ENERGY TRANSITION PATHWAYS

FOR THE 2030 AGENDA IN ASIA AND THE PACIFIC

Regional Trends Report on Energy for Sustainable Development 2018

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FOREWORD

The energy transition pathway in Asia and the Pacific is guided by the 2030 Agenda for Sustainable Development and the Paris Agreement on climate change, articulated through Nationally Determined Contributions (NDCs). The Sustainable Development Goal 7 on energy (SDG7) provides clear targets to be met on universal energy access, increasing renewable energy and improving energy efficiency. These targets require radically transforming our energy systems to a low carbon model if we are to limit global warming to a maximum of 2 degrees centigrade. With these imperatives in mind, this report explores a series of scenarios to help shape more sustainable energy production and consumption across Asia and the Pacific.

While many countries in the region have been making considerable progress, this is insufficient to achieve SDG 7 by 2030. Existing policies are expected to almost achieve universal access to electricity by 2030. But in the same year, 1.6 billion people will still lack access to clean cooking fuel. While energy efficiency is increasing, the growth of renewables in the energy mix is insufficient. If SDG 7 is to be met, renewable energy's share of total consumption will need to reach 22 per cent by 2030. To achieve the Paris Agreement goals, it will need to hit 35 per cent.

Both renewable energy and energy-efficient technologies have matured to allow for immediate deployment. But mustering the financing to deploy renewable energy solutions presents a considerable challenge. Private investment will be crucial to achieve the four-fold investment increase needed. Existing policy frameworks must be adjusted to harness the large untapped potential of private finances for renewable energy and energy efficiency. The drain on fiscal resources through fossil fuel subsidies must be phased out to achieve energy security, create a competitive energy market and encourage more sustainable energy use.

The interlinkages between energy, the SDGs and the NDCs make the energy transition enormously complex. This report considers the synergies between SDG7 and the NDCs when developing policy and institutional frameworks to guide the energy transition. Countries in the region can work together to share best practices and build capacities. Energy connectivity, particularly through interconnected power grids, must occur faster for countries to benefit more from renewables and cross-border power trade.

The United Nations Economic and Social Commission for Asia and the Pacific stands ready to assist its member States in every way it can to quicken the pace of energy transition. I hope this report will put sustainable fuel in the tank of all those committed to achieving SDG 7 by 2030.

Shamshad Akhtar
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Executive Secretary, United Nations Economic and Social Commission
for Asia and the Pacific

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EXECUTIVE SUMMARY

The Asia-Pacific region has emerged as a global economic powerhouse. The region's rapid and sustained economic growth, increasing population, expanding industrialization and rapid urbanization are driving strong growth in energy demand. Ensuring that energy supplies are adequate to meet that growth in ways that are socially, economically and environmentally responsible creates a new set of challenges for policymakers. Adding to this challenge is the need to substantially reduce greenhouse gas (GHG) emissions across the energy sector in line with the objectives of the Paris Agreement on climate change.

In order to address these challenges, this report proposes a pathway to the 2030 energy transition. This has four coherent and interlinked objectives: (a) an increased energy supply to meet the growing demand; (b) improved energy security; (c) meeting the SDG7 targets; and (d) achieving the GHG reductions under NDCs. This report examines, from an Asia-Pacific regional perspective, how the energy transition pathways that respond to these imperatives may be crafted. The findings are intended to guide policymakers who aim to develop comprehensive national strategies to navigate the energy transition.

PROGRESS ON SDG7 TARGETS

While the region's energy development has progressed well, that progress has not been uniform or consistent across the region. Access to electricity has reached 90 per cent, a marked increase from the level of 70 per cent achieved in 1990. This increase in access has been achieved despite a population increase of 34 per cent during the same period. The progress in providing access to clean cooking fuel, on the other hand, has been very slow in the region, just as it has across the world. Access to clean cooking fuel in the region increased by only 7 per cent to 49.6 per cent during the decade to 2014, leaving 2.2 billion people in the region still cooking with traditional biomass, the highest concentrations of whom live in China and India.

The share of renewable energy, both from modern renewables and the traditional use of biomass, in the total final energy consumption (TFEC) declined from 23 per cent in 1990 to 18.3 per cent in 2014. This drop was due primarily to the sharp increase in energy demand, which doubled during this period. While significant growth in renewable energy has occurred in absolute terms, it has been outpaced by growth in energy demand and fossil fuel use. Growth in the use of modern renewables reached a 37 per cent during this period. China made the most remarkable contribution – its renewable-based electricity generation increased more than five-fold between 2000 and 2014. Regionally, hydroelectricity contributed 82 per cent of the growth in renewables, while wind, solar photovoltaic (PV), geothermal and biomass contributed the remaining share.

Progress in energy efficiency has enabled the region to decouple energy use and gross domestic product (GDP). Primary energy intensity – the ratio of primary energy to GDP, which is an indicator used to measure energy efficiency – decreased at an annual compound rate of 1.8 per cent from 1990 to 2000. This rate of improvement has accelerated, reaching an annual decline of 3 per cent from 2012 to 2014. The energy intensity of the Asia-Pacific region, which in 2014 stood at 6.0 megajoules (MJ) per 2011 purchasing power parity (PPP) $, is converging with the global average of 5.4 MJ per 2011 PPP $. .

Energy transition pathways to 2030

This report examines three possible pathways for an energy transition to 2030:

1. The current policy scenario (CPS), also known as the baseline, is based on the policies and plans that have been already announced by the member States;

2. The SDG scenario entails the transition required to achieve the SDG7 targets;

3. The NDC scenario aims to achieve emission reductions, outlined in the NDCs from the energy sector, through the deployment of renewable energy technologies and energy efficiency measures.

These three pathways serve as a potential guide for policymakers seeking to make informed decisions regarding the most suitable energy transition pathway. The target for renewable energy growth in the SDG scenario has been constructed using the International Renewable Energy Agency (IRENA) REmap 2030 growth scenario for Asia-Pacific countries, covering 94 per cent of the region's TFEC. The difference between the CPS as a baseline and the following two scenarios helps to identify the gaps that must be bridged in order to realize these policy objectives. The synergies offered between the SDGs and NDCs indicate that these alternative pathways are not mutually exclusive but are in fact complementary. The pathway to the NDC scenario would therefore also help in achieving some components of the SDG scenario, although additional attention will be required to ensure the achievement of the SDG7 targets, the most notable of which is energy access.

IDENTIFYING THE GAP

The report highlights a series of gaps that must be bridged in order to achieve the energy transition. While the region will almost close the gap for access to electricity in 2030, progress in the other areas – notably access to clean cooking and growth in renewable energy – will need to be accelerated in order to achieve the targets. Energy efficiency improvements will continue to make good progress, but further strengthening of policy measures to accelerate the adoption of energy efficiency will be needed to close the gap.

Key findings of the gap analysis:

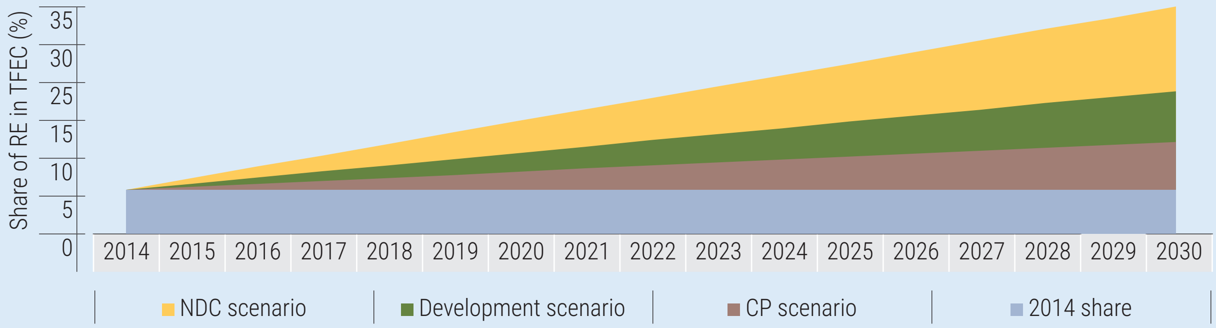
- Access to electricity under the CPS will reach 99 per cent, leaving an estimated 63 million people in the region without access to electricity, compared with 421 million people without access in 2014. Regionally, an investment of between $0.33 billion and $1.7 billion would be required to achieve the universal access, depending on the level of energy supply required per household;

- Access to clean cooking fuel under the CPS will reach 68 per cent in 2030, leaving 1.6 billion people still cooking with traditional biomass, 65 per cent of whom will be living in China and India. While that will be a significant reduction from the 2.2 billion people without access to clean cooking solutions in 2014, it falls well short of the target of universal access;

- The share of modern renewable energy in total final energy consumption will grow under the CPS from the current 7 per cent to 14 per cent by 2030. Under the SDG scenario, the share is required to reach 22 per cent, resulting in a gap of about 409 million tonnes of oil equivalent (Mtoe). The ambitious NDC scenario will require the renewables to grow to 35 per cent, which represents a gap of 1,074 Mtoe compared with the CPS. Compared with today's contribution, the additional amounts of renewable energy required are 778 Mtoe and 1,444 Mtoe by 2030 for the SDG and NDC scenarios, respectively (figure ES1);

- Primary energy intensity under the CPS will drop to 3.97 MJ per 2011 PPP $ by 2030 – still short of the 2.52 MJ per 2011 PPP $ that is required in the SDG scenario. In the NDC scenario, energy efficiency improvement will need to progress further in order to achieve a significant emission reduction.

Figure ES 1 | The growth in the share of renewables can have three different pathways to 2030



POLICY OPTIONS TO ENABLE THE ENERGY TRANSITION

Aligning national energy policy with the SDG7 targets

Existing policy frameworks are insufficient to enable the ambitious SDG7 goal to be achieved by 2030. Delivering on the energy transition requires aligning energy policies with SDG7, While the target for access to modern energy should be set at 100 per cent, each country's share of renewable energy growth will depend on the specific national context. Regionally, a robust mechanism will be needed to develop national targets, which in aggregate, deliver the chosen regional pathway.

Development of an energy transition roadmap

Countries with different capacities and resources erode confidence in the region's ability to succeed in the energy transition. The risk of failure can be significantly lowered by developing energy transition roadmaps to guide national policy development and facilitate resource mobilization. Such roadmaps should assist countries with specific targets, technology choices, assessment of financial viability, generation of investor interest, shared knowledge and best practices, together with progress monitoring and reporting. Development of a web-based tool that can be tailored to nationally relevant data and information to produce national roadmaps could be a cost-effective alternative to the development of physical roadmaps for each of the 53 ESCAP member States.

Technology options for universal access to energy

The declining cost of renewable energy technologies, such as solar PV and wind, offers a cost-effective alternative to extending networks to outlying and often challenging geographical locations. Distributed renewable energy (DRE) systems, such as mini-grids or standalone solar home systems (SHS), can be deployed quickly and are modular – a feature that enables increases in system size as energy demand grows. DRE systems also help in reducing GHG emissions and the fiscal burden created by fossil fuel subsidies. The technology choices for access to clean cooking fuel will depend on locally available resources and the socio-cultural aspects of the community. Biogas digesters, in addition to supplying clean gas for cooking, offer many benefits, including improved local and global environments, and improved agricultural productivity. The technology, however, is suitable only for communities with sufficient livestock. Liquefied petroleum gas (LPG) stoves are suitable for areas that have good LPG supply networks. The use of improved cook stoves (ICS) can be an option "for reaching the last mile", but further research and development is required to produce stoves that suit local contexts.

Financing the energy transition

The investment required to achieve the energy transition target cannot be met by public funds alone. Private investment will need to play an important role and will be the key to generating the risk capital for renewable energy projects that are traditionally considered high-risk projects. Creating an enabling investment climate will be essential for spurring the required private investment. Experience in the region and beyond, such as in Bangladesh and Thailand, has demonstrated that the availability of a revolving fund to allow entrepreneurs to access easy financing has the potential to generate significant private investment as well as stimulate market growth. Public-private partnerships in energy infrastructure projects, such as the build-operate-transfer (BOT) model, has proved attractive for private investment as the risks are shared and uncertainty is therefore reduced. Opening the door to foreign investors, such as by allowing 100 per cent foreign-invested companies to invest in projects, would also accelerate the inflow of private investment.

Market mechanisms, such as Feed-in Tariffs (FiTs), can be instrumental in stimulating initial markets for renewable energy growth, while renewable energy auctions can be an important mechanism for driving down the cost of energy for larger projects. Experiences from around the world suggest that the level of benefit from an auction depend largely on the proper design of the mechanism. IRENA has warned that poorly-designed auctions can eventually deliver negative impacts, including underdevelopment of projects.

The direct use of renewable energy in industries is relatively low compared with other sectors. Small and medium-sized enterprises (SMEs) represent a promising sector for the diffusion of renewable energy as well as energy efficient technologies. Energy services companies (ESCOs) have been found effective in assisting this market segment through the use of energy performance contracts (EPCs), in which the reductions in energy costs pay for the systems. Once paid off, the user can enjoy the full saving for the remaining lifetime of the technology. Some countries, such as Thailand, have taken the initiative in facilitating the development of ESCOs by establishing revolving funds.

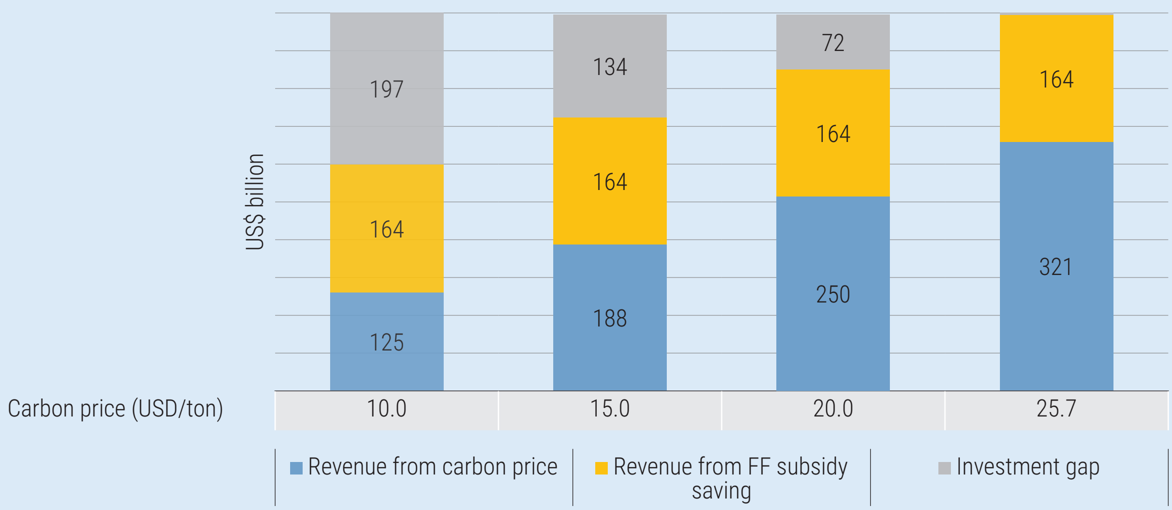
Phasing out fossil fuel subsidy

Total fossil fuel subsidies in the Asia-Pacific region amounted to $148 billion in 2014. Subsidies on fossil fuels have rarely been found to achieve their intended outcome of increasing the affordability of energy for poor people, as it is the wealthier, higher-income households that use larger amounts of energy who benefit the most from the subsidies. Phasing out fossil fuel subsidies is politically sensitive, but if achieved can prevent wasteful use of energy, avoid the loss of fiscal resources and can divert public funds to other development sectors, including investment in renewables. The financial viability of renewable energy technologies will be stronger if compared with other technologies in the absence of fossil fuel subsidies. Where there is a need to continue offering some fossil fuel subsidies, a mechanism needs to be developed to ensure that the subsidy reaches the people who need it the most. Some initiatives are in progress, such as the LPG subsidy for cooking in India; however, a performance assessment will be required to examine the effectiveness of such initiatives.

Levelling the playing field for renewable energy

The negative externalities, including the social and environmental damage from the combustion of fossil fuels, have long been a point of discussion but without significant progress in recognizing and institutionalizing adequate responses. A recent study by IRENA (2016a) estimated that doubling renewable energy globally could save up to $4.2 trillion per year, which is 15 times the investment required in renewable energy. In the absence of comprehensive mechanisms to factor in the costs of externalities and the challenges surrounding its institutionalization, some countries have adopted an alternative approach, such as placing a levy on petroleum fuel (Thailand) and introducing emissions trading schemes. Learning from regional experiences and best practices could foster such developments in other countries and promote greater regional cooperation to optimize the effectiveness of such approaches. A long-term vision for developing a regional emission trading market is a key avenue worth exploring. It has been estimated that a carbon tax of $25.7 per ton of CO2-e, together with savings from phasing out fossil fuel subsidies, would be sufficient to meet the entire investment needed for renewable energy to meet its target share (figure ES2).

Figure ES 2 | A price on carbon can close the investment gap for renewables



Accelerating renewable energy growth through energy connectivity

The required growth in renewable energy poses a technical challenge associated with the capacity of existing electricity networks to accommodate high penetration levels of variable renewable electricity (VRE). Forced curtailments have already started to occur in some countries, such as in China, caused by the inability of the grid to absorb the high share of VRE, and leading to significant lost revenue and the lowering of the renewable energy contribution. Without technical and policy interventions, this problem will increasingly occur in other countries of the region as they transition to higher shares of renewable energy in the generation mixes. Technological solutions are, however, available. One of these solutions is the interconnection of grids to expand the balancing areas. This is a promising solution as it also offers other benefits, including cross-border power supplies and improved energy security. A number of interconnection initiatives are currently in progress in the Asia-Pacific region, such as the Lao People's Democratic Republic-Thailand-Malaysia-Singapore Interconnected Grid and the Asia Super Grid. Further integration of networks will be crucial to absorbing increasing levels of VRE.

Leveraging the synergies between renewable energy and energy efficiency

The synergies between renewable energy and energy efficiency mean that they should be developed in conjunction rather than in isolation. Such synergies play an important role, in both the SDG and the NDC scenarios. In the case of the SDG scenario, improvements in energy efficiency act to lower final energy consumption and thus assist in increasing the share of renewable energy. For example, in the SDG scenario, if the energy intensity is reduced by an additional 25 per cent by 2030, the share of renewable energy will increase by a further 7 per cent without any additional investment in renewable energy. The same applies to the NDCs, as the marginal cost of abatement of energy efficiency is usually lower than the cost of building renewable energy plants. Therefore, prioritizing energy efficiency alongside adopting renewable energy will reduce the cost of achieving emission reductions.

Without doubt, the energy transition will be very challenging for countries and the region. Concerted efforts at the national level and coordination at the regional level are needed. Tackling SDG7 should not be done in isolation from the other SDGs, given the existence of many interlinkages. The identification and quantification of the impacts in order to accurately estimate energy demand and supply is challenging and calls for further research.

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LIST OF ACRONYMS

APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
BOT	build-operate-transfer
CAGR	compound annual growth rate
CBD	Commercial Building Disclosure
CPS	current policy scenario
DRE	distributed renewable energy
EE	energy efficiency
EERF	Energy Efficiency Revolving Fund
EPC	energy performance contract
ESCAP	Economic and Social Commission for Asia and the Pacific
ESCOs	energy services companies
ESP	energy service provider
ETR	energy transition roadmap
EVs	electric vehicles
FiT	Feed-in Tariff
GDP	gross domestic product
GHG	greenhouse gas
GTF	Global Tracking Framework
ICS	improved cook stoves
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
kWh	kilowatt-hours

LCOE	Levelized Cost of Electricity
LED	light-emitting diode
MTF	Multi-Tier Framework
Mtoe	million tonnes of oil equivalent
MWh	megawatt-hours
NDCs	Nationally Determined Contributions
PPP	purchasing power parity
PV	photovoltaic
RBF	results-based financing
RE	renewable energy
SDGs	Sustainable Development Goals
SE4ALL	Sustainable Energy for All
SHS	solar home system
SME	small and medium-sized enterprise
TFEC	total final energy consumption
TPES	total primary energy supply
TWh	terawatt-hours
UNIDO	United Nations Industrial Development Organization
VRE	variable renewable energy
WHO	World Health Organization
Wp	watt-peak

References to dollars ($) are to United States dollars unless otherwise stated.

Introduction

BACKGROUND

Energy provides the foundation for all development. A reliable, secure and affordable energy supply is a prerequisite to ensuring the economic growth of a nation or region and for alleviating poverty. The Asia-Pacific region has emerged as a global economic powerhouse, accounting for 35 per cent of the world's GDP with a remarkable average growth of 4.5 per cent per year since 2000 (see table A1 in Annex A). This GDP growth, together with increasing population, rapid urbanization and expanding industrialization have resulted in a dramatic increase in energy demand, averaging of 3.3 per cent per year during the past decade. This, in turn, has resulted in a heavy dependence by the region on imported fossil fuels for energy production, with associated energy security concerns.

The 2030 Agenda for Sustainable Development was adopted in 2015 by countries to end poverty, fight inequalities and tackle climate change, while ensuring that no one is left behind. It includes Sustainable Development Goal 7 (SDG7), "to ensure access to affordable, reliable, sustainable, and modern energy for all". Energy is also the key enabler for other SDGs, including those for poverty, food, health, education, gender and social equality, water and sanitation, climate and sustainable cities. Therefore, the degree of achievement of SDG7 will influence the success of other SDGs. Further commitments to sustainable energy are also embodied through the Paris Agreement on climate change, with each country submitting a climate pledge through the nationally determined contributions (NDCs). SDG7 requires an energy policy paradigm shift – business as usual will not be sufficient to meet the 2030 targets. Policymakers in the Asia-Pacific region face four complex and interlinked challenges:

1. Ensuring that energy supplies are adequate to meet growing demand, including that arising from providing universal access to modern energy;
2. Improving energy security;
3. Achieving the SDG7 targets by 2030 – ensuring universal access to modern energy, substantially increasing the share of renewable energy in the energy mix, and doubling the rate of energy efficiency improvement; and
4. Achieving the emission mitigation target of the energy sector under NDCs by 2030, given the dominant share of energy-related emissions.

Addressing this complex and challenging task requires policymakers to develop a clear, sustainable and achievable pathway that will enable each country, as well as the region collectively, to achieve the 2030 goals and targets. This report undertakes an in-depth analysis to first determine that the level of achievement is possible under the current policy regime by developing a baseline. It then identifies the gap between the baseline and the 2030 targets in order to inform policymakers of the additional efforts and resources that will be needed to adequately achieve the SDG7 targets as well as the NDC mitigation outcomes for the energy sector. Finally, different transition pathways have been developed and their socio-economic and environmental dimensions have been examined to assist policymakers in making informed decisions. The report also identifies the enabling policy, technology and market environment that would accelerate the achievement of the 2030 targets.

ORGANIZATION OF THE REPORT

- Chapter 1 provides brief information about the region, including the socio-economic, energy and environmental contexts. It also explains and rationalizes the underlying principles and considerations of the energy transition pathways.

- Chapter 2 presents the progress of the region on the SDG7 targets, based on data and information post-1990. Analysis has been undertaken for each of the three SDG7 targets. It also discusses the interconnectedness of SDG7 with other SDGs. The NDCs submitted by developed and developing countries under the Paris Agreement are also discussed. A summary of the synergies between SDGs and NDCs is presented.

- Chapter 3 discusses the the scenario development process and presents the scenarios and pathways for energy transition by 2030. They include: the CPS, which forms the baseline of current policies and plans; the SDG scenario for achieving SDG7 by 2030; and the NDC scenario for defining an option of emission cuts from the energy sector consistent with the Paris Agreement. Each scenario highlights the gap between the CPS and the alternative pathways.

- Chapter 4 analyses each pathway and critically examines, with empirical evidence, the challenges and opportunities associated with each. It presents regionally relevant technological, economic and environmental issues associated with the energy transition to 2030.

- Chapter 5 offers a "summary for policymakers", based on the findings in the previous chapter, in order to guide future policy development for achieving SDG7 targets by 2030.

- Chapter 6 presents concluding remarks on the entire analysis and suggests a way forward.

This report has relied primarily on information contained in the ESCAP Asia Pacific Energy Portal (APEP);[1] unless otherwise stated, the APEP should be considered as the source of all the data and information.

1 See http://asiapacificenergy.org/#en.

SDG7 AND ITS TARGETS

SDG7 aims to ensure access to affordable, reliable, sustainable and modern energy for all. It has three key targets, which are outlined below. The Global Tracking Framework,[2] which is the main data collection platform for all SDG7 targets, is compiled by a consortium of agencies led by the World Bank, Sustainable Energy for All (SE4ALL) and the International Energy Agency (IEA):

- Target 7.1. "By 2030, ensure universal access to affordable, reliable and modern energy services." Two indicators are used to measure this target: (a) the proportion of the population with access to electricity; and (b) the proportion of the population with primary reliance on clean cooking fuels and technology;

- Target 7.2. "By 2030, increase substantially the share of renewable energy in the global energy mix". This is measured by the renewable energy share in total final energy consumption. It is calculated by dividing the consumption of energy from all renewable sources by total energy consumption. Renewable energy consumption includes consumption of energy derived from hydropower, solid biofuels (including traditional use), wind, solar, liquid biofuels, biogas, geothermal, marine and waste. Importantly, this indicator focuses on the amount of renewable energy consumed, rather than the capacity for renewable energy production, which cannot always be fully utilized;

- Target 7.3. "By 2030, double the global rate of improvement in energy efficiency", as measured by the energy intensity of the economy. This is the ratio of the total primary energy supply (TPES) and GDP. Energy intensity is an indication of how much energy is used to produce one unit of economic output. As defined by the IEA, TPES is made up of production plus net imports minus international marine and aviation bunkers plus stock changes. For comparison purposes, GDP is measured in constant terms at 2011 PPP.

