CHAPTER 5

OUTLOOK FOR SDG 7

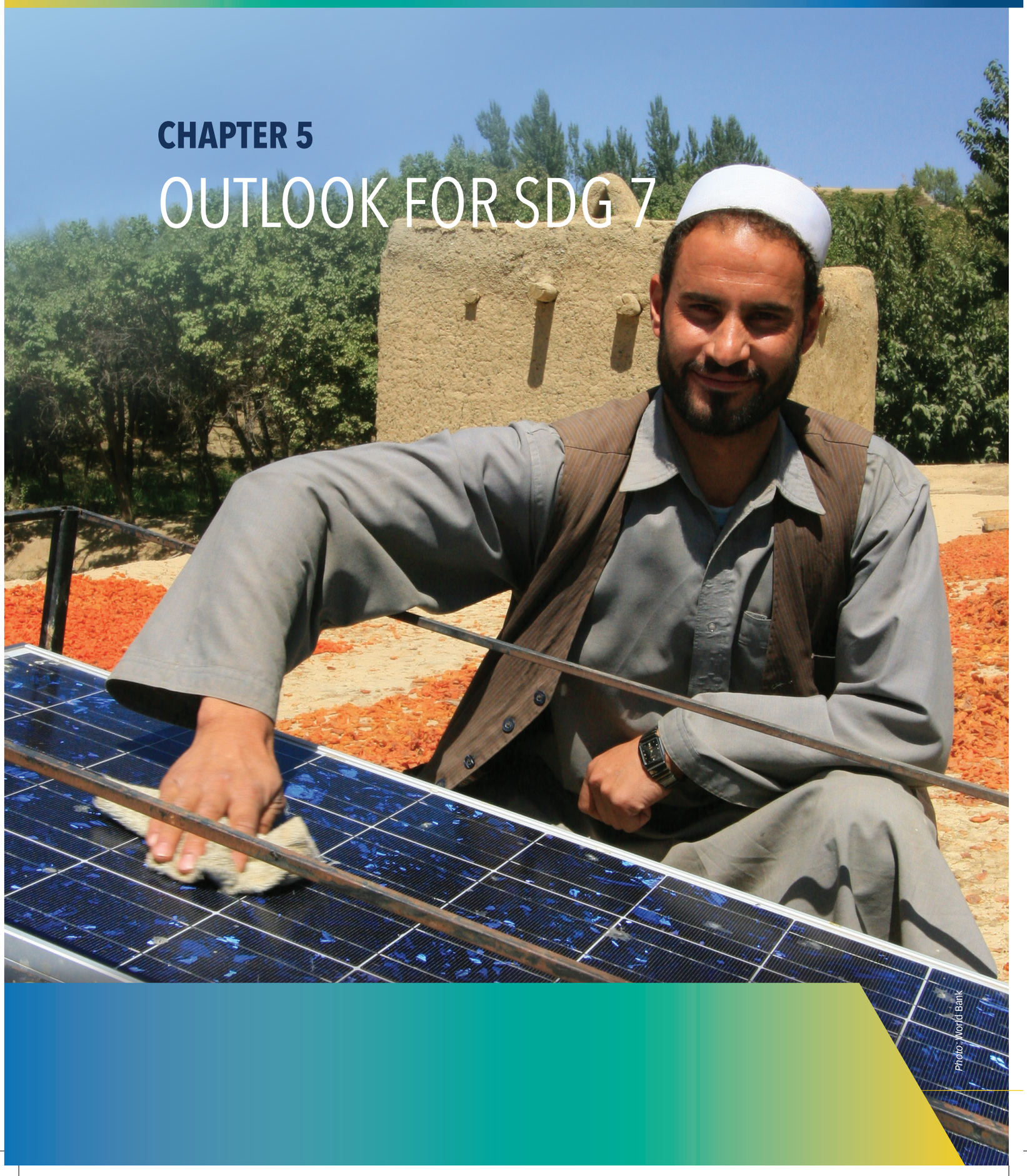


Photo: World Bank

MAIN MESSAGES

- **Outlook for overall progress by 2030:** The world is not on track to achieve Sustainable Development Goal (SDG) 7 at the current rate of progress. Two scenarios developed by the International Energy Agency (IEA) serve as benchmarks for the progress that is expected and that is needed by 2030. The New Policies Scenario, which accounts for current and planned policies, shows that none of the SDG 7 targets will be achieved by 2030. And the Sustainable Development Scenario indicates a possible least-cost pathway by which the world's energy system could be on track to achieve the SDG targets most closely related to energy (SDG target 3.9, and the targets under SDGs 7 and 13).[34]

- **Outlook for access to electricity:** Under current and planned policies, in the IEA's New Policies Scenario, 570 million people are projected to gain access to electricity worldwide between 2018 and 2030, thanks to significant public and private efforts to achieve universal access. Nonetheless, around 650 million people would still be deprived of access to electricity in 2030, of which 9 out of 10 would reside in Sub-Saharan Africa. Further international collaboration in sharing good practices and deploying new technologies will be essential to reach communities and locales otherwise left behind.

- **Outlook for access to clean cooking solutions:** By 2030, under current and planned policies, 2.2 billion people, mainly living in Asia and Sub-Saharan Africa, would still be dependent on inefficient and polluting energy sources for cooking. Several proven solutions are nonetheless expected to help more than 580 million people worldwide move away from traditional uses of biomass between 2018 and 2030. There is an urgent need to further enable the uptake of efficient solutions in order to reach universal access to clean cooking solutions by 2030.

- **Outlook for renewable energy:** Strong policy support combined with the increasingly competitive costs of solar photovoltaic (PV) and wind technologies will bolster the deployment of renewable electricity across all regions, though grid integration challenges will need to be addressed in some countries. However, the use of renewables for transport and heat remains limited. The modern use of renewables overall is projected to reach just 15% by 2030 under current trends and planned policies, compared with the 22% possible under the Sustainable Development Scenario. The International Renewable Energy Agency's (IRENA's) renewable energy roadmap (REmap) outlines a pathway by which the share of modern renewables could rise even more, to 28% by 2030 and 66% by 2050.

- **Outlook for energy efficiency:** A decoupling of energy demand and economic growth has led to significant improvements in energy intensity in recent years. However, such improvements are likely to fall short of SDG target 7.3, leaving a large portion of the world's energy efficiency potential untapped. Between 2017 and 2030, energy intensity improvements are projected to average 2.4% per year versus the 3.5% under a scenario where energy efficiency potentials are maximized.

- **Investment needed to reach SDG 7:** Achieving universal energy access, substantially accelerating the share of renewable energy, and doubling the rate of energy intensity improvements would require annual average investments of approximately around $1320 billion per year between 2018 and 2030, in a variety of technologies. This comprises annual investment of approximately $51 billion to achieve universal electricity access, $4 billion for clean cooking access, over $660 billion for renewable energy, and $600 billion for energy efficient technologies.

- **Synergies between SDG 7 and climate mitigation:** The SDG 7 and climate mitigation (SDG 13) targets are closely related and complementary pursuits. Providing universal energy access can yield net greenhouse

gas (GHG) savings, thanks to a reduction in methane emissions from traditional uses of biomass for cooking. Beyond the GHG savings likely to be achieved under current and planned policies, the leading sources of the additional GHG savings that countries need in order to realize their commitments under the Paris Agreement are (i) switching fuels to renewable energy and (ii) enhancing end-use energy efficiency.

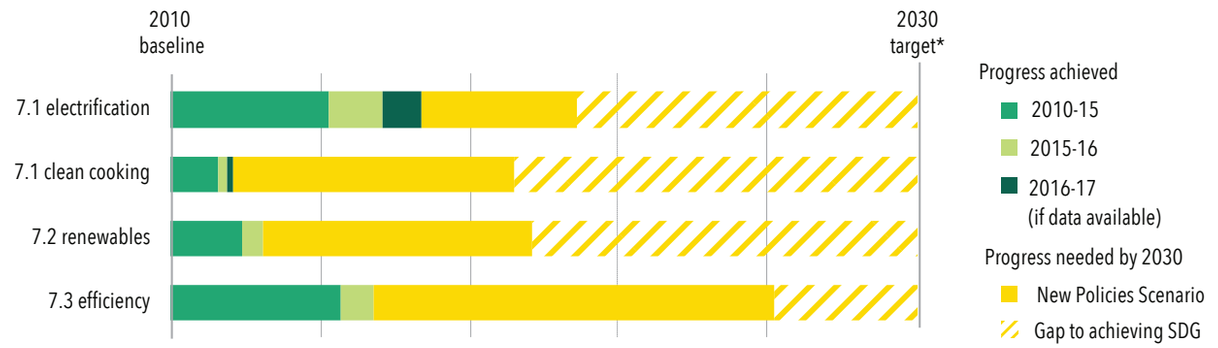
This chapter describes the results of a global modelling exercise to understand whether current policy ambitions are sufficient for meeting SDG 7 and what additional efforts are needed for success. The chapter also includes an evaluation of the investment needs as well as the energy benefits of meeting the relevant SDG targets (as measured by fuel savings), and concludes with an analysis of the interlinkages with SDG 13 on climate action.

