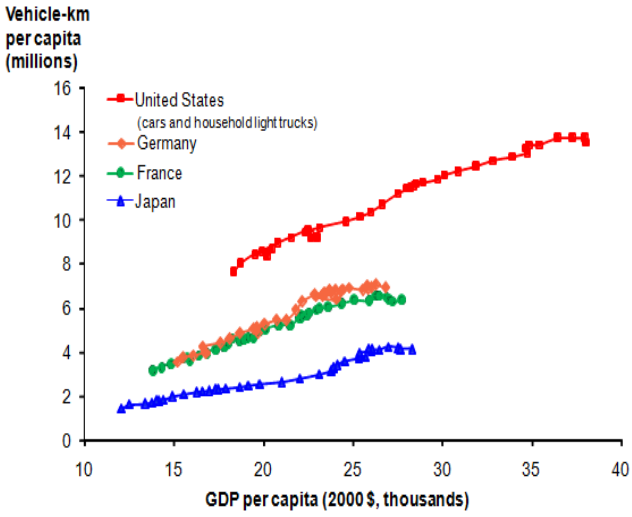
Bangkok's car ownership has risen from 4.2 million in 1999 to 6 million registered vehicles today. However, the increased rates of ownership do not necessarily translate into similar increases in car use (figure 2.4). Because car use drives energy demand and emissions from transport, policies to reduce the need to travel (such as road pricing and high parking fees), public transport infrastructure, and urban form can make a big difference.

Figure 2.4 Car ownership increases with income, but pricing, public transport, urban planning, and urban density can contain car use

Panel A



Panel B



Source: World Bank 2009a, 2009b

Note: In panel B, for Germany, data are from West Germany through 1992; from 1993 onward, the series includes all of unified Germany.

In this regard, experience from Europe and developed Asia offers insights (see box 2.3 for Singapore's experience). European and Japanese drivers travel 30 to 60 percent fewer vehicle-kilometers than drivers in the United States, with comparable incomes and car ownership. Hong Kong has one-third the car ownership of New York, the American city with the lowest ratio of cars per capita. How? Through a combination of high urban density, a high fuel tax and road-pricing policies, stringent fuel economy standards, and a well-established public transport infrastructure. Similarly, Europe has four times the public transport routes per 1,000 persons as the United States (World Bank 2009b). But in many Thai cities, public transport has not kept up with urban growth, so the move to individual car ownership is causing chronic and increasing problems of congestion.

Box 2.3 Singapore: A Model for Urban Planning and Transport

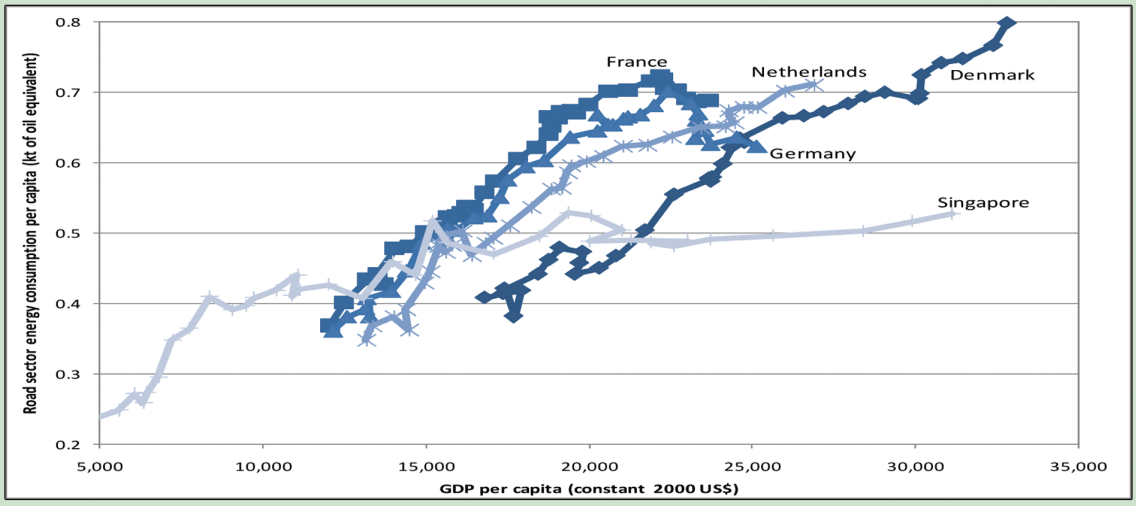
Singapore is a model of the most transformative urban development in the world. The city-state has made a remarkable transition from a poverty-stricken slum to a wealthy, bustling metropolis-all in less than 40 years. Adherence to strong planning practices and transport policies has made Singapore an attractive place to live and work and a desirable location for foreign investment.

With only about 650 square kilometers of land area and nearly 5 million inhabitants, Singapore is characterized by a high population density and efficient transport systems. This success is achieved through a multifaceted transport and land use strategy consisting of four key components:

- **Integration of town and transport planning:** Industrial, residential, and social infrastructure is placed within walking distance of bus stops and mass rapid transit stations. Road networks are designed to make bus service accessible from residential areas, and pedestrian walkways are covered to provide protection from rain and extreme weather. A mixed-use planning strategy puts work and home closer together, moderating the demand on transport systems.
- **Sustainable expansion of the road network:** Road construction and maintenance are both financed by revenues from road users. The road network was expanded over time to 12 percent of the total land area, which is considered the maximum desired land area allocation.
- **Management of vehicle ownership and usage:** Ownership of personal vehicles is limited by a government-controlled quota (Vehicle Quota Scheme) and a tax on new vehicle registrations (Additional Registration Scheme). Use of personal vehicles is deterred by a congestion charge for vehicles entering a designated restricted zone during certain hours (Electronic Road Pricing).
- **Improvements in public transport:** The far-reaching, multimodal public transit network consists of four major systems: mass rapid transit, light rapid transit, buses, and taxis. The transit systems have integrated operating institutions, service networks, and fare schemes. The stations are situated in or near commercial and office developments and are designed to facilitate efficient transfers between modes. Public transit is regulated to maintain its reliability, affordability, and efficiency.

The planning and policy measures to deter driving and encourage public transit have reduced congestion and pollution, which is a major draw for international business and investment (Willoughby 2001). Over time, Singapore's planning strategies have raised the GDP per capita higher than some already developed countries, all while maintaining a low level of energy consumption in the road sector (figure B2.3.1). Singapore has set a precedent for sustainable policy development, ensuring low-carbon land use and transport planning practices into the future.

Figure B2.3.1 Singapore has a much lower ground transport energy consumption than Europe



Source: World Bank 2009a

2.3 Sustainable water and waste management

Water Management

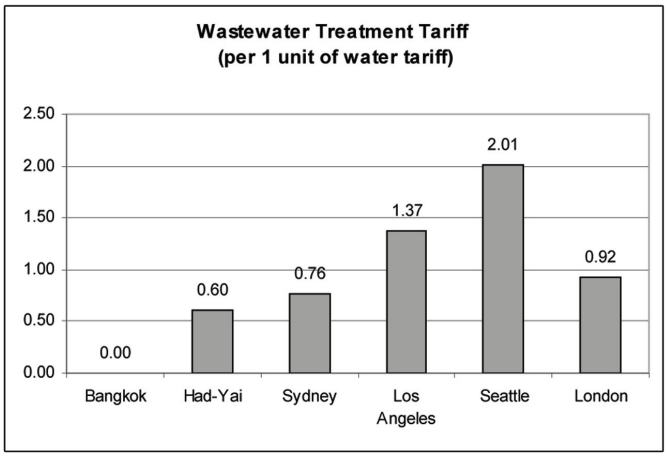
Water is an indispensible resource and is crucial to city development and growth. The goal of water management at the city level is to provide water services to all in a sustainable and optimal manner. Generally, water policies and legislation are set at the central level and regulations are imposed centrally or locally. There is close interaction between the national and local level in policy, legislative, and regulatory functions concerning water.

A sound institutional setup, which clearly defines policy, regulatory, and operating functions by service providers is a critical requirement. There are two main agencies responsible for sourcing, production, and distribution of water in Thailand-the Metropolitan Waterworks Authority for Bangkok and the metropolitan area and the Provincial Waterworks Authority for provinces outside of Bangkok and the metropolitan area.

The fundamental question in water management in a city is how to meet water demand with adequate supply. An insufficient water supply is becoming a major challenge in Thailand, due to excessive groundwater use by industry and a lower level of surface water and natural water resources. Therefore, nontraditional water resources such as wastewater reuse become increasingly important. However, only 12 percent of wastewater is treated in Bangkok, well below the regional average of 60 percent (Asian Green City Index 2010). Most of the wastewater treatment facilities are underused.

The absence of a pricing mechanism in wastewater treatment services partly explains the deficiency in wastewater treatment facilities, since there is no financial incentive for investment in the sector. Currently, there are only four municipalities that collect fees for wastewater treatment. The current tariffs, where they are collected, do not reflect actual costs of wastewater management and are not based on a polluter-pays principle (figure 2.5). Even when the tariffs are in place, tariff collection is a problem because of public resistance to wastewater treatment projects. Without sufficient financial support, long-term sustainability of the systems cannot be attained (World Bank 2008).

Figure 2.5: The wastewater treatment tariff is low in Bangkok compared to other developed cities



Source: ADB 1999.

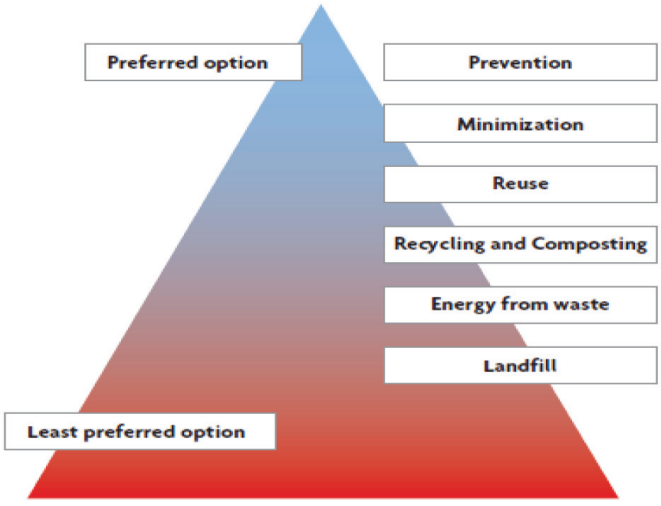
Cost-reflective pricing of water is also needed, as are progressive block tariffs that provide incentives to improve services and enhance efficiency, conservation, equity, and social and environmental protection. Innovative technological devices to promote water conservation can also help improve water consumption efficiency (Suzuki and others 2010). There is a direct relationship between water use and energy savings, and a synergy between the two in terms of design and operation could lead to mutual benefits of energy saving, sustainable and adequate water supply, and net monetary savings to Bangkok.

Waste Management

Solid waste management is an increasing concern for all urban areas in Thailand because volumes of waste have been increasing following expanding economic activities, while city administrators are trying to find feasible policy and technology solutions. The main objective of waste management is the protection of public health and the environment, primarily by controlling and eliminating air and water pollution. With greater emphasis being put on low-carbon and sustainable urban management, the conservation of materials and energy resources is becoming another important aim of well-designed management systems.

Approaches to waste management are universally presented in pyramid form (figure 2.6), where the most preferred option is prevention (at the top of the pyramid) and the least preferred option is waste disposal (at the bottom of the pyramid). Waste reduction at the source involves demand management practices including reuse and extending product life. Recycling also includes composting. Energy recovery such as methane is also gaining significance as the economy strives to optimize resources usage.

Figure 2.6 Pyramid of Choices for Waste Management



Source: Suzuki and others 2010. .

The waste management chain comprises waste storage, vehicle collection, formal and informal recycling (at collection points, treatment facilities, and disposal sites), collection at transfer stations, treatment facilities (including organic waste composting or incineration), and disposal sites for direct and residual waste from households, commercial establishments, and treatment facilities. Opportunities for energy recovery exist for incineration plants and landfill gas, which has about 50 percent methane composition, an important source of GHG emissions.

The Thai government's primary aim in solid waste management is to reduce the amount of waste generated, since Thailand has a relatively high waste generation rate compared to other countries in the region. The target set by the Ministry of Natural Resources and Environment is to reduce the rate of waste generated in Bangkok to less than 1 kilogram per person per day. In the meantime, the government is also promoting recycling and waste separation to reduce waste volume, with an emphasis on sanitary waste management to gradually reduce unsanitary waste handling (for example, open dumping and burning) and effective management and control of hazardous waste and substances.

Budget allocation is a major constraint to the development of an effective waste management system in Thailand. An insufficient budget results in several waste management facilities operating below sanitation standards and without proper maintenance. Due to insufficient budget allocation and poor operation, some waste management facilities generate pollution and negative externalities, such as leakages and smells, into local communities. In addition, insufficient fee collection leads to a lack of funding for services, which in turn results in inefficiencies in facility operations. Furthermore, local governments may lack expertise and experience in sanitary solid waste management and hazardous waste management. Insufficient expertise and manpower to operate the system reduces services efficiency. Some facilities, although financed and built, do not have enough qualified staff to become operational (World Bank 2008).

CHAPTER 3

Tapping Energy Efficiency Potential: Achieving the Energy Efficiency Development Plan

1. Energy efficiency in Thailand: Energy intensity has not changed much over the last decade, but the government is committed to reducing energy intensity in the future

1.1 Thailand has actively adopted policy measures for energy efficiency

Energy conservation is the largest and lowest-cost source of emissions reduction in Thailand. Energy Efficiency (EE) is one-third the cost of building new energy supply facilities and can be done more quickly. So energy efficiency (negawatts) should be considered on a par with traditional supply-side measures (megawatts) in energy resource planning. Energy efficiency mitigates the risks and costs of Thailand's high energy intensity and will allow Thailand to maintain competitiveness. It is also a cost-effective short-term option to help address power shortages and enhance energy security.

Annex 3 provides a detailed discussion of Thailand's efforts to promote energy conservation. This section will provide a brief discussion of those efforts.

- **Legal framework:** The Energy Conservation and Promotion Act (ENCON Act) laid out a solid legal framework for energy conservation in Thailand. To implement the ENCON Act, the government has implemented a series of mandatory regulations and fiscal incentives, conducted public education, and promoted technology research and development and technology transfer.

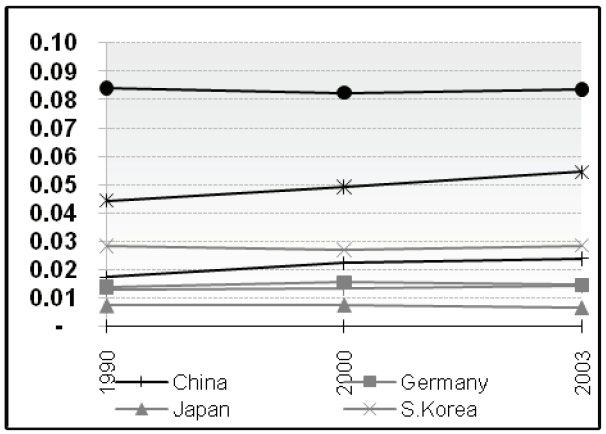
- **Mandatory regulations:**
  - ***Mandatory energy managers program for designated industries and buildings:*** Under this regulation, energy-intensive factories and buildings must appoint an energy manager to recommend and implement energy conservation measures. However, this program has not worked well. Much of the planned investments in the designated factories and buildings did not materialize, because the energy managers program is essentially an input-based, rather than an output or performance-based, regulation. The designated factories and buildings have no incentives to materialize the planned investments, since there are neither mandatory targets for achieving energy savings nor penalties for not achieving them.
  - ***Building codes:*** While Thailand issued its first building code in 1995 and revised it in 2007, the code achieved limited success. This was due to (a) a lack of differentiated standards for various types of buildings—public buildings, commercial buildings, and so forth; and (b) weak enforcement, resulting in low participation and implementation rates. A new building code was promulgated in 2010 that required new buildings to be designed with energy efficiency as a cornerstone of the construction.
  - ***Appliance standards:*** Thailand also implemented one of the most extensive appliance energy efficiency standards and labeling programs in the region, including mandatory energy performance standards, voluntary high energy performance standards, and voluntary energy performance labeling.

- **Fiscal measures:** The country has also been employing a range of pricing and fiscal incentives, with a focus on fuel taxes and levies. Thailand has high fuel intensity (figure 3.1). The current fuel prices in Thailand, inclusive of taxes and charges, reflect international market prices but are substantially lower than in Europe and Japan, which have much lower fuel intensity (figure 3.2). Therefore, Thailand could further increase fuel taxes to reduce fuel consumption. In addition, Thailand introduced an import duty exemption for EE equipment, investment incentives through the Board of Investment, tax rebates, grants and subsidies for demonstration projects, and soft loans through the EE Revolving Fund.

- **Energy Conservation Fund:** Thailand is also one of the first developing countries to establish an Energy Conservation Fund, in 1992, from a petroleum levy to support implementation of the ENCON Act (see details in section 2.2 and Annex 4).

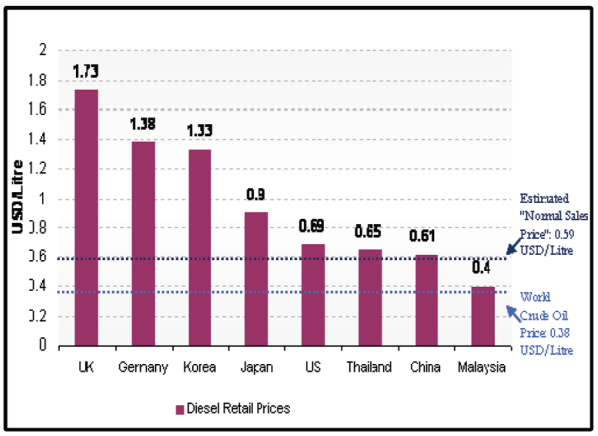
- **The Electricity Generating Authority of Thailand's (EGAT's) Utility Energy Efficiency/ Demand-Side Management (DSM) Program:** EGAT implemented a successful DSM program in June 2007 that has exceeded its energy-saving targets. However, the utility is in business to sell more electricity, not to save it, so energy conservation is against its inherent commercial interests. A successful utility-based EE/DSM program requires decoupling utility profits from electricity sales to give utilities incentives to save, as was done in California.

Figure 3.1 Diesel fuel intensity in Thailand is higher than in other countries



Source: Calculated based on data from IEA access via World Resources Institute; http://earthtrends.wri.org.

Figure 3.2 Thailand has a lower retail diesel price than Japan or Europe

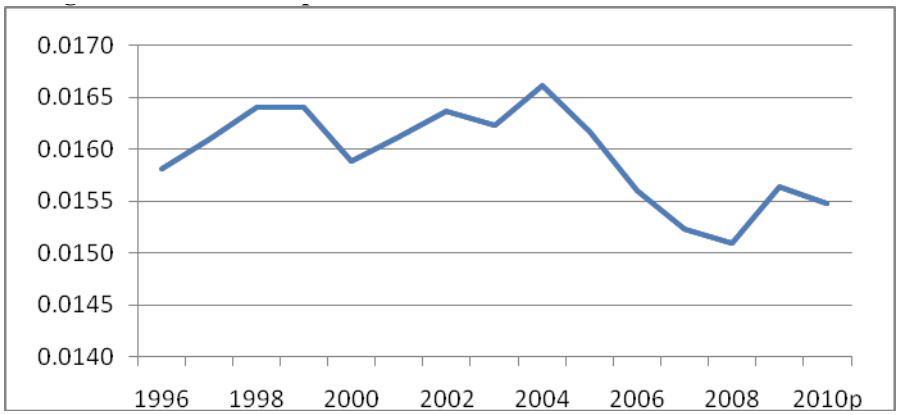


Source: GTZ 2007.