2 See http://gtf.esmap.org/.

1| Progress of SDG7 in Asia and the Pacific

Asia and the Pacific has made significant progress in providing access to electricity since 1990, with an annual average growth of 0.8 per cent to reach 90 per cent access rate in 2014, leaving 421 million people without access. On the other hand, the progress in access to clean cooking fuel has been disappointingly slow, increased from 40% in 2000 to 51% in 2014, leaving 2.2 billion people still cooking with biomass in traditional stoves. While the installed capacity of renewable energy has grown in some countries in recent years, the share of renewable energy in final energy consumption declined in the region by about 5 per cent between 1990 and 2014. The improvement in energy efficiency since 1990 has been remarkable, with energy intensity of GDP declining by an annual average of 1.7 per cent. Delivering on an energy transition to achieve the 2030 Agenda for Sustainable Development and the objectives of the Paris Agreement will require concerted efforts by all countries through the development of enabling policy measures as well as taking into account the interlinkages among SDGs and the synergies between SDGs and NDCs.

The SE4ALL initiative was launched in 2011 to pursue three major energy objectives by 2030: (a) ensuring universal access to modern energy services; (b) doubling the global rate of improvement in energy efficiency; and (c) doubling the share of renewable energy in the global energy mix. The 2030 Agenda for Sustainable Development reinforces these objectives by introducing a specific goal on energy – SDG7. Countries have agreed to achieve the 2030 Agenda and have started to make progress on SDGs, including SDG7. This chapter discusses the progress of ESCAP member States in Asia and the Pacific on the three SDG7 targets – energy access, renewable energy and energy efficiency.

The underlying principles of development of energy transition pathways to achieve the SDG7 targets by 2030 has been based on the following key features.

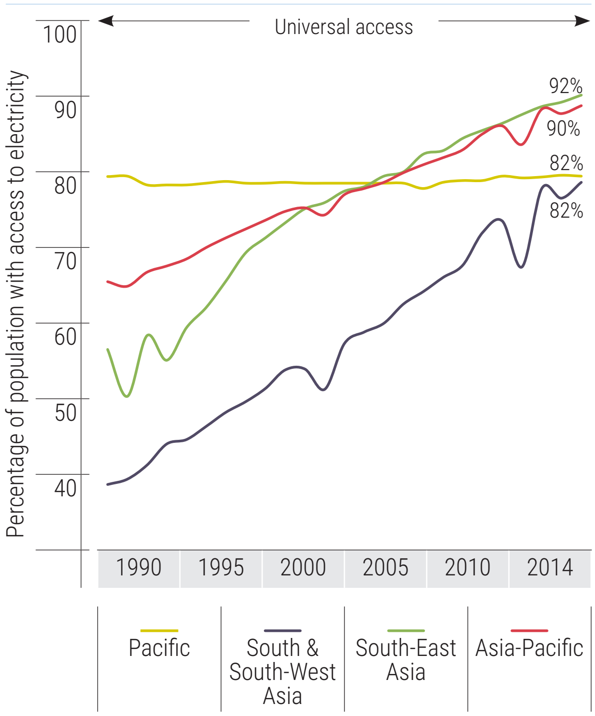
1. *Financial viability of policy options*. This is to ensure that the implemented policies can continue to be relevant in the rapidly changing energy market;
2. *Environmental sustainability*. The need for clean, low emission and climate-resilient energy technologies has been a key criterion, particularly in relation to NDCs and the Paris Agreement;
3. *Agility of deployment*. Achievement of SDGs during the next 12 years requires rapid policy implementation and technology deployment;
4. *Energy security*. Improvement of energy security through the reduction of dependence on imported fossil fuels and the diversification of energy resources has been given consideration; and
5. *SDG relevance*. The SDGs are integrated goals, all of which are required to be achieved by 2030. Therefore, consideration has been given to technological and policy options that support the achievement of other SDGs, including social equality, increased jobs, better health and improved access to education.

1.1 OVERVIEW OF PROGRESS

Progress in access to electricity

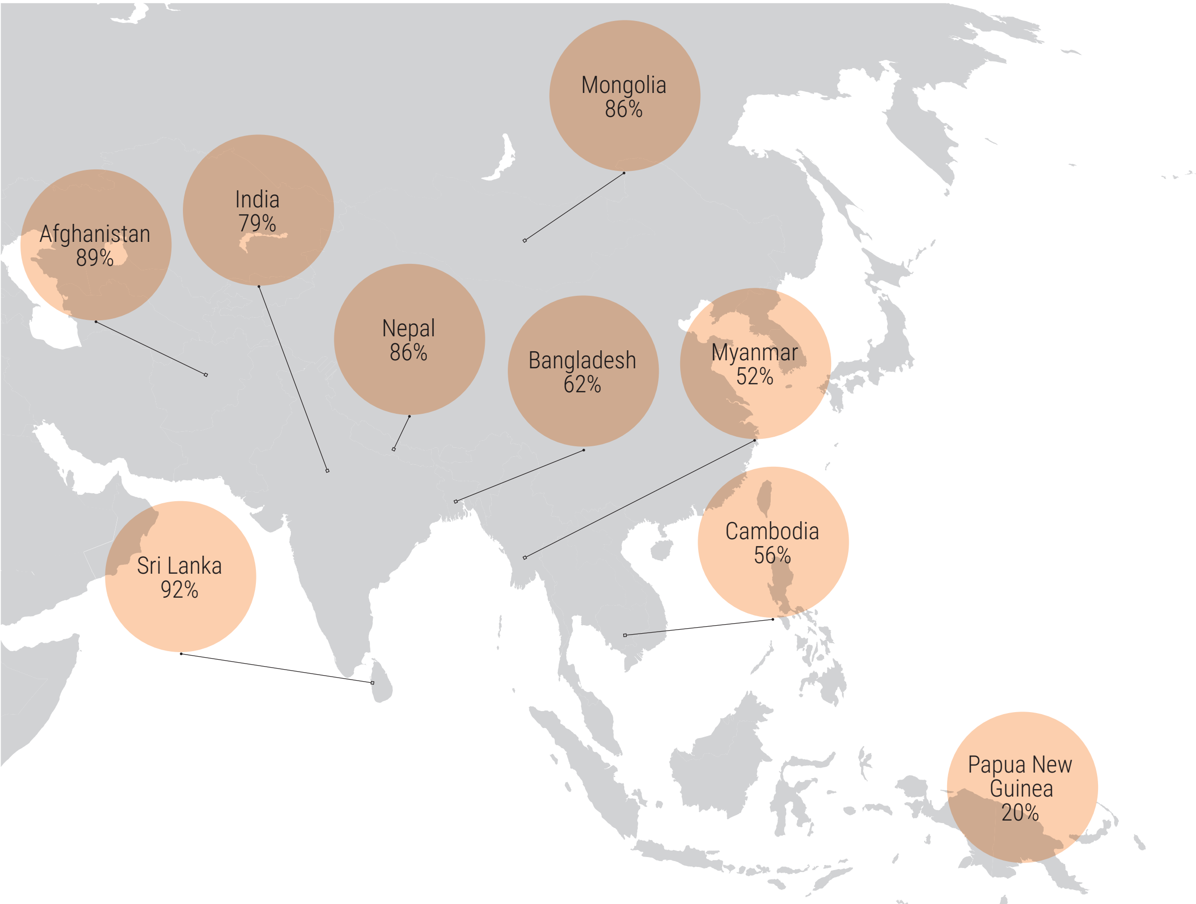
The Asia-Pacific region has made significant improvement in the access to electricity by increasing it from 70 per cent in 1990 to 90 per cent in 2014 (figure 1). North and Central Asia achieved universal access to electricity in 2011, while access to electricity in East and North-East Asia reached 99 per cent in 2014. The Pacific region has recorded no improvement during the past 25 years, remaining almost constant at about 82 per cent. Access to electricity almost doubled in South and South-West Asia, from 47 per cent in 1990 to 82 per cent in 2014, whereas in South-East Asia it increased by 46 per cent during the same period, reaching 92 per cent in 2014.

Figure 1 | Access to electricity in selected sub-regions 1990-2014



Rural areas have recorded the most improvement, with an annual access growth rate of 1.2 per cent compared to 0.3 per cent per year in urban areas. More than half of the countries in the region (27 out of 53 ESCAP member States) have already achieved universal access

Figure 2 | Access to electricity for selected countries in Asia and the Pacific



to electricity, while access in many of the remaining countries ranges from 95 to 99 per cent. Figure 2 shows the geographical distribution of selected countries in the Asia-Pacific region that do not yet have universal access to electricity. .

The countries in the Asia-Pacific region with very low access rates are concentrated in the Pacific, and South and South-West Asian subregions. India is the key concentration of population without access to electricity (269 million), followed by Bangladesh (60 million) and Myanmar (25 million). Therefore, ensuring universal access to electricity in India by 2030 will play an essential role in the progress by Asia and the Pacific towards universal access..

Progress in access to clean cooking

While much progress has been made in increasing access to electricity, progress in expanding access to clean cooking fuel has been disappointingly slow. In Asia and the Pacific, clean cooking access has increased by only 1.8 per cent annually during the past decade – leaving about half of the Asia-Pacific region's population without access to clean cooking. Of the 2.2 billion people who currently lack access to clean cooking, 65 per cent live in two countries – China (584 million) and India (853 million). The rate of progress in the Asia-Pacific region increased from 2000 to 2014, with a compound annual growth rate (CAGR) of 2 per cent, a higher rate of progress than in Africa and Latin America (figure 3). However, the access level is still below the world average of 57 per cent..

Figure 3 | Comparison of Asia-Pacific's progress on the access to clean cooking with the Africa and Latin America and Caribbean regions

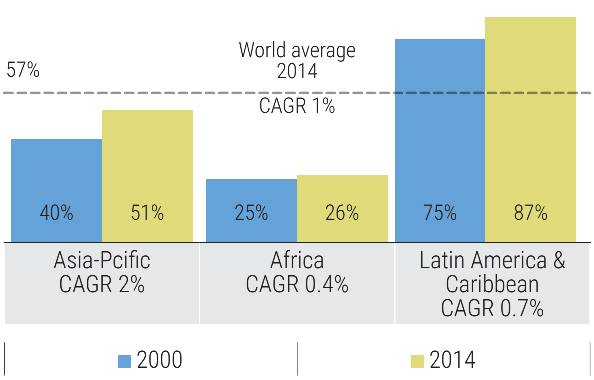


Figure 4 compares countries in terms of energy access indicators. Countries that are clustered closer to the origin have large deficits in energy access, while the countries that are close to the top right corner, are performing relatively better in energy access. While slightly more than half of the countries in the Asia-Pacific region have achieved universal access to electricity, only a few countries in the region have achieved 100 per cent access to clean cooking. Some 14 countries have surpassed an access rate of 95 per cent, while three countries remain below an access rate of 5 per cent.

Progress in renewable energy

The share of renewable energy (RE) in the total final energy consumption, including traditional use of solid biofuel, in the Asia-Pacific region in 2014 was 18.3 per cent, down from 23 per cent in 1990 (figure 5). This drop was driven by two factors – (a) the decrease in the use of traditional biomass by 37 per cent, and (b) the two-fold growth in total final energy consumption (TFEC) during that period – which reduced the relative share of renewable energy. Despite the growth in the share of modern RE, the overall contribution of renewables in TFEC has remained very low and is inconsistent across the ESCAP subregions.

In East and North-East Asia, the RE share more than doubled during 1990-2014. This growth was mainly driven by the rapid increase in renewables for electricity

Figure 4 | Comparison of energy poverty indicators in selected countries 2014

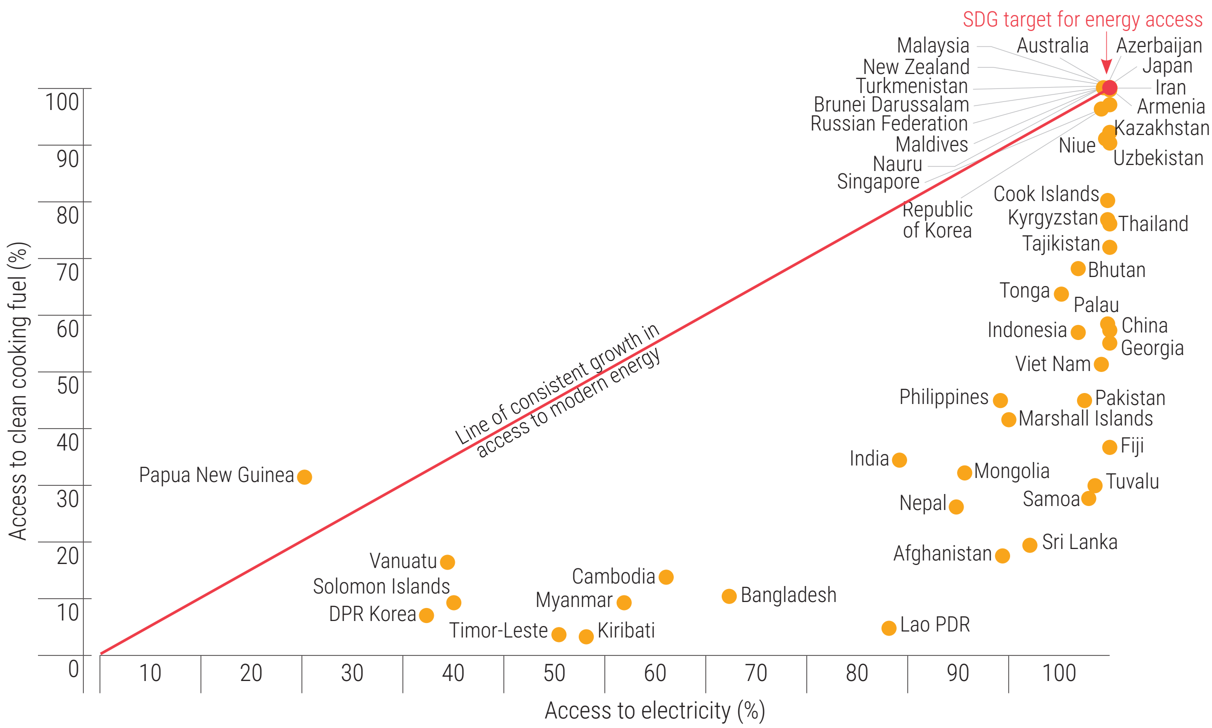
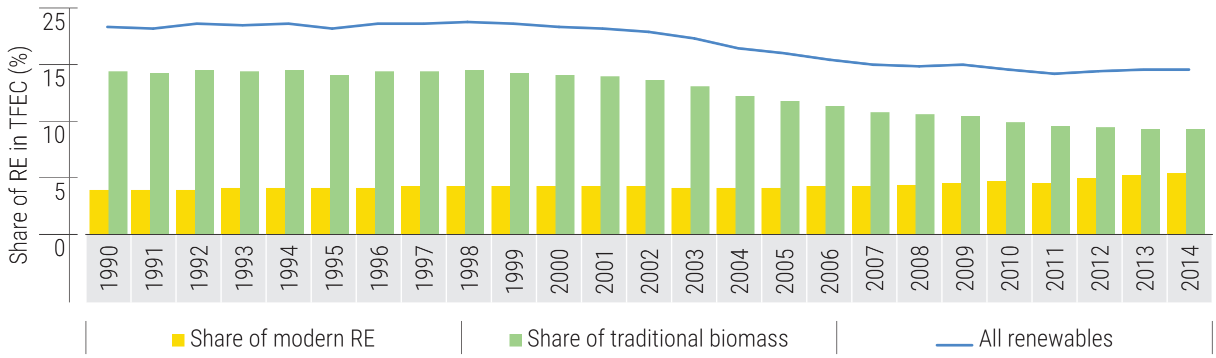


Figure 5 | Share of renewable energy in TFEC 1990-2014



generation in China, which experienced a more than five-fold increase from 226 terawatt-hours (TWh) in 2000 to 1,294 TWh in 2014. Hydropower contributed to 82 per cent of this growth, followed by wind at 12 per cent, solid biofuels at 3.4 per cent and solar (both PV and thermal) at 2.9 per cent.

In South and South-West Asia, the RE share decreased by 34 per cent during 1990-2014 despite a 42 per cent increase in energy consumption from renewables in the same period. This was due to the rapid increase in TFEC, which grew by about one and a half times in 2014 compared with the 1990 level.

In 2014, renewable energy in final energy consumption amounted to 746 million tonnes of oil equivalent (Mtoe), with 78 per cent consumed as heat, 21 per cent as electricity and only 0.8 per cent as a transport fuel (figure 6). About 80 per cent of the heat was supplied by traditional biomass, whereas modern renewables supplied only 20 per cent.

While the share of solid biofuel decreased by about 20 per cent between 1990 and 2014, modern renewables grew by about one and a half times, with hydropower contributing more than half of this growth (figure 7). The share of geothermal in TFEC was 5 per cent, which represented more than 17 per cent share of modern renewables.

Progress in energy efficiency

Energy intensity, the ratio of the total primary energy
Energy intensity, the ratio of the total primary energy
supply (TPES) to GDP, has been declining steadily in

Figure 6 | Renewable mix in the final energy consumption in Asia-Pacific in 2014

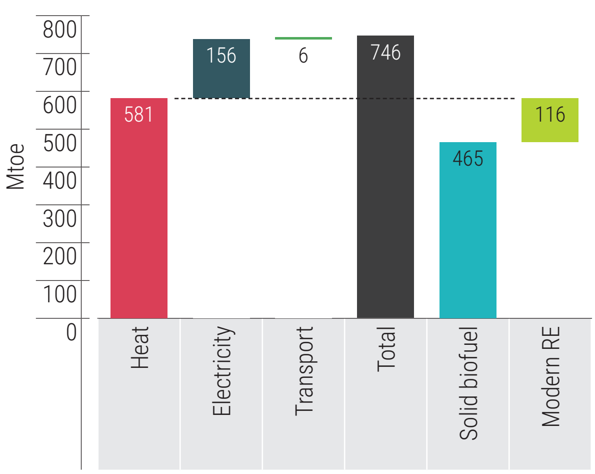


Figure 7 | Renewable energy production by sources in the Asia-Pacific region

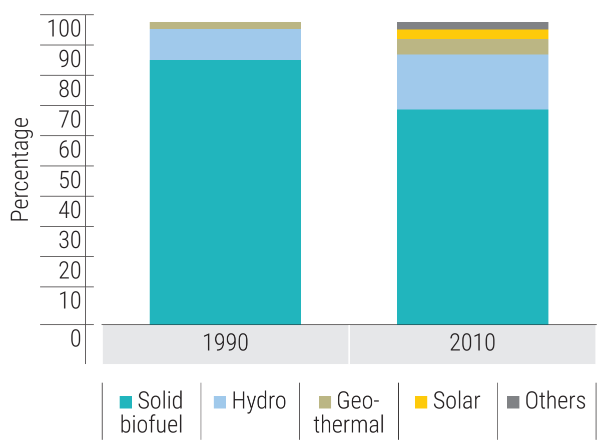
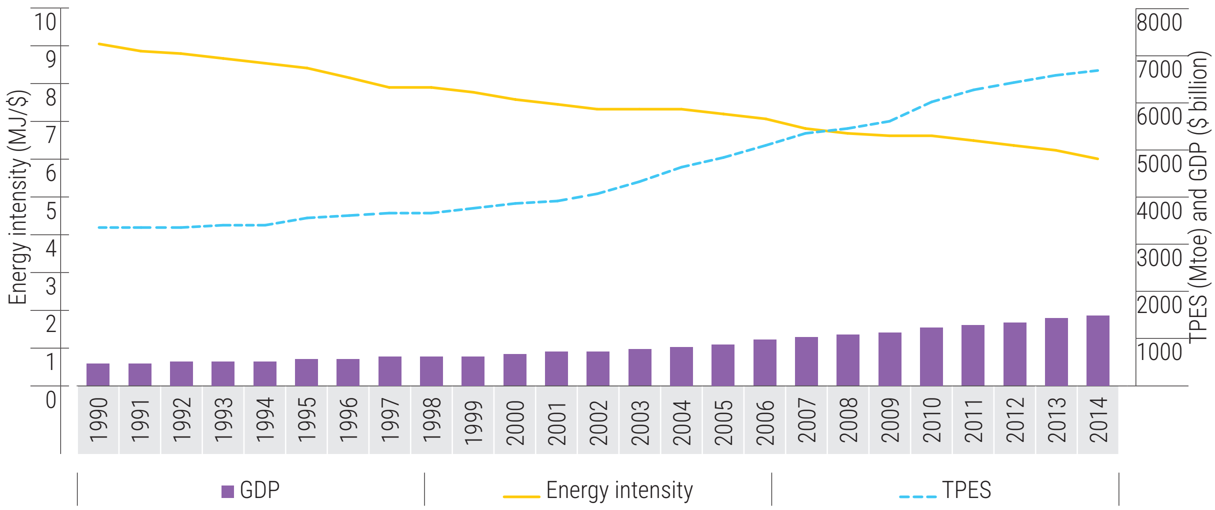


Figure 8 | Energy intensity has shown a declining trend during 1990-2014



the Asia-Pacific region, with an annual decline of 1.8 per cent from 1990 to 2014. By 2014, the region's average energy intensity had declined to 6.00 megajoules (MJ) per dollar from 9.00 MJ per dollar in 1990. This compares closely with the global average of 5.49 MJ per dollar.[3] Energy intensity relates to the structure of each country's economy and its efficiency, rather than the scale of the energy consumption. For example, Turkmenistan has the highest energy intensity in the region with 14.29 MJ per dollar compared with 7.43 MJ per dollar in China and 8.19 MJ per dollar in the Russian Federation.

This reduction occurred at the same time as a rapid increase in GDP with a CAGR of 5 per cent during this period (figure 8). It has been possible due to the increased energy efficiency across the region that, with other factors, has helped decouple GDP growth from energy consumption. The decrease in energy intensity has been consistent across the region with the highest rate (1.8 per cent per year) occurring in East and North-East Asia, and North and Central Asia, while the lowest decrease was observed in South-East Asia, where it declined by about 1 per cent per year. However, energy intensity dropped significantly in China to an annual rate of 2.5 per cent per year from 21.18 MJ per dollar in 1990 to 7.43 MJ per dollar in 2014. India recorded a moderate decrease in energy intensity of 1.6 per cent annually. .

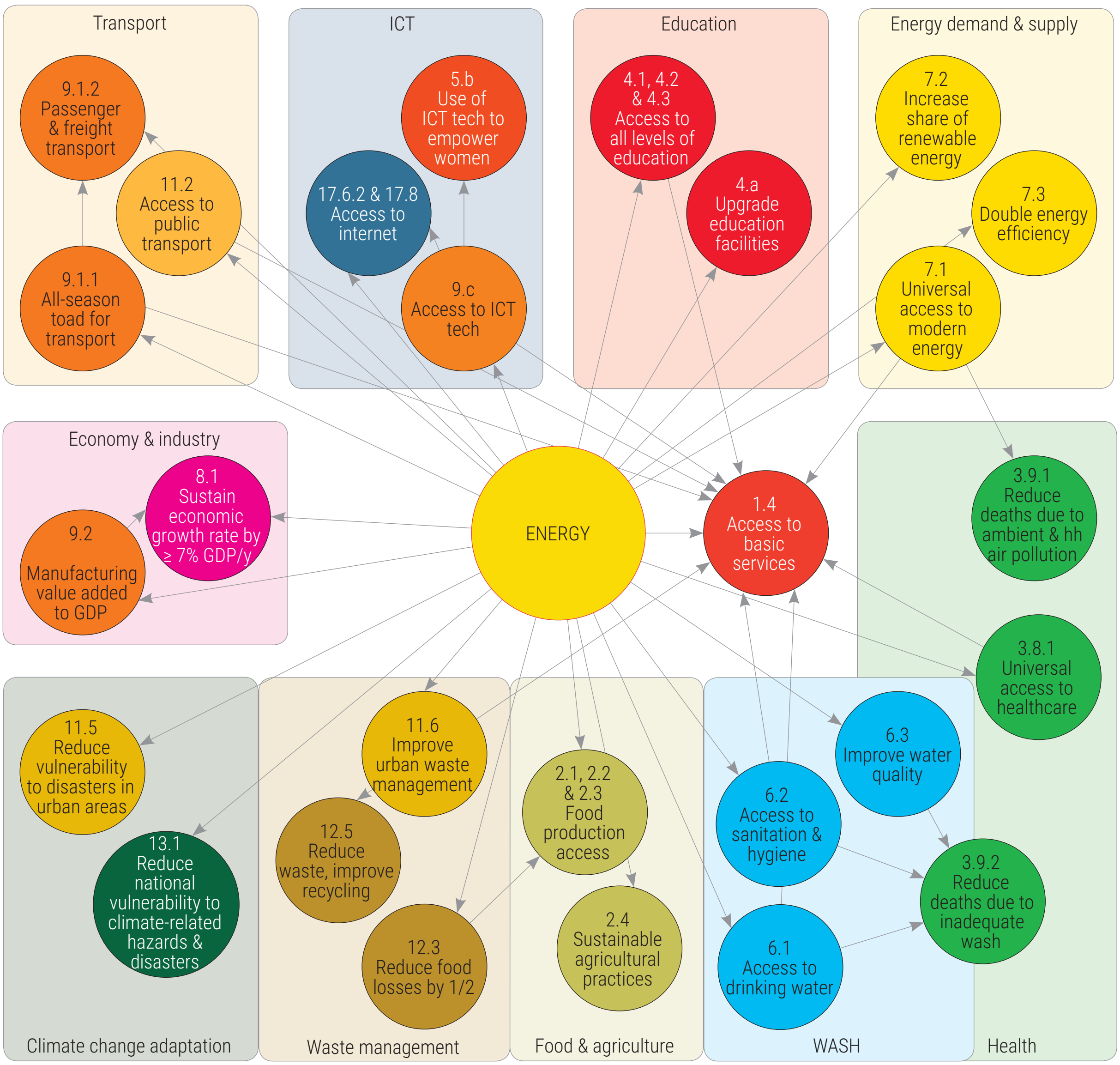
1.2 INTERLINKAGES OF SDGs OFFER BOTH CHALLENGES AND OPPORTUNITIES FOR ENERGY TRANSITION

One of the features that make the SDGs unique compared to previous agendas, such as the Millennium Development Goals,[4] is the interlinkages between different the goals and targets. This feature of SDGs requires integrated planning that takes into consideration the impacts and benefits across the whole economy. Each goal is dependent on several others, which poses both challenges and opportunities as the achievement of one goal may have an impact the others, either positively or negatively. Identifying the full scale of interlinkages of SDG7 with other goals and harnessing their benefits is complex and requires further investigation, which is outside the scope of this report. This section aims to shed some light on this complex nature of interlinkage in order to promote discussion in the research and policy-making communities.

