Philippine Energy Transition: Towards a Secure, Affordable and Clean Energy Future
# Table of Contents

*Key Messages* ........................................................................................................................................ iv

1 *Country and Energy Sector Context* .................................................................................................... 1

2 *Philippine Energy Outlook 2040* ......................................................................................................... 6

3 *Pathways and Implications for Decarbonizing the Power Sector* ...................................................... 10

4 *Policies for a Secure, Affordable and Clean Energy Future* ............................................................. 16

Annex: *Power Sector Decarbonization Analysis* ..................................................................................... 19

*References* ............................................................................................................................................... 21
Key Messages

- An energy transition toward a renewable-energy-dominated power system is technically feasible and will enhance energy security and affordability in the Philippines.
- Solar power, which is the most abundant and widely distributed renewable resources in the country, will be the main driving force of the energy transition while hydro and wind power also have substantial contributions.
- Rapidly decarbonizing the power sector entails doubling the cumulative capital investments in power systems by 2040 from USD31 to USD62 billion in present value terms, compared with the current ambition of the government.
- Mobilizing the additional financing for accelerated decarbonization requires increased and strengthened government financial facilitation and policy intervention in removing barriers to and reducing risks for private sector investments.
- The levelized cost of electricity supply is projected to decline in general during 2022-2040 as the power system moves away from coal due to savings of fossil fuel cost, expected long-term stability of fossil fuel prices, and the expected declining cost of integrating solar and wind power.
- Pursuing an accelerated energy transition pathway entails steady (starting in 2028) but drastic phasing down of coal-fired power generation, potentially retiring all current coal-fired power plants by 2040.
- Dealing with the complex and challenging process and the significant financial cost of early retirement of coal-fired power plants requires committed efforts. Particular attention is required to mitigate social and economic impacts on affected people and communities in support of a Just Transition.
- The priorities for the next five years are (1) rapidly scaling up investments in solar and onshore wind power and developing corresponding grid integration capacity, especially in transmission and flexibility; and (2) intensifying energy efficiency efforts in buildings and industries.

Main policy recommendations

<table>
<thead>
<tr>
<th>Sector, action</th>
<th>Pathway</th>
<th>Dev impact</th>
<th>Lead agency</th>
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<tr>
<td>Scale up investments in solar and wind power</td>
<td>High</td>
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<td>Intensify energy efficiency efforts in buildings and industries</td>
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<td>Invest in expanded power-grid capacity and improved renewable energy integration</td>
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<tr>
<td>Establish a framework to address the early retirement of coal-fired power plants</td>
<td>Med</td>
<td>+</td>
<td>DOE, DOF</td>
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Notes: A: Adaptation pathway; M: Mitigation pathway; +, ++ indicate the expected magnitude of benefits in terms of increased resilience, reduced emissions, and overall development impact. Lead Agencies: DOE: Department of Energy; DOF: Department of Finance.
# 1 Country and Energy Sector Context

The Philippines sustained robust economic growth in the decade before the COVID-19 pandemic hit in 2020. With increasing urbanization, a growing middle class, and a large and young population, the Philippines has been one of the most dynamic economies in the East Asia Pacific region. Its economy grew at an average annual rate of 6.4 percent between 2010 to 2019, from 4.5 percent in the previous decade. Growth has been anchored on robust domestic demand supported by steady remittances and vibrant labor market. The economy has maintained adequate policy space with ample international reserves and a sustainable fiscal position. As a result, it earned an investment grade credit rating from the big three credit rating agencies, helping to lower the government’s borrowing costs. However, the pandemic has caused an economic contraction of 9.5 percent in 2020 and brought socio-economic scarring through learning losses and poorer health outcomes.

The economy has been recovering since 2021 driven by the return of domestic activities, but faces headwinds caused by unfavorable external environment. The real GDP rebounded by 5.7 percent in 2021 and further accelerated in the first two quarters of 2022 given the economic reopening and return of robust domestic activity. Still, the confluence of the impacts of the war in Ukraine, monetary tightening in advanced economies, and the slowdown in the US' and China’s economies are challenging the recovery momentum. These headwinds have spilled over the domestic economy through currency depreciations and rising inflation. Headline inflation reached 6.3 percent year-on-year in August 2022, breaching the central bank’s 2-4 percent target range. The inflationary pressure was driven by increases in the prices of food and energy amid elevated global commodity and fuel prices.

The Philippines is highly vulnerable to climate change and natural disasters due to its unique geography. Climate-related events were the most frequent disasters recorded in the country. An average of 20 typhoons hit the Philippines each year; over the past 10 years the country has experienced very strong and highly destructive typhoons (with wind strength above 170 km per hour) almost every year. More intense rains now accompany even weaker typhoons, causing storm surges, heavy flooding, and landslides. Strong typhoons have had grave human, social and economic costs to the country. These strong typhoons affect nine of 17 Philippine regions, affecting an average of five million people with 850 individual casualties each year in the last 10 years. Annual losses from typhoons have been estimated at 1.2 percent of GDP.

The energy sector has anchored the growth of the economy with improved productivity but also posed challenges due to the high cost of energy. Primary energy supply increased by 1.5 times from 2010 to 2019, corresponding to a 1.7 times growth in GDP. Total electricity supply grew by 1.6 times in the same period. In broad terms, the Philippine economy had grown with improved energy productivity as reflected by the smaller increment of both primary energy and electricity than that of GDP from 2010 to 2019. Due in large part to the removal of energy subsidies, cost of energy in the Philippines are also among the highest in Southeast Asia, putting pressure on the country’s economic competitiveness.

The Philippine economy is significantly less energy intensive than its regional peers and less dependent on coal. The primary energy intensity of Philippines’ GDP, which has been falling since 2000, was 6.5 GJ/thousand 2015 USD in 2019, compared with 9.6 in Indonesia and 15.2 in Vietnam. The share of coal in primary energy supply, which has been steadily increasing, was 29 percent in 2019, compared with 29 in Indonesia and 51 percent in Vietnam. Coal is used much less in final energy consumption, with only a 6 percent share in 2019, compared with 15 in Indonesia and 26 percent in Vietnam.

