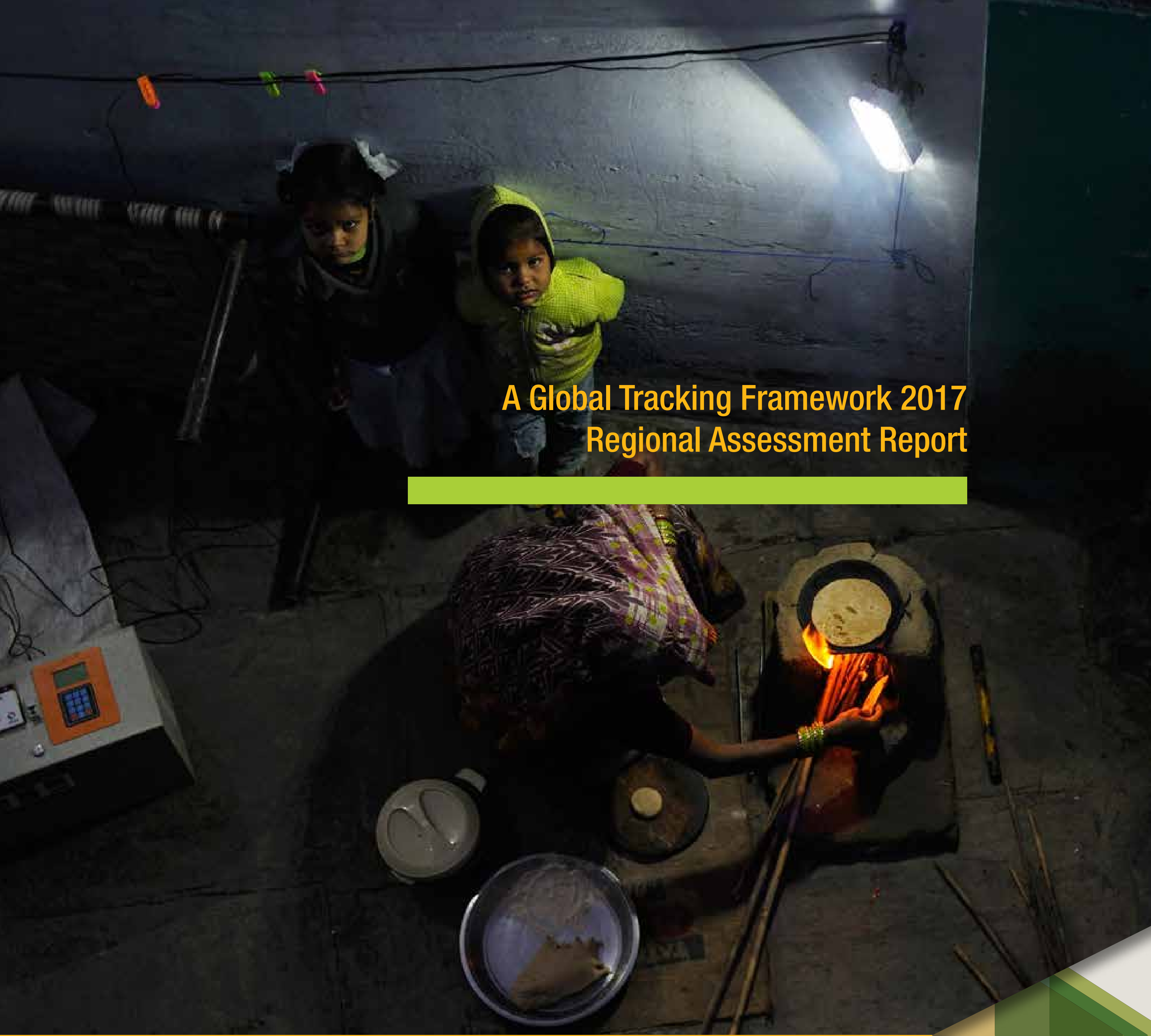

A Global Tracking Framework 2017
Regional Assessment Report

Asia-Pacific Progress in Sustainable Energy

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

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FOREWORD

Sustainable energy will play a central role in building a future based on sustainable development. Secure, clean and affordable energy is needed to address poverty, underpin economic growth and social development, while minimizing environmental pollution and mitigating climate change. The centrality of energy to economic progress, human welfare and environmental well-being is acknowledged by the 2030 Agenda, which includes a dedicated goal on sustainable energy incorporating targets for renewable energy, energy efficiency and energy access.

In support of this goal, the Global Tracking Framework (GTF) offers a valuable tool for policymakers and stakeholders to take stock of how the Asia-Pacific region is progressing on shared goals in the areas of energy access, energy efficiency, and renewable energy. This report is the result of collaboration between agencies under the GTF consortium and offers a detailed overview of the results achieved to date. It highlights examples of positive actions and progress, and pinpoints areas requiring additional attention.

There are significant challenges in realizing these goals. Across the Asia-Pacific, an estimated 420 million people lack access to electricity and nearly half the region's population still relies on polluting and unhealthy cooking fuels and technologies. Significant energy access disparities exist between rural and urban populations. Rural populations, in particular, women and children, bear the largest burden of energy poverty. Though much progress has been made, particularly in rural electrification, bridging the remaining gaps are difficult, calling for a focus on implementation by the region's policymakers.

We are continually reminded of the consequences of air pollution and climate change in our region, which are primarily the result of our reliance on fossil fuels. Renewable energy is a key solution to these challenges. The Asia-Pacific region leads the world in renewable energy installation. Yet further efforts are needed to expand the role of renewable energy within the energy mix. Greater investment, a supportive policy environment and innovative business models are needed to accelerate the transition towards a cleaner energy future.

Energy efficiency holds enormous promise to both decarbonize our energy systems and drive more productive economies. Over the past decade, the region has made significant progress in decoupling energy demand from economic output through energy efficiency, with significant advancements occurring in the industrial sector. Innovative technology has been developed, with countries such as China and Japan acting as global leaders. Nonetheless, Asia and the Pacific remains one of the most energy-intensive among the global regions, and the uptake of energy efficiency measures varies greatly among member States.

Given the scale and complexity of the challenges facing sustainable energy, regional cooperation is instrumental in developing comprehensive, integrated and durable solutions. Countries of the region have already demonstrated their capacity for cooperation. In 2013, ministers convened the first Asia Pacific Energy Forum (APEF), which set an ambitious sustainable energy agenda, exhibiting the leadership of regional policymakers. Since then, regional momentum has been building with the addition of interlinked objectives and commitments made under the 2030 Agenda for Sustainable Development and the Paris Agreement. In 2017, a significant milestone was reached with the establishment of the ESCAP Committee on Energy. A dedicated Asia-Pacific intergovernmental platform on energy was created. In April 2018, the second APEF will be held to review and shape the regional energy agenda.

This regional analysis under the Global Tracking Framework report plays a key role in assessing the efforts and progress in the three critical areas of sustainable energy, helping policymakers identify the most urgent areas for action.

The region needs to work towards providing all people with vital energy services; and to fast track a transition towards low-carbon, nonpolluting energy, with increased energy efficiency. ESCAP as the regional arm of the United Nations in the Asia-Pacific region, will continue to provide a platform that brings governments, development partners, civil society and the private sector together. We strive to build new partnerships and strengthen ongoing collaborations, including with our regional partner, the Asian Development Bank, to support our members in their efforts. I believe this report provides a practical contribution to regional dialogue among the many stakeholders who will contribute to the realization of our shared vision for sustainable energy.

S Akhtar

Shamshad Akhtar
Under-Secretary-General of the United Nations and Executive Secretary,
United Nations Economic and Social Commission for Asia and the Pacific

EXECUTIVE SUMMARY

Background

The Asia-Pacific region comprises 58 economies,[1] ranging from developed to least-developed, with a population of 4.3 billion, representing 60 per cent of the world total. Economies of the region produce approximately one third of the world's gross domestic product (GDP) and consume more than half of the global energy supply. In 2014, Asia and the Pacific was responsible for 55 per cent of global emissions from fuel combustion, nearly two thirds of which were from coal. Eighty-three of the world's top 100 polluted cities, as measured by PM2.5 levels,[2] are found in the region[3].

With the world's fastest rising regional energy demand and some of the largest national deficits in energy access, the decisions and actions taken by Asia-Pacific countries will largely shape the face of progress toward achieving global sustainable energy objectives, including targets under the Sustainable Energy for All initiative and Sustainable Development Goal 7. As the Paris Agreement has turned the world's focus toward decarbonization, countries across the region have offered up new and increasingly ambitious targets and approaches for transitioning to clean energy options that will help mitigate the energy sector's contribution to climate change.

Though facing many challenges, Asia-Pacific countries are demonstrating global leadership across the three main pillars of sustainable energy – access, efficiency and renewables – offering strong commitments and innovation in those areas. The present report gives an overview of progress and some of the remaining challenges under each of the three pillars.

Progress in access to energy: electrification

Key Figures

- More than 421 million people, or 9.7 per cent of the Asia-Pacific population, remained without access to electricity in 2014. 389 million of those are located in rural areas.
- Between 2012 and 2014, an estimated 93.1 million people in Asia and the Pacific gained access to electricity as the population grew by 83.8 million.
- The regional rate of electrification rose to 90.3 per cent, up from 89.8 per cent in 2012, though national rates are varied widely.
- Urban areas are gradually approaching universal access, at 98.7 per cent in 2014, while rural areas have stagnated in that regard, at 83.3 per cent since 2012.
- In the period 2012-2014, China, India and Pakistan each added between 13 and 16 million people to their populations with access to electricity. Afghanistan, Bangladesh, Indonesia, and the Philippines extended electricity service to between five and nine million people.

Sustainable development is impeded by energy poverty, which is experienced by a large portion of the Asia-Pacific population. Countries of the region are working to bring electricity to their growing populations in order to support social development and economic growth. In recent years countries have established clear policy targets that are increasingly backed by supportive programmes and economic measures.

According to the GTF data, China achieved universal access in 2014. During the period 2012-2014, Afghanistan, Bhutan, Cambodia, the Lao People's Democratic Republic, the Marshall Islands and Nepal reported some of the region's most rapid progress in raising their electrification rates. Approaches varied, but countries such as Cambodia and the Lao People's Democratic Republic combined grid extensions with broad solar home system distribution efforts to boost rural electrification. Other countries, such as India and Nepal, have demonstrated the potential for microgrids to offer higher quality and economically sustainable off-grid power. Public-private and public-civil society partnerships have also emerged, pioneering new models to incorporate the latest technologies and approaches to off-grid renewable power systems. These new partnerships are working to provide the most cost-effective electrification solutions, especially in remote communities that are often the most disadvantaged in terms of electricity access.

Nevertheless, the challenges remain numerous and diverse. Though progress in electrification continued at the regional level, it slowed in the recent period, attributable to population growth in rural areas and the ongoing difficulty of extending services to remote areas. The rate of progress has declined in countries with the largest deficits, namely India, Bangladesh, and Myanmar, while the lowest access rates are found among a number of Pacific Island and least developed State.[4] Though urban areas in most economies have achieved universal access, rural areas lag behind, and, in a few cases with growing rural populations, rural electrification rates are falling. Furthermore, low quantity, quality, and reliability of the power supply is a challenge in many places, as is legality and affordability.

1. This number includes ESCAP Asia-Pacific regional members and associate members. For a breakdown of ESCAP and ADB members, please see annex I.
2. Particulate matter (PM) are air pollutants known to produce respiratory and cardiovascular illness and are particularly prevalent in urban areas. The most widely used PM measurement is PM10 (particle size between 2.5 and 10 micrometers), though PM2.5, fine particles measuring less than 2.5 micrometers, are known to have greater adverse health effects and are increasingly being measured. PM10 is produced by mechanical processes, such as construction activities, and dust and wind, whereas PM2.5 is generated from combustion sources such as power plants and motor vehicles.
3. Data are available from the World Health Organization for more than 3000 human settlements, mostly cities in 103 countries, though not all cities collect or report on their ambient air quality.
4. Economies with less than 50 per cent electrification in 2014 include: Democratic People's Republic of Korea; Papua New Guinea; Solomon Islands; Timor-Leste; Vanuatu; and American Samoa.

Government budgets are often insufficient to meet the challenge because of the high costs of building and maintaining infrastructure in outlying and geographically challenging regions. Coordination and integrated planning between various government actors responsible for planning national grid extensions or rural and off-grid electrification remains inadequate in many countries. Addressing that requires not only the removal of barriers regarding institutional inefficiencies and overlaps, but also the creation of comprehensive, predictable policy frameworks that improve the investment climate.

Lastly, current measures of access to electricity suggest that nearly one in ten people lack electrical connections. However, this binary measure – either a household has a connection, or it does not – fails to capture relevant aspects of quantity, quality, reliability and affordability. New data will be published in forthcoming issues of the Global Tracking Framework report according to a multi-tier framework, which incorporates those aspects and ranks the level of access under five tiers. With this new data, light will be shed on the state of energy access, and the electrification picture may dim. A recent study in India using the tiered measurement framework suggests that many who are currently considered to have access to electricity may fall into tier 0, meaning that their connection is very poor, with less than four hours of power per day (Jain and others, 2015). To meet the universal access target, and in consideration of higher levels of access for better development outcomes, more effort is needed to provide access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services.

Progress in Access to Energy: Clean Cooking

Key Figures

- In the Asia-Pacific region, almost 2.1 billion people – nearly half of the region's population and more than a quarter of the global population – remain without access to clean cooking.
- The World Health Organization (WHO) estimates 92 deaths per 100,000 people to household air pollution in developing Asia.[5]
- In 2014, the regional rate of access to clean cooking reached 51.2 per cent, up from 39.8 per cent in 2000.
- In 2014, only 12 Asia-Pacific economies had clean cooking access rates of over 99 per cent.
- The average annual share increase in access to clean cooking has hovered around 0.8 per cent over the period 2000-2014, well below the pace to achieve universal access by 2030.

The use of traditional biomass in the form of wood, charcoal and dung in open fires or inefficient stoves compromises indoor air quality. This especially affects women, who are typically responsible for food preparation, and the children who accompany them. Generally, women also bear the burden of gathering biomass, such as fuelwood, which is time that could be spent on other social or productive activities. The use of clean fuels and technologies (such as liquefied petroleum gas (LPG), biogas, electricity, advanced biomass cookstoves and solar cooking) improves indoor air quality and reduces time spent on gathering fuels.

At the regional level, small, steady gains have been made in closing the gap between those with and without access to clean cooking fuels and technologies (herein after "clean cooking"), but the overall regional pace of improvement falls well short of what is required to achieve universal access to clean cooking by 2030. National situations are highly varied. High-income countries and those endowed with abundant natural gas supply make up the small Asia-Pacific country group that has obtained universal access to clean cooking. Some countries are making slow progress, while others are losing ground. Growing populations in rural areas, where traditional biomass use is most prevalent, has led to falling rates of access to clean cooking in countries such as Bangladesh, Afghanistan, Sri Lanka and Timor-Leste.

Exceptions to the overall lacklustre progress have emerged. In particular, Indonesia led the world in its pace of increasing access through the expansion and promotion of LPG fuel and technology markets, resulting in a dramatic increase from a mere 2.4 per cent in 2000 to 56.6 per cent in 2014. The Maldives has also reported impressive progress and is approaching universal access. Several other countries doubled their rates over the same period, including, among them, Cambodia, the Democratic People's Republic of Korea, Myanmar, Nepal and Viet Nam – but many have yet to achieve scale and pace.

Looking forward, progress on access to clean cooking may gain momentum as more attention is now being paid to the issue by the region's policymakers. Several Asia-Pacific countries have recently put forward clean cooking targets, and conducted research on and expanded markets for clean cooking fuels and technologies. However, current efforts remain small in comparison to the scope of the problem, and the challenges are great. For the switch from traditional to clean cooking to take place, the expansion and reliability of technology and fuel distribution networks is necessary, along with greater efforts to improve utility and affordability. Clean cooking must be better integrated into energy policy frameworks, and greater investment is needed to support the development of options that meet consumer needs and overcome barriers, such as cost and cultural preferences. Furthermore, increasing employment opportunities for women in rural areas raises the opportunity cost of gathering fuel for households. With value attributed to women's time, households are more likely to choose more efficient technologies with shorter cooking times and reduced fuel gathering requirements (Ekouevi and Tuntivate, 2012).

5. Developing Asia in this context refers to the member States of the South-East Asia subregion of WHO, namely Bangladesh, Bhutan, the Democratic People's Republic of Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand and Timor-Leste. Data are from the Global Health Observatory data repository, "Household air pollution burden of disease by WHO Regions, 2012", available from: http://apps.who.int/gho/data/node.main.HAPBYCAUSEBYREGIONANDWORLD?lang=en.

Progress in Energy Efficiency

Key Figures

- The region has demonstrated a long-term decline in energy intensity, falling from 9.1 MJ/2011 PPP$ in 1990 to 6.0 MJ/2011 PPP$ in 2014, and progressing towards convergence with the 2014 global average of 5.4 MJ/2011 PPP$.
- The region's energy savings between 2012 and 2014 were equivalent to the 2014 total final energy consumption of the Republic of Korea and Thailand combined.
- Supply-side efficiency in power generation showed a long-term upward trend, with regional thermal power generation efficiency increasing from 33.4 per cent in 1990 to 38.8 per cent in 2014.
- The industrial sector is responsible for the largest drop in energy intensity during the period 2012-2014, with a 3.2 per cent average annualized change in energy intensity. The service and, to a lesser extent, agricultural sectors were also reported to have made progress in that regard, at 2.5 per cent and 0.8 per cent, respectively.
- Energy efficiency gains in China between 2006 and 2014 eliminated the need for more than $230 billion in investment for new power generation in the country with nearly half of the region's total installed capacity.
- The Asia-Pacific region needs an average of $211 billion in annual investment to reach the 2030 efficiency target,[6] but current levels fall short.

Energy efficiency offers numerous and substantial benefits. It supports increased energy security through energy savings, reduced investment needs for new capacity, lowered reliance on energy imports and decreased vulnerability to fluctuations in global energy prices. Energy efficiency for importing countries can raise their currency reserves; while for exporting countries, domestic energy efficiency can increase the energy resources available for export. For those with energy subsidies in place, it can also lower government expenditures. Greater economic productivity is also possible with energy efficiency, while social and environmental benefits include increased energy affordability, improved air quality, reduced pollution and lowered greenhouse gas emissions.

A long-term decoupling of GDP growth and energy consumption has taken place in Asia and the Pacific, as the region increasingly produces more with less energy. During the period 2012-2014, progress in energy efficiency accelerated in the region. The short-term decline in annual average energy intensity in the Asia-Pacific region outpaced other global regions. Also, the rate of progress towards the long-term 2.6 per cent global annual energy intensity improvement rate required for meeting the SEforAll 2030 energy efficiency target increased in the region.

Energy intensity has fallen within the region primarily because of significant efficiency gains made in the industrial sector, where China, as a global leader in implementing industrial efficiency policies and measures, has largely driven the regional trend. Improvement was also seen in the power, agriculture and services sectors at the regional level. In contrast, in the residential sector energy intensity moved higher. As GDP per capita rises, populations have adopted higher standards of living that are more energy-intensive. For example, energy consumption associated with the transportation sector has increased in line with the growing passenger vehicle uptake.

National and regional energy intensity targets have been widely established. Over the years, these targets have grown increasingly broad and ambitious in scope, and are further driven by the Paris Agreement. Backing those targets, on the supply side, policies to upgrade inefficient power generation and reduce technical and non-technical transmission and distribution losses have had positive effects, with most countries showing falling loss rates. Strong progress in demand side efficiency has also been made through the introduction and strengthening of measures. These include the institution of minimum energy performance standards (MEPS) and energy conservation, particularly for lighting, appliances, space heating and cooling, and water heating.

Government financial incentives are helping drive investment and participation within the energy efficiency market. These incentives include tax reductions, subsidies, low-interest loans and equity, and risk guarantees, among others. Several countries have also established dedicated funds to alleviate technical and financial project barriers. In addition, the introduction of carbon taxation and emissions trading is also raising motivations to adopt efficiency measures in some countries.

Several governments are supporting energy service companies in efforts to realize the financial benefits of energy efficiency. Polices are in place to enable the shift away from direct subsidies for energy efficiency investments towards a market-based approach, introducing measures such as risk guarantees, increased lending and dedicated credit lines. The region also emerged as the 2016 global top issuer of green bonds. China, which is the global leader in terms of green bond issuances, as well as other countries have played a significant role in providing capital for energy efficiency, especially in transport, industry and building sectors.

Though progress in energy intensity reductions has been significant, large and sustained improvements in both supply- and demand-side energy efficiency are still needed to meet the SEforAll target. Despite the rapid progress in lowering energy intensity, Asia and the Pacific remained the most energy-intensive of all global regions in 2014. More final energy consumption across end-use sectors needs to be covered by efficiency standards, and enforcement improved to support the uptake of the most efficient technologies. However, advanced technologies remain cost-prohibitive in many cases, especially for developing countries, and a lack of investment and financing remains a major barrier. Governments are challenged to strengthen policies and standards that create a favorable investment environment and support competitive markets, particularly as data within end use sectors remains limited, hindering efforts to identify the most promising interventions.

6. Total of annual average energy efficiency investment in the 450 ppm scenario for developing Asia, and Asia and Oceana provided in the *SEforAll Advisory Board's Finance Committee Report 2015* citing the World Bank's *Global Tracking Framework 2015*. (note the GTF's reference is the *World Energy Investment Outlook 2014* published by the International Energy Agency.

Progress in Renewable Energy

Key Figures

- The share of renewable energy consumption, including both traditional (traditional biomass) and modern forms, such as solar, wind, hydro, modern biofuels and geothermal, reached 18.3 per cent of the region's total final energy consumption in 2014, down from 23.0 per cent in 1990, though up from a low of 17.9 per cent in 2011.
- In 2014, modern renewables comprised 6.8 per cent of total final energy consumption, up from 6.2 per cent in 2012, indicating a promising accelerating upward trend.
- In absolute terms, total renewable energy consumption amounted to 31.1 EJ in 2014, up from 29.3 EJ in 2012, continuing a long-term steady increase.
- Investments in renewable energy (excluding hydropower over 50 MW) in Asia and the Pacific rose from $97.2 billion in 2012, reached an all-time high of $171.1 billion in 2015, but fell in 2016 to $114.8 billion.
- The estimated yearly investment needed in Asia and the Pacific to meet the renewable energy goal by 2030 is $298 billion,[7] but current investment levels fall short.

The Asia-Pacific region has emerged as the global leader in renewable energy investment, installed capacity and consumption. Yet, the energy-hungry region has consumed more fossil fuels than the others. Fossil fuel consumption has risen substantially, limiting the growth of the share of renewable energy (including both traditional and modern forms) within the overall energy mix, and resulting in significant local and global environmental impacts.

However, the region's relatively low and recently stagnant renewable energy share masks the surge that has occurred in the sector. Modern renewables (which includes resources such as solar, wind, hydro, modern biofuels, and geothermal and excludes traditional biomass) are rapidly gaining traction and are exhibiting a promising upward consumption trend. Large increases in hydropower underpin this development. Wind and solar are also increasing at exponential rates, though they have yet to compete in share with more conventional energy sources.

The region's investments related to renewable energy reached a record high in 2015, but fell in 2016, largely because of the installation slowdown in the region's two largest markets, China and Japan. Declining technology production costs and project commissioning timing were also contributing factors. China has accounted for more than half of the total new investments in renewable energy in the region since 2008, and has been leading in new renewable energy investments globally since 2009.

Backing this development is the introduction of ambitious targets, financial incentives, public financing measures, new regulation, and continued technology maturity. Many countries provide capital subsidies, grants, and rebates for equipment and services to attract investment towards on- and off-grid renewable energy installations, helping reduce the cost of project development. Feed-in tariffs (FITs) have also been one of the most successful instruments used to drive renewable energy project development and installations. More recently, competitive auction schemes are gaining popularity, serving as a tool to further lower the costs of renewable energy.

Hydropower remains the least-costly renewable energy technology in most cases. Onshore wind and solar photovoltaics (PV) are approaching grid parity,[8] and are even beginning to compete with coal in some countries such as China, India, the Philippines and Viet Nam. India demonstrates the lowest costs for PV and onshore wind within the region. Biomass for power generation and biogas are also highly competitive in some contexts and are on the rise in countries such as China, Japan, India and Thailand, which have introduced energy crops and are taking advantage of agriculture and forestry residues. Looking forward, renewable energy costs are expected to continue to fall.

Several countries in the region have also invested heavily in technology research and development. Australia, China, India, Indonesia, Japan and the Republic of Korea have committed to doubling their respective clean energy research and development investment, targeting to invest $9.85 billion in clean energy research and development by 2021.

However, in order to double the share of renewable energy, greater efforts and progress are needed. Much of the share of renewable energy is contained within traditional biomass. Accordingly, if universal access to clean cooking fuels and technology is realized – which would result in a large decline in the use of traditional biomass – the region has to increase modern renewable energy use at greater rates. Importantly, grid system capacity and readiness for variable renewable energy integration remain key limiting factors, and large, more flexible systems with more rapid scheduling are needed to scale up variable renewable energy. In addition, the region has yet to show significant progress in incorporating renewables beyond the power sector, and focus must be directed to transport and heat.

Furthermore, investment levels are well below the amount needed to achieve the target of doubling renewable energy's share. To enable greater investment levels, legal and regulatory aspects supporting renewable energy development need to be strengthened and aligned to create the necessary enabling environment.

7. This is the amount suggested by the Sustainable Energy for All Advisory Board Finance Committee in its 2015 report, "Scaling up finance for sustainable energy investments."
8. Grid parity occurs when the levelized cost of electricity produced from sources is less than or equal to the price of purchasing power from the electricity grid.

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ACRONYMS

ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Center
APEF	Asian and Pacific Energy Forum
C2E2	Copenhagen Centre on Energy Efficiency
EJ	Exajoules
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
ESMAP	Energy Sector Management Assistance Program
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
GTF	Global Tracking Framework
IBRD	International Bank for Reconstruction and Development
IEA	International Energy Agency
IFC	International Finance Corporation
IRENA	International Renewable Energy Agency
LPG	liquefied petroleum gas
MJ	megajoules
OECD	Organisation for Economic Co-operation and Development
REN21	Renewable Energy Policy Network for the 21st Century
RISE	Regulatory Indicators for Sustainable Development
RSPN	Rural Support Programmes Network
SEforAll	Sustainable Energy for All
TFEC	total final energy consumption
TJ	terajoules
TPES	total primary energy supply
UNDP	United Nations Development Programme
UNSD	United Nations Statistics Division
WHO	World Health Organization

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01

BACKGROUND AND INTRODUCTION

Energy is fundamental to achieving sustainable development. How it is produced, distributed, and consumed affects progress within societies and across economic sectors, and determines local and global environmental impacts. Recognition of its interlinkages with development objectives has grown in recent years, and energy has emerged as a priority in national and global agendas.

In 2011, the Sustainable Energy for All (SEforAll) initiative was launched by the previous Secretary-General to pursue three major energy objectives by 2030: ensure universal energy access to modern energy services; double the global rate of improvement in energy efficiency; and double the share of renewable energy in the global energy mix. The General Assembly proclaimed 2012 to be the International Year of Sustainable Energy for All. Building on that the General Assembly declared 2014-2024 as the Decade of Sustainable Energy for All. Concurrently, in 2014, the Asian Development Bank (ADB), the Economic and Social Commission for Asia and the Pacific (ESCAP) and the United National Development Programme (UNDP) formed the SEforAll Asia-Pacific Hub to accelerate and facilitate achievement of the objectives set in the SEforAll initiative, and launched the first SEforAll Asia-Pacific Summary Report, in 2015.

Further solidifying the importance of energy, the 2030 Agenda for Sustainable Development – adopted in 2015 by countries to end all forms of poverty, fight inequalities and tackle climate change, while ensuring that no one is left behind – includes a number of targets including Sustainable Development Goal) 7: to ensure access to affordable, reliable, sustainable, and modern energy for all. Further commitments to sustainable energy are also contained under nationally determined contributions to the Paris Agreement seeking to address climate change.

With so much focus on sustainable energy, a clear understanding of progress made in achieving these goals and their influences on broader development objectives is required. The Global Tracking Framework (GTF), first published in 2013, supports the tracking of progress of the SEforAll 2030 objectives by offering the international community data and analysis on progress on energy access, energy efficiency and renewable energy. GTF is co-led by the World Bank/the Energy Sector Management Assistance Program (ESMAP) and the International Energy Agency (IEA), and, in an effort to bring the process closer to countries, the third most recent global report *Global Tracking Framework: Progress toward Sustainable Energy 2017*, released in April 2017, was produced with the support of the United Nations regional commissions. Building upon this global report, each United Nations Regional Commission has also produced their own regional version of GTF report to offer expanded and more in-depth analysis.

The Asia-Pacific report, *Global Tracking Framework 2017: Asia-Pacific Progress in Sustainable Energy,* is developed by ESCAP in cooperation with ADB. It offers an evidence-based look at progress at the regional and country levels, providing an overview of long-term trends since 1990, and focuses on progress achieved in the most recent period, 2012–2014. Furthermore, in the report, the key drivers behind progress are reviewed, and major challenges in achieving energy access, efficiency, and renewable energy objectives are identified. Evidence is drawn from the GTF data, as well as other international sources to provide a comprehensive view of progress in regional and national contexts. A strong focus is also placed on examining national policy frameworks and offering case studies to illustrate national approaches to common challenges faced by countries advancing the sustainable energy agenda.

The Asia-Pacific region comprises 58 economies[9] (Box 1.1), ranging from highly industrialized to least-developed countries, with a geographical scope that 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 home to a population of 4.3 billion, representing 60 per cent of the world total. In 2014, Asia-Pacific economies produced 32 per cent of the world's gross domestic product (GDP) and held more than half of the global energy supply. The region leads the world in terms of rising energy demand, yet some of its countries have some of the largest deficits in energy access. Therefore, the decisions and actions taken by Asia-Pacific countries will largely shape the face of progress towards achieving global sustainable energy objectives, including targets under the Sustainable Energy for All initiative and Goal 7 of the Sustainable Development Goals.

The region as a whole has experienced tremendous economic growth in recent decades, yet the energy challenges experienced by Asia-Pacific countries remain large and markedly diverse. As the distribution of energy resources remains geographically unequal, many economies face shortfalls in meeting their energy demand. A large percentage of the region's population lacks access to basic energy services, and current energy production and use practices have resulted in significant environmental impacts. In 2014, Asia and the Pacific was responsible for 55.2 per cent of global emissions from fuel combustion, nearly two thirds of which were from coal. In addition, 83 of the world's top 100 polluted cities,[10] as measured by PM 2.5 levels, are found in the region.

Asia and the Pacific remains on an economic and population growth trajectory. Increasing the energy supply to fuel growing industries and increasingly energy-intensive lifestyles

9. This number includes ESCAP Asia-Pacific regional member States and associate members. In addition to the regional members, ESCAP includes four non-regional member States, including France, the Netherlands, the United Kingdom of Great Britain and Northern Ireland, and the United States of America.
10. Data are available from WHO for more than 3,000 human settlements, mostly cities in 103 countries, though not all cities report on ambient air quality.

Box 1.1 Regional United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) and Asian Development Bank (ADB) member States and associate members, by ESCAP subregions

East and North-East Asia	North and Central Asia	The Pacific	South-East Asia	South and South-West Asia
China	Armenia	American Samoa*	Brunei Darussalam	Afghanistan
Democratic People's Republic of Korea	Azerbaijan	Australia	Cambodia	Bangladesh
Hong Kong, China*	Georgia	Cook Islands*	Indonesia	Bhutan
Japan	Kazakhstan	Federated States of Micronesia	Lao People's Democratic Republic	India
Macao, China*	Kyrgyzstan	Fiji	Malaysia	Islamic Republic of Iran
Republic of Korea	Russian Federation	French Polynesia*	Myanmar	Maldives
Mongolia	Tajikistan	Guam*	Philippines	Nepal
	Turkmenistan	Kiribati	Singapore	Pakistan
	Uzbekistan	Marshall Islands	Thailand	Sri Lanka
		Nauru	Timor-Leste	Turkey
		New Caledonia*	Viet Nam	
		New Zealand		
		Niue*		
		Northern Mariana Islands*		
		Palau		
		Papua New Guinea		
		Samoa		
		Solomon Islands		
		Tonga		
		Tuvalu		
		Vanuatu		

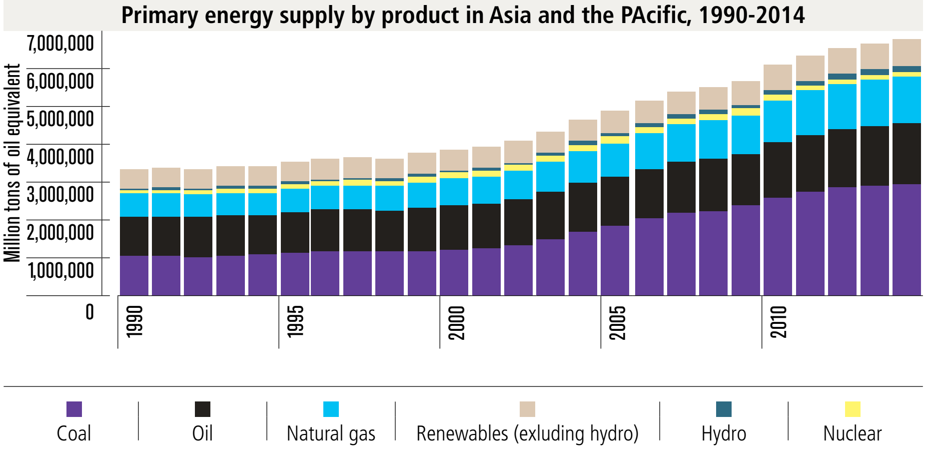
* Indicates an ESCAP associate member.
Economies in blue indicate ESCAP-only members.
Note: In addition to the list above, ADB members include Taipei, China.

is a top priority for many developing economies. Coal, natural gas, and hydro have been the primary resources backing regional growth (figure 1.1) and will remain fundamental to the energy mix for the foreseeable future, though renewable energy use is rising, particularly in the power sector. Capacity additions are changing the structure of the sector, which exhibits expansion and diversification (figure 1.2). The aspirations for a more sustainable energy future are growing, but financing options and investment fall short of needed levels, and, at the current pace of progress. The sustainable energy targets will not be achieved by 2030.

Though facing many challenges, Asia-Pacific countries are demonstrating global leadership across the three main pillars of SEforAll, offering strong

Figure 1.1 Fossil fuels dominate the energy mix

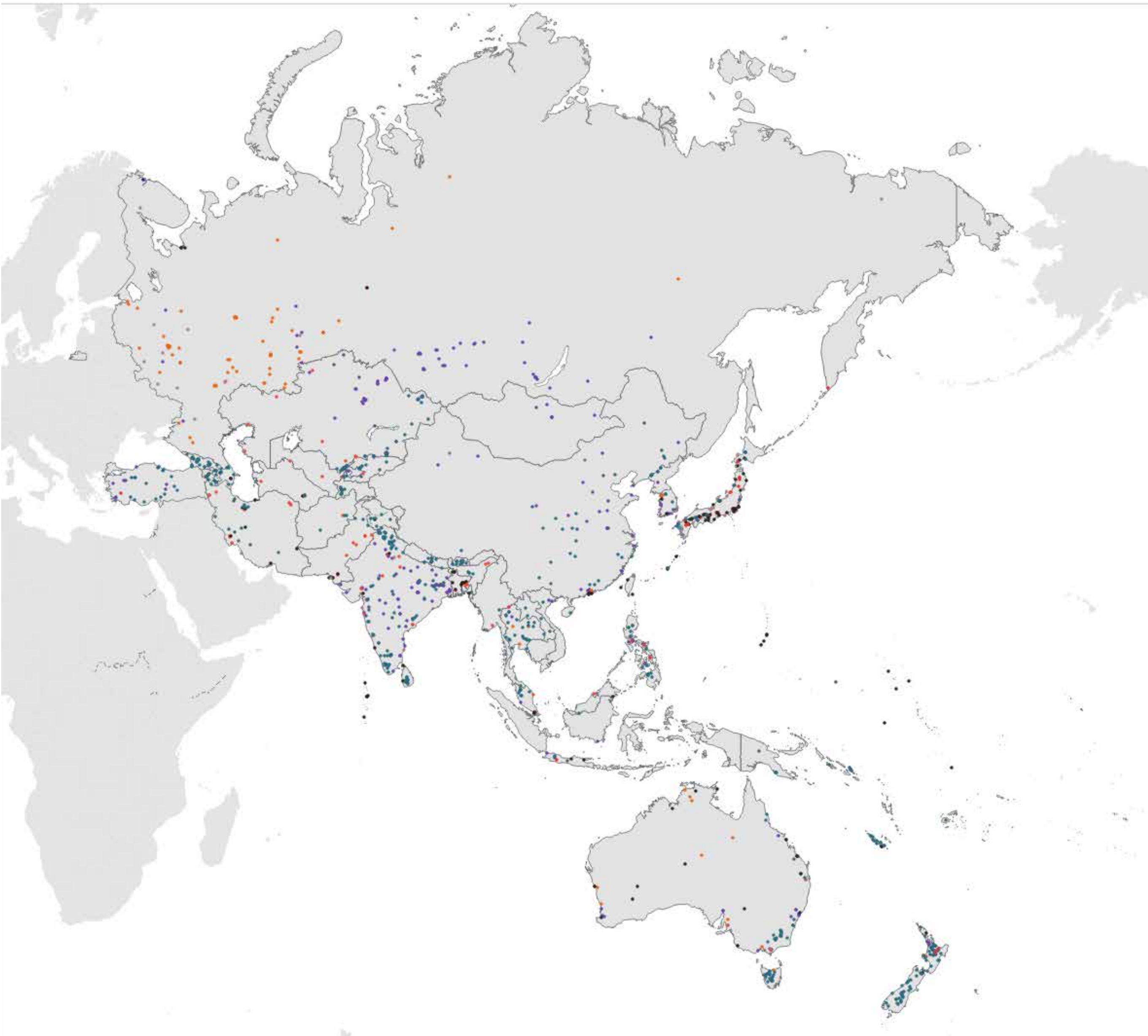
Primary energy supply by product in Asia and the PAcific, 1990-2014



Source: ESCAP based on IEA and World Bank commitments and innovation in the areas of energy access, efficiency, and renewables. New technologies and approaches have emerged, and as the Paris Agreement turned the world's focus toward decarbonization, countries across the region also set new and progressively ambitious targets for increasing energy efficiency and the renewable energy share. Sustainable energy policy frameworks across the region are evolving, with new supportive measures being adopted that expand their breadth and depth.

Figure 1.2 The power sector has grown and diversified with economic development

Power plants in Asia and the Pacific, 1990

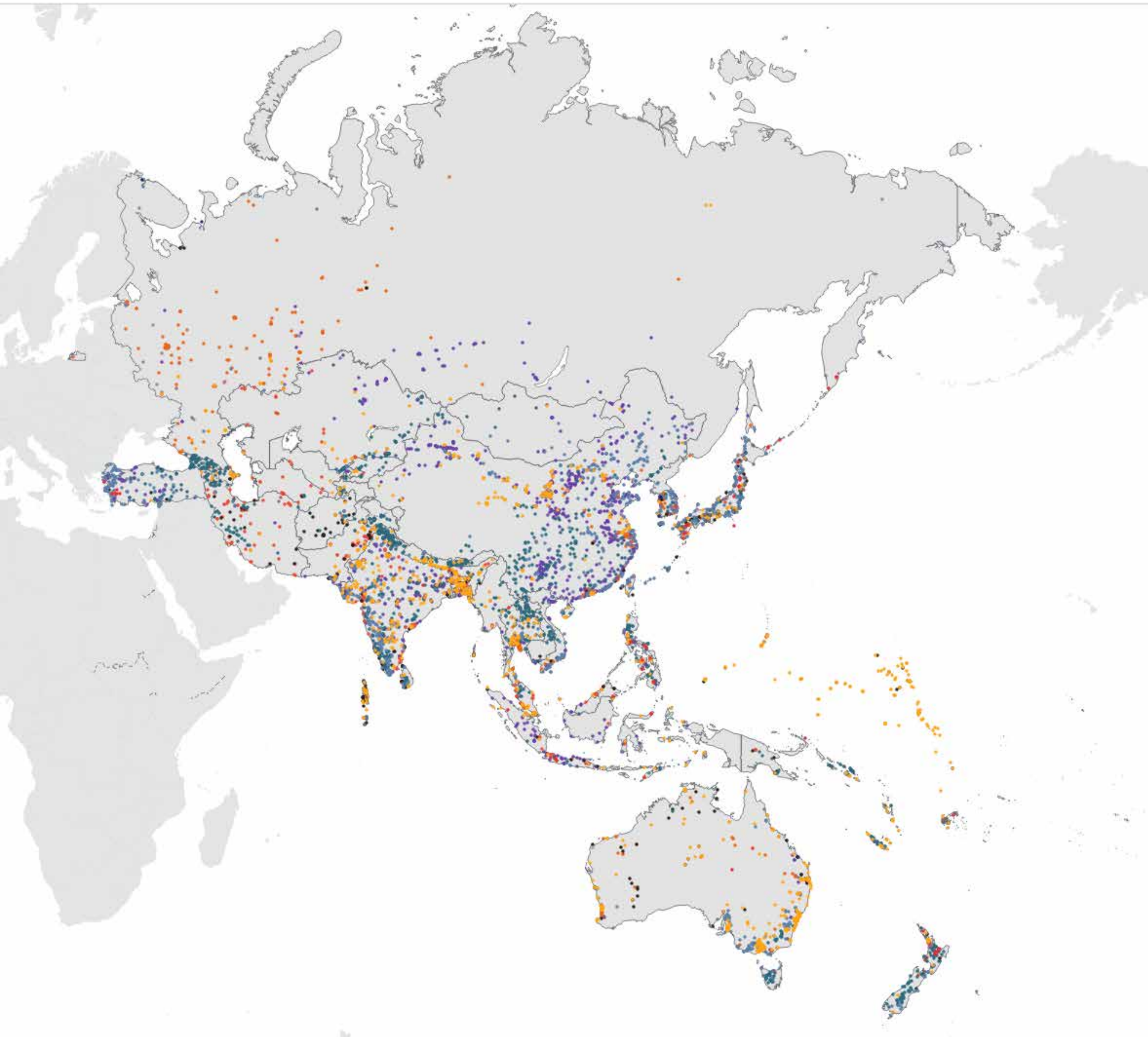


Coal | Gas | Oil/Diesel | Nuclear | Hydro

Source: ESCAP, Asia Pacific Energy Portal (asiapacificenergy.org)

Continuous review and assessment of policy measures and progress supports the ongoing improvement of national and regional efforts. Accordingly, GTF has an important role to play in offering insights into trends and case examples that can facilitate knowledge-sharing and improved decision-making. This report endeavours to provide a more in-depth look at the Asia-Pacific region than what is offered in the global GTF report, and can provide the foundation for continuous dialogue on accelerating progress.

Power plants in Asia and the Pacific, 2017



Wind | Solar | Geothermal | Biomass | Marine

02

UNIVERSAL ACCESS TO ENERGY

GOAL:
Ensure universal access to modern energy services by 2030

Though energy use at the household level is a highly complex matter, the GTF targets two dimensions of energy access – electrification and cooking. The first dimension captures whether households have electrical services supplied by grid or off-grid systems. The second dimension addresses the use of clean fuels and technologies for the preparation of food. These two dimensions are discussed separately in the following sections.