3 See http://gtf.esmap.org/results.

4 See http://www.un.org/millenniumgoals/.

Figure 9 | Examples of interlinkages between SDG7 and other SDGs



Source: Santika et. al. (2017)

SDGs offer a series of interlinkages with each other. For example, achieving universal and equitable access to safe and affordable drinking water for all (target 6.1) will reduce water-borne diseases, which will advance the achievement of target 3.3. Eliminating extreme poverty under target 1.1 will enable people to buy more food and other nutritious items, which will support the achievement of target 2.1 and reduce malnutrition (target 2.2). Interlinkages are more extensive and complicated when it comes to energy (SDG7) because energy is the key enabler for most SDGs. For example, energy is required for constructing more roads to provide increased access to basic services (target 1.4). These new roads will introduce additional vehicles, which will further increase energy demand in the transportation sector. Such interconnectedness exists for most SDGs. Figure 9 illustrates the potential interlinkages between energy and other SDGs.

Household demand for electricity has a strong link with household annual disposable income. Once target 2.3 is achieved by doubling the income of smallholder farmers, household electricity demand will rise beyond the initial threshold due to the improvement in socio-economic conditions. Ending hunger (target 2.1) will require increased food availability for the poor who also lack access to modern energy services (target 7.1) and suffer from malnutrition (target 2.2). The entire food chain, from field-to-plate, requires a significant amount of energy. For example, every tonne of wheat production requires about 6,500 MJ of energy, of which fertilizer (47%) and irrigation (22%) are the major contributing components (Safa et. al., 2011). Increased food production can also have a negative impact on other SDGs. For example, it can undermine GHG mitigation (Goal 13), as agriculture represents 20-35% of total anthropogenic emissions. Therefore, achieving Goal 13 may face some constraints on the choice of agriculture type, particularly those related to livestock production. Interestingly, the livestock industry has the potential to be compensated by securing food from fisheries. Increased fishing will improve food security (target 2.3) and reduce GHG emissions supporting Goal 13 (Nilson et. al., 2016). Universal health coverage and access to quality health-care systems (target 3.8), universal access to safe drinking water (target 6.1) and access to sanitation for all (target 6.2) cannot be met without an increase in energy availability. The World Health Organization (WHO) suggests that energy is the fundamental resource to provide access to health care for nearly 1 billion people in the world. A better health-care system will help to reduce malnutrition (target 2.2). Target 2.4 focuses on sustainable agricultural practices with increased resilience to food productivity. Increased use of renewable energy technologies, such as solar photovoltaic (PV) powered irrigation, to replace existing diesel generators in rural areas of developing countries and the use of solar dryer technology in food processing, can help to achieve this target (Alaofè et. al., 2016). This will also lead to increased renewable energy in the energy mix (target 7.2) and increased resource efficiency by decoupling economic growth from environmental degradation (target 8.4).

1.3 ROLE OF NDCs IN SHAPING ENERGY TRANSITION

The Paris Agreement, adopted in December 2015 at COP21 in Paris, is aimed at transforming future global development trajectories to a low carbon model in order to limit global warming to between 1.5 degrees and 2 degrees Centigrade above pre-industrial levels. The Parties to the Paris Agreement are requested to outline and communicate their post-2020 climate actions in line with the global climate goals, while taking into consideration national circumstances, development priorities and capabilities.

The NDCs, which are the heart of the Paris Agreement, embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. Article 4 of the Paris Agreement requires each Party to prepare, communicate and maintain successive NDCs that it intends to achieve. Parties are required to pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions. The climate actions communicated in these NDCs largely determine whether or not the long-term goals of the Paris Agreement will be achieved. As of October 2017, 51 countries in the Asia-Pacific had signed the Paris Agreement (43 have now signed and ratified). While these countries have a broad range of targets and normative benchmarks against which progress of NDCs can be measured, together they have set ambitious goals.

Understanding the synergies between SDGs and NDCs

The fundamental principle of the SDGs is that development must recognize the three pillars of sustainable development. Climate actions such as emission reduction are integral parts of the entire framework. The key aim of the NDCs, by comparison, is to scale-up and accelerate climate actions, such as emission reduction and adaptation to climate change, in a way that does not hinder the overall economic and social development goals. In essence, the SDGs and NDCs have synergies such that action in one of these can support the action in the other. For example, in addition to reducing emissions, many NDCs also indicate other priorities and ambitions that contribute to the broader sustainable development, particularly in the areas of water, food and energy. Various studies, such as the Stockholm Environment Institute's Policy Brief (Dzebo, 2017), have demonstrated that NDCs clearly reinforce the interlinked character of sustainable development. The fact that several SDG themes are addressed by numerous climate actions is an indication that there are multiple potential synergies and opportunities for policy coherence.[5]

This study also identified the fact that NDC activities have the most extensive links to SDG2, 6, 7, 11, 15 and 17. For example, SDG11 reflects the importance of urbanization in the 2030 Agenda. At the same time, it is central to the Paris Agreement, as more than 70 per cent of all GHG emissions are generated by towns and cities. These synergies suggest that it would be more practical to implement both the SDGs and the NDCs in an integrated manner. The following chapters will discuss this issue in further detail, based on the analysis of different energy transition pathways. .

5 See https://www.sei-international.org/mediamanager/documents/Publications/SEI-PB-2017-NDC-SDG-Connections.pdf.

2 | Scenario-based energy transition pathways

Most countries in the region aim to ramp up access to electricity. The current policy frameworks will push the access to 68 per cent by 2030. However, access to clean cooking fuel would reach only 67 per cent by 2030 compared to 100 per cent required to meet the SDG target. In the current policy scenario, the share of renewable energy, including the traditional use of biomass, will decline by 2.6 per cent. The share of modern renewable energy, excluding the traditional use of biomass, will grow from 6.8 per cent in 2014 to 14 per cent in 2030. Based on the technological maturity and the market potential for renewable energy, the SDG scenario suggests tripling of the renewable energy share to 22 per cent by 2030. The energy intensity of GDP is projected to decline from 6 MJ per dollar in 2014 to 4 MJ per dollar in 2030. By leveraging the synergies between SDGs and NDCs it will be possible to cost-effectively achieve NDC targets for the energy sector by increasing the share of renewable energy to 35 per cent by 2030.

2.1 SCENARIO DEFINITIONS

While SDG7 provides clear future directions for 2030, with pathways for access to modern energy (SDG7.1) and improvement of energy efficiency (SDG7.3), it does not include a quantified target for renewable energy (SDG7.2). The development of pathways in this report, therefore has greater focus on different options for renewable energy growth to 2030. The high socio-economic and environmental benefits of renewables, together with high levels of resource availability and declining costs, suggest that the region has an opportunity to leapfrog the polluting and resource inefficient technologies and to develop a modern, clean and smart energy system of the future. The following three pathways have been assessed in relation to achieving the sustainable development goal on energy:

1. *CP scenario* – This scenario takes into account the renewable energy targets that have been announced and adopted as policy measures by ESCAP member States. The renewable energy share in this report is expressed, in line with the SDG7 definition, as the share of total final energy consumption (TFEC) and covers all renewables, including traditional use of biomass[6] and hydropower. Modern renewables, on the other hand, exclude the traditional use of solid biofuel. Where countries have expressed renewable energy in a different format, such as a share in primary energy or electricity, values have been converted to TFEC. This scenario is also known as the baseline since this is the pathway to 2030 that would be followed if no changes in policy are made;

2. *SDG scenario* – This scenario is based on the IRENA REmap scenario in which renewable energy is expected to double globally, by being driven by technology maturity, cost-competitiveness and global mitigation commitments. Doubling renewables globally does not mean that every country would double the share – different countries will contribute differently, based on their socio-economic conditions and resource availability.

   The IRENA REmap scenario has identified 2030 targets for selected countries, covering 80 per cent of final energy consumption (IRENA, 2017a). The SDG scenario builds on those targets for the selected ESCAP member States covering 94 per cent of the region's final energy consumption. Although SDG7 does not provide an explicit target for renewable energy, this scenario assumes that a substantial increase in the share of renewable energy in the energy mix is a reasonable representation of the SDG target;

3. *NDC scenario* – This scenario assesses the potential for renewable energy and energy efficiency in order to achieve the regional emission reduction target from the energy sector under NDCs. Although NDCs are national commitments, a regional target has been estimated, using individual national commitments. Where a distinct commitment for the energy sector is not available, the share of energy sector emissions in national emissions has been used to estimate an equivalent target for the energy sector.

6 According to the IEA definition, all biomass use in the residential sector of the non-OECD countries should be traditional unless otherwise stated.

2.2 CURRENT POLICY SCENARIO – THE BASELINE

Access to electricity

The 2030 outlook developed based on the targets set by the ESCAP member States (ESCAP, 2017a) (see table A-2 in Annex A) suggests that 98.7 per cent of the population of Asia and the Pacific will have access to electricity by 2030 (figure 10), an 8 per cent increase from the current level. In the short term, the access rate will increase from the current rate of 90 per cent to 94 per cent in 2020 and to 96 per cent in 2025.

A large part of the growth will occur in South and South-West Asia (figure 11), up from 82 per cent in 2014 to 99 per cent in 2030. India will dominate the growth with its ambitious target of ensuring electricity for all by 2019 (Ministry of Power, 2017). The access levels in the Pacific and South-East Asia regions will increase by 11 per cent and 6 per cent, respectively, by 2030.

Figure 10 | Historic and projected rates of access to electricity in the current policy scenario in Asia and the Pacific

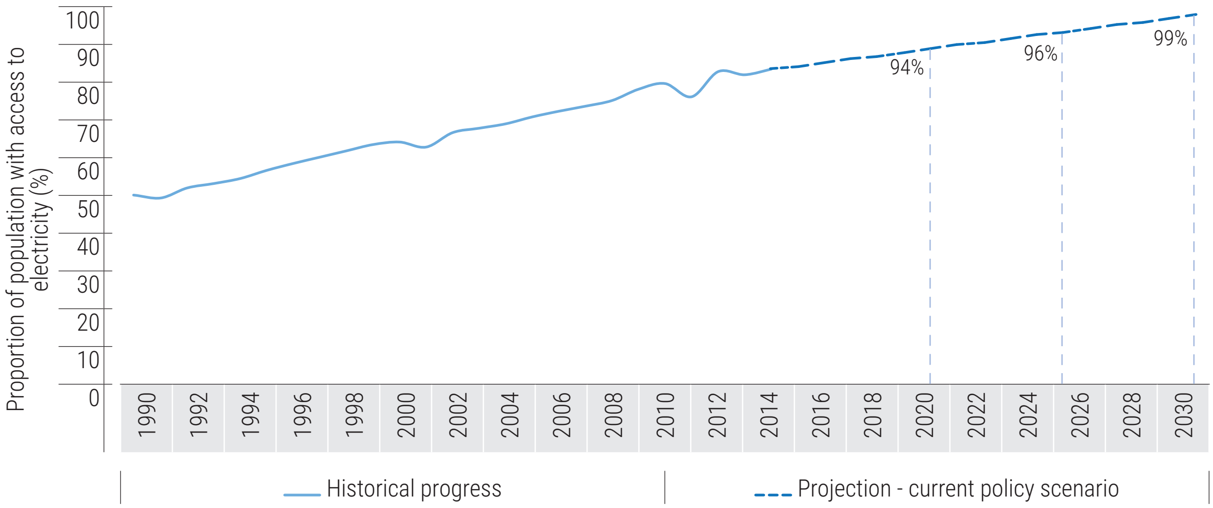
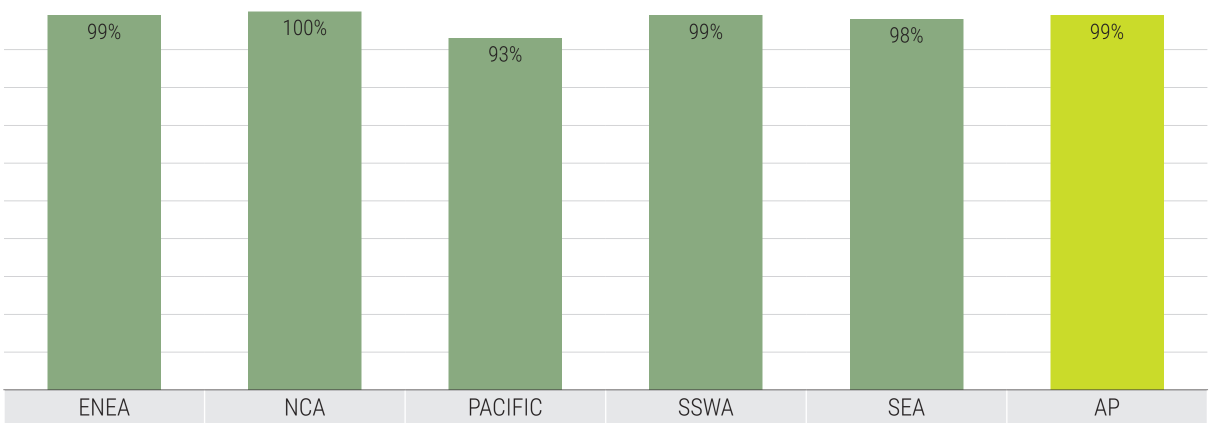


Figure 11 | Access to electricity across sub-regions in the current policy scenario



Access to clean cooking fuel

Clear policy measures to improve access to clean cooking are absent in most ESCAP member States, which prevents the development of a correct baseline. The estimated 2030 outlook for this case, therefore, has been based on a forecast model using a multivariate linear regression analysis. The analysis shows that the rate of access to clean cooking has a strong correlation with GDP, population, and the prices of fuel such as kerosene and LPG. The outlook suggests that access to clean cooking fuel will increase from 49.6 per cent in 2014 to 67.7 per cent by 2030 (figure 12). This estimate is similar to the global projection published in the Global Tracking Framework (2017) report, which suggests that global clean cooking access would reach 72 per cent globally by 2030.

Renewable energy

Based on the renewable energy targets set by the ESCAP member States (ESCAP, 2017b) (Annex A), the share of renewables (including traditional use of biomass) will decrease from 18.3 per cent in 2014 per cent to 15.7 per cent in 2030. The two primary reasons for the decline are:

Figure 12 | Pathways to universal access to clean cooking by 2030

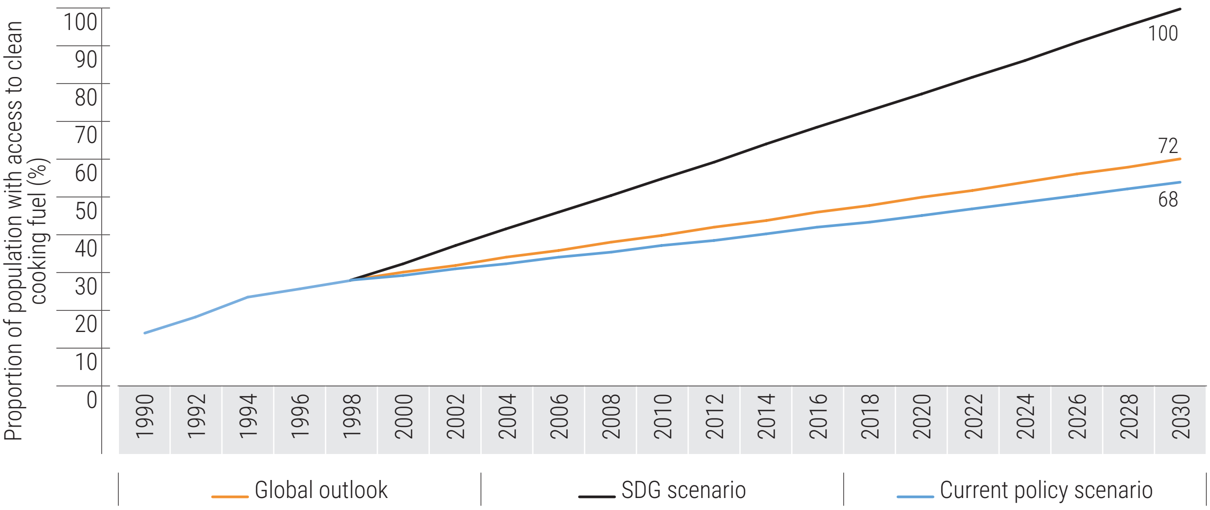
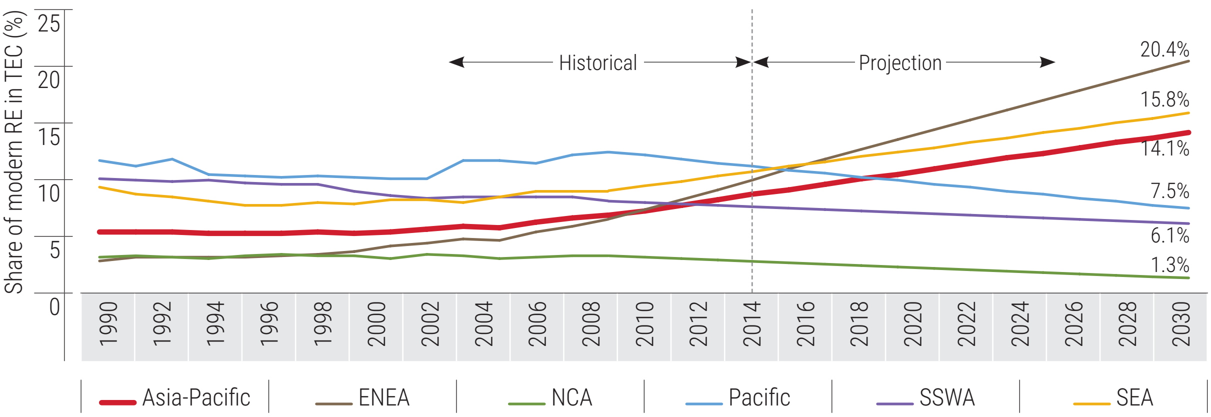


Figure 13 | Share of modern RE in TFEC in different sub-regions under the current policy scenario



1. The share of traditional use of biomass in TFEC is decreasing across the region, having dropped by 37 per cent between 1990 and 2014, and will continue to decline. This decrease in traditional biomass reduces the share of renewable energy in the TFEC;

2. TFEC has been increasing since 1990 and will continue to grow to 5,119 Mtoe[7] in 2030 at a much faster rate than the growth in modern RE, which also causes the overall share of renewable energy to decrease relative to TFEC.

The share of modern renewable energy (excluding the traditional use of solid biofuel) will increase at a modest rate from 6.8 per cent in 2014 to 14 per cent in 2030 (figure 13). The highest growth will take place in East and North-East Asia, rising from 6.5 per cent in 2014 to 20 per cent in 2030. The second highest growth rate will be seen in South-East Asia, rising from 9 per cent in 2014 to 16 per cent in 2030.

Energy efficiency

The outlook for energy efficiency improvement by 2030 is based on the Asia-Pacific Economic Cooperation (APEC) target of 40 per cent reduction in energy intensity by 2030 compared with the 2010 level. This

7 Based on the IEA estimate for the current policy scenario.

means that the region's energy intensity will need to drop to 3.97 MJ per dollar by 2030. Although there is a difference in the geographical coverage between the APEC and ESCAP regions, this estimate can provide an indicative regional outlook for 2030.

It is apparent that the CPS will fail to fully achieve SDG7 targets, and that this will eventually have a negative impact on the achievement of other goals. This provides the rationale for an examination of possible scenarios that can set the region on the correct path to achieving the SDG7 targets by 2030. Comparing these scenarios with the CPS will determine the potential gap, which can then lead to the exploration of various measures and the development of pathways to bridge the gap. While the SDG scenario elaborates on the actions needed for the region to achieve SDG7 targets, the NDC scenario takes the region further ahead by supporting the emission reduction targets as expressed in NDCs.

2.3 SDG SCENARIO

The key difference between this scenario and the CPS is that the rate of energy efficiency improvement is doubled by halving the energy intensity during 1990-2014, yielding a 2030 intensity target of 2.52 MJ per dollar. In addition, it also considers the fact that access to modern energy services, including access to electricity and clean cooking fuel, has been achieved by 2030. In this scenario, the region's final energy consumption will be 4,875 Mtoe, which is 5 per cent below the CPS level.

Universal access to electricity

The CPS shows some progress towards the SDGs but falls short of the full achievement by 2030. While the task to provide universal access to electricity will be nearly completed by this time at the regional level with an access level of about 99 per cent, there remain significant gaps at subregional levels. To close this gap, under the SDG scenario, governments will need to ramp up their electrification efforts to ensure universal access to electricity is achieved by 2030.

Universal access to clean cooking fuel

In the SDG scenario, the entire population in the Asia-Pacific region will require access to clean cooking. When this is compared with the CPS outlook, about 1.6 billion people will still be using traditional biofuel for cooking in 2030. According to the World Health Organization (WHO, 2016), this will cause more than 2 million premature deaths due to indoor air pollution from cooking with solid biofuels. Achieving universal access to clean cooking will remain a challenge, both from the technological and logistical viewpoints. Countries will need to explore locally-appropriate solutions that are cost-effective and can be implemented in a shorter timeframe.

Renewable energy

The SDG scenario proposes the tripling of renewable energy share by 2030. Technological maturity, cost reduction and the need for GHG mitigation will require countries to adopt a higher growth trajectory in this scenario, as the share of RE in TFEC will rise to 22 per cent in 2030 (figure 14). This is an 8 percentage point growth above the CPS, amounting to an additional renewables supply of 409 Mtoe. This takes into

Figure 14 | The growth in the share of renewables can have three different pathways to 2030

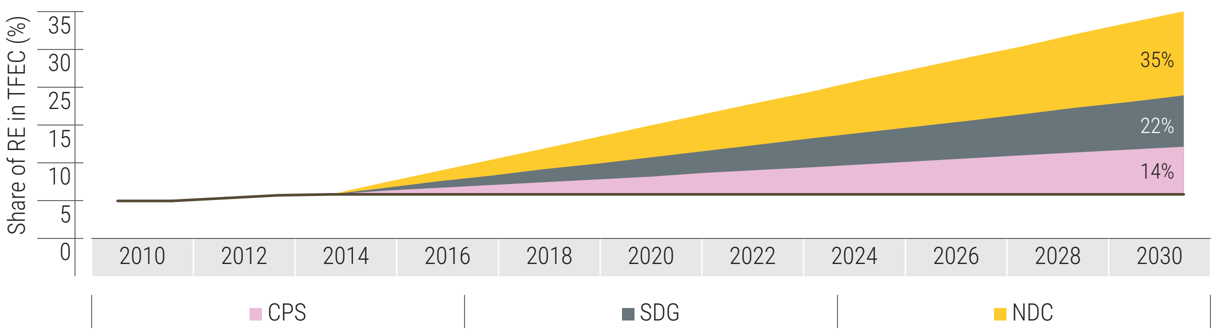
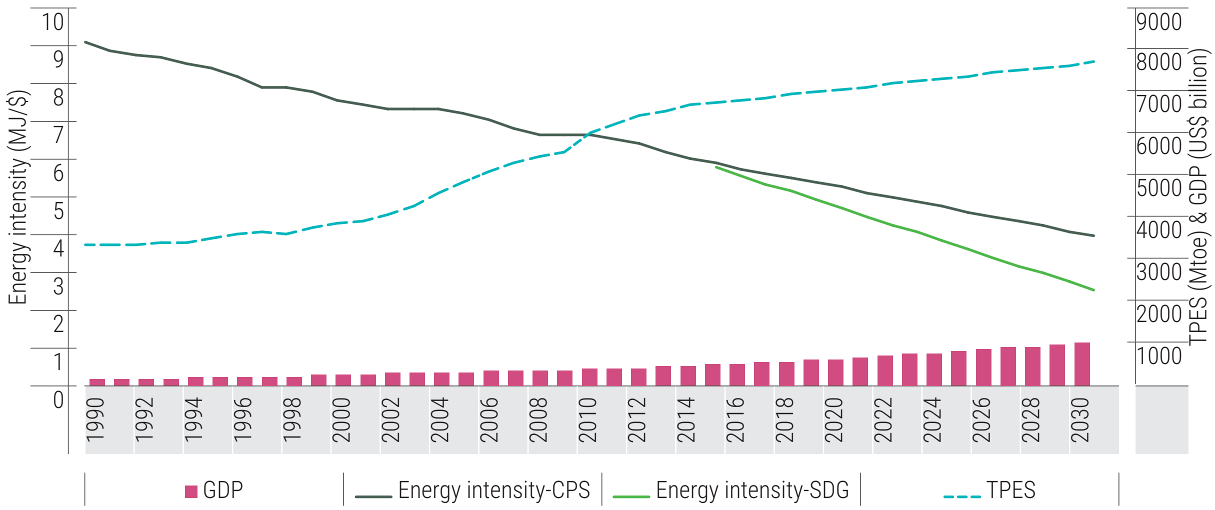


Figure 15 | Energy intensity in CPS would reach very close to SDG target in 2030



consideration the level of growth that is economically viable at the national level in the context of the current technology regime.