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1 Estimated using the Philippines Catastrophe Risk Model developed by AIR (World Bank, 2018).
2 Data are from IEA, Energy Statistics Data Browser. Values for 2019 are used for benchmarking because 2020 values are abnormal due to the economic contraction caused by the COVID-19 pandemic.
products and biomass than those of its peers, underscoring the outsized role of transport in fossil fuel demand and a large rural population which still relies on biomass.

There has been a marked shift towards fossil fuels in the primary energy mix over the past decade. The share of fossil fuels in primary energy supply increased from 60 percent in 2010 to 67 percent in 2020 due to a large increase of coal-fired power generation and sustained growth in oil demand from transport (Figure 1). This trend highlights the fast-growing carbon footprint of energy production and consumption, which is the largest contributor to GHG emissions in the Philippines, accounting for 59 percent of total greenhouse gas emissions in the country in 2019, up from 50 percent in 2010.³

Figure 1: Power generation and transport have been driving the increase of fossil fuel consumption

Energy supply in the Philippines is highly reliant on imported oil and coal and will soon be reliant on imported liquified natural gas (LNG) due to dwindling domestic gas production. Philippines is almost 100 percent dependent on imported oil while imports about 80 percent of its coal consumption, predominantly for power generation. Natural gas, which accounts for about 6 percent of primary energy supply and predominantly used for power generation, comes almost exclusively from the Malampaya gas field, which is rapidly approaching end of life (92 percent of proven reserves depleted) and may cease production by 2027. Until additional domestic gas production is developed, imported LNG is the solution for meeting power generation demand. Give such reliance on imported fossil fuels and the recurrent volatility of international energy market, energy security figures prominently in the government’s energy strategy.

The Philippines is a rarity among developing economies in having an energy sector generally free of market distorting subsidies. The energy sector reforms that started in the 1990s had eliminated most energy subsidies within a decade except for a few targeted social subsidies, such as lifeline subsidies for low-income households and price subsidies for households relying on diesel-powered mini grids on remote islands. Such social subsidies are generally financed by non-subsidized rate payers.

The Philippine power sector has undergone important institutional reforms and technological changes in the past 20 years. Following severe energy supply shortages in the late 1980s and the Asian Financial crisis of 1997, the government enacted the Electric Power Industry Reform Act (EPIRA) in 2001 to improve the quality of service and reduce electricity costs by introducing private participation and competition at the wholesale and retail levels. The EPIRA reforms were mostly completed by 2013, making the Philippine power market one of the freest in the region. These reforms unleashed a period of strong growth in private financing of power generation assets, lifting the total installed generation capacity from 16GW in 2010 to over 26GW in 2020. Boosted by the government’s “technology neutral” policy, coal-fired power increased from 30 percent of total installed generation capacity in 2010.
2010 to about 42 percent in 2020, and from 34 percent of total electricity produced in 2010 to 57 percent in 2020. Solar and onshore wind energy also made inroads, accounting for 15 percent of the capacity installed in the same period, growing from zero in 2010 to about 1.5 GW in 2020. But the overall share of renewables (primarily consists of hydro and geothermal power) in electricity generation shrank from 26 percent in 2010 to 21 percent in 2020 due to the rapid growth of coal-fired power.

Figure 2: Coal has become the dominant source of power generation over the last decade

The power sector’s current structure is the consequence of EPIRA. While the Department of Energy (DOE) sets national energy policy and is responsible for long-term planning, including the Philippine Energy Plan and the Power Development Plan, the private sector finances the investments in generation and grid assets. The Energy Regulatory Commission (ERC), an independent quasi-judicial body created by EPIRA, regulates rates and services and ensures consumer protection and competition. The Power Sector Assets and Liabilities Management Corporation (PSALM), a government owned and controlled corporation (GOCC) created by EPIRA to privatize power sector assets, still owns some older oil-fired power plants and some key hydropower assets, especially in Mindanao. The National Power Corporation (NPC), which was a vertically integrated monopoly before EPIRA, is now a much smaller GOCC responsible for off-grid electrification of remote islands unviable for private investments and operation of state-owned hydropower facilities and management of associated reservoirs. The Independent Electricity Market Operator of the Philippines (IEMOP), a non-profit corporation established in 2018, manages the Wholesale Electricity Spot Market (WESM), which has been operating in Luzon and Visayas for more than a decade. A spot market for Mindanao, which is not yet connected to the Luzon and Visayas grids, became commercially operational in July 2021. The National Grid Corporation of the Philippines (NGCP), a privately-owned consortium, is the transmission system operator under a 25-year concession agreement since 2009. NGCP is also responsible for investing in the maintenance, modernization and expansion of transmission assets, which are owned by the National Transmission Corporation (TransCo), a GOCC. Distribution is a mix of 20 investor-owned utilities and 121 rural electric cooperatives (ECs) which are supervised and assisted by the National Electrification Administration (NEA), a GOCC attached to DOE. One hundred of these ECs are connected to the power grids in Luzon, Visayas and Mindanao, while the remaining 21 are spread across the archipelago without connection to the larger grids. The main grids of Luzon and Visayas are interconnected. An interconnector between the Mindanao grid and Visayas grid is under construction and expected to become operational in 2022/2023.

Retail electricity tariffs in the Philippines remain among the highest in ASEAN, constraining economic competitiveness. The power sector reforms did not bring about reduced electricity tariffs, as initially hoped. The average retail tariff in the Philippines in early 2021 was US$0.15/kWh, compared with US$0.08/kWh in Indonesia and US$0.11/kWh in Thailand. While subsidies (or the lack of) explain much...
of the difference, studies also point to factors such as domestic taxation, the market power of generation companies due to limited competition, the lack of competition at retail level, and other inefficiencies in the sector. Studies also suggest that the sustained high cost of electricity in the Philippines may have contributed to a premature decline of the industrial share in the economy and suppressed the growth of industries for which electricity is an important production factor. An important challenge to any energy transition is to avoid harming the competitiveness of the Philippine economy by further increasing the cost of energy.

Last mile rural electrification remains a short-to-medium-term priority of the government. As of December 2020, the country’s overall electrification rate stood at 94.5 percent. While Luzon has almost achieved full electrification at 98.4 percent, Mindanao lags significantly behind at 83.6 percent. Some parts of Mindanao the access rate is around 40 percent. In total there are still over 1 million households without electricity access, about two thirds of them in Mindanao. The government has adopted a customized approach for the last-mile electrification that involves both off-grid (primarily based on renewable energy) and grid-extension (when economically viable) solutions.

