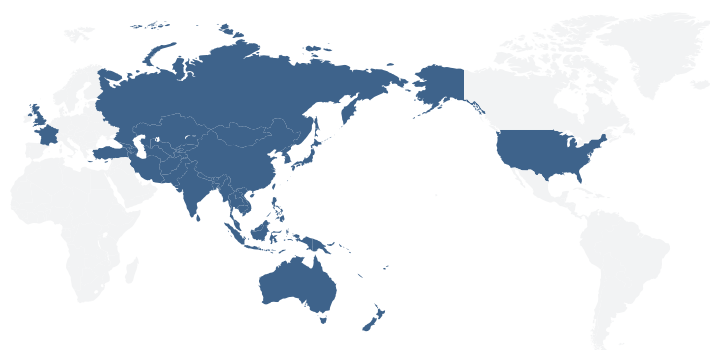


**ENERGY FOR
SUSTAINABLE
DEVELOPMENT**
in Asia and the Pacific



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2016 REGIONAL TRENDS REPORT

ENERGY FOR
SUSTAINABLE
DEVELOPMENT
in Asia and the Pacific



The countries of Asia and the Pacific are in the midst of an unprecedented energy transition. Driven by sustained economic growth over three decades, energy demand in Asia and the Pacific has been rising fast. Total final energy consumption in the region grew faster than that of the world between 1990 and 2014, reaching 45.9 per cent of the global total by 2014. At the same time, over 400 million people in the region, mostly in rural areas still lack access to electricity. In recent years, some of the negative externalities from energy generation and use have become more serious. Severe air pollution is a major cause of premature mortality in many of Asia's cities and the region's growing energy related greenhouse gas emissions are contributing to global climate change. Meeting the rising demand for energy, providing universal energy access and achieving this in a way that supports enhanced security, development, health and climate aspirations is a key challenge for the region.

The Regional Trends Report on Energy for Sustainable Development in Asia and the Pacific provides perspectives on a series of issues which influence achievement of the 2030 Agenda for Sustainable Development, in particular Goal 7 on ensuring access to affordable, reliable, sustainable and modern energy for all. The Report identifies key data and challenges, while presenting selected case studies, which can serve as a basis for regional energy cooperation initiatives. The Report also forms one of the main pillars for implementation of the Plan of Action on Regional Cooperation for Enhanced Energy Security and the Sustainable Use of Energy in Asia and the Pacific 2014-2018, adopted by Ministers at the first Asian and Pacific Energy Forum (APEF) in 2013 through the APEF Ministerial Declaration and the Plan of Action. The Report therefore also incorporates a regional snapshot of progress on the APEF's Regional Plan of Action.

In this context, the Report offers perspectives on energy solutions for improving access and promoting diversification towards clean and low carbon alternatives under two main topics, which were selected in consultation with member States at the annual policy dialogues: (a) Transboundary Power Trade for Increasing Power Sector Sustainability and Regional Connectivity; and (b) Developing Effective Policies for Widening Access to Energy Services.



There remains great potential for further interconnection of power grids and increased transboundary power trade as a key component of regional economic integration. In order to meet the projected increases in electricity demand, transboundary power trade will prove essential due to its ability to link dispersed supply and demand centres while also effectively integrating sizeable shares of renewable generation, which will play an increasing role in power generation.

Providing modern energy services to communities in remote areas provides multidimensional benefits that include economic opportunities, gender equality, livelihood enhancement and environmental sustainability. Universal energy access is one target of SDG 7 and forms an essential catalyst for achieving other SDGs, such as those addressing equality, climate change, education, public health, clean water and sanitation. Widening access to affordable, reliable, and modern energy services requires working concurrently on two paths: achieving universal electricity access through both grid and off-grid solutions; and increasing access to clean cooking fuels.

The Report draws on the outcomes of two policy dialogues on energy for sustainable development for Asia and the Pacific, held in November 2015 and April 2016. The case studies presented at the dialogues are included in the Report. Future editions will provide additional case studies relevant to energy policymakers across the region.