PROGRESS IN ENERGY ACCESS | ELECTRIFICATION

The role of electrification in supporting broader development objectives.

Electricity is a fundamental input to socioeconomic development. It is also an essential input to daily life for the majority of the global population, but, for the more privileged, it is a resource that may be taken for granted. At the household level, electricity is critical for basic functions, such as lighting, refrigeration and the operation of appliances. It is needed to support livelihoods, education and well-being, while enabling the comfort and conveniences of a modern standard of living. With approximately 50 per cent of the Asia-Pacific region's population using the Internet and the number of cell phone subscriptions exceeding the region's population (World Bank, 2017), electricity is critical to realizing the socioeconomic benefits of information and communications technology. Without a reliable electricity supply, individuals are less able to lead modern and healthy lifestyles, engage with the broader world or realize productive gains through the use of energy. Also, businesses are less competitive and communities and governments are impeded in their efforts to deliver quality services, and to expand their economies.

The development outcomes emanating from access to electricity are well-established. At the very basic household level, electricity provides the immediate benefit of lighting, which improves the interior environment by displacing polluting and potentially dangerous kerosene lamps, enables children to study at night, provides more time for household and social activities, including home-based income-generating activities, such as operating small shops or fabricating handicrafts. Studies show that children – both boys and girls – in households with electricity spend more time studying than those without and complete more years of school. With electricity, men and women are increasingly engaged in productive activities and public lighting in communities increases safety at night, particularly for women.

Access to electricity is not an issue that pertains only to households. It also has implications for development at national and regional levels. As a percentage of total final consumption in Asia and the Pacific, electricity's share has grown from 10.7 per cent in 1990 to 18.4 per cent in 2014, reflecting the growing role electricity plays within the region's development. Electricity is increasingly essential for producing food for the region's growing population, and the energy intensity of agriculture is rising with more mechanization and a growing reliance on pumping for irrigation. Asia-Pacific industry and services sectors, with recorded value additions of $17.0 trillion and $20.7 trillion,[11] respectively, in 2014, are dependent on a sufficient and reliable electricity supply.

Energy poverty impedes sustainable development progress.

In Asia and the Pacific, energy poverty[12] is experienced most greatly by people at the bottom of the pyramid and those living in rural areas. Lack of access to reliable and affordable energy reflects and worsens social inequality. Those in the lowest income brackets often pay higher prices per unit of electricity (Jain and others, 2015), and also tend to spend a higher share of their income on energy services that are often inferior, particularly in rural areas. For some urban dwellers, energy poverty is in the form of a lack of access to a legal connection. If energy poverty at the household, community and national levels are not addressed, the prospect of achieving sustainable development remains limited.

Measuring access to electricity is challenging.

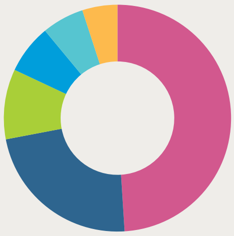
Access to electricity is used as a proxy indicator for energy poverty, as statistics are more readily available for that indicator than for other forms of energy services (ESCAP, 2016a). Yet, definitions of electrification differ, making it difficult to estimate electrification rates. Power utilities, for example, may count household electricity connections, while others calculate electrification according to the presence of a power distribution line at a locality. In some cases, an entire village may be considered be electrified if a percentage of households have a connection (IEA, 2015). Additionally, national data for access to electricity for off-grid locations are often limited. To more accurately capture the status of electrification, the GTF data are collected from utilities and national household surveys,[13] but for many countries, those surveys are not completed at regular or frequent intervals. Accordingly, modelling approaches[14] have been applied to fill in missing data points. Although not perfect, the models represent the most robust methodology available to produce comparable, standardized statistics based on existing data inputs. It should be noted, however, that GTF figures on energy access, because of the methodology applied, may differ from data produced by national statistical offices or other international institutions, such as IEA.

11. From World Bank unpublished data, measured in 2011 PPP.
12. Energy poverty is a broadly recognized development challenge, yet no accepted energy poverty line has been established by international agencies as consensus has not been reached on the methodological and conceptual issues (Khandker, 2012).
13. Survey types include national censuses, demographic and health surveys and living standards measurement surveys, multi-indicator cluster surveys, the World Health Survey, other nationally developed surveys implemented by various government agencies (for example, ministries of energy and utilities).
14. For more information, see International Bank for Reconstruction and Development (IBRD) and World Bank, 2017, available at: http://gtf.esmap.org/downloads

Box 2.1 Lighting brings household benefits, particularly to females

Electricity, when available and of good quality, brings benefits that improve the lives of females within households. Lighting makes it easier to carry out domestic chores, such as cooking, thereby enabling more women to enter the labour force, (Rama and others, 2014) and is a factor in women literacy and reading (Barkat and others, 2002; Barnes and Sen, 2004). Recent evidence shows that females are also the primary users of pico-PV kits (small PV systems with power output of 1 to 10W), which are mainly used for lighting and can replace unhealthy and inefficient sources, such as kerosene lamps and candles, when performing household tasks (Bloomberg New Energy Finance and Lighting Global, 2016).

Usage of pico-PV kits (share of studied households in percentage)



Source: (Chart) Bloomberg New Energy Finance and Lighting Global (2016).
Image: © Asian Development Bank/Flickr.com

Table 2.1 Multitier matrix for measuring access to household electricity supply

Attributes		Tier0	Tier1	Tier2	Tier3	Tier4	Tier5
1. Peak capacity	Power capacity ratings (in W or daily Wh)		Min 3 W	Min 50 W	Min 200 W	Min 800 W	Min 2 kW
			Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kWh
	OR services	1-3	Lighting of 1,000 lmhr/day	Electrical lighting, air circulation, television and phone charging are possible			
2. Availability (duration)	Hours per day	1-3	Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs
	Hours per evening	1.2-2.4	Min 1 hrs	Min 2 hrs	Min 3 hrs	Min 4 hrs	Min 4 hrs
3. Reliability						Max 14 disruptions per week	Max 3 disruptions per week of total duration <2hrs
4. Quality						Voltage problems do not affect the use of desired appliances	
5. Affordability					Cost of standard consumption package of 365 kWhr/year <5% of household income		
6. Legality						Bill is paid to the utility, pre-paid card seller, or authorised representative	
7. Health & safety						Absence of past accudents and perception of high risk in the future	

Source: ESMAP, 2015

Note: W, watt; Wh, watt-hour.


© UK Department for International Development/Flickr.com

It must also be recognized that electrification is a binary measure – either a household has an electrical connection or it does not have one – that provides a limited understanding of energy access. Even with a high level of precision, the measure fails to capture other aspects of energy access, such as capacity, reliability, legality or affordability. Recognizing these limitations, a multidimensional approach was introduced by the ESMAP under the SEforAll initiative in 2013, in consultation with multiple development partners.[15] The multi-tier framework (table 2.1) introduces five levels of access, ranging from tier 0 to tier 5, that consider the following contributing attributes of power supply at the household level: capacity, availability, reliability, quality, affordability, legality, and health and safety.

Data in accordance with the tiered approach is still highly limited as the household surveys that capture this information have yet to be conducted widely. However, at least one large survey using the tiered framework demonstrates how the electrification rate does not provide necessarily accurate or comprehensive measure of access. In a survey of 8,566 rural households in India, almost 50 per cent of users in the tier 0 category were included under that category even though they had an electrical connection and would be considered as having access under the binary electrification measure. This means that their connection was very poor: less than four hours of power per day (Jain and others, 2015). As tiered access data becomes more available, greater insights will be gained into the state of electrification, and enable improved policy responses to address energy access that can support broader development goals.

15. For more information on the multi-tier framework, see Bhatia and Angelou (2014).

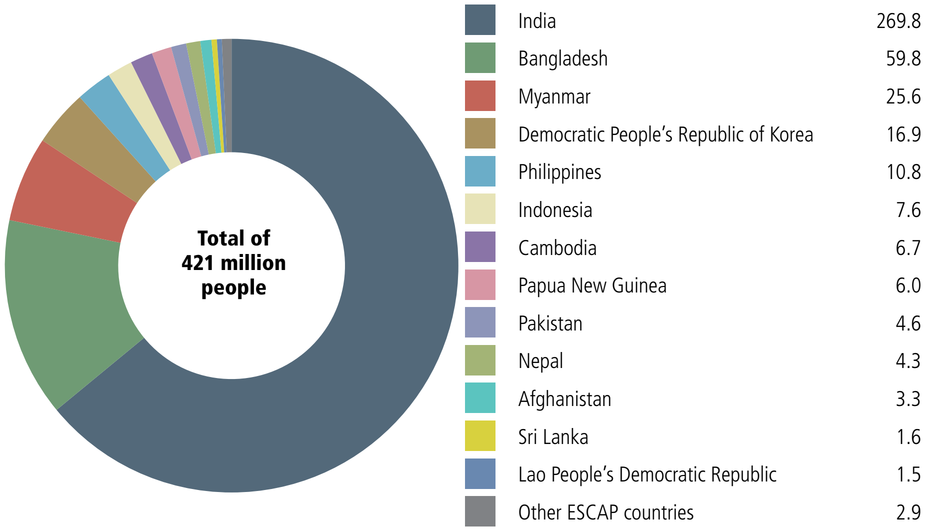
OVERVIEW OF PROGRESS

Regional progress in electrification continued, but slowed, during the period 2012-2014.

Between 2012 and 2014, an estimated 93.1 million people gained access to electricity in Asia and the Pacific, as the region's population increased by 84 million, leading to a rise in the rate of electrification from 89.8 per cent to 90.3 per cent. Urban access rates continued to rise, reaching 98.7 per cent, while access in rural areas stagnated at 83.3 per cent. At the subregional level, access rates continued to trend upward, though the Pacific remained relatively flat. Nationally, progress was varied, with the greatest average annual growth rates for the period recorded in Afghanistan, Bhutan, Cambodia and Nepal, each with between 4.3 per cent and 10.2 per cent annual gains. During the period 2012-2014, China, India,[16] and Pakistan each added between 13 and 16 million people to their populations with access to electricity; while in Afghanistan, Bangladesh, Indonesia, and the Philippines, electricity service was extended to between five million and nine million people.

In recent years, amid the growing attention paid to the link between energy and development, Asia-Pacific countries have increasingly introduced measures aimed at providing power to unserved populations, and, undeniably, much progress has been made. Yet, achievement of the goal of universal access remains distant. More than 421 million people, or 9.7 per cent of the Asia-Pacific population, are still without a basic level of electricity access. Progress has slowed among several countries with the largest access deficits (figure 2.1) and growing rural populations, such as India, Bangladesh and Myanmar (table 2.2).

Figure 2.1 Number of people without electricity, 2014 (millions)



Source: World Bank

Table 2.2 Trends in electrification among the top ten Asia-Pacific countries with the largest access deficits

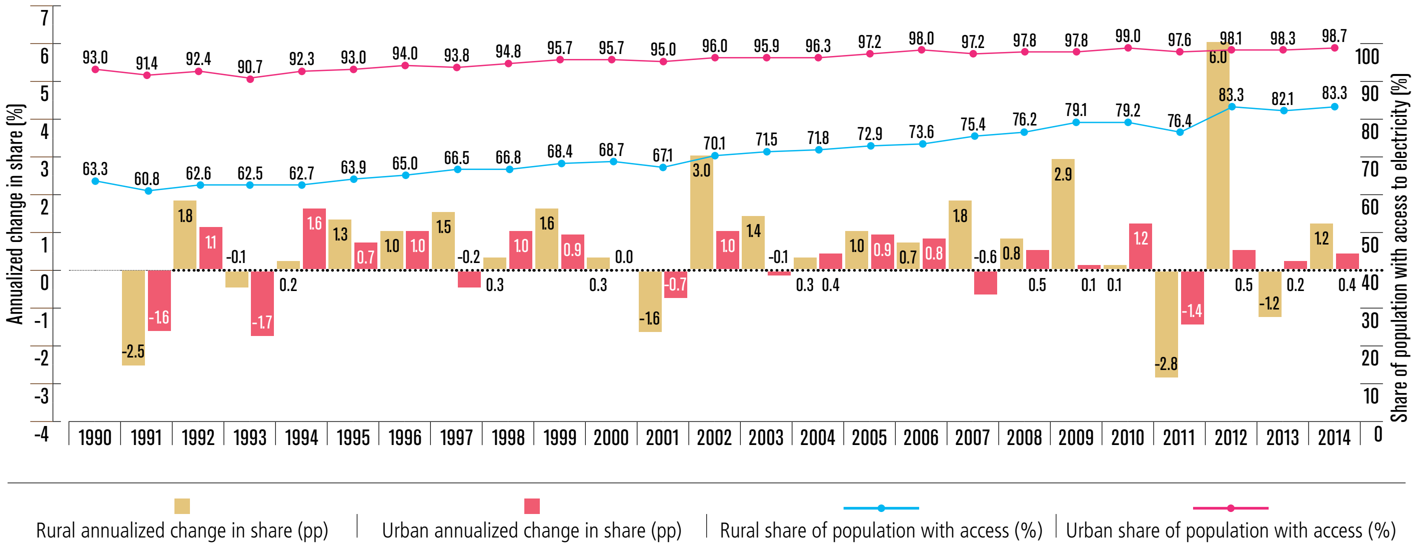
	Population without access to electricity (million)	Gains in population with access to electricity (million)		Average annual growth rate (%)		Access growth rate trend
	2014	2010-2012	2012-2014	2010-2012	2012-2014	
Bangladesh	59.8	8.6	6.9	2.1	1.5	▼
Cambodia	6.7	1.6	2.5	4.9	7.6	▲
India	269.8	70.4	15.9	1.8	-0.4	▼
Indonesia	7.6	10.6	8.7	10.6	8.7	▼
Democratic People's Republic of Korea	16.9	0.7	0.7	1.2	1.2	►
Myanmar	25.7	1.4	1.1	0.95	0.65	▼
Nepal	4.3	2.7	3.1	4.1	4.6	▲
Pakistan	4.6	12.5	13.2	1.6	1.6	►
Papua New Guinea	6.0	0.0	0.2	-0.2	0.6	▲
Philippines	10.8	4.7	5.0	1.1	1.1	►

Source: GTF

Note: ▲ growing rate of access; ▼ falling rate of access; ► unchanged rate of access

16. Estimating the 2014 rate of access of India is challenging because the most recent available survey data dates to 2012. A 2014 survey was conducted, though the results have yet to be published. The GTF statistical model estimates an access rate of 79.4 per cent, just below the 2012 figure. Accordingly, this report may slightly underestimate the progress made in India (IBRD and the World Bank, 2017).

Figure 2.2 Access to electricity in Asia and the Pacific increased over the past 25 years, with the gap between urban and rural access gradually narrowing



Source: World Bank

Note: pp, percentage point.

In absolute numbers of people with access to electricity, economies, such as the Lao People's Democratic Republic, Nepal, Pakistan, the Philippines and Turkey, reported modest acceleration in terms of expanding the reach of electrification during this reporting period, as compared with the results from the period 2010-2012. However, this was balanced against a slowdown in the top three countries with unserved populations India, Bangladesh and Myanmar. The majority of people without access reside in India, which accounts for 25.4 per cent of the global and 64.0 per cent of the regional electrification deficit. Deceleration in these countries contributed to an overall regional drop in electrification progress, which amounted to a 0.5-percentage change for the period 2012-2014, in comparison to a 2.2-percentage change in the previous period. Whereas population growth gains from the 2010-2012 and 2012-2014 periods were comparable, electrification gains fell, with 154.1 million people gaining access in the earlier period, followed by only 93.1 million in the following period.

Urban areas are approaching universal access while the regional rural electrification rate has stagnated in recent period.

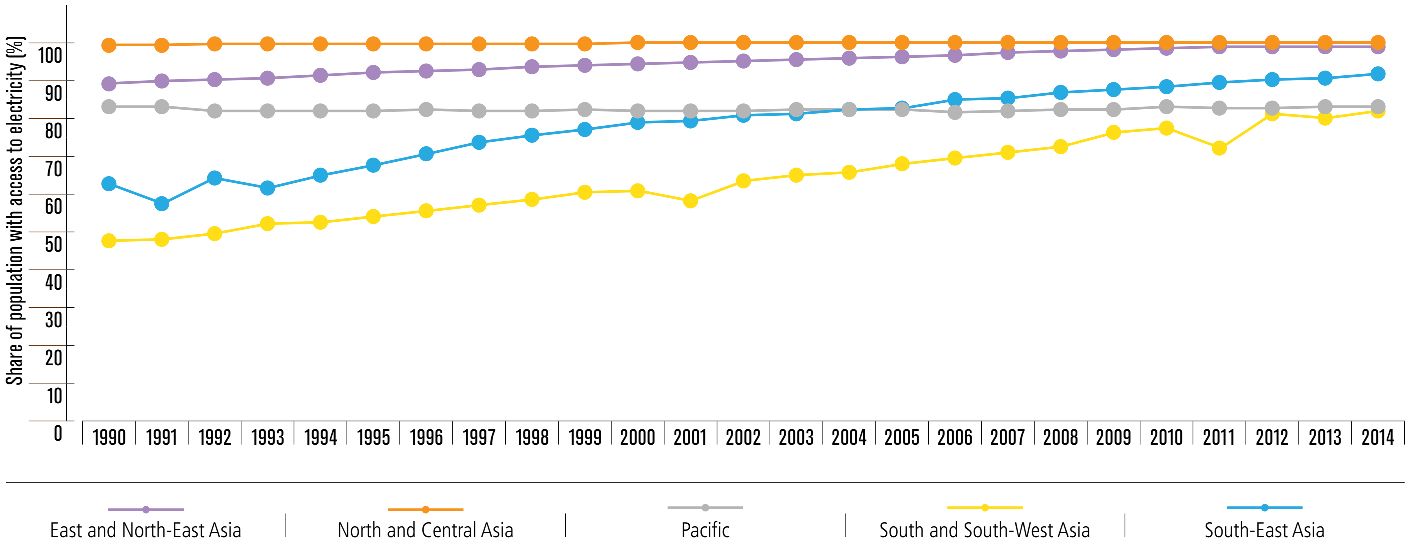
As noted earlier, the regional urban electrification rate reached 98.7 per cent in 2014, with the gap between rural and urban populations gradually narrowing (figure 2.2). For most countries, access was approaching 100 per cent. Since 2012, 105.2 million people in cities across the region have gained access to electricity, lowering the overall deficit to 32 million people. However, several Pacific countries, namely the Federated States of Micronesia, Kiribati, Papua New Guinea and Solomon Islands, along with Myanmar and Timor-Leste of South-East Asia, have some of the lowest access rates, and have recorded declines or volatility in their urban electrification rates, highlighting the pressing situation faced by small island developing States and least developed countries with growing populations and rapid urbanization.

Although some countries face difficulties in extending electricity in urban centres, particularly in slum areas where connections may be limited or illegal, the largest challenge is reaching the 388.7 million people without access to electricity in rural regions. Over the reporting period, the regional rural access rate to electricity did not advance from the 83.3 per cent recorded in 2012. In fact, 7.8 million fewer rural people had access to electricity in 2014, as compared to 2012, though the rural population during this period declined by 10.6 million, accounting for much of this decrease.

Nevertheless, several Asia-Pacific countries have continued to make steady progress in increasing their rural electrification rates. Notable gains in that regard have been made in Afghanistan, Bhutan, Cambodia, the Lao People's Democratic Republic, the Marshall Islands and Nepal. Exceptions to that trend are Kiribati, Mongolia and Vanuatu, which have recorded long-term falling rural electrification rates.

HIGHLIGHTS FROM ASIA-PACIFIC SUBREGIONS

Figure 2.3 Access to electricity grew steeply across much of Asia and the Pacific, but the trend is flat in the Pacific subregion



Source: World Bank

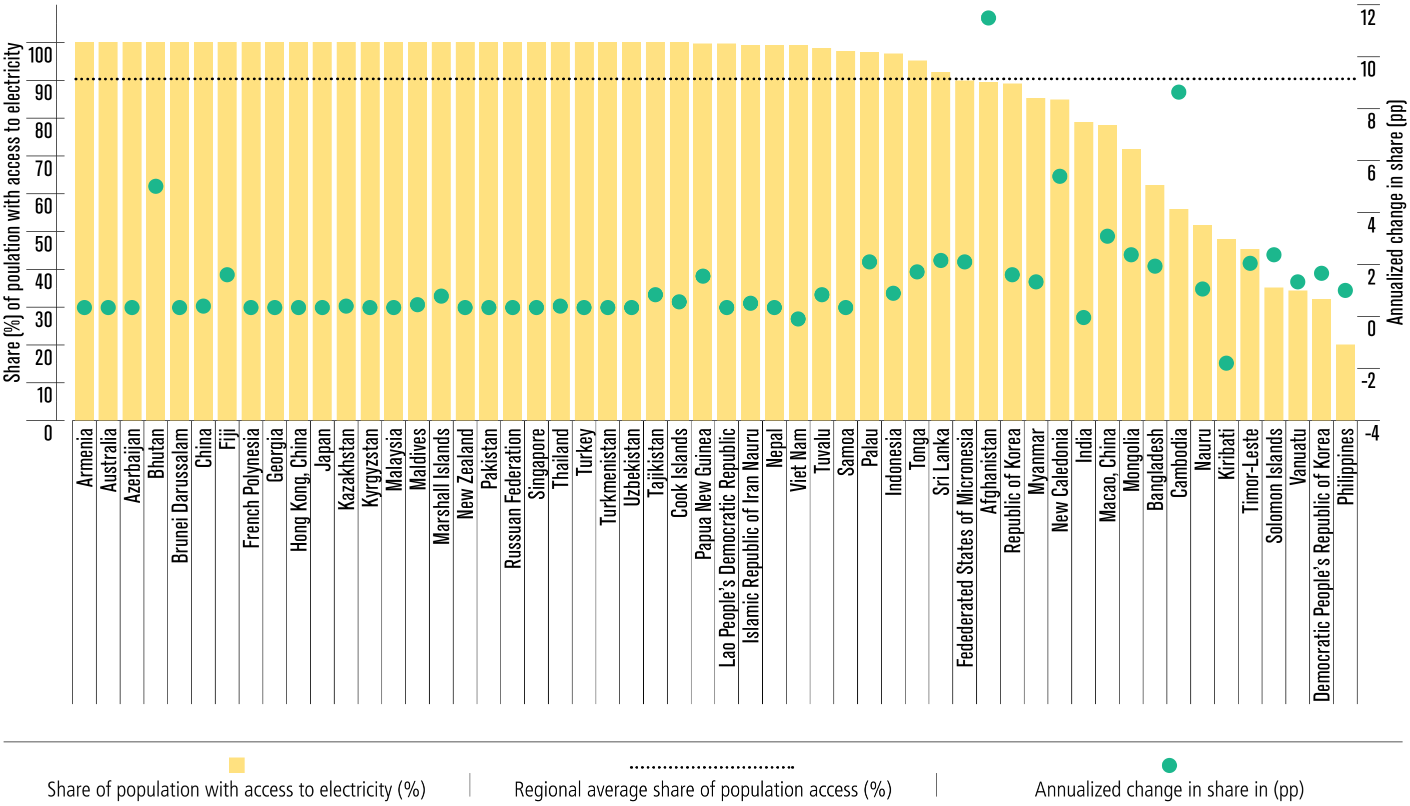
East and North-East Asia approached 99 per cent electrification in 2014 (figure 2.3), as China joined Japan and the Republic of Korea in achieving universal access. The subregion's remaining population without access to electricity are located in the Democratic People's Republic of Korea and Mongolia, two countries with overall low levels of infrastructure development. The Democratic People's Republic of Korea, which has the second lowest electrification rate in the region (figure 2.4), at 32.4 per cent, plans to increase power production capacity to meet demand under its recently released five-year economic plan.[17] Mongolia is experiencing an urbanization trend, but is challenged by large expanses of territories with populations that are small, dispersed and nomadic. The country is tackling the access challenge through the provision of wind and solar energy to herder families, and the establishment of small power generation plants for communities located near coal deposits.[18] According to the latest plan for the capital city, Ulaanbaatar, released in 2014, new power projects will enable supply to meet the power demand of the city by 2030.[19]

The **North and Central Asia** subregion has extensive power systems with mainly fossil-fuel fired and hydroelectric generation built during the times of the former Soviet Union, and has historically had universal, or near-universal electrification. However, deteriorating infrastructure threatens power reliability, while power shortages in winter months are common in these countries. Affordability challenges and poor collection rates have led to low levels of cost recovery for some economies, limiting investment attractiveness. Georgia is responding to this by implementing a programme to place individual household meters and improving its overall accessibility of power to improve the business environment (Georgia, 2013). Kyrgyzstan and the Russian Federation are among the countries in the subregion that have focused on distribution network upgrades.[20] To increase reliability, Tajikistan is developing small hydropower plants in remote and isolated areas with the objective to support small and medium enterprises.[21]

In the **Pacific subregion,**[22] as a whole, the electrification rate has not exceeded the 1990 level of 82.8 per cent (figure 2.3). Among the subregions, it has the lowest rural electrification rate of just 43.6 per cent. It has also not made progress in closing the electrification gap between urban and rural populations. If the developed and fully electrified countries of Australia and New Zealand are excluded from the calculations, the overall electrification rate is climbing. However, it still only reached a mere 36.3 per cent in 2014. Despite this overall poor progress, several countries in the

17. See http://rodong.rep.kp/en/index.php?strPageID=SF01_02_01&newsID=2017-01-02-0001
18. See https://www.adb.org/sites/default/files/linked-documents/cps-mon-2012-2016-oth-01.pdf
19. See https://asiafoundation.org/resources/pdfs/1-MasterPlanPublicSummaryEnglish.pdfSee http://www.energo.gov.kg/ru/normativnaja_baza/programmy_strategii
20. See http://government.ru/docs/1220/
21. See www.undp.tj/files/reports/Strategy_Small_Hydro_rus.pdf
22. Australia, Cook Islands, Fiji, Marshall Islands, Nauru, New Zealand, Palau, Samoa, Tonga, Tuvalu, French Polynesia and New Caledonia.

Figure 2.4 In 2014, 31 Asia-Pacific economies had universal access, while access rates ranged widely over the other 23



Source: World Bank Note: pp: percentage point

subregion have already reached universal, or near-universal access. Papua New Guinea, the country in the subregion with the largest population outside of Australia and with the lowest access rate in Asia and the Pacific region—at 20.3 per cent—is pulling down the subregional improvement rate. There is a lot of variation at country levels, with a clear grouping of economies that have achieved access levels of 90 per cent or higher,[23] and those whose majority of their population remain without electricity.[24] It is very difficult for developing island States, with small populations scattered across, in some cases hundreds of islands, to provide quality energy services. Kiribati, which is experiencing a falling electrification rate, has recently announced a plan to work with development agencies to develop solar PV microgrid systems on its islands (Kiribati, 2014). Papua New Guinea has released a national electrification plan to extend its grids and develop renewable energy stand-alone systems (Papua New Guinea, Department of Public Enterprises and Department of Petroleum and Energy, 2016). Solomon Islands (Solomon Islands, Ministry of Mines, Energy and Rural Electrification, 2014) and Vanuatu (Vanuatu, 2013) are pursuing similar approaches.

South and South-West Asia, with an overall subregional electrification rate of 81.7 per cent in 2014, has the majority share of the Asia-Pacific population without access to electricity. The subregion, as a whole, has a high electrification rate in its urban areas (97.6 per cent), but it also has the region's lowest urbanization rate, at 36.2 per cent. Grids have been slow to reach rural areas where access proves most challenging. Between 2012 and 2014, 59 million more people were provided access to electricity in the subregion, though this is half the number from the previous reporting period. Bhutan, Maldives and Turkey all achieved universal access during this period, while Sri Lanka continued to gain steadily, adding more than three percentage points in the same period to reach 92.2 per cent access. Afghanistan recorded a rapid rate of improvement, reaching 89.5 per cent electrification in 2014, up from 69.1 per cent in 2012. Bhutan and Nepal increased their electrification rate by approximately nine percentage points over the same period. Bangladesh has the lowest access rate in the subregion, at 62.4 per cent. The country still struggles to bring power to its rural population, of which only half of it has access to electricity. Looking forward, India and Bangladesh, which are the two countries with the largest populations lacking access to electricity, have introduced targeted access measures. India has stepped up its projected universal electrification programme, aiming to electrify all households by 2019 (India, 2016). Bangladesh targets 96 per cent access by 2020 through a combination of grid extensions and solar home system distribution (Bangladesh, General Economics Division, 2015).

In **South-East Asia**, the overall electrification rate reached 91.4 per cent in 2014. Brunei Darussalam, Malaysia, Singapore, Thailand and Viet Nam all recorded universal access rates during the

23. Kiribati, Papua New Guinea, Solomon Islands and Vanuatu.
24. See https://policy.asiapacificenergy.org/node/2924/portal

2012-2014-reporting period. Indonesia approached universal access with a rate of 97.0 per cent. The Philippines realized steady gains, rising to 89.1 per cent in 2014 over 86.8 per cent in 2012. The lower-middle income countries of Cambodia, the Lao People's Democratic Republic, Myanmar and Timor-Leste showed good progress, but are still lagging behind with rates ranging from 45.4 to 78.1 per cent. During this period, Cambodia made a significant leap from 40.9 per cent in 2012 to 56.1 per cent in 2014. The Lao People's Democratic Republic also reported a solid gain of more than five percentage points, which reached 78.1 per cent in 2014. The gains in those two countries can be attributed to efforts to expand grid infrastructure and distribute solar home systems in rural areas. Cambodia also introduced rural electrification programmes aimed at providing access to electricity to all villages by 2020. Timor-Leste, the country in the subregion with the lowest electrification rate, at 43.8 per cent, has set a universal electrification target for 2030 (Timor-Leste, 2011). Myanmar, through its National Energy Policy, is seeking 75 per cent electrification by the end of 2022, primarily through expansion of power grids and a focus on community-based hydropower.[25]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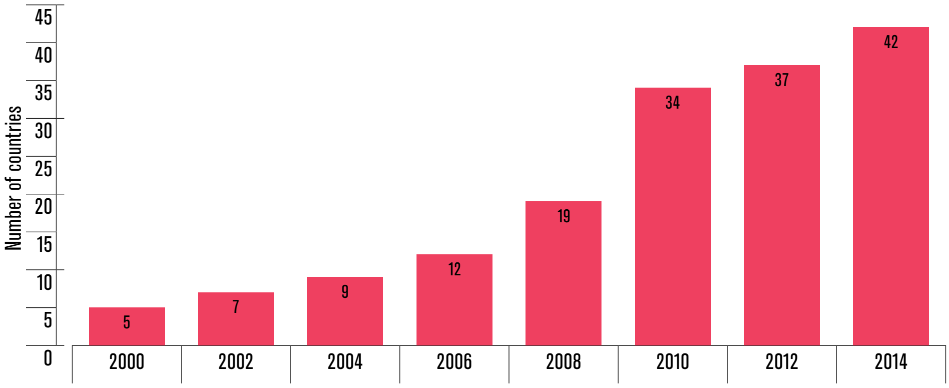
DRIVERS AND INFLUENCING FACTORS FOR PROGRESS

Figure 2.5 The number of Asia-Pacific economies with energy access targets climbed sharply in 2000-14



Source: Author's review of policy content contained with the Asia Pacific Energy Portal, available at: www.asiapacificenergy.org

Policies and institutions are being put in place to tackle access issues.

Achieving universal access to electricity has increasingly become a policy focus in the Asia-Pacific region. The countries that have yet to achieve universal access, according to the latest statistics, have established electrification targets[26] by identifying goals in terms of percentage of population or number of people to be provided with access to electricity (table 2.3). This signals significant progress in achieving universal access within national energy policies and planning considering that, in 2000, very few of these countries had integrated access in national policy (figure 2.5).

There are cases of underachieved electrification goals, but institutional arrangements, programmes, and economic measures that underpin the achievement of them are increasingly shoring up these targets. In many countries, separate government entities handle national grid extensions and issues related to rural energy access. This fragmentation has led to effort duplication; however, coordination and integrated planning are being progressively adopted to efficiently extend energy services.

Furthermore, policymakers in countries with and without universal electrification are also working to extend policy goals beyond the mere creation of electrical connections to address the multiple contributing factors of energy access, such as reliability and affordability. In addition to extending national grids and supplying remote rural populations with electricity, the usability of the power supply and its capacity to support social welfare and economic development is also increasingly becoming a dominant theme. This is being translated into regulations and standards directed at reducing the cost, increasing the capacity, and stabilizing the reliability of the power supply.

25. All are confirmed to have a policy statement on access, with the exception of the Democratic People's Republic of Korea, for which energy policy information is difficult to access.
26. Data drawn from the World Bank (2017). *Enterprise Surveys*, "Infrastructure". dataset. Available from: www.enterprisesurveys.org/data/exploretopics/infrastructure#all-countries.

Table 2.3 Selected national energy access targets

Country	2014 Electrification Rate		Target	Policy Document
Bangladesh	62.4% of Total Population; 90.7% Urban; 51.4% Rural	Current 62%; Target 2020 96%	96 per cent access to electricity by 2020.	Seventh Five Year Plan FY2016 – FY2020 "Accelerating Growth, Empowering Citizens"
Cambodia	56.1% of Total Population; 96.9% Urban; 49.2% Rural	Current 56%; Target 2030 70%	By 2020, all villages will have electricity of some type; by 2030, at least 70 per cent of households will have access to grid-quality electricity	Program for the Development of Rural Electrification of Department of Rural Electrification Fund Electricité du Cambodge (REF)
India	79.6% of Total Population; 98.3% Urban; 70.0% Rural	Current 80%; Target 2019 100%	Provide electricity to all villages by May 2018, and to provide 24-7 power to all households by 2019.	Power for All campaign
Lao People's Democratic Republic (rural)	81.7% of Total Population; 94.7% Urban; 68.1% Rural	Current 82%; Target 2020 90%	90 per cent of the total number of households in rural areas with access to electricity by 2020.	8th Five-Year National Socioeconomic Development Plan 2016–2020
Myanmar	52.0% of Total Population; 85.7% Urban; 49.0% Rural	Current 52%; Target 2030 80%	Electrification rate to 45 per cent by 2020-21, 60 per cent by 2025-26, and 80 per cent by 2030.	Myanmar's Intended Nationally Determined Contribution-INDC
Papua New Guinea	21.2% of Total Population; 76.4% Urban; 11.9% Rural	Current 21%; Target 2030 70%	By 2030, at least 70 per cent of households and more than 60 per cent of the rural population will have access to electricity.	Papua New Guinea Development Strategic Plan 2010-2030 - "Our guide to success"
Philippines	89.3% of Total Population; 97.3% Urban; 82.5% Rural	Current 89%; Target 2022 100%	Universal access by 2022.	Philippine Development Plan 2017-2022
Solomon Islands (urban)	35.9% of Total Population; 39.4% Urban; 33.9% Rural	Current 41%; Target 2020 100%	Increase access to electricity in urban areas to 100 per cent by 2020. Increase access to electricity in rural households to 35 per cent by 2020.	Solomon Islands National Energy Policy and Strategic Plan, Volume 1; National Energy Policy 2014
Timor-Leste	46.3% of Total Population; 63.0% Urban; 37.0% Rural	Current 46%; Target 2030 100%	Increase access to electricity in urban areas to 100 per cent by 2020. Increase access to electricity in rural households to 35 per cent by 2020.	Solomon Islands National Energy Policy and Strategic Plan, Volume 1; National Energy Policy 2014

Source: Author, compilation of information available in the Asia Pacific Energy Portal

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On- and off-grid infrastructure development increased access rates.

During the 2012-2014 reporting period, national grid extensions were the primary driver of increased electrical connections within the region, though extending off-grid systems backed progress achieved in several countries. Some examples of progress made in the region include Cambodia where the national electrification rate rose from 40.9 per cent to 56.1 per cent between 2012 and 2014. The country implemented a number of programmes under its Rural Electrification Fund, including interest-free loans for household connections to the power grid, subsidized solar home systems in areas where no extension of the grid was made, and access to funding for private investors who construct power supply infrastructure. Neighbouring Lao People's Democratic Republic continued its grid extensions in line with its 20-year electrification plan, and distributed solar home systems to off-grid areas. India continued to make grid improvements, and, in 2009, it launched a decentralized and distributed generation scheme that is helping to electrify villages through mini grids. Nepal continues to build transmission lines and expand access through the installation of mini/micro hydro and solar systems under the Rural Energy for Rural Livelihood programme. It also launched an urban solar rooftop programme in 2014 to help deal with cuts in power supply during regular load shedding, an issue that the country has recently made good progress in reducing. Solomon Islands also made significant progress with regard to electricity access by promoting renewable energy, and opening the rural electrification market to independent power providers. States, such as Fiji, Samoa and Tonga, have implemented solar mini grid projects within dispersed island communities.

Across the region, countries have worked to extend, link and upgrade power grid systems to allow new connections, with some countries making significant headway. However, the geographically dispersed, rural populations remain a challenge for several economies where grid extension can be considered economically unviable. With the continuing advancements and lower costs associated with solar and storage technologies, small, decentralized systems are proving to be an increasingly promising option for providing power to remote communities in a cost-effective manner. Governments are also taking advantage of new delivery models and lower costs by increasingly turning to small, decentralized energy systems to meet immediate and sometimes long-term power needs in these remote areas.

Decentralized, small hydropower is being used to provide electricity to remote locations in countries, such as China, Indonesia and Nepal, for an extensive period of time. The technology is well-established and systems are often designed to power communities or small industries, but the decentralized model can also operate at larger scales. A recent example of this can be seen in Tajikistan where a public -private partnership was set up to provide a remote region of 220,000 residents with reliable electricity from hydropower. This partnership also enables surplus power exports in summer months across the border to communities in Afghanistan (IFC, 2015). However, areas with available hydro resources are limited, making it necessary to seek additional options.

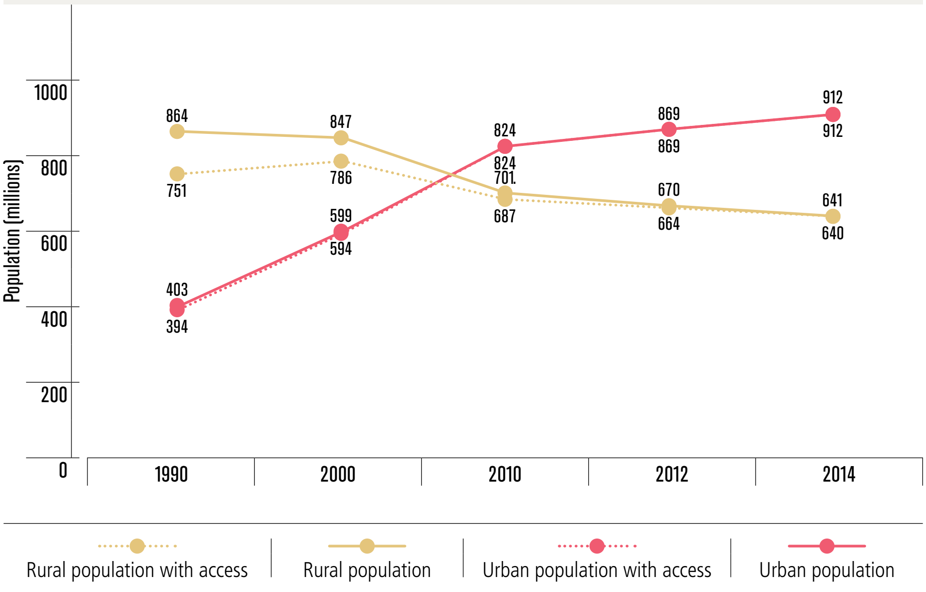
Solar mini grids are taking hold in areas where solar home systems were once the most feasible option to provide household power. The installation of mini grids makes it possible to achieve higher levels of energy access, including productive energy use, but this process is relatively complex and expensive compared to distributed and stand-alone solar home systems. A reversal, however, is seen in the near future as promising business and institutional models for the adoption of mini grid systems for off-grid areas are beginning to emerge. Many of these innovations involve joint ownership between governments, communities and private sector entities.

Population shifts are affecting access efforts.

Rural populations declined in a number of countries during the period 2012-2014. Though the regional trend is led (figure 2.6) by China, where the population shifted by almost 28 million people from rural to urban areas, Indonesia, Japan, Malaysia, Mongolia and Thailand also

Figure 2.6 Urbanization is playing a role in access to electrification

Rural and urban number of people with access to electricity in East and North-East Asia, 1990-2014



Source: World Bank

experienced significant urbanization. These countries have the advantage of the demand being concentrated near existing infrastructure, but may also be challenged to provide services to rising populations of urban poor or those located in informal settlements. In contrast, in Afghanistan, Cambodia, Kyrgyzstan, Nepal, the Philippines, Sri Lanka, Tajikistan and Uzbekistan, the most of their population growth is in rural areas. This increases the pressure in these countries to accelerate rural electrification efforts and to strengthen existing infrastructure and services.

Private sector interest and participation in electrification is growing.

Off-grid electrification schemes are promising approaches for meeting the electricity needs of remote communities

Box 2.2 Improving energy access: solar power in Bangladesh

With 59.8 million people without access to electricity, Bangladesh is actively using solar technology to reach its unserved population under a household solar system programme. Although the original objective to install 500 MW of solar power by 2016 under the country's "500 MW Solar Programme" was not realized, it reported in 2017 that 4.5 million solar home systems have been installed, amounting to 164 MW (Bangladesh, Sustainable and Renewable Energy Development Authority, 2017). The solar home programme is considered to be one of the most successful in the world, and has generated 70,000 direct jobs and 1.1 million carbon credits under the Clean Development Mechanism under a self-reinforcing framework that provides revenue to continue programme expansion (Chang, 2015).

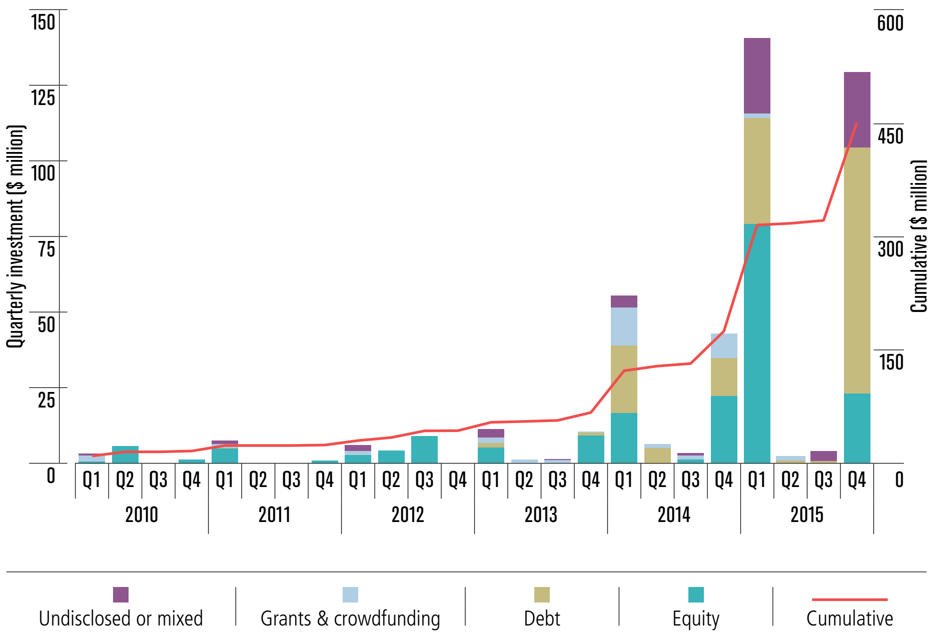
Solar home systems, however, remain costly for many Bangladeshis. To address this, the Government introduced a microfinancing scheme. The Infrastructure Development Company Limited, which is responsible for financing and implementing government programmes, has subsidized the systems and is now looking at financing an additional 6 million solar home systems by 2021 (Infrastructure Development Company, 2017).