1.2 But energy intensity has not changed much over the last decade

However, these policies and financing mechanisms have not yielded the intended results. Thailand's energy intensity has not changed much over the last decade (figure 3.3) and is higher than in its comparator country, Malaysia.

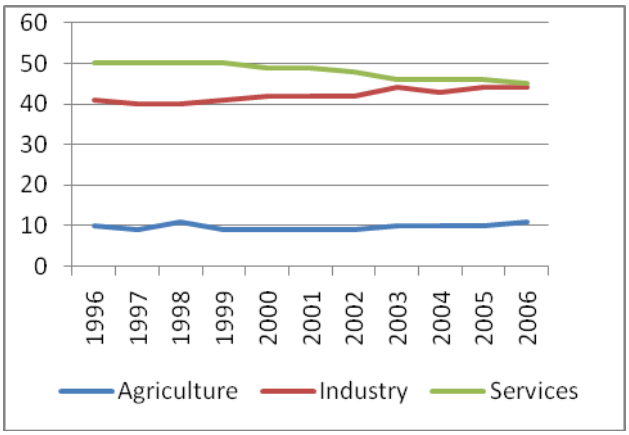
Figure 3.3 Energy intensity (1,000 ton of oil equivalent/million Baht of GDP at 1988 prices) has not changed much over the past decade in Thailand



Source: DEDE 2011a.

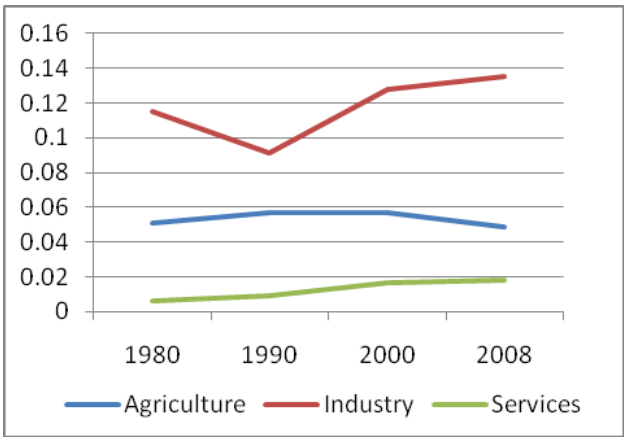
The main reasons for this are the increasing share of the energy-intensive industry sector and little improvement in energy efficiency at the sector level. As shown in figure 3.4, the energy-intensive industry sector's contribution to GDP increased from 41 percent in 1996 to 44 percent in 2006, while the less energy-intensive service sector share of GDP dropped from 50 percent to 45 percent during the period. Furthermore, an increase in energy intensity at the sector level, especially in the industrial and service sectors, contributed to an increase in the overall energy intensity. As shown in figure 3.5, during 1990–2008, energy intensity increased by 48 percent for the industrial sector (from 0.091 kilograms of oil equivalent [kgoe]/2005US$PPP to 0.135 kgoe/2005US$PPP) and by 100 percent for the service sector.

Figure 3.4 The share of energy-intensive industry GDP has been increasing



Source: World Bank 2009a

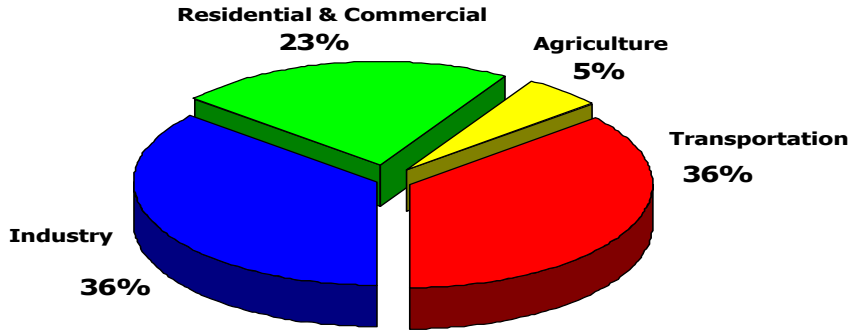
Figure 3.5 Energy intensity in the industry sector (kgoe/2005 US$ PPP) has also been increasing



Source: Enerdata; http://www.worldenergy.org/documents/tha.pdf.
Note: kgoe = kilogram of oil equivalent.
PPP = purchasing power parity.

In 2009, the industry sector and the transport sector each contributed to 36 percent of Thailand's energy consumption (figure 3.6). By 2030, the industry sector is expected to become the largest consumer of energy, consuming around 40 percent of total energy consumption, followed by the transport sector.

Figure 3.6 Industry and transport dominated Thailand's final energy consumption in 2009



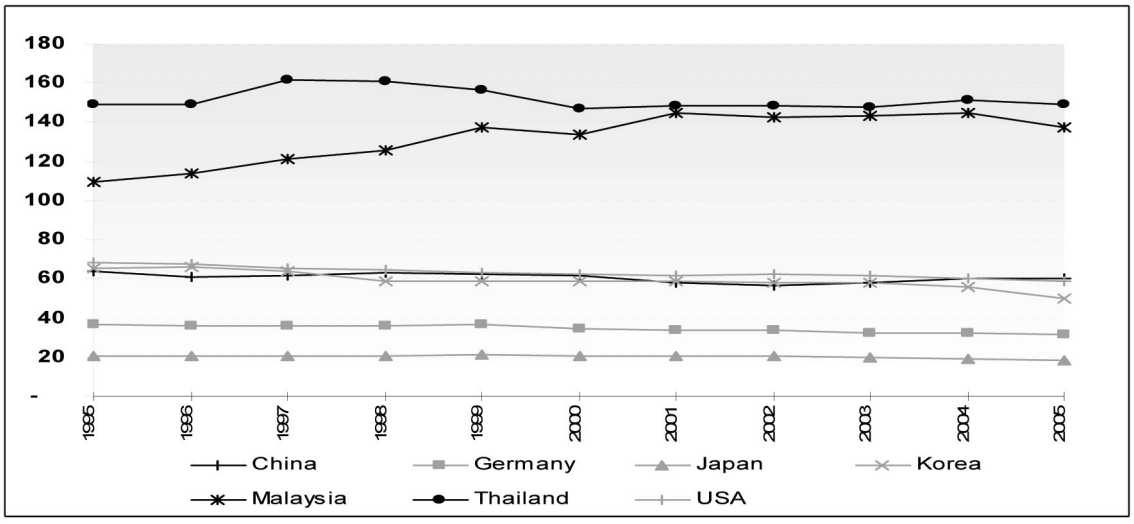
Source: DEDE, 2011a.

The increase in energy intensity in the industrial sector is mainly driven by the rising dominant share of the manufacturing industry. Thailand's industrial sector consists of the manufacturing, construction, and mining industries. The manufacturing industry is significantly more energy intensive than the mining and construction industries in Thailand. The manufacturing industry dominates the industry sector, accounting for 98.5 percent of industrial energy consumption, and its share has increased from 80 percent in 1981 to above 91 percent in 2000 (Bhattacharyya and Ussanarassamee 2004).

Thailand's manufacturing industry has employed both highly efficient and obsolete technologies. Thus, EE policies should focus on retrofitting or eliminating those obsolete technologies to improve the overall energy efficiency in the manufacturing sector. Among the nine subsectors within the manufacturing sector, the nonmetallic industry is the most energy intensive, followed by the basic metal, food and beverage, chemical, and paper industries.

The transport sector is one of the most energy intensive compared to China, Germany, Japan, Korea, and the United States (figure 3.7). Little improvement in transport energy intensity has been made over the last decade in Thailand.

Figure 3.7 Transport energy intensity (toe/million US$ GDP at 2000 constant prices) in Thailand is higher than in other countries



Source: World Bank 2009a

The high level of transport energy intensity in Thailand results from the high level of motorization, heavy dependence on road transport, and a lack of fuel economy standards (World Bank 2009c). Road transport dominates the transport mode and contributes to three-quarters of energy consumption in the transport sector, while rail plays a very small and declining role. In 2009, rail transport contributed to only 1.8 percent of modal shares of freight transport in terms of ton-kilometer. This is in sharp contrast to what is observed in countries like China (51 percent), Germany (21 percent), Korea (9 percent), and the United States (45 percent), where rail has played a significant role in freight transport.[3] In addition, the majority of Thailand's vehicles use diesel, and fuel economy standards are not applied to gasoline- or diesel-powered vehicles. The truck fleet is, on average, quite old and fuel inefficient. Due to low taxes, fuel prices are relatively low compared to Japan and Western European countries. The estimated fuel efficiency of Thailand's passenger vehicle fleet today is approximately 25 to 30 percent lower than the levels found in Japan and Western Europe (Word Bank 2009c). Because almost half of transport energy usage occurs around the Bangkok Metropolitan Region (BMR), traffic congestion in the BMR also contributes significantly to Thailand's high transport energy intensity. Therefore, special efforts should be made to improve transport energy efficiency in the BMR.

1.3 The government is committed to reducing energy intensity under the Energy Efficiency Development Plan

The government has set a target to reduce energy intensity by 25 percent from 2005 to 2030, or 20 percent from the business-as-usual case, equivalent to 30,000 tons of oil equivalent (ktoe) in 2030, in the latest Energy Efficiency Development Plan (EEDP). The EEDP was approved by the Cabinet this year, and provides a strategic long-term policy framework to drive the EE agenda and acts as another key policy pillar for the national low-carbon growth agenda.

To achieve the EEDP, the transport sector presents the largest energy savings, accounting for 44.3 percent of the target, almost half of the total savings in 2030. The industrial sector has the second-largest energy savings, with 37.7 percent of the target, followed by commercial and residential buildings. The potential energy savings in the transport sector could largely be achieved by improving the fuel efficiency of vehicles (for example, fuel economy standards, car labeling, eco-driving), and to a less extent through a modal shift to public transport. Within the industry sector, the nonmetal and food industries are estimated to have the largest potentials. In the building sector, one-third of the potential energy savings could come from a reduction in electricity use in large and medium-size commercial buildings (DEDE 2011a).

The government plans to use a mix of compulsory and voluntary measures to achieve the target. Policy instruments will include strengthening regulations and enforcement and intensifying the use of price and market incentives and raising public awareness. The implementation plan includes five types of measures: (a) compulsory regulations and standards, (b) voluntary and market-based measures, (c) awareness raising, (d) capacity building and institutional strengthening, and (e) technology and innovations (table 3.1).

[3] Data on percentage share of rail from total freight ton-kilometers for Germany (2006), Korea (2005), and the United States (2005) are from OECD/ITF (2008). Data for China (2005) are from the World Bank (2009a).

Table 3.1 Thai Government's EE Policy Measures to Achieve EEDP

Compulsory Regulations	Voluntary and Market-Based Measures
• Enforcement of the new ENCON Act • Mandatory labeling and Mandatory Energy Performance Standards (MEPS) for electric appliances • Energy efficiency portfolio standard (EEPS) for large industries with a penalty for noncompliance and financial incentives for exceeding the target	• Voluntary agreements with large energy consumers • Voluntary labeling • Mass transit and efficient logistics • DSM bidding • Subsidies for reducing peak load under Standard Offer program • Expanding energy service company (ESCO) Fund • Cost-reflective energy pricing • Fiscal incentives
Awareness Raising and Capacity Building	**Technology and Innovations**
• Educating the public on eco-driving • Promoting a low-carbon society and economy agenda • Building capacity for human resources and professionals • Strengthening public and private organizations for planning, regulating, and promoting EE policies and measures	• Increasing research, development, and deployment

Source: DEDE 2011a.

1.4 Energy efficiency continues to face major challenges in Thailand

Many EE measures are financially viable for investors at current prices but are not fully realized due to many market failures and barriers (box 3.1), which include:

- The current input-based approaches and voluntary measures to improve energy efficiency have not achieved their intended results. For example, the current energy managers program requires energy-intensive factories or buildings to appoint an energy manager, but they have no incentives to materialize the planned EE investments to achieve energy savings (see details in section 2.1).
- Financing the up-front investment in EE faces major challenges, despite their lifetime "negative" costs (that is, fuel savings greater than additional investments). EE investments tend to be small with high transactions costs. They are also perceived as risky since investors are not sure whether the expected future savings will be realized. Financial institutions lack the required expertise and interest in developing the EE business line. As a result, there is inadequate EE lending by domestic banks in Thailand, particularly to small and medium enterprises and energy service companies (ESCOs). While lack of domestic capital is rarely a problem, inadequate policy frameworks and institutional capacity are significant constraints to financing EE in Thailand (see details in section 2.2).
- Small-scale, fragmented EE measures, involving multiple stakeholders and tens of millions of individual decision makers, are organizationally more complex than large-scale, supply-side options. A lack of clear roles and responsibilities and effective coordination among sectors and between the central government and local governments are a major impediment to energy efficiency in Thailand (see details in section 2.3).

Box 3.1 Energy Efficiency Faces Many Market Barriers and Failures

Obstacles to energy efficiency include:

- Low or underpriced energy. Low energy prices undermine incentives to save energy.
- Regulatory failures. Consumers who receive unmetered heat lack the incentive to adjust temperatures, and utility rate-setting can reward inefficiency.
- A lack of institutional champion and weak institutional capacity. Energy-efficiency measures are fragmented. Without an institutional champion to coordinate and promote energy efficiency, it becomes nobody's priority. Moreover, there are few energy-efficiency service providers, and their capacity will not be established overnight.
- Absent or misplaced incentives. Utilities make more profit by generating and selling more electricity rather than by saving energy. For most consumers, the cost of energy is small relative to other expenditures. Because tenants typically pay energy bills, landlords have little or no incentive to spend on efficient appliances or insulation.
- Consumer preferences. Consumer decisions to purchase vehicles are usually based on size, speed, and appearance rather than on efficiency.
- Higher up-front costs. Many efficient products have higher up-front costs. Individual consumers usually demand very short payback times and are unwilling to pay higher up-front costs. Preferences aside, low-income customers may not be able to afford efficient products.
- Financing barriers and high transaction costs. Many energy-efficiency projects have difficulty obtaining financing. Financial institutions usually are not familiar with or interested in energy efficiency, because of the small size of the deal, high transaction costs, and high perceived risks. Many energy service companies lack collateral.
- Limited awareness and information. Consumers have limited information on energy-efficiency costs, benefits, and technologies. Firms are unwilling to pay for energy audits that inform them of savings.

Source: Wang and others 2010.

To address these barriers and achieve EEDP, Thailand needs to (a) strengthen mandatory performance-based regulations and increase the use of fiscal measures to complement the existing voluntary measures and input-based approaches in the transport and industrial sectors; (b) develop and implement innovative financing mechanisms; and (c) reform institutional arrangements to tap the country's large energy efficiency potential.

2. Harvesting the remaining potential of energy efficiency: Effective policies, innovative financing mechanisms, and institutional reforms

2.1 Strengthening EE regulations and fiscal measures

Effective policy is the driver to achieve the goal of the EEDP. Economywide energy-intensity targets, appliance standards, building codes, industry performance targets (energy consumption per unit of output), and fuel efficiency standards are among the most cost-effective measures. However, weak enforcement of regulations is a concern in Thailand, and regulations are also vulnerable to rebound effects.[4] Therefore, pricing and fiscal policies should go hand in hand with regulations.

Fuel taxes have proved to be one of the most cost-effective ways to reduce transport energy demand, along with congestion charges and insurance or tax levies on vehicles based on kilometres traveled, and higher taxes on light trucks and SUVs. However, the higher first costs of energy-efficient products are usually a barrier for consumers to adopt them, particularly low-income consumers. Financial incentives to offset these up-front costs, such as consumer rebates and energy-efficient mortgages,[5] can change consumer behavior, increase affordability, and overcome barriers to market entry.

[4] Rebound effects means that acquiring efficient equipment lowers energy bills, so consumers tend to increase energy consumption, eroding some of the energy reductions.

[5] An energy-efficient mortgage allows borrowers to qualify for a larger mortgage by including home energy-efficiency measures due to their energy savings.

In addition, a number of European countries and U.S. states oblige utilities to meet energy saving targets and allow them to trade energy saving certificates, often called "white certificates." In these cases, enterprises have the choice of meeting their obligations themselves fully through their own efforts or purchasing white certificates on the market to make up any differences. In Europe, such a system was first launched by the United Kingdom and then was also adopted in France and Italy. In the United States, it has been tried by several state governments in their regulation of electric power utilities. India has also implemented a similar program called Perform, Achieve, and Trade to set energy saving targets for top energy-intensive industries and to allow them to trade energy saving certificates. Box 3.2 describes the program.

If they can be effectively implemented, white certificate trading schemes can offer great advantages in terms of increased fairness and increased economic efficiency. Enterprises that have great difficulty meeting their energy savings obligations have the option of purchasing the required energy savings. Enterprises that have great remaining potential for energy savings have a cash incentive to deliver more savings after meeting their obligations. Economic efficiency gains are achieved by enabling delivery of energy savings according to comparative advantage. However, white certificate trading schemes require objective and fair certification systems, which may result in high transactions costs, at least initially. But probably a more difficult issue is the fair but effective definition of baselines.

Box 3.2 Energy Savings "White Certificates"

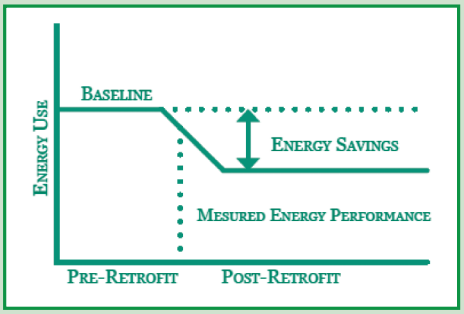
The "white certificate" system works with an obligation scheme. Market actors are obliged to reach a certain amount of energy savings. Target compliance requires submission of a number of certificates commensurate with the energy saving target. Certificates can be created from projects that result in energy savings beyond business as usual. The market actor receives certificates for savings achieved, which can be used for their own target compliance or can be sold to (other) obliged parties.

The key steps to establish the white certificate scheme include:

- Appointing an independent body to issue certificates
- Clearly defining certificates as to size, technologies, eligibility, validity, and so forth
- Formulating "rules of the game" regarding trading, parties, compliance, and so forth
- Establishing a registration system and systems for monitoring and verification
- Formulating compliance rules and setting penalties
- Organizing redemption of certificates.

Measurement and verification is the key to an effective tradable certificates mechanism applied to the promotion of energy efficiency in end-use sectors. Since savings cannot be measured, they need to be calculated by comparing measurements of energy use, energy demand, or both before (that is, the baseline energy use) and after implementation of the saving measure (see figure B3.2.1).

Figure B3.2.1 Calculation of Energy Savings



Source: EuroWhiteCert Project 2006.