The Philippines has substantial renewable energy (RE) resources, particular solar and wind, but they are underdeveloped and underutilized. Out of the 26.25 GW total installed generation capacity in 2020, hydro, geothermal, biomass, and solar/wind accounted for 3.78, 1.93, 0.45 and 1.46 GW, respectively, for combined share of 29 percent. The total untapped hydro is 13.1 GW. Estimated geothermal potential is 4.4 GW. Wind and solar have the greatest potential but so far are least developed. The total onshore wind electric potential from areas with good to excellent wind resource is estimated to be 76 GW of technical potential. The technical potential of offshore wind is estimated to be 178 GW. The average solar radiation ranges from 128 to 203 watts per square meter, which translates to potential power generating capacity of 4.5-5.5 kWh per square meter per day. Despite having introduced the Renewable Energy Act in 2008, the country is lagging behind regional leaders such as Vietnam and Thailand in installed solar and wind capacity by a significant margin due to a relatively small and cautious feed-in-tariff (FiT) program out of cost concerns and complicated and lengthy permitting process. The recently launched Green Energy Auction Program (GEAP) in conjunction with the implementation of the Renewable Portfolio Standard (RPS) is expected to unlock significantly private financing for scaling up grid-connected solar and wind while reducing cost through competitive bidding. The complex permitting process has been streamlined by the introduction of the Energy Virtual One Stop Shop (EVOSS) online system in 2019. It may still take some time to see effects in practice.

The government has also demonstrated a strong commitment to energy efficiency (EE). The commitment to EE was codified in the Energy Efficiency and Conservation Act (EECA) made effective in April 2019, followed by the issuance of the Implementation Rules and Regulations of the EECA in November 2019, providing the legal and regulatory underpinning for a wide spectrum of EE requirements such as minimum energy performance standards, energy reporting of significant energy consumers, government energy management program, and support for energy service companies. While the energy intensity of GDP in the Philippines is low compared to its peers, in part due to its service-oriented economy and a relatively small manufacturing sector, some key energy end-uses remain inefficient despite high energy prices. For example, over 80 percent of new window air conditioner (AC) units and 20 percent of new split AC units sold in the market are still using fixed speed

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6 https://www.doe.gov.ph/hydropower?withshield=1

7 https://www.nrel.gov/docs/fy01osti/28903.pdf


10 https://www.evoss.ph/Home/DisplayFaq/6
compressors which usually have 25 – 40 percent less energy efficiency ratio than those using inverter technology, which allow compressors to operate at variable speed. Another area of significant energy savings potential is the incorporation and enforcement of building energy code in the permitting and construction inspection process. The Philippines, while having a Green Building Code (GBC) as a referral code of the National Building Code, as well as guidelines for energy conserving design of buildings and utility systems issued by DOE, there is insufficient evidence about the actual enforcement of the GBC, especially in residential buildings.

The government is actively engaged with the international community on climate change and energy transition discussions, although it has not announced a timeline for achieving carbon neutrality or phasing out coal-fired power. The first Nationally Determined Contributions (NDC) was submitted on April 15, 2021, committing to a 75 percent reduction in cumulative emissions (excluding land-use change and forestry) in the period from 2020 to 2030, relative to projected business as usual cumulative emissions of 3,340 MtCO2e. However, only 2.71 percent of this proposed reduction is unconditional. In October 2020 DOE announced a moratorium on endorsing new greenfield coal-fired power plants. At COP26, the Philippines partially endorsed the “Global Coal to Clean Power Transition Statement” aiming to phase out the use of coal for power generation.12

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12 The Philippines endorsed clause 1 (rapidly scaling up clean power generation and energy efficiency) and partially endorsed clauses 2 (rapidly scale up technologies and policies in this decade to achieve a transition away from coal power generation) and 4 (strengthening efforts for a just and inclusive transition away from coal).
2 Philippine Energy Outlook 2040

The government projects sustained strong growth in energy demand in the next two decades as a result of expected strong economic growth and significant population growth. Final energy demand, the aggregate energy consumption of all economic sectors and households, is projected to triple in the baseline reference scenario (REF) of the Philippine Energy Plan (PEP) 2020-2040 while moderate slightly in a clean energy scenario (CES), in which greater economy-wide energy efficiency improvement is assumed (Figure 3, left panel). But Philippines starts from a low level of energy consumption. For example, per capita electricity consumption in the Philippines was 0.9 MWh in 2019, compared with 2.3 MWh of Vietnam, 5.0 MWh of Malaysia, and 9.4 MWh of Singapore. Using a broader metric, Philippines projected primary energy supply per capita in 2040 will still be far lower than the levels of Malaysia and Singapore in 2019 (Figure 3, right panel).

Figure 3: Energy demand is projected to grow rapidly, but from a low per capita consumption

Sources: Philippine Energy Plan 2020-2040, Department of Energy and International Energy Agency

The economy’s carbon footprint is projected to triple in REF due to large increases in consumption of fossil fuels driven by demand in power generation and transport, but will remain small at per capita level. While the share of coal is projected to decrease in both REF and CES, the overall share of fossil fuels in primary energy supply will grow due to the increased shares of oil and natural gas. The large increase in natural gas consumption is due to power generation fuel switching as the government intends to cap coal-fired power generation capacity after 2025. Future increase in GHG emissions will be dominated by power generation and transport (Figure 4, right panel), two focal sectors of the energy transition agenda.

Figure 4: Primary energy supply will rely more on fossil fuels driven by power generation and transport

Sources: Philippine Energy Plan 2020-2040, Department of Energy.

* Energy transformation is predominantly power generation.

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13 Philippine Energy Plan 2020-2040. The projected real GDP growth from 2020 to 2040 averages 7.2 percent per annum.
The PEP 2020-2040 outlines an energy future which sees installed coal-fired power capacity leveling off after 2025 in both REF and CES. The capping of coal-fired power capacity not only reflected the government’s intention to stay firm on the moratorium on the approval of green-field coal-fired power plants (CFPPs) but also implied that a significant number of the projects in the pipeline had been shelved. The overall additional 2.64 GW of CFPPs (compared to 2020) only included projects which are already in different implementation stages. The PEP 2020-2040 does not envision the phase-down of coal-fired generation capacity, although a peak of coal-fired generation in 2030 is envisioned in CES. The leveling-off of coal-fired generation would be counterbalanced by the expansion of natural gas-fired power and renewable energy sources, particularly, solar and hydropower.