Solar home systems comprise the bulk of the country's off-grid installed renewable energy, though growing capacity and acceptance of solar technology is prompting the introduction of mini grids (Alauddin, 2016) to deliver higher levels of access for off-grid communities. According to Infrastructure Development Company Limited, seven microgrids are in operation, and another 50 are targeted to be operational by 2018 with donor support. The Government is also targeting solar irrigation to reduce rural reliance on diesel fuel, which powers approximately 1.34 million pumps. For farmers, the fuel is expensive and the supply unreliable. For the Government, costly fuel subsidies are considered necessary to support its critical agricultural sector.

One of the main challenges for the country is financing these measures. Under its nationally determined contribution to the Paris Agreement, the Government has estimated that an investment of $2.42 billion is needed over the period 2011-2030 to implement its solar access programmes (Bangladesh, Ministry of Environment and Forests, 2015). Under its Seventh Five Year Plan FY2016-FY2020, the country envisions a significant private sector role in the development of solar infrastructure, including solar parks, irrigation, mini grids and rooftop applications (Bangladesh, General Economics Division, 2015).

Image: ILO in Asia and the Pacific/Flickr.com where grid extension is not feasible or practical. Given the insufficient capital available to governments for realizing universal access to electricity, other actors, particularly the private sector, must play a pivotal role in not only closing the investment gap, but also in innovating new technologies, delivery methods and business models. Private sector entities have been relatively long-term proponents and actors in rural electrification for some Asia-Pacific countries. However, with the improved technologies and declining costs for off-grid applications, along with active government support and restructuring of power markets, private sector interest is growing. Investments in off-grid electrification are on the rise (figure 2.7). Nepal offers an example of national policy measures aiming to expand the role of the private sector in electrification. The country liberalized its electricity market and is offering a new set of subsidies to private sector rural electrification project developers under its latest subsidy policy (Nepal, Ministry of Population and Environment, 2016b).

Figure 2.7 2011-2015 Investment in off-grid solar companies and intermediaries by asset class, Africa and Asia



Source: Bloomberg New Energy Finance, GOGLA.

Note: No dates were available for an additional $60 million of investments. Includes funds raised by intermediates with energy access mandates that are likely to focus heavily on off-grid solar.

CHALLENGES

Addressing the rural gap and increasing access rates requires expanded and strengthened power systems.

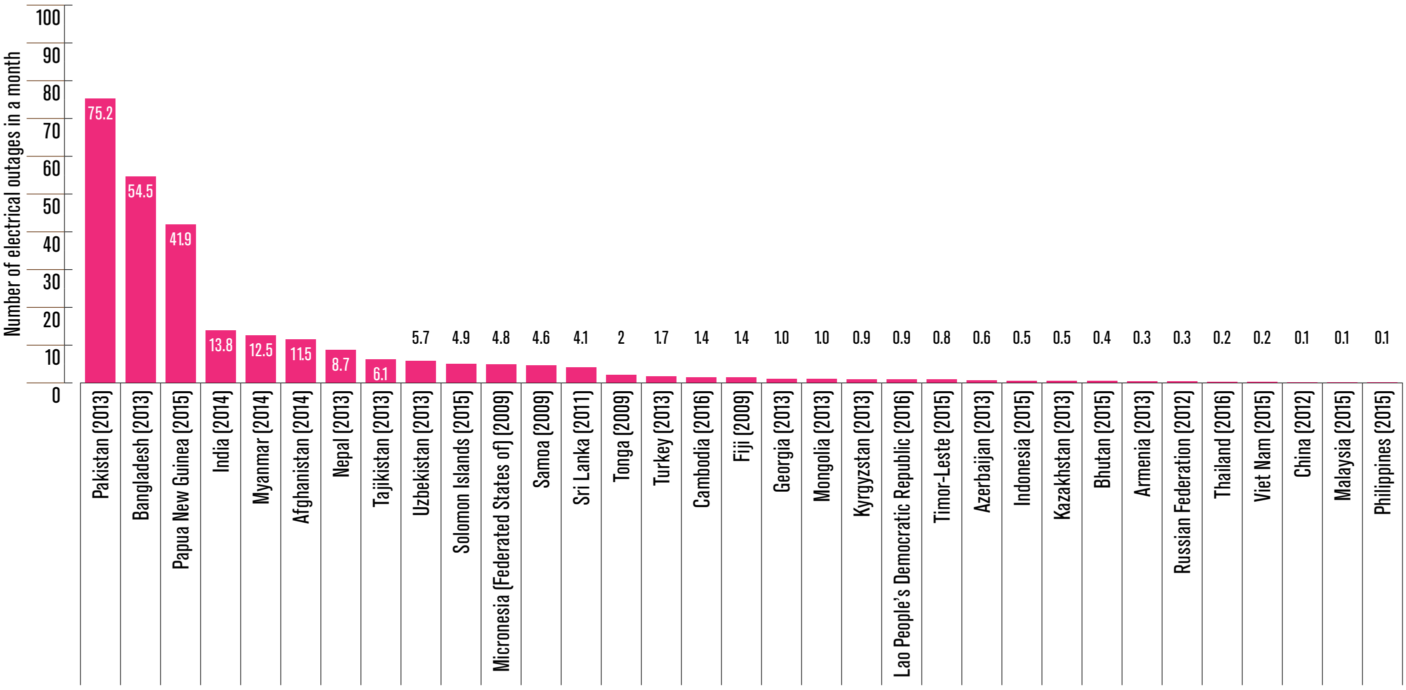
In 2014, almost 1 in 10 persons in the Asia-Pacific region did not have access to electricity. The vast majority of unserved households are in rural areas. Of the 421.4 million people without access, 388.7 million were living outside of cities. Small settlements located far from power supplies, and often scattered across areas with difficult terrain, such as mountains and island atolls, present a challenge to achieving universal access.

High costs of building and maintaining infrastructure in rural areas, low demand and sometimes poor collection rates, as well as often subsidized tariffs result in low or negative returns for utility operators. Even when grid lines are extended in those areas, the quality and quantity of the power supply are significantly hindering electrification. A study of villages in India where power outages were experienced for more than 20 hours per day, for example, indicated that even though power had reached the villages, only about 38 per cent of households had electricity. This was in contrast to villages without outages, which had an electrification rate of 81 per cent (Khandker and others, 2012). This suggests that the availability of a connection is not enough to motivate consumers to tap onto the grid and that the quality of the energy service and its ability to meet the needs of the population being served heavily also influences rates of uptake.

In many countries, the overall power supply remains inadequate to fully meet demand. Outages are common, with countries such as Pakistan, Bangladesh and Papua New Guinea experiencing an exceptionally high number of outages each month (figure 2.8). Although many thermal power plants have already surpassed their intended lifespans, they are still in use because replacement capacity remains unavailable. Many power plants need to be either modernized or decommissioned. Concurrently, grid infrastructure, particularly in remote areas, is deteriorating, and unable to adequately support growing, or perhaps even existing demand levels.

As power lines are extended, distribution losses may also increase, hence reducing the quality of the service. When power shortfalls occur, often those living in rural areas, which also tend to be the areas with higher loss levels, are the ones that are most likely to be impacted by load shedding. To address this issue, some countries have adopted certain measures. India, for example, has introduced separate power feeds, regulating power supply to agricultural and non-agricultural consumers (India, Ministry of Power, 2016a).

Figure 2.8 Average number of electrical outages in selected Asia-Pacific economies



Source: World Bank Development Indicators database

The socioeconomic benefits of electrification stem from the reliability of the service. According to the latest available data from the World Bank Enterprise Surveys,[27] at least 19 Asia-Pacific countries are experiencing electrical outages at least once a month, 13 of which experience weekly outages, and three have more than 40 outages per month. Evidence suggests that access to reliable grid power service increases household incomes by 17 per cent as compared to no access, but frequent power outages diminishes the rise in income to only 11 per cent (Samad and Zhang, 2016). Outages in many countries last hours on average, which have significant economic effects on businesses. In the most extreme case of Pakistan, for instance, enterprises have estimated their losses at more than a third of annual sales.[28] To achieve access levels that effectively support social welfare and economic development, significant progress in strengthening power supply and distribution systems is necessary.

Electrification provides socioeconomic benefits, but they may not be evenly distributed.

Evidence indicates that electrification leads to increased hours spent on education and productive activities across both genders, a reduction in the time women spend collecting biofuel and diversified income into non-farming activities. Among the development outcomes of electrification are significant decreases in poverty accompanied by increased household expenditures. However, reliability is a requirement of access as socioeconomic benefits of electrification are tied to the ability to consume electricity. Evidence shows that benefits accrue to those who have access to and can afford to consume higher levels and more diverse electricity services. Furthermore, the lack of reliable electricity service limits positive development outcomes (Khandker and others, 2012).

Learning from the experience of the Republic of Korea

For those at the bottom of the economic strata, rural electrification in the Republic of Korea failed to provide the same benefits as it did for those in better economic positions. Increased inequality resulted, as those who were wealthier were able more productive use of energy and enjoy the conveniences of new appliances. For others, electrification led to increased household debt to finance internal wiring. The result was a new class division (Van Gevelt, 2014). As countries target increased access, smart subsidies and financing mechanisms are needed to ensure that benefits are generated from electrification.

Especially in rural areas, ensuring that electrification leads to positive outcomes and equitable distribution

27. Data drawn from World Bank (2017). Enterprise Surveys, "Value lost due to electrical outages (% of sales)" Database. Available from: http://data.worldbank.org/indicator/IC.FRM.OUTG.ZS.
28. See http://energy.people.com.cn/n1/2016/1118/c71661-28878481.html.

of benefits is important for meeting objectives of sustainable development. The amplification of social inequalities is a risk emerging from electrification projects within the Asia-Pacific region, particularly in cases in which the energy supply is limited, such as under decentralized systems. Balancing the benefits of electrification, particularly in off-grid areas, in order to achieve stronger development outcomes is a challenge that can be tackled through instruments, such as subsidy models and financing options targeting the most disadvantaged.

Universal access requires moving towards off-grid solutions that provide better services.

To realize the goal of universal access, off-grid systems are necessary to reach small and dispersed populations. However, as explained earlier, these solutions often provide an inferior level of service.

Many electrification efforts in the region have provided households with low-capacity power, such as the power provided by most solar home systems. Stand-alone systems offering minimal levels of access, which support basic functions, such as task lighting and phone charging, only begin to provide the spectrum of benefits that can be realized from electricity use, and offer limited opportunity for productive uses. With growing emphasis on providing greater access, mini grids based on decentralized generation are emerging as a preferred technology. Even with mini grids, limited generation capacity and shorter hours of availability because of the limited size of the energy system or resource availability factors, such as low solar irradiance days or low water levels, may, in some cases, constrain the benefits that can be realized. And those accessing the service without cross-subsidization are doing so at higher costs when compared with grid power. Productive use may be limited because of lack or affordability of supply, leading to the view that these solutions are inferior or only temporary until the grid can be extended (Bhattacharyya and Palit, 2016). Therefore, governments are finding it difficult to ensure that off-grid energy systems deliver access levels to communities that can meet household, community and productive needs in a manner resulting in equitable socioeconomic development opportunities.

The private sector is emerging as an important rural electrification player, but it is grappling with the complexity and risks of implementing sustainable off-grid systems.

To support the achievement of electrification targets, governments are increasingly seeking to set up partnerships with the private sector to provide decentralized energy systems. However, an off-grid electrification market is daunting from the perspective of the private sector. This is partly because of the need to not only provide a workable technological solution to extending electricity, but also to develop a profitable business model for serving consumers with limited resources. Solar microgrids have emerged as a promising option for providing higher levels of off-grid energy services in more regions, but they are more complex than household-level systems. Much more effort to understand consumer preferences and behavior, to model revenue streams, and to manage ownership and operations as a small utility is required. In addition, even though the costs of off-grid technologies have been steadily declining, and financing has become more readily available, low economies of scale is the norm in remote areas, and the cost of capital remains high. Mobilizing communities to gain support for electrification projects in addition to mobilizing labour, materials and other in-kind contributions required is a time-consuming component of many projects, as is the development of local skills and capacities to operate a micro-utility. Nevertheless, evidence suggests community engagement to be a key factor in determining the long-term sustainability of off-grid electrification projects (Shi and others, 2016).

To implement off-grid systems in a sustainable manner, a careful balance among a number of factors is required (figure 2.9). Each one of these factors can compromise the sustainability of a project. The size of the system and projected demand is used to determine the necessary tariff rates that will allow cost recovery and funding of ongoing operations and maintenance. Developers have struggled to match supply with demand, while also allowing for growth in demand at the community level. Shifts in consumption patterns and willingness to pay over time may occur as local consumers become more familiar with the benefits of electricity. Some models have been centred around an anchor load, such as a cell phone tower, to create a predictable baseline demand and allow for a larger system that is more financially viable and can provide power at a more affordable rate. However, these anchor demand loads can be hard to find and load demand is unpredictable, affecting power availability for other paying consumers (Institute for Transformative Technologies, 2016).

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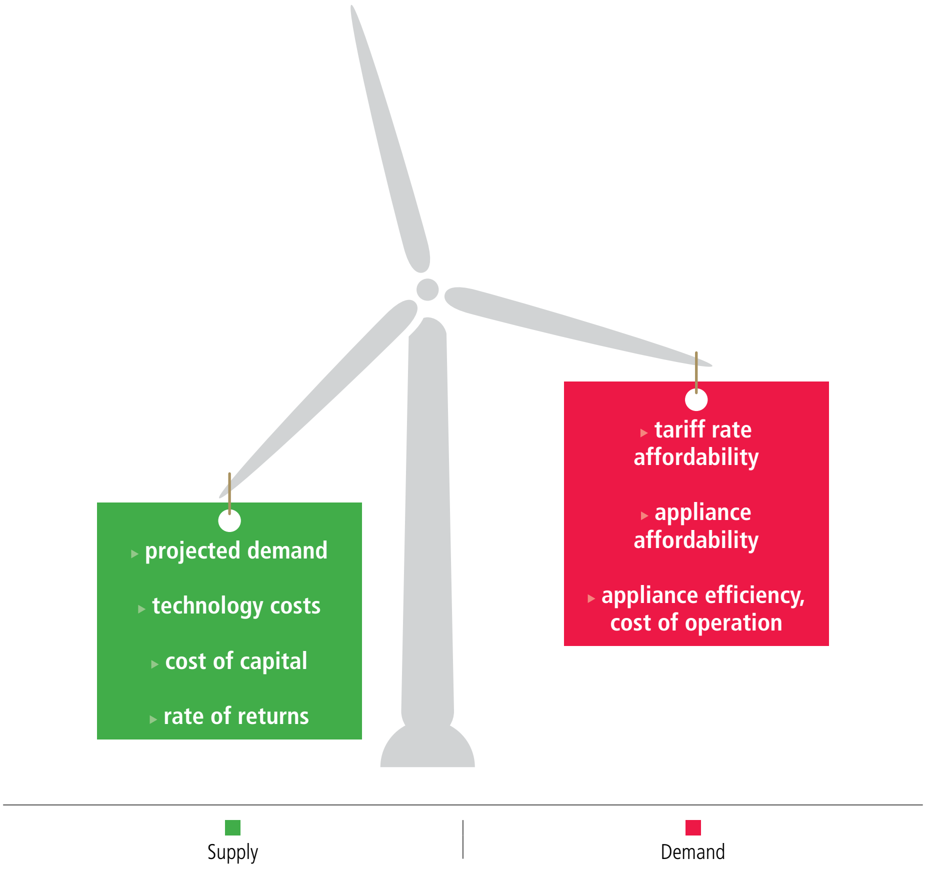
Figure 2.9 Balancing supply and demand is difficult for off-grid applications



Source: Author

The technical capacity of communities to operate these systems is also limited, and in projects in which local personnel are trained, the participants may move on to better paying jobs outside their locale once they have developed the necessary skill sets. Developing and retaining a skilled operator base is, therefore, a major challenge. Furthermore, micro-grid solutions require the establishment of governing and operating institutional arrangements, an additional step that is complex.

The emergence of private sector participation in a poorly regulated off-grid power sector has led to the application of many unsustainable business models. Limited understanding of the individual community social, economic, and environmental contexts and the appropriate conditions under which various models can be applied has resulted in, for example, inappropriate technology selection, too much focus on initial capital investments at the expense of financial planning and budgeting for sustaining operations and maintenance needs, and inadequate governance over a system that operates as a distribution monopoly (Bhattacharyya and Palit, 2016).

However, effective models for off-grid energy are emerging as a result of pilot projects that have been implemented or are underway within varied national contexts. Stronger guidelines from government regulations combined with innovation from the private sector can support lower costs and improve the pace and quality of electrification.

Underdeveloped policy, regulation and coordination inhibit the growth of off-grid energy.

Unlike national grid connections, mini grid technology, applications and operations are largely unregulated and lack standardization. While mini grids represent a relatively new market and governments and the private sector are piloting various technological solutions and business models, the weak regulatory environment also creates barriers for the successful growth of the off-grid sector. Regulatory uncertainties or lack of policy inhibit private sector investment since they create unpredictable and risky investment environments. Furthermore, small entrepreneurs are often put off by the amount of red tape involved in entering the off-grid market in many countries.

Power grid extensions present the greatest risk to investors (Bhattacharyya and Palit, 2016). National grid extensions are typically under the auspices of one agency, while several governing agencies tend to be responsible for issues involved in rural and renewable energy development. This institutional arrangement can lead to overlapping responsibilities and uncoordinated and potentially conflicting efforts. Lack of transparency while developing national grid extension plans may lead to further uncertainty for investors. In some cases, earlier-than-expected grid extensions to areas with private sector-owned off-grid technologies have resulted in losses as customers connect to more affordable government-supplied power. It has been shown that consumers discontinue payment against off-grid solutions that have been procured when they obtain access to the national grid or they are reluctant to participate in an off-grid electrification project if national grid extension is expected to be accessible to them anyway (Palit, 2013). As a result, the private sector operating off-grid business models tries to predict which areas will not be reached by the grid, which could result in projects being limited to the remotest and most challenging areas. Additionally, overly restrictive pricing regulations may be an additional deterrent that prevents private sector actors from entering these markets.

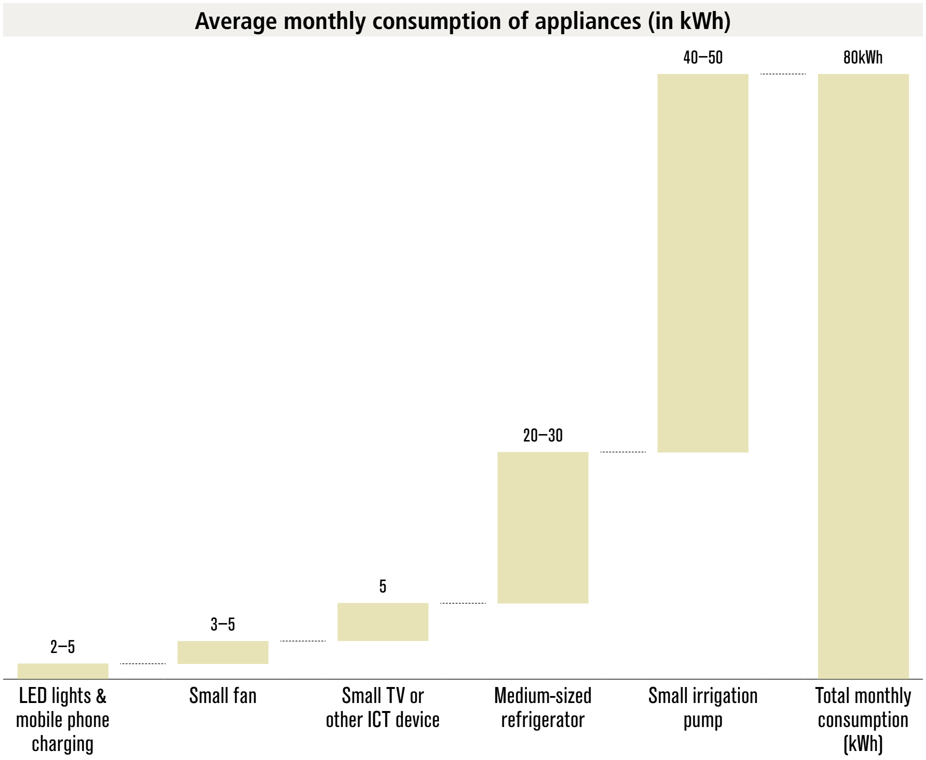
Equipment, ownership structures, and operational models vary widely within countries where the mini grid sector is taking hold. China is an example of a country that has made good progress in defining standards, and expected to continue investing in research and development of mini grid applications, including grid-tied, under its latest five-year plan.[29]

If and how mini grids are integrated into national grids as they reach areas served by off-grid energy systems is another area lacking clear policy which creates additional risks for private investors. The required technical standards for integration remain largely undefined, along with institutional frameworks under which those systems would operate as distributed energy suppliers. Moving forward requires improving regulatory environments to provide investment clarity and predictability in these emergent systems.

High costs of off-grid systems create challenges for delivery of affordable energy.

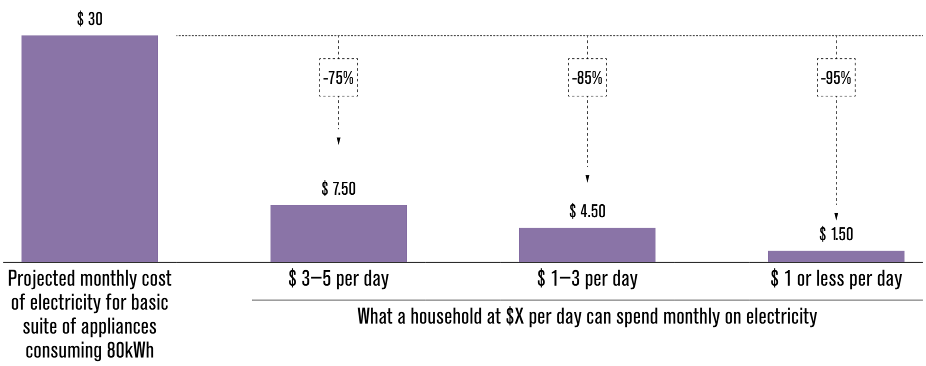
One of the key concerns policymakers voice with regard to off-grid electrification is the affordability of the power supply for their poor populations with low capacity to pay. Mini grids have emerged as a preferred approach for many remote areas because they are relatively economically viable compared to the cost of grid extension. This option can also provide higher quality energy services compared to individual solar home systems. However, there are high capital expenditures and operational costs per unit delivered associated with mini grids, making it difficult to compete with the pricing of grid power. Within some national contexts, subsidized grid power further adds to the challenges for the private sector seeking to establish small, off-grid utilities, particularly if they are expected to provide power at competitive rates. It has been shown that in some areas because of the ongoing operating costs, even a 100 per cent capital cost subsidy for establishing microgrid power supply may be insufficient in ensuring consumer price parity with subsidized grid power (Bhattacharyya, 2014). Capital expenditure remains high for solar mini grids, despite recent declines in the price of solar photovoltaics panels. This is in large part due to the high or fixed costs associated with other components, such as battery storage and distribution infrastructure. The rates for energy services are usually higher for the off-grid populations than for the grid-connected populations. This can be attributed to high capital costs, the need for continuous and stable revenue streams to support operations and maintenance, and the requirement for private sector actors to realize a rate of return through tariff structures. Also, many poor consumers cannot also to pay

Figure 2.10 Many consumers can only afford the most basic levels of energy consumption



Source: Institute for Transformative Technologies, 2014

Figure 2.11 Affordability for a basic suite of appliances remains beyond the reach of many



Source: Institute for Transformative Technologies, 2014

29. The National Medium Term Development Plan (Rencana Pembangunan Jangka Menengah Nasional, RPJMN) of Indonesia targets an electrification ratio of 96.6 per cent by the end of 2019 (ADB 2016). The Government also plans to add 35,000 MW of power plant capacity by 2019.

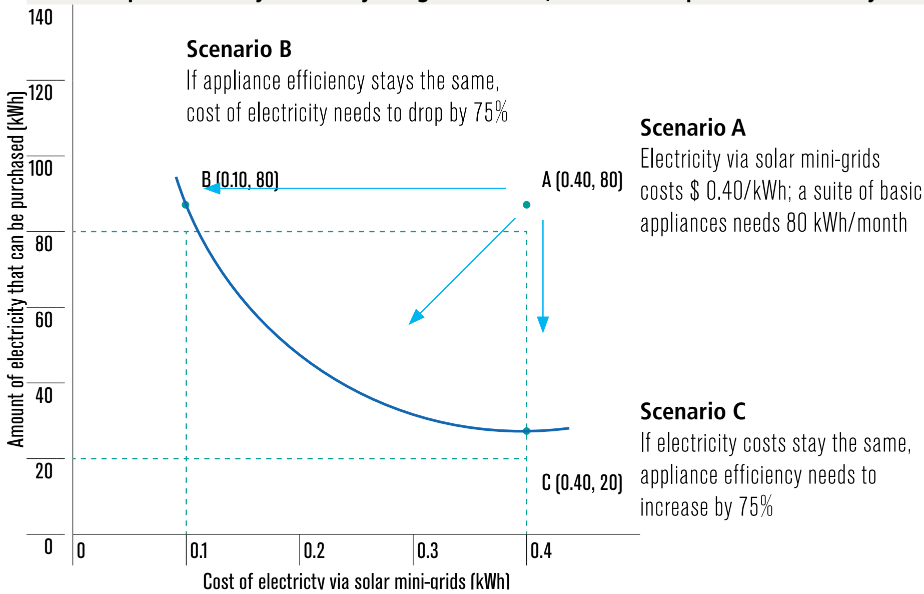
for electricity above levels that meet their most basic needs (figures 2.10, 2.11). As a result, systems require significant financial support in order to be able to deliver energy services at an affordable rate and create sufficient demand that generates the necessary revenue streams for the micro utility.

A review of off-grid electrification in India, of energy consumption for basic appliances, and the cost of powering them, illustrates this point. At the most basic level, LED lights and mobile phone chargers consume between two and five kWh per month. Adding a small fan doubles that consumption, and then adding a television increases it yet another five kWh. A refrigerator, at 20-30kWh, would present a significant cost, and a small irrigation pump would consume the same amount of electricity as all the other basic appliances combined. The approximate cost of powering all of these items, at $0.40/kWh, is $30 per month. However, for the poor, purchasing those appliances, and then paying to power them is unattainable. Rural consumers who are required to pay for connection services and have to purchase appliances, light bulbs, appliances, and other devices may need to obtain some sort of financing. One option, which is widely used, is micro lending, but high interest rates are rampant (Bahhacharyya, 2016).

A household earning $3-5 per day would not be able to afford a basic suite of appliances unless the appliances are highly efficient and consume a low amount of energy, or the cost of electricity is significantly lowered (figure 2.12). Consequently, cost reductions must therefore be supported by the introduction of more energy-efficient appliances (Institute for Transformative Technologies, 2016). Targeted subsidy programmes have an important role to play, but a lack of strong regulatory frameworks that result in systems operating under various ownership schemes, operational models, and tariff structures create administrative challenges to the provision of such subsidies and the control of tariffs. Only through stronger

Figure 2.12 Energy efficiency can increase the affordability of electricity

The electricity (kWh) that can be afforded by a household earning $ 3–5 per day (with an implied monthly electricity budget of $ 7.50), at different prices of electricity



Source: Institute for Transformative Technologies, "50 Breakthroughs", 2014

policies and standards combined with effective subsidies and flexible financial instruments can affordable off-grid electricity be truly realized. In the near future, off-grid electrification is expected to remain heavily dependent on subsidies, grants, and donor support, though promising business models are beginning to emerge involving joint ownership with the community and increased private sector involvement.

The availability of sufficient finance and investment to obtain universal access remains inadequate.

The 2014 Sustainable Energy for All Advisory Board Finance Committee Report indicated that an investment of $45 billion was required annually to achieve the global universal access to electricity by 2030. The amount invested in 2012 amounted to $9 billion, leaving a shortfall of $36 billion (Sustainable Energy for All Advisory Board Finance Committee, 2014). For developing Asia, IEA (2011) has estimated that $241 billion is needed in total for the years 2011-2030.

Furthermore, investment requirements scale with the level of access to be achieved. At the lowest access tiers, investment requirements are relatively modest but under those tiers, full socioeconomic development benefits are not provided, whereas achieving higher tiers of access requires significantly more funding (Sustainable Energy for All Advisory Board Finance Committee, 2015). Accordingly, defining access levels to be achieved is a critical determiner of investment requirements.

To date, national investment trends have failed to meet the requirements for achieving universal access by 2030. For example, in India, the country with the greatest electricity access deficit in the region, the Government's commitment of $1.25 billion will only affect a fraction of the population (Institute for Transformative Technologies, 2016). Some experts estimate that even if countries invest their entire energy budget on access, the funds available would still be insufficient (Bhattacharyya and Palit, 2016). This points to the need for governments to mobilize funds

through new partnerships and the pivotal role of the private sector as an investor and innovator of delivery models in efforts aimed at achieving universal access to electricity.

Indonesia, which aims to "approach" 100 per cent electrification by 2020 through its 2014 National Energy Policy, needs $3 billion to 18 billion to achieve this target. In 2015, the country budgeted about 5.5 trillion Indonesian rupiah (Rp)(approximately $420 million) for grid and off-grid electrification (ADB, 2016a).[30] The State-owned utility, Perusahaan Listrik Negara (PLN), secured a $435 million loan to finance its mobile power plant project in 2016. Its beneficiaries include communities in remote parts of Indonesia (General Electric, 2017).

Myanmar, which has the lowest electrification rate in South-East Asia, is implementing a national electrification plan to provide electricity to 7.2 million households, with the objective to achieve 100 per cent access by 2030.[31] In support of this plan, which will cost $5.9 billion, the World Bank, together with the Government and some local communities in Myanmar, are providing $567 million to finance the first six years of the electrification plan.[32]

Papua New Guinea, which has the lowest electrification rate in the Asia-Pacific region, envisions achieving an access rate of 70 per cent of its households by 2030 through its Development Strategic Plan 2030 (Papua New Guinea 2015).[33] To meet this target, the country needs to significantly increase its generating capacity (Oxford Business Group, 2015), and improve and expand its transmission and distribution facilities. The Government of Papua New Guinea, with assistance from partners, such as ADB, the Government of New Zealand and the Japan Fund for Poverty Reduction, has raised about $225 million in loans and grants to help carry out its electrification plans.

International finance institutions are playing an important role in supporting governments in boosting access to electricity. From 2010 to 2015, ADB invested $5.5 billion in energy access (including gas and heating connections) projects in the Asia-Pacific region (ADB, 2016b). The World Bank committed at least $962 million for projects involving access to electricity in the region for the same period.[34]

30. See http://documents.worldbank.org/curated/en/149061468191334165/pdf/PAD1410-CORRIGENDUM-IDA-R2015-0237-2-Box393200B-OUO-9.pdf.
31. Ibid.
32. Extending its goals through Vision 2050, Papua New Guinea aims to provide access to reliable and affordable energy supply to all its households and source 100 per cent of its power supply from renewable and sustainable energy sources by 2050.
33. The value, which includes projects with access to electricity components, was estimated based on World Bank data on its energy transmission and distribution in East Asia and Pacific, South Asia, and Central Asia. Available from http://projects.worldbank.org/. Accessed 29 May 2017 (accessed on 16 March 2017).
34. Developing Asia in this context refers to the member States of the South-East Asian subregion of WHO, namely Bangladesh, Bhutan, the Democratic People's Republic of Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand and Timor-Leste.

ACCELERATING PROGRESS

Strengthening national electrification planning and policies boosts investor confidence.

To accelerate electrification in a sustainable manner, Asia-Pacific countries must improve the investment environment. Master plans that define areas and timelines for grid extension, coupled with improved coordination between multiple agencies responsible for energy access, helps lower risk. Outlining grid extensions and off-grid electrification plans and policies to promote micro-grid integration into national or regional grids spurs predictability. This enables investments to be better-prioritized and financial support to be directed to areas where it is most needed. Strong standards and regulations support project delivery for predictable development outcomes, and also strengthen the overall market, which allows for sector-wide rather than one-off project or ad hoc programme approaches.

Integrating productive energy use into off-grid electrification can improve development results and project sustainability.

Evidence suggests that the productive use of energy may not be a top priority for rural households in gaining access to electricity (Jain and others, 2015), but it is a critical link for realizing affordability and, therefore, system sustainability. Electricity tariffs are financial burdens to the poorer segments of the population. Accordingly, coupling the introduction of a new energy supply with some microenterprise development activities that increase incomes for consumers are necessary for creating a circular economic system that can potentially enhance capacity to pay, reduce non-payment risk and ensure demand for the supply offered. To scale off-grid rural electrification subsidies will need to reduced, meaning that those systems must ultimately become self-sustaining.

Supporting integration of productive energy use in rural electrification

In recognition of the relationship between productive energy and energy affordability, the latest Renewable Energy Subsidy Policy of Nepal offers subsidies to project developers of small hydro projects designed for productive use, and to enterprises involved in renewable energy (Nepal, Ministry of Population and Environment, 2016b)

Project bundling using standardized technology models may offer greater efficiencies in rural electrification.

As single off-grid electrification projects are expensive to implement, the bundling of such projects under proven power utility models could result in lower costs a more efficient delivery. Greater efficiency in rural electrification could be realized through a higher degree of standardization, which, in turn, results in more affordable and scalable solutions. By some estimations, a "utility in a box" model that provides a standardized, integrated system of components designed to work well together, and that could be produced at scale, could result in a 10 to 20 per cent reduction in capital expenditure and better delivery of services (Institute for Transformative Technologies, 2016).

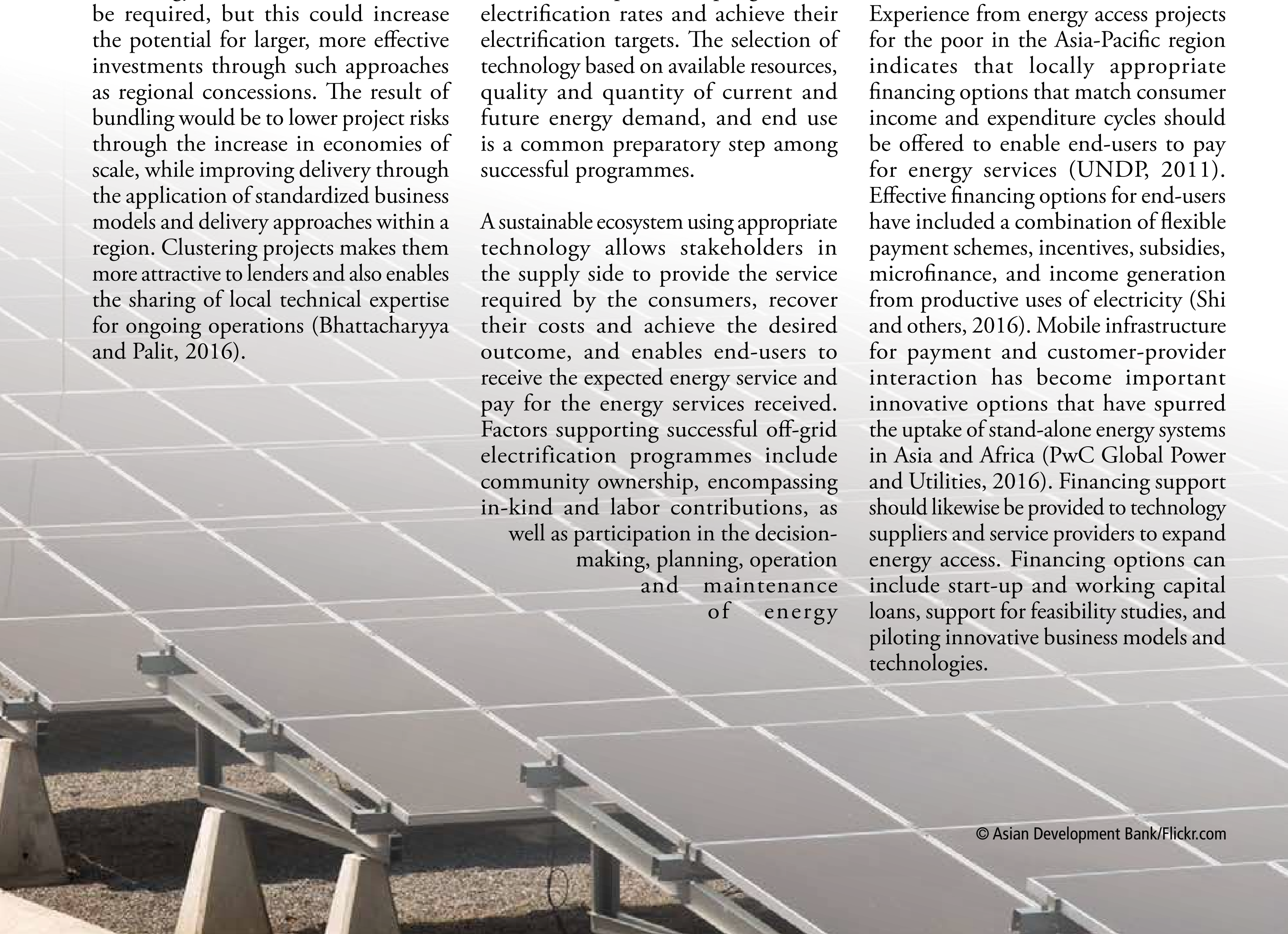
Greater efforts in community characterization and matching of technology and business models would be required, but this could increase the potential for larger, more effective investments through such approaches as regional concessions. The result of bundling would be to lower project risks through the increase in economies of scale, while improving delivery through the application of standardized business models and delivery approaches within a region. Clustering projects makes them more attractive to lenders and also enables the sharing of local technical expertise for ongoing operations (Bhattacharyya and Palit, 2016).

Increasing the economic viability of projects requires innovative business models and an enabling ecosystem anchored to a firm government commitment.

Many electrification projects are hindered by high transaction costs and cost of capital in developing countries, which can make them economically unviable, even when financing is available (IRENA, 2014). Experiences from past energy projects show that some of the critical elements required to make a project economically viable and sustainable include: a firm government commitment; an enabling ecosystem for project sustainability; flexible financing options; and appropriate technology. Also, it is important that the project benefits all of the stakeholders, namely financiers, consumers, service providers and governments. A firm government commitment displayed through policies, planning and funding, has allowed most countries to experience rapid growth in electrification rates and achieve their electrification targets. The selection of technology based on available resources, quality and quantity of current and future energy demand, and end use is a common preparatory step among successful programmes.

A sustainable ecosystem using appropriate technology allows stakeholders in the supply side to provide the service required by the consumers, recover their costs and achieve the desired outcome, and enables end-users to receive the expected energy service and pay for the energy services received. Factors supporting successful off-grid electrification programmes include community ownership, encompassing in-kind and labor contributions, as well as participation in the decision-making, planning, operation and maintenance of energy stsyems. Successful projects, which had local communities paying and operating the energy systems, have received high payback rates and on-time loan repayment from households (Sovacool, 2012). Strengthening the technical, including maintenance and after-sales service skills, and managerial capacity of local public and private stakeholders and educating end-users about the benefits and productive uses of electricity fosters an enabling environment for the establishment of high-quality products and service providers (Magradze and others, 2007), as well for the creation of a customer base for energy technologies and related products and services. Other enablers include: a supportive tax and customs framework for importation of technologies, supportive regulation, planning mechanisms that enhance ticket size and encourage process standardization, and interaction among stakeholders (PwC Global Power and Utilities, 2016).

Experience from energy access projects for the poor in the Asia-Pacific region indicates that locally appropriate financing options that match consumer income and expenditure cycles should be offered to enable end-users to pay for energy services (UNDP, 2011). Effective financing options for end-users have included a combination of flexible payment schemes, incentives, subsidies, microfinance, and income generation from productive uses of electricity (Shi and others, 2016). Mobile infrastructure for payment and customer-provider interaction has become important innovative options that have spurred the uptake of stand-alone energy systems in Asia and Africa (PwC Global Power and Utilities, 2016). Financing support should likewise be provided to technology suppliers and service providers to expand energy access. Financing options can include start-up and working capital loans, support for feasibility studies, and piloting innovative business models and technologies.



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UNIVERSAL ACCESS TO ENERGY

PROGRESS IN ENERGY ACCESS | CLEAN COOKING

The role of clean cooking fuels and technologies within broader development objectives.

Access to clean fuels and technologies – shortened here to "clean cooking" – is essential to modernize energy services, support public health, reduce gender inequality, and mitigate environmental impacts, paticularly the poorest segments of the population. The use of traditional biomass in the form of wood, charcoal, and dung in open fires or inefficient stoves for cooking and heating compromises indoor air quality. Notably, the World Health Organization (WHO) attributes 92 deaths per 100,000 people to household air pollution in developing Asia.[35] Indoor smoke contains a variety of pollutants,[36] with adverse health effects, which are predominantly caused by inhalation of fine soot particles, leading to respiratory, pulmonary, and cardiovascular diseases, as well as lung cancer and cataracts. Women and children are especially affected by poor indoor air quality, as women are typically responsible for food preparation and children often accompany their mothers (WHO, 2017b). Generally, women also bear the burden of gathering biomass, such as fuelwood, which reduces time that could have be spent on other social or productive activities. The use of traditional biomass and technologies emits greenhouse gases and black carbon particles and has led to deforestation in some regions. To mitigate the adverse impacts from everyday cooking-with-biomass activities, switching to clean cooking technologies and fuels, such as LPG, biogas, electricity, advanced biomass cookstoves, and solar cooking, is necessary.

A major redefinition from the World Health Organization used in the Global Tracking Framework (excerpt from Sustainable Energy for All: Global Tracking Framework, Progress toward Sustainable Energy 2017).

Up to the most recent Global Tracking Framework (GTF) report, issued in 2015, the indicator for cooking looked only at the primary fuel used, and responses were classified simply as solid or non-solid fuels. Households cooking with kerosene – also known as paraffin – were included as having access to clean cooking because kerosene is a liquid (non-solid) fuel. However, kerosene is a major source of air pollution, with formaldehyde, polyaromatic hydrocarbons, and particulate matter, including black carbon (a major contributor to near-term climate warming). Given the substantial evidence on the health and safety risks of kerosene, WHO guidelines for indoor air quality and household fuel combustion recommend abstaining from using it at home.

These guidelines also strongly recommend that for major household energy end uses, such as cooking, space heating and lighting, efficient fuel and technology combinations should be used to ensure health and environmental benefits. Focusing only on fuel limits the usefulness of this indicator for monitoring the impacts of sustainable development, as the emissions are directly correlated with how well the technology or device, such as cookstoves and lamps, burns the fuel.