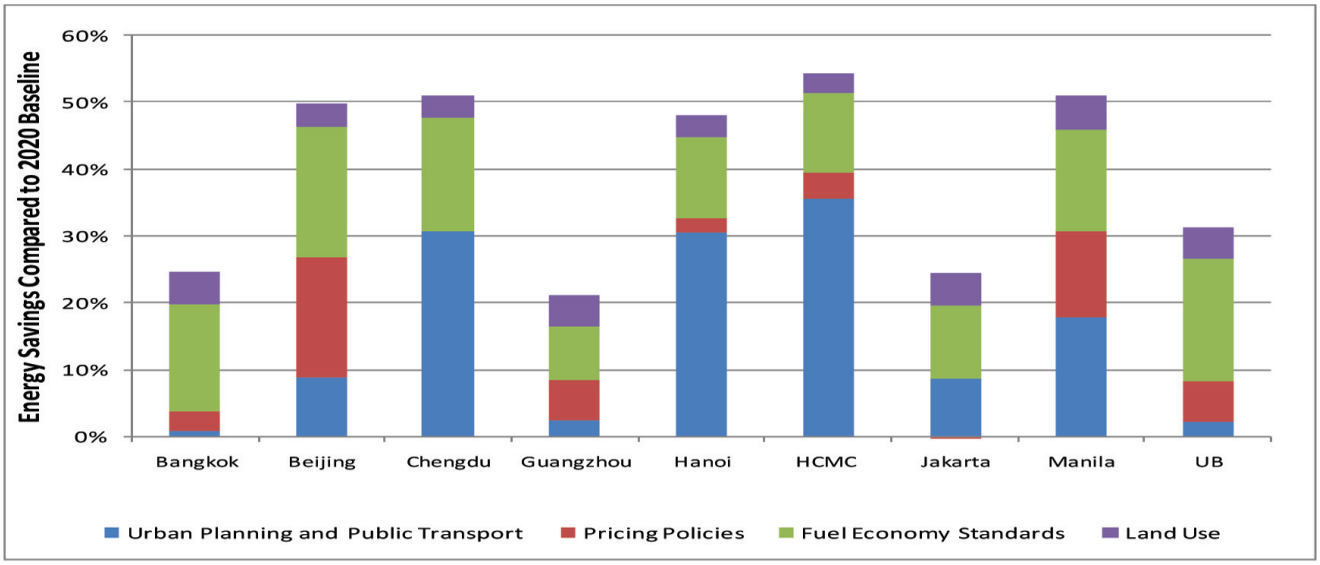
Given that the transport and industrial sectors are identified as having the largest energy saving potential, it is recommended that the government may consider increasing the use of mandatory regulations in the industrial sector such as industry performance targets for large energy-intensive enterprises, and in the transport sector, such as fuel-efficiency standards, in the future. In the meantime, Standard Offer, fuel tax, and road pricing have proven to be cost-effective fiscal measures to tap EE potential. Several of the recommendations below dovetail with the latest government's EEDP implementation plan.

2.1.1 Improving energy efficiency in the transport sector: Fuel economy standards, fuel tax, and road pricing

Fuel economy standards

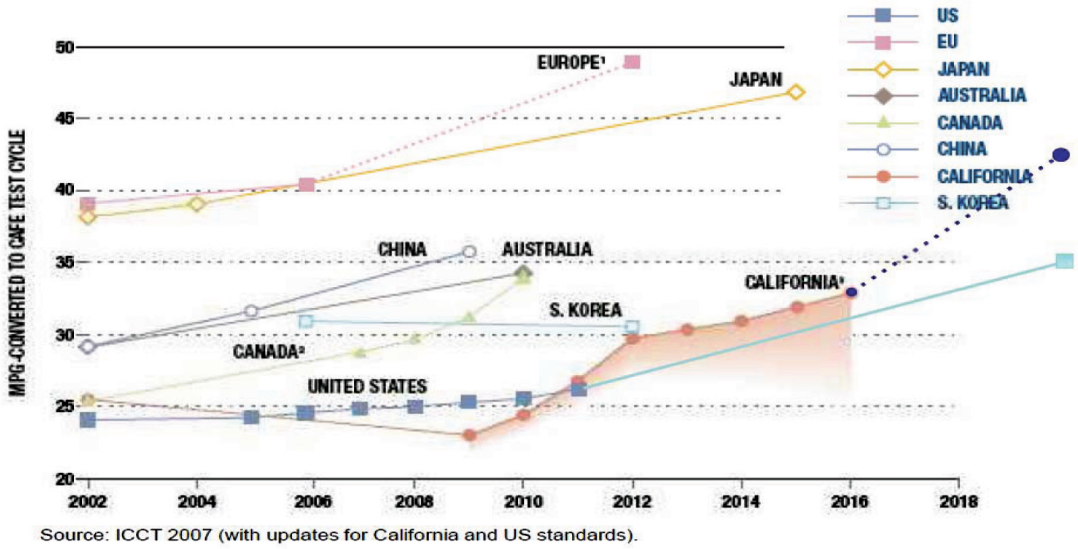
The Thai government may consider implementing vehicle fuel economy standards to improve fuel efficiency of vehicles. A World Bank study (Wang and others 2010) shows that improving automobile fuel economy standards to the current European Union level would make the biggest difference, contributing to more than 60 percent of energy savings in the transport sector in Bangkok by 2020 (figure 3.8). As shown in figure 2.4 in chapter 2, Europeans and Japanese drive 30 to 60 percent fewer vehicle-kilometers than Americans, and as shown in figure 3.9, their high automobile fuel economy standards are a major contributing factor.

Figure 3.8 Improving fuel economy makes the biggest difference for energy savings in the transport sector in Bangkok



Source: Wang and others 2010.

Figure 3.9 Europe and Japan have much higher fuel economy standards than the United States



Source: Energy Foundation 2009.

Fuel tax and road pricing

Fuel taxes play an important role in reducing transport energy consumption and emissions. European experience has shown that fuel taxes have restrained growth in fuel demand and associated carbon emissions. There is strong research evidence showing that fuel demand is elastic and responsive to prices. The price elasticity is in fact quite high, but only in the long run; in the short run it may be quite inelastic, which has important implications for policy makers. Had Europe not followed a policy of high fuel taxation but had low taxes like in the United States, fuel demand would have been twice as high. One study shows that fuel taxes are the most powerful environment and climate policy instrument implemented to date (Sterner 2007).

As mentioned in chapter 2, road pricing is another major fiscal policy that can be used to reduce energy consumption in the transport sector. Unfortunately, Thailand's current road use charges do little to moderate congestion. To contain energy growth in the transport sector, and based on international best practices, it is recommended that Thailand consider increasing the use of road pricing policies such as increased vehicle registration fees, congestion charges, and high parking fees.

2.1.2 Improving energy efficiency in the industrial sector: Energy performance targets and Standard Offer

Industrial energy performance targets

One effective policy measure to reduce energy consumption in the industrial sector is mandatory energy saving targets or energy performance targets (energy consumption per unit of output) for the nation's top energy-intensive industries through responsibility contracts between the government and industries. In return, the government can provide financial incentives, such as tax credits or subsidies, to those enterprises that achieve or exceed the target. This approach was first adopted as a voluntary measure in the Netherlands and, more recently, as a mandatory measure in China (box 3.3).

Box 3.3 China's 1,000 Industrial Enterprises Energy Conservation Program

To achieve the Chinese Government's ambitious target of reducing energy intensity by 20 percent from 2006 to 2010, the national 1,000 Enterprise Energy Conservation Program was launched in 2006. It established a new system for government-enterprise agreement on specific enterprise energy savings targets, and monitoring and supervision of compliance. The Central Government designated the top 1,008 energy-consuming enterprises in the country for participation. Together they account for about one-third of China's total energy use. Agreements on various enterprise energy conservation measures and energy savings targets for the five-year plan are established in energy savings responsibility contracts. National agencies have set the objectives, targets, scope, and implementation guidelines. Provincial governments are in charge of most of the implementation details. Progress in each enterprise is evaluated annually. The Program aims to make a major contribution to the country's five-year energy intensity reduction target by delivering some 100 million tons of coal equivalent (tce) of the 600 million tce to 700 million tce of total savings most likely needed to achieve the national 20 percent target. This 1,000-enterprise program would reduce annual CO_2 emissions by 245 million tons by 2010, higher than California's 2020 emission reduction target of 175 million tons (Energy Foundation 2009).

Additional measures to achieve the mandatory targets include (a) training of enterprise energy managers and organization of related technical assistance, (b) rollout of new standardized enterprise energy management systems (EMS), (c) development of comparative unit energy use benchmarking to assist enterprises in assessing savings potential, (d) supervision of and support for compliance with minimum energy efficiency performance standards and other key regulations, and (e) identification, packaging, and arranging types of financing support for energy efficiency investment projects.

In return, the government provides RMB 200 to RMB 250 (US$29 to US$36) per tce of annual energy savings capacity generated by eligible projects. This amounts to about 10 percent to 20 percent of the investment cost of a typical energy efficiency project. Unlike the previous investment subsidies programs, this program provides rewards disbursed only to enterprises with energy metering and measuring systems that can document proven savings of at least 10,000 tce from their previously approved energy saving technical transformation projects.

Provincial and prefectural governments have the main responsibility for monitoring and supervision of the key enterprise energy savings programs (although the Central Government also oversees the 1,000 Enterprise Program). Most provinces have established provincial-level supervision units to undertake this function, with authority broadly established by the Energy Conservation Law. A key task for the near term is the development and operation of new enterprise energy use data collection and reporting systems. Should they wish to apply pressure to comply with agreements, provincial and local governments have discretionary use of broad permitting and regulatory powers relating to enterprise operation and new project approvals.

Source: Taylor and others 2010.

Standard Offer

The Standard Offer is a mechanism for acquiring demand-side resources (energy efficiency and load management) under which a utility or a public agency "purchases" energy and/or demand savings using a predetermined and prepublished rate (Thai Baht per kilowatt-hour [THB/kWh] or Thai Baht per kilowatt [THB/kW]), which is called the Standard Offer. These rates are based on the value of the energy and demand savings to the utility system and not on the cost of implementation. Any energy user or energy service company (ESCO) that can deliver energy and demand savings is paid the fixed amounts per kilowatt-hour and kilowatt upon completion of the project and certification of the achieved savings by an authorized measurement and verification (M&V) organization.

The Standard Offer to energy efficiency is equivalent to a feed-in tariff to renewable energy, and has proven to be one of the most cost-effective approaches for energy conservation. In fact, it is used in many states in the United States. The World Bank team recommended the Standard Offer approach to South Africa to accelerate and scale-up the Eskom's Energy Efficiency and Demand Side Management Fund, which was well received by all stakeholders and is now being implemented.

The Standard Offer approach provides a number of significant benefits:

- It treats energy savings as a commodity and provides transparency and certainty on prices to purchase energy savings. Therefore, it benefits end users and ESCOs, which can generate EE projects quickly since they will be able to see the benefits of a short project completion cycle and specified payments. It will also help end users and ESCOs increase access to commercial financing because the project cycle is shortened and the payments are known in advance.
- The project approval process is streamlined without detailed evaluation of the technical and cost elements of the proposed projects, because the payments are made only after the savings have been delivered and verified.

The government can competitively select an Energy Efficiency Utility (EEU) as the fund manager and sign a time-bound, performance-based contract with them to achieve specified energy savings (see Annex 4 for details and examples). These are new institutions unrelated to electric power or other energy supply utilities whose sole purpose is to realize energy savings requested by governments as effectively and cheaply as possible. The EEUs operate under performance-based contracts, developed mainly in an effort to yield maximum energy savings at minimum cost. Entities operating the EEUs are typically procured through a public bidding process.

Following is a brief overview of a simplified Standard Offer approach for Thailand.

1. The Department of Alternative Energy Development and Efficiency (DEDE) and the Energy Efficiency Utility (EEU) develop the amount they will pay (THB/kWh) as the Standard Offer for delivered and verified energy savings. This amount is approved by the Energy Regulatory Commission and published.
2. The DEDE and EEU also prepare and publish a list of energy efficiency technologies or measures that will be eligible to receive payments under the Standard Offer.
3. The DEDE and EEU publish a list of certified M&V organizations that are authorized to verify the savings.
4. The end users or ESCOs develop the project concepts, prepare project proposals, and specify the client in the case of ESCO projects, the M&V organization, and the technologies and measures to be implemented.
5. The project proposal is submitted to the EEU for approval. The EEU needs only to approve the technologies or measures proposed and does not need to conduct a due diligence review of the technical, financial, or other elements of the proposal.
6. Upon approval of the technologies and measures by the EEU, a standard contract is signed between the ESCO and EEU.
7. The ESCO then implements the projects and asks the selected M&V organization to verify the savings.
8. The M&V organization completes the evaluation and prepares a verification report.
9. The ESCO submits the project results and the verification report to the EEU.
10. The EEU makes the payment to the ESCO.

A Standard Offer program can be implemented very quickly once the amount of the payment per kilowatt-hour has been determined. This amount should be developed to encourage rapid and large-scale implementation of energy efficiency projects. The calculation of this amount will require discussions among the DEDE, ERC, and EEU. Once the amount of the payment per kilowatt-hour is published, the ESCOs will be able to negotiate projects with their clients, and it is anticipated that a large number of energy efficiency proposals will be developed quickly.

In addition, the Thai industrial EE program can be improved by:

- Integrating industrial policy with EE policy to promote less energy-intensive industries
- Implementing a comprehensive market-based energy efficiency program, not only involving industries (host enterprises), but also promoting EE service providers
- Promoting an energy management system (EMS) that focuses on system optimization to improve energy efficiency, integrating EE into the management system, conducting a thorough assessment of actual system needs and lifecycle costs with integration of capital and operation costs, and training and increasing technical expertise on processes and systems, making available best practices and benchmarks
- Implementing a strategy to provide information and technical support for the local manufacturers of energy-efficient equipment and appliances, to reduce costs and increase employment.

2.1.3 Improving the energy efficiency of buildings: Strengthening enforcement of building codes and piloting zero-emission buildings

Improving building codes and their enforcement

The following actions are recommended to improve building codes and their enforcement:

- **Improve building codes** by (a) mandating that the building energy code apply to all types of buildings, not just to designated buildings, and adding residential buildings, including "passive" building design features; (b) adopting a process for improving codes on a regular basis and tightening the codes every three years; and (c) improving the building code to stress a performance-based approach.
- **Strengthen enforcement** by (a) establishing a system of strict compliance enforcement by an accredited third party to verify that the code was in fact followed during and after building completion. In instances where codes were not followed, stiff penalties should be applied. This should be done in conjunction with government spot-checking and significant sanctions against fraudulent approval; (b) ensuring closer coordination among relevant agencies, including sharing technical expertise, data, and information, particularly between the DEDE, which is responsible for implementing building codes, and the Ministry of Interior, which has authority over buildings in the Provinces; (c) providing sufficient enforcement resources by government agencies; (d) publicizing building compliance and energy-efficiency performance, including the names of building owners, operators, and designers, with shaming and penalties for noncompliance and recognition and awards for compliance; and (e) training code enforcement officials, builders, and contractors who need to understand how to install required materials and equipment in a manner that meets code requirements.
- **Provide financial incentives** by (a) providing tax incentives for commercial buildings that exceed building energy codes by 30 percent or more; (b) providing financial incentives for capital-intensive building envelope improvements, such as consumer financing mechanisms and rebates on building envelope materials; and (c) strengthening price incentives and market information, which are essential to achieving energy savings afforded by buildings that are compliant with Building Energy Efficiency Codes.
- **Lead by example** through imposing energy savings or CO_2 reduction targets on all levels of government buildings to heighten the importance of energy efficiency matters.

Piloting zero-emission buildings

To promote zero-emission buildings in Thailand, the following recommendations are made:

- **Apply the rent-a-roof concept to Thailand:** To overcome the high up-front cost barrier of solar PV, some companies in the U.K. offer consumers the option of having free solar PV panels installed on their roof. Under this "rent-a-roof" scheme, the companies own the solar PV panels and get paid by the feed-in tariff, and the customers enjoy significant savings on their electricity bills—usually one-third of the monthly bill—and get free electricity from the solar PV panels (Harvey and Hailes 2010).
- **"Lead by example":** The DEDE has set up demonstration "Net-Zero Emission" buildings in key regions of Thailand and has challenged other national, regional, and local government agencies to match or exceed the best energy-efficient buildings it has developed and offers awards to those units of government that do so.
- **Implement an accelerated program on zero-emission buildings** (Kristensen 2010):
  - Develop and implement standards for Low-Emission/Zero-Emission Buildings; voluntary during 2016–2020 and mandatory thereafter
  - Develop and implement a Design Guide on Zero-Emission Buildings in the Tropics, 2011–2012
  - Encourage energy efficiency in building and architectural design
  - Encourage energy efficiency in monitoring and evaluation design
  - Encourage integrated design development and optimization
  - Encourage design and integration of solar PV systems in buildings
  - Promote the construction of near-zero-emission buildings (at least two to three buildings during 2012–2016)
  - Monitor performance and evaluation of actual design.

2.2 Developing and implementing innovative financing mechanisms

Thailand has established an Energy Conservation Promotion Fund (ENCON Fund), one of the first in the region, from the petroleum levy in the early 1990s. The ENCON Fund is managed by the DEDE and the Energy Policy and Planning Office (EPPO), and supports subsidy, R&D, demonstration, and financing mechanisms for EE and RE. This is an important source of funding for EE in Thailand. This section draws lessons learned from the ENCON Fund and international experience with innovative EE financing mechanisms, and recommends improvement in EE financing schemes in Thailand.

2.2.1 Lessons learned from the ENCON Fund and international experience

Thailand ENCON Fund: Achieving the goals of the EEDP requires a substantial amount of financing. The Thailand ENCON Fund, established under the Energy Conservation and Promotion Act 1992, has been the government's key financing mechanism supporting energy efficiency and renewable energy development. Annex 4 provided details on the performance and achievements of the ENCON Fund. The source of funding for the ENCON Fund is a petrol sales tax of THB 0.04 (US$0.001) per liter on petroleum products (gasoline, diesel, fuel oil, and kerosene) sold in Thailand. This provides annual inflows of approximately US$200 million (DEDE 2010).

Two phases of the Energy Conservation Plan have been completed (the first phase covers 1995-99 and the second phase covers 2000–2004). These two phases were designed to primarily support the mandatory energy managers program and voluntary measures. They achieved limited success-US$ 630 million in investments from the ENCON Fund resulted in estimated energy savings

of US$696 million. This is largely because much of planned investments in designated factories and buildings did not materialize.

The third phase, covering 2005-2011, is under implementation. A budget of US$2,930 million was proposed to implement the remaining part of the third phase during 2008–2011, a major scale-up of ENCON Fund support from the first two phases.

The Energy Efficiency Revolving Fund and the ESCO Funds are two featured funds under the ENCON Fund. The EE Revolving Fund provides dedicated credit lines to 11 participating Thai banks at a zero interest rate, which will be on-lent to project borrowers at an interest rate of no more than 4 percent, with a repayment period of no more than seven years. The Revolving Fund supported over 335 energy efficiency and 112 renewable energy projects during 2003-2010 and resulted in a total investment of around US$453 million, with an average leverage ratio of around 1:1 from the ENCON Fund investments. The leverage ratio has been increased to around 2:1, as participating banks become more familiar and confident with EE/RE projects, and thus are more willing to take more risks.

The ESCO Fund was established by the Ministry of Energy (MOEN) in 2008 with an initial capitalization of US$30 million from the ENCON Fund. The ESCO Fund intends to address the need for start-up capitalization of energy service companies by providing government funds to co-invest with private developers. As of April 2010, the ESCO Fund has supported 26 projects, mostly renewable energy investments (see Annex 4 for details).