Much of the growth will be driven by two major economies – China and India. China's share of renewables in TFEC will need to grow by 2 per cent per year, while India's share will require about 2.3 per cent annual growth. Renewables in the Russian Federation will grow from 2.8 per cent in 2014 to 7 percent in 2030. Renewables will mainly be used for power generation and will make up 37 per cent of total power generation in Asia and the Pacific, nearly doubling the 2014 share of 19 per cent. In the electricity generation mix, the share of fossil fuel in power generation will fall from 76.6 per cent in 2014 to 54 per cent in 2030, while the share of nuclear power will increase by 0.6 per cent per year from its current share of 4.4 per cent.

Energy efficiency

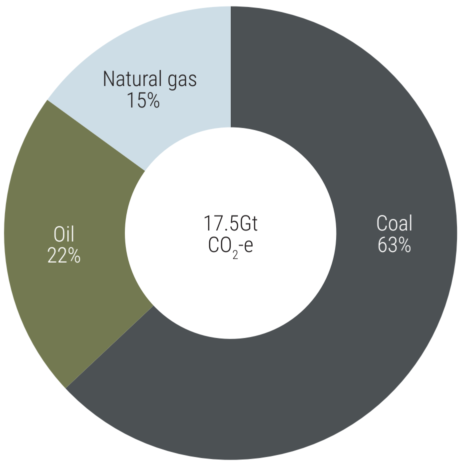
Energy efficiency is on track, but more action is needed to maintain momentum. The SDG target for energy efficiency states that the rate of energy efficiency improvement will need to double the by 2030, which should be measured by energy intensity – the ratio of total primary energy supply and GDP. On average, energy intensity decreased by 1.7 per cent per year between 1990 and 2014. Therefore, the rate of decrease from now until 2030 will need to be 3.4 per cent per year. This means that energy intensity will need to drop to 2.52 MJ per dollar in 2030 (figure 15). While improvement in energy efficiency is expected to continue to 2030, the current policy pathway falls short of achieving the SDG target, by 1.45 per cent.

2.4 NDC SCENARIO

The NDC scenario has primarily been based on the emission reduction opportunities from the energy sector, by ramping up growth in renewable energy and improvements in energy efficiency. While the use of traditional biofuel for cooking is expected to decline, as envisaged in the SDG scenario, this issue does not have an impact on this scenario as burning biofuel is assumed to be carbon neutral. For estimation simplicity, this scenario assumes that the energy efficiency improvement level is the same as the SDG scenario. However, efforts to achieve further improvement in energy efficiency, particularly in the industry and transport sectors, are discussed in chapter 3.

NDCs represent pledges by each country to reduce national emissions and are the stepping stones to the implementation of the Paris Agreement. Since the energy sector is the largest contributor to GHG emissions in most countries, decarbonizing energy systems should be given a high priority. Key approaches to reducing emissions from the energy sector include increasing renewable energy in the generation mix

Figure 16 | GHG emissions from fuel combustion in 2014



and improving energy efficiency. GHG emissions from fuel combustion in Asia and the Pacific amounted to 17.5 Gt CO_2-e in 2014 (figure 16), which is 65 per cent of the total anthropogenic emissions. Emissions from coal accounted for 62.9 per cent, while oil and natural gas accounted for 21.5 per cent and 15.2 per cent, respectively. If no additional mitigation action is undertaken, emissions from fuel combustion in 2030 could reach up to 20 Gt under the CPS, which will make the achievement of NDCs difficult.

In the NDC scenario, energy efficiency has been set to achieve the SDG target, i.e., doubling the rate of energy efficiency by 2030. Following this, it is then assumed that the NDCs emission reduction target will be achieved by deploying a higher share of renewables. The Asia-Pacific region collectively aims, through the NDCs, to reduce its emissions from the energy sector by 39 per cent by 2030. It is estimated that renewables will need to supply 35 per cent (i.e., 1,789 Mtoe in absolute terms) of the region's TFEC by 2030 in order to help achieve this energy sector emissions reduction. Under the NDC scenario, the growth of renewables is 21 percentage point above the CPS and 13 percentage point more than the SDG scenario (figure 14).

3 | Identifying the gap

The current policy scenario will almost miss universal access to electricity, leaving 63 million people without access, i.e., 28 million in South-East Asian and 20 million in East and North-East Asia. On the other hand, there will be a large gap in access to clean cooking fuel, leaving 1.6 billion people still cooking with traditional biomass and causing an estimated 2 million premature deaths from indoor pollution. The share of renewable energy will need to grow by 8 percentage points compared with the current policy scenario, which represents an increase of 15.2 percentage points over the 2014 share. To achieve the NDC scenario, the share of renewable energy will fall short of 21 percentage points compared with the current policy scenario. Energy intensity will fall short of 1.5 MJ per dollar, which is still half of the progress made during 1990-2014. The investment gap in renewable energy, compared with the current policy scenario, is estimated to be $101 billion and $282 billion for the SDG and NDC scenarios, respectively. In order to successfully implement the energy transition, a massive transformation of the existing policy frameworks is needed, such as aligning national energy policies with the 2030 Agenda and attracting private investment.

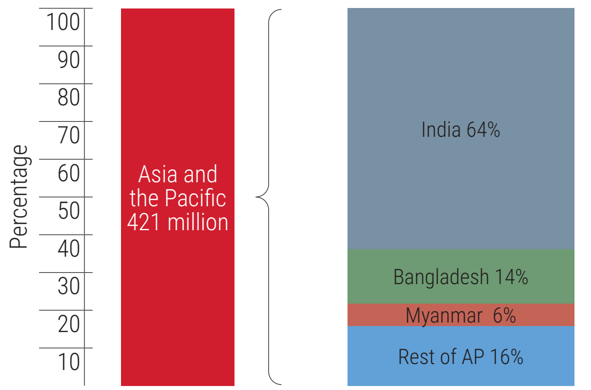
The "gap" in this report refers to the difference between the SDG scenario and the current policy scenario. The gap concept is used to assess the additional interventions and resources that would be required to achieve the SDG7 targets. For comparison purposes, this report also presents the gap between the current status and the SDG scenario to provide an estimate of the resources that would be required between now and 2030.

3.1 UNIVERSAL ACCESS TO ELECTRICITY

Universal access to electricity could be achieved well before 2030. Despite a remarkable growth in access to electricity, about 63 million people (1.26 per cent) will remain without access in 2030, most of whom will be in the South-East Asia subregion (figure 17). While the Pacific subregion is expected to almost close the gap, about 20 million people in East and North-East Asia will not have access to electricity.

Of the 421 million additional people that will need to be provided with access to electricity between now and 2030 in order to ensure universal access, the majority (64 per cent) will live in India (figure 18), followed by Bangladesh (14 per cent) and Myanmar (6 per cent).

Figure 18 | Over 420 million people will need to be provided with access to electricity between now and 2030



3.2 UNIVERSAL ACCESS TO CLEAN COOKING FUEL

A principal task ahead will be to ensure universal access to clean cooking fuel. This will require the Asia-Pacific region to supply appropriate technologies to an additional 1.6 billion people by 2030 (figure 19) in addition to what the current policies deliver. Two subregions – North and Central Asia, and the Pacific – are expected to achieve universal access by 2030. However, South and South-West Asia will reach only

Figure 17 | Gap in access to electricity in 2030

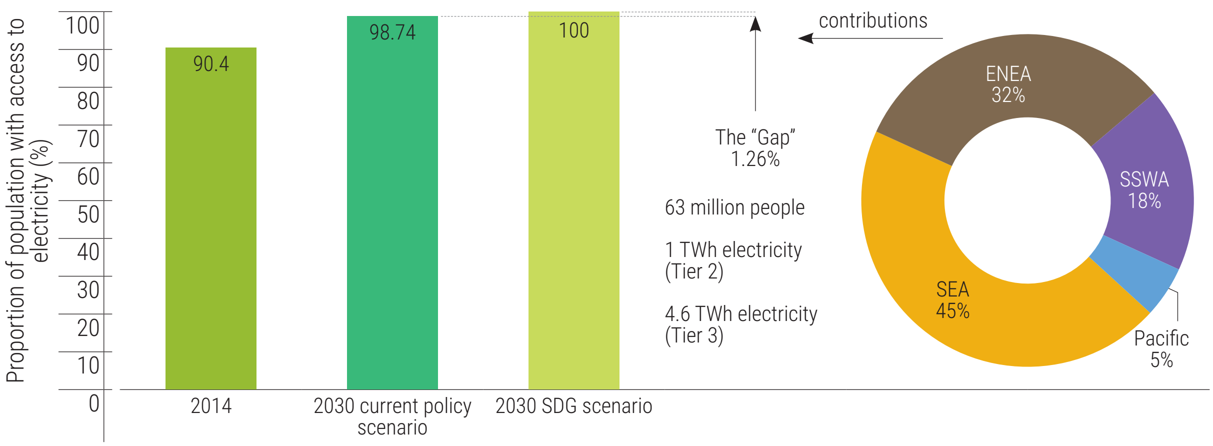
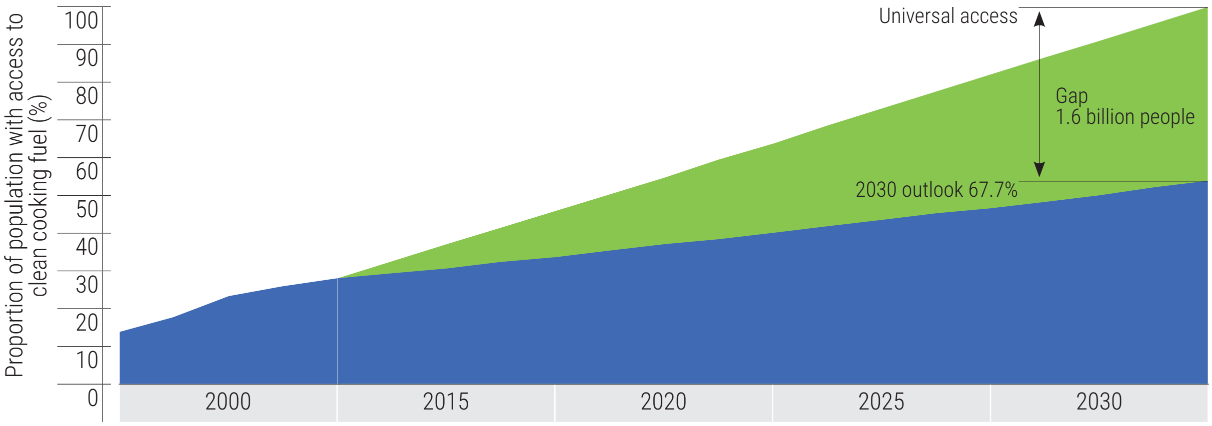


Figure 19 | Ensuring universal access to clean cooking by 2030 will require appropriate technology for an additional 1.6 million people



49 per cent as the task to meet the needs of more than 1.5 billion people between now and 2030 will not be easy. In South-East Asia, 24 per cent of the population will be without access, a large number of whom will be living in Indonesia, Myanmar, the Philippines and Viet Nam.

Renewable energy

A significant increase in renewable energy will be needed by 2030. As discussed in section 3.1, a quantitative target for renewable energy is absent in SDGs and therefore, the gap will depend on the chosen scenario. In the SDG scenario, the share of renewable energy will need to increase by another 8 percentage points (equivalent to 409 Mtoe) compared to the current policy scenario, an increase of 15.2 percentage points (778 Mtoe) from 2014 share. Half of this growth will need to occur in the power sector – rising from 2,235 TWh (19 per cent of total electricity generation) in 2014 to 6,747 TWh (37 per cent) in 2030. China is expected to contribute 55 per cent of this growth by increasing its renewables-based electricity generation from 1,294 TWh in 2014 to 3,697 TWh in 2030. India and Japan will contribute 17 per cent and 8 per cent of this growth respectively. Technology-wise, hydropower will contribute 14 per cent of the entire electricity generation followed by wind 11 per cent and solar PV 8 per cent. If the NDC scenario is chosen, the gap will be 21 percentage points compared to the CPS in 2030.

Energy intensity

Efforts in energy efficiency need to be intensified. If the Asia-Pacific region succeeds in achieving the energy efficiency target (as set in the current policy scenario), the gap in 2030 will be only 1.5 MJ per dollar. However, compared with the current situation, the region will need to decrease its energy intensity by 3.5 MJ per dollar, a similar progress made between 1990 and 2014.

Investment gap

The investment gap in renewable energy needs to be substantially scaled up. The total investment in clean energy technologies in Asia and the Pacific was $101 billion in 2014, a 42 per cent increase from the previous year. To close the gap in renewable energy will require additional investments (above the projected investment under the CPS) of $101 billion and $282 billion for the SDG and NDC scenarios, respectively (figure 20).

The additional investment required to close the gap in access to electricity through DRE systems is between $1 billion and $4.5 billion per year, depending on the tier level. This is a small amount because only 1 per cent of people (63 million) will lack access in 2030. Table 1 presents the additional investment that would be required for different cooking technologies (improved cook stoves, LPG stoves, electric stoves and biogas digesters) by 2030 needed to provide access to clean cooking for 320 million households (1.6 billion people).

Figure 20 | Annual investment in renewable energy in different scenarios

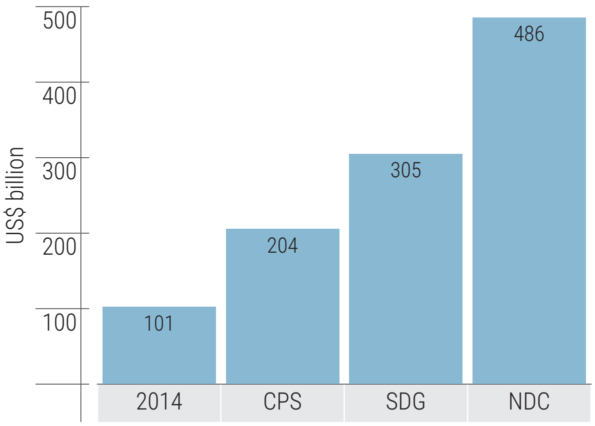


Table 1 | Costs of technologies needed to close the gap in access to clean cooking solutions

	ICS	LPG	Electric	Biogas
Average upfront cost ($/HH)	45.00	56.00	30.00	950.00
Average operating cost ($/year)	120.00	220.00	300.00	50.00
Total upfront cost ($ billion)	14.54	18.09	9.69	306.94
Annual operating cost ($ billion/year)	38.77	71.08	96.93	16.15
Life-cycle cost 2018-2030 ($ billion)	480.00	871.00	1,173.00	501.00

Source: *IRENA, 2017b.*

While the upfront cost of a biogas digester is very high, the low operating expenditure makes the life-cycle cost of this technology cheaper than LPG- and electric-based solutions. Government support in the form of a capital subsidy may be required for biogas digesters.

Policy gap

The existing policy frameworks need to be aligned with the 2030 Agenda as they are insufficient to drive the required energy transition to reach the SDG and NDC targets, partly because current energy policies are not aligned with these targets. Only 34 countries in the Asia-Pacific region have either achieved, or have set a target to achieve by 2030, universal access to electricity. Specific targets and actions for access to clean cooking fuel are largely absent in energy policies. The promotion of clean cooking technologies, such as improved cook stoves, LPG stoves and biogas digesters, is done on an ad hoc basis, commonly on a project basis funded by donor agencies.

The scenarios presented in the previous chapters of this report clearly indicate that achieving universal access to clean cooking fuel will be one of the hardest tasks for policymakers, not only in Asia and the Pacific but also globally. The first step to addressing this problem will reflect the target of universal access in the energy policies that will need to be supported by well-developed, robust and achievable plans.

The inclusion of renewable energy in energy policies has grown during the past decade – at least 41 countries (77 per cent) in the Asia-Pacific region have renewable energy targets. Since most of these policies were developed before the SDGs were adopted, they do not offer linkages to the SDGs. As a starting point, it is important to define targets as a share of total final energy consumption. If for a specific reason a country needs to define otherwise, such as a share of primary energy or electricity, the equivalent share of TFEC can be quoted. The next step would be to include the renewable energy target in the energy policy. As there is no quantified SDG target for renewable energy, one option for the Asia-Pacific region is to adopt a regionally-agreed target and then disaggregate this to the national level.[8]

The pathways developed in this report provide options (22 per cent for the SDG pathway and 35 per cent for the NDC pathway) for a regional target. The national targets will vary, depending on each country's renewable resources availability and financial capability. Energy efficiency policies need further strengthening to ensure that the projected gap of 1.5 MJ per dollar in energy intensity reduction is achieved by 2030.

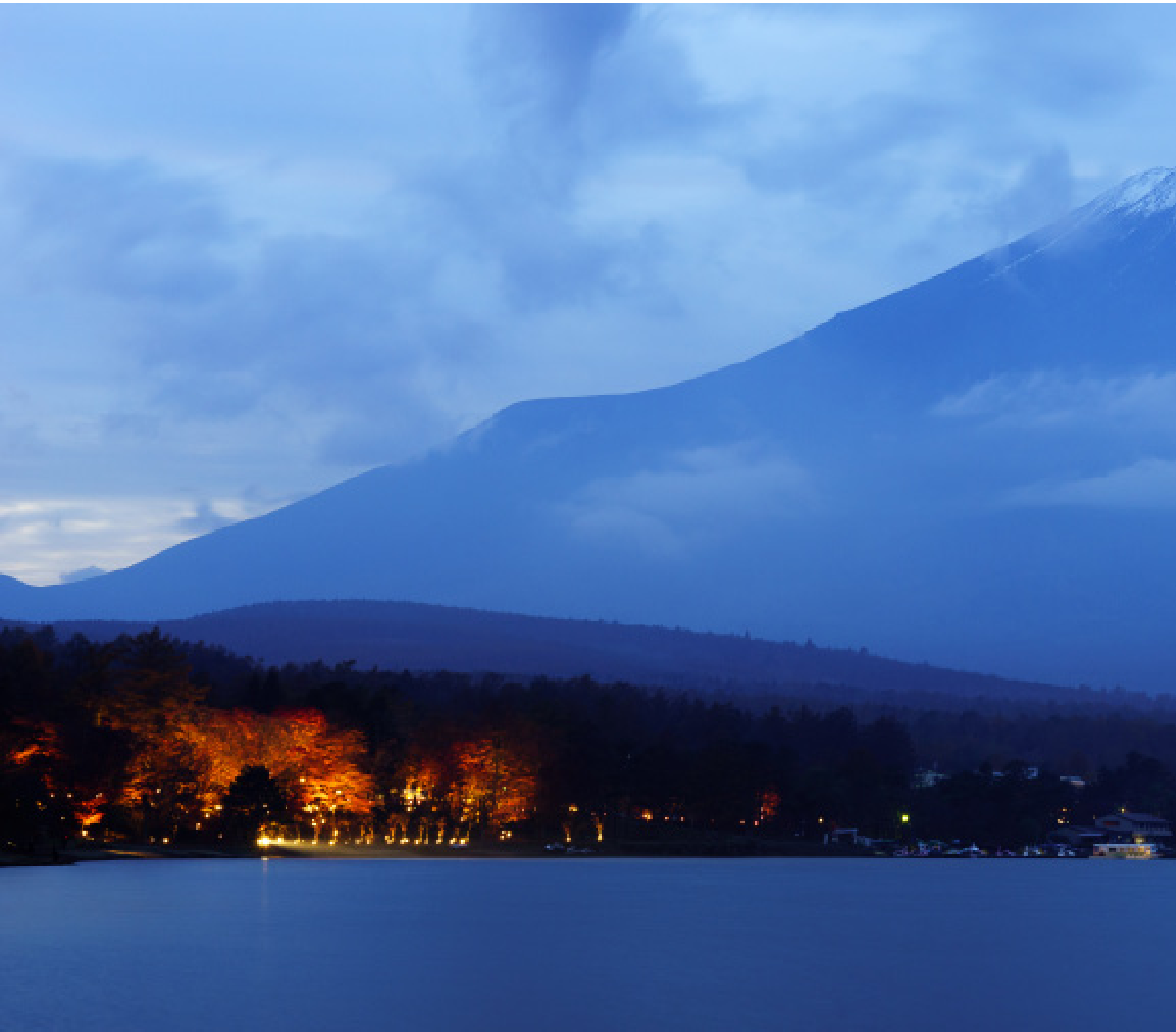
Capacity gap

Capacity strengthening is required to drive the energy transition. Delivering an energy transition to achieve the SDG7 targets and the NDCs by 2030 is a complex

8 For example, ASEAN has adopted 2025 targets for total renewables and renewable electricity.

task. Without a robust mechanism to navigate through the transition, Governments and their institutions are likely to find it overwhelming. Determining the interlinkages between SDG7 and other SDGs, and adjusting energy policy accordingly, is another task that requires capacity strengthening. Identifying and prioritizing economically viable mitigation actions and tailoring them to suit local contexts also require capacity enhancement. The scope for a regional capacity-building approach to address these issues is worth investigating.

An Energy Transition Roadmap (ETR) tool that can assist policymakers in setting the right target, choosing appropriate technologies, stimulating the market, generating private investment, deploying projects and measuring progress would be useful. Policymakers would be able to input country-specific data and information to generate their national roadmap, which would guide them through the transition. If hosted on a regional platform, the tool would assist in tracking the progress of energy transition. An ETR tool can also be useful in delivering a distant capacity-building programme through videos, webinar and online training modules.



4| Policy options for the energy transition

The energy transition will require a major transformation of the current policy frameworks. It should start with the alignment of energy policies with the targets of the 2030 Agenda, followed by prioritizing technologies to deliver the energy transition in a cost-effective manner. Without creating an enabling investment climate to stimulate private investment, the energy transition will be impossible, particularly with regard to financing the growth of renewable energy and energy efficiency. Long-term energy procurement policies, fiscal incentives such as a corporate tax holiday, and enabling easy access to finance have the potential to derisk capital investment and increase private sector participation. Phasing out fossil fuel subsidy deserves urgent consideration in order to discourage wastage of energy, prevent draining of fiscal resources, and improve the cost-effectiveness of renewable energy and energy efficient technologies. Market instruments, such as a price on carbon or a levy on fossil fuel, are instrumental in generating funds to cover the cost of damage by fossil fuel combustion as well as level the playing field for renewable energy. Finally, regional cooperation is essential to combating some of the crucial policy and technological challenges, such as allowing a higher share of variable renewable energy penetration in the grid by expanding the coverage of an interconnected network.

Achieving the SDG7 targets will require concerted actions by ESCAP member States to radically transform the energy sector. The degree of success in achieving such a transformation will depend largely on the innovation in policy mechanisms and adaptability to the continuously evolving energy landscape. This chapter undertakes an in-depth analysis of high-impact policy measures, with the aim of identifying a set of policies that would enable ESCAP member States to navigate such an energy transition. Where applicable, policy measures are further decomposed to shed light on their technological, economic and environmental soundness. Policies are national instruments, and every country therefore needs a tailored approach to suit its unique context while seeking to fulfil regional-level goals.

4.1 ACCESS TO MODERN ENERGY

Universal access to electricity

A number of technological options and delivery models are available for rural electrification, including grid extension, off-grid diesel generation, mini-grids and distributed renewable energy (DRE). While grid extension has always been the mainstay in providing access to electricity, connecting rural households via the grid network will inevitably take longer and connection for many areas may not be a practical option. Diesel generation may be unreliable in remote areas due to frequent downtime; in addition, they are emission-intensive and cause local air pollution. DRE systems such as standalone solar home system (SHS) and renewable energy-based mini-grids can offer a more rapid means of increasing access to electricity, allowing immediate positive impacts on rural development. Although RE-based DRE systems are likely to limit the opportunities for large-scale productive use, they can provide enough power to support simple productive technologies, particularly information and communication technologies. Where resources are available, micro-hydro or biomass gasification technologies can be explored to power motive and mechanical tools for on-farm activities. Use of solar PV for irrigation is increasingly becoming a preferred choice in many countries, including Bangladesh and India, due mainly to a shortage of grid supply and the increasing cost of diesel fuel. GHG emissions avoidance is an added benefit. These systems are also used as micro-grids during wet and non-farming seasons, multiplying the return on investment.

Various studies (IRENA, 2016b; and World Bank, 2017) suggest that DRE systems are becoming increasingly cost-competitive against other modes of electricity and will be critical in solving the energy access problem by 2030. The development and adoption of appropriate and locally adapted business models is the key challenge to ensuring the long-term sustainability of systems.

Ensuring quality of access will be equally important to improving the productivity in rural areas. The World Bank's Multi-Tier Framework (MTF) redefines energy access from the traditional binary count to a multi-dimensional definition as "the ability to avail energy that is adequate, available when needed, reliable, of good quality, convenient, affordable, legal, healthy and safe for all required energy services" (ESMAP, 2015). Tier 2 of the MTF suggests 73 kWh of electricity per household per year to enable a household to operate lights, watch television and charge mobile telephones. Tier 3 requires 365 kWh per household per year for households to meet most electrical needs for eight hours a day.

Ensuring universal access to electricity for the entire Asia-Pacific region will require generation of 6 TWh and 31 TWh on a Tier 2 and Tier 3 basis, respectively, with an annual investment of $1 billion and $5 billion, respectively, between now and 2030. With improved energy efficient appliances, such as light emitting diode (LED) technology, this demand is expected to drop further. MTF also suggests that access to electricity should be affordable, which can be measured in terms of the share of a household's total income. For example, the cost of a standard package of 365kWh per year should not be more than 5 per cent of a household's income. Reliability of service is another critical factor in ensuring the quality of access. MTF suggests that for Tier 3 there should not be more than three disruptions per week.