Figure 4: The power sector will see significantly diminished role of coal

The Philippines is pivoting toward natural gas for power generation in a time when domestic production is dwindling and international market prices for LNG have skyrocketed. The government has approved seven LNG terminal and regasification projects to be financed by domestic and international private investors. Three of them, with a combine capacity of 11.26 million ton per annum (equivalent of 15.5 billion cubic meter per annum natural gas capacity), are expected to be completed in 2022 and 2023, providing ample capacity for the existing power plants relying on Malampaya gas field. The additional terminals are in different stages of development and will be able to supply for the planned increase in gas-fired power capacity up to 2035. The main short-term challenge for the Philippines is securing LNG supplies at reasonable prices in a tightening global LNG market since it has yet struck any long-term LNG supply contracts. LNG benchmark price (Japan/Korea Marker) for spot cargoes in August 2022 doubled from that of January 2022 and was over 5 times higher than in January 2021. Inability to source LNG at competitive prices and in sufficient quantity could have significant consequences in higher electricity rates or causing potential shortfalls in generation.

The government’s ambition in scaling up RE deployment is clearly demonstrated in the CES in which the share of electricity generation from RE sources will grow from 21 percent in 2020 to 50 percent by 2040. This target is made official in the updated National Renewable Energy Program (NREP) 2020-2040, which seeks to significantly increase RE’s share in the country’s power generation mix by 2040. To give the target a firm backing, the NREP also increased the mandatory RE market share in the RPS from a minimum annual increment of 1% to 2.52% by 2023 and onwards. The GEAP successfully auctioned about 1.6 GW of solar and onshore wind in June 2022 at significantly lower prices than the prevailing FiT, a major step forward in moving to competitive bidding for large scale grid-connected solar and wind power. The private sector has shown great interest in developing RE projects. According to DOE, indicative solar and onshore wind projects for years 2022-2027 tops 13 and 6 GW, respectively, on pace with the CES trajectory for solar and far more than the CES expected for onshore wind.14 Moreover, with the World Bank Group’s

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14 [Link](https://www.doe.gov.ph/sites/default/files/pdf/electric_power/private_sector_initiated_power_projects/%5Bb-04%5D_summary_indicative_lopsipp_31-july-2022.pdf)
assistance, DOE launched the Philippine Offshore Wind Roadmap in April 2022, setting in motion the efforts to develop Philippines’ large offshore wind resources. Despite at a very early phase of the development process, local and international investors already obtained service contracts for 30 GW of offshore wind development as of August 2022.

**Overcoming the key challenges to achieving the government’s ambition in scaling up RE will lay a solid foundation for an accelerated clean energy transition:**

- **Grid capacity constraints.** With the expected rapid scaling-up of on-grid variable renewable energy (VRE), it is crucial to address the grid capacity constraints to VRE integration, particularly in transmission bottlenecks and energy storage systems and smart grid technologies. The existing grid infrastructure has limited capacity to dispatch newly built solar and wind farms due to delays in needed grid expansion projects. Despite a small footprint of if solar and wind power so far, there are already reports of curtailments. DOE has established Competitive Renewable Energy Zones (CREZ) which would facilitate proactive transmission planning and investment by identifying areas with the most economically viable RE resources with suitable topography, appropriate land-use classification, and demonstrated interest for development. To support the anticipated VRE integration, DOE also issued directives supporting the development of energy storage systems and deployment of smart grid technologies with an aim to transform the current grid into a secure, reliable, flexible, digitally-enabled, and interoperable system.

- **Climate resilience requirements.** The expansion of VRE, particularly solar PV, also adds new elements to the climate resilience of the power system. Given the frequency and strength of tropical storms in the Philippines, investment in storm-hardening of solar farms will need to be mainstreamed which could significantly increase the investment cost of solar power.  

- **Maintaining energy security and affordability.** These are the two fundamental principles underlying the government’s energy transition strategy. While energy transition promotes long-term national energy security and affordability, achieving these outcomes, especially in the short-to-medium term, requires the convergence of multiple supporting factors, most crucial among them, a stable and benign external environment (essential for reducing costs of technologies and capital) and sustained economic growth.

- **Mobilizing adequate and timely financing.** Financing RE scaling-up will become more challenging due to the large sum of the necessary investments and the need to increase participation by smaller developers and international investors. The nature of the Philippine power sector and the EPIRA determine that investments in new generation and grid assets will be financed by the private sector with minimum government facilitation or intervention. RE investment financing so far has concentrated among big players. The country’s largest banks have mostly financed RE projects of major developers linked with conglomerates while continue to shun smaller independent power producers due to perceived risks. Foreign ownership restrictions also constrain international capital for solar and wind projects. Since the most desirable projects are often developed first the scaling-up also mean that there will be more higher risk projects (e.g., offshore wind) coming into the pipeline, potentially requiring risk mitigation interventions by the government.

- **Managing strong and sustained demand growth.** The fast-growing demand for electricity in itself is a major challenge to energy transition since it may force the difficult trade-offs between growth and transition and lead to suboptimal solutions. For example, short-term energy choices may lead to overinvesting fossil fuel assets. Sustained and intensified energy efficiency and conservation efforts will help moderate electricity demand across sectors and reduce potential needs to expand power supply capacity. The government intends to achieve 5 percent energy savings on oil products and electricity by 2040, compared with REF. The pace of electrification of road transport

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Storm hardening is still a less studied area with very limited empirical data. Depending on the hardening measures adopted, the overall cost of solar PV systems could increase by up to 50-70 percent ([https://www.nrel.gov/docs/fy20osti/75804.pdf](https://www.nrel.gov/docs/fy20osti/75804.pdf)). Wider application of such hardening measures is likely to reduce their costs.
could have a significant impact on overall power demand and power system operation. While the CES included a 10 percent electric vehicle (EV) penetration rate by 2040, transport sector decarbonization and the accelerated shift of the global auto industry toward EVs could significantly increase EV penetration in the Philippines, a risk and opportunity which need to be analyzed in long-term power system planning.