The ENCON Fund has made substantial contributions to mainstreaming energy conservation and renewable energy development in the energy sector and to prioritizing RE and EE on the national agenda. The earlier efforts focused more narrowly on assisting designated factories and buildings to comply with the Energy Conservation Law (primarily the energy managers program) and promoting the early stage of RE development when the RE adder program was absent. The later period of the ENCON Fund saw an increasing effort to tackle barriers to RE and EE, particularly aiming at increasing access to financing, through the EE Revolving Fund and the ESCO Fund, and channeling more resources toward the transport and residential sectors, which are lagging behind in previous interventions.

International Experience of EE Financing: Six main financing mechanisms have emerged from international experience, where public funds can play an important role in leveraging commercial financing and achieving energy savings. Annex 4 provided details on the main EE financing instruments and case studies from international experience.

Each of the six EE financing instruments needs to be tailored to the market segments and barriers.

1. **Dedicated EE credit lines through local banks for debt financing** are effective at increasing participating banks' capacity, interests, and confidence in energy efficiency investments, but tend to favor large and medium-size enterprises and projects. Changing local banks' underwriting criteria to project-based financing that focuses on energy savings, which will increase access to financing for ESCOs and SMEs, has been a major challenge. The EE Revolving Fund in Thailand has been successful in increasing the participation of commercial banks and the private sector in EE and so far has supported many clean energy projects. Moving forward,

there is room to enhance the fund operation to further leverage untapped potential, particularly of small- and medium-size industrial EE and building EE projects. The fund terms and conditions (interest rate, repayment period) and design (loan size, technical assistance, and capacity-building program) of the Revolving Fund could be reviewed to meet changing local market conditions.

2. **Partial risk guarantees** are effective at increasing banks' confidence in clients at the borderline, such as ESCOs with creditworthy clients, but can only reduce banks' perceived risks. Partial risk guarantees allow borrowers to access commercial funding that may not have otherwise been available to them due to their risk profile. It also enables them to secure lower interest rates or longer maturity terms due to the reduced commercial risks to the lender. The World Bank and IFC have financed a series of partial risk guarantee projects for energy efficiency in China and Eastern Europe that provide either portfolio risk guarantees or a reserve fund for partial risk guarantees.
3. **Dedicated EE funds** are effective at increasing access to financing for SMEs and public sector projects, and are often used when the domestic financial market is not ready for EE investments. But sustainability and scale-up are key challenges.
4. **Utility EE/demand-side management funds** are effective at improving electricity efficiency at the end-user level, but decoupling sales from profits is a prerequisite to provide incentives for utilities to save electricity, or the government can competitively select an Energy Efficiency Utility as the fund manager with time-bound performance-based energy savings contracts.
5. **Mezzanine financing,** where unsecured debt requires no collateral and, instead, lenders have the right to convert their stake to equity or ownership in the event of default on the loan, is effective at closing the debt-equity gap, particularly for SMEs.
6. **ESCO equity funds** to close the equity gap. The ESCO Fund established in Thailand has been well received by the private sector because it is suitably designed to tackle the barrier of lack of equity financing for smaller-scale RE projects. The fund size, however, is still limited and could be further expanded. Innovative instruments such as risk guarantee, which is under the scope of the ESCO Fund and has strong potential to further leverage private sector investment, has not yet been operationalized, mainly due to limited funding and capacity of fund managers in more complicated financial markets and transactions.

Lessons Learned: The Thailand ENCON Fund and international experience with EE financing offer the lessons:

Effective energy efficiency policies are the main driver to increase demand and financing. The earlier phase of the ENCON Fund showed that support to the mandatory energy managers program has not produced satisfactory results, because the energy managers program is an input-based rather than output- based regulation, and the designated factories and buildings do not have performance-based mandatory energy saving targets and thereby do not have the incentives to materialize the planned investments. Since the EE regulations have been amended to address the previous loopholes and are creating a more favourable regulatory environment for EE investment, the effectiveness of the ENCON Fund has also increased. In China, for example, the government's mandatory performance-based targets have created huge demand for energy efficiency investment and ESCO services.

Technical assistance (TA) to participating banks and energy service companies (ESCOs) is critical and can have a high payoff. The World Bank and the International Finance Corporation (IFC) have financed a series of EE financial intermediary projects, mostly in China and Eastern Europe

(see Annex 4 for details). One of the key lessons of the experience is the importance of TA, particularly at the beginning, to raise awareness of EE, to provide training and advisory services to the banks in developing financial structures, and to build the capacity of project developers. But TA needs to go hand in hand with financing instruments backed with public funds to provide sufficient in centives or credit enhancement for participating banks to scale-up EE investments.

2.2.2 Recommendations for improvements

Since Thailand is embarking firmly toward a low-carbon growth strategy, and the government has set ambitious RE and EE targets, it is critical that the ENCON Fund continue its role in providing financial mechanisms to scale-up RE and EE investments and increasing technical capacity, complementary to the policy instruments.

The DEDE is reviewing its role in promoting energy conservation and is considering refocusing its role more toward providing technical support and consultancy services to the finance sector while gradually withdrawing government intervention in the EE lending market. International best practices show that TA to both domestic banks and ESCOs for EE project development and financing is critical to scale-up EE. But TA alone may not be enough to provide sufficient incentives to the banking sector to mainstream EE investments, unless domestic banks are fully committed to and interested in the EE market. International experience shows that TA usually needs to go hand in hand with financing instruments backed with public funds to provide enough incentives or credit enhancement for domestic banks to scale-up EE investments until the EE business line is fully mainstreamed.

The selection of financial instruments under the ENCON Fund should be tailored to the market segments and barriers. The ENCON Fund could use the following financial instruments:

- ***Adopting the Standard Offer approach that can be managed by a competitively selected performance-based Energy Efficiency Utility (EEU):*** The ENCON Fund can provide Standard Offer energy saving subsidies in THB per kWh once ESCOs or end users deliver verified energy savings, as recommended in section 2.1.2. This approach provides transparency and certainty on subsidies of energy savings to ESCOs so it can help ESCOs generate EE projects quickly and increase access to commercial financing. To this end, the EEU concept (see Annex 4 for details) could be a useful mechanism for managing the Standard Offer approach. An advantage of the concept is that the government can competitively select a fund manager, sign a time-bound performance-based contract with them, and require them to target a specific market segment.
- ***Partial risk guarantee for ESCOs:*** As mentioned, domestic banks usually do not need a credit guarantee to their established clients with a good credit ranking, nor will they lend to those clients with an unacceptable credit ranking, even with a credit guarantee. A partial risk guarantee can be effective to enhance credits and mitigate the perceived risks for ESCOs, in order to increase the confidence of the banks.
- ***Continuing EE Revolving Fund:*** The EE Revolving Fund might start to target ESCOs and building EE market. Since participating banks are more familiar with the EE business, the Revolving Fund can also require more co-financing from participating banks. This financing instrument can serve as the “carrot” and be linked with the industrial energy performance targets recommended in section 2.1.2 (“stick”) to reduce energy intensity in the industrial sector.

2.3. Reforming institutional arrangements

Successful implementation of the policy measures requires a strong national champion and effective institutional coordination. For example, many countries have established a dedicated energy-efficiency agency to coordinate multiple stakeholders, implement energy-efficiency programs, and raise public awareness. This section reviews existing institutional arrangements for EE in Thailand, discusses international experience, and recommends improvement in institutional coordination.

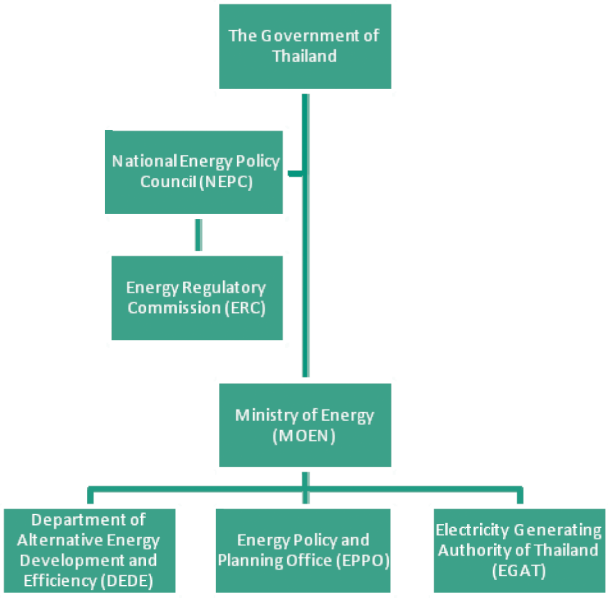
Current EE Institutional Arrangements

Overall management of the energy sector has been under the National Energy Policy Council (NEPC) since 1992, with the Energy Policy and Planning Office (EPPO) acting as the Secretariat. The NEPC is responsible for the promotion of energy conservation and the management of the Energy Conservation Promotion Fund (ENCON Fund). The NEPC is chaired by the Prime Minister, and members include the Deputy Prime Minister (Vice Chair) and the Ministers of Agriculture, Commerce, Energy, Finance, Industry, Science and Technology, and Transport, among others.

The Ministry of Energy (MOEN) is responsible for managing the energy sector and developing national strategic energy plans and targets. Its key objective is to promote Thailand's energy security. The two key EE agencies under the MOEN are the DEDE and EPPO. The DEDE is responsible for EE promotion, energy conservation regulation, development of alternative energy, and dissemination of energy technologies. The DEDE also oversees the Energy Efficiency Revolving Fund and the ESCO Fund. The EPPO, as the NEPC secretariat, acts as "policy maker." It recommends and sets overall energy policies, measures, and plans. It also implements voluntary and complementary energy conservation programs.

The Energy Regulatory Commission is the energy regulator for the power and gas sector. Its role is to regulate the energy industry operation to ensure its security and reliability. It promotes energy efficiency in energy industry operations and power planning. Figure 3.10 summarizes the EE institutional structure of these agencies.

Figure 3.10 Thailand National Energy Efficiency Institutional Structure



Source: Authors.

International experience of EE institutional arrangements

EE institutional models and implementation approaches are greatly influenced by the social, economic, and political context of a country, so there is no one institutional model that fits all countries. However, there are some common elements of EE institutional governance necessary for effective implementation of EE policies, as illustrated in box 3.4. In particular, since EE measures involve many sectors and stakeholders, a national institutional champion with clear mandates, necessary authorities, and sufficient resources is essential for effective coordination and implementation.

Box 3.4 Common Elements for "Good" Governance of EE Institutions

A 2010 international review based on the assessment framework found the following common elements of EE institutional governance necessary for effective implementation of EE policies:

- Motivation and Political Commitment: The prime motivation should be driven by country priorities (for example, energy security, need to reduce energy bills, environmental sustainability, or climate change), and top political commitment to EE policies and goals is essential.
- EE Policy Framework: EE policies, laws, regulations, and implementation mechanisms should be developed in consultation with all stakeholders to ensure a shared vision and to gain support.
- Reliable Data for Analysis and Planning: EE policies should be developed based on analysis of reliable data (particularly at the end-use level), and information on energy flows and EE goals should be realistic and defined in specific terms (for example, energy savings in a specific sector).
- EE Institutional Framework: EE institutions should be established under a legislative framework and have the necessary authorities to achieve their policy objectives.
- Leadership and Resources of EE Institutions and Agencies: Good leadership, adequate staffing and budget, and effective monitoring and evaluation are all critical to the successful functioning of EE institutions.
- Coordination with Stakeholders: EE institutions should coordinate their activities with other agencies in the public and private sectors to ensure effective implementation.

Source: World Bank 2010b.

When comparing different institutional models, a national EE agency that is powerful and has good representation at the cabinet level or directly under the Prime Minister may have the influence and clout needed to obtain the cooperation of and coordination with other agencies. Furthermore, the sector and the provincial/local levels need to be assigned clear responsibilities, with incentives and penalties to ensure effective implementation (box 3.5). For example, China's achievements in reducing energy intensity during the 11th Five-Year Plan period are largely due to its strong political commitment and effective institutional structure. The State Council established the National Energy Conservation and Emissions Reduction Leading Group, chaired by the Prime Minister and comprised of the ministry-level leaders of the key relevant agencies. Provinces have also established similar leading groups chaired by the governors. This facilitates timely and coordinated policy development and decision making for EE program implementation. The State Council has assigned responsibility, accountability, and evaluation criteria and procedures for achieving specific quantified energy intensity reduction targets to all provinces. The provincial government leaders are held accountable for the results of energy intensity reduction. Program development and implementation responsibilities and accountabilities have also been assigned to sector-specific agencies. Provincial governments have assigned energy-saving targets and responsibilities to prefectures and departments within their provinces.

Box 3.5 How to Improve EE Coordination between Ministries (Horizontal) and between Central and Local Governments (Vertical)

Horizontal coordination. When two or three institutions have overlapping or shared EE policy responsibilities, an effective approach to coordination may be a memorandum of understanding (MOU) or other bilateral intragovernmental agreement, specifying responsibilities, targets, resource flows, and so forth. The U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (U.S. EPA) share responsibility for EE policy in the United States and have used the EPA-DOE MOU to govern their shared implementation responsibilities for activities such as the ENERGY STAR Program. When EE is dispersed among many agencies, interagency agreements and coordinating committees become important. Examples of coordinating committees include Australia's Ministerial Council on Energy, Canada's Council of Energy Ministers, Korea's Green Growth Committee, Singapore's National Climate Change Committee, and Turkey's Energy Efficiency Coordination Board.

Vertical coordination. A number of mechanisms are available for national governments to use in coordinating EE implementation with subnational governments. These mechanisms seem valid for countries with either federal or unitary forms of government. Most vertical coordination mechanisms are programmatic approaches in which the national government takes the lead, providing guidelines, assigning tasks, and offering funding and technical assistance to subnational levels. A typical example of a programmatic coordination mechanism is the U.S. Weatherization Assistance Program.

In some countries, the national government has used subnational jurisdictions to demonstrate program innovations which, if successful, can be replicated. Cooperative partnerships between a national government and subnational jurisdictions work well in unitary states with a limited and manageable number of subnational jurisdictions. This is the case of the SwissEnergy program. Although there is no single approach for improving coordination among and between government levels, policy makers should keep in mind the following coordination mechanism guidelines:

- **Plan coordination early.** To encourage cooperation between policy makers and implementers, coordination should take place early in the policy design phase.
- **Build EE capacity as a prerequisite for good coordination.** Building EE capacity is a prerequisite to effective coordination and cooperation, especially when expanding EE responsibilities to nonenergy agencies. It is important to build capacity within partner institutions commensurate with the work program and coordination role.
- **Coordinate EE and climate change policy.** Energy efficiency and climate change policies need to be coordinated when responsibility for each falls under different agencies.
- **Identify strengths of each government level.** Policy makers should take advantage of the strengths of each government level and coordinate to ensure that these are maximized to implement EE.
- **Clearly define objectives and areas of responsibility.** National and subnational governments should clearly define the objectives and areas of responsibility for any coordination effort.
- **Create clear accountability.** Accountability is at the core of interagency and intergovernmental coordination. Policies and programs should ensure that accountability systems are in place from the beginning.

Source: IEA 2010.

Recommendations for improvement

EE institutional models and implementation approaches are greatly influenced by the social, economic, and political context of a country, so there is no one institutional model that fits all countries. However, there are some common elements of EE institutional governance necessary for effective implementation of EE policies, as illustrated in box 3.4. In particular, since EE measures involve many sectors and stakeholders, a national institutional champion with clear mandates, necessary authorities, and sufficient resources is essential for effective coordination and implementation.

- ***Establish a national institutional champion—two potential models:***
  - Strengthening the role of the DEDE. The DEDE should be given a higher level of authority for developing, coordinating, and overseeing EE policy implementations among all relevant ministries. It has demonstrated strong leadership in the areas of RE and EE. However, the DEDE currently sits under the Ministry of Energy, which does not have higher authorities to effectively coordinate with other key ministries such as the Ministries of Industry, Interior, and Transport to ensure that the EEDP targets will be met. For example, there are no clear roles and responsibilities between the Ministry of Energy and the Ministry of Transport on EE improvement in the transport sector. Similarly, the DEDE has difficulty obtaining information on energy use in the industry sector, as it is required to do by law. Furthermore, the DEDE has no authority over buildings in the Provinces, which are under the Ministry of Interior, even though the DEDE has a mandate to promote EE in buildings; or
  - Creating a new dedicated Energy Efficiency Agency. This new agency would be responsible for implementing the EEDP. It requires a higher level of authority above all the key ministries, adequate resources, ability to engage multiple stakeholders, independence in decision making, and credible monitoring of results.

- ***Hold regular NEPC meetings.*** The Prime Minister and other ministers responsible for EE policies need to meet on a more regular basis to achieve closer cooperation in order to be able to update information and better coordinate EE policies. The NEPC has met infrequently in recent years. In particular, significant energy-saving potential exists in the transport sector, and coordination between the Ministry of Energy and the Ministry of Transport is critical.

- ***Strengthen EE policy coordination and implementation at the sector and local levels.*** Since actual EE measures will be implemented at the sector and local levels, it is recommended that the national EE target should be disaggregated not only at the sector level but also at the local level in consultation with sector and local authorities based on their EE improvement potential. Subsequently, proper incentives for exceeding the target and penalties for noncompliance should be implemented.

CHAPTER 4

Scaling Up Renewable Energy: Achieving the Renewable Energy Development Plan (REDP)

1. Renewable energy development in Thailand: Meeting the REDP is on track, but alternative fuels for transport are lagging

Thailand relies heavily on fossil fuels in its primary energy supply (figure 4.1), particularly oil, to meet its transport energy needs, and is a net energy-importing country. It expects to import 60 to 70 percent of its energy needs by 2030 under a baseline scenario (Wang and others, 2010). Electricity generation relies heavily on natural gas, the least carbon-intensive fossil fuel. In 2008, 92 percent of total power generation came from fossil fuel sources comprising natural gas (70.5 percent), coal and lignite (20.7 percent), fuel oil (0.5 percent), and diesel (0.02 percent). Electricity generated from renewable energy (RE) sources such as biomass, wind, and solar still comprises a very small share of the power generation mix, at 1.7 percent in 2006. Thailand imported 1.6 percent of its electricity from hydropower in Lao in 2009.

Figure 4.1 Fossil fuels dominate Thailand's energy mix

Source: IEA 2009.

Thailand needs to change the trend from an increased role for coal to an increased role for renewable energy. While the current energy mix in Thailand is dominated by natural gas and oil, Thailand plans to expand the role of coal, since coal provides low-cost and secure energy supplies. This strategy will lead to costly environmental degradation and expensive long-term lock-in effects. To get onto a more environmentally sustainable energy path, Thailand needs to ramp up its renewable energy use from indigenous resources and imported hydro. In the short to medium term, renewable energy is the second-largest source of emissions reduction.

1.1 Thailand's REDP

Thailand's Department of Alternative Energy Development and Efficiency (DEDE) has implemented feed-in tariffs to promote private investment in renewable energy. The government's renewable energy adder program provides additional tariffs for renewable energy power generation from small power producers (SPPs) (10 MW to 90 MW) and very small power producers (VSPPs) (under 10 MW), as an incentive to improve the commercial viability of renewable energy projects (table 4.1).