Two scenarios derived from the World Energy Outlook, IEA's flagship publication, serve as benchmarks. The New Policies Scenario accounts for current and planned policies with a high likelihood of being implemented, including the GHG- and energy-related components of the nationally determined contributions pledged under the Paris Agreement.

The Sustainable Development Scenario combines the fundamentals of sectoral energy policy with three closely associated but distinct policy objectives related to the SDGs: to ensure universal access to affordable, reliable, sustainable, and modern energy services by 2030 (SDG 7); to substantially reduce air pollution, which causes deaths and illness (SDG 3.9); and to take effective action to combat climate change (SDG 13). The aim is to lay out an integrated least-cost strategy for the achievement of these important policy objectives, alongside energy security, in order to show how efforts toward them can be coordinated so as to realize mutually supportive benefits.

The world is currently not on track to meet SDG 7. Under the assumptions of the New Policies Scenario, despite notable recent progress toward expanding electricity access, particularly in developing Asia, and improvements in energy intensity across major regions, policy efforts are expected to fall short of all four SDG 7 targets. Progress on SDG indicator 7.1.2 (clean cooking) and SDG target 7.2 (renewables) is lagging behind the required pace. Under the New Policies Scenario, an estimated 2.2 billion people would still lack access to clean cooking solutions, and the share of modern renewables would reach 15% by 2030. Progress on SDG indicator 7.1.1 (electricity) and target 7.3 (energy efficiency) is expected to be better, but more efforts are needed to meet the targets in all regions (figure 5.1).

FIGURE 5.1 • PROGRESS TOWARD SDG 7 SINCE 2010, RELATIVE TO 2030 TARGETS, HISTORICALLY AND BY SCENARIO



Source: IEA, IRENA, World Bank, WHO, and UNSD (2018).
Note: The units used as proxies for progress are: the share of population with access to electricity (7.1.1) and to clean cooking fuels and technologies (7.1.2); the share of renewables in total final energy consumption, excluding traditional uses of biomass (7.2); and energy intensity, measured as tonnes of oil equivalent of energy consumed per thousand 2010 USD gross domestic product (purchasing power parity) (7.3).
** Please note that for SDG 7.2*, there is no quantitative target.

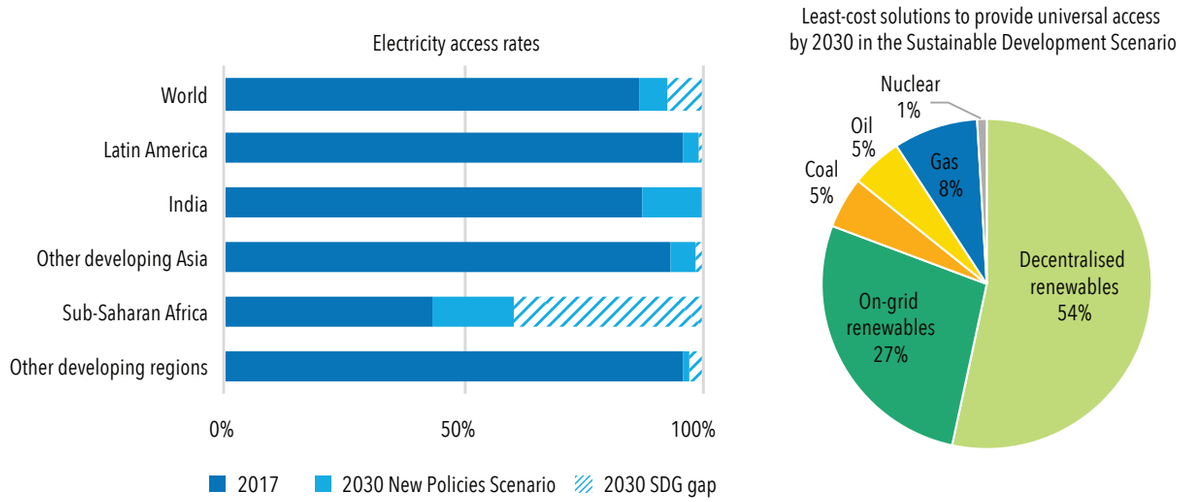
While the outlook under the New Policies Scenario falls short of SDG 7, the Sustainable Development Scenario works backward to identify what it would take to deliver this goal in a cost-effective way. In the Sustainable Development Scenario, by 2030 universal access to both electricity and clean cooking solutions is achieved, the share of modern renewables reaches 22% of total final energy consumption (TFEC), and annual energy intensity improvements accelerate to an average rate of 3.6% per year.

OUTLOOK FOR ELECTRICITY ACCESS

Great progress has been made recently in furthering access to electricity, at an annual global rate of 0.8 percentage points. But while several countries are about to reach full electrification by 2030, the world as a whole is not on track to achieve SDG indicator 7.1.1. People deprived of electricity services will be increasingly concentrated in Sub-Saharan Africa. Under current and planned policies, 8% of the world's population (about 650 million people) would still lack access to electricity, with 89% of them living in Sub-Saharan Africa (figure 5.2).

Different regions have different paths. In Latin America and the Caribbean, where 98% of the population had access to electricity in 2017, only Haiti is left behind. Haiti is not expected to achieve an electrification level greater than 90% of the population by 2030. Progress in developing Asia[35] is expected to be the fastest in the world, with more than 320 million people connected between 2018 and 2030, and an electrification rate rising from 91% in 2017 to 99% in 2030. This progress reflects a tremendous effort in India, where the government announced that electricity had reached every village in April 2018 and that it was aiming to provide reliable electricity supply, 24/7, to every household by the early 2020s. Thanks to similarly ambitious efforts, and building on significant recent progress, Indonesia and Bangladesh are also expected to achieve universal access by 2030. In the rest of Asia, the majority of countries would attain electrification levels greater than 90% by 2030. Additional efforts in the few countries left behind would get the entire region on track.

FIGURE 5.2 • ELECTRICITY ACCESS RATES BY REGION IN 2017 AND 2030, AND THE LEAST-COST SOLUTIONS TO PROVIDING UNIVERSAL ACCESS TO ELECTRICITY BY 2030



Source: IEA 2018a.
Note: SDG = Sustainable Development Goal.

Progress is slower in Sub-Saharan Africa. In 2030, under current and planned policies, 89% of the global population without access to electricity would live in this region. More than 220 million people would gain access between 2018 and 2030, increasing the electrification rate from 44% in 2017 to 61% in 2030, as electrification outpaces population growth. Ghana and Kenya stand out as successes and are projected to achieve universal access before 2030, but progress in the region is highly uneven. In 2030, around 80% of those without access to electricity would be from rural areas (while rural populations would represent about 50% of the total population).

Reaching universal access in the least-cost way requires further policy support for certain technologies. The unprecedented cost advantage of renewables, in particular decentralized renewables, will help efforts to reach the most remote locations. As such, 51% of the 1.2 billion people[36] who should gain access by 2030 could be electrified in a least-cost way through clean decentralized systems; in rural areas, this share reaches 77%. Grid-based connections

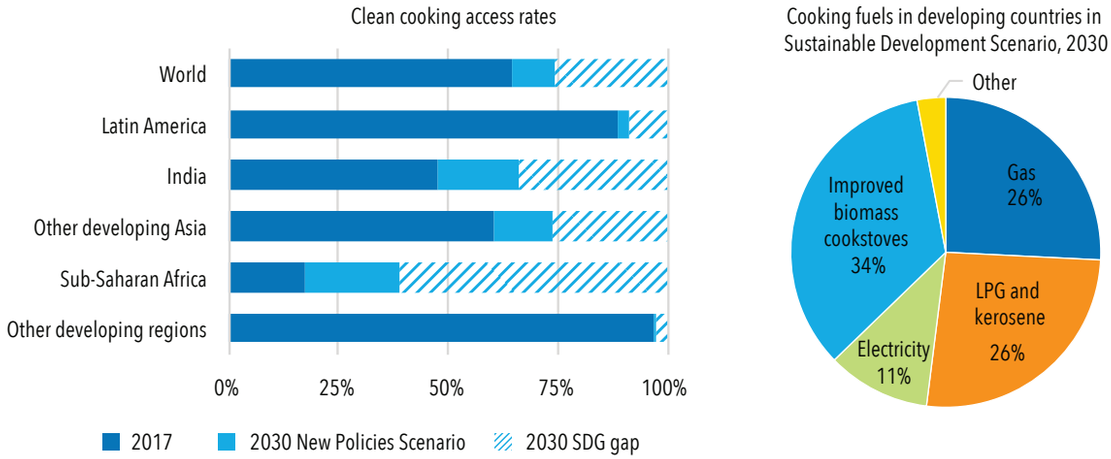
are still essential worldwide, as they offer a least-cost solution for 42% of people who need to gain a connection by 2030. Nonetheless, thanks to declining clean technology costs, on-grid renewables surpass fossil fuels in providing people with new connections.