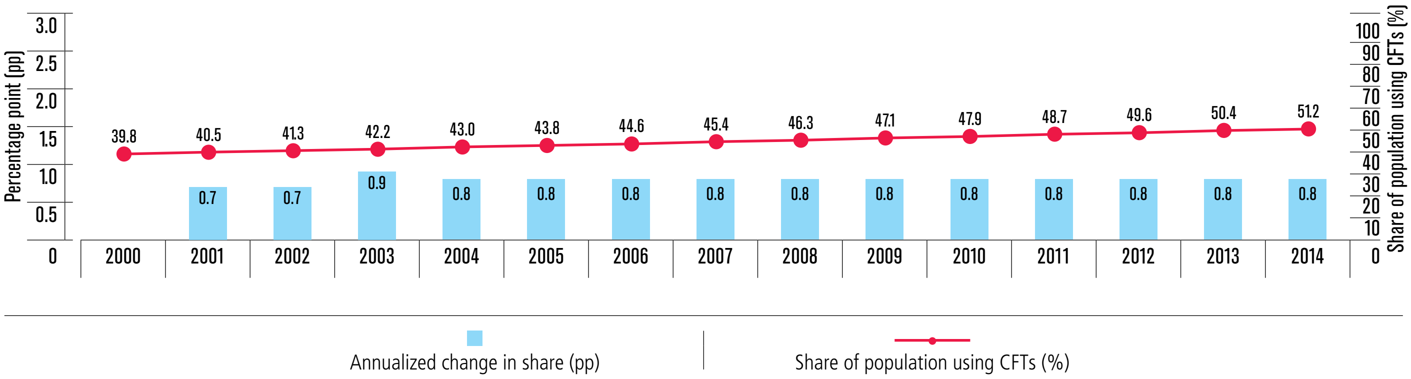
Understanding the type of technology can inform global tracking for energy efficiency and climate impacts. Biomass stoves that burn efficiently enough to be considered "clean" are not widely available in low- and middle-income countries. However, reformulating this indicator to account for the fuel in combination with technology allows future innovations in biomass stove technologies to be counted towards progress made in achieving the Sustainable Development Goals on energy efficiency, renewable energy, and other ones related to sustainability.

For these reasons, WHO has reformulated the access to clean cooking indicator to measure the "proportion of population primarily using clean fuels and technologies for cooking." This has been adopted as part of Sustainable Development Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all. This reformation automatically increases the cooking access deficit relative to what was reported in previous GTFs. For example, in 2012 the 134 million households estimated to be using kerosene were not counted as part of the cooking access deficit, but after the reformulation they would be. The present report recalculates the historical series using the new definition back to 2000, and all results are reported in these terms.

35. Armenia, Australia, Brunei Darussalam, Islamic Republic of Iran, Japan, Republic of Korea, Malaysia, Maldives, New Zealand, Russian Federation, Singapore, and Turkmenistan all have at least 99 per cent access rates under the GTF data. Data are not available for American Samoa, French Polynesia, Hong Kong China, Macao China, New Caledonia and Turkey, though universal access is assumed.
36. Pollutants from traditional fuels include: particles; carbon monoxide; nitrous oxides; sulphur oxides; formaldehyde; and carcinogens, such as benzene.

OVERVIEW OF PROGRESS

Figure 2.13 Clean cooking access is advancing slowly in the Asia-Pacific region



Source: WHO

Note: pp, percentage point

Progress remains slow in increasing access to clean cooking, with some cases of reported declining access rates.

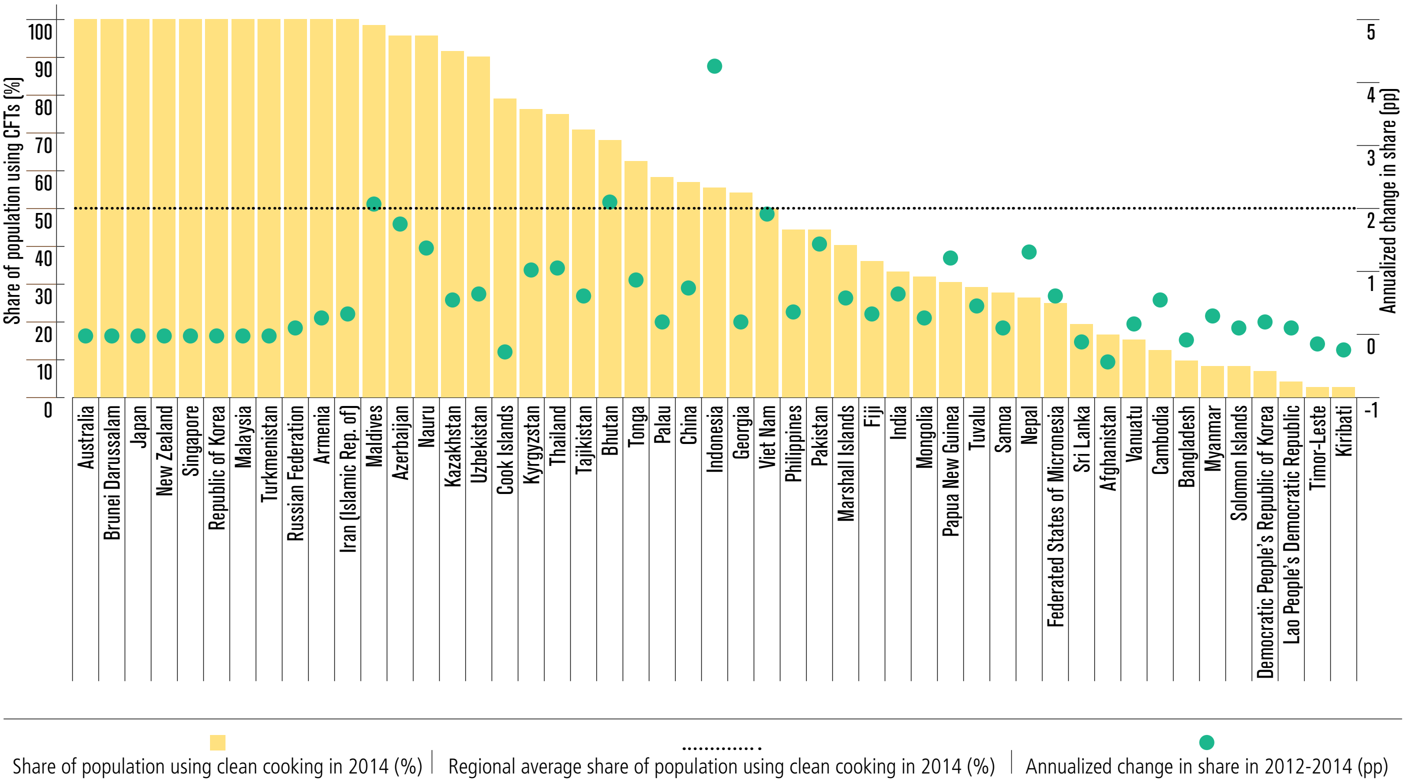
In the Asia-Pacific region, almost 2.1 billion people – nearly half the region's population and more than a quarter of the global population – remain without access to clean cooking. In 2014, the regional rate of access to clean cooking reached 51.2 per cent, up from 39.8 per cent in 2000 (figure 2.13). Small gains have been made in closing the gap between those with and without access to clean cooking with a steady but low average access annual share increase of 0.8 per cent over the period 2000-2014. The average yearly population increase with access to clean cooking was 51 million during this period, while the region's population grew on average by 41 million people per annum.

With some countries losing ground, and others making slow progress, the pace of improvement falls short of what is required to achieve universal access to clean cooking by 2030. Only twelve ESCAP economies[37] have access levels of at least 99 per cent (figure 2.14). India and China account for 69 per cent of the region's 2014 population without access to clean cooking (figure 2.15) – 1.4 billion people – and recorded average annual growth rates in usage of only 0.7 and 0.8 per cent, respectively. Bangladesh, with the region's third largest access deficit of 143 million people, has recorded a slow decline in access rates, falling from 10.6 per cent in 2000 to 10.2 per cent in 2014. Afghanistan, the Cook Islands, Kiribati, Sri Lanka, and Timor-Leste have also experienced declining access rates. In 2014, the lowest overall rates of access were found among least developed countries, including, the Lao People's Democratic Republic, Kiribati, and Timor-Leste, where access was less than 5 per cent. A notable outlier among least developed countries was Bhutan, which achieved a clean cooking access rate of more than 65 per cent through active promotion of clean options and enforcement of minimum efficiency standards for stoves.

In contrast to the declines experienced by several countries, Indonesia led the world in increasing access to clean cooking, with an annual growth rate of 4.3 per cent, resulting in a dramatic increase in the rate of access from a mere 2.4 per cent in 2000 to 56.6 per cent in 2014. Cambodia, the Democratic People's Republic of Korea, Maldives, Myanmar, Papua New Guinea, and Viet Nam more than doubled their access rates over the same period. Maldives is approaching universal access, and in Viet Nam, the rate recently passed 50 per cent, while the other economies mentioned with improved access rates still remain well below universal access. The twelve countries with at least 99 per cent access[38] are either high-income economies or natural gas-rich nations. With the exception of Bangladesh, natural gas as a higher percentage of total

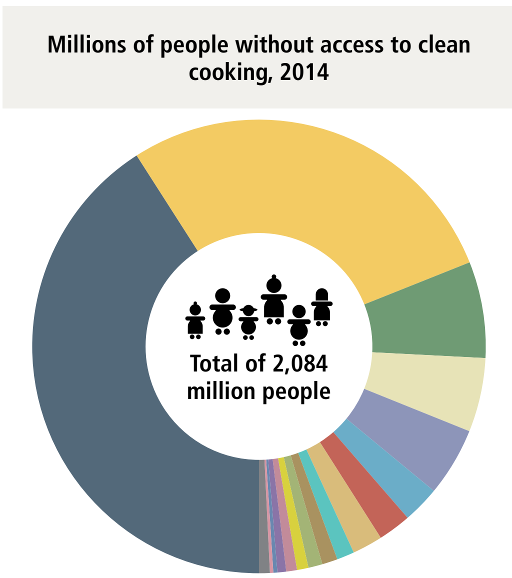
37. Armenia, Australia, Brunei Darussalam, the Islamic Republic of Iran, Japan, the Republic of Korea, Malaysia, Maldives, New Zealand, the Russian Federation, Singapore and Turkmenistan.
38. IEA defines developing Asia as Bangladesh, Brunei Darussalam, Cambodia, China, Democratic People's Republic of China, India, Indonesia, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand, Viet Nam and Taiwan Province of China, plus other Asian countries and territories for which individual data are not available but are estimated in aggregate, namely: Afghanistan; Bhutan; Cook Islands; Fiji; Kiribati; Lao People's Democratic Republic; Maldives; Palau; Papua New Guinea; Samoa; Solomon Islands; Timor-Leste; Tonga, Vanuatu; French Polynesia :Macau, China; and New Caledonia.

Figure 2.14 Levels of access to clean cooking vary widely among Asia-Pacific countries, with only twelve of them achieving access rates of more than 99 per cent



Source: WHO

Figure 2.15 The majority of the access deficit in the Asia-Pacific region is in India and China



India	853
China	584
Bangladesh	143
Indonesia	110
Pakistan	102
Philippines	55
Myanmar	49
Viet Nam	45
Afghanistan	26
Democratic People's Republic of Korea	23
Nepal	21
Sri Lanka	17
Thailand	16
Cambodia	13
Lao People's Democratic Republic	6
Papua New Guinea	5
Other ESCAP countries	16

Source: WHO

primary energy supply tends to correlate with high rates of clean cooking access in the Asia-Pacific economies.

According to the New Policies Scenario of IEA, 1.458 billion people in developing Asia[39] will not have access to clean cooking in 2030, with India projected to have the highest number of people in the region without access at 675 million, followed by China, at 244 million (IEA, 2016c). Unless significant efforts are made, it can be expected that the Asia-Pacific region as whole will not meet the SEforAll target of universal access by 2030.

39. Kerosene in previous report editions was categorized under clean fuels, but has been removed from this category for this report. Households cooking with kerosene —also known as paraffin—were included as having access to clean cooking because kerosene is a liquid (nonsolid) fuel. However, kerosene is a major source of air pollution, with formaldehyde, polyaromatic hydrocarbons, and particulate matter, including black carbon (a major contributor to near-term climate warming). Given the substantial evidence on the health and safety risks of kerosene, WHO guidelines for indoor air quality and household fuel combustion recommend discouraging its use in the home (WHO, 2014).

Challenges in measuring access to clean fuels and technologies

Similar to electrification, data on access to clean cooking are generated from household surveys from various sources, which are conducted on an irregular basis. The survey results vary significantly because of the different data collection methods used. The GTF data relies on survey data and modelling to close the missing data gaps.

Measuring access to clean cooking is also challenging at the data gathering stage. The designs of cookstoves vary widely, making it difficult to categorize them. Furthermore, fuel preparation, such as drying of biomass and user habits all factor into the resulting combustion efficiency and emissions (Edwards and others, n.d.). Those factors make it necessary to apply a classification scheme and average emissions factors for various fuel and stove types.

Another significant challenge is the verification of clean fuels and technologies use. Although GTF measures primary use of clean cooking fuels and technologies, fuel "stacking" is a common practice. Under this practice, different stoves or fuels are used for different purposes. Consequently, owning an improved cookstove does not necessary mean that it is the only cooking technology used on a day-to-day basis by a particular household. Furthermore, factors such as fuel availability and costs, cooking preferences, and maintenance requirements influence usage levels. As a result, the intended efficiency and health benefits may not be fully realized. For improved biomass cookstoves, verification of use is being approached through such efforts as remote sensing.

HIGHLIGHTS FROM ASIA-PACIFIC SUBREGIONS

In **East and North-East Asia**, the overall rate of access to clean cooking was 61.2 per cent in 2014. China has long promoted clean fuels and technologies, though it has achieved an access rate of only 57.2 per cent and has the second largest population in the Asia-Pacific region without access – 584 million people in 2014. The country has shown stable average annual share gains of 0.8 per cent, though urbanization has played a role in this progress. Mongolia reported a 31.9 per cent rate of access in 2014, while the Democratic People's Republic of Korea has the subregion's lowest access rate, at 6.6 per cent. These two countries recorded lower annual changes in shares (0.3 and 0.2 percentage points over the period 2000-2014, respectively), as their governments have yet to put in place comprehensive policies to promote clean cooking. However, under their recently submitted nationally determined contributions, both countries are planning to take actions in this area. Meanwhile, the high-income countries of Japan and the Republic of Korea have universal access to clean cooking.

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The subregion of **North and Central Asia** has the highest overall rate of clean cooking access in Asia and the Pacific region, at 95.6 per cent, with rates of the majority of countries at 90 per cent or above. Among those with relatively lower rates, Kyrgyzstan and Tajikistan, approximately three quarters of their populations use clean fuels and technologies, while Georgia has the lowest usage percentage in the subregion, at 55.0 per cent. Uzbekistan has the largest absolute deficit, with three million people without access. Natural gas is widely used in the subregion for cooking and heating, though many low-income households in rural areas continue to rely on traditional biomass. As a subregion, after steady progress in closing the gap between those with and without access, the increased rate of population growth unmet by accelerated progress in access has slowed annual gains.

The Pacific subregion recorded an overall access rate of 81.9 per cent in 2014. However, if Australia and New Zealand are excluded, the rate drops to just 30.2 per cent, though this represents almost a doubling of the 16.2 per cent access in 2000. Among the small island States, there is a broad range of access. The small country of Nauru has experienced the highest growth rate for the subregion, reaching 96.2 per cent in 2014, up by more than 20 percentage points from 2000. The country's progress can be attributed to heavily subsidized electricity, which led to a sharp rise in the use of electric cookers (IRENA, 2013). Papua New Guinea, the country with lowest urbanization rate in Asia and the Pacific and the second largest population in the subregion, also made good progress, more than doubling access over the same timeframe to reach 31.3 per cent. Pacific island countries are typified by dispersed populations and plentiful biomass, and many of them have low access rates to clean cooking of less than 50 per cent. The lowest rates are found in Kiribati (3.2 per cent) and Solomon Islands (8.9 per cent), and shares of the population with access are falling in the Cook Islands and Kiribati.

The subregion of **South and South-West Asia** had the lowest clean cooking access rate in Asia and the Pacific, at 35.4 per cent, in 2014, though national situations are diverse. Nearly

853 million people are without access in India, which has the world's largest deficit and little progress being made in closing it. The Islamic Republic of Iran was approaching universal use in 2014, as was the Maldives, which had exhibited a rapid annual 4.2 per cent rate of increase since 2000, when it was just 40.7 per cent. Progress in Maldives was driven in part by a limited availability of biomass and a well-established LPG distribution network. Access in Bhutan has also grown rapidly to reach 68.0 per cent in 2014, up from 38.0 per cent in 2000. Progress has been realized under government efforts to shift cooking towards fuel-efficient and electric cookstoves, which take advantage of a surplus of electricity. Progress in Nepal was driven by government programmes for improved cookstove distribution and subsidization of solar cookers (AEPC, 2016), while biogas played a role in Pakistan in the increased access (RSPN, 2015). Afghanistan, Bangladesh and Sri Lanka recorded access rates of below 20 per cent and showed declining trends.

Access rates in **South-East Asia** more than doubled from 25.7 per cent in 2000 to 52.7 per cent in 2014, driven largely by the sharp increase in Indonesia, which is due to its expansive programme to switch households from kerosene to LPG.[40] Viet Nam also recorded strong progress through a health risk awareness campaign and the introduction of biomass cookstoves in rural areas, which recorded a 50.9 per cent clean cooking access rate in 2014. Cambodia also showed gains, almost doubling its access rate since 2000, though the rate was only 13.4 per cent in 2014, while the rates for Myanmar, the Lao Peoples' Democratic Republic and Timor-Leste were at less than 10 per cent. LPG use is widespread in Brunei Darussalam, Malaysia, and Singapore, which have achieved and maintained universal access.

DRIVERS AND INFLUENCING FACTORS FOR PROGRESS

Focus on clean cooking is growing.

With few exceptions, government policies until recently have placed little emphasis on clean cooking in comparison to electrification. Much of the impetus for expanding access to clean fuels and technologies has come from non-governmental organizations. However, national governments also play a central role in supporting clean cooking access programmes with respect to creating sector-wide strategies, development and enforcement of regulations, strengthening institutional capacity, coordinating development partners, and engaging local communities and women networks. With growing awareness and increased focus on the critical issue related to clean cooking, a number of Asia-Pacific countries are taking the lead in tackling it by integrating cooking priorities within broader energy planning frameworks. The SEforAll initiative, the Sustainable Development Goals, and the Paris Agreement have provided further momentum, and, in recent years, a wave of policies directed at clean cooking have been implemented. Among many countries, including those with large clean cooking access deficits, national targets and government programmes have been introduced, promising accelerated future gains.

The approaches to expanding clean cooking vary, but for several countries with access to LPG supplies, this effort tends to focus on formulating appropriate subsidy mechanisms to lower the price of household cooking fuels and appliances, while expanding distribution networks. Other countries with a continued reliance on biomass are working to improve the design, affordability and distribution of improved cookstoves. Regionally, clean cooking programmes are often implemented with support from the private sector and non-governmental entities.

India – where 800 million people are adversely affected by household air pollution and one in four related global deaths occur each year (Global Alliance for Clean Cookstoves, 2016) – has recently set ambitious targets to leverage public-private partnerships under its latest policies and programmes. Under the Twelfth Five Year Plan, the country is aiming to develop hundreds of city gas distribution networks, while also expanding the number of biogas, solar, and improved biomass cookstoves (India, Planning Commission, 2013). The Unnat Chulha Abhiyan programme, initiated by the Ministry of New and Renewable Energy, envisages the development and deployment of 2.75 million efficient and cost effective improved biomass cookstoves by the end of 2017 to help combat the negative impacts from the use of the traditional firewood-based cookstove. The 2016 Pradhan Mantri Ujjwala Yojana programme, run by the Ministry of Petroleum and Natural Gas, aims to expand LPG use and reach 50 million households below the poverty line with new LPG connections made in the name of the female head of household. To subsidize household fuels and prevent funding leakage to other sectors, a subsidy is directly transferred to consumer bank accounts following each purchase of LPG in what is considered the world's largest cash transfer scheme, which reaches 150 million people.

In Bangladesh, the Sustainable Energy for Development Programme under the Ministry of Power, Energy and Mineral Resources which is supported

40. According to author's review of data offered by the Global Alliance for Clean Cookstoves, Carbon Finance Project Map, which is available from http://carbonfinanceforcookstoves.org/tools/project-map/?scale=all&standard=all&issuing=

Gender and clean cooking

The burden of disease from cooking with traditional fuels disproportionately affects women because of their role as the primary cooks in their families. A study in the Lao People's Democratic Republic, for example, found that in 74 of 100 cases, the wife is primarily responsible for cooking, and in 54 per cent of the cases, assistance was provided by a female child (Lao Institute for Renewable Energies, 2013).). Fuel collection also comes with high opportunity costs, as that time could be better used by women for economic activities, empowering them as earners in their families (UN Women, 2017). Biogas digesters, energy saving biomass stoves and solar energy cookers are found to reduce time in fuel collection (Ding and others, 2014), and use of modern cookstoves can reduce disease and lower health-care costs for women (Duflo, Greenstone and Hanna, 2008; Wilkinson and others, 2009). Asia-Pacific Governments, such as Bangladesh,[a] India,[b] and the Marshall Islands,[c] are beginning to take steps to address the unequal impacts of traditional cookstoves by targeting women under their clean cooking initiatives.

a See the 2013 Bangladesh Country Action Plan for Clean Cookstoves. Available from http://policy.asiapacificenergy.org/policy/?q=node/219.
b See the 2014 Unnat Chulha Abhiyan (UCA) Programme. Available from http://policy.asiapacificenergy.org/policy/?q=node/2797). Also see Pradhan Mantri Ujjwala Yojana, and the 2016 Pradhan Mantri Ujjwala Yojana. Available from http://policy.asiapacificenergy.org/policy/?q=node/2642
c See the 2016 National Energy Policy and Energy Action Plan. Available from http://policy.asiapacificenergy.org/policy/?q=node/2678

image: © Ton Schulten/Flickr.com

by development partners, envisages replacing traditional stoves with improved ones, "Bondhu Chula", by 2021. This will help save the lives of 46,000 Bangladeshi women and children estimated to die each year from household air pollution. In 2013, the country put forth the Country Action Plan for Clean Cookstoves, aiming to develop a national supplier network of improved cookstoves by adding clean cooking technologies to existing non-cooking product distribution and wholesale chains, such as grocery shops. Through this initiative, the country has distributed 1.5 million improved cookstoves (Bangladesh, Ministry of Environment and Forests, 2015). However, its efforts have yet to yield strong results, as the number of people without access to clean cooking continues to rise along with the growth of the population.

The Marshall Islands, which recorded a 41.3 per cent access rate to clean cooking in 2014, has set a target to raise the access rate to 90 per cent of all households by 2020 under its National Energy Policy and Energy Action Plan (Marshall Islands, Ministry of Resources and Development, 2016. Nepal, with 26.1 per cent access as of 2014, intends to increase the use of biogas in rural areas and provide all households access to clean cooking by 2030, supported by a subsidy mechanism (Nepal, Ministry of Population and Environment, 2016b). Niue also is trying to reach universal access by 2030 under its Strategic Energy Road Map (Niue, 2015). The Solomon Islands, with 8.9 per cent access in 2014, is developing the Cooking for Life programme to pilot biogas and promote LPG under its National Energy Policy and Strategic Plan (Solomon Islands, Ministry of Mines, Energy and Rural Electrification, 2014). These policy and programme examples demonstrate a clear push by some governments in the region to address the widespread challenge of access to clean cooking.

Government and private sector interventions are working to provide access in rural areas.

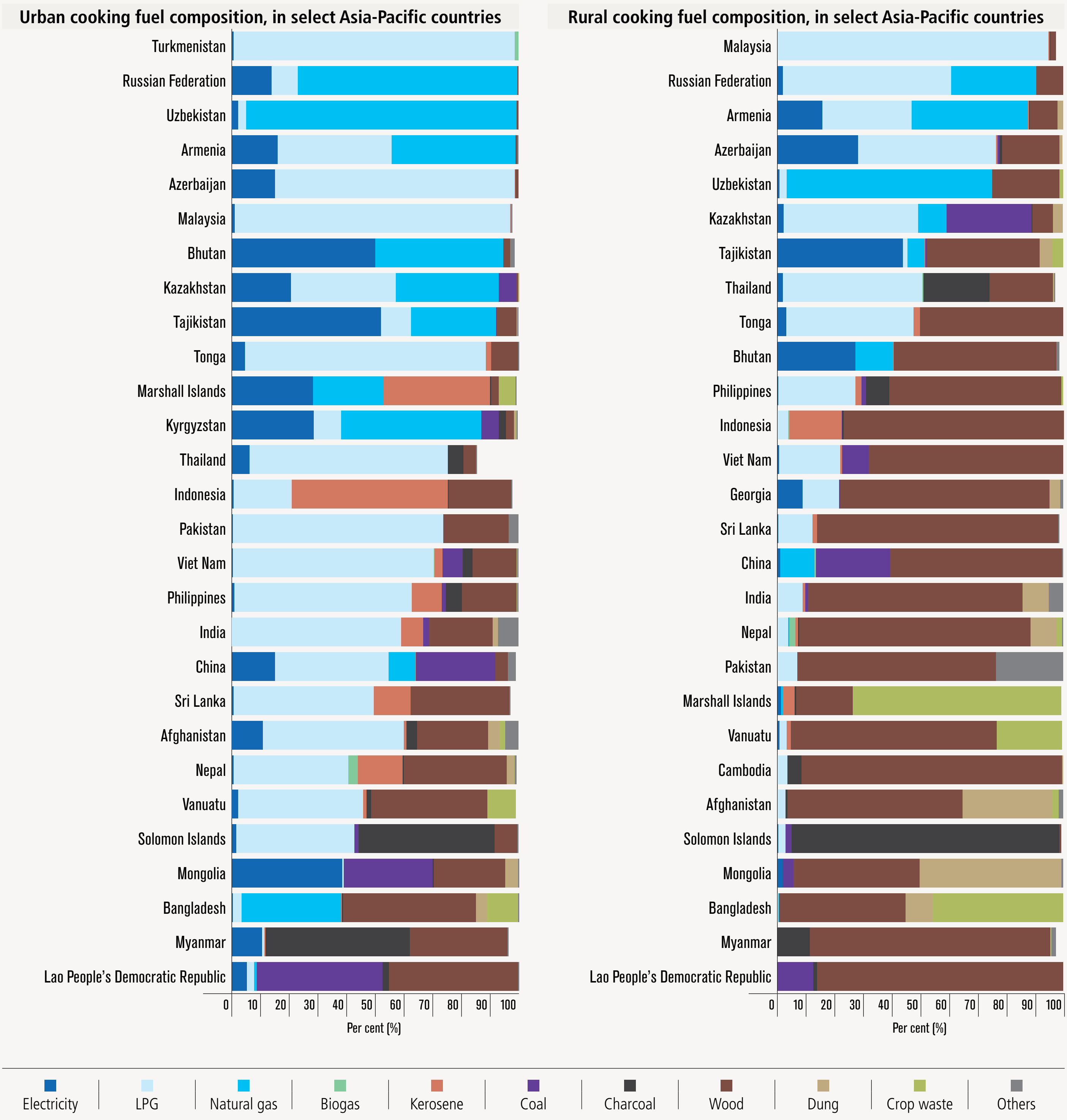
Many countries are experiencing an urban-rural divide in terms of fuels used for cooking. In urban areas, cooking fuels are based on a mix with a higher percentage of clean fuels and technologies, while rural areas remain largely reliant on traditional cooking fuels and methods (figure 2.16). Official statistics from India's 2011 census, for example, showed the use of LPG among urban households at 66.2 per cent compared to 15.5 per cent in rural households (India, 2015).

In urban areas, modern cooking options are more widely available and there is a greater choice of technologies and fuels with established distribution. Typically, fuel supply chains for LPG are generally better established and electricity to power inductions is available and affordable.

In contrast, rural areas lack the same availability and distribution networks for products, fuels and replacement parts. The majority of people without access reside in rural areas where traditional solid biomass, in the form of wood, dung, and charcoal, is often readily available at little or no monetary cost. Improved or clean cookstoves and clean fuels are relatively expensive, contributing to low demand and inhibiting market expansion in those areas.

For a broad switch from traditional to clean cooking in rural areas to take place, governments need to strongly support the expansion and reliability of technology and fuel distribution networks while increasing awareness of benefits and lowering economic barriers to uptake. Indonesia offers an example. As noted previously, the country has recorded the highest annual growth of clean cooking in the region. The Government put forth a programme in 2007 to distribute free of charge LPG stoves, including the cylinder, regulator and hose, and subsidized the purchase of small LPG cylinder refills. Concurrently, socialization and educational activities

Figure 2.16 Clean cooking fuels are more prominent in urban cooking



Source: WHO Household Energy Database

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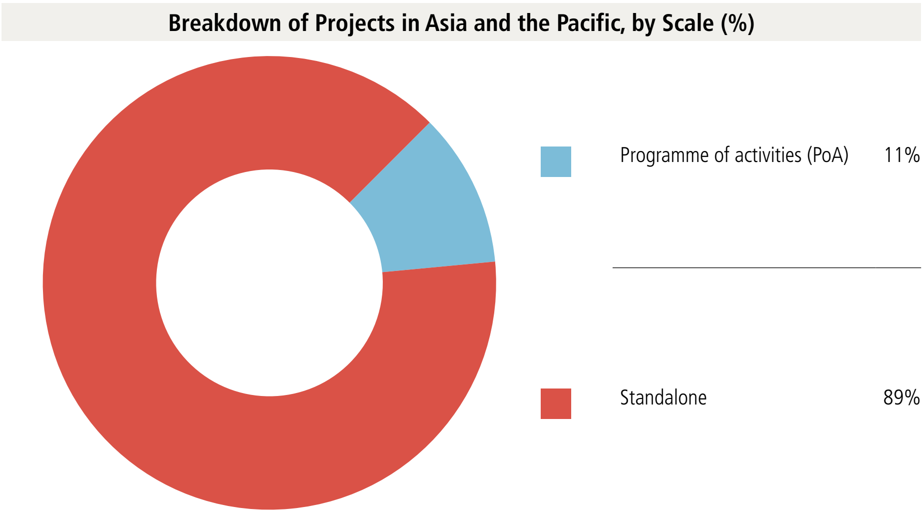
were undertaken to facilitate consumer uptake. Efforts have been made to expand access and reliable distributions to even the most remote island locations and, as a result, more than 95 per cent of the population has benefited (World LPG Association, 2015).

Carbon financing is supporting development of the clean cooking sector.

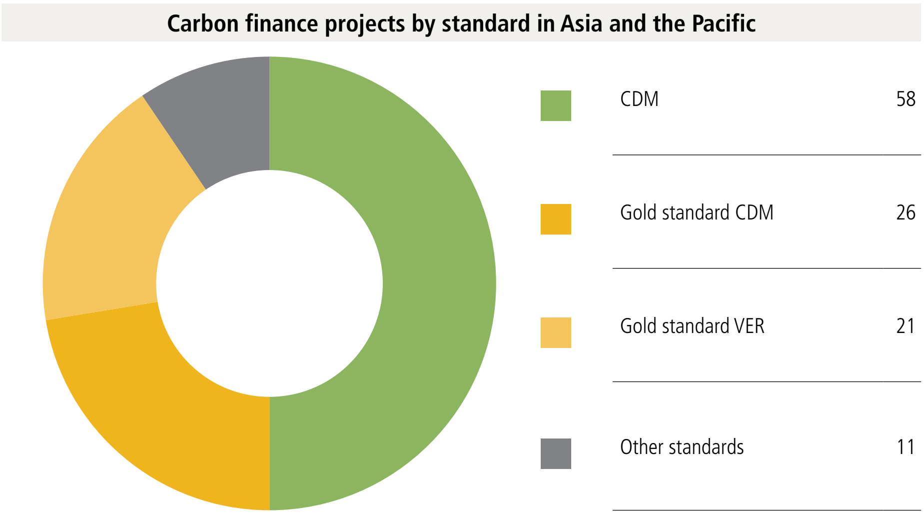
Governments, non-governmental organizations and private sector entities are tapping into the resources offered by carbon financing. More than 100 stand-alone and programme of activities projects have or are expected to produce carbon credits based on clean cooking.[41] The bulk of the projects are being implemented under the Clean Development Mechanism, though credits are also being issued under voluntary emissions reduction and other standards (figure 2.17). Among the countries using carbon financing are Bangladesh, Cambodia, China, India, Indonesia, Nepal, Pakistan, Vanuatu and Viet Nam.

For example, the Improved Cookstove Programme of the Lao People's Democratic Republic was launched as a carbon offset project. The sale of credits is used to finance the training of stove producers and retailers, promote new markets, improve product monitoring and testing, and manage certification and quality labelling (Nexus, 2017). In Viet Nam, the Ministry of Agriculture and Rural Development is disseminating household biogas-based cooking solutions, while credits are being issued in Cambodia for biodigesters. In China, subsidies are being offered to help cover the costs of improved cookstoves in ecologically sensitive areas where forest cover is critical to wildlife habitats (Global Alliance for Clean Cookstoves, 2017).

Figure 2.17 Carbon finance is playing a growing role in clean cooking



Source: Global Alliance for Cookstoves. 2017. Project Map. Available from http://carbonfinanceforcookstoves.org/tools/project-map/?scale=all&standard=all&issuing=



41. Companies include Bosch and Siemens Home Appliances Group, Shell and the Shell Foundation, Novozymes and Philips.

CHALLENGES

Providing access to clean fuels and technologies is not a well-integrated priority in broader energy planning.

Among the Asia-Pacific countries that lack universal access, clean cooking has been referred to in some of their national policies. However, for many of them, this is a recent development, and supporting action plans have been ad hoc in nature and the results have not been well-monitored. Much of the effort behind expanding clean cooking is still being undertaken by non-governmental organizations, development agencies and private sector organizations. Experience indicates that effective expansion of clean cooking requires comprehensive supply chain development and management of fules and technologies, an approach that is emerging among some countries, but has yet to be widely adopted.

Clean fuel supplies remain unavailable or unreliable.

Rural consumers cite poor availability of modern cooking technology or fuels as a major barrier to their uptake and use (Jain and others, 2015). Supply and distribution of LPG is limited in many rural areas, which are often the same areas where biomass is plentiful and often free. Markets based on local resources and traditional technologies tend to be well developed, such as in the case of China, which has an abundance of coal and a well-established market and distribution networks for coal and coal stoves. In contrast, the biomass stove market was established more recently, dependent on government subsidies and not well commercialized (World Bank, 2013). To support the uptake of clean cooking, stronger and expanded rural markets that provide reliable supplies of clean cooking technologies and fuels are needed.

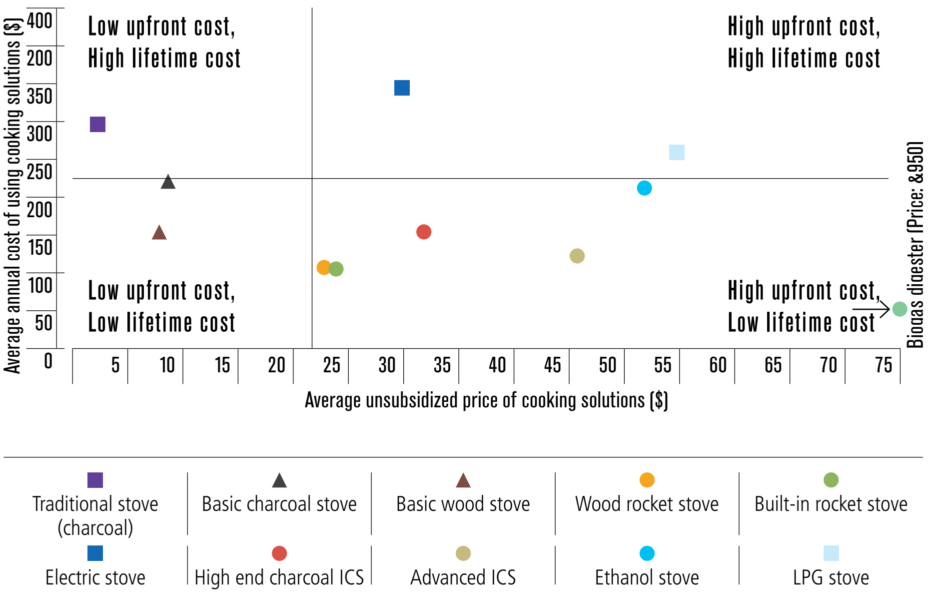
Modern cooking solutions remain expensive for poor households.

Households that lack access to clean fuels and technologies are concentrated in rural areas where poverty rates are typically higher. The cost of adopting clean fuels and technologies is a primary barrier to accessing clean cooking (World Bank, 2013). Upfront and ongoing operational costs for the cleanest cookstoves, such as electric and LPG, are high, while traditional biomass-based stoves have much lower price points (figure 2.18). Studies conducted in Bangladesh, China and India have pointed to pricing as a major obstacle in the uptake of clean cooking solutions (Arif and others, 2011; Shen and others, 2014; Jain and others 2015).

Traditional cooking fuels are often low-cost or free. In India, evidence suggests that 50-60 per cent of the rural population relies on free biomass. In a survey of six states in India, 95 per cent of the surveyed households cited high upfront costs as the largest hurdle to adopting the use of LPG (Jain and others, 2015). In the rural areas of China, coal is cheap and other biomass is nearly free (Shen and others, 2014). Clean fuels, such as LPG, and technologies, such as LPG cooktops and improved cook stoves are often unaffordable.

Households that face cash constraints will likely continue to use biomass if it is free. Modern cooking options become a more economically viable choice for households when biomass, such as firewood, is purchased rather than gathered at no cost (Jain and others, 2015), or when the clean alternative is considered superior. However, even in those cases, cash flow is an issue, as, for example, the cost to purchase LPG requires a relatively large sum of money at infrequent intervals. Even in cases in which biomass is purchased and the cost of LPG may be less when averaged over the long term, the more frequent but

Figure 2.18 More efficient cookstoves are more expensive



Source: Energy Sector Management Assistance Program (ESMAP) and the Global Alliance for Clean Cookstoves (2015).

low sums of money for biomass may be more achievable for some consumers.

A study conducted in the Lao People's Democratic Republic indicates the importance of other drivers of uptake. It shows that if expectations are met, willingness to pay is relatively high for adopting alternative fuels and stoves. In addition to price, the study also found that drivers for making cleaner choices include stove performance and fuel availability (Lao Institute for Renewable Energies, 2013).

Subsidies are not always successful.

Subsidization of clean cooking has proven to be complex. Indirect subsidies have been an essential feature of successful efforts in the form of awareness raising, research and development, and industry support. Meanwhile, direct subsidies to producers and consumers have had mixed results. Market distortions, promotion of technologies that do not meet consumer demand, and sustainability challenges following the withdrawal of subsidies are some of the challenges (ESMAP and Global Alliance for Clean Cookstoves, 2015).

Ensuring that direct fuel subsidies reach poor consumers can also be difficult. Because fuel consumption rises with income level, in some cases, subsidies fail to assist the poor. Instead, they accumulate to more affluent households. Consequently, intended benefits are not delivered while adding to government expenditures (Ekouevi and Tuntivate, 2012). In Indonesia, the national LPG fuel switching programme, which subsidizes fuels for household use, has been challenged by leakage into other LPG-consuming sectors. In India, the direct benefits transfer programme using bank accounts is designed to prevent such leakages and ensure that subsidies benefit the intended population groups. However, the unbanked is left to find other means of accessing the LPG subsidies.

"Modern" energy needs to compete with traditional energy in utility and convenience.

The achievement of health, gender and environment objectives may not always align with the preferences of target populations. The benefits that have been promoted for clean cooking – improved indoor air quality, better health and less time spent gathering biomass – do not always resonate with those who feel they are accustomed to indoor smoke (Lao Institute for Renewable Energies, 2013). Some also do not value the technology for its time-saving benefits or fail to link health problems with cooking methods (Pattanayak and Pfaff, 2009). Even when clean fuels and technologies are introduced, fuel stacking remains a common practice, and verification of the use of clean cooking methods is difficult as improved cookstove ownership does not equate to use (Jeuland, Pattanayak and Soo, 2014).

Clean options must, therefore, offer an equal or higher level of utility and convenience for the user compared to the existing choices, particularly if added costs are associated with the switch from traditional to modern methods. In a recent survey in rural India, for instance, it was found that LPG consumers were not familiar with the health benefits of using this modern fuel over traditional cooking fuels and methods, yet the people in general overwhelmingly favoured LPG over improved biomass cookstoves and biogas. This suggests that fuel uptake is a choice driven by usability factors. In fact, 75 per cent of households in the Indian study believed that LPG was more convenient than other choices (Jain and others, 2015).

Preferences related to convenience and utility include other factors such as cooking time, heat control, compatibility with preparation of local dishes, and fuel availability. Even when the stove meets user needs, the irregularity of the supply of commercial clean fuels impedes the adoption of clean cooking methods. LPG distribution may also be limited and

unreliable in many rural areas. Ensuring a consistent supply of other options, such as biogas, may also be challenging, as experienced in China where efforts to spread the use of biogas was impeded by an unreliable feedstock supply and shortfalls in labour for maintaining production (Shen and others, 2014).

Cultural practices can serve as a major barrier in adopting clean cooking.

Cultural preferences play a strong role in the selection of cooking appliances. Local food may require particular methods to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prepare, and those needs may not be met by "clean" options, resulting in the continued use of traditional biomass, including among non-poor households and in urban areas where modern options are available (Bacon, Bhattacharya and Kojima, 2010; Alauddin, 2016). For example, in the Lao People's Democratic Republic, households generally use wood, which is widely available because of heavy forest cover; yet, they prefer charcoal, which is more expensive, for grilling meat during special occasions. Electric rice cookers offer a convenient and clean solution, but they cannot be used to cook glutinous rice, which is the preferred rice in the country (Lao Institute for Renewable Energies, 2013). Several different stoves may also be used for various purposes and different fuels may be used to prepare different dishes. Much work remains to be done in understanding consumer preferences that also vary at local levels.

Poor standards and regulations limit delivery of intended benefits.

Market-based approaches support cooking market sustainability. Greater public support is needed for research and development and to establish standards and certifications, particularly where markets and the business environment are underdeveloped (Ekouevi and Tuntivate, 2012). Standards and regulations applicable to the cookstove sector are often weak, and the biomass-based cooking technology options available on the market may not deliver their intended benefits, particularly those related to health. Achieving emission levels that approach WHO guidelines is challenging. The cleanest, though often more expensive solutions – such as LPG, biogas, electricity and solar – offer the greatest benefits (ESMAP and Global Alliance for Clean Cookstoves, 2015). Meanwhile, evidence suggests the air quality in households using improved biomass cookstoves remains poor even though those cooking devices emit low levels of pollution, and that the health improvements associated with biomass cookstoves may be limited (Tielsch and others, 2016).

Tighter polices aimed at standardizing and regulating the market are fundamental to the success of clean cooking access efforts, as markets can be subject to the influx of low-quality, or even imitation stoves, which are often offered at lower prices. Without coordination and a common set of terms for evaluating stove performance, particularly for biomass, it is also difficult for policymakers, donors, investors, stove experts and programme managers to establish baselines for performance, creating the risk that the products available on the market fail to deliver all the benefits they are designed to provide.

Financing and investment remains inadequate.

In 2015, in the report of the Finance Committee of the SEforAll Advisory Board, it was shown that $4.4-billion needs to be invested annually to achieve universal access to clean cooking by 2030. Actual global investment in 2012 was low, at just 0.1 billion, leaving a gap of $4.3 billion (Sustainable Energy for All Advisory Board Finance Committee, 2015). Overwhelmingly, investment in energy access is directed to the power sector, with only a small amount used for increasing access to clean cooking (IEA, 2015).