Table 4.1 Thailand's Renewable Energy Adder Program for SPPs and VSPPs

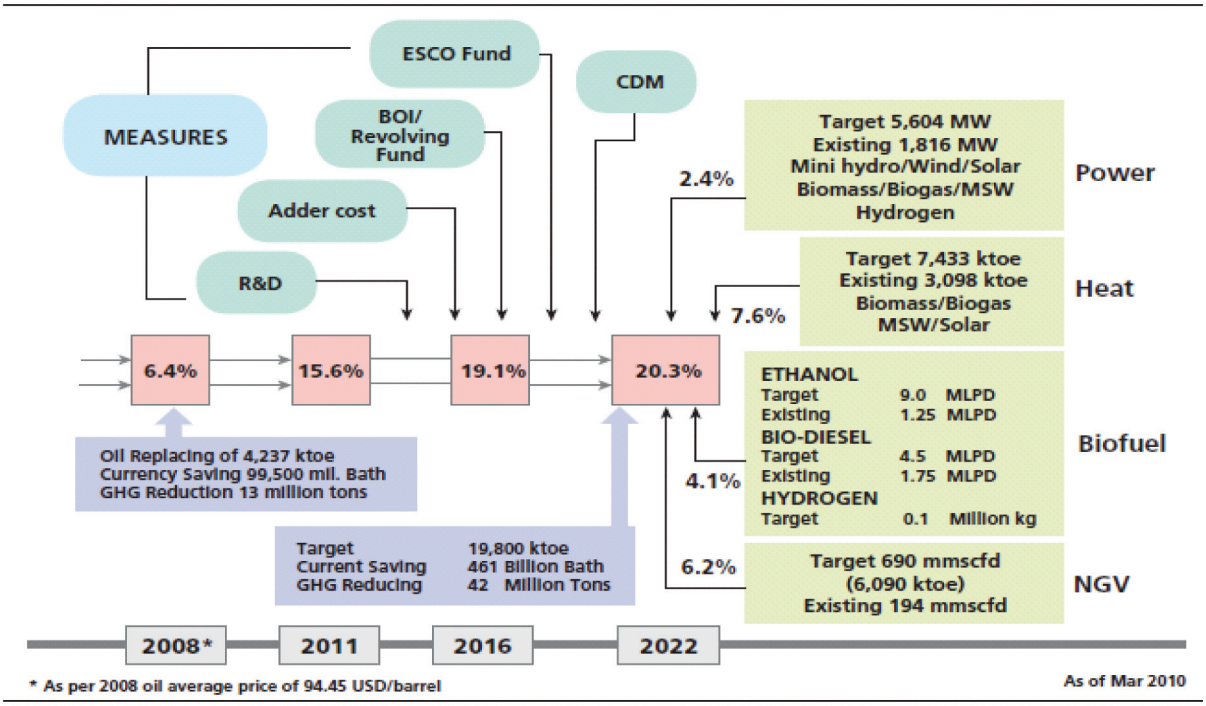
Types of Renewable Energy	Former Adder (Baht/kWh)	Current Adder (Baht/kWh)	Additional for Diesel Substitution (Baht/kWh)	Additional for RE generators in the most 3 southern provinces (Baht/kWh)	Period (Year)
1. Biomass					
- Installed Cap. <= 1 MW	0.30	0.50	1.00	1.00	7
- Installed Cap. >1 MW	0.30	0.30	1.00	1.00	7
2. Biogas (all sources)					
- Installed Cap. <= 1 MW	0.30	0.50	1.00	1.00	7
- Installed Cap. >1 MW	0.30	0.30	1.00	1.00	7
3. Waste (MSW and non-toxic industrial waste)					
- Fertilizer/Landfill	2.50	2.50	1.00	1.00	7
- Thermal Process	2.50	3.50	1.00	1.00	7
4. Wind					
- Installed Cap. <= 50 kW	3.50	4.50	1.50	1.50	10
- Installed Cap. > 50 kW	3.50	3.50	1.50	1.50	10
5. Hydro (Mini/Micro Hydro)					
- Installed Cap. 50 kW - <200 kW	0.40	0.80	1.00	1.00	7
- Installed Cap. <50 kW	0.80	1.50	1.00	1.00	7
6. Solar	8.00	6.50	1.50	1.50	10

Source: ERC 2011.

The government's REDP set a target of achieving 20 percent of final energy demand from renewable energy by 2022, of which 7.6 percent would be from RE for heating (biomass, municipal solid wastes, and solar), 6.2 percent from natural gas vehicles, 4.1 percent from biofuel (ethanol, biodiesel, and hydrogen), and 2.4 percent from RE for power (figure 4.2). The REDP is divided into the following three phases:

- The current phase, 2008 to 2011, focuses on funding proven RE technologies and the high-potential RE resources such as biofuel, power generation, and thermal energy from biomass and biogas projects.
- The second phase, 2012 to 2016, will focus on promoting the RE technology industry; supporting new RE technology prototype development, which is economically feasible; and encouraging new technologies in biofuel production, developing the green city model, and strengthening local energy production.
- The third phase, 2017 to 2022, will focus on the promotion of economically and financially viable new RE technology, including further implementation of green city and local energy production, and the promotion of Thailand as the Association of Southeast Asian Nations (ASEAN) biofuels and RE technology export hub (Ministry of Energy 2009).

Figure 4.2 The REDP is expected to be achieved by RE applications in the power, heating, and transport sectors in three phases



Source: Salvatore and Damen 2010.

1.2 Progress toward the REDP: Largely on track, with alternative fuels for transport lagging

In 2009, commercial alternative energy accounted for 8.8 percent of total energy consumption in Thailand, an increase from 6.4 percent in 2008. However, this met only half of the 15.6 percent target for 2011. As shown in table 4.2, RE for heating is largely on track to meet the 2011 target. The electricity sector showed very slow progress in 2009. As a result, RE (biogas, biomass, garbage, geothermal, hydro, solar, and wind) still plays a small role in overall power generation-a total of 2,808 GWh, or less than 2 percent of total power generation. However, RE for electricity is expected to increase dramatically and rapidly over the next few years, since the projected investments from the private sector in the pipeline have far exceeded the target. Alternative fuels for transport-biofuel (ethanol and biodiesel) and natural gas vehicles—are the only subsector that lags behind the RE target.

Table 4.2 Final Alternative Energy for Commercial Consumption (excluding Traditional Alternative Energy Consumption) in 2009

Types of Energy	2009 (ktoe)	Target 2011 (ktoe)
Thermal		
Solar thermal	0.4	5
Biomass	3,556	3,660
Biogas	—	470
MSW	1	15
Subtotal	**3,557**	**4,150**
Biofuel		
Ethanol	335	805
Biodiesel	463	950

Natural gas vehicle	1,260	3,469
Hydrogen	—	—
Subtotal	**2,058**	**5,224**
Electricity	**282**	**1,587**
Total final commercial alternative energy consumption	5,898	10,961
Total final energy consumption	66,698	70,300 (projected)
% of alternative energy in final energy consumption	8.8%	15.6%

Source: Department of Alternative Energy Development and Efficiency, Thailand Alternative Energy Situation in 2009.

Note: ktoe = thousand ton of oil equivalent.

While the actual investments in RE for power in 2009 and 2010 lagged behind the target, the last three years have seen huge private sector interest in investing in RE power projects, particularly for solar PV and wind power, thanks to attractive tariff rates under the adder scheme. As of October 2010, the total proposed investments under the small power producer (SPP) and very small power producer (VSPP) schemes already well exceeded the 2022 target (table 4.3). Most of the projects are expected to start commercial operation in the next five years. If the majority of the proposed private investments are realized, it is likely that the 2022 target could be achieved as planned.

Table 4.3 Proposed investments in RE under the SPP and VSPP Programs (MW) exceeded targets

	Target 2011	Target 2022	Total Installed Capacity 2009	Total SPP/VSPP Commercial Operation as of Oct. 2010	Total PPAs Signed for SPP/VSPP as of Oct. 2010	Total SPP/VSPP Applied (not signed PPAs) as of Oct. 2010	Total SPP/VSPP Expected Commercial Operation 2010–15
Solid biomass energy	2,800	3,700	n/a (1,610 in 2008)	1,294	2,178	787	
Wind	115	800	5	0.4	67	1,463	1,348
Solar	55	500	39	16	2,110	1,454	2,909
Hydro	165	324	107	1	6	0.03	
Waste	78	160	6	32	95	388	
Biogas	60	120	38	70	85	89	180

Source: Department of Alternative Energy Development and Efficiency, Thailand Alternative Energy Situation in 2009; Energy Policy and Planning Office for SPP and VSPP data. Data for solar, wind, waste, and biogas are from Sutabutr 2010. Data on hydro are from the DEDE's "Thailand Alternative Energy Situation in 2009."

Note: PPAs = Power Purchase Agreements.

This overwhelming private sector interest in RE power demonstrates that the adder program has been effective in stimulating investment in RE. In fact, given the large proposed investments in solar PV, the government in 2011 adjusted the adder tariff rate for solar PV downward to THB 6.50/kWh. This is because the government wants to keep the increase in the consumer electricity price no more than 8 satang per kWh (around 0.27 U.S. cents/kWh).

1.3 RE development in Thailand continues to face barriers

Renewable energy development in Thailand, however, continues to face significant barriers. These include:

- ***The signed contracts from SPPs and VSPPs may not be realized.*** Despite the high level of private sector interest in RE power investment, the Ministry of Energy has expressed concern about whether the submitted proposals will actually materialize, given that some SPPs and VSPPs do not have much experience with RE and have difficulty accessing financing. The Ministry has been revising application criteria to screen out investors that have no real expertise or experience. A complicated approval process for several types of RE resources also caused delay in implementation of a number of projects.
- ***Difficulties with biomass fuel supply.*** Biomass is the most abundant RE resource in Thailand at an affordable cost, and is the largest contributor to the RE target for heating, transport fuels, and power in the REDP. But it ran into difficulties with fuel supply. Balancing food and energy security is a key challenge for biofuel supply in the transport sector. To that end, biofuel policies need to coordinate energy and transport policies with agriculture, forestry, and land-use policies to manage the competing demands of water and land for food. If energy crops take land away from agriculture, the "medicine" of the requisite interventions might be worse than the "disease" in the sense that mitigation might heighten climate risks. In addition, biomass has been falling behind other RE resources in recent years, due to the shortage of materials for larger, and hence, a more economic, scale of power plant. Given that large-scale biomass plants are mostly built, the future trend is going to be small-scale biomass plants. But these plants face the challenges of insufficient fuel supply, unproven technologies, and a lack of community awareness.
- ***High costs of RE.*** The costs and tariffs for small hydro (10 to 12 U.S. cents/kWh), wind (19 to 22 U.S. cents/kWh), and solar (29 U.S. cents/kWh) in Thailand are substantially higher than those in other countries. The government is quite concerned that the high costs of RE would increase financial burdens on consumers, and maintains a ceiling on the increase in consumer electricity prices. Therefore, future RE development in Thailand needs to focus on cost reduction.
- ***Foreseeable grid integration bottleneck.*** Since most of the planned wind capacity is located in the northeast, where power demand is low, the transmission network needs to keep up with RE generation capacity expansion.

2. Scaling up renewable energy: Supporting SPPs and VSPPs, balancing energy and food security, and smoothing grid integration

To scale-up renewable energy in Thailand in the short term, it is necessary to support SPPs and VSPPs to ensure that the proposed RE investments materialize, and to reassess biofuel policies and targets to minimize the impacts on food security. In the medium term, future RE scale-up needs to focus on cost reduction through reevaluating the feed-in tariffs, improving efficiency and performance, and building a local manufacturing industry—a priority in the second and third phases of the REDP, which could not only reduce costs but also position Thailand as a leader in green energy technology. Smoothing grid integration, particularly in the wind-concentrated areas, will also be a priority in the foreseeable future.

2.1 Supporting SPPs and VSPPs

Applying more stringent due diligence criteria before a Power Purchase Agreement is signed

Given the concern that some of the RE proposals from the SPPs and VSPPs may not materialize, the government needs to tighten the evaluation criteria on technical qualification, demonstrated experience, and financial capacity for the SPPs and VSPPs. The government can also require project readiness, such as obtaining land and environmental permits, securing financing (conditional on the Power Purchase Agreement), and lining up contractors before signing Power Purchase Agreements with SPPs and VSPPs. The government could also provide an incentive for early project implementation and penalties for project delays.

Providing technical assistance and advisory services to SPPs and VSPPs

Some SPPs and VSPPs may not have much experience with RE development. Therefore, technical assistance, advisory services, and project preparation grants can be very useful to help them bring financial closure and make investments operational.

It is recommended that the DEDE set aside grant funds from the Energy Conservation Promotion Fund (ENCON Fund), and competitively select a competent fund manager that can provide technical and financial advisory services to SPPs and VSPPs. It can also provide project preparation grants to help developers bring financial closure, funding such activities as permitting, power purchase negotiations, and grid interconnection and transmission contracting. These grants can be on a cost-shared basis, or in the form of a contingent grant; that is, the grant becomes a loan and must be repaid if the project succeeds (as determined by close of financing or other milestones), but becomes a grant and does not have to be repaid if the project fails (UNEP 2008).

Increasing access to financing for SPPs and VSPPs

To date, most of the energy service company (ESCO) Equity Fund have gone to RE developers—SPPs and VSPPs—which demonstrates the demand from RE developers for increasing access to financing. However, the ability to raise equity can be an important indication of the financial capability of the developers. Therefore, it is suggested that a risk guarantee fund and mezzanine financing may be more appropriate for the ENCON Fund to help SPPs and VSPPs increase access to commercial financing.

Mezzanine Financing: This is an important financing instrument to bridge the equity debt gap. Subordinated debt is repaid from project revenues after all project operating costs and senior debt services have been paid. Subordinated lenders are compensated by a higher rate of interest on their loan. A mezzanine loan is unsecured debt, requiring no collateral to be put up; instead, lenders have the right to convert their stake to equity or ownership in the event of default on the loan. This is particularly appealing to private companies because mezzanine financiers do not retain an interest in the company except in the event of a default (UNEP 2010).

In 2003, the French Environment and Energy Management Agency (ADEME) and the French commercial bank Natixis launched FIDEME, a EUR 45 million public-private mezzanine fund aimed at

addressing the debt-equity gap that was preventing the start-up of wind and other RE sectors in France. EUR 15 million of FIDEME's capital was provided by ADEME as a subordinated tranche within the public-private fund. The fund then provided subordinated financing to projects helping sponsors fill the debt-equity gap and in so doing attract senior lenders. This double leverage structure allowed ADEME to mobilize over 20 times the public funding contribution it provided. Since inception, FIDEME has financed 30 RE projects for a total capacity of over 300 MW and about EUR 330 million mobilized, accounting for one-third of France's wind farm capacity up to 2006. Natixis is now planning their second FIDEME fund, but this time on a fully commercial basis, since the renewable market in France has matured beyond the need for ADEME public finance support (UNEP 2008).

Partial risk guarantees: Since the SPPs and VSPPs may not have sufficient experience with RE projects, banks may perceive them as risky and therefore charge a higher interest rate, making the investments more expensive. A guarantee scheme, for example, a portfolio guarantee that covers first and second losses on a portfolio basis as demonstrated in Annex 4 box A4.1, can enable SPPs and VSPPs to secure loans with lower interest rates or longer maturity terms due to the reduced commercial risks to the lender.

2.2 Balancing food and energy security

2.2.1 Biofuel feedstock, policies, and roadmap in Thailand

Biofuel feedstock in Thailand

In Thailand, molasses from sugarcane and cassava is the key feedstock for ethanol production, and palm oil is the key feedstock for biodiesel. Thailand started commercial production of ethanol in 2006 and biodiesel in 2007. As shown in table 4.4, current ethanol production is dominated by molasses, but cassava is expected to play an increasingly important role as a feedstock for ethanol.

Table 4.4 Share of Ethanol Targets by Feedstock

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Molasses	70%	50%	35%	35%	30%	30%	30%	25%	25%	20%
Cassava	30%	50%	65%	65%	70%	70%	70%	75%	75%	80%

Source: Salvatore and Damen 2010.

Biofuel policies in Thailand

The government has set mandatory targets for biodiesel production, with a B2 (that is, 2 percent of biodiesel blended with gasoline) production mandate in place, and provided subsidies, tax incentives, and low-interest loans for biodiesel production and processing. The government's plan aimed at expanding the palm oil growing area and increasing palm oil productivity and the crushing rate of crude palm oil. However, increasing palm oil planting has been challenging, and the harvested palm oil areas have been short of target over the last three years. The slow growth in fresh palm production led to concerns that supplies of crude palm oil may not be sufficient to meet biodiesel consumption in the near future.

The government also provides subsidies and tax incentives to ethanol producers, gasohol (a mixture of gasoline and ethanol) refineries, and automobile manufacturers. The government controls the price of biofuels. At the consumer level, the price of biofuel blends is maintained below the price of their fossil equivalents by using different tax and levy exemptions and reductions. At the producer level, the wholesale price of biofuels is also managed by the government.

Ethanol and biodiesel roadmaps

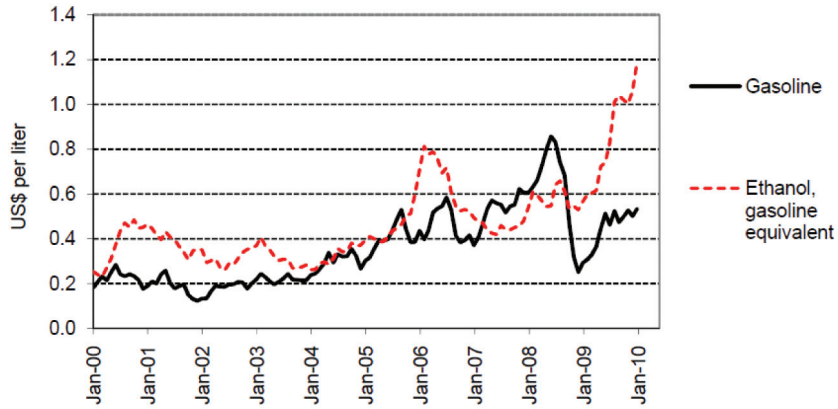
The REDP has set a target of quintupling its biofuel production to 5 billion liters by 2022. The government's Ethanol and Biodiesel Roadmaps projected future demand and market for biofuels and laid out plans for production, feedstock, and Research & Development (including R&D on second-generation biofuels); and estimated budgets. As of March 2010, ethanol production is 1.25 million liters per day (MLPD) with a target of 9 MLPD in 2022, which is expected to be met by increased yield. Biodiesel production is 1.75 MLPD with a target of 4.5 MLPD in 2022, which is expected to be met by increased yield and expansion of plantation area.

2.2.2 Recommendations for improvements

The largest barrier to biofuel industry development is economics. No country has been able to launch a domestic biofuel industry without active government support beyond its normal regulatory role (World Bank 2005). Despite high oil prices in recent years, financial incentives are needed because biofuel feedstock prices have also risen, thus increasing the cost of biofuels.

Ethanol production from sugarcane is by far the most efficient and the lowest-cost pathway for biofuel production. As shown in figure 4.3, over the last decade—from January 2000 to January 2010 (120 months)—there have been only 25 months when ethanol was more economic than gasoline, mostly in 2007 and 2008 and none in 2009. In the remaining months, a subsidy would have been required to make ethanol cost-competitive with gasoline. Consequently, without incentives, farmers would have preferred to sell sugarcane to sugar producers rather than to ethanol manufacturers.