Achieving universal access by 2030 requires a paradigm shift. The main mode by which people gained access over the past decade was through on-grid fossil fuels, as India's recent experience illustrates (IEA 2017). Holistic programs that make the most of both decentralized and centralized solutions are needed, including transparent grid extension plans and regulatory frameworks that protect against financial losses if the grid arrives in areas connected via decentralized modes. Furthermore, a strong emphasis on developing decentralized systems that can address the variety of energy needs required for economic development is necessary. Energy efficient appliances are essential to provide more substantial energy services with off-grid electricity supply, and could reduce electricity demand for typical energy services by up to two-thirds (IEA 2017).

OUTLOOK FOR ACCESS TO CLEAN COOKING

The world is not on track to meet SDG indicator 7.1.2 and provide universal access to clean cooking solutions. In the New Policies Scenario, 26% of the global population would still be cooking with polluting fuels in 2030 (figure 5.3), down from around 40% in 2017; the number of people relying primarily on highly inefficient fuels such as biomass, kerosene, or coal would decrease to 2.2 billion, of which 1.7 billion would be in rural areas. In developing Asia, more than 1.2 billion people would be without access to clean cooking solutions in 2030. In India, 500 million people would still rely primarily on traditional uses of biomass for cooking. Since biomass can often be collected for free, it would remain the least-cost solution for households, particularly in rural areas. In Sub-Saharan Africa, around 900 million people would still rely on polluting fuels and technologies for cooking in 2030. While rural populations represent two-thirds of the population without access by 2030, 290 million city dwellers would also lack access.

FIGURE 5.3 • CLEAN COOKING ACCESS RATES IN 2017 AND 2030, AND COOKING FUELS IN THE SUSTAINABLE DEVELOPMENT SCENARIO, 2030



Source: IEA 2018a.
Note: SDG = Sustainable Development Goal; LPG = liquefied petroleum gas.

Despite the challenges that lie ahead, it is noteworthy that more than 580 million people would move away from traditional uses of biomass for cooking by 2030, and these are equally split between developing Asia and Sub-Saharan Africa. As in the case of electricity access, population growth outpaces the provision of access to clean cooking facilities in Sub-Saharan Africa.

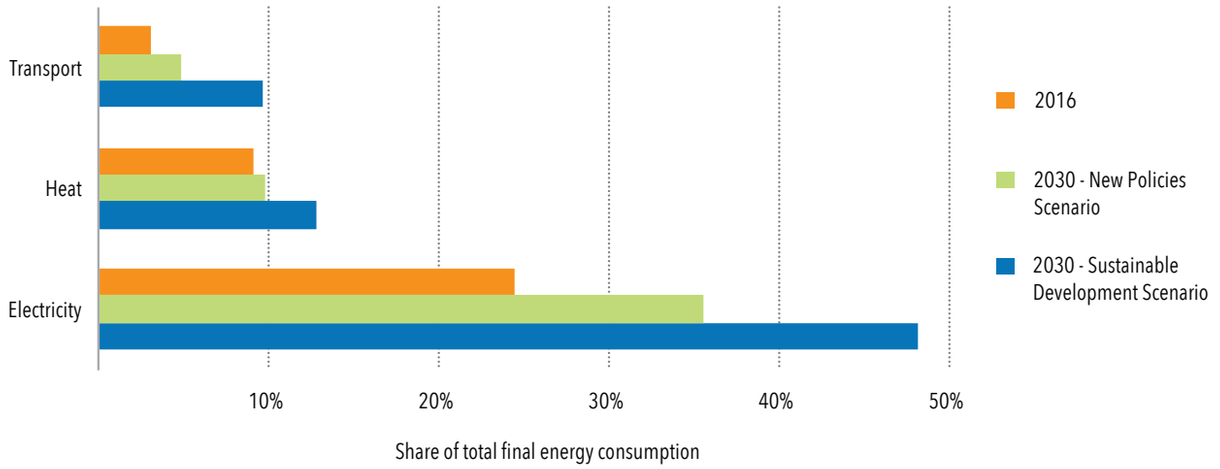
The Sustainable Development Scenario highlights two least-cost solutions for providing access to clean cooking: liquefied petroleum gas (LPG) and improved biomass cookstoves. Considering technology costs, historical progress, population growth, urbanization levels, and the availability of fuel, LPG is the predominant solution for urban households by 2030, as population density justifies investment in the necessary LPG infrastructure. In India, LPG is promoted by the government via the Pradhan Mantri Ujjwala Yojana (PMUY) scheme, which targets women in low-income households. The government has pledged to provide 50 million free LPG connections by 2019, and aims to target 80 million by 2020. Meanwhile, improved biomass cookstoves are particularly suited for rural areas, where they are the least-cost clean cooking solution for over half of households. The uptake of clean cooking solutions is essential to drive down indoor air pollution levels, and efforts to leverage effective technologies need to be elevated on the international political agenda. Engaging with local women in the design, uptake, and sale of clean cookstoves would significantly boost their adoption.

OUTLOOK FOR RENEWABLES

Unlike the targets for electricity access and energy efficiency, SDG target 7.2 does not include a numerical figure, making progress evaluation difficult. In the New Policies Scenario, the share of total renewables would rise to 21% of total final energy consumption by 2030, up from 17.5% in 2016, while that of modern renewables would increase to 15%, a moderate increase from 2016 levels of 10% (IEA 2018b). Electricity generation from renewables would expand the most, overtaking coal in the next decade to supply around 36% of electricity by 2030. The use of direct renewables for heating[37] and transport would also expand, though at substantially lower rates of 10% and 5%, respectively.

The Sustainable Development Scenario outlines the important role renewables can play in achieving a sustainable energy sector. In this scenario, modern renewables reach 22% of final energy consumption (total renewables[38] reach 24%). The share of electricity generation would increase the most, more than doubling the current share to reach 48% by 2030, which is more than 10 percentage points higher than in the New Policies Scenario (figure 5.4). The use of renewables in transport would increase substantially in the Sustainable Development Scenario, reaching 10% by 2030. Greater efforts are needed to move away from fossil fuel use in other transport modes as well, such as trucking, aviation, and shipping. The use of modern renewables for heat would increase less than for electricity and transport, reaching 13% by 2030.

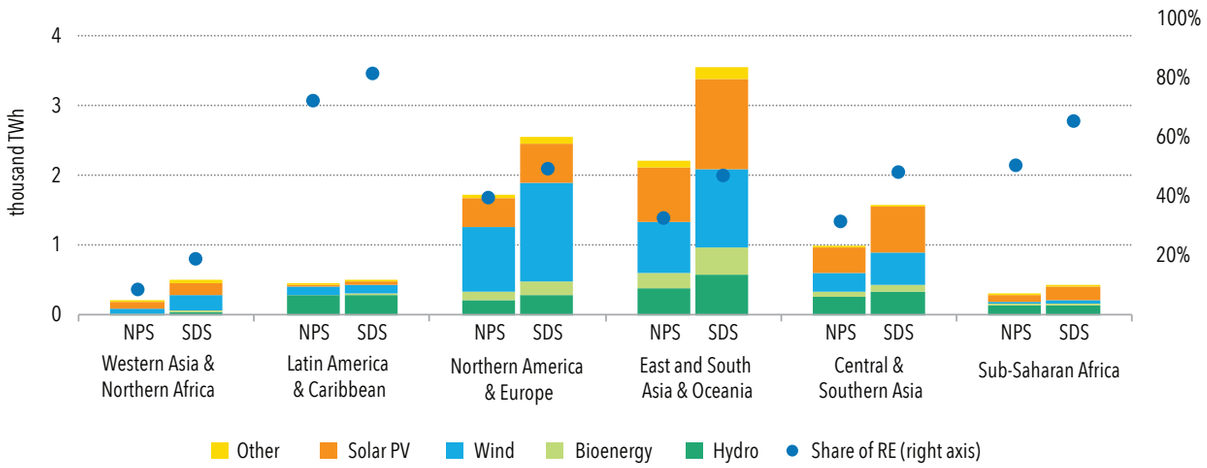
FIGURE 5.4 • SHARE OF MODERN RENEWABLE ENERGY IN TOTAL FINAL ENERGY CONSUMPTION, BY END USE



Source: IEA (2018a), UNSD (2018), and World Development Indicators.