I would like to take this opportunity to express our appreciation to those who have contributed to the publication, in particular, the Government of the Russian Federation, for supporting implementation of Commission resolution 70/9, Implementation of the outcomes of the first Asian and the Pacific Energy Forum. As one of the three pillars of the APEF Implementation Support Mechanism, it is intended that this Report will assist our member States to implement the Declaration and Plan of Action.



Shamshad Akhtar

Under-Secretary-General of the United Nations and
Executive Secretary of ESCAP

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ABBREVIATIONS, ACRONYMS AND EXPLANATORY NOTES

5P	Pro-Poor Public-Private Partnership
ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Center, Nepal
APEC	Asia-Pacific Economic Cooperation
APEF	The Asian and Pacific Energy Forum
APG	ASEAN Power Grid
ASEAN	Association of Southeast Asian Nations
ASERD	Afghanistan Sustainable Energy for Rural Development
BAU	Business as usual
BOM	Build-Own-Maintain
BOOM	Build-Own-Operate-Maintain
BOO	Build-Own-Operate
BOT	Build-Operate-Transfer
BOOT	Build-Own-Operate-Transfer
BM	Build-Maintain
BRICS	Brazil, Russia, India, China and South Africa
CASA-1000	Central Asia-South Asia Electricity Transmission and Trade Project
CEER	Council of European Energy Regulators
CERs	Certified Emission Reductions
COP 21	21st Conference of Parties
ECA	Economic Commission for Africa
EPC-CIS	Electric Power Council of the Commonwealth of Independent States
ESCAP	The United Nations Economic and Social Commission for Asia and the Pacific
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Programme
EVN	Viet Nam Electricity
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gases
GMS	Greater Mekong Subregion
GW	Gigawatt
GWh	Gigawatt hour
HELE	High-efficiency Low-emissions

HPS	Husk Power Systems
IDCOL	Bangladesh Infrastructure Development Company Limited
IEA	International Energy Agency
IFC	International Finance Corporation
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contribution
IPP	Independent Power Producers
IRENA	International Renewable Energy Agency
KW	Kilowatt
KWh	Kilowatt hour
LDCs	Least Developed Countries
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MDBs	Multilateral Development Banks
Mtce	Million Metric Tons of Coal Equivalent
MW	Megawatt
MWh	Megawatt hour
NGOs	Non-governmental organizations
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of Petroleum Exporting Countries
PLF	Plant Load Factor
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
QTP	Qualified third party
REC	Renewable Energy Certificate
ROI	Return on investment
RTR	Regional Trends Report
SAARC	South Asian Association for Regional Cooperation
SAMOA	Small Island Developing States Accelerated Modalities of Action
SAPP	Southern African Power Pool
SASEC	South Asia Subregional Economic Cooperation
SDG	Sustainable Development Goal
SE4All	Sustainable Energy for All

SEM Single Electricity Market

SIDS Small Island Developing States

SMEs Small and medium-sized Enterprises

SNV Netherlands Development Organization

SREP Scaling up Renewable Energy Programme

SURE Sakhi Unique Rural Enterprise

TAGP Trans-ASEAN Gas Pipeline

TPES Total Primary Energy Supply

TVEs Town and Village Enterprises

TW Terawatt

TWh Terawatt hour

UNCDF United Nations Capital Development Fund

UNDESA United Nations Department of Economic and Social Affairs

---

UNDP United Nations Development Programme

VRE Variable Renewable Energy

VERs Verified Emissions Reductions



EXECUTIVE SUMMARY

This report reviews emerging and persistent issues for Asia and the Pacific, including the implementation of 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs), in particular the SDG 7, focusing particularly on transboundary power trade for energy connectivity and energy access. As one of the three pillars of the Implementation Support Mechanism for the Asian and Pacific Energy Forum (APEF), this report also supports the implementation of the outcomes of the APEF 2013. An overview of the implementation status of the 15 areas of action is provided, to contribute to the final review and prepare for the second APEF, to be held in 2018.

The newly adopted 2030 Agenda for Sustainable Development, in particular SDG 7 on access to affordable, reliable, sustainable and modern energy for all and the Paris Agreement, will shape the future of energy development.