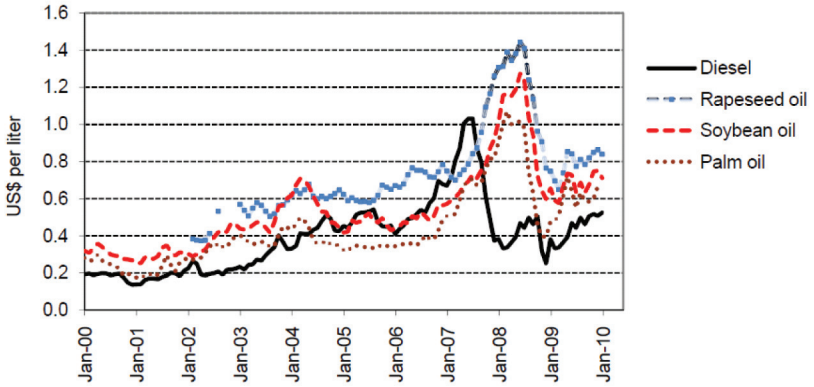
Figure 4.3 Ethanol costs from sugarcane were more economical than gasoline prices for only 25 months over the last decade



Source: World Bank 2010c.

Biodiesel economics have been even more unfavourable since biodiesel feedstock costs alone have generally been higher than petroleum diesel prices. Figure 4.4 compares prices of petroleum diesel with those of rapeseed oil (used in Europe), soybean oil (used in Argentina, Brazil, and the United States), and palm oil (used in Indonesia and Malaysia). Over the last decade—from January 2000 to January 2010 (120 months)—there have been only 39 months when palm oil prices were lower than diesel prices, only seven months when soybean oil prices were lower, and none when rapeseed oil prices were lower.

Figure 4.4 Comparison of International Market Prices of Diesel and Vegetable Oils



Source: World Bank 2010c.

Feedstock for biofuels accounts for about half of the total biofuel production costs, and their prices are volatile with various factors, such as weather, pathogens, oil prices, and other competing demands. In particular, competing demands for biofuel feedstock and food complicate feedstock availability and prices. Because global biofuels production will remain small compared to petroleum production, biofuels will continue to be price-takers in the market rather than drivers of transportation fuel prices. As countries try to increase biofuels production, the feedstock prices could be pushed up further (World Bank 2010c).

Comprehensive in-depth economic analyses are necessary to capture complicated direct and indirect impacts of biofuel development in Thailand, before proceeding to further development of the biofuel industry. Some limited analyses in Thailand and global experience show that the impacts of biofuel development are very complicated and far reaching. For example, a study that estimated the social costs and benefits of the Thailand biofuel program concluded that the economic benefits of biofuel development in Thailand may not be optimal (Bell and others, 2010). Although one of the key objectives of biofuel development in Thailand is rural development and poverty reduction, experience has shown that targeted measures such as direct payment schemes are more likely to achieve such objectives than biofuel development (OECD 2008).

2.2.3 Impacts of REDP biofuel targets on food security

It is expected that the feedstocks for biofuel production in Thailand would come from reduced export, increased yield, and expanded plantation areas of palm oil. Thailand needs to consider the opportunity costs of exporting feedstock (such as tapioca, molasses, and palm oil), which may outweigh the costs of producing biofuel. Increasing yield may put pressure on land and water through increased use of irrigation (Brazil ethanol production is mostly rainfed) and result in water pollution. Moreover, expansion of the biofuels industry in Thailand could cause a reduction of Thai

food exports. This, in turn, could spur a global shortage of food crops, particularly cassava and sugar, of which Thailand is one of the world's leading exporters (Bell and others, 2010). Fluctuation of availability and prices of these feedstocks has been affecting biofuel industry development, especially palm oil, with far-reaching effects.

Ethanol demand is expected to increase over the medium term through increased use of E20 and E85 gasohol (the blended ratio of ethanol and gasoline). To meet such demand without affecting other sugarcane- and cassava-based industries, sugarcane production is forecast to increase to 158 million tons from the current 73 million tons, and tapioca production to increase to around 50 million tons from the current 28 million tons. The Bank of Thailand's study found significant correlation between ethanol demand and increases in feedstock prices, particularly tapioca prices. The study indicated that the current tapioca price increase should result in greater yield improvements in the long run. Producers expect that the average tapioca yield could double from the current level, but expansion of plantation area for tapioca could result in reduced corn production due to the similar growing conditions.

Similarly, the government's plan to push compulsory biodiesel production from B2 to B5 across the country by 2011 will have a significant impact on demand for domestic palm oil. It is estimated that demand for crude palm oil and stearin (a palm oil by-product) will increase to 3.1 million liters a day from the current 1.2 million liters a day (USDA 2009). Increased demand for crude palm oil has pushed up domestic prices of fresh palm fruit and has led to a shortage of cooking oil. Producers have responded to the rising demand for biodiesel by expanding plantation area for palm oil. Domestic prices for fresh palm fruit increased from US$70/ton in 2006 to US$128/ton in 2007. In addition, palm oil prices have been more volatile than those of cassava and sugarcane and will likely be even more volatile when the B5 biodiesel production policy is fully implemented. This is because palm oil production for B5 will compete with cooking oil.

2.2.4 Achieving the REDP without risking food security

Thailand has been actively promoting biofuel to enhance energy security. Among the key biofuel feedstock of cassava from tapioca, molasses from sugarcane, and palm oil, cassava is the most efficient feedstock, followed by sugarcane. However, there are a number of risks to food security from expanded biofuel production in Thailand. These include increases in the prices of tapioca and palm fruits, reduced corn production, decreased cooking oil supply, and potential competition of land for food production by expansion of palm oil plantations. Palm oil and cassava prices are volatile. Other environmental risks include increased GHG emissions from land use changes, water pollution, and loss of biodiversity. As biofuel production and consumption expand, government subsidies and various financial incentives may not be sustainable. Therefore, the following recommendations are offered for government consideration.

- **Biofuel policies and targets may need to be reduced to minimize the impacts on food security.** For example, if world sugar prices soar, domestic production of ethanol can be reduced by lowering the mandated ethanol gasoline blend ratio. A regular, multistakeholder review of progress toward the REDP targets should be done to ensure that the targets are being met sustainably and not at the expense of food security and the environment. Policies and targets should be adjusted accordingly.
- **Regulations on land use and food security need to be implemented** to ensure that threats to food security are avoided and increased GHG emissions and biodiversity loss mitigated. The method of agroecological sugarcane zoning in Brazil can also be applied (Leal 2010).

- **Biofuel policies should proceed with caution and be part of a portfolio of policy measures to reduce oil consumption in the transport sector.** The best application of biomass energy is to use biomass wastes for power and heat generation to replace coal. For example, agricultural wastes or local oil seeds may economically be used for power generation, with a guaranteed market for farmers to sell their feedstock to the power company (World Bank 2010c). R&D should be encouraged in second-generation biofuels—those derived from lignocellulosic crops such as cellulose, lignin, and hemicellulose, which do not compete with land and water for food and forest. Finally, biofuel is not a panacea. There is a wide range of options, such as vehicle fuel economy standards, a fuel tax, public transport, electric vehicles, and walkable cities that may have greater impacts on reducing oil imports and enhancing energy security than biofuel.

2.3 Smoothing grid integration

Smooth grid integration of a large share of intermittent renewable energy resources (wind and solar) requires (a) sound policy and regulatory frameworks that provide interconnection standards and financial incentives to the grid companies; (b) coordinated generation-transmission planning; and (c) technology solutions such as smart grids (see Annex 5 for details), energy storage, complementary from pump storage, short-term wind forecasting, and grid-friendly turbines with better power factor control and grid fault management capability to reduce disturbances to the grid.

Policy and regulatory issues

The grid companies would need both mandates and financial incentives to accommodate more intermittent renewable energy resources, and the generators need to comply with grid interconnection standards. The cost of transmission interconnection from a wind power substation to the nearest substation of the existing network is usually paid by the generator (up-front or through tariffs, "beneficiary pays"). The pricing of transmission connection that is unclear or disadvantageously defined for wind power makes wind power projects unviable. The cost of transmission reinforcements to the rest of the system can be recovered according to general transmission network cost allocation and recovery principles (if they exist). Alternatively, a Renewable Energy Fund, possibly financed by an electricity levy and the ENCON Fund, could cover the incremental costs in additional transmission facilities and dispatch activities required to accommodate more intermittent renewable resources by the Electricity Generating Authority of Thailand and the Provincial Electricity Authority. Finally, Thailand could also develop both the Grid Code performance requirements that will be imposed on wind turbines to reduce uncertainty and scheduling and dispatch rules.

Planning issues

A planning process driven by interconnection-request (reactive process) is unmanageable and lengthy for wind power projects. A case study in the Philippines shows that the proactive planning process, by interconnecting proactively, organizing the process, and planning for sets of projects in a zone, resulted in half the cost of the transmission price of the reactive process approach. However, independent transmission companies do not always have information regarding wind power generation projects. In addition, transmission companies may not have an organized, participative, and recurrent transmission planning process. As a result, wind power projects could exhaust scarce planning and engineering human resources.

Traditional generation and transmission planning based on cost minimization and reliability will not lead to the requisite expansion with wind power integration. Traditional planning criteria do not consider other benefits of transmission, such as congestion cost, CO_2 and other pollution reductions, and so forth, or wind power and other renewable energy targets.

Therefore, it is recommended that the Thai government develop proactive transmission planning to reduce the cost of wind power grid integration as soon as possible. The transmission planning should include all potential renewable and nonrenewable power projects to pool the associated transmission costs. The Thai government might consider options for cost-sharing approaches outlined in the case studies in box 4.1.

Box 4.1 International Experience on Grid Integration

Renewable energy zones in Texas: The renewable portfolio standard was established in 2002. Given existing regulations, the regulator would not approve transmission expansion projects if they did not have financially committed generators or a firm expectation that transmission projects would meet specific project needs.

In 2005, the State of Texas introduced renewable energy zones. Renewable energy zones are special regulations so that the transmission company uses different planning principles in zones with identified wind power potential, and plans to achieve targets using best wind resources. Transmission expansions identified to these zones follow special regulations for approval, cost recovery, and cost allocation. Approval does not require prior firm commitment from wind projects. Wind power and other renewable power expansions are not considered as conventional generation interconnections. Cost recovery is ensured based on "public convenience and necessity" and rolled out through tariffs.

Denmark: For wind plants of less than 100 MW, the developer is responsible for interconnection cost to the nearest 10-kilovolt point. Any other reinforcements are paid by customers through transmission rates. For wind plants greater than 100 MW, operation rules request interconnection at 100-kilovolt levels; transmission reinforcements are also transferred to tariffs.

Germany: Transmission reinforcement costs are paid by rate payers. Interconnection costs reduce for offshore wind power; onshore wind power is exempt from paying transmission upgrade costs.

The U.K.: National Grid generators are offered firm access to the system and are compensated if the system operator restricts their generation. The high penalties provide the incentives to plan effectively for transmission investment. Transmission costs are passed 73 percent to load and 27 percent to interconnected generators based on benefits and obligations. The National Grid requires financial security from the interconnecting generator developer(s) before proceeding with construction.

Open season schemes in Mexico: In Mexico, public transmission utility planning principles would only expand for generation that serves public service demand. This includes connection to traditional generation projects that serve public-sector demand. However, private renewable energy power generation projects that self-supply direct customers are not considered part of "public service." There is no planning authority to address the expansion needs in this sector. The public sector is not allowed to subsidize the private sector. Wind power resources are often located far from the transmission network. Several projects concentrated in an area might be able to absorb the costs of the interconnection, but not individual projects.

The public utility determines transmission infrastructure needs, given initial private sector interest in developing wind power (both self-supply and Power Purchase Agreement commercial schemes). The transmission plan is presented to wind power developers to gauge their interest in reserving firm transmission capacity. A final plan is prepared and an "open season" commences, requesting formal commitments for firm transmission capacity reservations. Guarantees are then provided to the utility based on transmission reservations. The utility bids for the construction of transmission infrastructure to meet needs. This mechanism "pools" transmission costs, which are shared among wind power developers. Costs are not passed to customers. This approach has also been successful for large projects in the United States and could be successful where wind resources are excellent and large sites can be developed close to each other.

Source: Authors based on Madrigal and others 2010.

Annex

Thailand:

Clean Energy

for Green Low-Carbon Growth

September 2011

Annex 1

Selected Indicators for Green Growth

	OECD	European Green City Index	ESCAP	Korea	Singapore
Air quality and carbon emissions	• Emission trends and GDP growth (GDP, GHG, SOx, and NOx) • GHG emission intensities	• CO_2 emission per capita • CO_2 emission intensity • CO_2 reduction strategy • Annual daily mean concentration of $PM_{2.5}$, NOx, SO_2, and ozone • Clean air policies	• CO_2 emissions intensities • Air quality (NOx, SOx, CO, etc.)	• GHG emissions reduction • Carbon sink by forests (million tCO_2) • Volume of trade in domestic carbon emissions trading market	• Annual daily mean concentration of $PM_{2.5}$, and SO_2 against ambient air quality (the Pollutant Standards Index)
Energy	• Energy supply and GDP growth (GDP, energy supply, energy intensity per GDP and per capita, fossil fuel supply) • Share of renewable energy supply (%)	• Energy consumption per capita • Energy intensity • Share of renewable energy consumption • Clean and efficient energy policies • Energy consumption per square meter of residential buildings • Energy efficiency building codes	• Energy intensity	• Energy intensity • Share of new and renewable energy (%) • Share of nuclear energy use (%)	• Energy intensity • Share of the existing buildings with at least a Green Mark Certification rating (%)
Transport		• The percentage of the working population traveling to work on public transport, by bicycle, and on foot • Length of cycling lanes and public transport network • Green transport promotion • Congestion reduction policies	• Fuel intensity (MJ/GDP)	• Share of passengers using rail • Share of bicycle transportation • Share of passenger transportation • Share of mass transit	• 70:30 ratio between public and private transport journeys made during morning peak hours
Water resources	• Water abstractions and GDP growth (GDP, total water abstraction, irrigation, public supply, and population) • Water use intensities (m^3/person/year)	• Water consumption per capita • Water system leakage (percentage of water lost in the water distribution system) • Wastewater treatment (percentage of dwellings connected to the sewage system) • Water efficiency and treatment policies	• Wastewater intensity (m^3/GDP) • Biochemical oxygen demand (BOD) intensity (t/GDP) (manufacturing)	• Secure water resources (billion m^3)	• Domestic water consumption/person/day • Water catchment areas • Area (hectares) of reservoirs and length (km) of waterways open for recreational activities • Share (%) of water supply from nonconventional sources, e.g., desalinization and reclamation of total water demand • Water quality
Waste and materials	• Waste generation, materials use, and GDP growth (GDP, municipal waste, domestic material consumption)	• Municipal waste collected per capita • Waste recycling • Waste reduction and policies	• Material intensity (Direct Material Input/GDP) • Solid waste intensity (t/GDP)	• Recycling rate • Number of categories of goods for carbon footprint labeling • Amount of mandatory procurement of low carbon green goods in the public sector	• Recycling rate • Number of recycling facilities
Land use		• Green land use policies	• Land use intensity (km^2/GDP)	• Afforestation areas in North Korea (km^2) • National forest resources (km^2) • Nature reserve land (km^2)	• Green space (km^2/1,000 persons) • Greenery in high-rise buildings (km^2) • Green park space (km^2) • Length (km) of park connectors • Green roofs in multistorey car parks in public housing estates (km^2)

Green technologies, green industries, research and development	• Patents in environmental technologies by country[a] • Share of countries in environmental technology patent filed under the patent cooperation treaty[b] • Public spending on energy- and environment-related R&D as a percentage of total public energy technology R&D			• Korea's market share of the global green technological product market (%) • Government investment in green tech R&D • Number of green industrial complexes • Public credit guarantee for green technologies and green industry • Green partnership with SMEs and large enterprises • Increasing the number of new green jobs	

Source: OECD 2009, 2010; Economist Intelligence Unit and Siemens. 2010b; ESCAP 2008; Korea PCGG 2010 and Young 2010; and Singapore Ministry of the Environment and Water Resources and Ministry of National Development 2009.

Note: a. As a percentage of total patent cooperation treaty applications for air pollution control, water pollution control, solid waste management, and renewable energy.
b. As a percentage share of country for air pollution control, water pollution control, solid waste management, and renewable energy.

Annex 2

Existing Institutional Arrangements for Green Low-Carbon Growth in Thailand

Table A2.1 Current Institutional Arrangements for Green Low-Carbon Growth in Thailand

Agencies	Roles and Responsibilities
Office of the Prime Minister (OPM)	Responsible for overall regulation of climate change management in Thailand. Appointed the National Committee on Climate Change policy, which is chaired by the Prime Minister. The secretariat has been set up at the Office of Natural Resources and Environmental Policy (ONEP) within the Ministry of Natural Resources and Environment (MONRE).
National Economic and Social Development Board (NESDB) under the OPM	Responsible for medium-term National Economic and Social Development strategies. The 11th Plan will mainstream Low Carbon Society/Green Society in the development strategies. Also reviews and appraises government and state enterprise investment projects.
Ministry of Natural Resources and Environment (MONRE)/Office of Natural Resources and Environmental Policy (ONEP)	ONEP is the national focal point for the UNFCCC and is the secretariat to the National Committee on Climate Change Policy. ONEP developed Thailand's National Strategy for Climate Change Management (2008–2012), which was adopted in 2008. Responsible for overall coordination of national climate change policy and planning, with an allocated budget from the central government.
Thailand Greenhouse Gas Management Organization (TGO) under MONRE	Established in 2007 as a public organization to be the Designated National Authority for the Clean Development Mechanism in 2007.
Ministry of Finance (MOF)	The MOF Fiscal Policy Office is responsible for fiscal policies including conventional excise taxes (on motor vehicles, fuels, etc.) and the to-be-introduced "green" or environmental taxes. The Public Debt Management Office also has a key role as a focal point for the country in accessing international climate funding through grants and loans.

Source: Authors.

Table A2.2 Key Agencies Responsible for Low-Carbon Growth in the Energy, Transport, and Urban Sectors

Agencies	Functions	Roles and Responsibilities
Energy		
National Energy Policy Council (NEPC)	Policy	Sets national policies and strategies on energy. Is chaired by the Prime Minister and includes ministers from line ministries (e.g., Agriculture, Commerce, Energy, Finance, Industry, Science and Technology, and Transport). Responsible for the promotion of energy conservation and management of the Energy Conservation Promotion Fund (ENCON Fund).
Ministry of Energy (MOEN)	Policy	Since 1992, has been promoting energy conservation based on the Energy Conservation Promotion Act (1992). In 2009, MOEN announced the Fifteen-Year Alternative Energy Development Plan and long-term energy intensity and energy efficiency targets.
Energy Policy and Planning Office (EPPO)	Policy	Sets overall energy policies and plans. Implements voluntary energy conservation programs and promotion of natural gas vehicles for transportation.
Department of Alternative Energy Development and Efficiency (DEDE)	Policy/ implementation	Sets and implements RE and EE policies and promotion program. Responsible for EE promotion, energy conservation regulation, development of alternative energy, and dissemination of energy technologies. Also oversees the Energy Efficiency Revolving Fund and the ESCO Fund, which provides funding to RE and EE projects.