The outlook for renewable electricity generation is by far the most encouraging thanks to the rapidly declining costs of wind and solar PV, and competitive procurement processes. Globally a total 5,860 terawatt-hours (TWh) of additional renewable electricity generation is projected for 2030, equal to the current electricity generation of Canada, Japan, and the United States combined. Much of this growth is expected to occur in Asia and Northern America and Europe. In the New Policies Scenario, the share of renewable electricity consumption rises from 24% in 2016 to 36% in 2030. While this growth in renewable electricity is encouraging, fossil fuels and coal in particular still account for the vast majority of electricity generation globally, which is unsustainable in relation to climate change, air pollution, and, for certain regions, energy security. To support the broader sustainable development agenda, a more rapid decarbonization of the electricity sector is needed.

FIGURE 5.5 • GROWTH IN RENEWABLE ELECTRICITY GENERATION, 2017-2030, AND THE SHARE OF RENEWABLES BY SCENARIO IN 2030

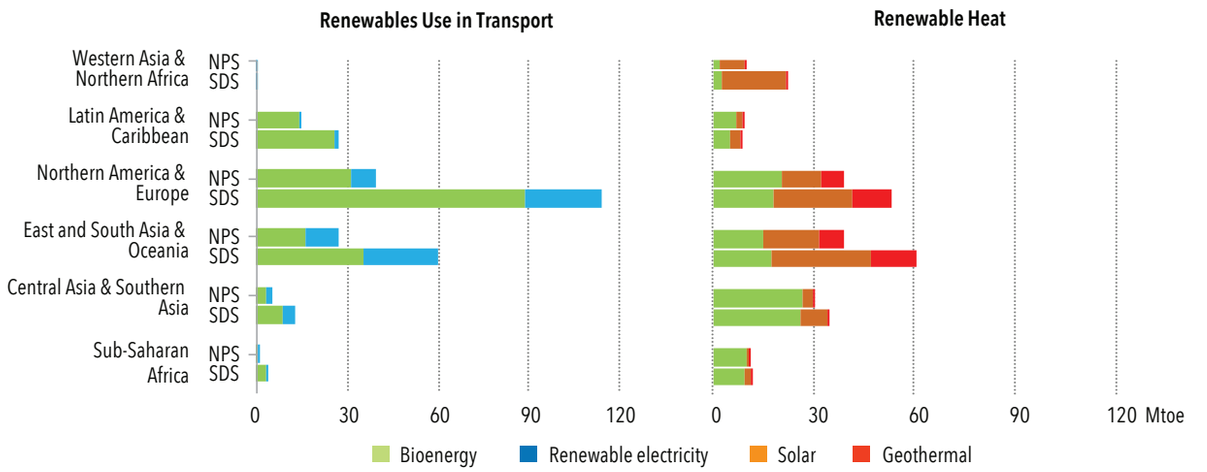


Source: IEA 2018a.
Note: NPS = New Policies Scenario; PV = photovoltaic; RE = renewable energy; SDS = Sustainable Development Scenario; TWh = terawatt-hours.

At a regional level, the outlook for renewable electricity generation varies substantially. Different energy resource potentials across regions play a key role in influencing the use of renewables. In the New Policies Scenario, the outlook for the share of electricity generation in 2030 varies from 8% in the oil- and gas-rich regions of Western Asia and Northern Africa to as high as 72% in Latin America and the Caribbean thanks to an abundant hydropower potential (figure 5.5). In the Sustainable Development Scenario, the share of renewable electricity generation increases in all regions. In many, the share of renewables is set to approach or even surpass half of all electricity generation by 2030.

East Asia and Southeastern Asia together with Northern America and Europe expect the largest additions to renewable electricity generation, largely enabled by wind and solar PV. Rapidly declining costs, good resource potential, and a supportive policy environment make solar PV attractive in East Asia and Southeastern Asia. These factors are even more pronounced in Central and Southern Asia, where solar PV drives the largest increase among all regions—to 32% by 2030 in the New Policies Scenario and 46% in the Sustainable Development Scenario.

FIGURE 5.6 • GROWTH IN RENEWABLES USED IN HEAT AND TRANSPORT, BY SCENARIO, 2017-2030



Source: IEA 2018a.
Note: Mtoe = million tonnes of oil equivalent; NPS = New Policies Scenario; SDS = Sustainable Development Scenario. Traditional uses of biomass are excluded from the "renewable heat" category.

The use of renewables in transport and for heat in buildings and industry represents a significant opportunity to increase the share of renewables in final energy use, although growth is expected to be substantially less than in the electricity sector. In transport, biofuels would represent 11% of the growth in energy use in the New Policies Scenario; renewable electricity, consumed mainly for passenger cars and rail, would account for 15% of the increase in transport energy demand between 2016 and 2030. In the Sustainable Development Scenario, the total use of renewables in transport would be more than double that in the New Policies Scenario. Increased use of renewable electricity would rise sharply in regions where the deployment of electric vehicles is high (figure 5.6). Latin America and the Caribbean have the highest share of renewables used in transport thanks in part to high levels of biofuel deployment in Brazil.

Bioenergy accounts for the bulk of renewables used in transport in both the New Policies Scenario and Sustainable Development Scenario in 2030. In contrast, modern bioenergy for heat represents a smaller share of the total renewable heat used in buildings and industry. In the Sustainable Development Scenario, traditional uses of biomass are completely phased out as Africa and Central and Southern Asia shift to modern technologies. Asia and Northern America and Europe represent the largest markets for renewable heat. In the Sustainable Development Scenario, heat consumption from solar thermal (84 million tonnes of oil equivalent [Mtoe] in 2030) surpasses that of modern bioenergy use (79 Mtoe in 2030).

BOX 5.1 • RENEWABLE ENERGY TO 2050: A VIEW FROM IRENA'S REMAP ANALYSIS

There is broad consensus that renewable energy will play an increasingly important part in the world's energy mix over the coming decades. In this context, the International Renewable Energy Agency (IRENA) is focused on further advancing understanding of the global energy transformation, and setting forth a vision for how it could unfold. This transformation involves more than the energy sector to encompass key elements identified in the larger group of Sustainable Development Goals. Importantly, it involves a transformation of national economies that will bring new opportunities, greater prosperity, and jobs all while improving the air quality in cities, preserving the environment, and protecting the world's climate (IRENA 2016, 2018a). IRENA's renewable energy roadmap (REmap) outlines one possible route forward.

If IRENA's REmap were followed, growth in renewable electricity would be the single-largest driver of change. The share of electricity in final energy would increase from 20% in 2017 to 30% in 2030 and 49% by 2050. The share of electricity consumed in final energy in the industry and buildings sectors would double by 2050, while in the transport sector it would increase from 1% in 2017 to 11% in 2030 and over 40% in 2050. This increasingly electric energy system would transform how the power sector addresses demand. By 2030, 57% of electricity could be renewable (of which 34% would come from solar and wind) and this share could reach 86% by 2050 (of which 60% would come from solar and wind). Gross generation in 2050 is foreseen to be more than double what it was in 2017, with wind and solar dominating the expansion.

This acceleration in the deployment of renewables, combined with increased electrification and energy efficiency, could achieve over 90% of the reductions in energy-related carbon dioxide emissions needed by 2050 to set the world on a pathway to the "well below 2°C" aim of the Paris Agreement. Electrification via renewables is key, making up around 60% of the mitigation potential. However, the world is far from this path—the last two years saw emissions rise by around 2% per year, and IRENA analysis shows that in a Reference Case scenario, which considers current and planned policies (including Nationally Determined Contributions), emissions would peak slightly by 2030 and remain flat thereafter. This trend risks putting the world on a path toward warming by 3°C or higher.

If the REmap were followed, global energy demand in 2030 and 2050 would be slightly lower than today's level, despite significant population and economic growth. The share of modern renewable energy (which excludes

traditional uses of bioenergy) would meanwhile rise from about 10% of final energy in 2016 to about 28% in 2030 and 66% by 2050. To achieve this, there would need to be a sixfold acceleration in renewable energy growth compared with recent years, and the rate of energy intensity improvement would need to rise by 3.1% every year over the period. Fossil fuel consumption would need to continuously decline from 2020 onward—by 2030 demand for fossil fuels would need to decline by 21%, and by 2050 this would need to decline by 66%.