A review of World Bank projects and initiatives on energy for clean cooking attributes the absence of mainstreaming household energy access interventions in lending operations to a number of factors. These include time-consuming upstream studies and complexities within a limited budget during project preparation, limited number of household energy experts within the Bank, high transaction costs compared to the volume of lending it can leverage, and the low demand for intervention from countries perhaps due to lack of awareness of the issues (Ekouevi, 2013). Furthermore, small- and medium-scale entrepreneurs of clean cooking solutions often lack access to investment capital to start their businesses and working capital to operate. They usually operate on a low profit margin (Ekouevi, 2013) and therefore are unable to expand the production and distribution of clean cooking solutions and conduct further research and development on their technologies.

Space heating is a basic need often met with traditional biomass.

The Asia-Pacific region is host to many countries where heating represents an important share of the energy used by households. Not captured in the GTF data, traditional fuels, such as wood and coal, are used not only for cooking, but also for providing warmth within the household. Biomass used for heating purposes can compromise indoor air quality and carries similar health risks associated with cooking. Even households that have central heating systems operating on wood, oil, gas, or coal, may be vulnerable to fuel shortages and price increases that place households at risk of not being able to meet this basic need. Modernization of lifestyles increasingly increases the demand for improved levels of comfort. It is, therefore, expected that energy needs in this area will continue to increase, and policy efforts are needed to support sustainable solutions in this sector.

> As a regional example of an effort to provide more sustainable and secure heat supplies, Mongolia, under a city master plan, intends to install comprehensive heating infrastructure to ger areas that lie on the fringe of Ulaanbaatar where 85 per cent of the population relies on traditional biomass. Heat will be provided through central or partially central heating systems integrated with cogeneration power plants (Mongolia, 2014).

ACCELERATING PROGRESS

Improved and integrated policies for clean cooking.

Integrating clean cooking within national energy policy frameworks sets the foundation for making progress. The introduction of and strengthening of targets, regulatory frameworks, and intervention programmes can support value chain development and drive market growth. The current weak state of policy frameworks for clean cooking in many countries requires concerted efforts by policymakers to prioritize this development challenge and introduce the necessary and nationally-appropriate measures to broaden access.

Creating stronger partnerships and increased awareness.

Even when clean fuels and technologies are present in the market, consumers may not know that they are available or they may be unaware of the procedures, such as how to obtain an LPG connection or service on a device. These awareness barriers limit sales of clean cooking technologies.

Public campaigns support clean cooking uptake when conducted through channels that will reach and are trusted by target groups. Evidence suggests that partnerships with non-governmental organizations or other community actors already actively reinforce efforts to encourage the use of clean cooking (Jeuland, Pattanayak and Soo, 2014). Increasing partnerships between governments, civil societies and private sector actors can leverage the expertise, experience, and community awareness of those entities to produce better outcomes. An example from the region is Viet Nam, where private sector actors have been working to develop distribution chains to deliver affordable clean biomass stoves to rural areas, and have partnered with the community-based Women's Union to act as sales agents at local levels (Business Call to Action, 2016).

Consumers naturally weigh the costs and benefits of their purchases, particularly if they face economic constraints. In the clean cooking market, awareness of the health impacts of cooking with traditional biomass is generally low, yet monetary cost perceptions may be high from the perspective of overall cost and cash flow. Consumers who are sensitive to cost, when given the choice to purchase a lower priced item that provides the needed functions, are unlikely to choose a higher priced item with the same perceived functions. However, it has been shown that households that are aware of the harmful effects of indoor air pollution are more likely to choose clean options (Ekouevi and Tuntivate, 2012), especially if they meet performance and convenience expectations (Lao Institute for Renewable Energies, 2013). Furthermore, assisting consumers in reviewing their existing household energy costs and potential cost offsets with a new cooking device can improve their willingness to pay for clean fuels and technologies.

> In 2014, Nepal introduced interim benchmarks for biomass cookstove performance.

Getting the design right and improving performance standards.

If user preferences are not taken into in the design of cookstoves, adoption rates tend to be low (Ekouevi and Tuntivate, 2012). Therefore, an increase in research and development is required to better understand the determining factors behind the selections made by consumers, how they use the devices and

for what purposes. As having an improved cookstove is not a top priority of the poor (Ekouevi and Tuntivate, 2012), other convenience and utility features need to be included and adequately attractive.

Improving and enforcing better standards.

A number of government and non-government actors operate research and testing facilities to support the advancement of cookstoves. From those facilities, next generation options are needed that improve the performance in terms of increased efficiency and better health outcomes. Based on the new generation designs, more rigid standards and tighter regulation of cookstove markets can help eliminate low-performing options.

> Bangladesh adopted the Country Action Plan for Clean Cookstoves in 2013 with the objective to develop a national network of improved cookstove suppliers and encourage retail outlets that do not specialize in sales of cooking products and wholesale chains, such as grocery shops, to stock improved cookstoves, fuels, and other clean cooking appliances.

Markets and distribution networks targeting rural areas.

Lack of reliable supply and distribution of clean cooking fuels and technology is a significant barrier to increasing access to electricity. Accordingly, governments, in cooperation with private sector and civil society organizations, should establish and maintain effective supply and distribution networks, with the objective to expand markets and to commercialize clean cooking technologies, which will support long-term sustainability.

Improving subsidies and their delivery.

To support the accelerated adoption of clean cooking, more competitive pricing of improved cookstove models and subsidies on LPG are required (Shen and others, 2014). Encouraging households that have access to free or low-cost biomass to switch to relatively expensive improved cookstove models or LPG requires consumer incentives. This would negate financial barriers that, in particular, adversely affect the poor. Lowering the cost of cooking devices boosts the number of potential buyers. In Nepal, for example, the Government is providing up to a 50 per cent subsidy on metal improved cookstoves for targeted beneficiary groups under its latest renewable energy subsidy policy (Nepal, Ministry of Population and Environment, 2016b). Also, improved cookstove programmes that include microfinancing options have tended to be more successful (Ekouevi and Tuntivate, 2012).

In the case of LPG, the ongoing purchase of fuel, in addition to the cost of the stove, may be unaffordable without subsidies. Lowering the upfront cost of switching to clean cooking options, while ensuring that the ongoing use remains affordable is a challenge that could be met through better targeted subsidies and flexible financing options.


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Maximizing the contribution of the business sector towards attaining universal access to clean cooking.

The supply, deployment and adoption of clean cooking solutions must be scaled up in order to achieve universal access to clean cooking. To do this, greater support from the private sector is required along with the efforts to build awareness of the benefits of clean cooking. In all these activities, public and private financing plays vital roles.

Public financing is needed to build awareness and support research and development, standard setting and testing, and the collection of market and resource data. Public funds can also enable advisory services to develop business plans, strengthen local technical and management capacities, and support microlenders through guarantees and smart subsidies (Ekouevi, 2013). Private finance may play a larger role in the building of production facilities, distribution network expansion, as well as technology research, development and deployment.

Local entrepreneurs have been at the forefront of producing and marketing cookstoves. Increasingly, multinational companies[42] have also been promoting clean cooking by developing affordable cookstoves for low-income markets in, for example, Indonesia and India. National and international banks have also contributed valuable funding through partnerships with international non-governmental organizations.[43] Actively engaging businesses and financial institutions not only results in much needed financial resources, but it could also accelerate product and service innovation, improve service delivery, and provide management and technical capacity (World Business Council for Sustainable Development, 2012).

Increasing rural economies and opportunities for women's employment to increase demand for more efficient clean cooking options.

Affordability is a primary barrier to the adoption of clean cooking fuels and technology. Therefore, a long-term strategy would be to boost rural economies to increase the spending power of rural households. This, in turn, allows consumers to weigh more heavily other factors, such as convenience and utility, when considering cooking options.

Increasing employment opportunities for women would also encourage households to switch to clean cooking option. As noted previously, gathering fuelwood and other biomass is a task typically performed by unemployed women. With few productive options available, this time may not be valued. However, as wage opportunities for women increase, the opportunity cost of gathering fuel increases and households are likely to choose technologies with shorter cooking times (Ekouevi and Tuntivate, 2012).

42. The Global Social Investment Group of Deutsche Bank and the Bank of America partnered with the Global Alliance for Clean Cookstove to help finance early-stage clean cooking ventures. The Global Social Investment Group and the Global Alliance established the $4 million Clean Cooking Working Capital Fund (Deutsche Bank, 2014)
43. For households seeking to take advantage of electricity's many benefits, the efficiency of appliances is a factor that helps determine the affordability of energy services. The high electricity expenditure associated with appliances that consume a relatively high amount of energy limits its use and leaves less resources for the operation of additional appliances. However, if appliances operate at highly efficient rates, then the ability to take increased advantage of energy services and power more appliances is increased.


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03

PROGRESS IN ENERGY EFFICIENCY

GOAL:

By 2030, double the global rate of improvement in energy efficiency

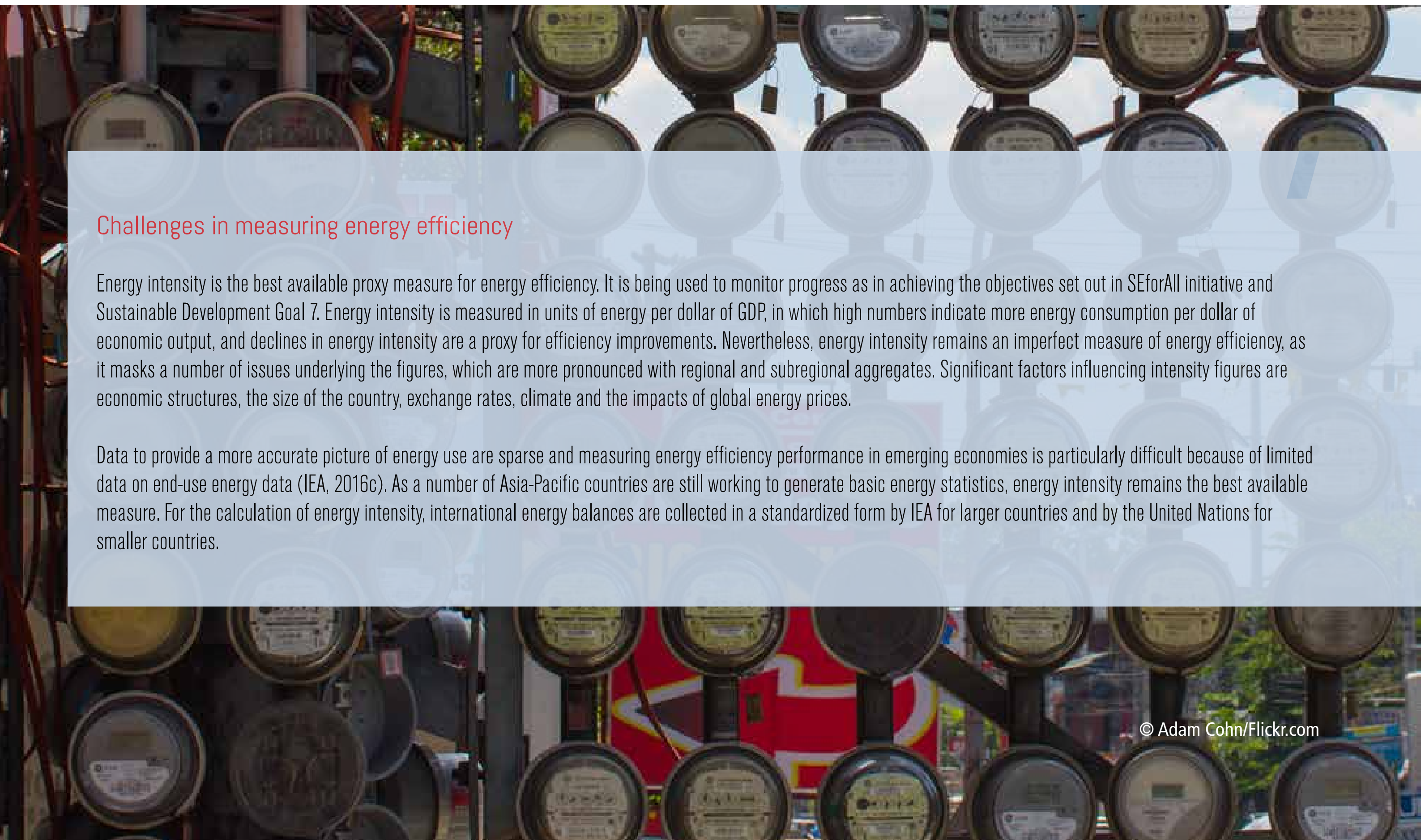
THE ROLE OF ENERGY EFFICIENCY IN SUPPORTING DEVELOPMENT OBJECTIVES

Rapid economic growth in the Asia-Pacific region is being accompanied and supported by rising energy demand. Yet, many national energy systems are struggling to sustainably meet energy needs. At the same time, countries have also pledged to reduce emissions under the Paris Agreement, which has created additional pressure to make more efficient use of energy resources. However, progress in improving efficiency is unevenly distributed within various sectors.

Energy efficiency measures have the potential to result in a 35-per cent cut in energy consumption over the business-as-usual scenario for the region by 2035 (ESCAP, 2015). Efficiency is also key to the realization of sustainable development objectives that pertain to the energy sector, as well as to other sectors, offering numerous and substantial benefits. Increased energy security is supported through energy savings and reduction in investment needs for capacity additions, reliance on energy imports and vulnerability to fluctuations in energy prices. While energy efficiency for importing countries can boost currency reserves, energy efficiency for exporting countries increases their energy resources available for export. For countries that have energy subsidies in place, energy efficiency also lowers government expenditures, supporting both conventional and renewable energy (IEA, 2014). Energy efficiency also facilitates greater economic productivity and provides social and environmental benefits, including, among them, increased energy affordability, improved air quality, reduced pollution and global climate change mitigation.

Energy efficiency is also closely tied to the realization of universal access targets by enabling higher levels of energy services at lower consumption rates and costs.[44] Synergies between efficiency and renewable energy are also strong, as lower overall energy demand contributes to efforts aimed at meeting renewable energy targets by making it easier to increase the share of renewable energy in the energy mix. The deployment of renewables for electrification and cooking also supports reduced energy intensities (IRENA and C2E2, 2015).

44. Fiji, the Federated States of Micronesia, Palau, Tonga, Tuvalu and Vanuatu showed growing energy intensity. Data are not available for American Samoa, the Cook Islands, French Polynesia, Nauru, New Caledonia, and the Northern Mariana Islands.



Challenges in measuring energy efficiency

Energy intensity is the best available proxy measure for energy efficiency. It is being used to monitor progress as in achieving the objectives set out in SEforAll initiative and Sustainable Development Goal 7. Energy intensity is measured in units of energy per dollar of GDP, in which high numbers indicate more energy consumption per dollar of economic output, and declines in energy intensity are a proxy for efficiency improvements. Nevertheless, energy intensity remains an imperfect measure of energy efficiency, as it masks a number of issues underlying the figures, which are more pronounced with regional and subregional aggregates. Significant factors influencing intensity figures are economic structures, the size of the country, exchange rates, climate and the impacts of global energy prices.

Data to provide a more accurate picture of energy use are sparse and measuring energy efficiency performance in emerging economies is particularly difficult because of limited data on end-use energy data (IEA, 2016c). As a number of Asia-Pacific countries are still working to generate basic energy statistics, energy intensity remains the best available measure. For the calculation of energy intensity, international energy balances are collected in a standardized form by IEA for larger countries and by the United Nations for smaller countries.

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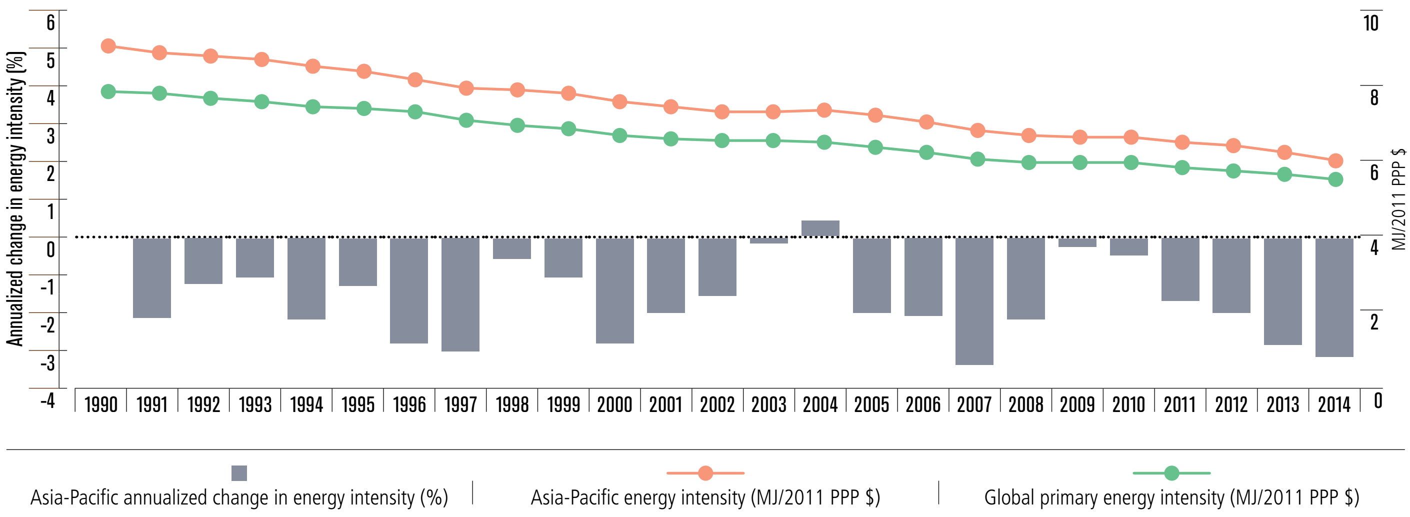
OVERVIEW OF PROGRESS

Figure 3.1 Primary energy intensity Asia and the Pacific continued to fall, but continues to be higher than the global average

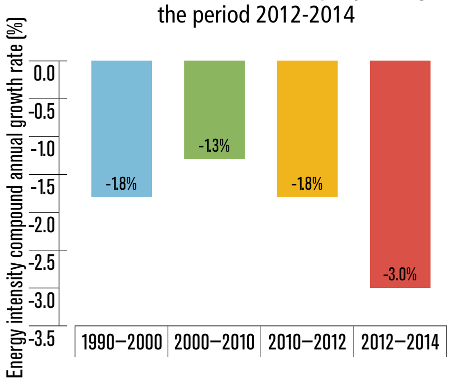


Source: IEA and UN Statistics

Energy intensity declined in line with major efficiency improvements in the industrial sector.

The Asia-Pacific region has experienced a steep decline in regional energy intensity, from 9.1 MJ/2011 PPP $ in 1990 to 6.0 MJ/2011 PPP $ in 2014 (figure 3.1). With the further decoupling of GDP growth and total final energy consumption during the period 2012-2014, the region achieved a short-term annual average energy intensity reduction of 3.0 per cent (figure 3.2), outpacing other global regions. This had helped the region meet the long-term 2.6 per cent global annual energy intensity improvement rate needed to achieve the SEforAll energy efficiency target in 2030. Yet, despite gains and rapid progress towards convergence with the global average of 5.4 MJ/2011 PPP $, **the region continues to rank the highest among the global regions in terms of overall energy intensity** (figure 3.3).

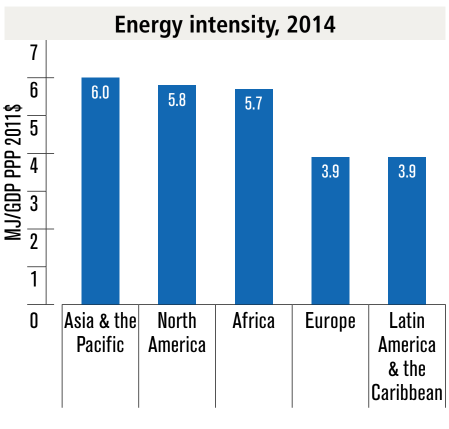
Figure 3.2 Energy intensity in Asia and the Pacific declined rapidly during the period 2012-2014



Source: IEA and UN Statistics

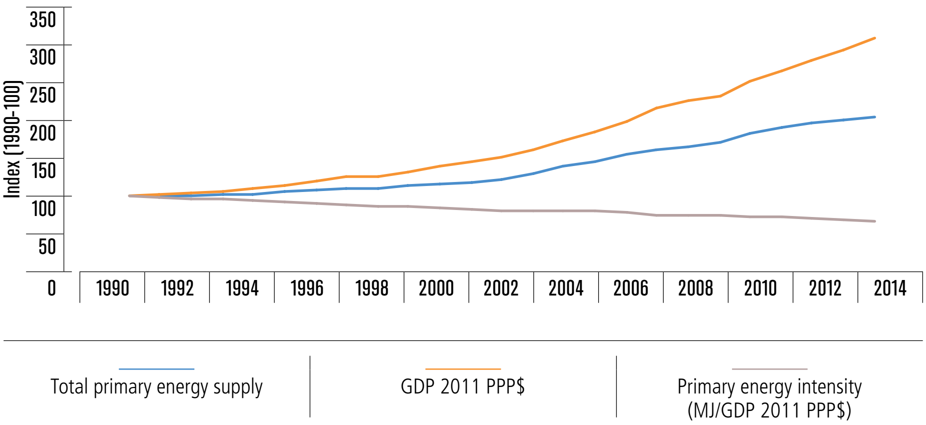
Energy consumption in Asia and the Pacific has increased rapidly since the early 2000s, in line with the rapid industrialization of the region, though decoupling of energy consumption and GDP growth has occurred (figure 3.4). In 2014, Asia-Pacific countries consumed more than half of the global total final energy, and approximately three fifths of the global industrial energy. The industrial sector is responsible for the largest percentage decrease in energy intensity during the period 2012-2014, at 3.2 per cent annually, though the service (2.5 per cent) and, to a lesser extent, agricultural (0.8 per cent) sectors also showed progress in that regard (figure 3.5). During the 2012-2014 period, China – the region's largest economy, which accounted for 55 per cent of regional industrial energy consumption in 2014, helped push the regional trend lower by continuing to adopt aggressive measures in the industrial sector. This included eliminating outdated technologies and the establishment of

Figure 3.3 Energy intensity in Asia and the Pacific remains the highest among the global regions



Source: ESCAP based on IEA and UN Statistics

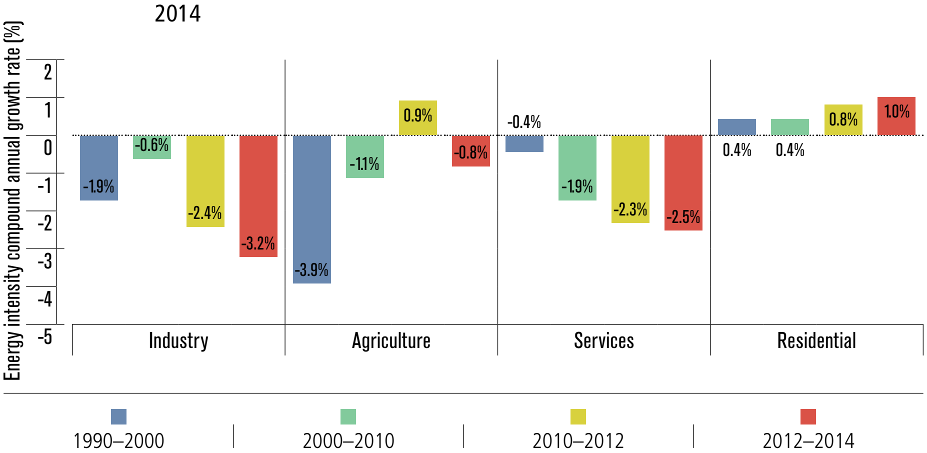
Figure 3.4 Growth in gross domestic product and energy consumption has markedly decoupled



Source: IEA and UN Statistics

Note: GDP 2011 PPP$ = gross domestic product in US dollars at 2011 purchasing power parity.

Figure 3.5 Industry, and to a lesser extent services, drove energy intensity reductions in 2012-2014



energy consumption standards that resulted in a 4.9 per cent reduction in industrial energy intensity. Since 2012, an apparent deceleration of Asia-Pacific industrial energy consumption growth occurred (figure 3.6), while value added continued to rise (figure 3.7).

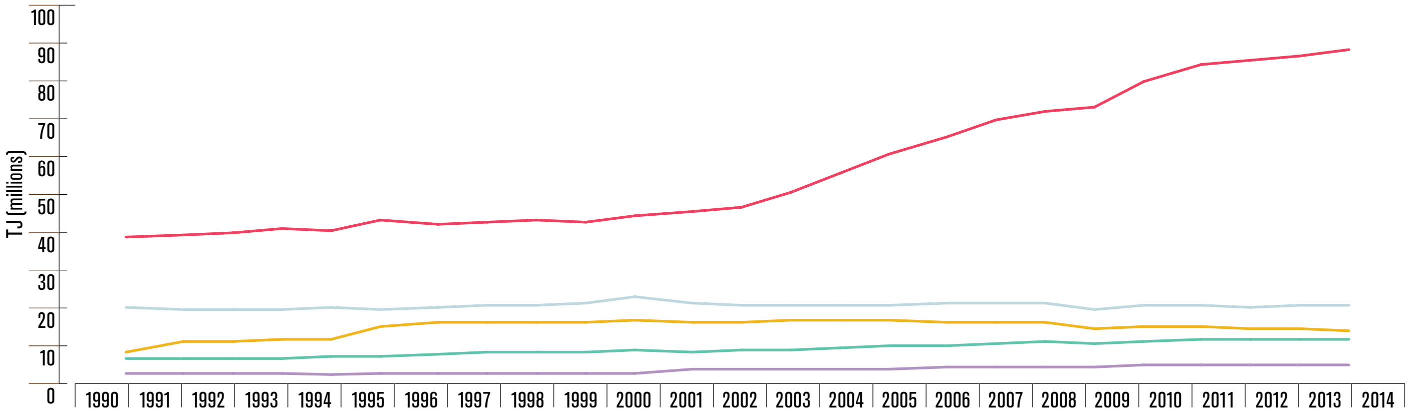
The rate of reduction in energy intensity in the region's economic sectors – industry, services and agriculture improved over the previous reporting period, 2010-2012. In contrast, the rate for the residential sector accelerated during the 2012-2014 reporting period. In line with the rising GDP per capita is a growing middle class. The residential energy intensity annual rate of increase was up to 1.0 per cent for the period 2012-2014, as compared to 0.8 per cent for the period 2010-2012. One of the key factors responsible for the increase in intensity is the rise in standard of living of the general population.

A decomposition analysis, which examined changes in total final energy consumption since 1990 based on three underlying effects of activity, efficiency, and structure, indicated that the regional decline in energy intensity is primarily supported by the effects of growing populations and economic output (activity effect), and, to some degree, energy efficiency (efficiency effect). It also indicated that shifts in the mix of economic activity across sectors (structural effect) did not have a notable impact (figure 3.8) at the aggregated regional level. GDP has tripled since 1990, while energy consumption has only doubled. Between 2012 and 2014, the region avoided 8.2 exajoules (EJ) of total final energy consumption, amounting to more than two thirds of the global avoided energy, and more than 200 million tonnes of coal. The region's energy savings are equivalent to the 2014 total final energy consumption of the Republic of Korea and Thailand combined.

Decomposition analysis is used to quantify relative contributions of pre-defined factors to the change in energy consumption. Several methods of decomposition analysis exist, which support the assessment of energy policy and technology effectiveness. The Logarithmic Mean Divisia Index decomposition of energy consumption method is used in this GTF report.

Much of the regional energy intensity trend is attributable to China, mainly due to the sheer size of its economy. The country experienced a sharp decline in the global ranking of energy-intensive economies from being near the top in 1990 to an upper-middle position in 2014 (though its energy intensity rate is still 35.3 per cent above the world average). However, energy intensity at the subregional and national levels is highly varied, as are the activity, structure, and efficiency effects. Accordingly, to gain a better understanding of progress in reducing energy efficiency, data at the national level in consideration of individual contexts must be reviewed.

Figure 3.6 Industrial growth has led to an increase in industrial energy consumption in Asia and the Pacific



Asia and the Pacific | North America | Western and Central Europe | Latin America and the Caribbean | Africa

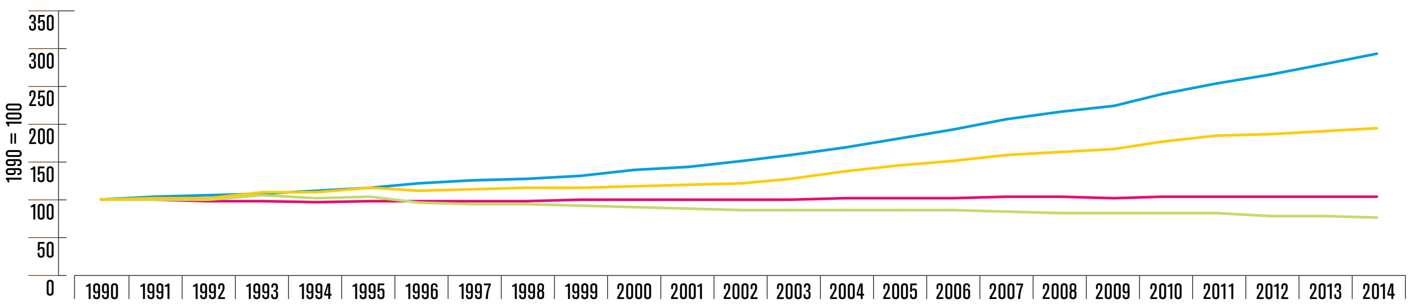
Source: IEA and UN Statistics

Figure 3.7 Asia-Pacific industrial energy consumption eased while value-add continued to climb

Industry value added (Trillion 2011 PPP$) | Industry value added (Trillion 2011 PPP$)

Source: IEA and UN Statistics

Figure 3.8 Economic activity and efficiency contributed to the decoupling of gross domestic product and energy consumption



Activity effect | Structure effect | Efficiency effect | Total final energy consumption

Source: World Bank based on IEA and UN Statistics

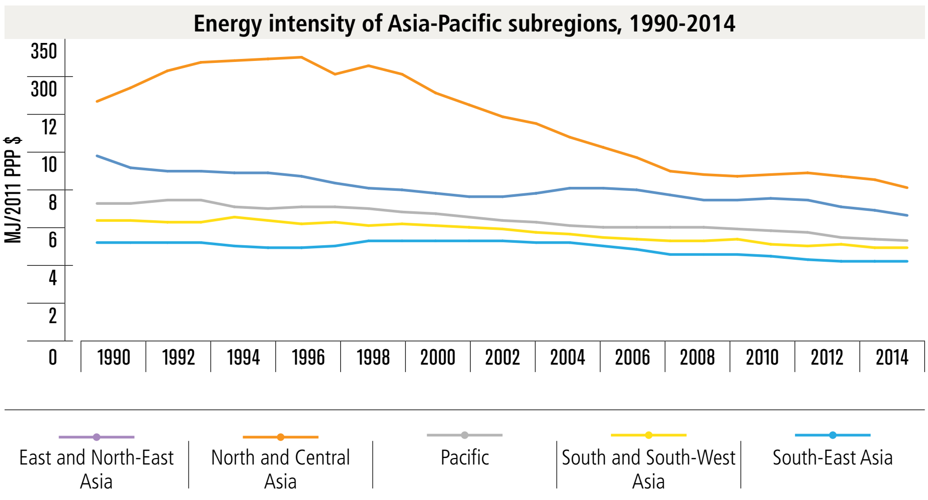
HIGHLIGHTS FROM ASIA-PACIFIC SUBREGIONS

East and North-East Asia recorded strong headway in its efforts to reduce primary energy intensity with an average annual reduction of 3.6 per cent between 2012 and 2014, reaching 6.6 MJ/2011 PPP $ (figure 3.9), as compared to 9.8 MJ/2011 PPP $ in 1990. The industrial sector accounted for the progress during the period, with a 4.2 per cent average annual decline in final energy intensity. Intensity improvements in the region's largest energy consumer and the subregion's most energy-intensive economy, China (7.4 MJ/2011 PPP $), led to a 4.7 per cent annual reduction for the reporting period, enabling the country to lower its primary intensity rate from the 2.9 per cent rate obtained between 2010 and 2012. Increasingly strong standards for energy consumption in key industries in the country have supported this progress, which contributed 47 per cent of global energy savings in the period 2012-2014 (IBRD and World Bank, 2017). From a long-term perspective, the energy efficiency gains achieved in China between 2006 and 2014 have eliminated the need for more than $230 billion in investment for new power generation (IEA, 2016c).

Japan, a leader in advanced technology development and applications with strong standards and regulations, is the subregion's least energy intensive economy at 4.1 MJ/2011 PPP $ (figure 3.10). Long-running government energy efficiency programmes have steadily reduced the country's energy intensity. Moreover, the 2011 Fukishima disaster provided further impetus for the country to increase energy efficiency, ensure sufficient supply, and reduce the consumer burden of higher-priced energy imports, as the country sought to rebalance its energy portfolio.

The Republic of Korea continues to make steady progress through an increasingly strong policy framework and targets for energy demand reduction across sectors. It has released its second energy master plan, and, similar to Japan, is introducing the concept of "negawatts", a theoretical unit of power saved, that can be traded in the same way as generation megawatts (Republic of Korea, Ministry of Trade, Industry and Energy, 2014). Mongolia, in 2015, introduced a new energy conservation law, and is focusing on improved building performance as well as reducing electricity transmission losses through improved grid performance.

Figure 3.9 Energy intensity has fallen across subregions



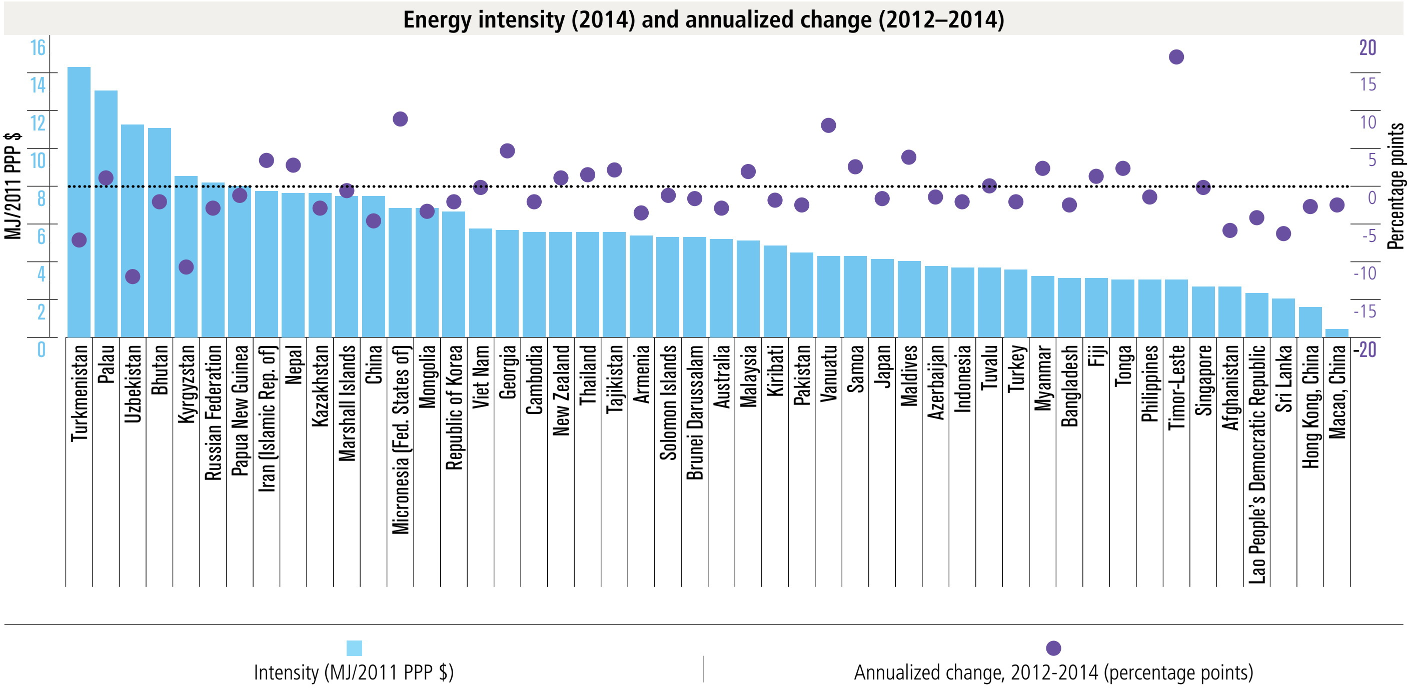
Source: IEA and UN Statistics

Under its nationally determined contribution, the Democratic People's Republic of Korea, meanwhile, is turning to technical modernization and public awareness to lower energy consumption.

North and Central Asia had been the most energy-intensive subregion since 1990 when energy intensity was 12.7 MJ/2011 PPP $. Following the breakup of the Soviet Union, the subregion experienced a steep decline in energy intensity, largely stemming from structural changes in the mix of activities across sectors, which has continued in line with recent gains in the industrial and agricultural sectors. Consequently, the subregion's energy intensity level declined to 8.1 MJ/2011 PPP $ in 2014. The underdeveloped policy frameworks, standards, and regulations in the subregion along with its high industrial intensity, present great scope for further efficiency gains.

Turkmenistan is the region's most energy-intensive economy, at 14.3 MJ/2011 PPP $ in 2014; however, it made good progress in the period 2012-2014, recording an average reduction of 7.2 per cent per year. Uzbekistan, also is highly intensive (11.2 MJ/2011 PPP $ in 2014), recording the steepest drop for the 2012-2014 period, at 12.1 per cent per year. Primary intensity in Armenia fell to just below the world average (5.5 MJ/2011 PPP $). Azerbaijan had a very high energy intensity rate of 15.6 MJ/2011 PPP $ in 1990, but the country's recent policies have resulted in a rapid decline in energy intensity to just 3.8 MJ/USD in 2014. Kazakhstan recorded steady progress in the period 2012-2014, during which time the country reversed a previous trend of rising energy intensity, managing to lower its intensity to 7.6 MJ/2011 PPP $. Georgia (5.6 MJ/2011 PPP $) and Tajikistan (5.5 MJ/2011 PPP $) showed increased intensity levels compared to the previous reporting period.

Figure 3.10 Energy intensity is highly varied across economies



Source: IEA and UN Statistics

Note: Data are unavailable for the following economies: American Samoa, Cook Islands, French Polynesia, Guam, Democratic People's Republic of Korea, Nauru, New Caledonia, Niue, and Northern Mariana Islands.

Energy intensity in **the Pacific** declined to 5.3 MJ/2011 PPP $ in 2014 as compared to 7.3 MJ/2011 PPP $ in 1990. However, the improvement in the intensity level slackened over the 2012-2014 reporting period to an annual average rate of 2.4 per cent, as compared to 3.0 per cent between 2010 and 2012, because of slowing improvement within the industry and services sectors. The subregion's developed and largest economies defined the trend, with Australia recording a deceleration in energy intensity during the period 2012-2014. During that same period, the energy intensity of New Zealand increased. The transport sector consumed the largest share of energy in Australia, a reflection of the country's reliance on road networks and large land area. This sector accounted for 83 per cent of the subregion's total final energy consumption. Among the developing Pacific States, energy consumption and GDP growth remain low. Data availability for Pacific small island States are limited, but, among the countries with data available, many of them [45] also recorded increasing energy intensity, with energy consumption rising more rapidly than the economy. Kiribati, Papua New Guinea, and the Solomon Islands are exemptions as they recorded falling energy intensity, though at reduced growth rates, as compared to the period 2010-2012.

In **South and South-West Asia**, energy intensity remained well below the global average and continued to decline, falling to 4.9 MJ/2011 PPP $ in 2014, as compared to 6.4 MJ/2011 PPP $ in 1990. The annual rate of energy intensity improvement was modest at 1.6 per cent over the period 2012-2014. During this period, the service sector of India led the decline while energy intensity associated with industry, agriculture, and residential sectors rose. Bhutan is the most energy intensive economy in the subregion, at 11.1 MJ/2011 PPP $, though the country recorded an impressive decline in the rate, from 30.0 MJ/2011 PPP $ in 1990. This can be attributed to an increase in GDP from hydropower-based electricity exports. The Islamic Republic of Iran, which has recorded a slowing GDP, and Maldives, which has experienced rapid growth in energy demand recently, are the only countries in the subregion recording an increasing intensity trend.

South-East Asia had the lowest energy intensity among Asia and the Pacific subregions at 4.2 MJ/2011 PPP $ in 2014, down from 5.2 MJ/2011 PPP $ in 1990. It also recorded the lowest annual decrease in energy intensity, at 0.5 per cent, between 2012 and 2014. This is a significant slowdown as compared to the period 2010-2012 when the subregion exhibited rapid declines in energy intensity, at an average annual rate of 3.5 per cent per annum. Intensity improvements across economic sectors slackened, except for agriculture. Energy consumption within the transportation sector rose at a rapid pace, reflecting the rising members of the population with motorized vehicle. Indonesia, the

45. See http://energo-cis.ru/wyswyg/file/Zakon/Nacional/RF/Postan%20i%20rasp/%D0%A0%D0%90%D0%A1%D0%9F%D0%9E~QI.pdf (In Russian).

subregion's largest economy, continued to record a falling intensity rate, though at a slowed pace from the previous reporting period; so did Cambodia, Indonesia, the Philippines, Singapore, and Viet Nam. Brunei Darussalam recorded a significant drop in the intensity rate. Other countries that had previously recorded improvement in their energy intensity rates, Malaysia, Myanmar, Timor-Leste, and Thailand, were experiencing increased intensity.

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DRIVERS AND INFLUENCING FACTORS FOR PROGRESS

Targets backed by measures and instruments have driven progress.

Over the previous couple of decades, policy to support energy efficiency has progressed in many countries from statements recognizing the need to promote efficiency and conservation to more comprehensive frameworks that include targets backed by a variety of regulatory measures and instruments. In many countries, factors that have spurred the adoption of policies include the need to (a) meet domestic demand for adequate and reliable supply while lowering the need for new capacity, (b) support increasingly productive economies and (c) mitigate local and global environmental impacts.

The approach to targeting and measuring energy efficiency has expanded and evolved. Earlier focus was almost exclusively on conservation and loss reduction within various sectors, whereas a growing number of national targets are now focused on energy intensity (table 3.1). Intensity targets incorporate the concept of productivity within economies, or specific sectors, such as the power and industrial sectors. Increasingly robust policies and supportive measures have helped to steadily, and in some cases, dramatically, lower energy consumption per unit of GDP. Those policy development trends, combined with advancements in technology and decreasing costs, are expected to continue to lower energy intensity across countries of the region.

Table 3.1 Sample national energy intensity targets

Country	Target	Policy Document
Australia	40 per cent energy intensity reduction by 2030, based on 2015 level.	National Energy Productivity Plan 2015 - 2030
Bangladesh	20 per cent reduction by 2030, based on 2013 level.	Energy Efficiency and Conservation Master Plan up to 2030
China	15 per cent energy intensity reduction by 2020, based on 2015 level.	13th Five-Year Plan for Energy Development
Hong Kong, China	40 per cent energy intensity reduction by 2025, based on 2005 level.	Energy Saving Plan for Hong Kong's Built Environment 2015-2025+
India	20-25 per cent energy intensity reduction by 2020; 33 to 35 per cent by 2030, based on 2005 level.	Nationally Determined Contribution
Kazakhstan	40 per cent energy intensity reduction by 2020, based on 2008 level.	Concept on Transition towards Green Economy until 2050
Russian Federation	40 per cent energy intensity reduction by 2020, based on 2007 level.	Presidential Decree No. 889: On Measures for Energy and Environmental Efficiency Increase of Russian Economy
Viet Nam	Reduce energy consumption per unit of GDP by 1-1.5% per year.	Green Growth Strategy for the period 2011-2020 with a vision to 2050 (Decision No. 1393/Q-TTg)

As an example, the Russian Federation has established a target to reduce its energy intensity to less than 63 per cent of 2014 levels by 2035 under its draft energy strategy. This is based on estimates that energy conservation potential amounts to approximately 40 per cent of the country's total domestic energy supply. Recent policies set by the country have focused on the modernization of existing generation capacity and broader deployment of advanced technologies.[46] Bangladesh, in anticipation of needing to deal with gas and power supply shortages, is targeting lower industrial sector energy intensity, as well as residential energy conservation under its Energy Efficiency and Conservation Master Plan Up to 2030. For some countries, particularly least developed countries and small island developing States, energy efficiency offers a means for reducing their reliance on imported energy, while for others, energy efficiency is an important component of a low-carbon growth approach. Adding momentum to efficiency efforts, the Paris Agreement ushered in a wave of new energy efficiency targets, with many countries adopting even more aggressive ones under their nationally determined contributions.