- **Managing the socio-economic risks of coal transition.** Transitioning out of coal-fired power needs long-term planning and coordinated efforts across a wide spectrum government agencies. While the Philippines does not have a large coal-mining sector and the current coal mining operation is large concentrated in one island, the value chain of CFPPs are still very extensive and highly critical because of its foundational contribution to the economy. Replacing that foundation is transformational efforts not only in technology but also in socio-economic development.
3  Pathways and Implications for Decarbonizing the Power Sector

Decarbonizing the power sector holds the key to a successful clean energy transition in the Philippines. Power generation is the largest source of GHG emissions. Its transition to low- or zero-carbon technologies also enables the decarbonization of transport through electrification. This would effectively address most of the CO₂ emissions from energy production and consumption (80 percent in 2020 and 70 percent in 2040 under the CES of the PEP 2020-2040).

To inform the discussion on clean energy transition pathways, the World Bank conducted an exploratory analysis of decarbonization of the power sector. PLEXOS, a power system least-cost planning software platform, was used to analyze the implications of different levels of emissions reductions on power system expansion given assumptions about demand growth and available technologies. The results should not be interpreted as forecasts, but as projections of the scale and speed of necessary interventions. The analysis included four scenarios, two of them replicating the REF and CES in the PEP 2020-2040 using the World Bank's long-term projection of GDP growth. They are described below.

- **Business-as-usual (BAU)** scenario is the baseline, similar to the REF in PEP 2020-2040, but at a lower GDP growth rate (thus a corresponding lower power demand growth rate). This scenario already included the cap on coal-fired generation capacity from 2026 onwards but does not have an explicit emissions reduction target.

- **Current Policy Scenario (CPS)** is similar to the CES in PEP 2020-2040 but also adjusted to a lower GDP growth rate. It represents the government’s current ambitions in improving energy efficiency and developing e-mobility on the demand side and in scaling up renewable energy on the supply side. The emissions reduction target is implicit in peaking coal consumption in power generation by 2030 and also in demand side energy savings target.

- **Accelerated decarbonization scenario (ADS)** analyzes how power system expansion needs to adapt to achieving the goal of reducing annual CO₂ emissions by 80 percent by 2040, compared with BAU, in response to the same electricity demand growth as in CPS. The ADS, with a deep emissions reduction target in 2040, provides useful analytical insights for achieving net zero emissions in the power sector beyond 2040.

- **A moderate decarbonization scenario**, which targets reducing annual CO₂ emissions by 40 percent by 2040, is also analyzed but not discussed in this note so as to simplify the presentation and highlight the key shifts brought upon by the ADS. The annex on power sector modeling attached to this note included the results of the moderate decarbonization scenario.

Accelerated decarbonization would result in substantial changes in the mix of power generation technologies. The power system would become pre-dominantly RE-based by 2040. Figure 5 compares the projected mix of installed capacity and energy generation between CPS and ADS. Under the ADS, coal-fired power generation would peak in 2025, reaching about 78 TWh and would be gradually phased down to 12 TWh by 2040, about 15 percent of its peak level. Solar photovoltaics would become the dominant technology, accounting for 56 percent of total installed capacity and 41 percent of total generation by 2040, compared with 44 and 21 percent, respectively in the CPS. Other renewable energy technologies, including onshore and offshore wind and hydropower would see substantial growth, as would the battery storage needed for integration of VRE. Natural gas would still play an important role for supporting integration of VRE and as a transition fuel of decreasing

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16 The World Bank has a more conservative projection of the long-term GDP growth than that of the Philippine government. While the short to medium term outlook (next 3 years) is similar to that of the government, the longer-term prospect is less optimistic but still robust in the World Bank projection, yielding an average annual GDP growth rate of 5.4 percent from 2022 to 2040, compared with the 7.2 percent annual growth rate used by PEP 2020-2040.
significance as other clean technologies become cost efficient. Under the ADS, the share of RE in power generation would reach 83 percent by 2040, compared with 42 percent in the CPS. Continuation on the ADS pathway, potentially with the help of new technologies which will become cost-effective (e.g. carbon capture and storage for gas-fired power plants), could lead to the full decarbonization of the power sector by 2050.

Figure 5: An energy transition would result in substantial changes in the mix of power generation technologies and sources of energy

The transition to a RE-dominated power system contributes to the global mitigation efforts. It also generates significant national benefits in reduced local air pollution. The phasing down of coal-fired power and reduced need for natural gas-fired power in the ADS will significantly reduce the emissions of SOx, NOx and PM2.5 (Figure 6), which are main ambient air pollutants. Using the air pollution damage assessment values adopted by the International Monetary Fund in its assessment of global fossil fuel subsidies, the present value of the annual air pollution damage costs of the ADS is estimated at US$9.8 billion, compared with US$14.5 billion under the CPS, a US$4.7 billion (or 32 percent) damage reduction.

The levelized cost of electricity (LCOE) of the power system is projected to decline for much of the modeling period due to savings of fossil fuel cost, the expected long-term stabilization of fossil prices, and the expected declining cost of deploying and integrating VRE. While accelerated

17 Note that in the CES of PEP 2020-2040, which the CPS resembles, the RE share would reach 50 percent. The lower RE share in the CPS is due to a lower growth rate of power demand assumed in the World Bank modeling. Thus, other things being equal, it would take a few more years for the CPS to reach a 50 percent RE share.

18 International Monetary Fund Getting Prices Right Database.
Decarbonization will lead to higher cost of energy, compared with those of BAU and CPS (Figure 7), the cost trend also points to a general decline for all three scenarios, compared with 2021. The LCOE starts to increase again for ADS toward the end of the period due to the uptake of more costly technologies such as offshore wind and battery storage. Although the system LCOE is not what end users will pay for electricity, it nevertheless reflects the core of the overall cost of electricity and could be considered as indicative of the potential trend in the level of average tariff.