Variable renewable energy (VRE) technologies, particularly solar photovoltaic and wind, will play a central role in the energy transition. If the REmap were followed, VRE capacity would increase from just over 900 gigawatts (GW) in 2017 to over 5,700 GW in 2030 and to over 14,500 GW in 2050. With rising shares of VRE in electricity generation, maintaining the balance between supply and demand in a cost-effective manner is necessary. To maximize the value of low-cost but variable renewable energy sources requires more flexible and integrated power systems and an overall shift toward using more electricity in a smarter manner in end-use sectors.

To achieve both the medium- and longer-term milestones set out in the REmap would require fostering the development and deployment of innovative solutions that create the flexibility needed to integrate a high share of VRE. For example, in the transport sector, smart charging of electric vehicles can improve the flexibility of power systems and is crucial to enable optimal renewable energy integration while avoiding network congestion. Smart charging of electric vehicles allows charging demand to be matched with network capacity—charging levels can be adjusted to flatten peak demand, fill load valleys, and support real-time balancing of grids (IRENA 2019a). An important new energy vector that would emerge is renewable hydrogen, produced from renewable electricity, that can be used as a feedstock in industry, and also in end uses. Renewable hydrogen production would be double the level of today's hydrogen production from fossil fuels.

Despite the progress of recent years, the world is at a critical point. Accelerated action is needed to support the energy transformation, particularly in the near term: emissions need to decrease by 3.5% per year over the next decade—not increase as has happened in the last couple of years and is forecasted to continue under current and planned policies. The REmap analysis shows that energy-related emissions would need to decline by 25% by 2030, and by 70% by 2050.

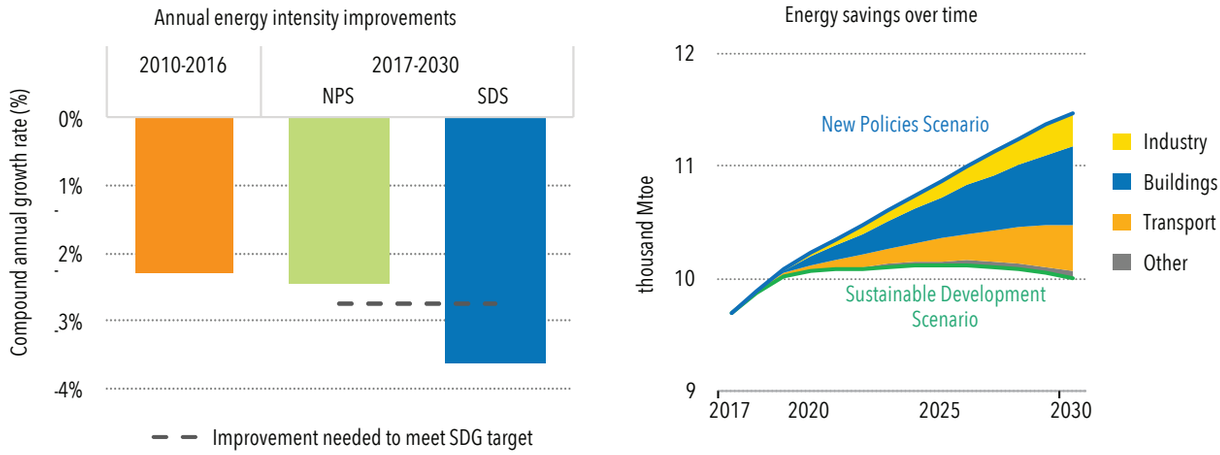
In addition to wide-sweeping societal and market change, the transformation requires adjusting the traditional way energy is consumed and shifting toward a more decentralized energy system, which would require new infrastructure investments, further development of innovative technologies, new business models, and new energy market designs. The transition touches on topics beyond energy and enshrined in the wider aims of the Sustainable Development Goals, particularly as these relate to ensuring universal access to modern energy services, the water-energy nexus, and potential geopolitical implications of the transition.

OUTLOOK FOR EFFICIENCY

Global energy intensity improved by 2.3% on average per year between 2010 and 2016, slightly short of the 2.6% indicated in SDG target 7.3. To make up for this shortfall, the average rate needs to rise to 2.7% between 2017 and 2030. In the New Policies Scenario, only a 2.4% annual improvement is anticipated and global final energy consumption continues to rise, reaching almost 11,500 Mtoe in 2030 or 18% higher than 2017 levels (figure 5.7).

In the Sustainable Development Scenario, an acceleration of energy efficiency measures across all end-use sectors fulfills the potential for global energy demand to peak by about 2025 and decline thereafter. The enhanced efforts yield additional energy savings of nearly 1,500 Mtoe or a reduction of 13% compared with energy consumption in the New Policies Scenario. The annual energy intensity improvement in the Sustainable Development Scenario of 3.6% actually surpasses SDG target 7.3, and demonstrates the key role energy efficiency plays in helping to meet sustainability goals.

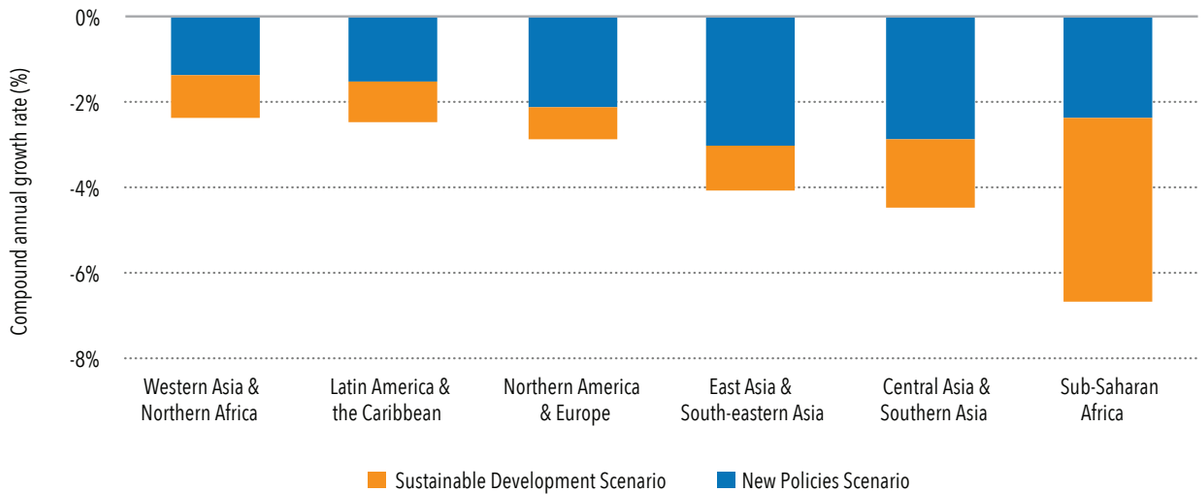
FIGURE 5.7 • GLOBAL ENERGY INTENSITY IMPROVEMENTS AND TOTAL ENERGY SAVINGS IN THE SUSTAINABLE DEVELOPMENT SCENARIO COMPARED WITH THE NEW POLICIES SCENARIO



Source: IEA (2018c), UNSD (2018), and World Development Indicators.
Note: Mtoe = million tonnes of oil equivalent; NPS = New Policies Scenario; SDG = Sustainable Development Goal; SDS = Sustainable Development Scenario.

At a sectoral level, about half of the global savings identified in the Sustainable Development Scenario come from the buildings sector, where more stringent building codes as well as energy efficiency standards for appliances and other electrical devices are lacking in many regions. Transport accounts for the second-largest contribution as fuel economy standards for both passenger and freight transport are assumed to be implemented across a growing number of regions. Industry makes up the remainder through the adoption of more efficient processes and systems.

FIGURE 5.8 • AVERAGE ANNUAL CHANGE IN ENERGY INTENSITY BY SCENARIO, 2017-2030



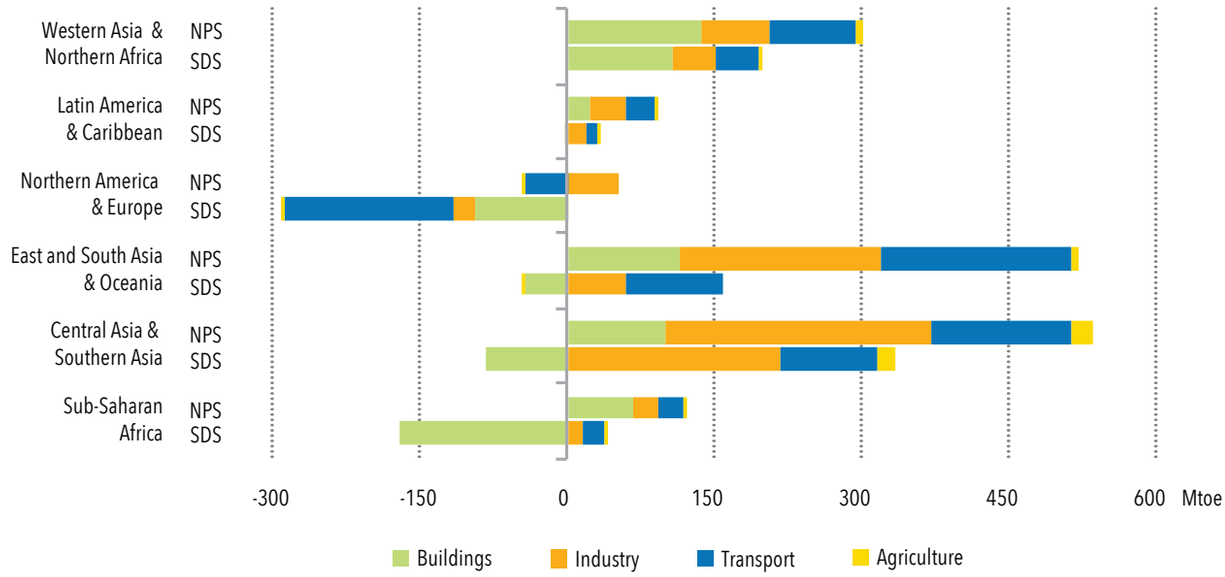
Source: IEA 2018a.