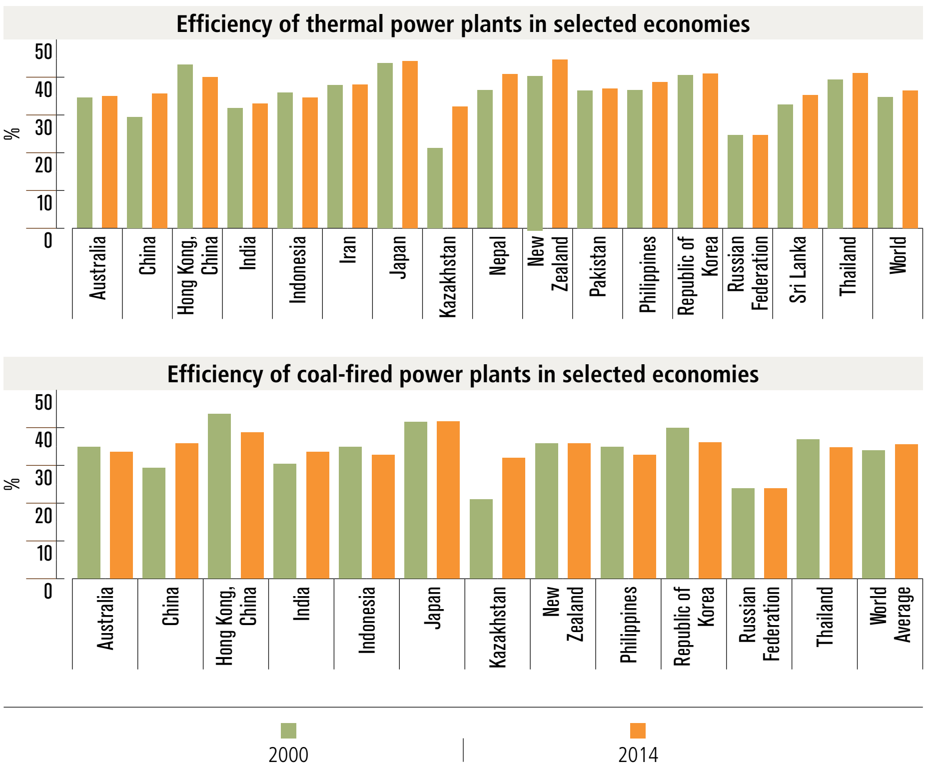
In addition to the setting of national targets, the Asia-Pacific region has shown the potential regional cooperation can play in the efforts to achieving energy efficiency goals. Member States of the Association of South East Asian Nations (ASEAN) have collectively set a target to reduce energy intensity by 20 per cent by 2020 based on 2005 levels under the ASEAN Plan of Action for Energy Cooperation 2016-2025 (ASEAN Centre for Energy, 2015), while the Asia-Pacific Economic Cooperation (APEC) members have pledged to work together to reduce aggregate energy intensity of APEC members by 45 per cent from 2005 levels by 2035 under its Beijing Declaration (APEC, 2014).

Supply-side improvements are being implemented in the power sector.

Supply-side efficiency in power generation is advancing in the region as indicated by the increase in thermal power generation efficiency from 33.4 per cent in 1990 to 38.8 per cent in 2014 (IBRD and World Bank, 2017). However, the results at the national level are mixed (figure 3.11). As the power sector's share of final energy consumption increases (up from 10.7 per cent in 1990 to 18.4 per cent in 2014), the potential for efficiency gains is rising.

In a move to enhance the efficiency and reduce environmental impacts, a number of countries have recently improved minimum standards for new power plants, updated older facilities and introduced advanced technology, such as supercritical coal-fired power. Strong measures in China, for example, have pushed the efficiency of the country's coal-fired power from 29.3 per cent in 2000 to 35.8 per cent in 2014. Kazakhstan has also shown notable progress in that regard by raising its coal-fired efficiency from just 21.9 per cent in 2000 to 31.9 per cent in 2014. Azerbaijan is planning to convert its power plants to natural gas to improve efficiency and reduce environmental impacts, and has established a strategic road map for new gas terminals.[47] India has recently started to focus on introducing supercritical technology for new coal power plants, retrofitting older plants to meet higher efficiency standards, and developing an extensive gas grid, which is to be completed by 2020.[48]

Figure 3.11 Progress in increasing efficiency of thermal power production is mixed



Source: Enerdata

Note: 2000 data is unavailable for coal-fired power plants in Sri-Lanka

46. According to a representative's statement made at the 2017 ESCAP Committee on Energy.
47. According to a representative's statement made at the 2017 ESCAP Committee on Energy.
48. Introduced by IEA in 2016, the Efficiency Policy Progress Index measures progress in mandatory energy efficiency policy coverage and effectiveness. As outlined in the Energy Efficiency Market Report 2016, the index covers eleven countries, of which the Asia-Pacific countries are China, India, Japan, and the Republic of Korea.

Table 3.2 Sample national power supply and distribution efficiency targets

Country	Target	Policy Document
Bangladesh	Reduce system loss from 13 per cent to 9 per cent.	Seventh Five Year Plan FY2016 – FY2020 "Accelerating Growth, Empowering Citizens"
China	Average coal consumption per kilowatt-hour is kept below 310 grams in existing power plants and below 300 grams in new power plants. Total energy consumption sill stay below five billion metric tons of standard coal.	The 13th Five-Year Plan For economic and social development of the People's Republic of China (2016-2020)
DPR Korea	Reduce power transmission and distribution losses to 6 per cent.	Nationally Determined Contribution
India	Reduce losses to 15 per cent.	Committee on Energy statement
Mongolia	Reduce internal energy use of combined heat and power plants (improved plant efficiency) from 14.4 per cent in 2014 to 11.2 per cent by 2020 and 9.14 per cent by 2030.	Nationally Determined Contribution
Marshall Islands	Combined percentage decrease in power generation and distribution losses of the power utilities: 26.21% in 2014, 20.97% in 2018.	National Energy Policy and Energy Action Plan
Sri Lanka	Reduce the technical and commercial losses of the electricity transmission and distribution network from 11 per cent to 8 per cent by 2020.	Sri Lanka Energy Sector Development Plan for a Knowledge-based Economy 2015-2025
Tonga	Reduce electricity line losses to 9 per cent by 2020.	Nationally Determined Contribution
Turkey	Loss and illegal consumption rate in electricity distribution shall be reduced to 10 per cent by the end of the plan period.	Strategic Plan 2015-2019

Policies to reduce technical and non-technical transmission and distribution losses have had positive effects across the region, with most countries showing a reduction in losses. Some countries have made dramatic progress in that regard. Bangladesh recorded lowered losses, from 33.6 per cent of power generation in 1990 to 11.4 per cent in 2014. Viet Nam, over the same period, also experienced a decline in losses, from 25.4 per cent to 9.2 per cent. Targets for loss reduction are central to recent policies and programmes (table 3.2), and when combined with increased adoption of smart grid technologies, point to future improvements power system efficiencies.

Energy performance and consumption standards are increasingly being adopted.

Many Asia-Pacific countries have made significant progress in introducing and strengthening measures, including minimum energy performance standards and energy conservation targets, as part of the effort to achieve their energy efficiency targets. Inroads have been made in introducing standards for lighting, appliances, space heating and cooling, and water heating. Those standards are being used to control the import and sale of inefficient electrical appliances and industrial equipment. Several countries are also harmonizing their standards with trade partners. This, in turn, is contributing towards building an energy efficiency market. For instance, Fiji has adopted standards and energy labelling information that are being used by Australia and New Zealand to enable closer economic ties among the countries. ASEAN and APEC have achieved significant progress in harmonizing energy efficiency testing and other standards among their member countries through long-term cooperation (Shi, 2015).

A number of countries in the region are promoting the replacement of inefficient technologies. This is being bolstered by public awareness and the labelling of certifying products that meet a given performance level. For example, India, as indicated under its nationally determined contribution, expects to replace all incandescent lamps with LED lamps in the next few years, in a move that is projected to result in annual savings of up to 100 billion kWh (India, Ministry of Power, Coal and New and Renewable Energy, 2016b). Under Malaysia's MyHijau Mark programme, a uniform labelling system for products and services is being expanded under the country's latest five-year plan into key product areas, such as household products, electronic, and electrical appliances. Labelling in China now covers 28 appliance types (IEA 2016c).

Top-runner programmes, such as those found in Japan and China, use the highest efficiency models to set benchmarks for others to achieve in a given time period. The long-running programme in Japan, which was established in 1998, has continuously set and improved energy performance standards for a broad range of machinery, equipment and appliances. The extensive policy coverage in China includes the Top 10,000 programme, which covers two thirds of the country's energy consumption, and targets approximately 16,000 individual companies. According to the IEA Efficiency Policy Progress Index,[49] this programme has been an influential

49. Introduced by IEA in 2016, the Efficiency Policy Progress Index measures progress in mandatory energy efficiency policy coverage and effectiveness. As outlined in the Energy Efficiency Market Report 2016, the index covers eleven countries, of which the Asia-Pacific countries are China, India, Japan, and the Republic of Korea.

driver for progress in improving global efficiency from 2005 to 2015 (IEA, 2016c). Under the programme, managers of industrial, manufacturing, and public facilities are encouraged to compete against top energy efficiency achievers. This and other measures have allowed China to realize energy efficiency savings between 2006 and 2014 to a level that is equivalent to the country's renewable energy supply (IEA, 2016c). Under its 13th Five Year Plan, China also plans to meet or exceed international standards across numerous industries by establishing mandatory per-unit standards covering 82 per cent of the industrial energy consumption (for more information, see the case study on page 58). India has also focused on industry in that regard where mandatory targets cover 37 per cent of current industrial energy (IEA, 2016c).

To build on performance standards, some countries have introduced mandatory reporting to ensure compliance. Examples of this are requirements in Singapore in which corporations must appoint an energy manager responsible for preparing, implementing and reporting on energy compliance (Singapore, 2014). Beginning with the largest energy consumers, target schemes and reporting requirements are then expanded to cover small- and medium-sized enterprises. This is a trend seen in, for example, China and the Republic of Korea.

Energy efficiency in buildings and urban planning is spreading.

Accompanying the rapid population and economic growth across the Asia-Pacific region is the development of

Table 3.3 Sample national industrial energy intensity targets

Country	Target	Policy Document
Democratic People's Republic of Korea	25 per cent reduction in energy consumption in industry by 2030.	Nationally Determined Contribution
Kazakhstan	15 per cent reduction in manufacturing energy intensity from the 2012 level, by 2019.	State Program for Industrial and Innovative Development, 2015-2019
Russian Federation	Reduce energy intensity of industrial production (per unit GDP) by 40 per cent from 2007 to 2020. Decrease energy intensity of steel production from 700 kg of oil equivalent to 550 kg of oil equivalent, by 2020.	Energy saving and increase of energy efficiency for the period till 2020 State Program on Industrial Development and Improving Industrial Competitiveness

Country Case Study: Industrial Energy Efficiency in China.

China, the region's largest energy consumer, has seen the benefits from its aggressive policies to promote energy efficiency, particularly in the industrial sector, in which energy intensity has fallen from 20.9 MJ/2011 PPP$ in 1990 to 6.1 MJ/2011 PPP$ in 2014. The current energy efficiency target under the thirteenth Five Year Plan – a 15 per cent reduction in energy intensity by 2020 over 2015 levels – is expected to be achieved largely through continued adjustments in economic structuring, moving from industry to services, and shifting from high-intensity to lighter manufacturing. Along with this shift in the industrial sector, in which the share of primary (extraction) and secondary (manufacturing) industry to GDP have fallen while the tertiary (services) sector has grown, the number of large enterprises has decreased, accompanied by an increase in the number of small- and medium enterprises. These changes, combined with the implementation of effective energy efficiency and environmental policies, have contributed to a reduction in the use of coal. The rapid growth of energy demand in China, particularly from industry, is slowing as a result of the Government's policy to promote energy efficiency in the industrial sector (IEA, 2016c).

Progress in energy efficiency is the result of long-term planning and progressive policies. Under the eleventh Five-Year Plan for Economic and Social Development (2006-2010), the country set a target to reduce energy intensity by 20 per cent by 2010. To achieve this, strategic planning, and a suite of supportive measures, including regulatory and economic instruments, and research, development, and deployment programmes resulted in the closing of inefficient plants, efficiency upgrades of coal-burning industrial boilers, kilns, and electric motors, and the expansion of co-generation. The plan also called for the introduction of the Top 1,000 Energy-Consuming Enterprises Program, which established consumption targets for top-consuming enterprises, resulting in total energy savings of 125 Mtce, exceeding the programme's target of 100 Mtce.

Building on the success of the previous plan, under the twelfth Five Year Plan, an energy intensity reduction target of 16 per cent by 2015 was introduced, and the Top 10,000 Program was launched, with a key requirement to establish energy management systems in industrial and transportation companies that consume more than 10,000 tce per year. The outcome was a net energy annual saving of 216 Mtoe, surpassing the target of 175 Mtoe. As a result of the implementation of energy efficiency policy measures, the energy intensity of the key steel enterprises in China decreased from 18.90 gigajoules per ton (GJ/t) of crude steel in 2006 to 17.67 GJ/t in 2012.

The Energy Development Strategic Action Plan (2014-2020) limits the expansion of high energy-consuming industry and sets forth the phasing out of obsolete industrial technologies and excess capacity. Key industry energy efficiency benchmarking standards were introduced, for instance, for high-efficiency boilers and motors, to support industrial demand-side management, along with deadlines for compliance.

Under the thirteenth Five Year Plan (2016-2020), China plans to reduce its energy intensity by 15 per cent, This will be achieved by setting compulsory standards for energy consumption enforced by the "100, 1,000, 10,000" energy conservation initiative, which places the top 100 energy consuming enterprises in China under national regulation, the top 1,000 energy consuming enterprises under the regulation of their respective provincial-level governments, and the other high energy consuming enterprises under the regulation of lower-level governments.

The results from these significant efforts are impressive. China is now among the top countries globally to regulate energy consumption. However, for the country to further increase energy efficiency, it must deal with the following barriers:

- **Structural barriers**: The Chinese industrial sector is based mainly on heavy industry, such as iron and steel, chemical and petrochemical, non-metallic minerals, non-ferrous metals, machinery, paper pulp and printing; the phasing out of obsolete capacity is weak; the energy efficiency market system, including multilevel national, provincial, and local governance; equipment manufacturers and energy management services providers need to be strengthened, even though appreciable results have been gained, for instance, through the establishment of energy service companies.

- **Information/knowledge barriers**: A lack of expertise in energy efficiency measures and technologies, while limited data and information on manufacturers of energy-efficient equipment, implemented energy efficiency projects and energy-saving results creates knowledge barriers for analysts, policymakers and energy service companies.

- **Management barriers**: Limited awareness about the potential of energy efficiency at top-management levels and concerns about investment costs of efficiency projects has led to inadequate updating of technologies.

- **Financial barriers**: In 2007, the Government of China introduced the landmark Green Credit Policy to restrict bank loans to projects involving polluting industries and foster loans to projects that benefit the environment. Yet, according to a 2012 survey conducted by the Ministry of Environmental Protection's Policy Research Centre, only 12 per cent of the 50 largest banks examined at that time were fully implementing the Green Credit Policy (Innovation Seeds, 2012). That year, the mandatory *Green Credit Guidelines* were issued, requiring environmental compliance reviews for all clients, environmental and social risk assessments for high-risk projects, and biannual bank self-reporting. Nonetheless, the availability of financial instruments remains limited in comparison to the dimension of the problem, and by one estimate the financial gap for decarbonizing the energy industry and energy efficiency could reach $370 billion by 2030 (Amin, Ng and Holmes,2014).

- **Policy and compliance barriers**: The country has developed ambitious targets and policies, however, broadening and strengthening obligation schemes must be completed. The necessary policy and legal frameworks are incomplete, while incentives, standards for reporting and monitoring for compliance remain inadequate. Furthermore, local pressures and performance requirements favouring short-term economically profitable projects are strong, while green investments remain less commercially attractive (Zhang and others, 2015).

new building stock to house growing industries, businesses, and populations with rising lifestyle demands. For many countries, regulations pertaining to building energy efficiency have only recently begun to emerge in their policies. Rushing to meet the physical space requirements, energy efficiency has fallen behind because of inadequate standards or lack of enforcement. In 2014, the residential sector consumed 30.0 per cent of final energy in Asia-Pacific. But it also represents an important area of recent progress in many countries as building energy codes that regulate building construction for improved energy performance are aggressively introduced. The trend is to first regulate government-owned and occupied buildings, and then expand standards to cover commercial and residential structures. Some countries, particularly those in colder climates, are steadily tightening their building energy codes, while net-zero buildings are also being targeted in some contexts (table 3.4).

Table 3.4 Sample national building efficiency targets

Country	Target	Policy Document
Japan	Net zero energy for standard newly constructed houses by 2020 and for all newly constructed houses by 2030.	Fourth Strategic Energy Plan
Mongolia	Reduce building heat loss by 20 per cent by 2020 and by 40 per cent by 2030, compared to 2014 levels.	Nationally determined contribution
Republic of Korea	Zero energy for all newly built buildings by 2025.	Korea Energy Master Plan - Outlook and policies to 2035
Turkey	Increase by at least 20 per cent energy efficiency in buildings of the Ministry and its affiliated, associated and related Institutions, over 2013 levels.	Strategic Plan 2015-2019

A range of performance reporting and rating systems are also being leveraged within the region to drive energy efficiency adoption in new buildings and retrofits. In the Russian Federation, the construction of low-performing buildings is banned.[50] Australia requires owners or managers of commercial buildings to disclose a property's energy efficiency performance when it is being sold or leased. This measure has also been adopted in other countries in the region, such as the Philippines and Turkey. Examples of labelling systems for buildings include the BCA Green Mark Scheme in Singapore, the energy intensity card classification in Turkey, and the Green Building Index in Malaysia. Japan, in addition to developing a labelling system, leverages building performance with developers, allowing the construction of buildings with larger floor space if higher standards are met.

Beyond individual buildings, urban planning for resource efficiency is also an emerging trend. As the urban areas of China expand, for example, the country is developing eco-cities in which green buildings account for 50 per cent of the structures.[51] Another promising direction is the upgrading of existing urban environments. In 2015, India launched its Smart Cities Mission, which covers 100 cities over five years for retrofitting, redeveloping, and utilizing integrated, smart solutions to improve urban infrastructure.

Fuel quality and vehicle efficiency is improving.

The status of efficiency for the transportation sector is highly varied among Asia-Pacific countries. The first passenger vehicle fuel-efficiency standards for new cars in India took effect in 2016. Viet Nam is tightening its standards on fuel specifications and vehicle emissions. The Republic of Korea plans to expand its standards to cover small commercial vehicles, and is advancing fuel efficiency efforts. Fiji, in addition to complying with international fuel and vehicle standards, has prioritized the promotion of fuel efficient driving practices through information campaigns and by including them in drivers' training programmes. China, which has the world's largest automobile market at 28 million vehicles sold in 2016, is raising fuel efficiency and aggressively pushing hybrid and electric vehicles, which are projected to account for 20 per cent of total vehicle production and sales by 2025 (Reuters, 2017).

Financial incentives and disincentives are helping drive investment and consumption within the energy efficiency market.

Economic measures that support energy efficiency are being implemented widely across Asia and the Pacific. They have contributed to energy savings, and are being expanded and strengthened to drive energy efficiency projects and consumer uptake. Tax incentives and subsidies for the production or purchase of energy-efficient appliances, vehicles, equipment and technologies are in place or being considered by the majority of the region's countries. These measures are demonstrating the ability of countries to effectively promote shifts within the energy efficiency market. For example, the Malaysia 2011-2013 SAVE programme, a collaboration involving the Ministry of Energy, utilities and appliance manufacturers, has offered consumer rebates on purchases of high-efficiency appliances and the replacement of older chillers. It has encouraged the production of new energy efficiency appliances, resulting in 27 new brands of air conditioners and refrigerators (Unit, Economic Planning Unit, 2015). Furthermore, preferential policies, such as an income tax reduction and other tax reductions for enterprises that implement energy conservation, are also taking hold.

50. See https://policy.asiapacificenergy.org/node/791.
51. See http://policy.asiapacificenergy.org/?q=node/138/portal.

Government funds offer financing and risk guarantees in a number of countries. In Thailand, the Energy Conservation Fund, established in 1992 and funded by a petroleum tax, provides working capital as grants or subsidies for the implementation of energy conservation-related work. This fund has been complemented by the 2003 Energy Efficiency Revolving Fund to stimulate investments in large-scale industrial projects with low-interest loans. The country's ESCO Fund further supports investments through the establishment of financial mechanisms, such as equity investment, venture capital, and credit guarantees, for project developers and energy service companies (ESCO Information Center, 2016). The Partial Risk Guarantee Fund for Energy Efficiency of India, another example, supports financial institutions with partial risk coverage for loans for energy efficiency projects, while the Venture Capital Fund for Energy Efficiency offers last mile equity capital for funding specific energy efficiency projects.

Carbon taxation and emissions trading is growing.

Emissions trading schemes and carbon taxes are being introduced at municipal and national levels with the objective to encourage large emitters and increasingly medium- and small-enterprises to shift to using more energy efficient and low carbon technology. They have been implemented or are under consideration in Australia, China, Japan, Kazakhstan, New Zealand, the Republic of Korea and Singapore.

Emissions are traded under the Japan Voluntary Emission Trading Scheme and the mandatory Tokyo Emission Trading Scheme, which requires large facilities to participate in a cap-and-trade market. Under its thirteenth Five Year Plan, China plans to adopt a unified national carbon emissions trading market, building on carbon emission trading pilots in seven provinces across key industries, such as power generation, petrochemicals, aviation and paper making, construction materials, non-ferrous metals and steel. Discussions are also ongoing for a proposed North-East Asia carbon market, which would link China, Japan and the Republic of Korea, and could result in a reduction of carbon prices and further encourage private sector investment.

Energy savings are also being traded. For example, under its latest energy plan, the Republic of Korea plans to create a demand management resources market while revising relevant regulations to allow energy saved during peak hours as a result of efficiency projects to be traded in the power market (Ministry of Trade, Industry and Energy, 2014). India has yet to establish a carbon market or carbon pricing policy, but it has introduced the Perform Achieve and Trade Scheme, which creates a market-based mechanism that results in the certification of tradable excess energy savings in energy-intensive industries. The first Perform Achieve and Trade Scheme resulted in savings of 6.7 million tonnes of oil equivalent (mtoe) over two years, equal to 31 million tonnes of avoided carbon emissions (India, Bureau of Energy Efficiency, 2014).

Energy service companies are playing a growing role.

Energy service companies (ESCOs) – designed to offer energy supply and demand side services, such as identification and the implementation of energy conservation, retrofitting, and energy infrastructure projects – are emerging with government support in a number of countries to increase energy efficiency in public facilities, industrial applications, and the residential sector. The models vary, but typically, the energy service companies receive payments based on realized energy savings from implemented projects. Evolving technology offers the opportunity for new business models, and new companies are emerging while utilities are expanding to provide energy services.

Based on revenue, China represents more than half of the global ESCO market. The market was first established in 1998 and has grown significantly in recent years. Implementation of energy performance contracts has created energy savings for the country's economy as a whole and within various sectors, particularly the industrial sector. In 2013, energy savings attributable to Chinese ESCOS amounted to 17 million tonnes of oil equivalent, or approximately one third of the targeted annual savings under the twelfth Five Year Plan in force at the time (IEA, 2016c).

A relatively new case includes Armenia, which demonstrated the potential for savings through an energy savings programme implemented in schools, hospitals, and other public facilities, in which service contracts were awarded to companies able to provide the quickest return on investments. Companies invested in energy efficiency measures, which produced energy savings used to pay back their investments. If energy savings were not realized, then repayment could be refused. The highly successful project more than doubled the project's energy savings targets and nearly tripled the emissions reduction target, saving 540.2 million kWh and 145.7 thousand tons of CO_2 emissions (World Bank, 2016). It also demonstrated a 105 per cent collection rate, prompting new interest from the banking sector.[52] Another case, the public energy savings company in India, Energy Efficiency Services Limited, has been instrumental in implementing a demand-side management programme to sell and distribute LED lightbulbs, which, in just two years, resulted in 5,670 MW of avoided generation capacity and almost a 90 per cent reduction in bulk bulb prices (IBRD and World Bank, 2017).

Governments are increasingly looking to energy savings companies as means to shift away from direct subsidies for energy efficiency investments towards a market-based approach with risk guarantees, increased lending, and dedicated credit lines. To tackle the barrier presented by requiring an upfront investment to finance energy efficiency

52. According to a representative of Armenia's statement made at the 2017 UNESCAP Committee on Energy.

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projects, government-backed financing and incentive models are being developed in several countries. For example, Thailand established an energy savings company revolving fund to alleviate technical and financial risks for projects that lacked project financing. Additional support has been granted in the form of corporate income tax exemption for energy savings companies.[53] India is also working to bring down high lending rates for energy efficiency investments and has opened up the thermal power industry to private sector investment. The Philippines has introduced a policy to allow government agencies to redirect funding for internal energy services to engage energy savings companies, and is piloting the deployment of these services on public sites.

China drives regional energy efficiency investment.

China is leading energy efficiency investment in the region, and between 2006 and 2014, the country invested $370 billion in energy efficiency. Under the current five-year plan, another $270 billion investment is expected (IEA, 2016c), helping to bring intensity levels closer to those of Organization for Economic Co-operation and Development (OECD) countries.

The private sector continues to push energy efficiency investments in China. From 75 per cent of the total energy efficiency investment in 2011, private sector investment continuously rose to comprise 90 per cent of the total in 2014. This trend is expected to continue as the central government scales back spending on energy efficiency policies and programmes, shifting from government incentives toward private-sector investment (IEA, 2016c).

In terms of incremental investment in energy efficiency, China represented at least 20 per cent of the $221 billion global total in 2015. China spent about $22.4 billion in buildings, $13.9 billion in light duty vehicles, and $8 billion in industry energy efficiency. The country's incremental investment in light duty vehicle energy efficiency is about 41 per cent of the global investment in this sector (IEA, 2016c).

Asia led in issuance of green bonds in 2016.

Led by China, which issued $36.2 billion in green bonds[54] in 2016 (Climate Bonds Initiative, 2017), the Asia-Pacific region emerged as a top issuer of green bonds, which have played a significant role in providing capital for renewable energy and energy efficiency. Other Asian countries active in the green bonds market include Australia, India, Japan and the Republic of Korea.

Green bonds have been a substantial source of capital for energy efficiency, especially in the transport, industry and building sectors. Of the $40 billion global green bonds issued in 2015, more than $8 billion are targeted to be used to finance energy efficiency projects (IEA, 2016c). Eighteen per cent of the green bonds issuance in China for 2016 is directed at energy-saving

53. See http://policy.asiapacificenergy.org/?q=node/2442/portal.
54. The definition and standards for green bonds vary significantly among countries.

projects (Climate Bonds Initiative, 2017). In 2016, ADB raised $1.3 billion to help finance climate mitigation and adaptation projects, including energy-efficiency projects.

Development finance institutions boost energy-efficiency initiatives.

Development financial institutions have provided critical support to energy-efficiency initiatives implemented by the public and private sectors by extending loans, credit lines, partial risk guarantees, equity funds, utility financing, special purpose funds, and other products (REN 21 2016). For instance, the World Bank and the Government of India launched the $43 million Partial Risk Sharing Facility for Energy Efficiency to help enterprises and energy service companies mobilize commercial finance for investments in energy efficiency initiatives (World Bank, 2015). In 2017, the World Bank approved a $102 million loan to help the Government of Viet Nam in its efforts to encourage industrial enterprises to adopt energy-efficiency technologies and practices (World Bank, 2017). ADB, in implementing its Clean Energy Program,[55] invested up to $4 billion in energy efficiency projects during the period 2012-2015. Those energy efficiency investments account for about 42 per cent of its clean energy investments for the said period.[56]

CHALLENGES

Large and sustained improvements in energy intensity are needed to meet the SEforAll target.

Meeting the SEforAll 2030 target of doubling the rate of improvement in energy efficiency requires a long-term 2.6 per cent annual lowering of energy intensity over the period 2010-2030. The average annual 3 per cent rate of energy intensity improvement recorded by the Asia-Pacific region over the period 2012-2014 cannot be considered a long-term trend, particularly as previous reporting periods have averaged 1.8 per cent at best. Progress with regard to energy efficiency is highly varied among countries, and fluctuations are seen in rates of progress over time. The region has met or exceeded the target rate in only 6 out of 15 years. To achieve the SEforAll target, more concerted efforts are required across individual economies to ensure steady progress to meet or exceed the benchmark rate of improvement.

Greater efficiency of energy supply, transmission, and distribution is required.

Electricity's percentage of final energy consumption is rising steadily within the Asia-Pacific region, increasing from 10.7 per cent in 1990 to 18.4 per cent in 2014. Although the share of renewable energy in electricity generation is growing, fossil fuels will continue to dominate the power mix. Coal use has risen rapidly, while the share of more efficient natural gas has steadily declined at the regional level. Improving the conversion efficiency of fossil fuels through, for instance, super-critical and combined cycle technologies, is necessary to lower energy intensity. However, many countries continue to operate outdated, inefficient thermal power stations, which are kept in operation because of the lack of an alternative, more efficient supply. Transmission and distribution losses of electricity remained stable during the period 1990-2014 in the region, but the majority of countries experienced electricity losses at a rate that was above the global average indicating the weak state of many transmission and distribution networks (figure 3.12). The problems are most pronounced among low and lower-middle income countries, which record lower power generation efficiency and higher rates of transmission and distribution losses. Increased losses in natural gas transmission and distribution in Indonesia, Malaysia, and Pakistan, which account for 31 per cent of global natural gas losses, have also reversed the efficiency trend for this sector (IBRD and World Bank, 2017).


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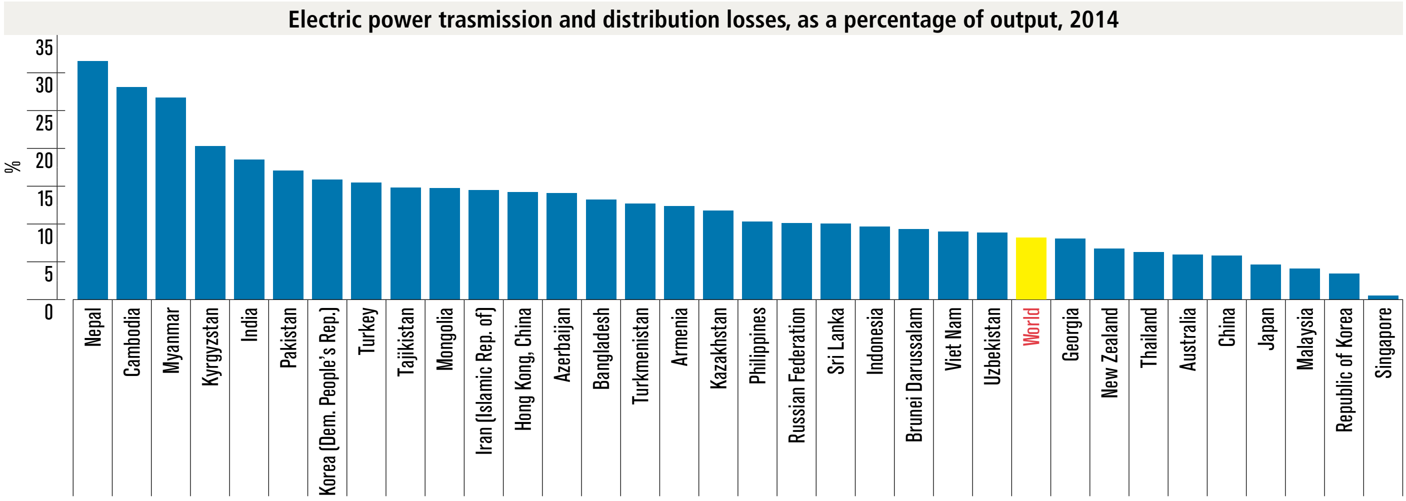
55. Energy efficiency is one of the priorities of ADB under its Clean Energy Program. Information about Clean Energy Program is available from https://www.adb.org/sectors/energy/programs/clean-energy-program
56. ADB dedicates $4 billion annually to climate change mitigation which includes support for renewable energy, energy efficiency, sustainable transport, and building smart cities (ADB, 2016).

Figure 3.12 Electricity losses of most Asia-Pacific economies exceed the global average



Source: World Bank Development Indicators Database

Improving the efficiency of energy supply, transmission and distribution could potentially provide significant efficiency improvements, but it remains a challenge, especially from the perspectives of planning and financing. Advanced technologies for new or upgraded systems are cost-prohibitive in many cases. In addition, for many countries, insufficient quality data on losses are hampering efforts to identify the best approaches for improving efficiency in these areas.

Investment towards energy efficiency is insufficient.

An annual investment of $560 billion is required to achieve the SEforAll energy efficiency target by 2030 (Sustainable Investment for All Finance Committee, 2015).[57] Of this amount, the Asia-Pacific region needs to invest $211 billion annually.[58] Available data, however, signals that current investment levels are still insufficient to meet this goal. In many developing countries, lack of financing serves as a major barrier in implementing energy efficiency projects.

Technical and financial barriers to energy efficiency deployment need to be lowered.

The flow of financing towards energy efficiency projects is hampered by challenges that drive project transaction and development costs up, increase risk, and make projects less attractive to investors. These problems include the small size and spread of projects, project benefits appearing less tangible, lower priority given to energy efficiency projects versus other "core business" investments, and technical diversity of projects, which often requires considerable specialized experience (Taylor, 2012).

Expanded and improved policies and standards are needed to cover more of energy consumption.

Good progress has been made in increasing energy efficiency in the areas of lighting, appliances, and space heating and cooling. Yet, standards in many countries remain limited in scope and not well enforced, or have room to be tightened. Countries with large shares of energy use in other sectors, such as industry or transportation, may not have realized significant savings. Increased focus must be directed towards expanding and tightening minimum energy performance standards and energy targets to sectors with high levels of energy consumption. Energy efficiency standards are also lagging the industrial sector in many countries, particularly in countries where electric motors account for the largest share of energy consumption. While new units are increasingly covered by minimum energy performance standards, equipment turnover tends to be slow in the absence of mandatory targets or obligations for energy savings. A number of economies have also continued to allow the import of used, low-performing equipment for manufacturing and industrial processes in the face of higher capital costs of procuring more efficient equipment.

57. In the World Energy Investment Outlook 2014. It is estimated that "current" investment to improve energy efficiency above the average level in 2012 is around $130 billion/year. Energy efficiency investment covered in the publication includes improvements achieved through more efficient technologies (such as more efficient vehicle engines), better insulation of buildings and implementation of improved energy management systems. Categories include buildings, transport, and industry (IEA 2014).
58. Total of annual average energy efficiency investment in the "450 ppm" scenario for developing Asia, and Asia and Oceania provided in the Sustainable Energy for All Advisory Board Finance Committee Report citing the World Bank Global Tracking Framework 2015. (note the GTF reference is the IEA World Energy Investment Outlook 2014).

ACCELERATING PROGRESS

Comprehensive design of finance programmes.

Public finance programmes have played a significant role in stimulating private sector investment and boosting energy efficiency markets. Sustaining those markets, however, still faces many challenges. While there may be no standard formula for success, experience has shown that designing programmes requires a clear definition and understanding of target markets and mapping and strengthening of supply chains. With fundamental drivers for action in place, this knowledge supports the targeting of market barriers and the implementation of financial and technical solutions. Measures are also needed to continue the financing of energy efficiency once public funding ends (Carbon Trust, 2017).

Strengthening policies and standards.

The improvement and expansion of existing minimum energy performance standards to cover a greater share of total final energy consumption across sectors can support the lowering of energy intensity while encouraging the further development of energy efficiency markets. Policies influence the cost-effectiveness of switching to higher standards and can prevent energy prices from affecting uptake of energy efficiency. This can be done by introducing economic measures that counteract the pressure that lower energy prices create to de-prioritize efficiency. Policies can also be adopted to create new and improved markets for energy efficient equipment, systems, and technologies using energy use taxation, efficiency obligations, and direct financial incentives. Recognition and adoption of international standards for energy efficiency within policy frameworks through appropriate laws and regulations further supports this objective.

Creating competitive markets.

Adopting market-based mechanisms that engage the private sector in the technology and services markets can facilitate the acceleration of efforts associated with energy efficiency. Providing economic incentives has been shown to catalyse market development, but for such measures to be effective, the introduction and enforcement of standardized monitoring and verification guidelines for energy efficiency projects is required. Such actions support an environment that is more conducive for market competitiveness.

Building capacity.

Knowledge generation and dissemination enables the formulation and implementation of effective energy efficiency policies. Capacity-building through technical assistance and training in areas such as best practices, emerging and proven technologies, performance testing, and development and application of regulations and measures, can support efforts to increase energy efficiency.

Technology development for improved and more affordable energy efficiency.

Technology development continues to improve the way energy is used since it leads to smarter, more efficient systems, equipment, and appliances. Increased research, development, and deployment to offer more affordable energy-efficient appliances, equipment, and systems is critical to expanding their market potential and increasing technology uptake.

Increasing data quality and availability.

Available data on energy end use are inadequate in many cases, hindering efforts to perform advanced analysis, including decomposition analysis to track the effects of policies and measures. Energy efficiency is essentially invisible, in that it represents unused energy. As a result, statistics that enable the quantification of value created through energy efficiency are not always accorded priority. Strengthened statistical gathering efforts that improve the availability of reliable, timely, and detailed data can support policymakers in identifying the most beneficial and cost-effective measures to increase energy efficiency and realize its multiple benefits.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04

RENEWABLE ENERGY

GOAL:
Double the share of renewable energy in the global energy mix

THE ROLE OF RENEWABLE ENERGY IN SUPPORTING DEVELOPMENT OBJECTIVES

Increasing the use of renewable energy[59] supports the development of energy and other sectors. It also offers social, economic, and environmental benefits. In recent years, greater focus has been placed on developing renewables in Asia and the Pacific to meet a number of objectives. To meet energy demand and to temper growing import dependencies that raise vulnerabilities to global market shifts, some economies are also promoting the use of renewables to balance their energy mixes with indigenous resources. Renewable energy also offers options for energy access through decentralized applications. On-grid and off-grid renewable energy markets are expanding, as private sector participation increases. Renewable energy technologies are also becoming more affordable and investment in renewable energy has rapidly increased to the point that when large hydropower, investment in terms of dollars and capacity supersedes conventional energy (Frankfurt School-UNEP Centre/Franfurt School of Finance and Management, 2017).

Asia-Pacific countries are at the forefront of renewable energy development. New economic sectors have been developed, while jobs are being created in the manufacturing, distributing, installing, operating, and servicing renewable energy. For example, in 2016, excluding large hydropower, there were an estimated 4.5 million jobs related to renewable energy in Bangladesh, China, Japan, and India (IRENA, 2017).

Renewables are also a key component for decarbonizing economies. Under the Paris Agreement, countries have pledged to reduce carbon emissions largely from the use of fossil fuels. In 2014, the Asia and the Pacific region was responsible for 55.2 per cent of global emissions from fuel combustion, 66 per cent of which were from coal. Decarbonizing the energy sector by shifting to renewable energy, thus, supports efforts to achieve climate objectives, including nationally determined contributions.

Together with energy efficient technologies, renewable technologies also provide local environmental benefits by avoiding air pollution. Eighty-three of the world's top 100 polluted cities,[60] as measured by PM 2.5 levels are in the Asia-Pacific region.[61] Those pollutants are being emitted from sources, such as power generation, manufacturing, vehicles, and residential buildings.[62]

Challenges in measuring renewable energy's share

Solid biofuels, such as wood and charcoal, represent 72.6 per cent of the renewable energy consumption and 13.5 per cent of total final energy consumption in Asia and the Pacific. The data used in this report – a combination of IEA and United Nations Statistics Division (UNSD) datasets – indicate that the majority of solid biofuel consumption occurs in the residential sectors of developing countries. Because of the lack of reliable data in this sector, for this report, it is assumed that, for the most part, it is inefficient and traditional. Household surveys report on the type of primary fuels used by households, but they fail to provide the volumes or quantities of fuels used. Alternative data sources, such as sales data, are also not available because of the often-informal nature of biofuel sources.

The Food and Agriculture Organization of the United Nations (FAO) publishes fuelwood data for the residential sector, but the calculations tend to be much lower than estimates from IEA and UNSD, and do not include some biofuels, such as dung and crop residues. Uncertainties in quantifying traditional biofuels create challenges for determining global renewable energy share, with major impacts for calculating the doubling objective for the renewable share in global total final energy consumption. Universal access to clean fuels and technologies for cooking makes it difficult to achieve the renewable energy goal, as it would eliminate traditional uses of biomass, which, in turn, would result in a decrease in the current share of renewables. It is estimated that, should universal access be achieved at the global level, therefore removing traditional biomass from the renewable energy share, "doubling" the world's renewable energy share would in effect require almost quadrupling modern renewable energy's share. These issues underscore the need to improve measuring and accounting methods used for solid biofuels to better track progress in increasing renewable energy use (IBRD and World Bank, 2017).

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59. Under the GTF reporting process, hydropower, including large hydropower, is considered to be a renewable.
60. Data are available from WHO for more than 3,000 human settlements, covering cities in 103 countries, though not all cities collect or report on their ambient air quality.
61. Author's calculation from the World Health Organization database, WHO global Urban Ambient Air Pollution Database (update 2016). Available from www.who.int/phe/health_topics/outdoorair/databases/cities/en/. Accessed 7 June 2017.
62. See http://www.who.int/phe/health_topics/outdoorair/databases/PHE-AAP-database-FAQs.pdf?ua=1.