EMERGING ENERGY ISSUES

Significant changes have taken place in the economy and the energy market in 2015. Fossil fuels have been the primary energy resources for Asia and the Pacific, accounting for more than 80 per cent of total primary energy supply. The prevailing low oil prices present both opportunities and challenges; while they help to reduce inflationary fiscal and external pressures in oil-importing countries, they affect oil-exporting countries adversely by weakening fiscal and external positions and reducing economic activity. Countries are taking the opportunity for fiscal reform to diminish fossil fuel subsidies. Regional demand for natural gas will increase, as a result of continuous economic growth, energy security concerns, and the need for diversification of energy mix and transition to cleaner energy. Pricing structure reform is becoming a critical concern, as importers in this region are paying higher prices. Notwithstanding high environmental and health costs, countries in this region continue to rely on coal because of its availability and cost-effectiveness in addressing regional energy issues. Thus, it will be necessary to transition to cleaner coal technologies that have both high efficiency and low emissions.

Despite falling prices for fossil fuel, the year 2015 set a new record for global installation and investment in renewable energy. Investment in renewables – excluding large hydro – rose 5 per cent, to \$285.9 billion globally, of which \$160.6 billion was invested in Asia and the Pacific. Globally, investment in renewable power capacity was more than double the investment in new coal and gas generation in 2015. Overall, new renewable power capacity, excluding large hydro, accounted for 53.6 per cent of the newly installed global capacity in 2015, the first time it has represented a majority of new capacity.

The newly adopted 2030 Agenda for Sustainable Development, in particular SDG 7 on access to affordable, reliable, sustainable and modern energy for all and the Paris Agreement, will shape the future of energy development.

ENERGY CONNECTIVITY AND SUSTAINABILITY

Deepening economic integration and cooperation could be beneficial to countries and instrumental in achieving key developmental goals. As energy demand rises, energy connectivity can help to meet growing energy demand and also enable countries to increase the sustainability of the energy sector. Energy connectivity can help in reducing the share of the population without access to energy services and reducing the region's carbon footprint by increasing efficiency in the delivery of energy and the sustainability of power generation. Through trading and exchange of electricity, the sustainability of power generation within the region could be greatly increased by integrating larger, more efficient generation technologies in addition to variable renewable energy.

While energy demand is forecast to substantially increase from 2010 to 2035, electricity demand is predicted to more than double, illustrating the growing role of electricity in an age when sustainability of energy has become increasingly important. Meeting this future power demand using domestic resources will become increasingly challenging. As the cost of power generation from wind and solar continues to fall and financing for renewables becomes easier to attain, the need for increased transboundary energy trade becomes increasingly clear, as interconnected grids are more flexible and thus better able to integrate variable sources of energy.

Obstacles to promoting regional integration include political, technical, regulatory, and financial barriers. No single barrier is insurmountable; however, the combination often proves difficult to overcome, as evidenced by the lack of regionally integrated power markets within Asia and the Pacific. While technical, regulatory, and financial barriers can be overcome through effective policy, this requires political will, which can be challenging due to numerous factors. Energy security concerns have led some countries to discourage the expansion of transboundary power trade – e.g. through the introduction of local content requirements. Fundamentally, a shift is needed, from the idea that energy security requires self-sufficiency of domestic energy supply towards the principle that energy security requires diversity and redundancy of domestic energy supply through both maximization of domestic supply and fluid trade with regional suppliers. Stable policy environments with long-term predictability and favourable investment conditions to minimize risk are needed to attract international investment.

In order to effectively move forward with energy connectivity within Asia and the Pacific so that technical, legal, and regulatory standardization takes place, there is a need for an established vision shared by member States. The common challenges associated with increased transboundary power trade and the creation of an integrated regional power market can be addressed through a regional mechanism, with the goal of facilitating increased transboundary power trade through streamlining of contracts, increasing availability of financing, reducing risk and accelerating project development through building mutual trust among parties. Key aspects of this way forward include: energy interdependence; reliable energy supply; unlocking large regional renewable energy resources; mainstreaming technologies that limit carbon footprints; obtaining additional resources from the private sector; improved regional governance; and thought leadership and knowledge-pooling within the region to underpin the sustainable development of the energy sector. ESCAP offers a vital platform where governments can work together to harmonize policy and regulations and receive the technical guidance needed to build the industrial capacity to meet the growing demands of trade partners and compete on an intra-regional scale.