Investment for universal access to electricity

The level of investment to close the gap between the CPS and SDG scenarios will depend on the chosen tier category and chosen technologies (figure 21). For example, achieving universal access through grid extension would require $0.33 billion per year for the Tier 2 category and $1.7 billion per year for the Tier 3 category. The level of investment would be the same for utility-scale solar PV and 33 per cent more if the solar PV mini-grid is chosen. GHG emissions from grid-based electricity will be 4.4 MtCO2-e and 22 MtCO2-e for Tier 2 and Tier 3, respectively. The choice of technology will depend on the location and the resources available. For households near to a grid network, it would make more sense to connect to the grid. For others, DRE systems would be more economically feasible. Communities with a high density of households would be ideal candidates for mini-grids, while for places that have sparsely settled households standalone systems, such as solar home systems, would be appropriate. Figure 22 presents a decision-making process for the selection of technology for access to electricity.

Figure 21 | Technological options and investment requirements for universal access to electricity

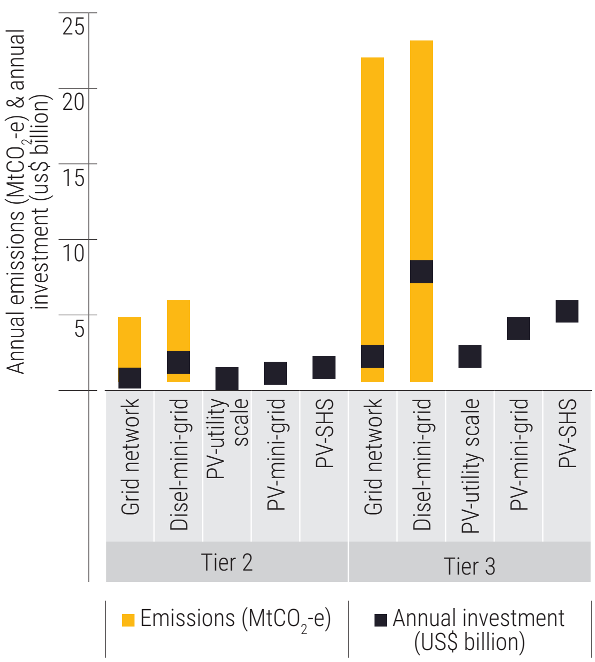
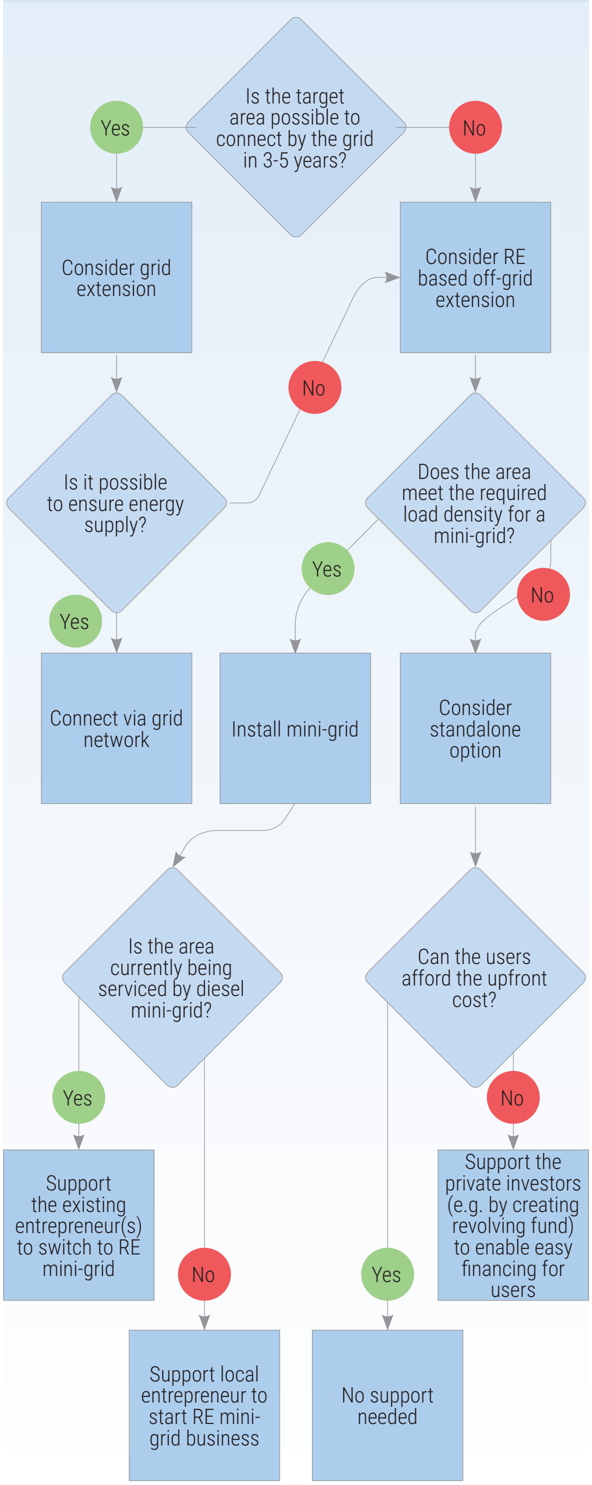


Figure 22 | Decision tree for policy options on universal access to electricity



Universal access to clean cooking

Four clean cooking fuel technologies are commonly used to replace traditional use of biomass – ICS, LPG stoves, electric stoves and biogas digesters. A biogas digester offers a range of benefits, such as creating a better local environment with improved manure management, as free bio-slurry would replace the need for chemical fertilizers. Based on IRENA's estimate, the life-cycle cost over a 12-year cooking period would be $124, $225, $303 and $129 for ICS, LPG stoves, electric stoves and biogas digesters, respectively. From the socio-environmental perspective, IRENA ranks biogas digesters highest, followed by LPG stoves, electric stoves and ICS. Figure 23 presents a matrix of socio-economic and environmental benefits from promoting different clean cooking fuel technologies. The life-cycle cost of a biogas digester becomes highly attractive when subsidies are made available; this is due to its very high upfront cost, whereas the other technologies have low up-front costs and therefore, the difference that the subsidy makes to the user is very low.

The main difficulty in rolling out a biogas digester programme at the national or regional level is the lack of sufficient livestock across the region. The performance and usability of ICS are highly dependent on the local context, such as the type of fuel used and the cooking culture of the community. Therefore, it is necessary to implement a nationally relevant research and development programmes to develop stoves that suit the local condition. Promotion of LPG stoves will depend on the availability of resources. In the short term, cooking with LPG and ICS appear to be suitable options because of their low upfront cost and the fact that they are unlikely to need a subsidy. In the longer term, when grants are made available, biogas digesters could be promoted in communities with enough livestock. Figure 24 presents a simple decision-making tree for the technology choice for clean cooking.

LPG stoves are suitable for use in countries with available LPG resources and a well-established LPG supply chain. Remaining areas that are far away from the supply chain can be served with ICS to close the gap. Given the severe and lasting power deficit

Figure 23 | Comparison of socio-economic and environmental benefits of clean fuel technologies for cooking

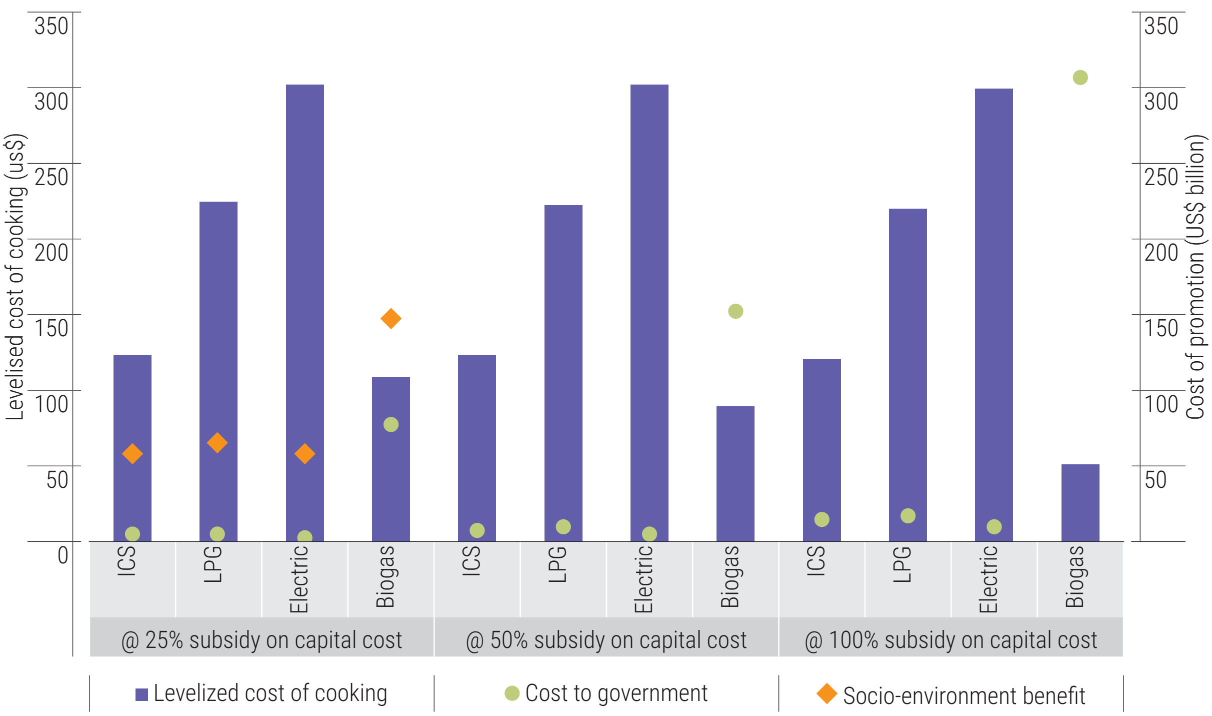
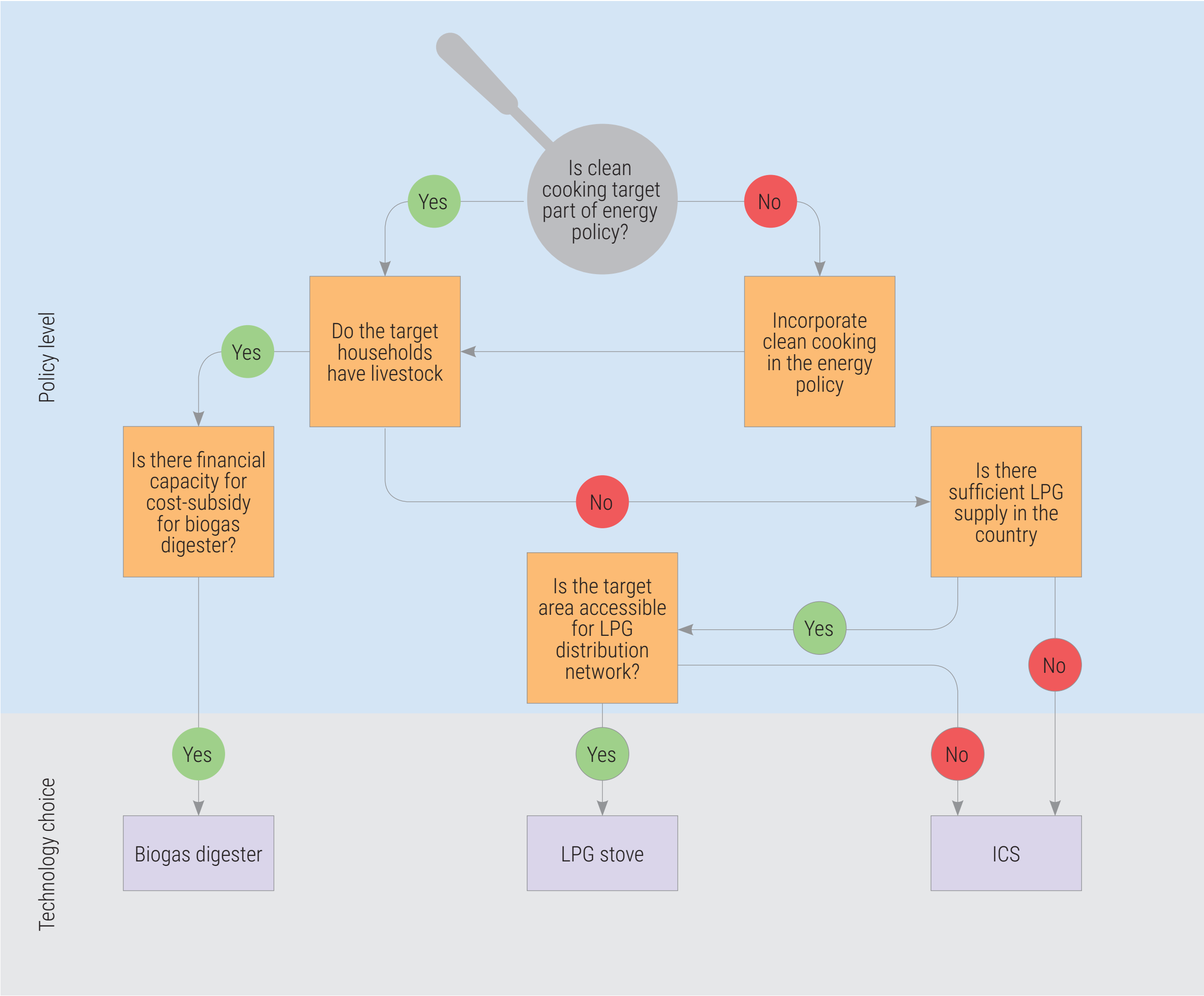


Figure 24 | Simple decision tree for the technology choice for clean cooking



in most developing countries with poor economics, predominant reliance on thermal generation and the competing needs for electricity, there is little rationale to support the large-scale rollout of the electric cooking technology.

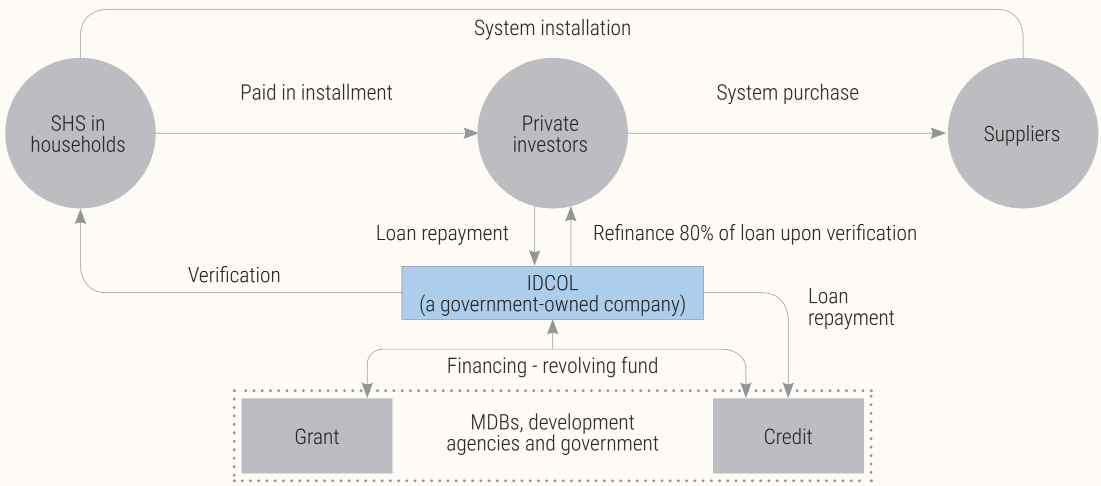
There have been various initiatives in the region and beyond aimed at improving access to clean cooking. The Indonesian Kerosene-to-LPG Conversion Programme has been successful in moving 30 million households away from hazardous kerosene to LPG for cooking in just five years (2007-2012). At the centre of this success has been the leadership of the Government, cross-sector cooperation, results-based financing (box 1) and appropriate technical assistance. The key driver for the Government to start this programme was to lessen the fiscal burden of kerosene which accounted for 57 per cent of all petroleum subsidies in 2006; the programme is believed to have saved 8.2 million litres of kerosene by June 2012 (World Bank, 2013). Lessons from this programme suggest that awareness among potential users about the importance of clean cooking, together with the setting of a price that is affordable to users, are critical to the successful implementation of the programme. The programme delivery involved providing existing traditional stove producers with the required knowledge and supporting them with easy access to financing. This is similar to the business model discussed in the "access to electricity" subsection where existing diesel generator operators can be trained and supported in switching to DRE systems. While the programme succeeded in distributing 30 million cookstoves, mainly

Box 1 | Results-based financing (RBF) – an appropriate financing model

Results-based financing (RBF) is a mechanism that links financing to predetermined results, where payments are made only upon verification that the results have been achieved as agreed. RBF has been widely used in many development sectors, including health and sanitation, energy access and education, to achieve thriving results and to make domestic funds more effective. In an RBF framework, the funding agency – typically a Government, development bank or other agencies – deals directly with the service provider (e.g., a private firm, public utility, civil society organization or financial institution).

Unlike traditional public procurement, which uses public resources to purchase goods or services and pays the supplier directly to deliver them to users, the RBF approach uses private sector resources to finance the goods or services and public resources to reimburse the service provider upon the delivery, based on predetermined criteria. This basic difference gives RBF the potential to improve the efficiency and effectiveness of disbursing public resources and the support of market-based interventions.

Figure 25 | Roles and responsibilities in the SHS program in Bangladesh in relation to RBF



The RBF approach has been widely used by the World Bank, including in the promotion of SHS in Bangladesh where private investors (known as "participating organizations") use their own fund to procure and install systems in users' premises. An independent verification body established by the Infrastructure Development Co., Ltd, the fund manager, verifies the installation to ensure that it conforms to the predetermined standards and guidelines (figure 25). Once verified, 80 per cent of the cost is financed by the Infrastructure Development Co., Ltd. as a loan. This model has helped to stimulate the market, significantly attracted private achievement and was a key to achieve targets much earlier than planned.

among the urban poor, 11.7 million rural households, far from the LPG distribution network, continued to rely on firewood. Estimates suggest that the use of wood in rural areas during this period declined by only 9 per cent. To close this gap, another programme, the Clean Stove Initiative, has been launched in Indonesia with the support of AusAID, to distribute 10 million ICS to rural households (World Bank, 2013). Once implemented, Indonesia will have achieved the SDG target of "universal access to clean cooking."

4.2 RENEWABLE ENERGY

Increasing renewable energy from its current share of 6.8 per cent to 22 per cent by 2030 in the SDG scenario (and to 35 per cent in the NDC scenario) will require a radical transformation of the energy sector. While electricity generation currently dominates the use of renewable energy resources, a multi-sectoral approach to allow renewable energy to grow across the economy will be essential. A concerted effort by all ESCAP member States is essential to making this happen. Such efforts will need to be built on technological innovation, economic viability, and an efficient and robust governance system. This subsection discusses several options for policymakers to make this growth possible.

Achievement of the SDG scenario will require countries to revisit their existing renewable energy sources to increase the level of ambition. Countries would need to devise appropriate strategies based on their resources availability, socio-economic conditions and policy landscape in other development sectors. Scope for the large renewable energy increases will continue to exist in electricity generation, where a three-fold increase is expected, 14 per cent of which will be contributed by hydropower, followed by wind power (11 per cent) and solar PV (8 per cent). This will require the total renewable installed capacity to grow by about four times from less than 745 GW now to about 2,700 GW in 2030.

Sectoral scopes of renewable energy not fully utilized

- **RE in the power sector**. Historically, the power sector has represented the bulk of renewable energy use and will continue to do so in future because of its technical and economic feasibility (see Box 2). Among all renewable energy technologies, hydropower will continue to dominate electricity generation, but wind and solar PV will grow significantly up to 2030. While large-scale grid-

Box 2 | Renewable energy is now a viable business case

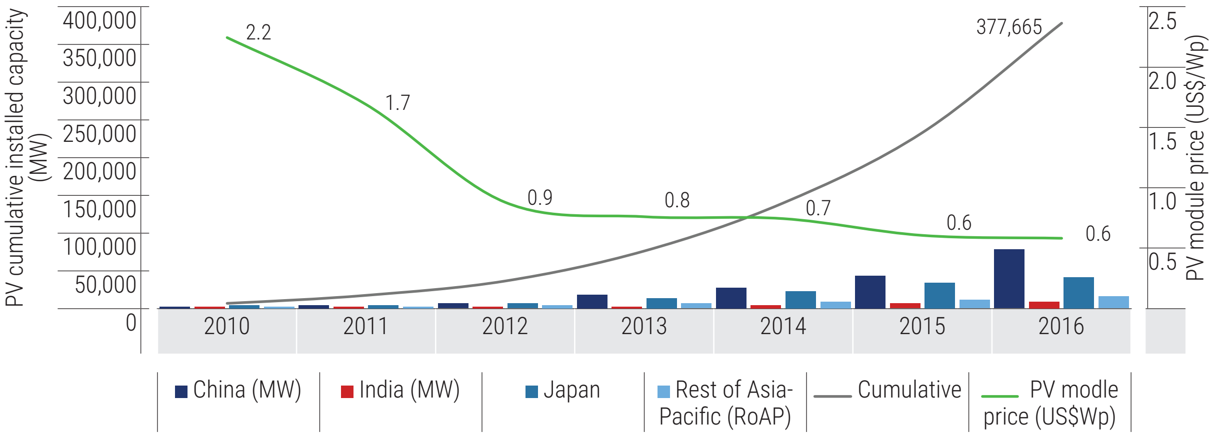
Cost-competitiveness: Renewable energy, particularly for electricity generation, and to some extent for heat generation, is increasingly becoming cost-competitive over fossil-fuel based generations. The levelized cost of electricity (LCOE) estimated by IRENA (IRENA, 2016c) demonstrates that renewable power technologies in ASEAN and its neighbouring areas will fall within the cost range of conventional generation or slightly below. IRENA suggests that the fastest deployment in capacity growth will occur in solar PV and wind, both of which have average costs of around $80 per MWh but it is likely that the value will further drop to $40 per MWh for solar PV and $60 per MWh for wind (IRENA, 2016c).

An abundance of renewable energy resources: The Asia-Pacific region has abundant renewable energy resources, including some of the best-untapped hydropower potential in the world, in countries such as in China, the Lao People's Democratic Republic and Myanmar. Solar irradiance in most parts of the region is very high, averaging between 1,500 and 2,000 kWh per square metre per year, which allows for capacity factors of 20 per cent and above. Wind speeds in many countries in the region average between six and seven metres per second, enabling wind farm capacity factors well into the high 20s. There is also significant geothermal potential in some countries, but it is not consistent across the region. High levels of agricultural activity make the bioenergy supply potential very high.

Socio-economic benefits: part from the fact that renewables are becoming low-cost options for power generation, they have the potential to reduce the economic loss. Increasing climate impacts in the region are a threat to ensuring modest GDP growth in future. IRENA has estimated that the GDP losses due to climate change in 2060 could be as high as 5.6 per cent in South Asia and South-East Asia, compared with the global average of about 1.5 per cent. Of this, 84 per cent will be in the agricultural sector, the prime industry in most countries of this region. IRENA has also estimated that unlike the conventional power generation sector where job losses are increasing due to limited activities, particularly in resources exploration and processing, jobs in the renewable energy sector are rising rapidly. In 2016, the renewable energy sector employed 9.8 million people globally, 32 per cent of whom were in the solar PV industry, followed by 17.6 per cent in liquid biofuel, 15.5 per cent in hydropower and 11.8 per cent in wind power industries.

Improving energy security: Reliance on indigenous and renewable resources, as opposed to dependence on imported fossil fuels, improves the energy security by eliminating the chances of supply disruptions and increasing resilience to global fuel price fluctuations. Past experiences of oil supply disruptions on many occasions indicated that markets react nervously to news about political or economic unrest. IRENA suggests that diversification of energy mix and reducing dependence on imports can significantly improve energy security.

Figure 26 | The rapid growth in installed capacity of solar PV driven by the sharp decline in solar PV module prices"



connected projects will remain attractive choices for investors due to higher returns on investment, small-scale off-grid projects will need to be accelerated in order to achieve universal access to electricity. The sharp decline of RE cost has been the key driver of RE growth in the region (figure 26). The cost of solar PV modules dropped from $2.2 per watt-peak (Wp) in 2010 to $0.6 per Wp in 2016, resulting in growth of cumulative installed capacity from 5.8 GW in 2010 to 378 GW in 2016. Unsurprisingly, China contributed the most to this growth, but growth in India, Japan and in some other countries has been remarkable as well. The installed cost of wind turbines also declined from $1,800 per kW in 2010 to $1,500 per kW in 2016.

- **RE in the transport sector.** Use of renewable energy in the transport sector is currently limited. Where possible, liquid biofuel, e.g., bioethanol and biodiesel, could be promoted to replace or be blended with traditional petroleum fuel. Sourcing of biofuel will require careful measures in order to avoid potential competition with food crops. Introducing electric vehicles (EV) is another viable avenue for countries to explore. Like biofuel, sourcing of electricity for EVs also demands careful attention, as charging EVs with power generated from fossil fuel may not offer an optimal solution. Charging EVs from renewable energy systems, such as solar PV installed in car parks, is becoming increasingly popular. The uptake of EVs has been limited but is now growing strongly, with most mainstream manufacturers introducing or planning electric models in their product ranges. Diffusion of EVs requires an enabling environment with appropriate support mechanisms, both for passengers and across the supply chain. There are three key barriers currently limiting the uptake of EVs – high upfront cost, lack of sufficient recharging stations and concerns over the driving distance between charges.