**Figure 6: The ADS pathway would lead to substantial reduction in emissions of CO2 and air pollutants**

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<tr>
<th>CO2 emissions under CPS</th>
<th>CO2 emissions under ADS</th>
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<td>40</td>
<td>40</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Annual emissions of air pollutants under CPS

Annual emissions of air pollutants under ADS

Source: World Bank staff estimates

**Figure 7: System levelized cost of electricity is projected to decline**

System Levelized Cost of Energy

System Levelized Cost of Energy by Component

Source: World Bank staff estimates

Note: CAPEX = capital expenditure, FOM = fixed operation and maintenance, VOM = variable operation and maintenance, T&D = transmission and distribution
Accelerated decarbonization would require a substantial increase in capital spending for renewable energy scale-up and integration. The present value of cumulative capital investments required for ADS by 2040 would be 100 percent higher than for CPS based on current estimate of the cost trends of technologies. The net increase in cumulative investment in the ADS vis-à-vis CPS is entirely accounted for by increased investment in RE. Solar, battery storage and offshore wind have the highest increments, followed by hydro and onshore wind (Figure 8).

![Figure 8: Cumulative investment cost](image)

Source: World Bank staff estimates

Phasing out coal-fired power would result in substantial stranded assets, which need to be properly addressed. To achieve the 80 percent annual emissions reduction by 2040, less than 3 GW of coal fired power would be in operation in 2040 under ADS, compared with about 14 GW under CPS. This study used a relatively narrow definition of stranded cost by calculating the lost revenues due to the decommissioning of the generation assets. Using this metric the present value of the financial losses due to the stranded CFPPs is about US$10 billion in the ADS. The current fleet of CFPPs (11 GW in 2020) in the Philippines are relatively young, most of them commissioned since 2010. The phasing down of this capacity would take place from 2028 to 2040 under the ADS as dictated by the goal of achieving 80 percent annual CO₂ emissions reduction by 2040. Given the large financial cost of the stranded assets in accelerated decarbonization, active pursuit of solutions needs to start early.

The socio-economic impact of phasing out coal-fired power in the Philippines is little understood and must be tackled with great care. While the Philippines has limited domestic production of coal, mines as well as the existing 63 CFPPs will need to be gradually retired to achieve the net zero goal. CFPPs in themselves only directly employ relatively few personnel, however, more people are relying indirectly on the power-plants for their livelihood (including the supply chain and service sector) and the larger community might therefore still be significantly impacted by their closing. While RE production will result in employment opportunities, labor market misalignments will likely arise: Temporally, job losses from closing CFPPs etc. and labor gains from renewables may not happen in parallel. Renewable jobs may be created in different areas of the country and the labor force may not move with the jobs. Retraining efforts can help personnel move to renewable energy jobs, skills from vanishing jobs do not necessarily match occupational needs of new job opportunities.

Accelerated electrification of the transport sector will increase the cost of power sector decarbonization. Electricity demand projections in the CPS and ADS assume a 10 percent penetration of EVs in road transport by 2040. A much higher share of EVs in road transport would significantly increase the demand for electricity, pushing up the investment needs in power supply. For example, a

19 The cost of stranded assets in coal-fired generation is estimated based on discounted net revenue drop compared with CPS level and applies estimated market prices. The retirement schedule is based on power system least cost planning to achieve the desired emission reduction goal and predefined techno-economic parameters for retirement.

15 percent higher electricity demand in 2040 would increase the present value of cumulative capital investment by 2040 under ADS by 20 percent.

The implications of an energy transition for resilience require further study. Some aspects of the transition seem likely to increase resilience, while others may reduce it. On the negative side, some elements of the energy transition are fragile. Solar PV panels are vulnerable to damage from tropical storms. Large-scale solar and wind plants are usually sited far from urban areas, and the transmission lines are subject to interruptions. On the positive side, the wide distribution of solar and wind plants could reduce the portion of total power generation that is affected by a given storm. Distributed solar power with battery storage could maintain partial local power supplies if transmission lines are interrupted. Greater understanding of the geo-spatial nature of climate risks and their impact on power system expansion and the cost and benefit of strengthening resilience will help enhance power system planning and implement appropriate risk-mitigation measures.

Pursuing the ADS pathway requires both national commitment and international financial assistance. While the ADS pathway is costlier than CPS it would also generate significant local and global environmental benefits. Taking the reduction of local pollution damage costs resulting from lower air pollution into account would show that adoption of ADS pathway is partly in the Philippines’ own interest. Pursing ADS would also generate substantial global benefits through higher cumulative reduction of CO₂ emissions. Using the World Bank’s carbon price guideline this study estimates that the present values of the global environmental damage cost of CO₂ emissions up to 2040 would be US$51 billion under CPS and US$35 billion under the ADS. Thus it is also in the interest of the global community, particularly the developed countries, to support the Philippines in pursuing an accelerated energy transition pathway by sharing some of the incremental financial burdens.

Mobilizing financing for accelerated decarbonization requires enhanced government facilitation or intervention in removing barriers and reducing risks for private investors. There are still multiple legal/regulatory and bureaucratic constraints to overcome, including limitation on foreign ownership of solar and wind projects and the land rights issues slowing project development. The substantial incremental capital cost of ADS implies that private investors will need to double their investments under the CPS to meet the financing requirement of ADS. This would be a tall order. Completely relying on private financing for an accelerated energy transition is likely untenable and could risk falling far short of expectation. The Philippine government has kept its financial assistance to RE and EE investments with limited fiscal interventions, such as tax holidays and import tariff relief. The government also has provided indirect support through its fully owned and controlled financial institutions, such as the Development Bank of the Philippines, the Land Bank, and the Philippine Guarantee Corporation, which lend to private sector for RE and EE investments, or provide risk mitigation guarantees for such investments. Pursuing an accelerated decarbonization agenda would require the government to expand its financial facilitation both in scope (types of instruments) and in size. For example, international donor assistance for decarbonization (e.g., concessional financing from the Climate Investment Funds) requires sovereign co-financing, often tied to specific projects or programs.
Table: Comparing the cost of ADS and CPS, 2022-2040, US$ billion present value