WIDENING ACCESS TO ENERGY SERVICES

The Asia-Pacific region includes 455 million people living without access to electricity and 2.06 billion people who rely on solid fuels for cooking and heating. Development of effective policies, streamlined institutional frameworks and innovative financing will be required for universal energy access.

Energy access is a development issue and therefore a sector-wide approach is needed, and depends on a number of enabling factors, such as financing for business, technology availability and ownership, productive activities and potential development opportunities. Moreover, policymakers need to consider the adaptation of technologies and community development over the longer term. Appropriate institutional arrangements are necessary for planning, coordinating and implementing energy access policies and programmes, expanding policy dialogue, sharing knowledge, engaging relevant partners and mobilizing financing to ensure universal energy access. A competent and responsive national institution accountable for delivering results in terms of reliability, quality and timeliness is required. Strengthening institutional capacity involves: reviewing the mandates of relevant government sectors and identifying their constraints as well as technical and financial capacities; streamlining the government sectors to promote cooperation and coordination; promoting collaboration between governments in planning and implementing; ensuring appropriate legislative frameworks; establishing an appropriate regulatory framework; developing a legal and institutional framework; and formulating policy frameworks.

Government plays a central role in planning, regulating, measuring, issuing policies, and implementation, but other stakeholders can also balance the costs and ensure long-term system operation. Building partnerships with relevant stakeholders ensures availability of appropriate energy services, promotes community ownership and responsibility, increases contributions of labour, time and other resources, and encourages participation in decision-making, planning and implementation. Furthermore, capacity-building is necessary to enhance the capability of relevant stakeholders for energy access. ESCAP's Asia Pacific Energy Portal provides a good example, offering a comprehensive view of statistical data and policy information. Similar information is needed at the national and local levels, to provide stakeholders with accurate, easily accessible and up-to-date information about the status, technology and progress of energy access, as well as existing policies and measurements. Consumer education and public awareness play an important role in transitioning to electricity access and cleaner fuels such as liquefied petroleum gas. Effective capacity-building also includes strengthening the technical or managerial capacity of private and public firms, and educating villagers and communities about productive energy uses.

Significant levels of financial resources will be needed to achieve universal energy access. To engage the private sector, Asia-Pacific countries need to have: strong financing institutions and an ecosystem that can develop and implement energy access projects; national finance architecture consisting of national development banks, commercial banks and capital markets as well as structures to lower investment risks; and policy and regulatory frameworks that are progressive and encourage private sector participation and investment.

Many countries will need to establish enabling environments that can attract financing for expanding energy access, as levels of financial market development and business sophistication vary. In addition, energy access programmes and projects will need to be conceived and developed to engage the private sector. More effort is needed to establish business models and financing structures for a transition to non-solid fuels for thermal energy. The financing challenge is likely to be significant in this area, due to limited government policies and the absence of models and track records. Including productive use opportunities while considering investments and taking a regional and programmatic approach could result in better utilization of energy for sustainability and for rural and local development. Financing to

support productivity increases and expansion of existing economic and social development opportunities could be included as part of the energy access programmes in Asia and the Pacific.