  Cost reduction is an important starting point for making EVs affordable to users. Setting special import duties, or eliminating them, would give EVs a competitive edge over conventional vehicles. An appropriate infrastructure for enabling recharging when needed is essential to enabling the EV market to grow. On the other hand, installation of charging stations will not be an attractive investment until there are sufficient EVs to create that demand for new infrastructure. Governments can play an important role by setting up initial EV charging stations at suitable locations, using renewable power, to create an increase in the number of early adopters. Expanding the availability of public areas, workplaces and homes with built-in charging options should be considered. The initial concerns over distance are, to some extent, being addressed by more user experience that has accompanied greater adoption of EVs, better availability of charging and improvements to the energy density of batteries. Innovation in battery technology to drive up the efficiency and lower cost needs is underway with many major auto manufacturers investing in R&D. Creating an enabling business environment is critical, such as providing manufacturing support for the industry. For example, the State of Nevada in the United States of America has supported the Tesla battery Gigafactory with tax breaks and incentive grants. By hosting the Gigafactory, Nevada stands to attract more than 6,500 jobs over a span of eight years (IRENA, 2016d).

Some countries in the Asia-Pacific region are showing leadership in promoting EVs and associated equipment. China is introducing 80,000 electric buses, and 20 million electric two-wheelers are sold in that country annually. Japan now has 2,800 fast-charging EV stations. At the end of 2017, there were 102,308 registered EVs (including all varieties – plug-in hybrid, hybrid and battery-operated electric vehicles) in Thailand, of which battery EVs totalled 1,394. The number of charging stations in Bangkok grew from zero in 2015 to 200 stations in 2017, of which 60 per cent have been built by private companies and the remainder subsidised by the Government. The Government of Thailand has targeted 1.2 million EVs and 690 charging stations to be made available by 2036. Examples of enabling policy environment to support the growth of EVs in Thailand include tax holidays of 5 to 8 years for car assemblers and parts makers, import tariff exemptions on machinery and 30 per cent subsidies for building charging stations. The new incentives proposed by the Energy Planning and Policy Office will include further tax deductions for buying EVs (*Bangkok Post*, 2018).

- **RE in industry sector.** Iron and steel, chemicals and petrochemicals, and pulp-and-paper are the three major industries that represent the bulk of industrial energy use. The current practice of using renewable energy in these industries is to heat process water for low-temperature applications (varies by activity, and ranges from 50°C to more than 1,000°C). While the current cost of supplying heat by using solar thermal generation is higher than using fossil fuel-based technologies, IRENA estimates that the technological improvements and economies of scale by 2030 will close the cost gap.

Box 3 | What is an Energy Performance Contract?

An EPC involves providing an energy consumer, or "host facility," with a range of services related to the adoption of energy-efficient products, technologies and equipment. The services provided may also include the financing of the energy efficiency upgrades, so that the host facility is required to commit little or no capital. The host facility pays for the services by using the money that it saves from reduced energy consumption. In many cases, the compensation is contingent on demonstrated performance in terms of energy efficiency improvement or some other measure, thereby creating a system where the services and equipment can be paid for from actual energy cost savings.

EPCs can be divided into two basic types of agreements: "shared savings" and "guaranteed savings." In the shared savings model, the ESP provides or arranges for most or all of the financing needed to implement the project. The EPC specifies the sharing of the cost savings between the ESP and the host facility over time. The EPC may last between 3 and 10 years, with the sharing of payments structured such that the ESP will recover its costs and obtain the desired return on its investment within that period. The host facility does not usually invest in the project but receives a share of the savings during the contract period and all the savings after the contract period, thus maintaining a positive cash flow throughout the life of the project.

The guaranteed savings agreement provides the ESP with a fixed payment or payment stream upon satisfying the performance guarantee, and it may also provide the ESP with an incentive payment if actual performance exceeds the guaranteed level. On the other hand, if the savings fall below the pre-agreed levels, the ESP would be obligated to cover the host facility's loan repayments until project performance has been restored.

Source: Singh et. al., 2010

Another potential area for renewable energy application is small and medium-sized enterprises (SMEs), where energy costs are a substantial part of overall expenses, and where there is ample demand for low-temperature heat. Use of solar thermal technology is particularly feasible for SMEs, because integrating it into the existing system is much easier compared to, for example, a large-scale chemical plant. Many SMEs are also suitable for generating on-site electricity using renewable energy technologies, such as solar PV, wind, geothermal and bioenergy, subject to locally available resources. Energy technologies currently used by SMEs are often ageing and inefficient, making a valid case for energy efficiency and renewable energy; however, it will need to be delivered at an affordable price. There are various business models for increasing the affordability of renewable energy application, for example, energy performance contract (EPC), which is becoming popular as there is no capital cost requirement for the industry owner. Under this model, it is the responsibility of the energy service provider (ESP) to ensure optimum performance of the system (box 3).

The key to supporting the growth of energy services companies (ESCOs) offering EPCs to SMEs is the availability of accessible financing. Thailand has demonstrated leadership in this approach by establishing a "revolving fund" for energy conservation and efficiency. ESCOs can borrow funds from financial institutions at an interest rate lower than commercial rates, over an extended repayment period (box 4). Other countries in the Asia-Pacific region should be encouraged to replicate this model.

The ESCAP secretariat can act as an important platform in rolling-out a regional awareness programme to foster the energy transition in SMEs. The benefits of supporting SMEs with energy transitions will spur action beyond the achievement of SDG7 to the accomplishment of SDG 8.3.

Box 4 | A revolving fund in Thailand has made a breakthrough in attracting private investment in energy efficiency and renewable energy

The Thai Energy Efficiency Revolving Fund (EERF) is part of the framework of the Energy Conservation Promotion fund and was established in 2003 by the Department of Alternative Energy Development and Efficiency. The Energy Conservation Promotion fund is financed by a tax (levy) on petroleum products ($0.03 per litre). The key objective of EREF is to provide financing for energy efficiency and renewable energy projects that are viable but seek financing. The project also aims to encourage 10,000 tonnes of oil equivalent energy savings per year, valued at about $10 million, and to promote and support private investments through ESCOs.

The EERF encourages commercial banks to finance EE and RE projects by providing soft loans (at an interest rate of 0.5 per cent for seven years). Commercial banks then offer loans to EE and RE project investors at an interest rate much lower than general commercial loans (no more than 3.5 per cent) (ASEAN Centre for Energy, 2017). The guiding principle of this fund is to stimulate and leverage commercial lending by providing initial capital. Although the Department of Alternative Energy Development and Efficiency was the key agency running this programme, it has now withdrawn the support after its successful implementation, as currently 11 commercial banks are running this programme on their own. The "revolving fund" is so named because the revenue generated via repaid loans is made available for issuing new loans.

Initially, EERF provided the participating banks with zero interest credit lines to jump-start projects. However, the interest rate was subsequently reset to 0.5 per cent to cover administrative costs. Interest for on-lending to borrowers was set at a ceiling of 3.5 per cent per annum for a maximum loan amount of Baht 50 million per project in order to distribute the money to as many medium-sized projects as possible. Between 2003 and 2011, EERF stimulated 294 EE and RE projects with an investment of about $500 million, which included $230 million loans from EERF and $278 million loans from commercial banks. These projects together resulted in savings of 1,170 gigawatt hours of electricity and 234 million litres of oil savings per year and about 1 million tonnes of CO_2-e savings annually.

Source: ASEAN Centre for Energy, 2017 and FS-UNEP-Centre, 2012.

Financing the future growth of renewable energy

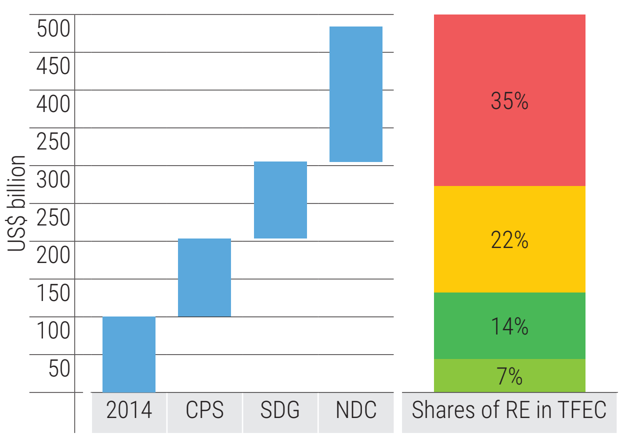
Estimating future investment requirements on a regional basis is rather difficult due to the wide variation of geography, cost of technology and socio-economic context. Therefore, the investment scenarios presented in this report (figure 27) are used mainly to provide an indication of the relative financial context across different scenarios. The level of required investment for the SDG pathway to 2030 would be $305 billion per year, while the IRENA (2016a) global estimate is $770 billion per year for a similar transition pathway.

While the NDC pathway requires significantly high investment, this pathway also demands high attention from policymakers for two reasons. First, renewable energy is one of the primary ways to achieve NDCs and the Paris Agreement. Second, renewables will have a competitive advantage over conventional fossil fuel-based technologies due to technological maturity and cost reduction.

Leveraging public-private partnerships

The private sector has a crucial role to play in achieving and mobilizing the additional investment needs, while Governments have a vital role to play in creating an enabling investment environment. In 2016, 92 per cent of global investment in renewable energy projects came from the private sector. However, there are risks associated with renewable energy investment, especially in developing countries, such as the macroeconomic risks arising from political instability and currency volatility. Technical risks, such as difficulty with grid connectivity or efficiency of the grid infrastructure also influence investment decisions. Long-term and well-defined policy instruments can address some of these risks, such as introducing long-term and clear renewable energy targets and attractive energy purchasing policies, in order to provide strong market signals and increase investor confidence.

Figure 27 | Incremental investment in renewables for different scenarios and shares of RE



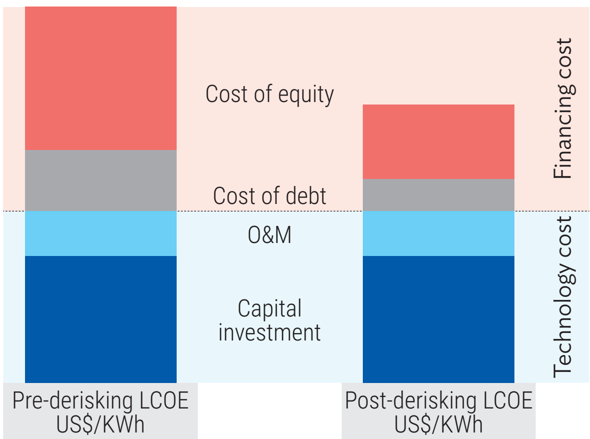
The build-operate-transfer (BOT) approach is that in which an investor builds a power generation project, operates it for a period and then transfers it to the Government. This business model has proven to attract private and foreign investments. The Government of Viet Nam has made changes to the country's regulatory framework that allow 100 per cent foreign ownership of Vietnamese companies in the energy sector. Foreign investors can choose from the range of allowed investment mechanisms, including a 100 per cent foreign-invested company, joint ventures and public-private partnerships in the form of a BOT contract. To ensure a good return for investors, the Government has also approved long-term (20 years) electricity prices for on-grid renewable energy. In addition, renewable energy projects benefit from import duty exemption for imported goods and tax-holidays (zero per cent corporate tax for four years, followed by a 50 per cent reduction for the next nine years). The $2 billion investment in an 800 MW wind farm in Soc Trang province, for which General Electric (GE), Mainstream Renewable Power and the Phu Cuong Group have signed an agreement in June 2017 (EVBN, 2017), is one of the most recent examples.

Derisking capital

In contrast to investments in conventional electricity generation, investments in renewable energy technologies – such as solar PV and wind power – require large upfront investments. From an investor's perspective, this increases the overall investment risks. In addition, the cost of finance in developing countries may be significantly higher than that in developed countries due to issues such as uncertainties with grid integration, the longer lead time for project approval and potential delays in project completion. The task of addressing these investor risks has inspired the development of a wide array of public instruments in recent years that can be broadly divided into two groups (UNDP, 2013):

1. Policy derisking instruments. These instruments seek to address the root causes of risks and include, for example, support for renewable energy policy design, institutional capacity-building, resource assessments, grid connection and management, and skills development for local operations and maintenance;

Figure 28 | An example of how public derisking instruments can reduce financing costs of renewable energy investments



Adapted from UNDP (2013), not to scale

2. Financial derisking instruments. These instruments include, for example, loan guarantees, political risk insurance (PRI) and public equity co-investments, which are used to transfer investors' risks to public actors, such as development banks. However, not all risks can be eliminated through policy derisking or transferred through financial derisking. The residual risks can, however, be addressed by supplementing with direct financial incentives such as price premiums or tax breaks, to compensate for residual incremental costs and thereby increase returns (figure 28).

International financing institutions (IFIs) can play an important role in derisking private sector investments. In Bangladesh, the solar home system programme has received significant support from international donors and multilateral banks. The IFIs contributed to creating a large revolving fund under the management of a government-operated company that lends capital equity to private investors. A robust business model, commitment by the Government and interests from private investors paved the way for the IFIs to participate in the programme.

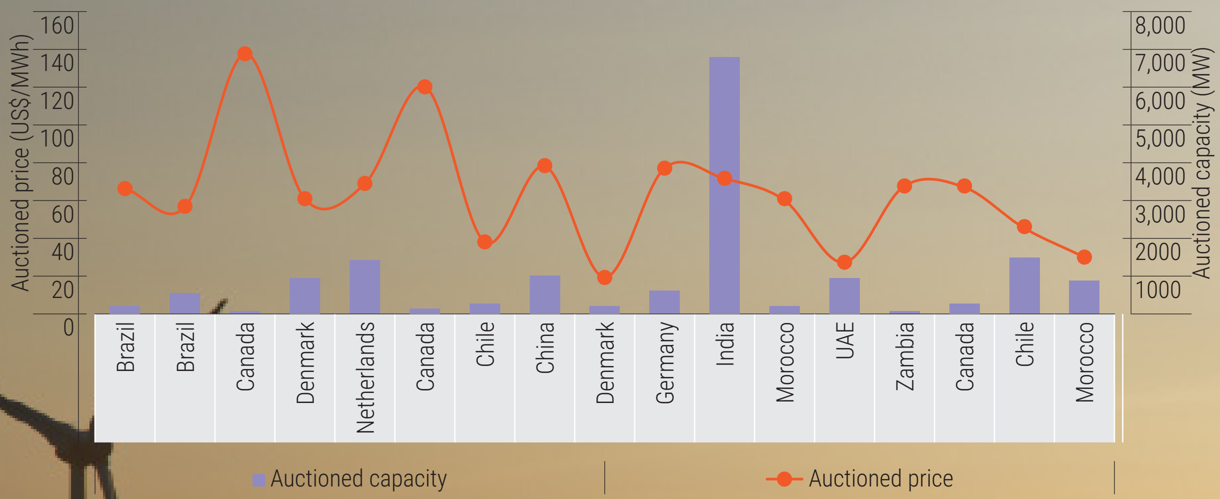
Various market-based mechanisms are used to derisk investment such as FiTs where independent power producers are guaranteed an additional/premium payment for feeding electricity into the grid. FiTs have been found to be a strong instrument to stimulate the market and attract private investment. In addition to attracting large-scale projects, an appropriate rooftop solar FiT can attract a significant amount of household investment. A more recently developed renewable energy auction has been found to have a major impact in efforts to reduce the cost of renewable energy.

Renewable energy auction

Appropriately designed renewable energy auctions can reduce cost of energy and stimulate the market growth. Renewable energy auctions have become more and more popular in recent years and have often been the preferred policy option to advance renewable energy deployment in many countries. The number of countries that have adopted renewable energy auctions has increased from six in 2005 to more than 67 by early 2017 (IRENA, 2017c). Auction prices vary from one country to another as well as for type of technology, but they have demonstrated a significant price reduction in energy generation (figure 29).

The key strength of such auctions is their ability to limit risks for investors because they offer guaranteed revenue over a specified period. However, a poorly designed auction system can lead to discontinuous market development, where the industry can see activities only during the auction and no activities in between, known as stop-and-go cycles. This can be detrimental to the industry. However, various measures can be put in place to address this problem, such as linking auction schemes to a fixed schedule at regular intervals or rolling out another large-scale programme alongside the auction scheme to foster on-going market activity (box 5).

Figure 29 | Auction prices for RE-based projects in different countries and for different technologies



During the past few years, auction schemes have significantly driven down the cost of renewable electricity, with reductions averaging 22 per cent per annum since 2010 for solar PV and 11 per cent for wind (figure 30). A recent auction in India recorded a record low of just $30 per MWh. Therefore, renewable energy auctions are a useful policy tool that warrant further adoption.

Box 5 | Renewable energy auctions – key design principles

A renewable energy auction, also known as a "demand auction" or "procurement auction", is essentially a call for tenders to procure a certain capacity or generation of renewables-based electricity. The auction participants submit a bid with a price per unit of electricity at which they are able to realize the project. The winner is selected on the basis of the price and other criteria, and a power purchase agreement is signed. The auctions have the ability to achieve deployment of renewable electricity in a well-planned, cost-efficient and transparent manner. Most importantly, it makes the achievement of targets more precise than would be possible by other means, such as a FiT. Auctions are flexible and they allow Governments to combine and tailor different design elements to meet deployment and development objectives. Unlike FiTs, where the Government decides on a price, auctions are an effective means of discovering the price appropriate to the industry, which is the key to attracting private sector investment. In addition, an auction provides greater certainty about future projects and is a fair and transparent procurement process. However, the administrative and logistic costs associated with auctions are very high unless multiple auctions are undertaken at regular intervals.

It is imperative that an auction be appropriately designed to (a) avoid the risk of underbuilding and project delays, and (b) allow sufficient competition among different levels of bidders in order to drive down the cost. IRENA suggests the following key design elements:

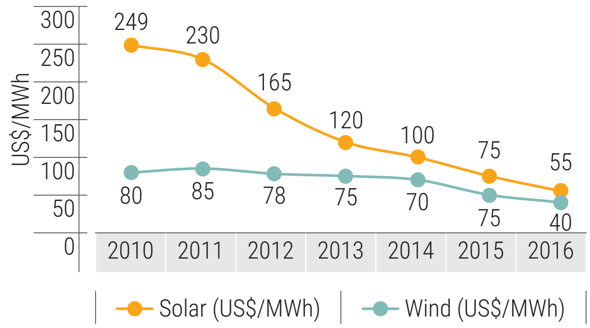
- Auction demand. Governments need to clearly indicate the scale or size of each auction, the preferred technology (technology neutral of a specific technology), auction frequency, and the upper and lower limits of projects size and price.
- Pre-qualification. A strict or high pre-qualification for bidders will leave out the smaller entities, while a relaxed pre-qualification may undermine the quality of the project and increase the administrative costs. Governments need to make a trade-off, depending on the project size and other development objectives.
- Selection criteria. Commonly two selection criteria are used: (a) the lowest bid where only the lowest bidder will win; and (b) lowest bids plus other objectives where in addition to the price, other objectives such as local content and jobs are taken into consideration.
- Payment modalities. The pay-as-bid model is good to minimize the cost; however, the marginal cost payment model, where the same price (selected based on the highest cost winner) is paid to all winners is also practised.
- Penalties for non-compliance. There could be cases where the developer either delays the project or fails to complete. To avoid such cases, penalties should be in place. There are two modes of penalty. In the monetary penalty, money will be deducted from bidder's "bond" or the price of energy will be reduced for a delayed completion. A form of non-monetary penalty can be the exclusion of the bidder from future auctions.

Pros and cons of auction mechanism

Advantages	Disadvantages
Cost efficiency and price competition	High administrative costs and the level of complexity
High investor security through long-term power purchase agreement	Discontinuous market development (stop-and-go-cycles)
Volume and budget control	Risks of not winning project increases finance costs
Predictability of RE-based electricity generation	Risk of underbuilding hindering deployment and target achievement
Can be combined with other policy objectives such as local content, jobs, etc.	Potential for exclusion of small-scale actors

Source: IRENA (2017c

Figure 30 | Auction prices for solar and wind 2010-16

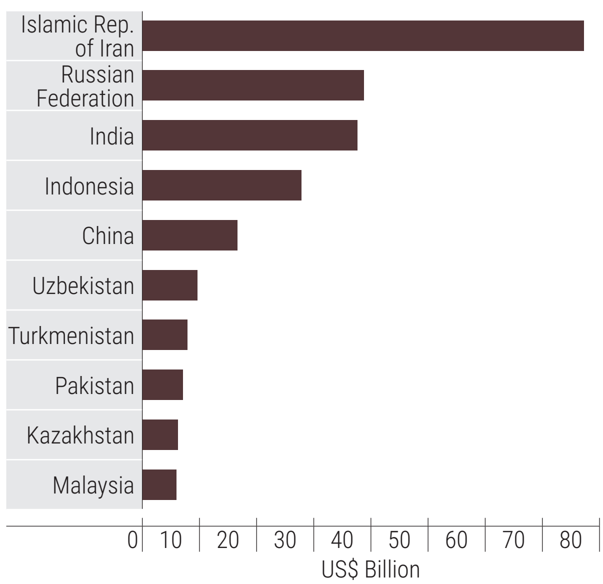


Are auctions and FiT mutually exclusive or complementary? While the use of renewable energy auctions is ramping up in many countries and FiT policies are either being down-scaled or eliminated, the question now is whether renewable energy auction should replace FiTs. In essence, they are not mutually exclusive but are complementary. Implemented alongside each other, they can be used to meet different sets of objectives. The decision as to which mechanism is to be used will depend on several factors. The basic difference between these two is the price discovery mechanism. In the case of FiTs, policymakers undertake a desk-analysis based on available cost and technical information in hand, without consulting the industry, to determine the cost of energy. Whereas in the case of an auction, the industry is asked to offer the price of energy at which the project would be economically viable. The choice of mechanism will also depend on the size and scale of the target project. If the target is to develop a small and one-off renewable energy project at a specific location in the country, it would make more sense to use a FiT to avoid the high administrative cost of the auction. However, if the target is large and there is sufficient interest from local and foreign private investors in investing in renewable energy, the auction mechanism would be more appropriate.

Fossil fuel subsidy reform

Phasing out fossil fuel subsidies will narrow the investment gap for renewable energy. Fossil fuel subsidies are government actions that result in prices paid by end-users being below the cost of supply,[9] which, for fuels, is measured as the gap between the national prices and an international reference price. Historically, the rationale for the introduction of fossil fuel subsidies has been the alleviation of energy poverty, boosting domestic supply, redistributing national resources wealth, protecting employment and ensuring environmental protection. However, international experiences indicate that the range and scale of the unintended outcome of fossil fuel subsidies are significant. While the macroeconomic effects of large fiscal spending are common and clearly visible, such subsidies also crowd out other highly-needed expenditure that would have a higher social return. While Governments accept that the economy-wide impacts of fossil fuel subsidies are costly, regressive and inefficient, the phasing out of subsidies does not appear to be a popular choice among policymakers, because of the risks involved in the political process. Fossil fuel subsidies, which are widespread in ESCAP member States, amounted to $148 billion in 2014 out of the $493 billion global total (IEA, 2016; ESCAP, 2017c). Figure 31 shows the top 10 countries with the highest expenditure on fossil fuel subsidies.

Figure 31 | Top 10 fossil fuel subsidy countries in Asia and the Pacific



9 Reference (IEA, 2016)

While fossil fuel subsidies are aimed at reducing the cost of energy production and making the energy commodity affordable to the public, IEA has found that the economic and environmental costs of fossil fuel subsidies far outweigh any social benefits. Often, fossil fuel subsidies promote wasteful use of energy, leading to many unintended effects across the economy, society and environment (figure 32).

There are two forms of energy subsidies. One is a pre-tax subsidy, which is paid by taxpayers through energy bills, and the other is tax subsidy, which includes the cost of pollution caused by fossil fuel energy systems and nuclear power. The latter, also known as a pollution subsidy, is to pay for the environmental degradation and higher health bills.

There are strong economic cases for Governments to consider fossil fuel subsidy reform. Removal of a subsidy will make fossil fuel expensive and will discourage its wasteful use, which would make renewables more cost-competitive and attract private investment. The savings from the subsidy reform can be used in other development sectors such as education and health or can be invested back into renewables. Indonesia has demonstrated leadership in fossil fuel subsidy reform, and currently has no subsidy for petroleum products. Fossil fuel subsidies also tend to raise concerns of social inequality by disproportionately benefiting the rich, as this group of population uses more energy than the poor.[10] Therefore, eliminating fossil fuel subsidies and diverting the savings to other development activities, such as rural electrification, health and education, will increase social equality and advance SDG target 10.3.

10 http://www.unescap.org/sites/default/files/Clean%20Energy%20report%2001022018.pdf.

Internalizing externalities

Internalizing externalities levels the playing field for renewable energy. The challenges associated with accurately estimating the externalities of fossil fuel energy technologies have continued to result in unfair comparisons with renewables. If the external costs of fossil fuel systems are considered, energy generation from renewables would have been equal, if not lower, to that of conventional energy systems. The external costs arise from pollution and environmental degradation caused by the extraction of fossil fuel resources, indoor and outdoor air pollution, and the negative economic impacts of extreme weather events caused by global warming, such as its impact on agricultural yields.

While the challenges to estimating externalities continue to exist, policymakers can take appropriate steps to design energy and environmental policies that correct for externalities. This may include putting in a pollution penalty, such as carbon price. There have been a few carbon pricing initiatives in the region, such as in China. Externalities in the transport sector, for example, can be introduced by imposing specific regulations, such as higher fuel efficiency standards for passenger vehicles which in turn will make the EVs cost-competitive.