<table>
<thead>
<tr>
<th></th>
<th>CPS</th>
<th>ADS</th>
<th>Deviation</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital costs for new generation and storage</td>
<td>23.5</td>
<td>53.9</td>
<td>30.4</td>
<td>129%</td>
</tr>
<tr>
<td>Coal</td>
<td>1.2</td>
<td>1.2</td>
<td>0.0</td>
<td>0%</td>
</tr>
<tr>
<td>Gas</td>
<td>2.5</td>
<td>1.7</td>
<td>-0.8</td>
<td>-32%</td>
</tr>
<tr>
<td>Solar</td>
<td>11.8</td>
<td>25.8</td>
<td>14.0</td>
<td>119%</td>
</tr>
<tr>
<td>Onshore wind</td>
<td>1.1</td>
<td>3.9</td>
<td>2.8</td>
<td>255%</td>
</tr>
<tr>
<td>Offshore wind</td>
<td>0</td>
<td>4.9</td>
<td>4.9</td>
<td>NA</td>
</tr>
<tr>
<td>Hydropower and other renewables</td>
<td>6.8</td>
<td>11.2</td>
<td>4.4</td>
<td>65%</td>
</tr>
<tr>
<td>Battery storage</td>
<td>0.1</td>
<td>5.2</td>
<td>5.1</td>
<td>5100%</td>
</tr>
<tr>
<td>Grid network expansion and upgrade costs</td>
<td>7.1</td>
<td>7.8</td>
<td>0.7</td>
<td>10%</td>
</tr>
<tr>
<td>Capital costs of existing generation and grid assets *</td>
<td>23.7</td>
<td>5.3</td>
<td>-18.4</td>
<td>-78%</td>
</tr>
<tr>
<td>Variable operational and maintenance costs</td>
<td>0.6</td>
<td>0.9</td>
<td>0.3</td>
<td>50%</td>
</tr>
<tr>
<td>Fixed operational and maintenance costs</td>
<td>14.2</td>
<td>17.3</td>
<td>3.1</td>
<td>22%</td>
</tr>
<tr>
<td>Fuel costs</td>
<td>56.3</td>
<td>47.8</td>
<td>-8.5</td>
<td>-15%</td>
</tr>
<tr>
<td><strong>TOTAL SYSTEM COST</strong></td>
<td><strong>125.4</strong></td>
<td><strong>133.0</strong></td>
<td><strong>7.6</strong></td>
<td><strong>6%</strong></td>
</tr>
<tr>
<td>Cost of stranded assets</td>
<td>0</td>
<td>10.0</td>
<td>10.0</td>
<td>NA</td>
</tr>
<tr>
<td>Local environmental damage costs</td>
<td>14.5</td>
<td>9.8</td>
<td>-4.7</td>
<td>-32%</td>
</tr>
<tr>
<td>Global environmental damage costs</td>
<td>51.0</td>
<td>35.0</td>
<td>-16.0</td>
<td>-31%</td>
</tr>
</tbody>
</table>

Source: World Bank staff estimates

* NA = Not applicable

* The large reduction of the capex of the existing generation and grid assets in ADS is due to the decommissioning of CFPPs.

The key analytical results associated with the costs of ADS pathway vis-à-vis CPS are summarized below. It is important to note that the analyses conducted by this study used a host of assumptions based on historical trends and generally held expectations of future developments. The interpretation of the results should be indicative instead of predicative. Sensitivity analysis on key variables suggest that the broad trends and directions revealed by this study are generally robust. It is also important to note that this power system decarbonization analysis did not consider the full spectrum of potential technology choices in part to limit the higher uncertainties of technologies which are still early in their development, such as carbon capture and storage and green hydrogen, and in part to maintain consistency with the government’s current energy plan (e.g., nuclear power is not included in the PEP 2020-2040).
4 Policies for a Secure, Affordable and Clean Energy Future

The Philippines would benefit from an energy transition toward low- and zero-carbon alternatives. A clean energy transition will substantially increase the use of indigenous and renewable energy resources such as hydropower, solar, and wind while reducing reliance on imported fossil fuels, enhancing energy security. A cleaner energy future is expected to be more affordable given the global trends of declining cost of deploying and integrating solar and wind power, enhancing the competitiveness of the economy. Reducing fossil fuel consumption, particularly by electrifying urban transport and reducing the use of coal in power generation, would reduce ambient air pollution in urban areas, improving public health. A transition would also help the country meet its commitments under the Paris Agreement.

The government has keen interest in leveraging clean energy transition for sustainable and inclusive economic development. In his first State of the Nation Address, President Marcos Jr. called for the transformation of the energy sector for achieving energy security and affordability and taking advantage of best available technologies, especially in the areas of renewable energy.

It is critical to build a solid foundation for accelerated decarbonization in the power sector in the next five years. As demonstrated in the ADS the pathway toward accelerated decarbonization has a steep climb in the latter period of the planning horizon. To be successful in reaching the goal, early efforts in building the support and momentum are crucial. The government already has some critical enabling policies in place to support an accelerated deployment of RE although gaps still exist in policy implementation. Improvement and amendment of existing policies are also needed to remove constraints to competition, financing and ease of doing business. The main short-to-medium-term actions include:

- **Promote competition in the investment in and consumption of renewable energy to accelerate the deployment of solar and wind power.** To attain the goal of accelerated decarbonization aligned with ADS, the share of electricity generation from solar and and wind sources will need to increase from 2 percent in 2020 to about 60 percent in 2040. This requires policies and regulations that promote competition in the investments in and consumption of solar and wind power. Moving from a FiT-based program to an auction program would increase competition in investment and lower the cost of renewable energy. The government has introduced competitive procurement through the GEAP. Introducing a mandatory minimum share of renewable energy in energy supply creates market and demand for renewable energy. The government also started implementing the RPS in 2020, with an elevated target to achieve 50 percent RE share of total electricity generation by 2040. Both GEAP and RPS will need to be expanded to support accelerated decarbonization.

- **Incentivize provision of ancillary services and promote investment in grid capacity and flexibility to address the challenges of large-scale integration of intermittent solar and wind power.** In addition to the planned addition of gas-fired capacity in the medium term (critical for system flexibility), investments are needed to upgrade the capacity of the transmission and distribution networks to remove constraints to rapidly scaling up grid-connected solar and wind power generation. Pricing incentive mechanisms for the provision of ancillary services, such as energy storage and voltage and frequency regulation, could promote investment in energy storage systems, power system automation tools, load dispatch management capabilities, smart grid technologies, expanded use of grid digitalization, and telecommunication equipment upgrades.