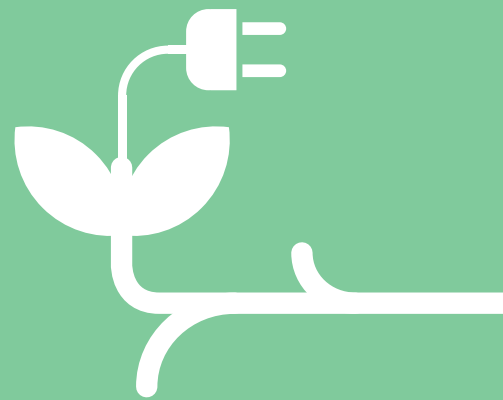
Potential alternative financing mechanisms also exist. Reallocation of public finance is one possibility, as current government expenditure on energy subsidies primarily supports production and consumption of fossil fuels, and only a minimum amount of this expenditure reaches the poorest populations. Labelling domestic or international debt as “green bonds” in mature financial markets could be an option since Asia and the Pacific has a large bond market and green bond issuances have a potential to grow. Climate finance from the Global Environmental Facility, the Green Climate Fund and the Paris Agreement offers financial sources for energy access in Asia and the Pacific, especially for least-developed countries, landlocked developing countries and Small Island Developing States. As an emerging financing mechanism, crowdfunding has supported more than 300 renewable energy projects. If integrated into policy and institutional frameworks, crowdfunding could provide significant supplementary resources for supporting universal energy access in Asia and the Pacific. Remittances from migrating workers offer a steady and significant finance stream, which could supplement public and private resources to finance energy access investments. To what extent these sources of finance could be utilized for energy access and how these sources can be mobilized needs to be further studied. Creating an enabling policy environment and streamlining institutional capacity among governmental agencies would be a prerequisite.

REVIEW OF THE APEF 15 AREAS FOR ACTION

The Asia-Pacific region is making notable progress across the APEF 15 areas for action, expanding access to energy, achieving greater levels of efficiency, increasing modern renewable energy production, forging new energy trade agreements, improving infrastructure and technology, and making better use of fossil fuels. On many fronts, the region is leading global trends. However, achievements are varied at national levels, and accelerating progress will require strengthened policy frameworks, market reforms, increased investment and technology uptake, and new means of cooperation among member States. Many nations, particularly those at lower levels of development, struggle with the short-term objectives of meeting basic energy needs, while others have established longer-term plans to improve the overall sustainability of energy supply and use. Given the wealth of regional experience in addressing the many common challenges within the energy sector, increasing knowledge exchange offers an opportunity to hasten progress at national and regional levels.

THE WAY FORWARD

With energy demand in Asia and the Pacific forecast to increase by 60 per cent from 2010 to 2035, access to reliable and adequate energy services will remain a focus for decades to come. Renewable energy is a sustainable and long-term solution to enhancing energy supplies but requires careful calibration and management. The development of renewable generation and cross-border connectivity through regional cooperation can contribute to greater energy security and offer lower risks from fuel supply disruptions and geopolitical uncertainties. Since new power transmission infrastructure may last a century or so, it should be designed and located in such a way so as to provide a conduit for future “green electrons”, facilitating the renewable energy plants of the future.



INTRODUCTION

REPORT STRUCTURE AND AIMS

The Regional Trends Report on Energy for Sustainable Development in Asia and the Pacific is an annual publication that feeds into the Policy Dialogue to serve as an input for discussions on identifying potential policy solutions, through regional cooperation, to the challenges identified and analysed. The 2015 Regional Trends Report on Energy for Sustainable Development in Asia and the Pacific was the first publication under APEF. It covers three main areas that were pre-selected by ESCAP member States: (a) the Asia-Pacific energy scene; (b) integration of variable renewable energy (VRE) into electricity systems; and (c) promotion of high-efficiency, low-emissions (HELE) coal technologies in power generation, which were relevant to 5 of the 15 areas for action contained in the APEF Plan of Action.

Development of the 2016 Regional Trends Report on Energy for Sustainable Development in Asia and the Pacific follows a similar process to the 2015 Report: consultation with ESCAP member States for topic selection, case study collection and review; discussion with experts on thematic areas; and engagement of consultants on specific research. The 2016 Regional Trends Report consists of two parts. Part I (Chapters 2, 3, 4 and 6) discusses emerging energy issues in the global market and Asia-Pacific region and two pre-selected topics by ESCAP member States: (a) transboundary power trade for increasing power sector sustainability and regional connectivity; and (b) developing effective policies for widening access to energy services. Part II (Chapter 5) provides an overview of the implementation of the 15 areas of action, which will contribute to the final review of the outcomes of the APEF 2013 and preparation for the second APEF, to be held in Tonga in 2018.