Improvements in energy intensity promise to accelerate in all regions, with the largest improvements seen in Asia as many emerging economies rebalance, shifting toward less-energy-intensive services and higher-value-added manufacturing. In the New Policies Scenario, average intensity improvements across regions vary from 1.3% in Western Asia and Northern Africa to 3% in East Asia and Southeastern Asia (figure 5.8). The additional improvements needed to realize the energy savings potential in the Sustainable Development Scenario highlight where energy efficiency measures are most needed. Sub-Saharan Africa stands out in particular: only a third of the energy savings potential identified in the Sustainable Development Scenario would be realized in the New Policies Scenario, versus 80% of the potential in Northern America and Europe.

To harness all potential energy intensity reductions, a fuller understanding of how and where current energy is used as well as expected future trends is needed. While energy efficiency measures are needed across all sectors, trends in energy demand vary significantly across regions, with certain sectors playing a larger role than others. In the New Policies Scenario, all regions would see energy demand continue to rise. In Asia, industry followed by transport would account for the majority of future demand growth, while in Africa and Western Asia, growth in energy demand would be dominated by the buildings sector.

In the Sustainable Development Scenario, all regions show significant potential for energy savings compared with the New Policies Scenario. Northern America and Europe and Sub-Saharan Africa can expect lower energy use than today. In Northern America and Europe, all sectors show a decline in energy consumption. Sixty percent of savings would come from transport, thanks to a combination of fuel economy policies together with the electrification of transport. Total energy consumption in these regions would decrease by about 300 Mtoe to drop nearly 9%. In Sub-Saharan Africa, a shift away from traditional uses of biomass, which have very low efficiency levels, to modern and clean fuels means that total energy consumption in buildings would decline by more than 150 Mtoe, and total energy use would fall by 28%. As noted earlier, the buildings sector stands out. In the Sustainable Development Scenario, energy use in this sector would fall or remain the same in all but one region.

FIGURE 5.9 • CHANGES IN ENERGY USE BY END-USE SECTOR IN THE NEW POLICIES SCENARIO AND SUSTAINABLE DEVELOPMENT SCENARIO, BETWEEN 2017 AND 2030



Source: IEA 2018a.
Note: Mtoe = million tonnes of oil equivalent; NPS = New Policies Scenario, SDS = Sustainable Development Scenario.

Government policies—in the form of both regulations and incentives to leverage the power of the market—are essential for realizing the savings possible due to improved energy efficiency. However, only about one-third of global energy consumption is currently covered by mandatory efficiency codes and standards.

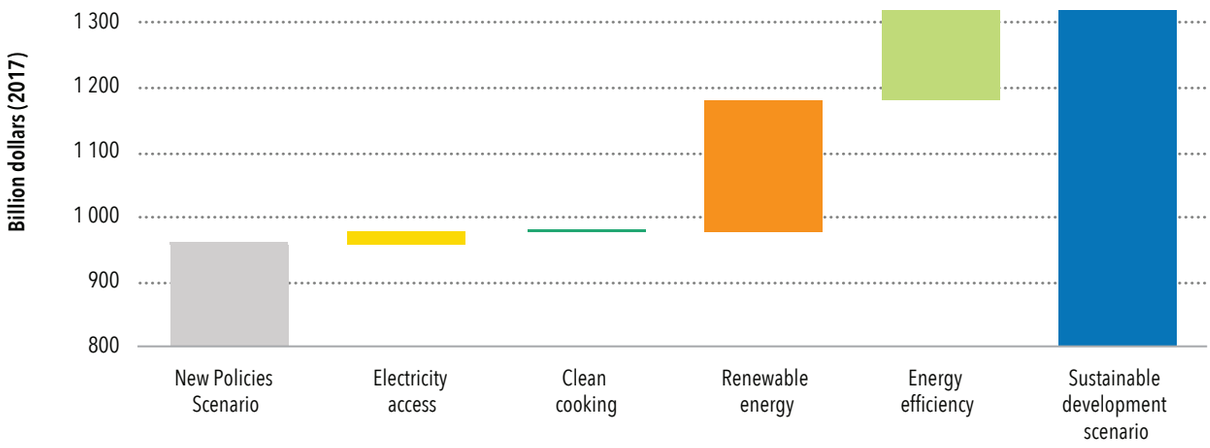
To achieve the energy savings potential outlined above requires a broad range of efficiency measures across all end uses. In transport, key measures include fuel economy standards for cars and trucks, global targets and measures for aviation and shipping, incentives for electrification, and information to support efficient vehicle uptake and mode shifts. While many countries have implemented building energy codes and standards, achieving the large savings identified in the Sustainable Development Scenario requires codes to be strengthened and expanded to cover new and existing buildings. Minimum energy performance standards for key equipment not currently covered, such as electric heat pumps and air conditioners, also need to be strengthened and expanded. In industry, mandatory policy-driven energy efficiency targets and standards cover less than 36% of total energy use. Increasing coverage and stringency is important, as are incentives to shift production toward the best available technologies.

INVESTMENTS NEEDED TO ACHIEVE SDG 7

In the New Policies Scenario, total energy sector investments in energy access, renewable energy, and energy efficiency are estimated to average $950 billion per year between 2018 and 2030 (IEA 2018a). Investments in energy access represent just $31 billion of this total, with investments in electricity access accounting for the vast majority (97%) of the spending; the remainder would go toward clean cooking. However, achieving universal energy access by 2030 would require $55 billion per year, with $4 billion going toward expanding access to universal clean cooking solutions. At a regional level the greatest attention would need to be on Sub-Saharan Africa, where 82% of the additional investment for energy access is needed in the Sustainable Development Scenario compared with the New Policies Scenario is needed.

Total additional spending for meeting SDG 7 is estimated in the Sustainable Development Scenario at an average of around $400 billion per year, of which over $200 billion per year is needed to increase the share of renewables in total final energy consumption to 22%, and another $140 billion per year for end-use efficiency. These additional investments are partially offset by $45 billion capital savings in other electricity generation investments thanks to a combination of lower electricity consumption from energy efficiency and a switch to renewable generation. The combination of lower energy use from efficiency and higher shares of renewables leads to a reduction in fossil fuel use of about 2,350 Mtoe and total fuel savings of $280 billion per year. The higher up-front investments in energy efficiency and renewables are only marginally higher than the resulting savings in fuel purchases, highlighting the economic viability of meeting SDG 7.

FIGURE 5.10 • ADDITIONAL ANNUAL AVERAGE NEEDED INVESTMENTS TO ACHIEVE SDG 7 TARGETS, 2018-2030



Source: IEA 2018a.
Note: New Policies Scenario and Sustainable Development Scenario investments in this figure only include those related to SDG 7.

SDG 7 AND CLIMATE ACTION (SDG 13)

Minimizing the potential future damages of climate change has become a central concern for the energy sector, with a large portion of nationally determined contributions reflecting energy-sector-specific commitments and increasing private sector commitment to environmental sustainability. SDG 13, to take urgent action to combat climate change and its impacts, will be reviewed at the 2019 High-Level Political Forum.

As the energy sector emits around 75% of global GHG emissions, transformative changes in the energy sector, such as realizing the SDG 7 targets, inevitably have implications for global climate mitigation. The Sustainable Development Scenario, in modelling the integrated pursuit of both SDGs (as well as the reduction of health costs from air pollution—SDG target 3.9), finds that the changes implicit in each of the SDG 7 targets are compatible with climate mitigation efforts. Given the energy sector's large share of GHG emissions, SDG 7 can be seen as a prerequisite for achieving SDG 13.