OVERVIEW OF PROGRESS

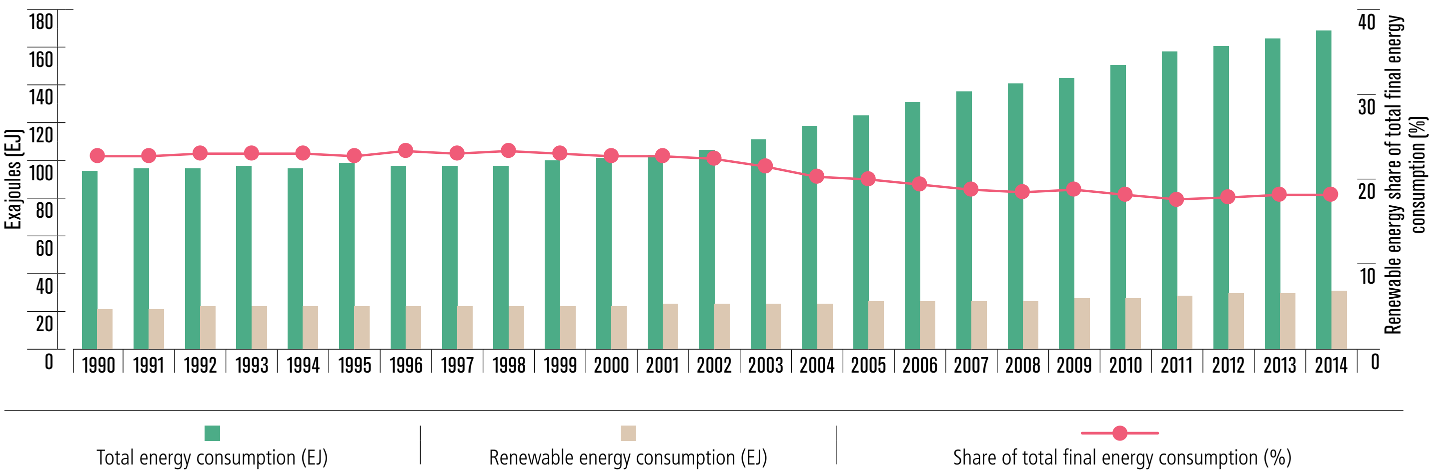
The Asia-Pacific region has emerged as the global leader in renewable energy with more investment, installed capacity, and consumption than any other world regions. Renewable energy production and use in the region continues to rise; in 2014, consumption was 31.1 EJ, up from 22.0 EJ in 1990 and 29.3 EJ in 2012, and accounted for nearly half of global consumption. Yet, at the same time, the energy-hungry region's consumption of fossil fuels has risen dramatically, hindering the growth of share of renewable energy's share in the overall energy mix. The share of renewables, including large hydro and traditional biofuels, was 23.0 per cent in 1990. It remained relatively constant until the early 2000s when the share began to decline, hitting a low of 17.8 per cent in 2011 as the consumption of fossil fuels to meet growing energy demand increased. A key factor behind this downward trend was the rapid increase of coal supply in China, which, in 2014, accounted for more than 30 per cent of the entire region's primary energy supply. In addition, the share of traditional solid biofuels over the years 1990-2014 fell in line with modernization, which led to a switch to fossil fuels and electricity for heating and cooking. In the following years, consumption of renewable energy began to gain traction, with its share in the energy mix climbing to 18.3 per cent in 2014 (figure 4.1). Countries with higher shares of renewable energy in the overall energy mix tend to be less-developed economies, which are heavily reliant on the use of traditional biomass (figure 4.2). Notably, the use of traditional biomass is increasing in South and South-West Asia, and South-East Asia, as rural populations in some countries in those subregions increase. In recent years there have been small gains in the overall energy because of the introduction of modern renewables, supporting the annualized gain of 0.10 per cent in the renewable energy share over the 2012-2014 period. However, this still falls short of the 0.92 average annual percentage gain needed to achieve the objective of doubling the share of renewable energy in the global energy mix by 2030.

More positively though, there is progress in expanding the share of modern renewable energy within the regional energy mix. Modern renewables, which exclude traditional biomass and include resources, such as solar, wind, hydro, modern biofuels, and geothermal, are rapidly gaining traction and its share in the energy mix is exhibiting a shifting upward trend.

At the regional level, modern biofuels, such as wood pellets used in efficient stoves, biofuels, biogas, and waste-to-energy, continue to hold a baseline share within the modern renewable energy mix. Waste-to-energy has recently garnered attention in a number of countries, such as India, Indonesia, and Thailand, as a means to increase supply, offset reliance on other resources, and reduce the growing burden of dealing with waste. Modern biomass was only surpassed by hydro in the mid-2000s, while other forms, particularly solar and wind, have been gaining traction recently (figure 4.3).

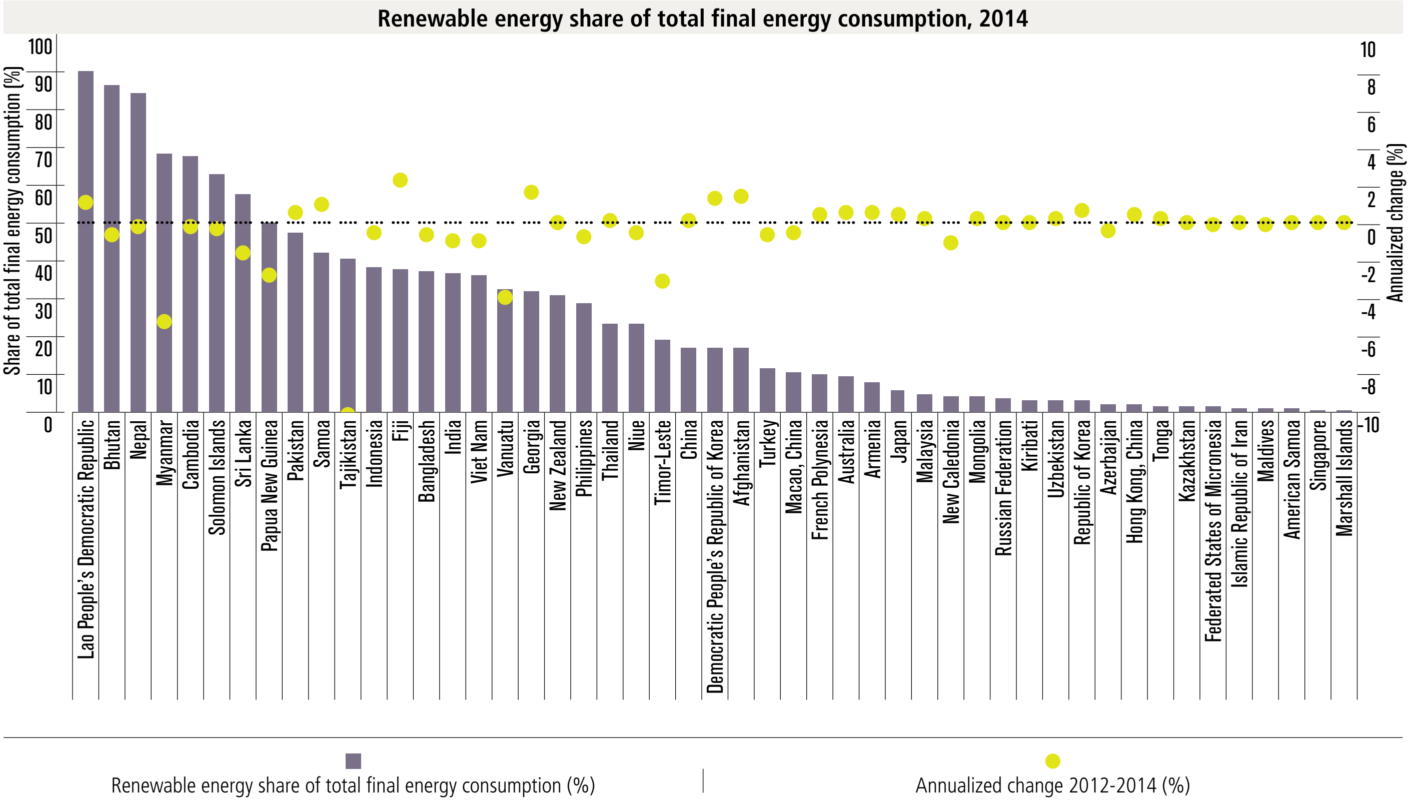
Between 2012 and 2014, modern renewables recorded an annualized gain of 0.3 per cent, reaching an overall share of 6.8 per cent in 2014 (figure 4.4). Large increases in hydropower underpin this trend, though the shares of wind and solar are also increasing. However, wind and solar have yet to compete in

Figure 4.1 Renewable's share of total final energy consumption in Asia and the Pacific slumped as fossil fuel consumption increased at a rapid pace



Source: IEA and UN Statistics

Figure 4.2 Traditional biomass contributes to the region's countries with the highest shares of renewable energy



Source: Source: IEA and UN Statistics

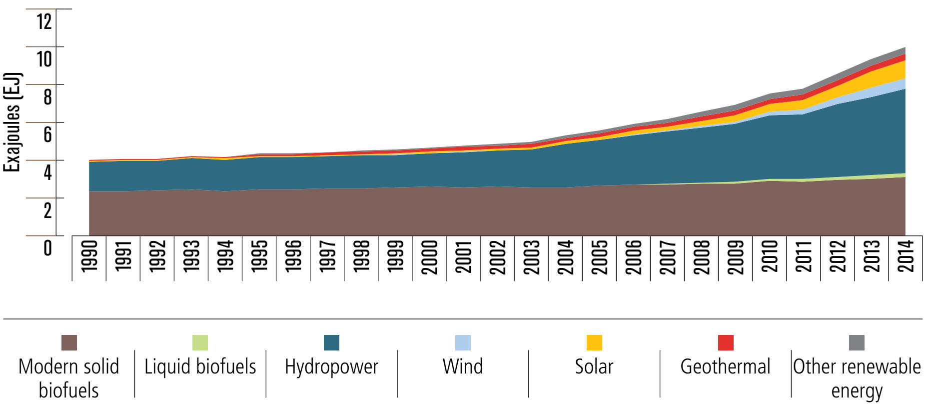
Note: Brunei Darussalam, Cook Islands, Guam, Nauru, Northern Mariana Islands, Palau, Turkmenistan, and Tuvalu had effective renewable energy shares of 0.0 percent and are not shown on this chart.

terms of share with conventional energy sources. When examining national shares of renewables, it can be noted that countries consuming higher shares of modern renewable energy tend to be hydro-rich (figure 4.5). Domestic energy supplies in some countries, such as Nepal, Kyrgyzstan, and Tajikistan, are almost entirely reliant on that resource.

Renewables, in the form of hydropower, have contributed to the economic growth in countries, that export hydropower as a significant portion of their GDP, such as the Lao People's Democratic Republic and Bhutan. Yet, historically, diversified energy supplies, comprised mostly of fossil fuels, have largely supported economic growth among countries in the region. The recent surge in renewable investment and capacity suggests, nonetheless, that, although fossil fuels will still comprise a majority share, renewables are destined to play an increasingly important role in future development.

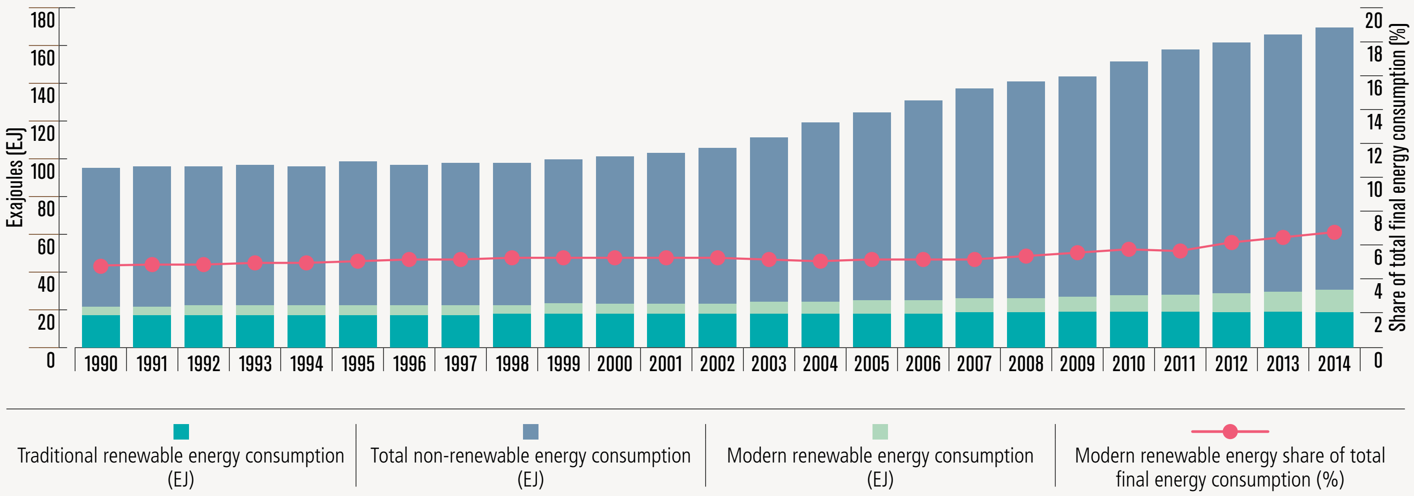
Large installations of renewables have been made across the region in recent years (figure 4.6), with the installation of solar and wind power growing rapidly (figure 4.7). This upward trend is largely driven by China, which has aggressively pursued technology development and capacity installations of those and other renewable energy resources. Japan used to dominate solar power in the region until it was surpassed in total installed capacity by China in 2013. Australia, India, the Republic of Korea, Thailand,

Figure 4.3 Consumption of modern renewable energy in Asia and the Pacific is increasing and supplies have become more diversified



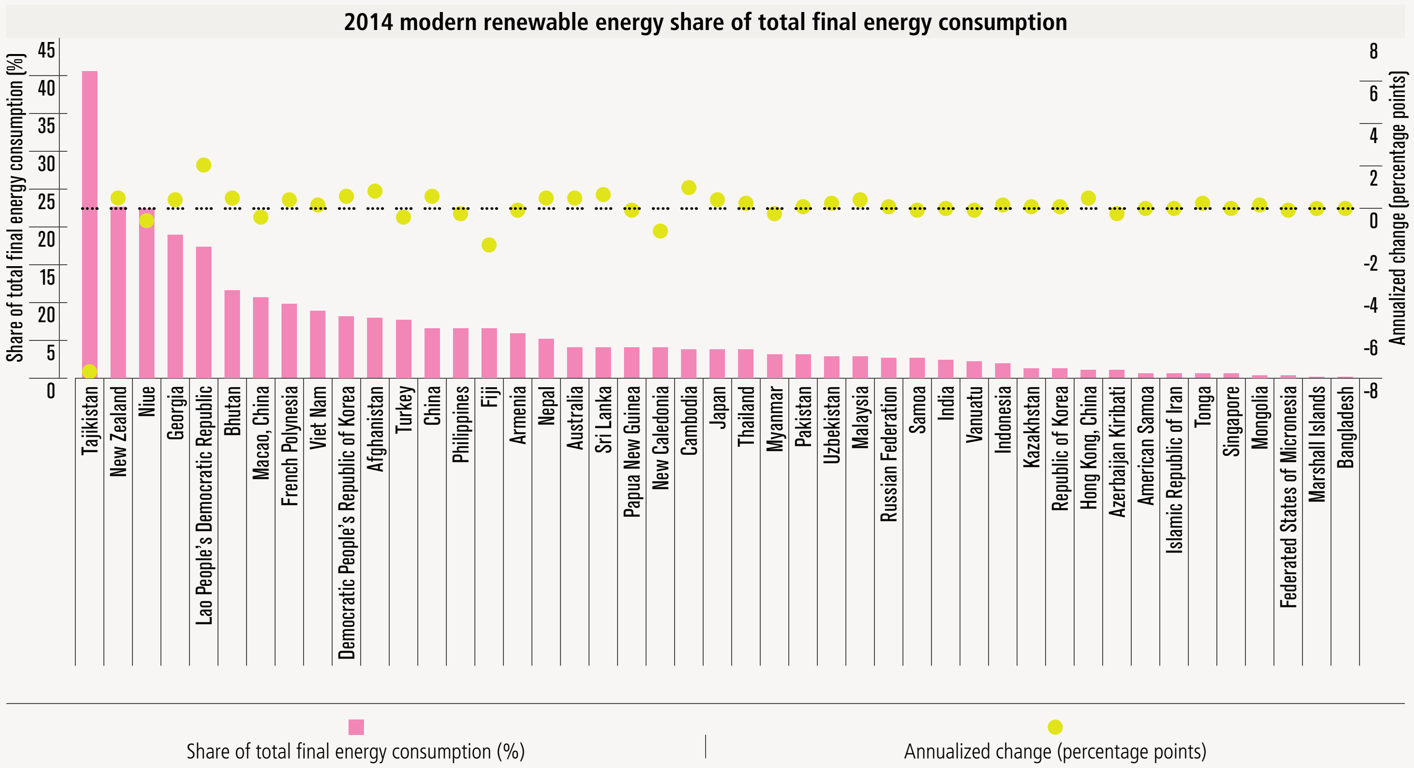
Source: IEA and UN Statistics

Figure 4.4 Modern renewable energy's share of total final energy consumption in Asia and the Pacific is increasing



Source: IEA and UN Statistics

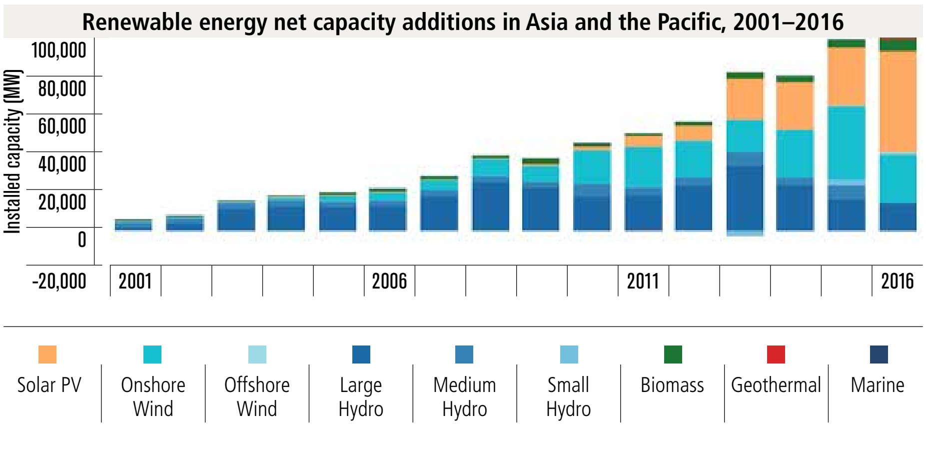
Figure 4.5 Modern renewable energy's share is highest in hydro-rich and some small economies



Source: IEA and UN Statistics

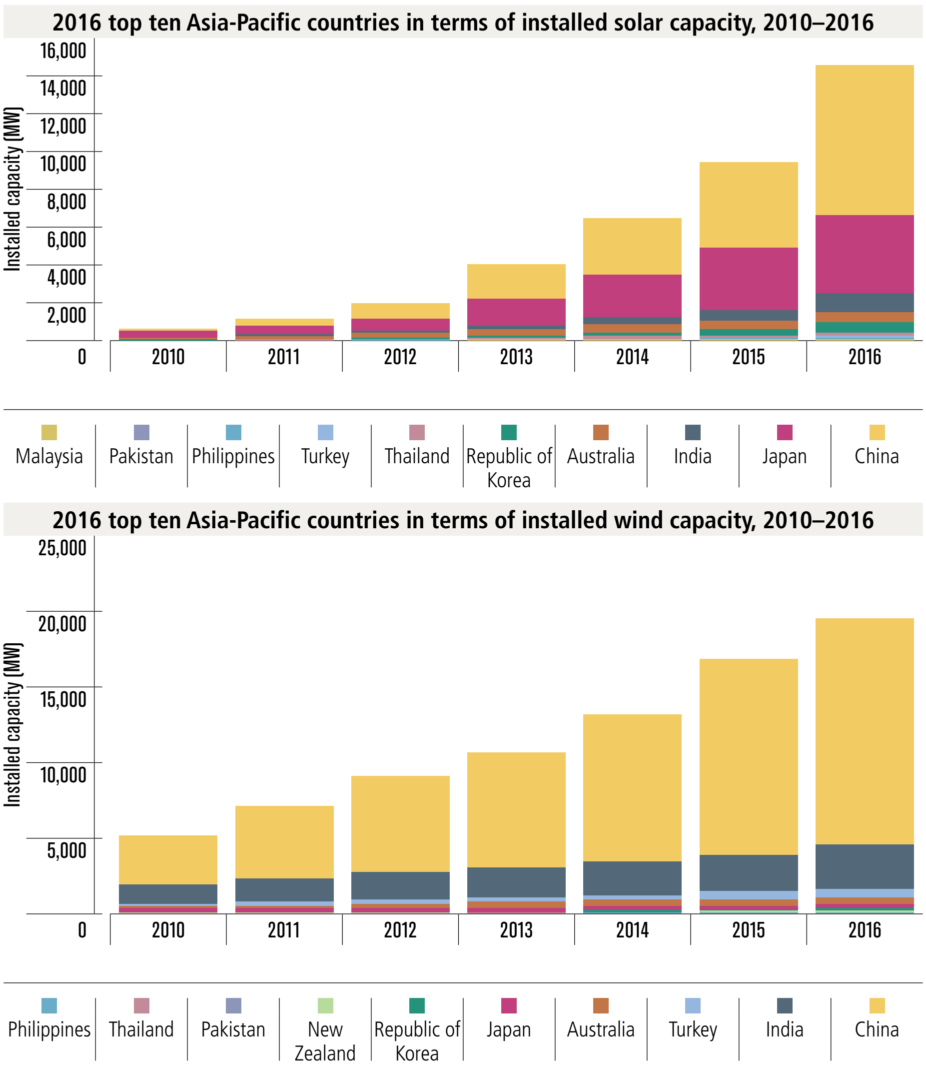
Note: Brunei Darussalam, Cook Islands, Guam, Kiribati, Maldives, Nauru, Northern Mariana Islands, Palau, Solomon Islands, Timor-Leste, Turkmenistan, and Tuvalu had effective shares of 0.0 percent and are not shown on this chart.

Figure 4.6 New capacity additions are rising, though slowed in 2016 with a decline in wind installations



Source: IRENA

Figure 4.7 Solar and wind installed capacity is increasing rapidly



Source: IRENA

and, most recently, Turkey have also made strong gains with regard to solar power installation. As for wind power, those countries followed the lead of China, where more than 34 GW of new wind energy was installed in 2016. Wind power installations, however, slowed in 2016, mostly because of adjustments in feed-in tariff rates in some countries. Some relatively new national actors are also expanding their use of renewables. A 135-MW project commissioned in 2016 in the Philippines became the largest solar installation in South-East Asia, while Viet Nam continues to dominate small and large hydropower capacity. Malaysia, in 2014, boosted its biogas power plant capacity by 500MW. Pakistan, which is making inroads in expanding its use of renewables, demonstrated 464 MW of new installed wind and solar capacity in 2016, according to International Renewable Energy Agency statistics.

HIGHLIGHTS FROM ASIA-PACIFIC SUBREGIONS

East and North-East Asia is the major contributing subregion to the growth of renewables in overall energy consumption in Asia and the Pacific. The share of renewables in the subregion bottomed out at 13.9 per cent in 2011, as fossil fuel consumption outpaced the consumption of renewables. However, renewable energy capacity installations have since gained momentum, with hydro and solar playing the largest roles; wind power installation, nonetheless, is also increasing. With rising use of modern renewables, coupled with a continued decline in traditional biomass use in line with urbanization, the modern renewable energy's share for the subregion rose to 6.5 per cent in 2014 from 2.3 per cent in 1990.

China has the largest share of renewable energy in its energy consumption mix, at 17.1 per cent, though 10.2 per cent of it is from traditional solid biofuels. The Democratic People's Republic of Korea had a nearly equal share of renewable energy and the subregion's highest, but a fluctuating national share of modern renewable energy, which is largely derived from large hydropower. During the 2012-2014 reporting period, Mongolia introduced a small share of wind power to its energy consumption mix. Japan also added solar and wind power during this period, which resulted in an increase in its renewable consumption share to 5.5 per cent compared to 4.5 per cent in 2012.

The consumption of renewable energy in **North and Central Asia** has remained relatively flat in recent years. The share of renewable energy of total final energy consumption in 2014 was 3.4 per cent, of which 3.2 per cent is considered modern. Hydropower represented 2.9 per cent of energy consumption in the subregion, while solid biofuels comprised 0.6 per cent. Other renewable resources have yet to hold measurable shares in the subregion although some countries are already implementing projects to develop wind, solar, modern biomass and geothermal energy.

With its rich hydro resources, Tajikistan held the highest share of renewable energy in North and Central Asia in 2014 at 40.7 per cent, although in recent years this share has been declining. Georgia similarly stands out because of its high level of hydro use, which contributed to the country's 31.9 per cent share in total final energy consumption, of which 19.1 per cent was modern renewables. The share of renewable energy in Armenia was 6 per cent, with hydro being the main source of renewable energy. Turkey has the subregion's most diverse renewable energy mix, consisting of hydro, solar, wind, and geothermal energy. The country's consumption of modern renewable energy stood at 7.7 per cent of its energy consumption. Azerbaijan, Kazakhstan, the Russian Federation, and Uzbekistan all have small shares of renewables from hydro. Turkmenistan, as of 2014, had not reported any renewable energy consumption.

The Pacific subregion, in 2014, had a renewable energy share of 13.8 per cent, and also the region's highest share of modern renewable energy at 12.4 per cent. Without Australia and New Zealand, those figures are 36.5 and 9.7 per cent, respectively, reflecting reliance on traditional biomass among developing States.

The subregion exhibited significant gains during this reporting period as Australia added wind and solar, while New Zealand ramped up its geothermal and wind power consumption, which, in addition to hydro, enabled the country to claim the Pacific subregion's highest share of modern renewable energy consumption at 22.9 per cent. Niue closely followed, with a share of 22.6 per cent, which was mostly derived from solar. Fiji boosted its modern biomass power, while solar and wind are beginning to take hold among many of the subregion's other small island developing States.

South and South-West Asia recorded a declining share of renewable energy, at 29.5 per cent in 2014, down from 30.7 per cent in 2012, as increased capacity for fossil fuels outpaced renewables. The shares of traditional and modern renewable energy fell to 21.4 per cent and 8.1 per cent, respectively. Modern solid biofuels accounted for the bulk of the subregion's modern renewable energy consumption, while hydro was also significant. Meanwhile, solar and wind claimed small but growing shares.

India, whose share of renewable energy consumption was 36.5 per cent in 2014, including 9.9 per cent for modern renewables, drives down the subregional trend as its consumption shares in both categories fell. However, the country has made significant renewable energy capacity additions during this reporting period, particularly with regard to wind and solar, and is accelerating those efforts. In 2016, India completed the construction of the Ramanathapuram solar complex in Tamil Nadu, which at the time of construction was the world's largest solar photovoltaic facility with a capacity of 648MW.

Hydro resources in the subregion are abundant. In Afghanistan, Bhutan, and Nepal, the consumption of modern renewable energy increased as a result of the development of hydropower, reaching 7.9, 11.7, and 5.3 per cent, respectively in 2014 although much potential remains untapped. Modern renewable energy's share rose in Pakistan to 8.0 per cent, while consumption of traditional biofuels also increased. This subregion also has the highest rate of traditional biofuel use within the energy consumption mix, at 21.4 per cent. Nepal is highly reliant on biofuel, with a 78.2 per cent share in 2014 – the highest in the Asia-Pacific region – and is closely followed by Bhutan, at 74.8 per cent. Modern renewable energy consumption in Bangladesh, the Islamic Republic of Iran, and Maldives amounted to less than one per cent.

South-East Asia recorded the highest share of consumption of renewable energy at 31.4 per cent during the reporting period, but this share had been falling. Energy consumption from traditional solid biofuels is declining while modern solid biofuels comprises more than half of the subregion's modern renewables. Renewable energy deployment is rising in Indonesia, Malaysia, the Philippines, and Thailand. Several countries in the subregion are also implementing hydropower development schemes, which have contributed to the subregion's rising share of modern renewables, which stood at 9.0 per cent in 2014. The Lao People's Democratic Republic stands out, with hydro accounting for 16.7 per cent of its total final energy consumption in 2014. This represented a 4 per cent gain in the share over 2012. Geothermal resources are also abundant but capacity additions have not increased significantly because of technical and financial barriers, though new efforts are being pursued in Indonesia and the Philippines where the potential is high. Solar is also increasingly being used in on- and off-grid applications across countries, with Thailand accounting for 75 per cent of solar energy consumption in the subregion.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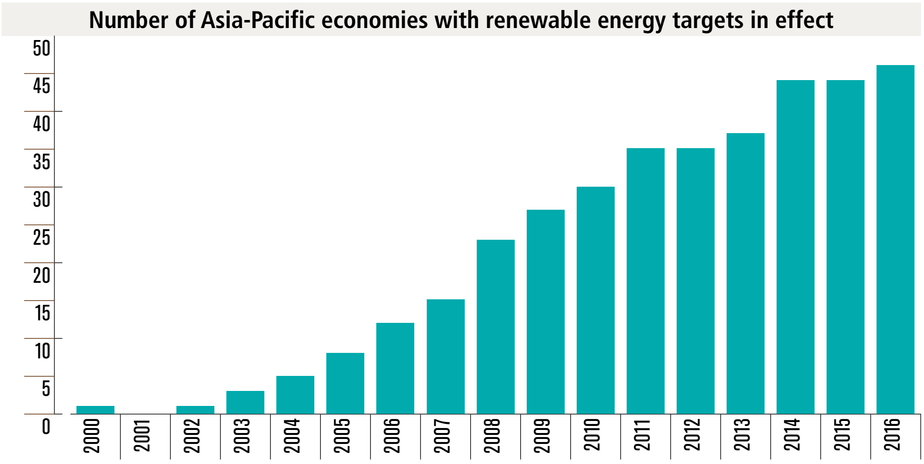
DRIVERS AND INFLUENCING FACTORS FOR PROGRESS

Policy targets have set the direction of renewable energy development.

The low share of renewable energy in the overall energy mix in the Asia-Pacific region masks the surge of development in the sector. Backing this development is a shift in policy stance towards supporting renewables with the introduction of targets, financial incentives, public financing measures and regulations. Such policies and measures were rarely implemented in the region prior to 2000. However, in the following years, they have been increasingly adopted by many economies, creating an increasingly favourable investment environment for renewables. Combined with continuously declining technology costs, this has resulted in a burgeoning uptake of these technologies. Momentum is consistently growing with new national commitments and ambitious targets. With new efforts to transition away from fossil fuels, this could lead to a future in which renewables could comprise a significant share in the region's energy consumption mix.

Renewable energy targets have catalysed the uptake of renewable energy and the development of enabling policies and incentives. One review indicates that, as of 2016, 46 of the 58 Asia-Pacific economies have identified economy-wide and/or sector-specific renewable energy targets, up from zero in 2000 (figure 4.8). Increasingly progressive targets are being set by countries to increase the consumption of renewable energy, and for many countries, their nationally determined contributions were decisive in reaffirming and raising their pledges to expand the use of it. In addition to targets, the scope of instruments related to renewable energy being introduced is also broadening, demonstrating a deepening commitment towards renewable energy.

Figure 4.8 Target adoption demonstrates the growing commitment to renewable energy by policymakers



Source: Author's review of policy content contained with the Asia Pacific Energy Portal, available at: www.asiapacificenergy.org

Pursuing increased renewable energy has been driven by the need for enhanced energy security for many countries, even though the prices of the fossil fuel commodities decreased from peak levels in 2007, particularly those that heavily rely on imports of oil and gas. For instance, Sri Lanka, under its latest energy sector development plan, is seeking to significantly increase the share of renewable energy while reducing petroleum imports, which have risen dramatically over the past decades (Sri Lanka, Ministry of Power and Renewable Energy, 2015). Pacific Island States, particularly the Cook Islands, Fiji, Samoa, Tuvalu, and Vanuatu, are leading the region in setting up an ambitious target of 100 per cent renewable energy.

Other countries have also set ambitious national renewable targets, although they have typically remained balanced against conventional energy development. One example of those national targets and the plan set by China through its nationally determined contributions, in which the country pledged a cumulative 200 GW and 100 GW of installed wind and solar power generation capacity, respectively, by 2020. Additionally, under the country's Energy Development Strategic Action Plan, hydro is expected to reach approximately 350 GW. The nationally determined contribution of India, in which the country has aimed to increase its installed renewable energy capacity by five times over 2015 levels by 2022 to 175 GW, is another example. India is also adding 100 GW of solar and 60 GW of wind under its National Solar Mission, and considering new wind-solar hybrid models. Thailand, under its Alternative Energy Development Plan 2016-2036, has established specific renewable energy quotas for waste, biomass, biogas, wind, and solar. The country has set detailed zoning for renewable energy development to help meet its target of 30 per cent renewable energy supply by 2036. Indonesia, which has large geothermal potential, intends to meet its renewable energy target of 23 per cent by 2025 by exploiting this resource. To boost investment interest in the sector, the country had updated its geothermal law in 2014 by removing the sector from its mining classification, and started to receive tenders on geothermal energy development. By 2030, Myanmar plans to rely entirely on its rich hydropower resources to meet its electricity needs,[63] as well as export hydropower to neighbouring countries. Other examples of renewable energy national targets are provided in annex III.

Regional cooperation is also enabling countries to collectively establish regional targets. In 2014, APEC economies committed themselves to doubling the share of renewables in the APEC energy mix, including power generation, from 2010 levels by 2030. This target has been formally documented in the Beijing Declaration in 2014 and reinforced in the Cebu Declaration in 2015. In 2016, ASEAN member countries have collectively set an aspirational target of 23 per cent renewable energy by 2025 in the ASEAN energy mix.

Economic incentives have supported the development of the renewables market.

Many countries are offering economic incentives, such as capital subsidies, grants, and rebates for equipment and services, to attract project developers and investment to the renewable energy sector (see table 4.1). Further support in the form of tax incentives are also being offered in other countries, such as sales tax and customs duty exemptions, tax rebates and holidays, and accelerated depreciation. Those measures help reduce the cost of projects for on- and off-grid applications, and are designed to target the important issue of consumer affordability. For example, Bhutan is extending capital subsidies and grants to finance small-scale individual and community investments in renewable energy projects (Ministry of Economic Affairs, 2013). In the Philippines, a capital subsidy is being offered to cover full or part of initial procurement and installation costs of eligible solar home systems in remote locations (Department

63. See http://policy.asiapacificenergy.org/?q=node/2934/portal.

Table 4.1 Economic incentives in place or planned under current policies

	Feed-in Tariffs	Net metering	Biofuels mandate	Capital subsidy, grant, rebate	Public investment loans or grants	Tax incentives
Afghanistan						
American Samoa						
Armenia	●			●		
Australia	●		●	●	●	●
Azerbaijan				●		
Bangladesh	●			●	●	●
Bhutan	●			●	●	●
Brunei Darussalam		●		●		
Cambodia				●		
China	●	●	●	●	●	●
Cook Islands	●	●		●		
DPR Korea						
Fiji	●	●	●	●	●	●
French Polynesia				●		
Georgia						
Guam		●		●		
Hong Kong, China						
India	●	●	●	●	●	●
Indonesia	●		●	●		●
Iran (Islamic Rep. of)				●		
Japan	●	●	●	●		
Kazakhstan	●			●	●	●
Kiribati	●	●		●		
Kyrgyzstan	●					●
Lao PDR			●	●		●
Macao, China						
Malaysia	●	●	●	●		
Maldives	●	●	●	●		
Marshall Islands	●			●		

	Feed-in Tariffs	Net metering	Biofuels mandate	Capital subsidy, grant, rebate	Public investment loans or grants	Tax incentives
Micronesia (F.S.)				●		
Mongolia	●					
Myanmar			●	●		
Nauru				●		
Nepal	●			●	●	●
New Caledonia				●		
New Zealand			●	●	●	●
Niue				●		●
Northern Mariana Is.				●		
Pakistan	●	●	●	●	●	
Palau	●	●		●		
Papua New Guinea	●	●	●	●	●	●
Philippines	●	●	●	●	●	●
Republic of Korea	●		●	●	●	
Russian Federation	●					●
Samoa				●		
Singapore	●			●		●
Solomon Islands		●	●	●		●
Sri Lanka		●	●	●		
Tajikistan				●		●
Thailand	●	●	●	●	●	●
Timor-Leste			●	●		
Tonga	●	●		●	●	●
Turkey	●			●		●
Turkmenistan						
Tuvalu				●		●
Uzbekistan				●		●
Vanuatu	●	●		●	●	●
Viet Nam	●		●	●		●

Source: Author review of policies contained within the Asia Pacific Energy Portal, available at: asiapacificenergy.org, and REN21 Renewables 2016 Global Status Report

of Energy, 2014). India has provided excise duty exemptions for off-grid rooftop solar projects, while foreign investors are exempted from income tax for 15 years for solar power projects in Bangladesh (Bangladesh, Ministry of Power, Energy and Mineral Resources, 2013). Fiji introduced a 10-year tax holiday in 2009 for entities processing biofuels, and a duty-free importation of equipment (Fiji, Revenue and Customs Authority (2016).

Public investment loans and grants are also being used to offset project costs and increase economic viability. India introduced a $794 million worth of tax-free infrastructure bonds for funding renewable energy projects in 2015-2016 (India, 2015b). Thailand continues to use its ESCO Revolving Fund to provide venture capital for energy services companies to jointly invest with private operators in small-size renewable energy projects. In Bangladesh, 80 per cent of small solar project costs are covered by grants and soft loans (Bangladesh, Ministry of Power, Energy and Mineral Resources, 2013). In Kazakhstan, renewable energy project developers are offered investment priority and access to special financing. Renewable power producers are also exempt from paying power transmission costs.

Subsidies of modern biofuels based on agricultural products and wastes are also growing. China has moved away from subsidizing renewable energy power, and has instead introduced subsidies to industrialize the production of modern biofuels.[64] Thailand leverages its oil fund, fed by a petroleum tax, to manipulate the price of ethanol and biodiesel to make biofuel blends cost competitive. Mandated and targeted biofuel blending has also been introduced in a number of countries, including, among them, Malaysia, Papua New Guinea, the Philippines, Thailand, the Republic of Korea, and Timor-Leste, along with subsidies for biofuel production.

64. As stated under the country's Thirteenth Five Year Plan.

Feed-in tariffs have encouraged investment, while auctions are lowering prices of renewables.

Feed-in tariff have been one of the most successful instruments used to support large and small renewable energy investment and installations. It provides predictable returns for project investors. More than 50 per cent of Asia-Pacific countries have adopted or are considering feed-in tariffs for utility- and small-scale distributed solar, wind, biomass, geothermal, and small hydropower.

Malaysia, following the introduction of the Renewable Energy Act 2011 and the associated feed-in-tariffs, experienced an increase in installed renewable energy capacity from 53 MW in 2009 to 243 MW in 2014 (Economic Planning Unit, 2015). Japan introduced a feed-in tariff for renewable power in 2012 as part of its plan to quickly reduce its dependence on nuclear energy, a move that has been highly successful for small-scale solar energy. This unleashed investment in solar photovoltaic projects such that, in 2014, those projects received $34.3 billion or about 82 per cent of the country's total investment volume (REN21, 2016). As a result, the country represents a globally leading market for distributed solar photovoltaics. China began using feed-in tariff in 2011. As renewable energy capacity has expanded, progressive downward adjustments to the tariffs have been duly made, making renewable energy more cost competitive with conventional energy. Under the country's latest Five Year Plan, wind feed-in tariff are expected to reach parity with coal by 2020. The country plans to continue reducing financial subsidies for renewable energy power and to eventually remove them.

Thailand introduced feed-in tariff in 2014, replacing an earlier adder programme introduced in 2007. The country is now shifting from a feed-in tariff system to a competitive bidding process to add 300MW more solar. These auctions focus on maintaining balanced distribution between 5MW solar farms and larger. During a recent tender, the prices were 40 per cent lower than the offer, reflecting strong private sector interest. [65]

Competitive bidding is gaining preference over feed-in tariff in a number of countries, such as in India, where bidding for solar parks resulted into a drop in tariffs to below thermal and hydro. Auctions provide regulatory certainty to investors, while also supporting "real price" discovery. In 2016, India awarded solar projects in at least 13 different auctions that amount to 6,500MW at approximately $73/MWh. During the same year, China contracted 1 GW of solar power capacity under its largest auction to date at $78/MWh. The Russian Federation held its fourth renewables auction to contract 610 MW of wind energy capacity, but the response was rather limited (IRENA (2017b). Other countries are also planning to hold renewable energy auctions. Sri Lanka is planning to use this mechanism to attract investments toward large solar and wind installations (Ministry of Power and Renewable Energy, 2015). As Asia-Pacific countries adopt auctions, some challenges have emerged where eager private sector bidding below market rate has created financing challenges, but, overall, results are positive.

Auctions have put downward pressure on the costs of renewables. Across Asia, the weighted average levelized cost of electricity of hydropower is the lowest among renewable energy technologies. Although onshore wind and solar photovoltaics are approaching price parity (table 4.2), and are even beginning to compete with coal in some countries, such as in China, India, the Philippines and Viet Nam (Bloomberg New Energy Finance, 2016a), grid system capacity and readiness for variable renewable energy integration remains a key limiting factor.

India has recorded the lowest costs for solar photovoltaics and onshore wind in the region, which can be attributed to a number of recent initiatives, including auctions. These initiatives have allowed the country to exceed its capacity installation targets at the region's lowest costs for those technologies. In the beginning of 2016 a $64/MWh solar facility was contracted in Rajasthan, India, which brought regional prices to a new low. However, this price is still more than twice the global low realized later that year, suggesting that solar power in Asia and the Pacific may continue to get cheaper. In China and India, low financing costs have contributed to the relatively low costs of wind and solar, whereas land and labour costs are behind the higher costs of solar and onshore wind in Japan (Bloomberg New Energy Finance, 2016a).

Biomass and biogas are also highly competitive in some contexts. Their use is increasing in countries such as China, India, Indonesia, and Thailand, where agriculture and forestry residues and energy crops are in abundance. Commercial biogas plants for power generation fed with organic waste from large-scale livestock operations and municipal waste are also being constructed in countries such as Bangladesh and Malaysia. In line with commitments to increase the use of renewable energy, countries can be expected to continue to explore the most viable options based on their indigenous resources.

Investment in renewables is outpacing conventional energy and resulting in rising shares.

The Frankfurt School-UNEP Centre and BNEF report that the upward trend in new investments in renewable energy (excluding large hydro) in Asia and the Pacific continued in the period 2012-2014, where it rose from $97.2 billion in 2012 to $146.2 billion in 2014. This has led to a large increase in capacity across Asia and the Pacific, particularly with regard to wind and solar. Following the reporting period, investment in renewables reached an all-time high of $171.1 billion in 2015, but then fell dramatically in 2016 to $114.8 billion

65. Representative of Thailand, statement to the Policy Dialogue on Energy for Sustainable Development, Bangkok, 17 January 2017. Available from www.unescap.org/events/policy-dialogue-energy-sustainable-development.