BACKGROUND OF THE REGIONAL TRENDS REPORT

The first Asian and Pacific Energy Forum (APEF) was organized in May 2013 in Vladivostok with the support of the host government of the Russian Federation. APEF was the first ministerial conference convened by the United Nations that focused specifically on energy. Its purpose is to promote regional cooperation for enhanced energy security and the sustainable use of energy.

The Ministerial Declaration and Plan of Action adopted at the first APEF were aligned to the goals of the Sustainable Energy for All (SE4All) Initiative. The vision of the Plan of Action is to ensure that: (a) sustainable energy for all is a reality; (b) enhanced energy security from regional to household levels is present; (c) an energy future of equity, diversification and access for all is secured; and (d) the share of cleaner energies in the overall energy mix is increased.

In 2014, the ESCAP Commission adopted Resolution 70/9, endorsing the outcomes of APEF 2013 and mandating the ESCAP secretariat to support the implementation of the Plan of Action, to periodically review the progress leading up to the next APEF in 2018 and to collaborate on regional cooperation. An APEF Implementation Support Mechanism has been developed to meet this mandate and consists of three pillars: **Data & Policy Information Portal; Policy Dialogue; and Analysis & Reporting**. The Mechanism is solution-driven, with expected outputs in the form of multilateral policy initiatives.

REGIONAL GLOBAL LINKAGES: SUSTAINABLE ENERGY FOR ALL AND THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT



ESCAP is committed to supporting member States in defining and responding to sustainable development priorities in areas of energy through regional cooperation and to ensure that work programmes on energy contribute to the implementation of SE4All and the 2030 Agenda for Sustainable Development – in particular Sustainable Development Goal 7 (SDG 7), which is to “ensure access to affordable, reliable, sustainable and modern energy for all”. SDG 7 has the following targets:

- 7.1 By 2030, ensure universal access to affordable, reliable and modern energy services;
- 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix;
- 7.3 By 2030, double the global rate of improvement in energy efficiency;
- 7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil fuel technology, and promote investment in energy infrastructure and clean energy technology;
- 7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least-developed countries, small island developing countries, and land-locked developing countries, in accordance with their respective programmes of support.

Together with the Asian Development Bank (ADB) and the United Nations Development Programme (UNDP), ESCAP leads the Asia-Pacific hub of the global network to facilitate and coordinate implementation of the SE4All Initiative at the regional level. The hub supports countries in conducting rapid assessments, building constructive dialogue on policy, and catalysing investments and mobilizing bilateral and global funds for clean energy development. ESCAP aims at energy security and sustainable energy development by fostering subregional and regional cooperation on energy access, energy efficiency and renewable energy development. ESCAP is the secretariat for UN-Energy Asia-Pacific, a part of the global coordination group UN-Energy, which coordinates, improves and initiates partnerships between countries, the United Nations and all development partners. ESCAP initiated a regional framework for the Asian Energy Highway, as well as the Pacific Regional Data Repository for SE4All, and developed the Pro-Poor Public Private Partnerships model for widening access to energy services. In addition, APEF facilitates regional promotion of sustainable energy policies, projects, and good practices developed at the subregional and country levels and supports the recognition of SE4All-related national actions by the governments in the region.

Chapter 2 *reviews emerging and persistent issues in the global energy market and in the Asia-Pacific region.* It discusses the impacts of declining international oil prices and strategies of ESCAP member States, the increasing demand for natural gas and need for pricing structure reform, the environmental concerns over coal consumption in developed countries and continuing reliance on coal by developing countries, and the development of renewable energy. It captures the status of regional cooperation on energy connectivity and highlights the importance of incorporating social, environmental and economic dimensions into energy development.

Chapter 3 *discusses the benefits of, barriers to, and strategies for transboundary power trade and interconnection and explores the potential of regional energy connectivity to meet broader energy goals within the framework of the 2030 Agenda for Sustainable Development.* Through connecting regions with diverse energy resources and generation and consumption patterns, transboundary power trade can enhance economic cooperation and environmental protection. However, political, technical, regulatory and financial barriers must be addressed in order to realize these benefits. Chapter 4 also provides an overview of the ongoing energy connectivity initiatives in Asia and the Pacific.