Achieving universal access to modern energy does not increase the (already very small) climate burden imposed by the population living in Sub-Saharan Africa. Though providing access to more people increases energy service demand, it does not necessarily increase GHG emissions.

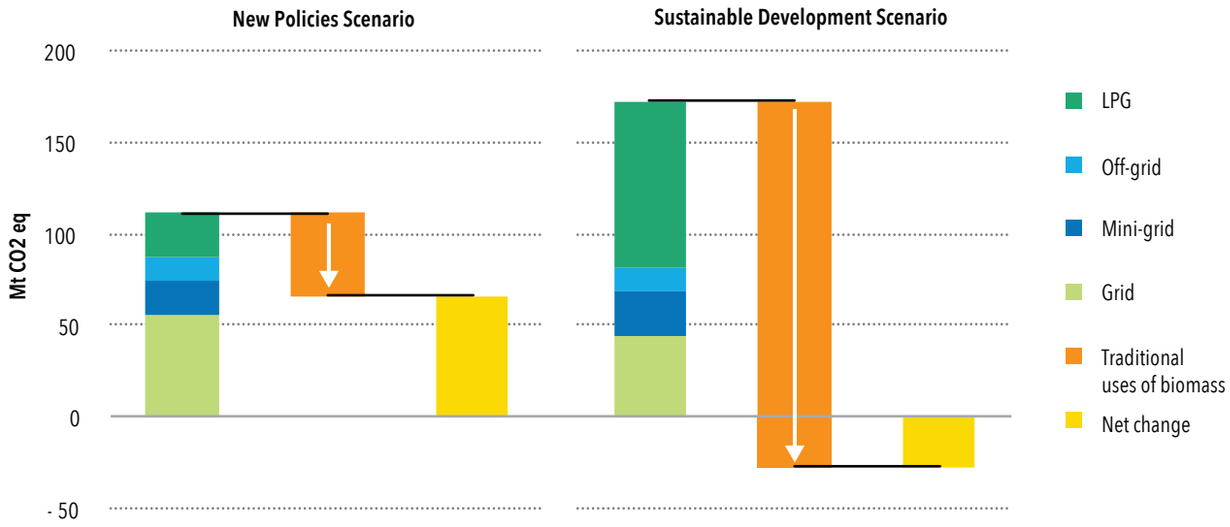
First, the change in energy demand associated with access is relatively minor. Per capita energy consumption among households who are gaining access for the first time tends to be quite low. For example, in Africa, per capita energy consumption is still six times lower than the average of advanced economies. Even assuming that every household's energy consumption reaches the regional average 8 to 12 years after gaining access, additional electricity demand amounts to only 338 TWh in 2030 in the Sustainable Development Scenario, or 1.1% of the global total. The use of LPG for clean cooking requires around 1 million barrels per day (mb/d), or 0.8% of global oil demand in 2030.

Energy demand also stays relatively low because of an increased proliferation of energy efficient appliances with new connections. Energy efficient technologies free up capacity in the power grid, such that the same capacity can provide energy services to more consumers.

Other factors lessen the carbon intensity of households gaining access, making the goals of universal access and climate mitigation compatible. The Sustainable Development Scenario involves a greener fuel mix of electricity generation. In the New Policies Scenario, 33% of connections are provided by fossil fuels, increasing GHG emissions by 90 tonnes of carbon dioxide equivalent (Mt CO2eq). In the Sustainable Development Scenario, 600 million more people gain access to electricity access, but this is accompanied by greater deployment of decentralized renewable solutions. In this context, only 25% of connections are provided by fossil fuels, such that GHG emissions from electricity access are lower, at 80 Mt CO2eq.

The simultaneous pursuit of universal access to both electricity and clean cooking solutions yields net savings of GHG emissions. Though the uptake of LPG as a clean cooking fuel does increase GHG emissions, significant emissions are avoided when people switch away from the use of solid biomass in traditional cookstoves, which is associated with high levels of methane and to a lesser extent nitrous oxide. Taking into account the high equivalent warming effect of methane and nitrous oxide relative to CO2, even a conservative calculation shows a net climate benefit from switching to LPG and other modern cooking fuels such as natural gas and electricity. Where solid biomass remains, it is used in improved, relatively efficient cookstoves.

FIGURE 5.11 • ENERGY-ACCESS RELATED CO2 AND METHANE EMISSIONS DUE TO EXPANDED ACCESS TO ELECTRICITY AND CLEAN COOKING SOLUTIONS, BY SCENARIO, BY 2030



Source: IEA 2018a.
Note: LPG = liquefied petroleum gas; Mt CO2 eq= tonnes of carbon dioxide equivalent.

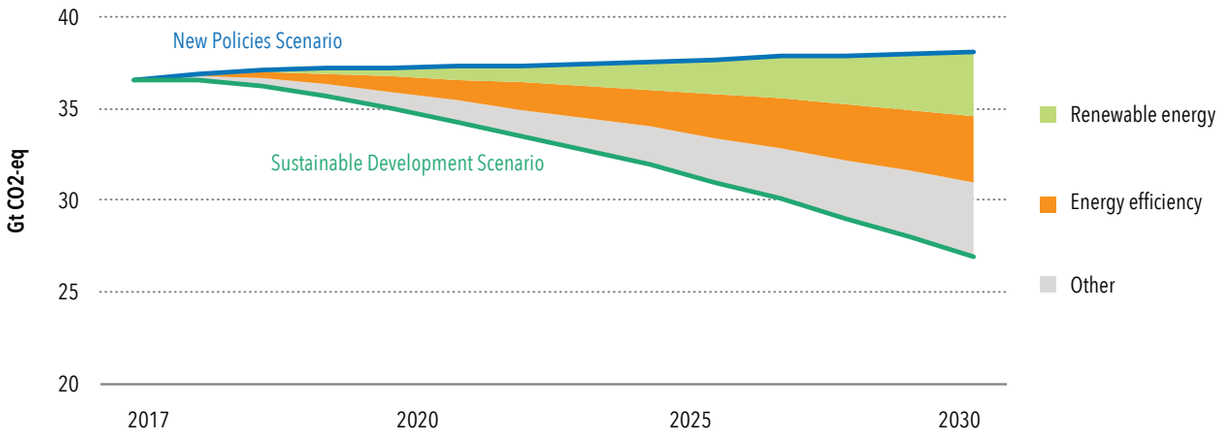
In the New Policies Scenario, in which around 580 million people gain access to clean cooking solutions, the switch away from traditional uses of biomass for cooking saves 45 Mt CO2eq. In the Sustainable Development Scenario, in which nearly 2 billion more people gain access to clean cooking solutions, there is a 75% reduction in these uses by 2030 relative to the New Policies Scenario, and the relevant fuel switch saves 200 Mt CO2eq (figure 5.11).

The complementary link between (i) renewable energy and energy efficiency, and (ii) climate mitigation is comparatively clear. The two SDG 7 targets of increasing renewable energy and energy efficiency are the largest sources of the emissions reductions needed to realize the Paris Agreement. Both contribute around 33% each of the greater CO2 and methane savings to be achieved in the Sustainable Development Scenario relative to the New Policies Scenario (figure 5.12).

Importantly, the deployment of renewables is not an isolated effort; instead, phasing out the most inefficient fossil fuel power plants must be part of any strategy to reduce the overall carbon intensity of power generation. The cumulative additional CO2 and methane savings to be realized by 2030 in the Sustainable Development Scenario total around 18 gigatonnes (Gt) CO2eq, around three-quarters of which come from the deployment of renewables for electricity generation.

Energy efficiency reduces the fuel intensity of energy service demand in the end-use sectors. Correspondingly, the cumulative CO2 and methane savings expected by 2030 in the Sustainable Development Scenario are 4.7 Gt CO2eq in the buildings sector, 6.0 Gt CO2eq in the industry sector, and 3.8 Gt CO2eq in the transport sector. Energy efficiency tempers the peak loads that the grid must be able to support, ruling out the necessity to rely on higher-cost and often more carbon intensive peaking capacity.

FIGURE 5.12 • CO2 AND METHANE EMISSIONS REDUCTIONS FROM SDG 7 TARGETS IN THE SUSTAINABLE DEVELOPMENT SCENARIO RELATIVE TO THE NEW POLICIES SCENARIO



Source: IEA 2018a.
Note: Gt CO_2 eq= gigatonnes of carbon dioxide equivalent.

Beyond the benefits that achieving the two SDG 7 targets contribute to climate mitigation, the energy sector has a broader role in furthering the sustainable development agenda (box 5.2).