In the NDC scenario, renewables have the potential to avoid $164 billion worth of a fossil fuel subsidy per year, which is about 38 per cent of the required annual

Figure 32 | Potential unintended outcome of fossil fuel subsidies

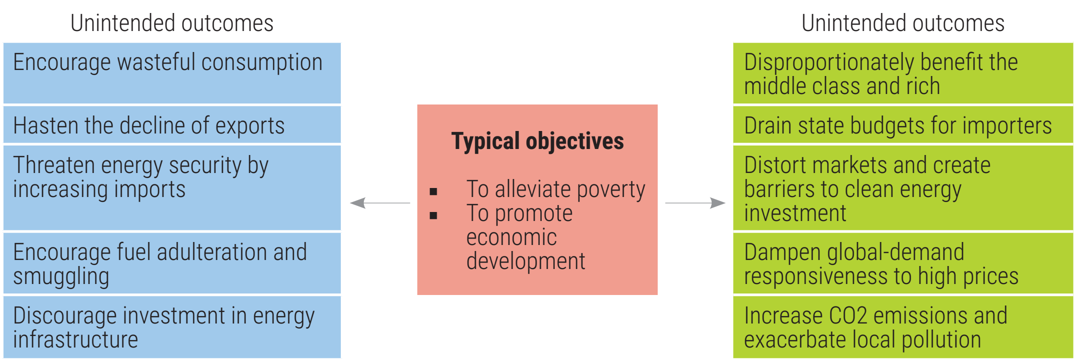
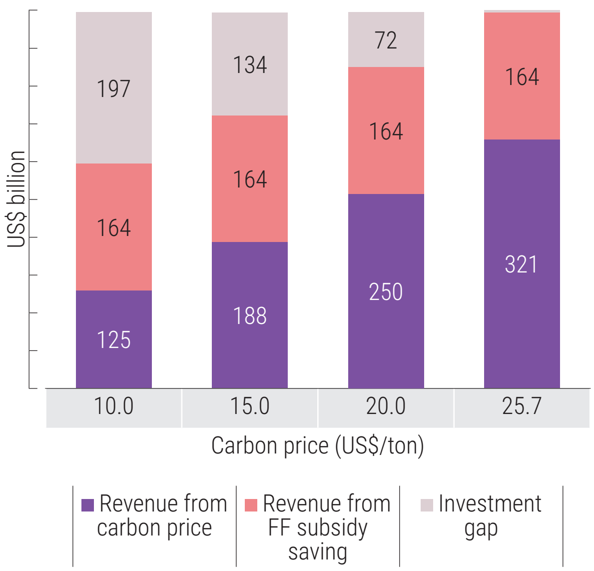


Figure 33 | A price on carbon can close the investment gap for renewables



investment. Investing this saving back into renewables will significantly improve the cost-effectiveness of the energy transition pathway. A price on carbon, together with the revenue stream from avoided fossil fuel subsidies, can close the investment gap. A sensitivity analysis shows that $25.7 per ton carbon price can entirely cover the investment required for the energy transition (figure 33).

The introduction of an emissions trading scheme is underway in several cities in China, with a starting price of $7.5 per ton of carbon (Rathi and Huang, 2017), which is lower than the price required to close the investment gap. However, experts predict that the price in the Chinese carbon market could rise to $45 per ton in the near-future.

Streamlining renewable energy growth through energy connectivity

More than 80 per cent of the projected three-to-five-fold increase in renewable energy will be used in power generation, the bulk of which will be fed into the grid network. This rapid growth of renewable electricity presents a new set of technological challenges, including the difficulty of integrating the growing volumes of the intermittent or variable supply of renewable electricity generation technologies. Generally, electricity grids and their operational, planning and market management mechanisms have been designed during many decades, based on the characteristics of incumbent fossil fuel technologies; thus they may face challenges in coping with such variations as the contribution by increases of renewables. The integration challenges include localized grid congestion, frequency control and supply/demand imbalance that, if not managed well, can compromise system reliability.

Such problems are seldom observed at low penetration levels, as existing grid systems can smooth out minor variations in both load and in generation. However, as renewable penetration increases, and without adequate planning and management, this can lead to forced curtailment of renewable penetration into the grid or prevention of capacity expansion of renewables. This issue is already starting to emerge in China. For example, in 2015, wind power curtailment reached an average of 15 per cent and solar PV faced 31 per cent curtailment in Gansu province – making it more difficult for China to reach its renewable energy goals. It is estimated that the curtailment losses in the wind power sector in 2015 were as high as $2.8 billion (IRENA, 2017d). On a positive note, technical and economic solutions exist, which indicate that these challenges are surmountable. Several approaches that have some degree of relevance to Asia and the Pacific are discussed below.

Grid interconnection

Widening the balancing area of grid networks through the interconnection of national or subnational grids can reduce the relative variability of both load and generation. Connecting geographically distant wind power and solar energy plants can smooth out the variability of these variable renewable energy sources (see Box 6). Larger balancing areas can also lead to cost savings on spinning reserve as this service can be pooled over the entire area. The National Renewable Energy Laboratory (NREL) suggests that a larger and diverse interconnected grid system is a suitable solution for integrating higher shares of renewable energy. An interconnected grid offers an even wider range of benefits, including enabling cross-border power trade and improving energy security. Cross-border power trade has an important role to play in realizing mutual economic benefits for ESCAP member

Box 6 | Australian interconnected grids

The National Electricity Market in Australia is one of the world's most extended, integrated electricity networks, spanning 5,000 km across six States and covering an area with extremely diverse weather conditions and electricity load requirements. Electricity generators in the National Electricity Market sell electricity into a wholesale spot market where prices are determined on a half-hourly basis by levels of demand and supply. States regulate their own retail electricity markets and there are varying degrees of competition in those markets as well as in State Government ownership. While some degree of limitation exists, the National Electricity Market offers greater flexibility in integrating electricity from renewable energy, even with high levels of variation across States. For example, South Australia generated about 48 per cent of its electricity from renewables in 2016, while Queensland produced only 5 per cent during the same period (Clean Energy Council, 2016).

States and facilitating increased sustainability of the energy sector.

Several initiatives have emerged in recent years in the Asia-Pacific region for expanding the balancing areas and the benefit from cross-border power trade. These include the Lao People's Democratic Republic-Thailand-Malaysia-Singapore Power Integration Project, which expects to commence power trade in 2018. The Central Asia and South Asia Electricity Transmission and Trade Project aims to enable the export of surplus summer hydropower from Kyrgyzstan and Tajikistan to Afghanistan and Pakistan, to facilitate seasonal power balancing. The ambitious Asian Super Grid initiative aims to harness the potential of solar and wind energy in the Gobi Desert amounting to about 2,600 TWh per year and to supply power to the Russian Federation, Mongolia, China, the Republic of Korea and Japan. The overall cost of this project is estimated to be around $293 billion for an installed capacity of approximately 100GW (Batmunkh, 2016). There are also opportunities through the co-deployment of transboundary power transmission infrastructure and optical fiber networks, using shared easements or technologies than combine power and ICT links in hybrid conduits.

ESCAP has been playing an important role in fostering the development of regional interconnection of energy infrastructure through regional and intergovernmental dialogue, regional knowledge sharing and compiling best practices.

Increasing the share of readily-dispatchable capacity

The availability of flexible electricity generation capacity in the grid network, such as the open cycle gas turbine, oil or hydro generators, can manage the variability and uncertainty in renewable generation. Increased system flexibility can be achieved through increased transmission or the addition of flexible resources to the system, such as more flexible generating units, storage, and demand response.

Storage devices such as electrochemical batteries and pumped hydro systems can be used as fast-response dispatchable technologies, while the availability of cheaper electricity during off-peak times can be used to charge them. The stored electricity can be fed into the grid during times when demand (and price) is high. Storage devices also provide a cushioning effect on electricity prices through price arbitrage. According to IRENA, (2017e), by 2030 the cost of storage may have declined by 50 to 66 per cent, indicating that storage may become an increasingly viable solution for assisting the integration of renewables in the future.

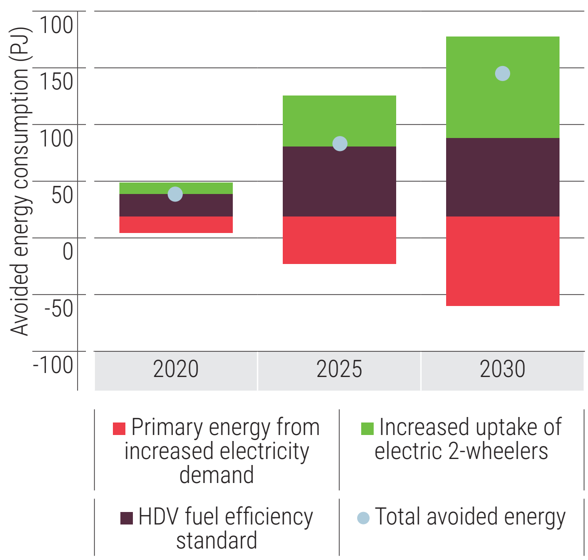
4.3 ENERGY EFFICIENCY

Improving energy efficiency is equally as important as increasing the share of renewables. Some estimates show that if the full potential of energy efficiency is met, global energy demand can be reduced by up to one-quarter by 2030 (IRENA, 2017f). The opportunity for energy efficiency improvement in Asia and the Pacific is enormous, both in the industry and transport sectors, given the predominance of inefficient technologies now in use. Well-designed, implemented and enforced policies are essential to fostering widespread and lasting improvements in energy efficiency.

Energy efficiency is recognized as the most cost-effective means of reducing emissions. The cost of every unit of energy saved is less than the cost of generating the same amount of energy. Countries in Asia and the Pacific and other regions have set ambitious targets for improving energy efficiency in order to achieve their NDCs; about 90 per cent of the NDCs submitted mention energy efficiency as one of their actions.

According to IEA (2017a), the energy efficiency policies that are in place or under consideration today can curtail energy demand in end-use sectors in South-East Asia by 10 per cent by 2040. Improved energy efficiency can also improve energy security at the local and national levels through reducing energy imports as well as the burden on electricity generation and distribution systems.

Figure 34 | Potential for energy efficiency improvement in Indonesian transportation sector



Source: IEA (2017b)

Energy efficiency in the transport sector

The transport sector accounts for 19 per cent (852 Mtoe) of the total final energy consumption in Asia and the Pacific; consumption has almost doubled since 2000 due the rapid growth in population and economic development. About 40 million cars have been sold in the region, of which more than 20 million are in China alone (ESCAP, 2018). The continuing growth in the number of on-the-road vehicles, energy efficiency in the transport sector will play an important role in reducing the region's emissions. However, the transport sector has adopted very limited measures towards increasing fuel efficiency. ESCAP (2018) suggests a number of short-term priority actions to improve energy efficiency in the transport sector, including the introduction of measures to improve the efficiency of trucks. Such measures will have a significant impact in reducing energy intensity and emissions from on-the-road vehicles such as trucks. For example, IEA estimates that the growing economies and expanded road infrastructure will more than double the fuel consumption by trucks in the Asia-Pacific region by 2040. Based on Indonesia's ambitious energy efficiency target of 1 per cent energy intensity reduction per year until 2025, IEA estimates that further strengthening of energy efficiency policies can reduce energy use by 4.5 per cent by 2025 compared with 2 per cent under the current policy context. Figure 34 presents an estimated avoided energy consumption that Indonesia can harness from appropriate policy measures in the transportation sector.

Energy efficiency in the residential and commercial sectors

The residential sector accounted for 21.8 per cent (974 Mtoe) of the total final energy consumption in Asia and the Pacific in 2014, resulting in about 677 $MtCO_2$-e in emissions. Rising population and increasing urbanization will continue to increase energy demand in this sector. In the residential and commercial sectors, perhaps the easiest measure to implement is switching to CFL or LED lighting technologies. Some countries in the region have already demonstrated their leadership in this area. For example, switching to CFLs helped Indonesian consumers to save $3.3 billion on their electricity bills in 2016. The country is now moving towards LED; it is estimated that if the current adoption rate of LED continues, Indonesian consumers will save $560 million per year by 2030. Indonesia has also implemented a performance standard for space cooling, but this has not resulted in a high impact.

Further refinement of this programme could save Indonesian consumers $690 million per year by 2030.

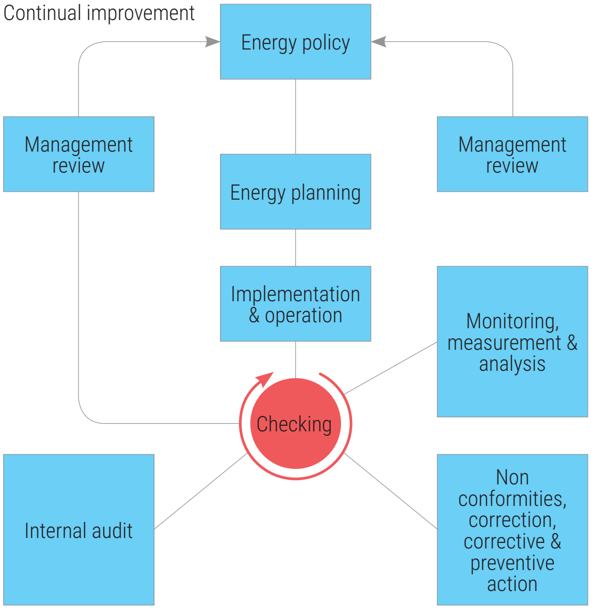
The introduction of building codes for residential and commercial facilities is an effective means of addressing energy efficiency in those sectors. Such codes should include energy performance requirements for new construction and major renovations, complemented by minimum energy performance standards. Energy-efficient buildings are believed to have a higher market value as they assist in a cost-effective way of managing rising energy prices, increase productivity and reduce operating costs. The Commercial Building Disclosure programme in Australia is a national programme that requires sellers and lessors of large commercial office spaces to provide energy efficiency information to prospective buyers and tenants. Initially, the programme covered commercial office space of 2,000 square metres or more; this figure was recently expanded to cover commercial office spaces of 1,000 square metres. The Commercial Building Disclosure programme has made great strides – during 2010-2014, the programme reduced energy consumption of more than 10,000 terajoules, abated two million tonnes of emissions and delivered $15 million of net financial benefits (Australian Government, 2017).

Energy efficiency in the industry sector

Industry, which is the second-largest energy consuming sector after the energy sector, accounted for 38.2 per cent (1,706 Mtoe) of the total final energy consumption. The growth in energy demand in this sector has more than doubled since 2000 and will continue to grow, which makes a compelling case for ramping up energy efficiency in this sector. Given that the industry sector is highly heterogenous, it is not possible to suggest a single measure for the entire sector. Identification of potential for the industry sector requires an in-depth subsectoral analysis; however, this subsection provides a brief insight into two common measures that can be largely implemented in this sector.

More than half of the electricity consumed globally in all end-use sectors (buildings, industry, transport and agriculture) is used in motor systems. IEA (2017b) has estimated that globally, motor driven systems account for about 70 per cent of the electricity demand in the industry sector. Given that the existing motors are about 90 per cent efficient, increasing the motor efficiency alone does not hold promise of making a significant difference. The introduction of variable-speed drives and the improvement of efficiency of end-use devices also need to be considered in benefiting from a larger saving. For example, the improvement in motor efficiency in China will deliver a saving of about 150TWh of electricity by 2040, but the saving is likely to double when variable-speed drive and improved end-use devices are also introduced (IEA 2017b).

Figure 35 | EnMS model for ISO 50001



Source: UNIDO, 2017

The concept and practice of energy management in the industry sector is becoming increasingly popular as it can deliver savings at the least-cost level. The United Nations Industrial Development Organization (UNIDO) suggests that scaling up the deployment of industrial energy management systems (EnMS) and standards such as ISO 50001 can lead to 10-20 per cent of annual energy consumption in industries, and reduce their costs through better energy management, often by just making operational changes with minimal or no investment (UNIDO, 2017). The unique feature of the ISO 50001 is that it is based on the management system model of continual improvement (figure 35) to maximize the benefits and reduce the costs.

Leveraging the synergies between renewal energy and energy efficiency

While at first glance these two tracks do not appear to be strongly related, a closer analysis reveals some strong interlinkages. Countries can benefit from important synergies between renewable energy and energy efficiency, in particular for achieving the SDG7 targets. This subsection discusses the following two areas for which the synergies are more demonstrable than for other areas:

1. The SDG7.2 target needs to substantially increase the share of renewable energy in total final energy consumption. Greater improvement in energy efficiency will reduce the final energy consumption which will, in turn, require relatively less renewable energy deployment to achieve a given share. Alternatively, if the amount of renewable energy installed capacity is kept fixed, the share of renewable energy will increase. This illustrates the fact that a higher level of energy efficiency will increase the renewable energy share in the final energy mix without any additional investment in renewable energy. For example, the SDG scenario aims to achieve a 22 per cent renewable energy share in Asia and the Pacific by 2030, when the final energy consumption is expected to reach 4,875 Mtoe and an energy intensity level of 2.52 MJ per dollar. If further energy efficiency improvement can reduce the final energy consumption by an additional 25 per cent to 3,656 Mtoe, the renewable energy share will increase to about 29 per cent without any additional investment;

2. Synergies between RE and EE also play an important role in reducing the cost of achieving NDCs. More efficient use of energy reduces GHG emissions, while renewable energy also offsets emissions. However, the marginal abatement cost of energy efficiency is usually less than that for renewable energy technologies. For example, IRENA estimates the average marginal cost of abatements of renewable-based electricity generation and energy efficiency at \$75 and \$35 per tCO_2-e, respectively (IRENA, 2017f). This indicates that it would require more than twice the investment in renewable energy than in energy efficiency for each unit of emission reduction. Since energy efficiency is a more economically viable approach, NDCs should consider the implementation of energy efficiency improvement as a priority, with the balance being achieved by renewable energy.

The synergies discussed above demonstrate that concurrently implementing energy efficiency measures and renewable energy options contributes significantly to increasing the renewable energy share in TFEC, accelerating the rate of annual energy intensity improvements and reducing the overall cost of emission mitigation. Governments often support renewable energy and energy efficiency with separate policy instruments, and designate responsibilities to different institutional entities. As the scale and pace of deployment will need to grow, both in the SDG and in the NDC scenarios, the case for a system-wide integrated approach to their promotion becomes more compelling (IEA, 2017b).

4.4 A PROPOSED MEASURING, REPORTING AND VERIFICATION SYSTEM FOR ENERGY TRANSITION

Development of an integrated Measuring, Reporting and Verification (MRV) system would be crucial to tracking the progress of energy transition achievement. It is imperative for an MRV to be designed in a way that is consistent, transparent, comparable, complete and accurate. In addition, an MRV also needs to have a sufficient level of rigorousness and be fully harmonized with national policies and priorities. An MRV system that collects information at the national level and aggregates them at the regional level would be ideal to track progress both at the national and regional levels. This MRV covers both the SDGs and NDCs. The following list is a summary of the type of data collection that will be required. All required data will be on an annual basis. Some parameters, such as FiT, will need to be checked if there is an update.

Data collection

1. Access to electricity:

    a. Number of new/additional people with access to electricity – by technology;
    b. Details of technologies used – capacity, cost, mode of application

2. Access to clean cooking fuel:

    a. Number of new/additional people with access to clean cooking fuel – by technology;
    b. Details of technologies used – capacity, cost, mode of application.

3. Share of renewable energy in TFEC:

    a. Total final energy consumption;
    b. Electricity generated from renewables in large-scale power plants – by technology;
    c. Electricity generated on-site from renewables – by technology;
    d. Renewable mini-grids – by technology;
    e. Electricity generated from renewables – rooftops, standalone and mini-grids – by technology;
    f. Heat generated from renewables in industries and SMEs – by technology;
    g. Solar hot water;
    h. Renewable fuel/energy used in vehicles;
    i. Investments made – public and private;
    j. Feed-in Tariff.

4. Energy efficiency:

    a. Total primary energy supply;
    b. Gross domestic product;
    c. Efficient technologies applied – by technology and industry;
    d. Cost and lifetime of technology;
    e. Expected results – monetary savings and emission mitigation.

5. (e) Emissions data (NDC-related) – for the energy sector only. The key data segments given below refer to IPCC 2006 guidelines for data details in each segment:

    a. Emissions from stationary combustion;
    b. Emissions from mobile combustion;
    c. Fugitive emissions;
    d. Upstream emissions.

Institutional responsibilities

The data and information collected by different organizations/institutes will be shared with a national working group that can carry out the initial assessment of the energy transition progress and submit a draft report to the national committee for verification and approval. The approved report and data can be shared with the regional energy transition expert group for regional assessment of data quality check and consistency. Following the assessment, the regional group can share the data and information with ESCAP for publication and reporting. A brief description of key institutional responsibility is given below, Figure 36 presents a summary of the MRV data and information flow.

1. **Energy transition working group**: Members are selected from a wide range of public agencies, private sector experts and academia. This group will contain two subgroups – an SDG working group and an NDC working group. The SDG group will have the key responsibility for assessing and reporting the progress in achieving the SDG7 targets, while the NDC working group will assess the progress of emission mitigation, with the support of a mitigation experts team.

2. **Independent agency**: An independent agency comprising a team that does not have any "conflict of interest" will be assigned for data quality check.

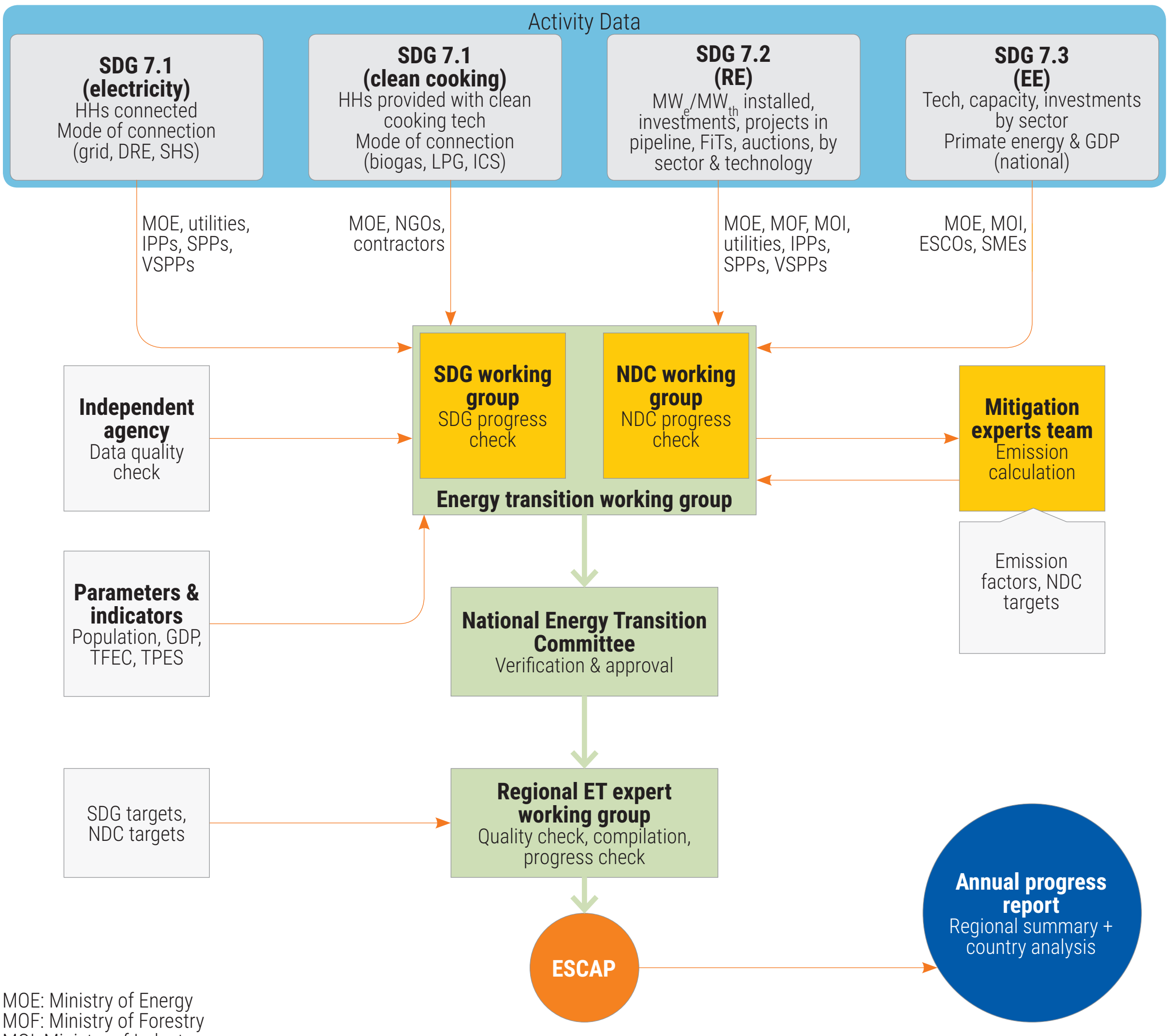
3. **National energy transition committee**: The highest MRV body in the country, comprising representatives from line ministries, the private sector, research institutions and other stakeholders. The committee will be responsible for verification and approval of the report submitted by the working group.

4. **Mitigation experts team**: A small team comprising sector experts will estimate emissions from the energy sector, based on the data supplied by the energy transition working group.

5. **Regional energy transition expert working group**: This will be a body of experts comprised representatives from the ESCAP member States, regional agencies, ESCAP secretariat representatives, the private sector and research institutes.

6. **ESCAP**: Upon receipt of the data and report from the regional working group, ESCAP will produce a regional report with country highlights.