Energy Regulatory Commission (ERC)	Regulator	Regulates power and gas sector including proposing adder policies for decision by the NEPC.
Electricity Generating Authority of Thailand (EGAT) Metropolitan Electricity Authority (MEA) Provincial Electricity Authority (PEA)	Implementation	EGAT accounts for 45 percent of the power generation market and is the sole transmission utility. MEA is the distribution utility in metropolitan areas (covering 3 provinces or 32 percent of customers). PEA is the distribution utility in provincial areas (covering the remaining 73 provinces or 66 percent of customers).
Transport		
Commission for the Management of Land Traffic (CMLT)	Policy	Sets national policies and strategies on land transport.
Ministry of Transport (MOT)	Policy	Responsible for overall transport policies and increasingly focuses on national transport strategy on sustainable transport including reducing energy consumption while improving transport system efficiency.
Office of Transport and Traffic Policy and Planning (OTP)	Policy	Responsible for overall transport planning including Master Plans for the mass transit system in Bangkok and other cities.
Department of Land Transport (DLT)	Policy/regulator	The main regulator with authority to issue licenses for personal and public vehicles including setting vehicle registration fees and charges. Also regulates public bus operators, and other road transport matters according to the Motor Vehicles Act.
Bangkok Mass Transit Authority	Operator/ regulator	Operates the bus system in the Bangkok Metropolitan Area and issues licenses for other private bus operators.
Mass Rapid Transit Authority	Regulator	Regulates mass rapid transit system in Bangkok, i.e., the Blue Line and future lines.
Bangkok Metropolitan Administration (BMA) and Local Administrative Organizations (LAOs)	Policy/regulator	BMA and other local governments are given mandates to provide local infrastructure services deliveries including urban transport. BMA and LAOs in major cities have developed policies and plans to improve urban transport to be more sustainable, with a focus on mass transit. For example, BMA issued the Global Warming Mitigation Action Plan and the concession for mass transit systems in Bangkok, including the Skytrain, and invested in the bus rapid transit.
Private Operators (Bangkok Metro Company Limited [BMCL] and Bangkok Transit System [BTS])	Operators	There are currently two private mass transit operators, BMCL (the Blue Line or subway) and BTS (the Green Line or the skytrain and the bus rapid transit). BMCL is under a concession contract with the central government through MRTA. BTS is under a concession contract with BMA.
Urban		
Department of Public Works and Town and Country Planning (DPT)	Policy/regulator	Responsible for city and land use planning and for building regulations, and has worked with BMA and other local governments in producing urban plans.
Local Administrative Organizations (LAOs)	Enforcing urban plans	The urban plan and building regulations are enforced by local governments, i.e., LAOs.

Source: Authors; adapted from "USAID Eco-Asia Country Report: Thailand," 2007.

Annex 3

Existing Energy Conservation Policies in Thailand

Mandatory regulations

Energy managers program: To implement the Energy Conservation and Promotion Act (ENCON Act), the Royal Decree on Designated Factories A.D. 1997 was adopted to institute an energy management scheme in Thailand, which was then amended and updated in 2009 to prescribe qualifications, responsibilities, and number of people responsible for energy management, and standards, criteria, and procedures for energy management in designated factories and building. Under the regulation, factories and buildings with more than 1,000 kW of power demand or energy consumption of more than 20 million MJ/year must appoint personnel responsible for energy, who implement energy management, report annual energy data, conduct an annual energy audit, and implement the recommendations.

However, this input-based program has not worked well. Much of the planned investments in the designated factories and buildings did not materialize (see Annex 4 for details). This is because the energy managers program is essentially an input-based, rather than an output- or performance-based, regulation. The designated factories and buildings do not have mandatory targets for energy savings, and there is no penalty if energy savings are not achieved.

Building codes: Thailand started building code regulation in 1995, to implement the ENCON Act, aiming to improve the energy efficiency of the design and construction of new and existing buildings. The 2007 revision of the ENCON Act requires that each designated building that uses more than 3,000 kW of electricity must appoint two personnel responsible for energy, and each designated building that uses less than 3,000 kW of electricity need appoint only one such person. The 2007 revision also requires that an annual energy audit take place and the results reported to the Department of Alternative Energy Development and Efficiency (DEDE) (APERC 2010).

However, the previous building code in Thailand achieved limited success due to (a) a lack of differentiated standards for various types of buildings, that is, public buildings, commercial buildings, and so forth; and (b) weak enforcement, resulting in low participation and implementation rates.

The new building code, implemented in 2010, introduced the concept of designing new buildings with energy efficiency as a cornerstone of construction. The new code also addressed some of the pitfalls in the past; for example, a building system and life cycle cost analysis is now required. EE standards under the new code are set in six areas: (a) the building envelope, (b) lighting, (c) heating, (d) air conditioning, (e) renewable energy, and (f) overall performance. Approvals are made during the construction permitting process by the central and local administrative offices. The DEDE provides supporting tools and training when needed. The Ministry of the Interior coordinates with the DEDE in enforcing the code process.

Appliance standards: Thailand also implemented one of the most extensive appliance energy efficiency standards and labeling programs in the region (DEDE 2011b). This includes:

1. *Mandatory Energy Performance Standards (MEPS):* Standards are set by the DEDE and regulated by the Thai Industrial Standards Institute under the Ministry of Industry. The MEPS currently cover six types of products—air-conditioners, refrigerators, motors, ballast, fluorescent lamps, and compact fluorescent lamps—and 16 more are under development.
2. *High Energy Performance Standards (HEPS):* This is a voluntary program in which standards are set by the DEDE and labeling programs responsible by the DEDE and the Electricity Generating Authority of Thailand (EGAT). The HEPS currently covers 8 products, and 27 more are under development.
3. *Labeling of appliances:* This program is largely voluntary and is based on a five-star ranking system. It covers both electric appliances (refrigerators, air conditioners, compact fluorescent lamps, electromagnetic ballasts, electric fans, automatic rice cookers, lighting luminaries, T5, electric ballasts, double-oscillating fans, T5 luminaries, exhaust fans, standby 1-Watt televisions, and standby 1-Watt monitors), and nonelectric appliances (liquefied petroleum gas stoves, variable speed drives, glazing, and insulators).

Fiscal measures

The fiscal measures to tackle environmental and energy problems have two objectives: (a) to influence the resource conservation behaviour of consumers and producers, and (b) to collect revenues for mitigation actions that will improve environmental performance or reduce energy consumption.

Fuel tax: Past fiscal measures have focused on taxes and levies on fuels. The revenues collected also provide a revenue source for both the Environment Fund and the ENCON Fund. The taxes and levies on fuels have been instrumental in keeping domestic consumption in check and in being responsive to price signals in the international market. However, to mitigate the shocks of sharp rising global oil prices, the government put a price cap on diesel products this year, which account for half of domestic consumption of petroleum products, at THB 30, or US$1, from December 2010 to April 2011. As a result, Thailand has high fuel intensity (see figure 3.1) The current fuel prices in Thailand, inclusive of taxes and charges, reflect international market prices that are substantially lower than in Europe and Japan, which have much lower fuel intensity (see figure 3.2). Therefore, Thailand could further increase fuel taxes and remove fuel subsidies to reduce fuel consumption.

Tax incentives: Thailand in 2005 initiated a number of tax incentives to encourage investment in energy efficiency. They include (a) a Pilot Program of Tax Privilege for Energy Conservation made available to building and factory owners. This measure provides a tax deduction for 100 percent of the savings generated by an EE investment, up to a cap of THB 2 million (US$50,000); (b) a Cost-Based Tax Incentives Program, which is a tax measure that allows companies to receive a 25 percent tax break on investments in projects that result in EE improvements. The tax incentives apply to the first THB 50 million (US$1.25 million) invested and can be spread over five years; and (c) the Import Duty Exemption, administered by the Board of Investment, which is an incentive that offers an exemption on import duties for new investments in energy conservation businesses, such as high-efficiency machines or equipment and renewable energy equipment and manufacturing, ESCOs, and so forth.

Utility EE/DSM Program at EGAT

In 1993, Thailand initiated a demand-side management (DSM) program, through financial support from the Global Environment Facility (GEF) and the Australian and Japanese governments, to help curb electricity demand growth and promote more energy-efficient equipment and cost-effective energy services within the country. EGAT, as the national implementing agency of the US$189 million DSM Program, established a Demand-side Management Office to develop, implement, and evaluate the national DSM program, with an overall target of reducing peak demand by 238 MW and annual cumulative energy savings of 1,427 GWh by the end of 1998. As of June 2007, the EGAT DSM program has achieved success, with actual reduced peak demand of 1,435 MW and reduced energy demand of 8,148 GWh. Moreover, the program also reduced CO2 emission by 5.6 million tons.

However, utilities are in the business of selling more electricity, not saving it. Energy conservation is inherently contrary to the commercial interests of utilities. A successful utility-based EE/DSM program requires decoupling utility profits from electricity sales to give utilities incentives to save. Regulators forecast demand and allow utilities to charge a price that would recoup their costs and earn a fixed return based on that forecast. If demand turns out to be lower than expected, the regulator lets prices rise so that the utility can make the mandated profit; if it is higher, the regulator cuts prices to return the excess to customers.

Annex 4

Experience and Lessons Learned on Energy Efficiency Financing from the Thailand ENCON Fund and other Countries

ENCON Fund in Thailand: Performance and achievements

The Energy Conservation Promotion Fund (ENCON Fund), which was established under the Energy Conservation and Promotion Act 1992, has been the Thai government's key financing mechanism to support energy efficiency and renewable energy development. The source of funds for the ENCON Fund is a petrol sales tax of THB 0.04 (US$0.001) per liter on petroleum products (diesel, fuel oil, gasoline, and kerosene) sold in Thailand. This provides annual inflows of about US$200 million (DEDE 2010).

The financial supports from the ENCON Fund are monitored under the framework of the Energy Conservation Plan. Two phases of the Energy Conservation Plan have been completed (the First Phase covers 1995–1999 and the Second Phase covers 2000–2004). The Third Phase, covering 2005–2011, is under implementation.

The first two phases of the plan were designed to support three main measures in line with the ENCON Act: compulsory, voluntary, and complementary. During the 10-year period 1995–2004, the ENCON Fund supported approximately US$630 million of EE measures, which resulted in estimated energy savings of US$696 million. The support during this period emphasized compulsory measures—providing financial support to the designated factories and buildings in preparing energy saving plans and investing in energy efficiency equipment, and technical assistance. The majority of the investment support went to public buildings while investments in factories were lower than targeted. Table A4.1 shows that the compulsory measures of the energy managers program did not yield much energy savings and fell behind the target. This is because much of the planned investments in designated factories and buildings did not materialize. The performance of the voluntary measures—supporting a variety of activities including EE, RE, and R&D—turned out to be more satisfactory and resulted in higher estimated savings (Ministry of Energy 2004).

Table A4.1 Total Costs and Benefits of ENCON Fund: 1995–2004

Measures	Total Cost (US$M)		Energy Savings (US$M)	
	Actual	Target	Actual	Target
Compulsory measures	351	1,134	60	597
Voluntary measures	277	—	636	—
Complementary measures	68	—	—	—
Total	**696.52**	**696.38**		

Source: Energy Conservation Plan, 2004.

Note: Exchange Rate of 30THB/US$.

The Second Phase (2008–2011) of the third Energy Conservation Plan (2005–2011) is under implementation. The Third Phase replaced the previous design by reorienting support to four key areas: energy efficiency, renewable energy, human development, and public awareness. The energy saving targets achieved to date (completion of the First Phase covering 2005–2007) under the Third Plan are shown in table A4.2. The total budget of US$2,930 million (US$2,675 million for EE including investments in the transport sector, US$245 million for RE, and US$10 million for

strategic management) was proposed to implement the remaining part of the Third Phase during 2008–2011 (some activities are budgeted up to 2012). This represents a major scale-up of ENCON Fund support from the first two phases. It is projected that at the end of 2013, the Fund will have an outstanding balance of around US$1 billion.

Table A4.2 Targets and Achievement of the Current Energy Conservation Plan (ktoe), 2005–2011

Areas	Target 2011	Achieved 2007	To be Achieved 2008–11
Energy Efficiency			
Transport	3,413.0	437.0	2,976.0
Industries/commercial/agriculture	3,190.0	892.0	2,298.0
Residential	1,217.0	225.0	992.0
Total	**7,820.0**	**1,554.0**	**6,266.0**
Alternative Energy			
Renewable energy	6,688	3,274	3,414
NGV	2,170	312	1,858
Total	**8,858**	**3,586**	**5,272**

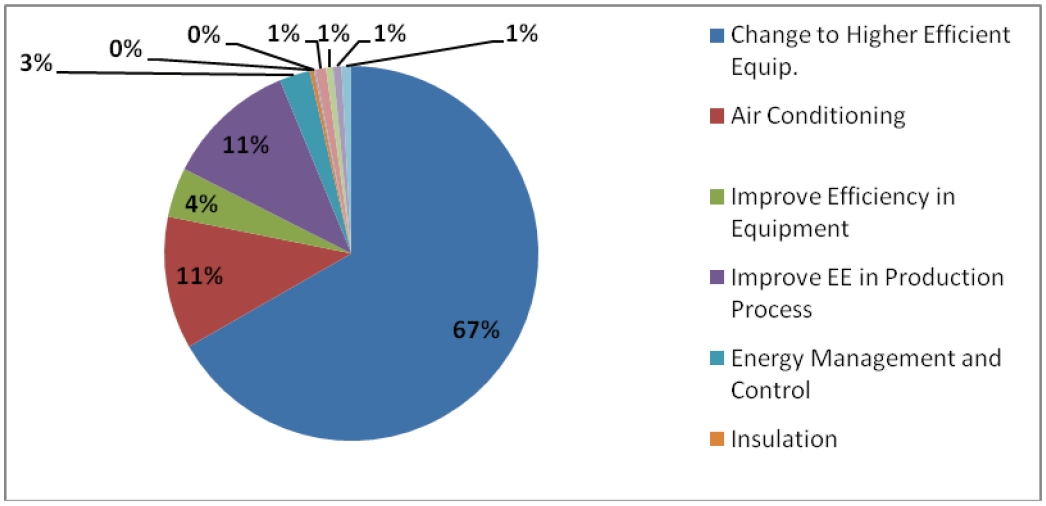
Source: Energy Conservation Plan 2008–2011.

Note: Exchange Rate of THB 30/US$.
ktoe = thousand ton of oil equivalent.

The Energy Efficiency Revolving Fund and the Energy Service Company (ESCO) Fund are two featured funds under the ENCON Fund. The EE Revolving Fund provides dedicated credit lines to 11 participating Thai banks (expanded from six participating banks in 2005) at zero interest, with the requirement that the funds be on-lent to project borrowers at an interest rate of no more than 4 percent, with a repayment period of no more than seven years. The maximum loan size from the Revolving Fund per project is US$1.25 million (THB 50 million). The Revolving Fund sets no fixed conditions regarding the leverage ratio in each project. In practice, projects requiring less than THB 50 million normally borrow 100 percent from the Revolving Fund. When a project requires over THB 50 million, the commercial banks will also provide their own funds to cover the remaining amount. The participating banks are responsible for marketing, appraisal, and credit approval, and for loan collections and enforcing all remedies in the event of default. The Department of Alternative Energy Development and Efficiency (DEDE) also provides technical assistance in project appraisal and in supporting energy audits and feasibility studies. Repayment of the loan flows back to the ENCON Fund and not the Revolving Fund. When each phase is committed, a proposal to replenish the Revolving Fund is submitted to the ENCON Fund. According to the DEDE, the repayment rate has been highly satisfactory.

The Revolving Fund supported over 335 EE projects and 112 RE projects during 2003–2010 and resulted in a total investment of around US$453 million, including US$210 million in financing from the Revolving Fund. This represents an average leverage ratio of around 1:1 for the total portfolio. The leverage ratio of the total portfolio has been increasing to around 2:1, as participating banks become more familiar and confident with EE and RE projects, and thus are more willing to take more risks. Total energy savings up to 2010 are estimated to be over US$154 million per year. The average payback period is approximately three years. The breakdown of activities supported by the Fund during 2003–2009 is shown in figure A4.1.

Figure A4.1 Projects Supported by the EE Revolving Fund during 2003–2009 by Type of Technology

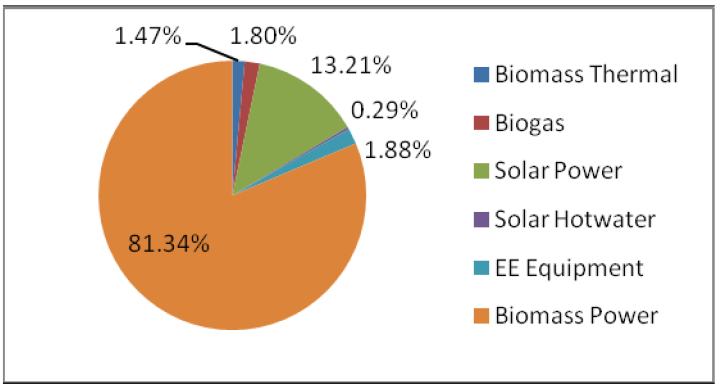


Source: DEDE 2010.

To date, the revolving fund has completed four phases for which 100 percent of the fund had been committed. The fund is currently in the Fifth Phase, of which 90 percent had been committed, and the remainder is expected to be committed soon, with several projects in the pipeline of the approval process. The Sixth Phase proposal for US$1,000 million Baht was recently submitted to the ENCON Fund Committee for consideration and approval.

The ESCO Fund was established by the Ministry of Energy (MOEN) in 2008 with initial capitalization of US$30 million from the ENCON Fund. The ESCO Fund intends to address the need for start-up capitalization of energy service companies by providing government funds to co-invest with private developers. The Fund can provide equity investment, venture capital, and credit guarantees; facilitate equipment leasing; and support project development. Two Fund Managers have been selected—the Energy Conservation of Thailand Foundation and the Energy for Environment Foundation. As of April 2010, the ESCO Fund has supported 26 projects (figure A4.2), mostly renewable energy investments, with a total investment of US$145 million, with US$12 million from the ESCO Fund, resulting in 32,000 tons of oil equivalent (ktoe) of energy saved, or US$18 million per year.

Figure A4.2 Projects Supported by the ESCO Fund



Source: DEDE 2010.

International experience of innovative EE financing mechanisms

Public funds can play an important role in removing market barriers and catalyzing EE investments. One key question is how to best use the limited public funds to leverage commercial financing and achieve the highest energy savings. This section focuses on international experience to address this issue and introduces several financing models that have been successful in other countries. To address EE financing barriers, there are six main financing mechanisms with public funds for energy-efficiency investments. They are discussed below.

Increasing financial institutions' capacity and confidence: Dedicated credit line and partial risk guarantee

1. Dedicated EE credit line through local financial institutions for debt financing. The objective of this instrument is to increase the confidence and capacity of domestic banks through a learning-by-doing process. Under this instrument, the governments (for example, the Thailand Energy Conservation Fund) or the multilateral development banks (MDBs) and donors (for example, the China Energy Efficiency Financing [CHEEF] program) provide concessional loans to participating banks in developing countries, which will on-lend to end-beneficiaries at either the concessional rate or market rate. This is by far the largest volume of EE financial support by MDBs.