BOX 5.2: SDG 7 AND THE BROADER SUSTAINABLE DEVELOPMENT AGENDA

SDG 7 has important cobenefits for wide-ranging aspects of the sustainable development agenda, particularly health, air pollution, and sustainable cities; gender equality; education, work, and economic growth; as well as the sustainable use of forestry and water resources (figure B5.2.1).

FIGURE B5.2.1 • SDG 7'S WIDE-RANGING CONTRIBUTIONS TO THE SUSTAINABLE DEVELOPMENT AGENDA

Health, air pollution, and sustainable cities: Electricity connections are vital for hospital operations and the cold storage of vaccinations. SDG 7 is also essential for reducing both indoor and outdoor air pollution: the use of solid biomass and coal for cooking in enclosed spaces causes indoor air pollution associated with millions of premature deaths. Outdoor air pollution also improves where renewable energy replaces fossil-fuel-fired power plants. Energy efficiency that lowers the energy demand of urban areas decreases the demand placed on polluting power plants near population-dense areas.

Gender equality: In developing countries, women tend to bear primary responsibility for collecting and preparing fuel for cooking, as well as for cooking itself (Practical Action 2016), such that they are disproportionately exposed to the harms of cooking without clean fuels. Women collect and carry loads of wood that weigh as much as 25-50 kilograms (UNEP 2017). Households dedicate an average of 1.4 hours a day to collecting fuel, a burden mainly borne by women and children. This is time that could be spent on education and income-generating work. Energy access is also a necessary input for women's productive activities in agriculture and small businesses.

Education, meaningful work, and economic growth: Access to affordable, reliable, and sustainable modern energy can have a transformative impact on productivity and incomes (IRENA 2019b). Global renewable energy employment reached 10.3 million jobs in 2017, an increase of 5.3% over the year before (IRENA 2018b). Access to adequate and reliable energy services enables economic productivity. Access to electricity also improves the operation of schools and other community services by providing lights, cooling, and so on.

Sustainable consumption: While the use of solid biomass is not the leading cause of deforestation, wood is exhaustible unless stocks are managed sustainably. The overall extent of forested areas continues to decline (FAO 2015), while the global population depending on biomass for cooking continues to rise. Increased energy efficiency, the move away from coal-fired power generation, and the increased deployment of solar photovoltaic and wind power all contribute to overall lower water withdrawals in the energy sector (IEA 2018a).

CONCLUSION

Achieving SDG 7 requires a rapid and far-reaching transformation of the energy sector. While notable progress has been made in the past few years, enabled by the declining costs of renewable energy technologies and concerted government efforts in certain regions, the world is not yet on track to achieve SDG 7 by 2030.

Investment in and careful planning of electrification need to be stepped up in Sub-Saharan Africa, and the world needs to see amplified political momentum in expanding access to clean cooking solutions. Commercially viable solutions for renewables, especially for heat and transport, and renewed commitment to improving the coverage and stringency of efficiency regulations are urgently needed. The benefits of achieving the energy transformation are countless. Energy and climate goals are closely interlinked and complementary pursuits. SDG 7 is an essential component of several other SDGs, a golden thread in the sustainable development agenda.

METHODOLOGY

The analysis presented in this chapter is based on results from the World Energy Model (WEM) and International Energy Agency (IEA) analysis in the World Energy Outlook (WEO). A detailed documentation on the WEM methodology can be found at https://www.iea.org/media/weowebsite/energymodel/WEM2018.pdf.

IEA SCENARIOS

The analyses outlined in this chapter are built on two main scenarios:

- The **New Policies Scenario** aims to provide a sense of where today's policy ambitions seem likely to take the energy sector. It incorporates not just the policies and measures that governments around the world have already put in place, but also the likely effects of announced policies, including the nationally determined contributions that are part of the Paris Agreement.
- The **Sustainable Development Scenario** is a forward-looking, normative scenario that involves an integrated least-cost pathway for the world's energy system to deliver on energy-related SDGs: to ensure universal access to affordable, reliable, sustainable, and modern energy services by 2030 (SDG 7); to substantially reduce the number of deaths and illnesses attributable to air pollution, among other hazards (SDG target 3.9); and to take effective action to combat climate change (SDG 13). It shows how efforts toward these objectives can be accomplished simultaneously so as to realize mutually supportive benefits. In this scenario, looking toward 2030, universal access to both electricity and clean cooking is achieved; and modern renewables reach 21% of total final energy consumption, more than doubling today's share. SDG target 7.3—to double the global rate of improvement in energy efficiency—is exceeded in the Sustainable Development Scenario, with average annual improvements in global energy intensity accelerating to 3.4% to achieve critical energy sector objectives. More information about this scenario can be found at https://www.iea.org/weo/weomodel/sds/.

METHODOLOGY FOR ACCESS TO ELECTRICITY AND ACCESS TO CLEAN COOKING

The projections presented in the WEO and in this chapter focus on two elements of energy access: a household having access to electricity and to clean cooking facilities. These are measured separately. The IEA maintains databases on levels of national, urban, and rural electrification rates. For the proportion of the population without clean cooking access, the main sources are the World Health Organization's Household Energy Database and the IEA Energy Balances. Both databases are regularly updated and form the baseline for WEO energy access scenarios in 2040.

The projections shown in the New Policies Scenario take into account current and planned policies, recent progress, as well as population growth, economic growth, the urbanization rate, and the availability and prices of different fuels. In the Sustainable Development Scenario, we identify least-cost technologies and fuels to reach universal access to both electricity and clean cooking facilities. This is done by incorporating a Geographic Information Systems (GIS) model based on open-access geospatial data, with technology, energy prices, electricity access rates, and demand projections from the WEM. This analysis has been developed in collaboration with the KTH Royal Institute of Technology, Division of Energy Systems Analysis (KTH-dESA) in Stockholm, Sweden.

Further details about the IEA methodology for energy access projections can be found at https://www.iea.org/energyaccess/methodology/.

METHODOLOGY FOR RENEWABLE ENERGY PROJECTIONS

The annual updates to WEO projections reflect the broadening and strengthening of policies over time, including for renewables. The projections of renewable electricity generation are derived in the renewables submodule of the WEM, which projects the future deployment of renewable sources for electricity generation and the investment needed. The deployment of renewables is based on an assessment of the potential and costs for each source (bioenergy, hydropower, photovoltaics, concentrating solar power, geothermal electricity, wind, and marine) in each of the 25 WEM regions. By including financial incentives for the use of renewables and nonfinancial barriers in each market, as well as technical and social constraints, the model calculates deployment as well as the resulting investment needs on a yearly basis for each renewable source in each region.

METHODOLOGY FOR ENERGY EFFICIENCY PROJECTIONS

The key energy efficiency indicator refers to gross domestic product and total final energy demand.

Economic growth assumptions for the short to medium term are based largely on those prepared by the Organisation for Economic Co-operation and Development, International Monetary Fund, and World Bank. Over the long term, growth in each WEM region is assumed to converge to an annual long-term rate. This is dependent on demographic and productivity trends, macroeconomic conditions, and the pace of technological change.

Total final energy demand is the sum of energy consumption in each final demand sector. In each subsector or end use, at least six types of energy are shown: coal, oil, gas, electricity, heat, and renewables. The main oil products—liquefied petroleum gas, naphtha, gasoline, kerosene, diesel, heavy fuel oil, and ethane—are modelled separately for each final sector.

In most of the equations, energy demand is a function of activity variables, which again are driven by:

- Socioeconomic variables: In all end-use sectors, gross domestic product and population are important drivers of sectoral activity variables.
- End-user prices: Historical time-series data for coal, oil, gas, electricity, heat, and biomass prices are compiled based on the IEA Energy Prices and Taxes database and several external sources. Average end-user prices are then used as a further explanatory variable—directly or as a lag.

All 25 WEM regions for energy demand are modelled in considerable sectoral and end-use detail. Specifically:

- Industry is separated into six subsectors.
- Buildings' energy demand is separated into six end uses.
- Transport demand is separated into nine modes with considerable detail for road transport.

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ENDNOTES

34 The analysis in this chapter is based on results from the World Energy Model and IEA analysis in the World Energy Outlook (WEO).

35 Geographical groupings presented in this chapter are derived from the World Energy Outlook and are described in annex 1 of the World Energy Model (WEM) documentation: https://www.iea.org/media/weowebsite/energymodel/WEM2018.pdf. Developing Asia refers to non-OECD Asia in the WEM.

36 This figure includes projected population growth by 2030.

37 Heat in this chapter refers to the amount of energy consumed for heat-raising purposes in industry and other sectors. It is not equivalent to the final energy end-use service.

38 Given that traditional uses of biomass are linked with significant pollution and deforestation, and must be phased out to achieve the SDG indicator for clean cooking, among others, the discussion in this section focuses on the use of modern renewables.