Figure 36 | Data flow and responsibilities in an MRV for energy transition



MOE: Ministry of Energy
MOF: Ministry of Forestry
MOI: Ministry of Industry
SPPs: Small power producers
VSPPs: Very small power producers
IPPs: Independent power producers

5| Summary of Policy Options

Achieving the SDG7 targets by 2030 will require a radical transformation of the energy sector, facilitated by innovative energy technologies and policy measures. Because energy technologies are continuously evolving, policy instruments need to be continually adapted to maintain a stable and attractive environment for investment, while ensuring long-term cost effectiveness and sustainability of the energy system. There is no single policy package that can be applied across the Asia-Pacific region; therefore, policymakers will need to tailor solutions to suit local, national and regional contexts. This study has undertaken its own exploratory assessment in order to identify technology and policy options that could be used to realize a 22 per cent and 35 per cent renewable energy share in the SDG scenario and NDC scenario, respectively. While the SDG scenario will ensure the achievement of the SDG7 targets, the NDC scenario will put the region on the path to limiting the global temperature rise to below 2°C. This section lists technology and policy options, grouped under five key themes, that have been deemed as suitable based on the analysis and findings in relation to the energy transition pathways. A list of recommended actions for each of the policy themes, including potential actors, is presented in table A-3 in Annex A.

5.1 INSTITUTIONALISING ENERGY TRANSITION

Align energy policy with the SDG7 targets

Current energy policies of countries in the region are not adequately aimed at achieving the SDG7 targets. It is crucial that energy policies be aligned with the SDG7 targets to support the national efforts and resource mobilization. With regard to increasing access to electricity and access to clean cooking solutions, there is a coherent 2030 target that can be directly incorporated into national energy policies. For countries that have neither achieved nor have planned for universal access to electricity by 2030, it would be possible to amend policies. The situation with regard to increasing access to clean cooking solutions, however, is different. In many countries in the region, no definite target for access to clean cooking has been adopted and incorporated into country energy policies and this has resulted in disappointing progress during the past two decades.

For renewable energy, this report recommends that a regionally appropriate target be agreed upon, based on the two energy transition pathways developed in this study (22 per cent and 35 per cent in the SDG scenario and NDC scenario, respectively). The regional target can be disaggregated at the national level. Although policies aimed at improving energy efficiency are heading in the right direction, they need to be further strengthened to ensure that the projected gap in energy intensity reduction is addressed by 2030.

Determine the interlinkages between SDG7 and other SDGs,

As energy is the key enabler of many other SDGs, failure to achieve SDG7 will undermine the achievement of other SDGs. However, SDG7 cannot be achieved in isolation – the impacts of other SDGs on energy need to be identified and incorporated in the energy transition scenarios. The complex and diverse nature of interlinkages suggests that further research and development is undertaken, both at the national and the regional levels.

5.2 PRIORITIZING TECHNOLOGY OPTIONS AND SECTORAL SCOPING

Identify appropriate technology to provide universal access to electricity

While grid extension has been the mainstay in providing access to electricity, reaching the last mile with grid networks is challenging due to the locations of the households that have remained unconnected. However, electricity supply with DRE systems such as mini-grids and solar home systems has become an economically viable alternative, due to the continued drop in renewable energy technology prices, particularly for solar PV technology. DRE systems also can ensure a faster deployment of electricity access, which is crucial not only to ensuring the timely achievement of this target but also to allow immediate stimulation of rural development to assist in achieving other SDG targets.

Identify clean cooking technologies that are appropriate to achieving universal access

The appropriateness of clean cooking fuel technologies is highly dependent on the socio-cultural characteristic of a community, locally available resources and the ability of the Government to offer cost-subsidy. In communities with sufficient livestock, biogas digesters are often be the most appropriate technology as they offer many benefits, including improving the local environment, improving agro-productivity through use of organic fertilizer and reduction of GHG emissions. Cooking with LPG is suitable for locations that have good access to an LPG distribution network. The suitability of ICS will depend on the cooking habits of the particular community and the locally available solid biofuel resources. Locally relevant research needs to be undertaken to determine the appropriateness of ICS as a clean cooking solution. As there is an acute electric power supply shortage in most countries in the Asia-Pacific region, cooking with electric stoves is unlikely to be an appropriate solution unless there is a reliable and adequate electricity supply in target areas. The high cost of biogas digesters may render this technology option unaffordable for most users in rural areas, and a cost-subsidy to reduce the upfront cost would need to be made available. Appropriate financing models can increase the affordability of various technology solutions for users and could partially, or totally, eliminate the need for subsidies.

Conduct a feasibility study to identify renewable energy technologies to achieving the national target

The choice of renewable energy technology will depend on the country and the location where the technology is to be applied. Feasibility studies to determine the resource availability and the likely cost of energy would serve as the starting point. Large-scale power plants are economically attractive if supported by a long-term power purchase agreement, whereas rooftop solar PV has proved to generate momentum in the renewable energy market where FiT is available as a start-up support mechanism. The application of renewable energy would also need to be expanded to other sectors, i.e., the residential, industrial and transport sectors. While solar water heaters hold a promise for the industry sector, particularly for SMEs, policies to support the uptake of EVs (charged by renewable energy) can be a promising opportunity for the transport sector. It is necessary to ensure that biofuels, such as bioethanol and biodiesel as a blend in passenger and commercial vehicles are sourced from a sustainable process. Countries without existing market research can benefit from a feasibility study to examine the resource availability and financial viability.

Accelerate the deployment of energy efficiency and renewable energy technologies in the industrial and transport sectors

Renewable energy technologies such as solar thermal systems have potential in the industry sector, specifically in SMEs. SMEs are a promising sector for the adoption of sustainable energy technologies; however, they are time- and resource-poor. The EPC model, through ESCOs where the users do not need make a capital investment, has proved to be effective. Energy efficiency in the transport sector can be delivered by, for example, promoting EVs. Government intervention would be required in creating the required economies of scale by installing an initial set of charging stations.

5.3 FINANCING THE ENERGY TRANSITION

Leverage private investment to generate risk capital

Public funding in the Asia-Pacific region is insufficient to enable energy transition. For example, increasing the renewable energy share from the current level to 22 per cent and 35 per cent for the SDG and NDC scenarios, respectively, will require incremental annual investments of an estimated $101 billion and $282 billion. In addition, accessing public funding by the energy sector remains a challenge due to competing priorities in other sectors. Leveraging private sector investment is therefore essential to supporting the required transformation of the energy sector and to developing a long-term sustainable market. Specifically, private investment can increase the availability of risk capital as public funds are often shielded from investing in high-risk projects. Policy adjustment would open the door to private investment in the energy sector, such as by developing a long-term power purchase policy and public-private partnerships, promoting renewable energy auctions and enabling easier access to financing.

Develop fiscal measures to incentivize market development

Sustainable energy technologies and projects have high upfront costs, and minimal operating and maintenance costs. This places a higher focus on the cost of financing and can deter investment in renewable energy and energy efficiency projects, which consequently results in a limited number of market players. Fiscal measures, such as reduced corporate income tax, corporate tax holiday, import duty exemption for eligible technologies and equipment, and exemption from value-added tax, can attract investors and small businesses to foster market stimulation.

Promote entrepreneurship through easy financing and the adoption of robust business models

ESCOs in Asia and the Pacific face challenges in accessing capital finance, as renewable energy and energy efficiency projects are perceived as high-risk investments and most local commercial banks are therefore not interested in financing them. Strengthening the capacity of ESCOs, through making financing easier, would be a step in the right direction by governments. The investment risk can be reduced or eliminated by establishing a revolving fund to offer concessional loans for implementing energy efficiency and renewable energy projects.

Phase out fossil fuel subsidies to improve the economic viability of energy transition

Fossil fuel subsidies rarely achieve their intended objectives – the wealthy are usually the major beneficiaries of these subsidies as they consume more energy than the poor, although the subsidies are designed to assist the poor. Fossil fuel subsidies also have a wide range of unintended outcomes, including encouraging wasteful use of energy, increasing GHG emissions and creating social inequality. Phasing out fossil fuel subsidies increases market competition in the energy sector, reduces the drainage of foreign currency and can divert investment to renewable energy projects. That redirection of funds would cover a significant share of required investment. Where a subsidy is critical to making the energy affordable for poor people, payment could be made directly to a user's bank account to avoid misuse of the subsidy.

Level the playing field for renewable energy

The costs of environmental and social damage of fossil fuel-based power generation technologies are significant. Comparing the financial viability of renewable energy projects with fossil fuel-based projects, without considering these costs, leads to uneven competition in the marketplace. IRENA has published the likely environmental and social costs associated with fossil fuel technologies, and those projected costs can be incorporated in project cost calculations for fossil fuel projects. An alternative is to introduce a levy on every unit of energy generated from fossil fuel, such as a carbon tax, to offset the cost of damage. This would level the playing field for sustainable energy technologies. The additional investment required for the growth in renewable energy share in Asia and the Pacific can be entirely covered by investing the avoided fossil fuel subsidy and introducing a carbon price of $25.7 per $tCO_{2\text{-e}}$.

5.4 DEVELOPING AND IMPLEMENTING A REGULATORY FRAMEWORK

Stringent regulations on fuel economy can reduce fuel consumption and emissions by the transportation sector

Such regulations should target light-duty vehicles and require all new vehicles to meet an emissions limit based on vehicle-kilometres travelled. This policy instrument would be particularly relevant for countries with megacities, such as China, India, Indonesia and Thailand. Such stringent regulations will also level the playing field for EVs by making them cost-competitive and encouraging a more rapid uptake of EVs.

Minimum energy performance standards (MEPS) and a labelling programme for electrical appliances are a good regulatory approach for increasing energy efficiency

Such programmes can start with some selected appliances and equipment that are likely to result in high energy, financial and environmental savings, and can be expanded later to cover a wide range of appliances. Special attention should be given to the enforcement and monitoring of the programme. Allocation of resources to appropriately monitor and verify the level of compliance with the standards will be critical to ensuring the effectiveness of the programme.

Develop and implement mandatory building energy codes and energy performance benchmarks

Such measures have the potential to reduce energy consumption in buildings and are essential to increasing energy efficiency in the building sector. The codes and standards should require all new buildings as well as buildings that are being renovated to meet minimum performance levels; this should cover both the building envelope and energy-using equipment. The types of codes will depend on the country but can include specific renewable energy technologies, such as solar water heaters, and minimum energy performance standards, such as maximum energy consumption per square metre of floor area. Governments can consider making it mandatory for building owners who are selling buildings to make energy performance information available to prospective buyers.

5.5 LEVERAGING REGIONAL COOPERATION

Accelerate the expansion of an interconnected grid to allow absorption of a higher share of renewable energy generation

While the share of renewable energy needs to grow significantly, connecting increasing levels of renewable electricity generation to grids will inevitably give rise to security and reliability problems, unless appropriate technical and management processes are put in place. Such processes should start to be put into place immediately. Enlarging the balancing area by connecting national grids is one of the suitable solutions, at least, until highly efficient large-scale energy storage technologies are available. Although increasing the amount of flexible generation connected to the grid is another alternative, it is expensive.

Develop an energy transition roadmap tool to assist countries to successfully move through the transition

The energy transition to 2030 requires a well-developed plan, backed by concerted actions with cross-sectoral and regional cooperation, to ensure all the SDG7 targets are achieved comprehensively and on time. Setting targets appropriately and undertaking resource planning in a way that is not only financially viable but also has a long-term sustainability is crucial. The challenges in achieving the NDCs add another layer of difficulty. Public resources are scarce and government officials are not equipped with the tools that can be used to make this happen. A web-based "Energy Transition Tool" can facilitate the countries and the region to navigate through the transition. An initiative by the ESCAP secretariat to carry out the initial scoping and development of the platform that countries can tune to suit the local context would be instrumental in crafting the right path.

Initiate an awareness campaign programme for addressing the cultural and behavioural aspects that prevent the introduction of biogas digester technology

Many people believe that gas from biogas digesters is not clean and should not be used for cooking. The message that this is a misconception should be disseminated with the assistance of the advocates in each community in order to increase the confidence of potential users. ESCAP can be an effective platform for such an awareness campaign and information dissemination. Local non-governmental organizations can be used to disseminate the relevant information and the technology in hard-to-reach areas in order to keep the cost of deployment low. Crop residues should be used where available, as this can eliminate some of the cultural issues.

Figure 37 | Action-map for energy transition

	Policy and planning	Technology prioritization	Investment and market access	Fiscal measures	Regional cooperation
SDG 7.1	▪ Incorporate 100% electrification by 2030 in energy policy	▪ RE-based mini-grid for high load density areas ▪ SHSs for low load density areas	▪ Invite IPPs, SPPs, VSPPs ▪ Create revolving fund to offer concessional loans		
SDG 7.1	▪ Incorporate 100% clean cooking by 2030 in energy policy	▪ Biogas digester to areas with livestock ▪ LPGs in areas with supply network ▪ ICS to reach the last mile	▪ Capital subsidy for biogas digester ▪ Develop local entrepreneurs ▪ Improve LPG supply network		▪ Develop energy transition roadmap ▪ Develop mechanism for national RE targets ▪ Regional dialogues ▪ Knowledge sharing ▪ Capacity building ▪ Energy connectivity/ interconnected grid ▪ Analyse interlinkages and develop guidelines ▪ Measure progress of energy transition (MRV)
SDG 7.2	▪ Disaggregate regional target to national levels ▪ Incorporate national target in energy policy	▪ Feasibility study to identify suitable technologies ▪ Choice will depend on locally available resources and load demand	▪ Long-term power purchase ▪ RE auction for large projects ▪ Public-private partnership ▪ Feed-in-Tariff	▪ Exempt import duty ▪ Phase out FF subsidy ▪ Introduce levy/ carbon tax ▪ Corporate tax holiday	
SDG 7.3	▪ Estimate historical changes in energy intensity ▪ Incorporate twice the rate in energy policy by 2030	▪ Feasibility study to identify sectoral scopes ▪ Use best practices guidelines to identify energy efficient equipment for industry sub-sectors	▪ Support ESCOs development ▪ Promote energy performance contract model for SMEs ▪ Create revolving fund to offer concessional loans		
ACTORS	MOE, MOF, investors, research institutes, business community	MOE, MOF, MOT, MOI, utilities, civil society groups, NGOs, investors and entrepreneurs	MOE, utilities, MOF, Petroleum and Coal associations, national financial institutes, IFIs, MDBs	Board of Investment, MOF, MOE, MOI, MOT	ESCAP, expert group, IFIs, MDBs, partners, think tanks, investors,

Analyse interlinkages of SDG7 with other SDGs and reassess energy scenario

6| Conclusion

The energy transition in Asia and the Pacific offers both opportunities and challenges. The target for universal access to modern energy by 2030 will open the door for economic productivity in rural areas and bring significant social benefits to communities that have long received little attention. The increased share of renewable energy will diversify energy systems and reduce the region's reliance on imported fuels, outcomes that are crucial to the improvement of energy security. Furthermore, growth in renewables will see increased private investment at the national and regional levels as well as increased job creation. Measures to accelerate energy efficiency improvement will enhance productivity, and reduce the cost of renewable energy growth and GHG mitigation efforts.

Achieving the transition represents a major undertaking and will require concerted efforts by countries as well as facilitation through a well-coordinated regional approach. Leveraging private investment will be one of the key tasks, as public funding is neither sufficient to make the transition nor easy to mobilize to ensure the timely achievement of the SDG7 targets. Policymakers are entrusted with creating an enabling business environment to lower risks and build market confidence in order to attract private investment and spur innovation. Renewables are now cost-competitive with their fossil fuel counterparts on a level playing field, which includes consideration of externalities and the elimination of fossil fuel subsidies.

The SDGs and NDCs are mutually reinforcing. Both can be achieved by 2030 by devising a robust energy transition roadmap that accounts for all the SDG7 targets and the mitigation target under NDCs. A regionally agreed pathway would be the preferred approach, as it can be further disaggregated at the national level based on the local context, available energy resources, and financial and institutional capacity of each country. ESCAP can be an important platform for facilitating the roadmap for development, sharing knowledge and resources, building capacity at the national level, coordinating progress through an MRV tool and providing technical assistance to those countries experiencing difficulties in implementing the transition. Finally, the interlinkages between SDG7 and other SDGs will need to be identified, and the impacts of other SDGs on energy will need to be incorporated in the energy transition roadmap.

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ANNEX A:
REGIONAL CONTEXT FOR SDG7

The Asia-Pacific region, with a population of 4.3 billion and comprising 53 member States ranging from highly industrialized to least-developed countries, has diverse geography, economic size and conditions, poverty and social circumstances, energy use and resources, environmental impacts and overall quality of human well-being. The geographical scope stretches from Turkey in the west to the Pacific island state of Kiribati in the east, and from the Russian Federation in the north to New Zealand in the south. The region is divided into five sub-regions – East and North-East Asia (ENEA), North and Central Asia (NCA), South-East Asia (SEA), South and South-West Asia (SSWA), and the Pacific. In 2014, Asia-Pacific economies produced 32 per cent of the world's GDP and held more than half of the global energy supply (Table A-1).

Table A-1 | Selected development indicators for Asia and the Pacific

Indicators	Units	East and North-East Asia	North and Central Asia	Pacific	South and South-East Asia	South-East Asia	Asia and the Pacific
Total GDP (2005 $)							
1990	($ billion)	4,950	955	540	848	457	8,932
2000	($ billion)	6,896	679	788	1,322	766	10,268
2014	($ billion)	11,886	1,219	1,139	2,848	1,507	18,599
Population							
1990	Millions	1,368	214	27	1,243	444	3,297
2000	Millions	1,491	218	31	1,516	525	3,780
2014	Millions	1,604	228	39	1,877	627	4,376
Total primary energy supply							
1990	Mtoe	1,447	1,072	99	495	233	3,346
2000	Mtoe	1,906	747	127	752	393	3,854
2014	Mtoe	3,690	900	146	1,335	618	6,689
Total final energy consumption							
1990	Mtoe	1,041	776	66	396	173	2,453
2000	Mtoe	1,264	500	83	550	273	2,669
2014	Mtoe	2,353	566	95	945	435	4,394

The energy demand in the region has experienced a rapid increase in recent decades to fuel the world's fastest economic growth. Yet the energy challenges encountered by Asia-Pacific countries remain large and distinctly diverse. These challenges add further difficulties in achieving the SDG7 targets and therefore, necessitate an early review of the state to foster the development of plans that would set the region on the correct pathway to SDG7.

ANATOMY OF SDG7

SDG7 aims to ensure access to affordable, reliable, sustainable and modern energy for all. It has three key targets as discussed below. The Global Tracking Framework (GTF)[11] is the main data collection platform for all SDG7 targets which is compiled by a consortium of agencies led by the World Bank, Energy Sector Management Assistance Program, and the International Energy Agency.

Target 7.1

The first target states that "By 2030, ensure universal access to affordable, reliable and modern energy services." Two indicators are used to measure this target – (a) proportion of the population with access to electricity and (b) proportion of the population with primary reliance on clean fuels and technology. The World Bank Electrification Database, covering more than 180 countries, is the key data source for the access to electricity. The data collection system for access to clean fuel focuses on the primary fuels used for cooking which are categorized as solid or non-solid fuels – where solid fuels are considered polluting and non-modern, and non-solid fuels are considered clean. The limitation in collecting sufficient and quality data on the non-solid fuel part has led to considering access to clean cooking fuel only. The new guidelines of the WHO suggest that the use of non-solid fuel also needs to be considered, and recommend against the use of unprocessed coal and discourage the use of kerosene (a non-solid but highly polluting fuel) in the home. This report refers to the proportion of households with primary reliance on solid biofuel (mainly fuelwood) for cooking and neglects the use of non-solid fuels.

Target 7.2

This target states that "By 2030, increase substantially the share of renewable energy in the global energy mix" and requires it to be measured by the renewable energy share in the total final energy consumption. It is calculated by dividing consumption of energy from all renewable sources by total energy consumption. Renewable energy consumption includes consumption of energy derived from hydro, solid biofuels, wind, solar, liquid biofuels, biogas, geothermal, marine and waste. Importantly, this indicator focuses on the amount of renewable energy consumed rather than the capacity for renewable energy production, which cannot always be fully utilized.

Target 7.3

This target states that "By 2030, double the global rate of improvement in energy efficiency", which should be measured by the energy intensity of the economy obtained by dividing total primary energy supply (TPES) over the gross domestic product. Energy intensity is an indication of how much energy is used to produce one unit of economic output. As defined by the IEA, TPES is made up of production plus net imports minus international marine and aviation bunkers plus-stock changes. For comparison purposes, GDP is measured in constant terms at purchasing power parity.

11 http://gtf.esmap.org/

Table A-2 | Announced renewable energy targets in the selected ESCAP member States

Country	Target
Armenia	6.9% of PE by 2025
Australia	23% of electricity by 2020
Azerbaijan	20% of
Bangladesh	10% of FE by 2020
Brunei Darussalam	10% of electricity by 2035
Cambodia	25% of electricity by 2035
China	20% of FE by 2030
India	40% of electricity by 2030
Indonesia	25% of PE by 2025
Fiji	23% of FE by 2030
Japan	14% of PE by 2030
Kazakhstan	50% of electricity by 2030
Lao People's Democratic Republic	30% of FE by 2025
Malaysia	11% of electricity by 2030
Mongolia	25% of PE by 2020
Nepal	10% of PE by 2030
Pakistan	10% of electricity by 2015
Palau	20% of PE by 2020
Philippines	40% of electricity by 2030
Republic of Korea	11% of PE by 2030
Russian Federation	4.5% of electricity by 2020
Samoa	20% of PE by 2030
Sri Lanka	20% of electricity by 2015
Tajikistan	20% of electricity by 2020
Thailand	30% of FE by 2036
Turkey	30% of electricity by 2023
Vanuatu	65% of FE by 2020
Viet Nam	8% of PE by 2025

Source: (ESCAP 2017b)

Table A-3 | Recommended actions and actors to implement the energy transition

Action areas	Action level	Recommended actions	Actors
Institutionalising SDG7 targets	National	▪ Determine SDG7 target levels relevant to national context ▪ Discuss with stakeholders to identify feasibility of targets ▪ Incorporate targets in energy policy ▪ Develop implementation plan and mobilise resources	Ministry of Energy, business community, investors, research institutions
	Regional	▪ Establish an "expert working group" ▪ Develop energy transition roadmap tool ▪ Train countries on the use of the tool	ESCAP, subregional associations, experts and think tanks
Prioritizing technology options and sectoral scopes	National	▪ Conduct technology and market assessment ▪ Prioritise technologies for each target ▪ Identify areas for DRE-based electrification ▪ Identify technology options for clean cooking solutions ▪ Determine appropriate RE technologies ▪ Define prioritised sectors for energy efficiency	Ministries of Energy, Finance, Transport and Industry. Utilities, civil society groups, NGOs, investors and entrepreneurs
	Regional	▪ Develop a comprehensive guideline for technology prioritization ▪ Develop an RE resources atlas ▪ Compile best practices on energy efficiency ▪ Develop an online knowledge product	ESCAP, expert working group, IRENA Ministry of Energy, utilities, Board of Investment,
Financing energy transition	National	▪ Establish an investors forum ▪ Discuss factors for investment climate ▪ Develop a long-term power purchase policy ▪ Develop policies for fiscal incentives ▪ Identify and develop market mechanisms e.g. FiT ▪ Promote renewable energy auctions ▪ Enable foreign investments ▪ Develop and regularly update high-value projects to inform investors ▪ Initiate fossil fuel subsidy reform ▪ Introduce carbon tax or levy on petroleum products	Ministry of Finance, Petroleum and Coal associations, banks, IFIs, MDBs
	Regional	▪ Compile robust business models ▪ Arrange foreign investors forums ▪ Conduct an assessment of a regional emission trading system	ESCAP, expert working group
Leveraging regional cooperation	National	▪ Share lessons and knowledge ▪ Promote technology transfer ▪ Discuss opportunities for the expansion of interconnected grid	Entrepreneurs, investors, high-level decision makers
	Regional	▪ Organise regional conference and seminars to promote knowledge sharing ▪ Develop and implement programs to build capacity of policymakers ▪ Facilitate intergovernmental dialogues ▪ Develop a master plan for the expansion of interconnected grid, and facilitate the implementation	ESCAP, subregional associations, foreign investors, experts and think tanks
Measuring the progress	National	▪ Develop a comprehensive data collection system ▪ Develop a reporting framework ▪ Define institutional responsibilities and streamline data reporting process ▪ Regularly update and share data at the regional level	Ministries of Energy, Transport, industry. Ministry /Bureau of Statistics, utilities, IPPs, investors
	Regional	▪ Develop an MRV guideline ▪ Establish an interactive data management system ▪ Evaluate the progress on annual basis ▪ Identify and communicate non-achievements ▪ Provide technical assistance to non-achievers	ESCAP, subregional associations, expert working group

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The Asia-Pacific region has evolved as a global economic powerhouse. Rapid and sustained economic growth, increasing population, expanding industrialisation and fast urbanization are driving the region's growth in energy demand. Ensuring adequate supplies of energy to meet the rising energy demand is a major challenge. In addition, the 2030 Agenda for Sustainable Development and the commitments under the Paris Agreement on climate change create a new set of challenges for members and associate members. Developing an energy transition pathway that addresses these challenges by enabling policymakers in determining the right set of technology and policy choices is crucial.

ESCAP Resolution 67/2 gave the Secretariat the mandate to convene the Asian and the Pacific Energy Forum (APEF) in 2013 on the theme of enhanced energy security and the sustainable use of energy. At APEF, member States agreed on the Ministerial Declaration and Plan of Action. The APEF Regional Trends Report is prepared annually in order to support the implementation of the first APEF outcomes and the implementation of the Sustainable Development Goal on energy (SDG7).

This edition of the Regional Trends Report aims to contribute to discussions at the Second Asian and the Pacific Energy Forum in 2018 on the energy transition, in the context of the 2030 targets and commitments. Through an empirical analysis of the region's current and future development, this report describes a series of scenario-based pathways to inform policymakers how the region as a whole can prepare for the energy transition in the period to 2030. The report will guide members and associate members and their policymakers in developing robust, economically viable, socially acceptable and environmentally sound national energy plans to navigate the energy transition.

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