Table 4.2 Levelized Cost of Energy and Capacity Factors* for Renewable Technologies in Asia and the Pacific

Technology	USD/kWh			Capacity Factor*		
	min	max	w.a.	min	max	w.a.**
Bio Power						
Asia	536	6082	1486	0.202	0.95	0.623
Eurasia	1344	7106	1756	0.713	0.958	0.831
Pacific	3851	3852	3851	0.508	0.506	0.507
China	542	6082	1576	0.206	0.95	0.618
India	536	5497	1112	0.202	0.976	0.626
Geothermal Power						
Asia	1514	8736	3148	0.411	0.929	0.83
Eurasia	2613	3278	3113	0.8	0.8	0.8
Pacific	3303	4676	3796	0.6	0.8	0.8
China	1501	9722	1943	-	-	-
India	1501	7475	2169	-	-	-
Hydropower						
Asia	458	7553	1212	0.139	0.947	0.46
Eurasia	519	5416	2945	0.169	0.854	0.421
Pacific	1780	4119	2984	0.241	0.614	0.504
China	458	7220	1023	0.131	0.947	0.451
India	467	5759	1321	0.115	0.898	0.451

Technology	USD/kWh			Capacity Factor*		
	min	max	w.a.	min	max	w.a.**
Solar PV						
Asia	819	7997	1624	0.101	0.247	0.166
Eurasia	1545	3697	2775	0.117	0.127	0.119
Pacific	1180	7539	2857	0.114	0.271	0.191
China	998	7780	1439	0.101	0.184	0.170
India	833	4916	1403	0.159	0.247	0.206
Concentrated Solar Thermal Power						
Asia	3501	13693	4423	0.17	0.535	0.275
Pacific	9735	10767	9829	0.21	0.21	0.21
China	3501	13639	3680	0.17	0.28	0.272
India	3539	7475	4328	0.206	0.535	0.276
Onshore Wind						
Asia	958	2784	1280	0.172	0.435	0.243
Eurasia	1550	2651	1751	0.272	0.35	0.344
Pacific	1060	3752	2533	0.275	0.436	0.337
China	1032	1553	1251	0.221	0.36	0.242
India	958	1625	1228	0.172	0.258	0.234
Offshore Wind						
China	2115	3061	2767	0.204	0.287	0.26

Source: Adapted from REN21 (2016)

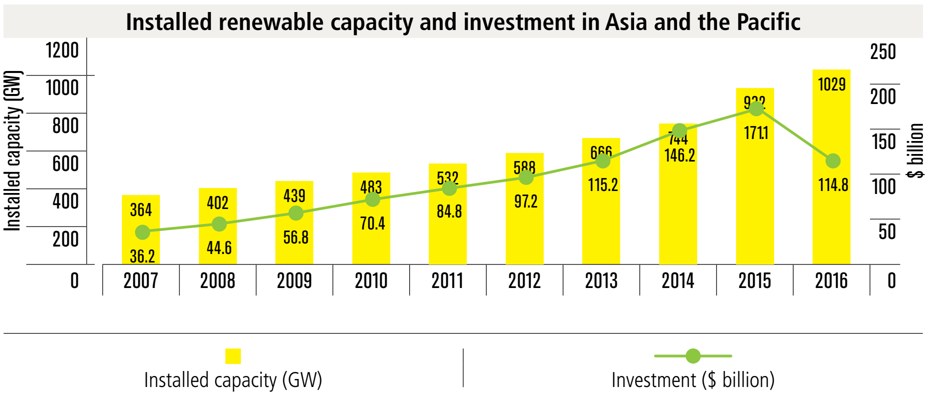
Note: *w.a; weighted average; kWh, kilowatt -hour.
** Capacity factor = the ratio of the actual output of a unit of electricity or heat generation over a period of time (typically one year) to the theoretical output that would be produced if the unit were operating without interruption at its rated capacity during the same period of time.

(figure 4.9). This was mainly because of an installation slowdown in the region's two largest markets, China and Japan. Other factors behind the decline were lower technology costs and the timing of project commissioning. China has accounted for more than 50 per cent of total new investments in renewable energy in the region since 2008 and remained a global leader in renewable energy investments since 2009. The country's wind and solar installations slowed after it lowered feed-in tariffs and cut its wind installation target as it grappled with existing capacity, slowing demand, and curtailments. Investment in renewable energy in China fell from $115.4 billion in 2015 to $78.3 billion in 2016, although offshore wind investment bucked this downward trend. In 2016, Japan, the world's second-largest solar photovoltaic market[66], with small installations comprising the bulk share, recorded a decline in installations and a 56-per cent reduction to $14.4 billion in renewable energy investments (Frankfurt School/FS-UNEP Collaborating Centre, 2017).

The Republic of Korea also recorded a decline in renewable energy investment to $1.4 billion in 2016. Meanwhile, Australia bucked the trend, as investment rose to $3.3 billion, or by 51 per cent, in 2016 in the country compared to 2015. The increase was mainly due to large investment in wind power. Increased investment in renewable energy in 2016 was also recorded in Thailand, Singapore,

66. Japan introduced a generous feed-in tariff (FiT) for renewable power in 2012, as part of its plan to quickly reduce its dependence on nuclear energy. In 2017, Japan reduced solar photovoltaic prices through an auction programme for large-scale photovoltaic plant and changes to its FiT system.

Figure 4.9 Investment had grown rapidly until 2016 when it eased off, but capacity has continued to increase



Source: IRENA and Frankfurt School-UNEP Centre

Note: GW, gigawatt; investment figures exclude large hydropower whereas renewable capacity includes this resource.

Viet Nam, and Indonesia.[67] The level of investment in India, however, remained steady at $9.7 billion. Investment in solar power surpassed those made in wind in the country. The Philippines and Pakistan experienced a decrease of about 50 per cent in new investment in renewable energy in 2016, as compared to 2015.[68] In Thailand, investment in solar power increased slightly, helping the country keep a top spot in terms of investment among developing countries in the region (Frankfurt School/FS-UNEP Collaborating Centre, 2017).

Investment in renewable power generation continues to outpace fossil fuel and nuclear power generation. Although renewables still hold a relatively small share of installed capacity, the dominant role of renewables in new capacity additions is evident. Despite the recent decline in investment figures, falling capital costs resulting from more capacity being installed per dollar spent resulted in a record high installation in 2016. Bloomberg New Energy Finance estimates that the installed power generation capacity in the Asia-Pacific region will triple over the next 25 years with the addition of 4,890 GW, and that renewables will account for about 66 per cent, or $3.6 trillion, of this investment (Bloomberg New Energy Finance, 2016b).

Sources of capital and financing instruments are growing and diversifying.

Local banks have been known to be skeptical lenders to what used to be viewed as unproven technologies and business models. However, as governments push and offer incentives, and knowledge and experience has been gained, financing institutions are showing increased willingness to offer financing to the renewable energy sector. Low interest loans for renewable energy are being offered in many countries. For example, local banks in Thailand, which have worked together with the government to increase project assessment capacity and develop funding mechanisms, are now aggressive lenders for renewable energy projects.[69] In India, renewable energy projects are given priority and offered lower lending rates. However, the falling cost of renewable energy technologies is resulting in many new, inexperienced market participants, which can increase lending risks.

International finance institutions are also increasing their lending through such mechanisms as clean energy bonds. ADB, for example, has raised more than $820 million worth of those bonds since 2010 to finance clean energy in the region (ADB, 2016c).

New sources of investment are also increasingly becoming available, hence scaling financial flows. At the project level, a greater number of non-recourse loans bonds and leasing arrangements are being offered while at the corporate level, increased borrowings are being recorded. Institutions, such as the Green Climate Fund and Asian Infrastructure Investment Bank, have launched several programmes to support renewable energy deployment in Asia, including framework development initiatives and funding programmes for project development.

Newer project financing mechanisms, such as green bonds, are also gaining traction, as private companies and institutions are becoming more aware of their positive attributes. A host of international private equity firms[70] are active in the region and have set up dedicated green energy funds to help develop a healthy ecosystem of greenfield as well as secondary markets in the region. Corporations and other entities[71] have also launched an investment accelerator at the SE44All event in New York in 2017, hoping to mobilize $50 million between 2018 and 2020 (Climatescope, 2016).

67. With its investment in solar and wind power, Australia is the third largest market for renewable energy in region after China and Japan. In 2016, new investment in renewable energy was $0.7 billion in Singapore and Viet Nam, $3.3 billion in Australia, $0.5 billion in Indonesia, $1.4 billion in Thailand and $ 1.4 billion in the Republic of Korea.
68. According to the Global Trends in Renewable Energy 2016 report, new investment in renewable energy was about $1 billion in the Philippines and $0.9 billion in Pakistan. Most of the investment in the Philippines was to expand solar capacity; while, in Pakistan, the new investments in renewable energy were mostly directed to solar and wind power. Under development in Philippines are wind, solar, geothermal, biomass and small hydro projects (Frankfurt, Germany: Frankfurt School/FS-UNEP Collaborating Centre, 2017). Projects in the pipeline in Pakistan are related to solar, wind, small hydro and biomass.
69. Representative of Thailand, statement to the Policy Dialogue on Energy for Sustainable Development, Bangkok, 17 January 2017. Available from www.unescap.org/events/policy-dialogue-energy-sustainable-development.
70. Firms include, but are not limited to: Asia Green Capital Partners, Equis, Infravest, Black Rock, MacQuarie Energy and Olympus Capital Asia.
71. Implementing partners include Facebook, Microsoft, Allotrope Partners, cKers Finance in India, CrossBoundary Energy in Africa, California Clean Energy Fund, Electric Capital Management, Morrison & Foerster LLP and GivePower.

Countries are investing in technology research and development.

Countries in Asia and the Pacific have been at the forefront of research and development, leading to new technologies and cost reductions, and the overall advancement of the renewable energy sector. China has led the region in terms of investment in innovation. The country is the highest global spender on energy research and development as a share of GDP, topping Japan in 2014 (IEA, 2017a). Although recent years the trend in research and development has been stagnant, Australia, China, India, Indonesia, Japan and the Republic of Korea have also joined other countries around the world in committing themselves to double their respective clean energy research and investment over a five-year period through the Mission Innovation initiative. The initiative works to accelerate the pace of clean energy innovation. Asia Pacific countries are targeting to invest $4.87 billion annually in clean energy research and development in various areas (table 4.3) (Mission Innovation, 2017). Much of the investment is intended to contribute towards the use of renewable energy.

Table 4.3 Clean energy research and development focus areas and baseline annual investment

	Australia	China	India	Indonesia	Japan	Republic of Korea
Focus Area	Baseline investment amount ($ million per year)					
	81	3,800	72	17	410	490
Industry & buildings	●	●	●	●	●	●
Vehicles and transportation	●	●	●	●	●	●
Bio-based fuels & Energy	●		●	●		●
Solar, wind & other renewables	●	●	●	●	●	●
Nuclear energy	●	●				●
Hydrogen and fuel cells	●	●	●		●	●
Cleaner fossil energy		●	●	●		●
CO_2 capture, utilization & storage	●	●	●	●	●	●
Electricity grid	●	●	●	●	●	●
Energy storage	●	●	●	●	●	●
Basic energy research	●		●	●	●	

Source: Mission Innovation (2017).

Renewables and battery storage are driving growth in distributed power generation.

New models for distributed renewable power generation are being developed, which are contributing to the growing shares of modern renewable energy, as well as improving access to modern renewable energy and boosting energy security. Policies and measures within the region identify the need to create stronger power systems that take advantage of domestic energy resources, while also increasing grid capacity and resiliency. Resources being tapped for generation are numerous, though solar and wind power dominate recent developments in the sector because of broad availability of resources, rapid deployment timelines, low environmental impacts and increasingly affordable technology prices.

Solar rooftop installations are being promoted in several economies, including, among them, Japan, India, China and Thailand, where land is either limited or expensive. In urban areas, rooftop systems have the advantage of locating generation supply at the demand centre. For residential, commercial or industrial consumers who are also suppliers, those systems can offer the benefit of avoided costs of electricity, and, depending on local policy frameworks, revenue from power sales to the grid. As an example, power market liberalization in Japan along with its feed-in tariff system has created a boom in small-scale solar power producers, which include individuals and small businesses. The country recognizes the advantage of diversification to strengthen its energy supply structure, and is also looking to increase the number of small and medium hydropower producers (Government of Japan, 2014). Another example of the importance of distributed energy pertains to the Republic of Korea, which is targeting 15 per cent distributed generation by 2035, to be achieved in part through small-scale renewable energy distribution in homes, villages, and schools.

Concerns over grid instability are subsiding. Planning and integrating a large number of small power generation plants utilizing different resources, and dispersed over broad geographic regions, has helped support a more stable supply that incorporates variable renewables in some areas. Furthermore, the introduction of increasingly affordable battery storage enables variable renewable energy, such as solar and wind, to become "dispatchable" resources, which are able to store surplus generation and then supply power systems when demand is present. Technology for battery-based energy storage systems is improving and costs are projected to continue to fall, pointing to the growing potential for increased renewable energy uptake. Very recently, notable energy storage deployments have taken place in among the following countries: Australia, China, India, Japan and the Republic of Korea.

Private sector actors are rapidly entering the distributed energy market, though conditions may not yet be completely suitable to adopt decentralized energy model in market structures and regulations. Independent power producers still face market barriers and financing challenges. Meanwhile, countries need to continue to strengthen underdeveloped grid infrastructure to realize the full potential of distributed energy.

CHALLENGES

Legal and regulatory aspects governing renewable energy development need to be strengthened and aligned.

The development of renewable energy is being adversely affected by incomplete, contradictory and unpredictable policies and regulations related to power generation, grid integration, land use and legalities of ownership structures. A comprehensive, well-aligned, and stable policy atmosphere is needed to create a favourable investment environment. Absent this, investors and project developers face greater uncertainty and risks, which could lead to higher levelized cost of electricity, mainly on the back of increased financing costs. The Regulatory Indicators for Sustainable Energy scoring methodology set by the World Banks Energy Sector Management Assistance Program (ESMAP), indicates that many Asia-Pacific countries are not in a strong position to effectively mobilize energy investments (figure 4.10).

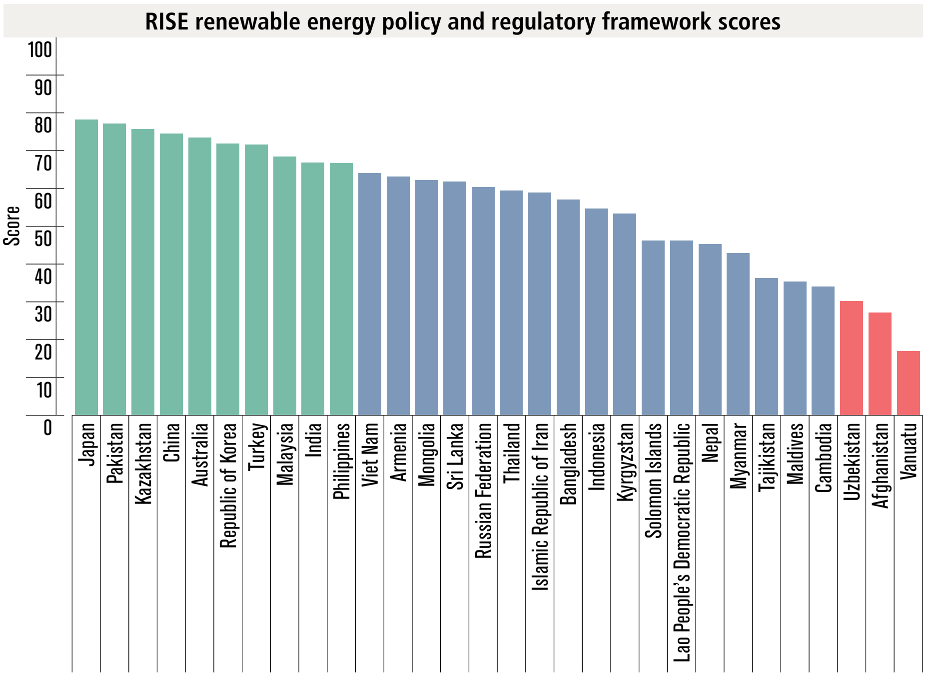
Policymakers and regulators struggle to put in place the necessary legal frameworks, planning, regulations and incentives to support this rapidly growing and evolving sector. Drawing on the best industry practices and experience is a first step, but to proceed, they need to deal with the challenges of adapting measures based on the conditions and constraints of individual national contexts, while effectively combining existing and new policies and regulations.

Use of best practices in grid development planning to increase capacities and improve system management are needed.

To generate and transmit renewable energy in a large scale, grid capacities must be upgraded and expanded. The uptake of renewable energy is hindered by inadequate grid systems required to transmit energy from supply to demand centres and to provide sufficiently broad balancing areas to handle the variability of generation from resources, such as wind and solar. Inadequate grid systems can be easily overloaded, resulting in curtailments, which lower capacity factors and have negative economic consequences for power producers. This is a challenge faced, in particular, by China. As renewable energy capacity is continuously being added, technical challenges persist in evacuating wind and solar power to load centres. These barriers include transmission congestions and the lack of long distance transmission lines, resulting in severe curtailments in some regions. In 2016, curtailments of solar and wind averaged 20 per cent and 17 per cent, respectively.[72]

China and a number of other countries are implementing large transmission and distribution expansion projects. In 2016, China accounted for 30 per cent of the $277 billion in global spending on power grids and storage, while India and South-East Asia accounted for 13 per cent (IEA, 2017a). These forms of investments will need to continue and expand across Asia-Pacific countries.

Figure 4.10 Many countries are not yet well-positioned from a policy and regulatory standpoint to mobilize investment in renewable energy



Source: Regulatory Indicators for Sustainable Energy (RISE), 2017 database. Available at rise.esmap.org. Accessed 8 June 2017.

Note: The score is derived from the combination of a number of factors examined within each country. For renewable energy, indicators are created based on: legal frameworks; planning; incentives and regulatory support; attributes of fiancial and regulatory incentives; netowrk connection and pricing; counterparty risk; and carbon pricing and monitoring. Indicators in each pillar are scored between 0 and 100 and are weighted equally to reach a score. Scores are not available for all countries.

72. Bambang Susantono, Vice-President for Knowledge Management and Sustainable Development of ADB, opening remarks at the Asia Clean Energy Form, Manila, 5 June 2017.

A key factor influencing the success of grid upgrades and expansions is whether they will be able to optimize linkages with the most viable renewable energy resource areas, which are often located far from demand centres. A mismatch between the shorter time scales needed to develop wind or solar generation and the typically much longer period needed for new transmission can result in projects being concentrated in areas close to existing transmission centres, which may not necessarily be the most technically or economically feasible locations. This situation can also create grid overload problems. Grid system planning, which takes into account the shifting landscape of the power supply, as well as future technology developments affecting supply, storage, and consumption patterns, is necessary. To address some of the challenges it faces, India introduced the Green Energy Corridor initiative to establish renewable energy zones and concurrently plan transmission lines and generation to best facilitate the transfer of power from renewable resource rich areas to areas where the demand is high.

Integrating variable renewable energy sources also requires increased grid flexibility. This can be achieved through a variety of measures, such as improved forecasting, more rapid scheduling, ancillary services and demand response and storage. Greater focus must be placed on building national technical capabilities in Asia and the Pacific for more sophisticated grid management. More attention must also be directed towards establishing institutional arrangements and coordination between grid balancing authority areas, including cross-border coordination.

Regional connectivity is gaining support but it faces challenges.

Support for regional connectivity is growing. Through multilateral market integration, unevenly distributed regional renewable energy could be delivered more broadly, while wider balancing areas can be created to enable an increased uptake of renewables. Current efforts aimed at increasing regional connectivity can result in larger shares for renewables in the power mix and increased trade in renewable energy. However, the technical, political, and financial arrangements required to integrate markets are yet to be designed. Although some countries, such as the Lao People's Democratic Republic, are developing renewable energy resources with the primary objective of energy trade, current trade agreements are primarily bilateral, not regional. Progress has been made in some areas, such as on the proposed Lao People's Democratic Republic-Thailand-Malaysia power trade market. There are many reasons for slow advancement in this area, but the discrepancies related to technical harmonization, legal and regulatory frameworks and tariffs are the most significant one. Finance and investment sources to develop regional cross-border power infrastructure have yet to be identified. Available data on existing energy systems, remain limited, which hinder efforts to thoroughly examine the costs and benefits of regional power market integration.

Investment is not enough to achieve the target of doubling renewable energy's share.

The annual renewable investment in Asia and the Pacific has yet to meet the estimated yearly amount of the $298 billion required to meet the renewable energy goal by 2030 (Sustainable Energy for All Advisory Board's Finance Committee, 2015). As noted earlier, new investment in renewable energy (excluding large hydropower) in the Asia-Pacific region peaked in 2015 at $114.8 billion, but fell dramatically in the following year, widening the gap between needed and actual investment.

In their nationally determined contributions, a number of countries have pledged to achieve ambitious targets for renewable energy, contingent upon appropriate financial and technical support. However, investment in new and renewable energy face strong competition for financial resources with conventional energy and other infrastructure projects (Kimura and others, 2015). Renewable energy projects, in comparison to conventional infrastructure, may be less attractive because of a lack of familiarity among some finance institutions, high capital costs and greater perceived risks (Ng and Tao, 2016).[73] In Asia and the Pacific, the challenge is heightened by the lack of diversity in financial instruments that meet both project and investor interests (Ng and Tao, 2016). The introduction of renewable energy into grid systems may also push the early retirement of fossil fuel generation, a cost consideration that may create significant barriers in some national contexts.

Many renewable energy developers and entrepreneurs still lack access to finance. Particularly in developing countries in the region, many developers and entrepreneurs lack capacity to develop bankable projects that can attract necessary financing. In some situations, investors may have limited understanding of renewable energy technologies, business models, and the risks and returns of financing renewable energy (O'Mealy and others, 2017), thus making it more difficult for them to evaluate and place funds in renewable energy projects.

73. IRENA (2016) identified political and regulatory risk; counterparty, grid and transmission link risk; currency, liquidity and refinancing risk; and resource risk, which is particularly significant for geothermal energy, as investment constraints in renewable energy.

ACCELERATING PROGRESS

To reduce real and perceived risks for investors, renewable energy policy and planning must be transparent and predictable, even as countries continue to develop and strengthen their legal and regulatory frameworks. For example, long-term planning and implementation schedules for transmission lines supports the identification of development sites with the highest economic returns that are aligned with grid development. Streamlining of approval processes for projects, priority access and dispatch, and avoidance of backlogs and delays support the development of a more conducive business environment. In addition, in cases in which standards and regulations do not exist, they need to be introduced, while existing standards and regulation should be strengthened to respond to the changing technology and market conditions. As markets mature, a shift can be made from softer, voluntary standards to stronger and mandatory ones.

Optimal policy solutions to facilitate the integration of renewables should comprise long-term planning with support for the development of a number of renewable energy resources; a mix of centralized and distributed generation; strengthened transmission and distribution infrastructure; rapid and responsive systems with large balancing areas and smart grids; demand response mechanisms; and storage. It also must be noted that this sector is predominantly focused on wind and solar power. In that regard, policy attention must look beyond those two resources and the power industry, and target other available indigenous renewable resources across sectors.

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Placing more focus on increasing renewable energy in the transport and heating sectors.

Although the power sector dominates recent renewable energy development, electricity makes up less than 20 per cent of total final energy consumption in Asia and the Pacific. The transportation sector comprises a growing share of final energy consumption, and the heating sector has been largely ignored. Fossil fuels are predominately used in those two sectors, but biofuels are gaining traction in the transportation sector, and electric vehicles are increasing market share in some countries. However, the current market share of electric passenger light-duty vehicles represents only 0.2 per cent of the global market (IEA, 2017b), and looking to the future, electric vehicles are predicted to comprise only approximately 54 per cent of vehicle sales in 2040 (Bloomberg New Energy Finance, 2017). Despite the promising growth of such vehicles, more rapid progress is needed in order to significantly affect fossil fuel demand and decarbonizing the way the world moves people and goods. New technology development is also needed to support the development of affordable and competitive renewable fuels and heat supply system technologies for residential, commercial and industrial applications. Without addressing those two sectors, it will be very difficult to achieve the target of doubling the share of renewable energy.

Increasing grid capacity, flexibility, and connectivity.

Upgrading, expanding, and integrating grid infrastructure and management systems across the region, including through cross-border connections, in a planned and strategic manner can significantly increase the amount of renewable energy that can be brought into power systems. Factors such as long-term planning, flexible grid design, and fiscal and institutional arrangements that enable the unrestricted flow of energy within and across borders support the increased share of renewables. They allow resources to be tapped in the most technically viable areas via the most economic means.

Integrating large-scale storage into energy systems.

Storage can increase renewable energy consumption by making it possible for higher percentage shares of variable renewable energy from wind and solar in power systems because of the added ability to balance a fluctuating supply. When solar or wind power exceeds the demand, rather than curtailing power production, excess power can be stored and later released to the grid.

Pumped hydro storage systems, which have already been in use for an extensive period, can continue to be developed, subject to geological and market conditions. Additionally, the use of batteries is growing rapidly in this area, promising new and expanded utility-scale storage capabilities. Because of the explosion of the electric vehicles market, sales of which were up 40 per cent in 2016, the cost of batteries has rapidly declined, and costs associated with battery storage are beginning to fall. With battery storage, which is particularly attractive for providing short-term balancing for wind and solar installations, the levelized cost of electricity remains high, but it is expected to decrease in line with declining technology costs.

Many countries are beginning to pilot new storage options. Notably, Australia, China, India and the Republic of Korea have announced plans to install large storage systems (Popper and Hove, 2017) and some island States are also looking to adopt this technology to meet the challenges of smaller grid systems based on variable renewables. Also, extensive research and development in this area is being conducted. Thailand, under its Energy 4.0 strategy is supporting research and development for energy storage across of number of applications for increasing grid resilience, renewable energy uptake, and electric vehicles. Sharing lessons learned from currently operating battery storage systems and results from research and development efforts can inform planning for grid capacity upgrades and expansion, enabling countries to take better advantage of renewable energy resources.

Increasing research and development to deliver more effective and affordable models.

More research and development is needed to improve and further reduce the cost of renewable energy technology and storage to more affordable levels. Further research is also needed to develop more effective and lower-cost business models for large- and small-scale systems. Better understanding is needed of the innovations and business models that can, and in some cases, already are, disrupting the utility supply and distribution models of many Asia-Pacific

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countries. The further development of new means of combining and packing technology and systems, such as pre-designed kits for smaller applications, can facilitate the proliferation and distribution of renewable energy.

Increasing private sector engagement.

The private sector has the capacity to offer financing and innovations that support the more rapid development and deployment of renewable energy technology. Increased cooperation between the private sector and government is required to accelerate innovation and the deployment of new technologies, systems, and business models. Policymakers are entrusted with improving the planning, investment, and innovation environments within their own countries to offer predictability, lower risks and the space from which new technologies and business models can emerge.

Strengthening the financing environment to mobilize investments.

Strengthening the renewable energy financial environment by developing the capacity of local financial institutions to provide more loans, offer other financial mechanisms, and obtain capital to support renewable energy projects is essential. Equally important is helping renewable energy project developers and entrepreneurs access finance. Both are vital in mobilizing more renewable energy investments in emerging markets in the region (O'Mealy and others, 2017). Governments, development institutions, and other stakeholders can facilitate and expand initiatives[74] that seek to mobilize sustainable energy investments by providing different services, such as capacity development and investment matching to entrepreneurs and investors.[75] Development financial institutions should also increase their on-lending structures, which combine technical, and policy assistance to local banks (IRENA 2016). Governments and financial institutions can further help mobilize investments by classifying renewable energy as a priority lending sector and encouraging the bundling of small projects to make them more financially viable (O'Mealy and others, 2017). Risk mitigation, such as through political risk guarantees, partial credit guarantees, and currency risk mitigation instruments are also important to encourage more investments in renewable energy.[76]

Improving data availability and knowledge sharing to tap the potential of renewable energy.

The Asia-Pacific region in general has much experience in developing renewable energy, particularly in the power, transport, and residential sectors. Although each country has its own context, knowledge sharing plays an important role in guiding decision-makers in formulating solutions. More shared data and information is needed to better understand the following: (a) the challenges of integrating renewable energy into existing systems; (b) the influences of various economic instruments on markets and investment; (c) the short and long-term costs and trade-offs; and (d) the realized multi-sectoral benefits and impacts. Within countries, improving the availability and use of data on renewable energy, existing infrastructure capacities and operations, land use and other factors, such as the population and economic growth dynamic, can support planning, decision-making, and investment in energy system development.

Strengthening regional cooperation on connectivity and integrated energy markets.

Ongoing dialogues are needed to support existing and emerging initiatives aimed at integrating the region's energy markets. Beyond the harmonization of technical, legal, and regulatory frameworks, a consensus is needed on how to calculate and share the benefits of market integration. Through a greater commitment to ongoing dialogue, a better shared understanding of partner countries' needs, limitations, and capacities can be achieved, which would pave the way for achieving a common vision backed by political will. New partnerships are needed among countries and between governments, the private sector, development agencies, financial institutions and civil society to push forward connectivity that offers broad and inclusive benefits.


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74. Existing initiatives include Sustainable Energy for All Project Development Facility of ADB and the Private Financing Advisory Network _ Asia of the United States Agency for International Development.
75. More information on the All Project Development Facility and the Private Financing Advisory Network_ Asia are available from: http://www.se4all.org/sites/default/files/l/2014/11/PDF-Brochure.pdf and https://www.usaid.gov/asia-regional/fact-sheets/private-financing-advisory-network-asia
76. In the IRENA report, Unlocking Renewable Energy Investment: The Role of Risk Mitigation and Structured Finance, barriers to renewable energy investments and presents an all-in-one guide to financial market instruments to renewables is examined in full detail. The report is available from: http://www.irena.org/publications/2016/Jun/Unlocking-Renewable-Energy-Investment-The-role-of-risk-mitigation-and-structured-finance .


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CONCLUDING REMARKS

Although the three pillars of sustainable energy, namely access, efficiency, and renewables, are presented separately in this report, they are inextricably intertwined, and as the Asia-Pacific region undergoes efforts to make progress towards sustainable energy, none of these areas can be advanced without consideration of the others. Ultimately, many of the themes for accelerating progress are common. As heard from many countries and institutions in numerous forums, affordability is a key barrier, and better financing options and more investment are needed to realize objectives related to sustainable energys. Furthermore, knowledge sharing and capacity building support efforts to identify common challenges and solutions.

Quite clearly, better data are required across the three pillars of sustainable energy in order to more accurately capture the complexities in each of these realms and enable better decision-making. The GTF data represent the best available information for assessing progress across the Asia-Pacific region and globally, but gaps remain and improvements are required. To improve, more engagement from States is needed in increasing the quality of the GTF data and reporting framework. It must also be kept in mind that the GTF data will never offer the depth and breadth of data needed by countries to conduct their own decision-making processes. Therefore, it is up to countries to improve their own statistical collection efforts, work to engage and align their efforts with the global community, and make the best use of available information to formulate evidence-based policies.

Finally, the data and information presented under the GTF follows progress made in the past. Given the rapid nature of development, and the ramping up of efforts being seen in many areas, the data presented in this report, which lags by approximately two and half years because of the time needed to collect, standardize, and process for all countries, may not represent current situations, particularly at national levels. Potentially, some economies may have made significant new progress, and those stories will emerge in subsequent issues of this report. It is also impossible to capture all the efforts being made, new innovations, and various approaches from within the Asia-Pacific region within one document. The most current information can be found by engaging in dialogue with various actors within the energy sector. Accordingly, it is hoped that this report will motivate public, private, and civil society stakeholders to actively participate in forums, and to form new partnerships designed to support progress towards achieving sustainable energy for all.

ANNEX I: ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC AND ASIAN DEVELOPMENT BANK MEMBERS AND ASSOCIATE MEMBERS

Afghanistan
American Samoa*
Armenia
Australia
Azerbaijan
Bangladesh
Bhutan
Brunei Darussalam
Cambodia
China
Cook Islands*
Democratic People's Republic of Korea
Fiji
French Polynesia*
Georgia
Guam*
Hong Kong, China*
India
Indonesia
Islamic Republic of Iran
India
Indonesia
Kiribati
Kyrgyzstan
Lao People's Democratic Republic
Macao, China*
Malaysia
Maldives
Marshall Islands
Federated States of Micronesia
Mongolia
Myanmar
Nauru
Nepal
New Caledonia*
Niue*
New Zealand
Northern Mariana Islands*
Pakistan
Palau
Papua New Guinea
Philippines (the)
Republic of Korea
Russian Federation
Samoa
Singapore
Solomon Islands
Sri Lanka
Taipei, China
Tajikistan
Thailand
Timor-Leste
Tonga
Turkey
Turkmenistan
Tuvalu
Uzbekistan
Vanuatu
Viet Nam

Note: * Indicates an ESCAP associate member
ESCAP only member
ADB only member

ANNEX II: METHODOLOGY FOR ACCESS TO ELECTRICITY

Note: Content contained in this annex is excerpted and summarized from the global GTF publication, *Sustainable Energy for All Global Tracking Framework: Tracking Progress Toward Sustainable Energy.* For full details, see annex 2.1 of the report, which is available from: http://gtf.esmap.org.

The Global Tracking Framework 2017 (GTF 2017) updated the methodology for tracking access to electricity. Key differences from past GTF editions include:

- Use of a new statistical model to estimate missing data.
- In-filling the data series from only four snapshots in time to the full 1990–2014 time series.
- Use of a different method to calculate the annual access rate increase.

About the data sources

Data sources include survey data from the World Bank's Global Electrification Database (and occasionally census data, from sources going back as far as 1990 (table A2.1). The database also incorporates data from the Europe and Central Asia Poverty Database.

Survey estimates can differ based on their natural sampling error and their methodology. Some surveys measure whether a household has access to electricity for any purpose, while others ask whether electricity is the main source of lighting. The Global Electrification Database includes grid connections and off-grid sources, such as generators and solar home systems, though the data may or may not include off-grid solutions, depending on the conventions in each country. The strength of the surveys is that households are able to report directly their experience with regard to access. Survey results, however, may be affected by sampling errors or unreliable responses. IEA has maintained a supply-side database on household electrification since 2000 based largely on utility connection data, which differs from the household survey data. Utility data captures what is happening in service areas, but the data does not incorporate access through decentralized forms of electrification in rural areas or illegal connections in urban areas. Both types of data offer valid and complementary perspectives, but they should not be combined, because of the different methodologies.

For the majority of countries, access rates between these two methods are similar, but not in large countries, including Indonesia and Pakistan.

Estimating missing values

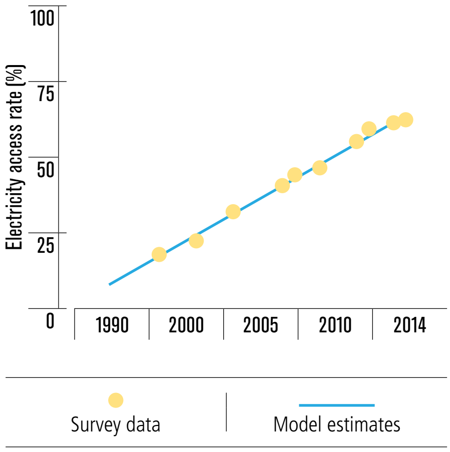
Relatively few countries conduct surveys annually. Depending on the national context, surveys can be irregular and infrequent, leaving data gaps. A multilevel nonparametric modeling approach, developed by WHO, was adapted to electricity access and used to fill in the missing data points for 1990–2014. In this approach, time series comprise survey data and estimates. Bangladesh, for example, had 10 surveys in 1994–2014 comprising demographic and health surveys, multi-indicator

Table A2.1 Overview of data sources for electricity

Name	Entity	Electricity		
		Number of countries	Number of survey	Question
Census	National statisitcal agencies	62	100 (13%)	Is the household connected to an electricity supply? Or does the household have electricity?
Demographic & health survey	USAID funded ICF International implemented	82	221 (29%)	Does your household have electricity?
Living standards measurement survey, income expenditure survey, or other national surveys	National statistical agencies supported by the World Bank	77	177 (23%)	Is the house connected to an electricity supply? Or what is your primary source of lighting
Multi-indicator cluster survey World Health survey	UNICEF World Health Organization	23 8	27 (4%) 8 (1%)	Does your household have electricity?
Other		13	12 (2%)	

Note: USAID, United States Agency for International Development; UNICEF, United Nation Children's Fund.

Figure A2.1 Survey data and model estimates for Bangladesh



Source: GTF

cluster surveys, and other national surveys; the remaining 15 years are filled in with estimates (figure A2.1). Multilevel nonparametric modelling takes into account the hierarchical structure of the data: survey points are correlated within countries, which are then clustered within regions. Time is the only explanatory variable; no covariates are used. The model is applied for all countries with at least one data point. However, to use as much real data as possible, results based are reported in their original form for all years available. The statistical model is used only to fill in data for years where they are missing.

This methodology differs from the approach applied in GTF 2015, when survey data ranging around the reference years 1990, 2000, 2010, and 2012 were used to establish a simple time series with four data points, so a survey for a given reference year was not necessarily taken in that year. Further, missing data in this earlier series were estimated using simpler linear model. The new approach was chosen to improve precision and allow for more comprehensive annual tracking. However, the values reported in GTF 2015 and the estimation using the new model yield similar results (table A2.2).

An important implication of the new approach is that all estimated values will change slightly when the model is re-run each year with the new data points released for that year. The reason is that the new data points affect the overall trend line.

Table A2.2 Comparison of GTF 2015 and GTF 2017 results

Access rates (%)		1990	2000	2010	2012	2014
Total	GTF 2015	75.6	79.3	83.2	84.7	
	GTF 2017	73.5	77.6	83.6	85.0	85.3
Urban	GTF 2015	94.2	95.2	94.9	96.1	
	GTF 2017	94.4	94.7	96.2	95.9	96.3
Rural	GTF 2015	60.8	64.2	70.3	71.8	
	GTF 2017	61.6	63.1	70.2	72.9	73.0

ANNEX III: ASIA-PACIFIC RENEWABLE ENERGY TARGETS

Table A3.1 Recent national renewable energy targeted shares and capacities

Country	Target Shares	Policy Document
Armenia	Renewable account for 21% of total power generation by 2020, and 26% by 2025.	Scaling Up Renewable Energy Program: Investment Plan for Armenia
Australia	23.5% of the country's electricity from renewable sources by 2020.	Plan for a Cleaner Environment
Bangladesh	10% of total electricity generation from renewable resources by 2020.	Seventh Five Year Plan FY2016 – FY2020
Brunei Darussalam	10% of the total power generation from renewable energy by 2035.	Nationally determined contributions
Cook Islands	100% renewable electricity by 2020.	Nationally determined contribution
Fiji	Renewable energy share in electricity generation to approach 100% by 2030.	Nationally Determined Contributions
Indonesia	23% new and renewable energy by 2025.	Government Regulation Number 79/2014 Concerning the National Energy Policy
Lao People's Democratic Republic	Increase the share of renewable energy to 30% of energy consumption by 2025.	Nationally determined contribution
Kazakhstan	Share of alternative sources (solar, wind, hydro and nuclear) in electricity generation to reach 30% by 2030.	Concept on Transition towards Green Economy until 2050
Kiribati	60% grid connected renewable energy by 2025.	Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management
Marshall Islands	Share of installed power generation capacity from indigenous renewable energy target to reach 20% by 2020.	National Energy Policy and Energy Action Plan
Malaysia	Electricity generation capacity through renewable sources including biomass, biogas, solar photovoltaics, , and mini hydro are targeted to reach 7.8% of total installed capacity in Peninsular Malaysia and Sabah by 2020.	Eleventh Malaysia Plan 2016-2020
Maldives	Provide 30% of daytime peak load of electricity demand in all inhabited islands through renewable sources.	National Biodiversity Strategy and Action Plan 2016-2025
Marshall Islands	20% of power generation from indigenous renewable resources by 2020.	National Energy Policy and Energy Action Plan
Micronesia (Federated States of)	At least 30% of total energy production from renewables by 2020.	2012 Energy Policy
Mongolia	20% renewable electricity generation capacity by 2020 and 30% by 2030.	Nationally Determined Contributions
New Zealand	90% renewable generation by 2025.	New Zealand Energy Strategy 2011–2021
Niue	80% renewable energy generation by 2025.	Niue Strategic Energy Road Map 2015–2025
Pakistan	At least 5% of total commercial energy supplies through alternative and renewable energy by 2030.	Alternative and Renewable Energy Policy
Palau	20% of electrical generation from renewables by 2020.	Palau National Energy Policy
Papua New Guinea	Promote 100% electricity usage from renewable energy sources by 2050.	National Energy Policy 2016-2020
Republic of Korea	11% new and renewable primary energy supply by 2035.	Fourth Basic Plan for New and Renewable Energies
Russian Federation	Share of renewable energy power plants 16-17% by 2020, 19% by 2030.	State Program on Energy Efficiency and Power Sector Development, 2013-2020

Country	Target Shares	Policy Document
Samoa	100% renewable electricity generation by 2025.	Nationally determined contributions
Singapore	Renewable energy could potentially contribute up to 8% of peak electricity demand.	Nationally determined contribution
Solomon Islands	50% renewable energy use for power generation by 2020.	Solomon Islands National Energy Policy and Strategic Plan, Volume 4; Renewable Energy Strategy and Investment Plan
Sri Lanka	60% electricity generation from renewable energy by 2020.	Sri Lanka Energy Sector Development Plan for a Knowledge-based Economy 2015-2025
Thailand	Renewable energy to replace 30% of final energy consumption by 2036.	Alternative Energy Development Plan 2015
Timor-Leste	At least half of energy needs will be provided by renewable energy by 2020.	Strategic Development Plan 2011-2030
Tonga	50% of electricity generation from renewable sources by 2020, 70% by 2030.	Nationally determined contributions
Tuvalu	100% renewable energy consumption by 2025.	Te Kakeega III: National Strategy for Sustainable Development 2016 to 2020
Vanuatu	Percentage of grid-based electricity from renewable sources to reach 65% in 2020 and 100% in 2030.	Updated National Energy Roadmap
Viet Nam	Increase the share of electricity produced from renewables (excluding large- and medium-scale and pumped- storage hydropower) to 7% in 2020 and over 10% in 2030.	Decision 428 / QD-TTg: Approval of the Revised National Power Development Master Plan for the 2011-2020 Period with the Vision to 2030
Bhutan	5000 MW of installed hydropower by 2020.	Economic Development Policy
China	By 2020, installed capacity targets include: 340 million kilowatts of conventional hydropower; more than 210 million kilowatts of wind power, of which about 5 million kilowatts are offshore wind power; 110 million kilowatts of solar power, of which distributed photovoltaic represents more than 60 million kilowatts; 15 million kilowatts of biomass power generation installed capacity.	Thirteenth Five-Year Plan for Energy Development
Japan	More than 300 billion kWh of renewable energy, 190 billion kWh excluding hydropower, by 2030.	Innovative Strategy for Energy and the Environment
Nepal	By 2030, have installed 12,000 MW of hydroelectricity; 2,100 MW of solar energy; 220 MW of electricity from bio-energy.	Nationally determined contribution
Philippines	15,304 MW of installed renewable capacity by 2030.	National Renewable Energy Programme

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In 2011, the Sustainable Energy for All (SEforAll) initiative was launched to pursue three major objectives by 2030: ensure universal energy access to modern energy services; double the global rate of improvement in energy efficiency; and double the share of renewable energy in the global energy mix. The Global Tracking Framework (GTF), first published in 2013, supports the tracking of progress, and is co-led by the World Bank/the Energy Sector Management Assistance Program (ESMAP) and the International Energy Agency (IEA). In an effort to bring the process closer to countries, the third most recent global report Global Tracking Framework: Progress toward Sustainable Energy 2017 was produced with the support of the United Nations regional commissions. Building upon this global report, each United Nations Regional Commission has produced their own regional version to offer expanded and more in-depth analysis.

This report, Asia-Pacific Progress in Sustainable Energy, offers an evidence-based look at progress at regional and national levels. It provides an overview of long-term trends in energy access, energy efficiency, and renewable energy since 1990, and focuses on progress achieved in the most recent period, 2012–2014. Furthermore, the key drivers behind progress are reviewed, and major challenges in achieving objectives are identified. Evidence is drawn from the GTF data, as well as other international sources to provide a comprehensive view of progress in regional and national contexts. A strong focus is placed on examining national policy frameworks and offering case studies to illustrate approaches to common challenges faced by countries working to advance the sustainable energy agenda.

GTF | GLOBAL TRACKING FRAMEWORK

Tracking progress toward sustainable energy goals

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