- **Remove ownership limit to international private investment in solar and wind power.** The private sector already dominates all aspects of investments in the energy sector in the Philippines. Given

the additional capital investments required for accelerated decarbonization, increasing foreign direct investments will be critical to bridge the financing gap. However, entry of international private sector investors is still limited in areas that are critical to the energy transition agenda: a 40 percent ownership threshold still applies to solar and wind projects, as stipulated in the implementation rules and regulations of the REA. The ownership restriction is of particular concern for the development of Philippines’ rich offshore wind resources, which is likely to need substantial international know-how and capital in its initial phase. DOE could amend the implementing rules and regulations of the REA and remove the cap on foreign direct investment (FDI) to accelerate deployment of FDI in RE projects.

- Use public resources prudently to leverage private sector risk sharing in energy transition financing. For technologies and applications that still pose significant risks to private investors, such as floating solar and offshore wind, public support would be needed to de-risk investments in early and large scale projects, for example, by alleviating grid bottlenecks, ensuring credit-worthy off-take agreements, and/or providing market-based guarantees. The government is also the window for international concessional climate financing. By working with multilateral financial institutions and bilateral partners the government can enable blended finance mechanisms to draw in private sector capital for accelerated decarbonization.

- Intensify energy efficiency efforts. EE is an important part of the energy transition. Based on sensitivity analysis of the ADS scenario, a 5 percent increase in electricity demand by 2040 would result in a 6 percent increase in cumulative capital investment by 2040. Thus, cost-effective demand-side EE measures to reduce demand, which are generally cheaper than investing in additional supply capacity, make an attractive investment on financial merits alone. In particular, improving EE in residential, commercial and public buildings through regulations (for example, enforcing energy efficient building codes and minimum energy performance standards for air conditioners and major appliances) and incentives (for example, rebates for purchasing high-efficiency appliances, accelerated permiting process for high-class green buildings) would go a long way to moderate future electricity demand.

- Improve power system planning to better guide energy transition investment decisions. The commonly used least-cost planning tools need to be augmented by taking into consideration of the costs of carbon and local air pollution, and stranded assets to align future investments with power sector decarbonization goals. It is important to keep a dynamic view of technological changes and enhance the capability to assess the viability of emerging technologies, such as hydrogen and carbon capture and storage, and the potential to maximize RE while managing the cost of services. This approach can help avoid potentially costly long-term carbon lock-in that is not aligned with climate and development objectives.

- Establish a framework for addressing the retirement of coal-fired power plants. To move towards net-zero carbon beyond 2040, the Philippines needs to start phasing out coal-fired generation by the late 2020s. The early retirement of coal-fired power plants will result in significant stranded assets as indicated in the ADS analysis. It will be a complicated and difficult process since it affects energy security, the reliability of power supply, jobs, communities, as well as fair compensation of the financial losses of private investors. The Philippines is a pilot country under the Accelerating Coal Transition Program of the Climate Investment Funds and supported by the Asian Development Bank (ADB), the World Bank, and IFC. This pilot could be used to help design a framework for phasing out coal-fired power.

- Establish a framework for Just Transition. It is important to recognize that energy transitions will have strong socio-economic impacts with differentiated impacts across different groups, including both direct and indirect workers and the broader community. A comprehensive cross-sectoral approach will be required to properly prepare a framework for a just energy transition process in the Philippines, involving early on key stakeholders in a consultative planning process, including
government, private sector and communities in the affected areas. The Just Transition process should include three focus areas: (i) institutional governance; (ii) people and communities; and (iii) environmental remediation. While the Philippines has limited domestic production of coal, the closing of mines and the retirement of coal-fired powerplants will require coordinated cross-sectoral planning to manage careful the negative impact on individuals and communities.
Annex: Power Sector Decarbonization Analysis

The power sector decarbonization pathways were analyzed to assess the impact of sector policies and technology choices, as well as the implications for power system expansion, reliability, investment needs and electricity affordability.

PLEXOS, a power system least-cost planning software platform, was used to understand the implications of different levels of emissions reductions on the capacity and generation mix given assumptions about demand growth and available technologies. The results should not be interpreted as forecasts, but as projections of the scale and speed of necessary interventions.

Four power system expansion scenarios were analyzed, each corresponding to a different electricity demand scenario.

- **Business As Usual (BAU):** The BAU is used as a baseline, which corresponds to the REF of PEP 2020-2040. But it is re-timed to match an adjusted demand projection due to a lower GDP growth rate assumed by the CCDR.
- **Clean Policy Scenario (CPS):** The CPS, which corresponds to the CES of the PEP 2020-2040. It is also re-timed to match the adjusted demand projection of the CCDR.
- **Moderate Decarbonization Scenario (MDS):** The MDS, under the same demand as in CPS, models a target of 40% abatement of annual emissions by 2040 relative to the BAU and scaled linearly starting in 2025. Existing plants may retire on an economic basis, leaving a cost of stranded assets.
- **Accelerated Decarbonization Scenario (ADS):** The ADS, under the same demand as in CPS, models a target of 80% abatement of annual emissions by 2040 relative to the BAU and scaled linearly starting in 2025. Existing plants may retire on an economic basis, leaving a cost of stranded assets.

Energy demand was forecasted by a simple linear model, with assumed intensity, elasticity factor from PEP 2020-2040, and GDP growth rate projections of the World Bank. Peak demand forecast was derived from electricity demand as sold and is based on 70.25 percent historical load factor for Luzon, 72 percent for Visayas, and 67.69 percent for Mindanao. Adjustments for technical losses assumptions were made based on PEP: 8.63 percent in Luzon, 10.63 percent in Visayas, and 12.14 percent in Mindanao.

The assumed capital expenditure values of different generation technologies for 2021 are based on World Energy Outlook 2021 and the 2021 Vietnam Technology.

Fuel prices are expressed in 2019 USD, as delivered fuel prices and are based on the World Bank commodity forecast on April 11, 2022. The figure shows a short term spike in coal, fuel oil and gas in
2021-2024, followed by a gradual reduction until the end of the period. Gas averaged USD7.04/GJ and coal USD2.98/GJ over the 2024-2040 period.

Notes: CCGT: Combined cycle gas turbine; CCS: Carbon capture and storage; Water: Hydropower; Geo: Geothermal; PV: Photovoltaic/Solar; WIND: Onshore wind; WIND_OFF: Offshore wind; BESS: Battery energy storage system; xhr: duration, in hours

Sources: See text.
References