This approach offers the best prospect for program sustainability, and can play a significant role in increasing banks' capacity, interests, and confidence in mainstreaming the EE financing business line. One of the key lessons learned is that the financing schemes must go hand in hand with technical assistance, particularly at the beginning, to build capacity and provide advisory services to the banks in appraising EE investments and developing financial structure, and to build the capacity of project developers in EE. However, local banks tend to rely on their traditional underwriting criteria of balance sheet financing that focuses on sub-borrowers' credit ranking, which favors their established clients, usually large established companies and large projects. Changing local banks' underwriting criteria to project-based financing that focuses on energy savings, which will increase access to financing for ESCOs and small and medium enterprises (SMEs), has been a major challenge.

The CHEEF Project is such an example. The World Bank provides US$200 million in IBRD loans to two Chinese banks for EE lending, with a US$13.5 million Global Environment Facility grant for technical assistance and capacity building. Participating banks are required to provide 100 percent cofinancing for the IBRD loans. The CHEEF project has made excellent progress since its implementation in 2008. It has played a significant role in increasing participating banks' capacity, interests, and confidence in mainstreaming the EE financing business line, and leading the Chinese banking sector to finance EE. The project also played a catalytic role in leveraging additional financing for EE to the two Chinese participating banks from the KfW, the African Development Bank, and the European Investment Bank.

During the two-year implementation of the CHEEF project, US$106 million in IBRD loans have leveraged more than US$430 million in investment in industrial energy efficiency from participating Chinese banks and industrial enterprises. These investments are expected to result in an energy savings of 1.6 million tons of coal equivalent and to reduce CO_2 emissions by 4.1 million tons.

Experience has taught the following valuable lessons:

- Capacity building of staff on evaluation of EE investments and a dedicated team within the participating financial institutions is crucial to successful project implementation
- Strong management commitment within the participating financial institutions is critical
- Government's EE commitments and policies are the determinant factor.

2. Partial risk guarantee scheme. The objective of this instrument is to share and mitigate perceived risks for domestic banks investing in EE projects, particularly those from ESCOs. Partial risk guarantees allow borrowers to access commercial funding that may not have otherwise been available to them due to their risk profile. It also enables them to secure lower interest rates or longer maturity terms due to the reduced commercial risks to the lender.

The World Bank and IFC have financed a series of EE financing projects in China and Eastern Europe. Such a risk guarantee scheme can be managed by domestic insurance companies (for example, the World Bank/GEF China Energy Conservation II Project that provides partial risk guarantees to ESCOs), and dedicated international teams (for example, the IFC/GEF China Utility Based Energy Efficiency (CHUEE) Program, which provides portfolio risk guarantees to participating banks for EE [box A4.1]). This instrument is effective to mitigate banks' perceived risk and increase their confidence in EE lending to borderline clients—that is, enterprises with a reasonably good credit ranking but without established clients with banks or ESCOs doing business with good credit ranking host enterprises.

Again, technical assistance is critical. Careful selection of participating banks that are interested in EE and SME business lines is important. Detailed design of management structure and evaluation criteria is the key to success. To that end, a commercial-oriented professional management firm for the guarantee fund is essential. The fund management entity should have a strong relationship and alignment with participating banks and be awarded for generating deals under a defined ceiling of default rate. Finally, partial risk guarantee is not a panacea; it can only reduce the perceived risk of lenders.

Setting up special-purpose financing vehicles

3. Dedicated fund. This instrument is used in cases (a) where domestic banks are not interested in lending to SMEs and most ESCOs; or (b) where EE is in the early stages and the domestic financial market is not yet mature or ready to provide financing. A dedicated fund is then set up, with a dedicated professional fund management team competitively selected. The dedicated fund management team is tasked to open up this second-tier market, with various financing instruments such as debt, mezzanine financing, and equity. The World Bank has set up such dedicated EE funds in Bulgaria and Romania. This approach is transitional, with the objective that domestic banks will eventually pick up this market when they see the profitability. However, sustainability, leverage, and scale-up are key challenges.

4. Utility Energy Efficiency/Demand-Side Management Funds. Utility demand-side management, widely adopted by many U.S. states, is usually funded through a system benefit fund (financed by a tariff surcharge per kilowatt-hour to all electricity customers), which is more sustainable than

government budgets. Administered by either utilities or dedicated energy-efficiency agencies, the funds cover incremental costs between renewable energy and fossil fuels, consumer rebates, concessional loans, research and development, consumer education, and low-income consumer assistance.

A number of state governments in the United States have created new Energy Efficiency Utilities (EEUs), or similar institutions, which involve contracting special entities to implement the state's main publicly funded energy conservation programs or key aspects of them (see box A4.2 on the Vermont Energy Efficiency Utility). These are new institutions unrelated to electric power or other energy supply utilities whose sole purpose is to realize energy savings requested by governments as effectively and cheaply as possible. The EEUs prepare comprehensive programs of investment project promotion, targeted subsidies, awareness-building activities, community organizing, and technical assistance, and execute these programs under a comprehensive contract with the state government. The EEUs operate under performance-based contracts, developed mainly in an effort to yield maximum energy savings at minimum cost. Entities operating the EEUs are typically procured through a public bidding process, and the performance contracts provide for a tying of compensation to the energy savings levels validated by the state government.

Aggregating small-scale EE projects through ESCOs

5. Third-party financing through ESCOs. ESCOs provide a wide range of services, such as energy auditing, recommendations of energy-saving measures, EE financing to end users, and implementing EE projects with performance-based agreements under which the end users pay for these services from the demonstrated energy savings. But they are not a magic bullet. Most ESCOs have had difficulty obtaining adequate financing from commercial banks because of their weak balance sheets and the perceived higher risks of loans dependent on revenues from energy savings. Policies, financing, and technical support from governments and international development banks can strengthen ESCOs and mainstream their business model. In China, for example, given the strong government EE policies that create a demand for ESCO services and provide favorable financial incentives to ESCOs, together with a decade of capacity building supported by the World Bank and the GEF, the ESCO industry grew from three companies in 1997 to nearly 500, with US$3 billion in energy performance contracts in 2009.

Closing the equity gap

6. Equity fund for ESCOs. As mentioned, ESCOs have difficulty securing equity financing because of their weak balance sheets and the perceived high risk of loans dependent on revenues from energy savings. For the same reasons, ESCOs also face enormous difficulties accessing debt financing. The Thai ESCO Fund is intended to address this barrier, although most of the investments to date have gone to RE developers. The Indian government is also setting up equity funds for ESCOs, and the Chinese government has expressed interest in this instrument.

Box A4.1 World Bank/GEF China Second Energy Conservation Project's ESCO Loan Guarantee Program and IFC/GEF China Utility Energy Efficiency Financing Project (CHUEE)

The World Bank/GEF China Second Energy Conservation Project: This project provides (a) a GEF grant of US$22 million to create and operate a reserve fund for a partial risk guarantee program to help Chinese ESCOs develop project financing channels with local banks and thereby help foster the growth of Chinese ESCOs, implemented by the China National Investment and Guarantee Company (I&G); and (b) US$2.0 million in technical assistance to I&G and creation of an ESCO Association.

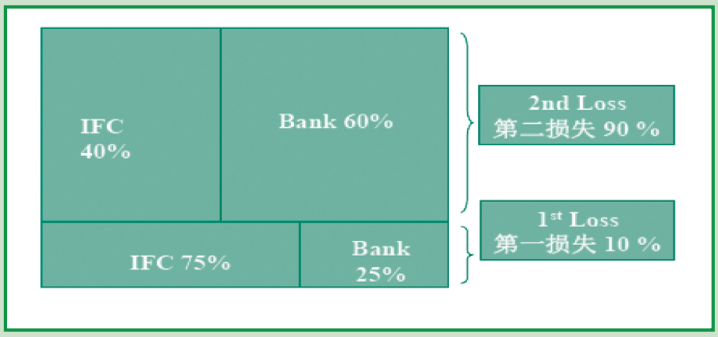
The scope of the guarantee program only covers loans for the energy performance contracting project investment, and ESCOs must be the loan borrowers. I&G provides 90 percent loan guarantees to commercial banks that make loans to ESCOs for qualified EE projects. I&G appraises and originates guarantees with ESCOs and banks. The guarantee is a three-party agreement. The guarantee fee is about 1 to 1.5 percent of the loan, paid by the ESCO.

The ESCO Loan Guarantee Program has helped create a bridge for many ESCOs into the world of formal financing. As a result, I&G issued guarantees for 148 energy performance contracting projects developed by 42 ESCOs, with a total project investment of US$137 million. Capital in the reserve fund has been basically retained, with an actual default rate of 1.08 percent. The leverage ratio of the total project investment to the guarantee reserve is 6 to 1, and the guarantee amount was 3.4 times the guarantee reserve. The public costs (including the technical assistance cost) of direct energy savings was estimated at about US$0.5/ton of coal equivalent. Eleven banks participated in the program and the confidence in ESCO lending has greatly increased. Many participating ESCOs received Bank loans for the first time because of the guarantee scheme.

China Utility Energy Efficiency Financing (CHUEE) project: CHUEE cooperates with Chinese commercial banks and offers them a facility whereby the IFC shares part of the loss for all loans within the GHG emission reduction portfolio. The program also provides technical advisory services related to marketing, engineering, and project development; and equipment financing services to banks, projects developers, and suppliers of EE and renewable energy products and services.

The IFC provides "Loss-Sharing Agreements" with partner banks. Losses are defined on a portfolio basis. In the first-generation loss-sharing agreement, the IFC shares 75 percent of the "first losses," defined as 10 percent of the total original principal amount of the loan portfolio. Second losses are all losses after the first losses; these are shared 40/60 between the IFC and the bank (figure BA4.1.1).

Figure BA4.1.1 Financing Structure of the CHUEE Loss Risk-Sharing Facility



The IFC has helped its first two bank partners develop a pipeline of about 280 projects. The key areas have been waste heat recovery and power generation, electricity saving, building energy saving, boiler renovation, wind farm development, and cogeneration, and the total investment has exceeded US$672 million. The sub-borrowers tend to be participating banks' existing clients—medium and large enterprises—but the EE loan portfolios of the participating banks have grown strongly.

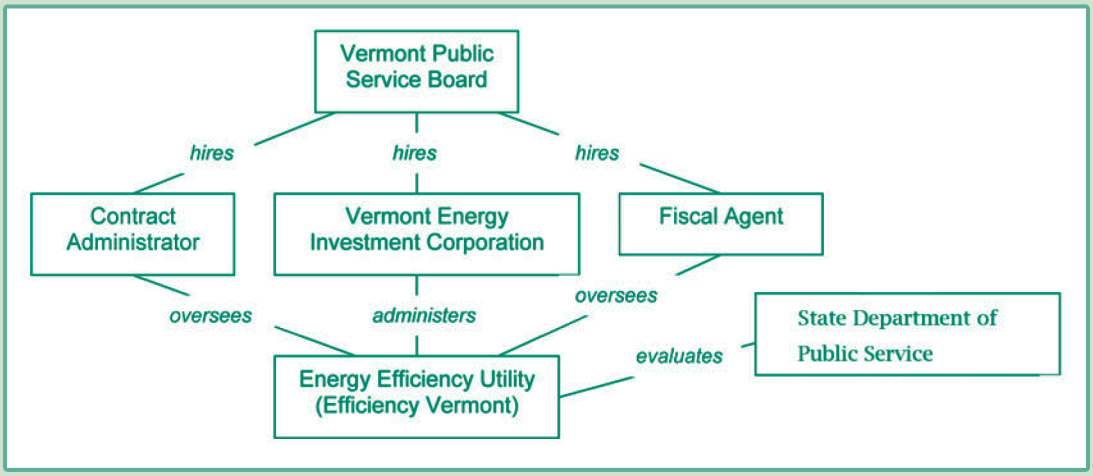
Source: World Bank 2010d; and Eco-Asia Clean Development and Climate Program 2009.

Box A4.2 Vermont's Energy Efficiency Utility (EEU)

Overview. The EEU, called "Efficiency Vermont," was established in 1999. Its objective is to supply the maximum amount of electricity savings for the least amount of public funding. The EEU is implemented by an independent corporation, the Vermont Energy Investment Corporation, under a contract with the state's electric power regulatory agency, the Vermont Public Services Board. The contract was awarded following competitive bidding. The contract is for three years but can be renewed for an additional three years. Every six years, a new competitive bidding procedure must be followed for awarding the contract, according to state law.

Organizational Structure. The Public Services Board hires a Contract Administrator who oversees the details of contract and EEU implementation. The contract is financed from an electricity sales surcharge amounting to 2.82 percent of the total payment consumers make in the state for electricity. The surcharge funds are collected from the State's many electricity distribution companies and are paid to the EEU contractor according to the terms of the contract by a fiscal agent, who is also hired by the Public Services Board. Rigorous and detailed monitoring and verification of the actual electricity savings achieved by the EEU program is undertaken by the State's Department of Public Services. The results of the independent verification of the savings achieved are an important factor in the payment of the EEU contractor's performance-based fee.

Figure BA4.2.1 Organization Structure of the Vermont EEU



Impacts. The EEU program is considered among the most successful state energy efficiency programs in the United States. Savings in 2007 and 2008 completely offset total electricity demand growth despite growth in the number of electricity consumers. The levelized cost per kWh saved in 2008 was U.S.3.1cents compared to an avoided cost of electricity supply of 14 U.S.cents/kWh.

Source: Efficiency Vermont 2008; www.efficiencyvermont.org.

Annex 5

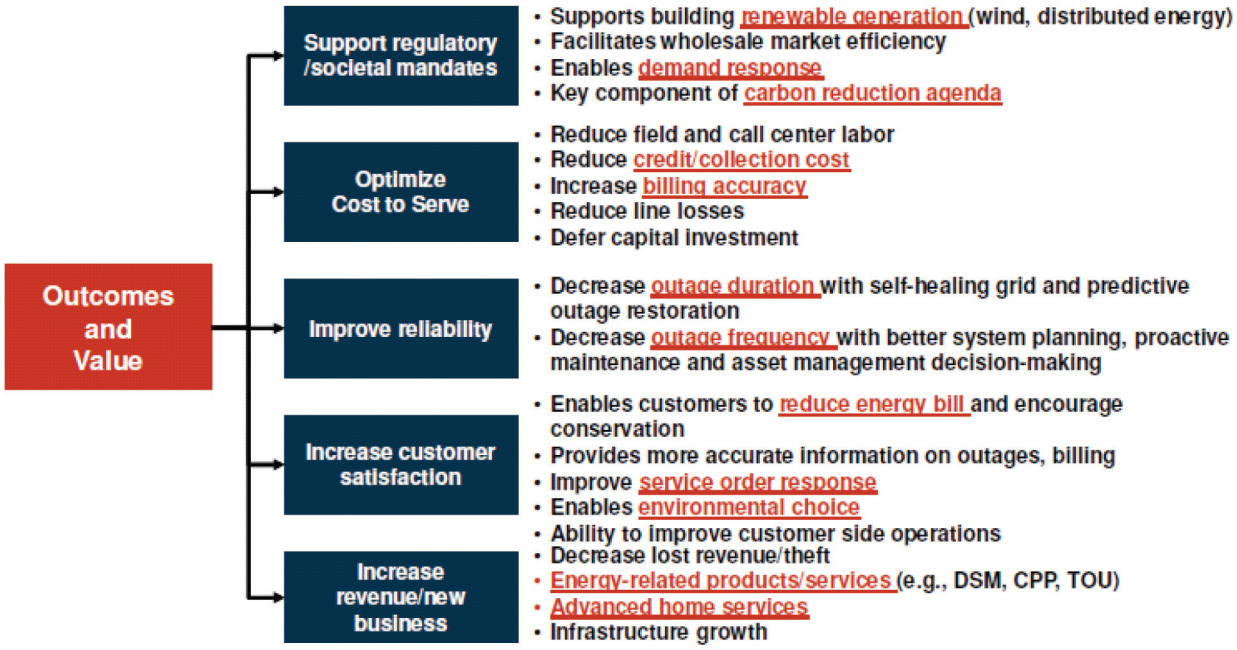
Smart Grids

Definition of smart grids

Generally, a smart grid is characterized as the following:

- Increased use of digital information and control of technology to improve reliability, security, and efficiency of the electric grid
- Deployment and integration of distributed resources and generation, including renewable resources
- Development and incorporation of demand response, demand-side resources, and energy efficiency resources; provision to consumers of timely information and control options; and real-time transport and power congestion and load management combined with real-time electricity pricing
- Deployment of "smart" technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation; integration of "smart" appliances and consumer devices
- Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning; accommodation of zero-emission building (Bollen 2011; Kezunovic 2011).

Figure A5.1 Values and Outcomes of Smart Grids



Source: Accenture.

Current status of smart grids

In the last several years, many European countries and U.S. states have piloted smart grids using government subsidies. However, the high capital and operation and maintenance costs continue to be the main barrier to broader use.

There are successful cases of implementing smart grids, such as smart cities in Amsterdam; Austin, Texas; and Boulder, Colorado. In particular, Italy's largest power company, ENEL, has invested about 2 billion euros to replace all retail conventional meters with smart meters at a system price as low as US$100 per customer. Smart meters, or advanced metering infrastructure, also showed success in developing countries in reducing high technical and nontechnical losses cost-effectively, such as in Brazil and India. Installation of an advanced metering infrastructure for a high- or medium-voltage consumer, using the signals provided by the existing metering transformers, requires an investment of US$300 to US$400 on a system basis (Antmann 2009).

Recommendations

Given that Thailand has (a) a high electrification rate with low technical and nontechnical losses; (b) a good telecommunication system; (c) the need to integrate renewable energy, including wind power sources located far from the load center; and (d) some aspects of smart grids already in place, such as time-of-use pricing and net metering, the following recommendations are made:

- ***Reform energy pricing:*** Review and asses the current implementation status and impacts of the current electricity tariff using an optional time-of-use tariff structure and regular progressive tariff structure, and net metering, including the number of consumers using each option, impacts on energy efficiency, demand response and peak load management for each option, alternative options for free electricity up to 90 kWh/month, and explore potential modification of tariff structures, including potential introduction of critical peak pricing and peak time rebate.

- ***Develop a smart grid roadmap:*** Given the large investment required, phasing implementation plans with clear and measurable targets and milestones for smart grid development are important for all stakeholders. The first step is to develop a comprehensive integrated plan and roadmap of smart-grid development. Potential options for introducing smart grids including smart meters and two-way communication should be explored to enforce (a) accommodation of renewable energies, zero-emission buildings, and electric vehicles, which can also serve as a power storage, and other distributed power generation; and (b) real-time transport and power congestion and load management.

- ***Develop regulations and standards:*** Interoperability standards and testing and certification requirements should be developed and adopted as a part of policy making. Industry regulations and enforcement of technical and quality standards are critical for efficient deployment of smart grid technologies. Existing legal, regulatory, and institutional frameworks should be revised and adjusted to provide an enabling environment for smart grid development.

- ***Start piloting smart-grid technologies with large customers:*** Technology demonstration and commercial-scale pilot projects are required before scaling up specific technology and or solutions. The first step is to start targeting large customers because their demand responses are high, including not only using the time-of-use tariff but also critical peak pricing and peak time rebate (U.S. experience shows that critical peak pricing combined with advanced technology is most effective in reducing demand). In Korea, the industry sector, such as POSCO, a Korean Steel Company consuming 7 percent of the total national electricity consumption, is actively promoting smart grids to improve its energy efficiency.

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