Chapter 4 *focuses on developing effective policies for widening access to affordable, reliable, sustainable and modern energy services.* The importance of universal energy access has been well recognized by member States and highlighted in the 2030 Agenda for Sustainable Development. In the process of increasing access to electricity and access to clean cooking fuels, this chapter emphasizes the central role of policy and institutional frameworks, as well as the need for mobilizing and engaging financing. From a development perspective, universal energy access needs to not only meet basic energy needs but provide opportunities that will engage community development, improve social welfare and generate economic benefits.

Chapter 5 provides a review of the 15 Areas for Action as established in the APEF Plan of Action, including:

- A. Establishment of a platform for facilitating continuous dialogue and cooperation among ESCAP member States on enhanced energy security and the sustainable use of energy
- B. Work towards universal access to modern energy services;
- C. Advance the development and use of new and renewable sources of energy;
- D. Improve energy efficiency and conservation and observe sustainability in the supply, distribution and consumption of energy;
- E. Diversify the energy mix and enhance energy security;
- F. Improve energy trade and investment opportunities to optimize the development and utilization of current and emerging energy resources;
- G. Improve fiscal policy and financing mechanisms to incentivize and strengthen markets for sustainable energy;
- H. Improve energy statistics and facilitate data and information sharing;
- I. Minimize the environmental impact of the energy sector;
- L. Promote expanded production, trade and use of natural gas as a low-emission fuel;
- N. Develop common infrastructure and harmonized energy policies with a view to increasing regional economic integration;
- O. Promote capacity-building, education and knowledge-sharing in the field of energy.

Chapter 6 concludes the 2016 edition of the Regional Trends Report on Energy for Sustainable Development by *describing how development trends for next decade will focus on implementation of the 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change, which align well with the 15 Areas for Action of the APEF Implementation Mechanism*. It also outlines the way forward for transboundary power trade and widening energy access, as part of the overall energy transition taking place within region.



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ENERGY SCENE AND EMERGING TRENDS IN ASIA AND THE PACIFIC

KEY MESSAGES



- Significant changes have taken place recently in the global economy and the international energy market. The prevailing low oil prices present both opportunities and challenges for countries in Asia and the Pacific. Oil-importing countries are taking the opportunity to reform fossil fuel subsidies, from which government savings could be re-allocated to sustainable infrastructure construction.
- Demand for natural gas is likely to increase in Asia and the Pacific through 2020, due to continuous economic growth, diversification of energy supply and transition to cleaner fuel sources. Consumers in Asia and the Pacific are paying higher prices for natural gas than elsewhere, and pricing structure reform is becoming a critical area of concern for countries in region.
- Coal has been and will continue to be an important fuel for the Asia-Pacific region. It currently dominates power generation and will continue its role in the foreseeable future. The challenge of increasing environmental concerns and continuing reliance on coal requires a transition to cleaner coal HELE technologies.
- Despite low fossil fuel prices, renewable energy investment and installation reached a historical high in 2015, due to the declining cost of renewable energy technologies, and concerns over environmental sustainability, climate change and energy security.
- The importance of energy connectivity, with its potential of optimizing the use of all energy resources, connecting energy supply to demand centres, and facilitating energy security, sustainable use of energy and economic integration, has been well recognized in the region. Emerging new initiatives on regional energy connectivity are shaping the energy scene of the region.
- Energy is a fundamental and cross-cutting issue for development. Achieving SDGs and mitigating climate change, as well as breaking the energy-poverty nexus, will require incorporating the social, economic and environmental dimensions of energy development.

OVERVIEW

Significant changes have taken place recently in the global economy and the international energy market. Both global and regional economies face declining growth rates. The Asia-Pacific region grew by 4.5 per cent in 2015, the lowest rate since 2010 (ESCAP, 2016a), and only a modest rebound has been forecast, to 4.8 per cent in 2016 and 5 per cent in 2017 (ESCAP, 2016b). While the growth rate is still higher than the world average, economic slowdown is a major factor influencing the growth prospects and energy profile of this region.

Fossil fuels have been and will continue to be the primary energy sources in the region, while renewable energy investment and installation reached historic highs in 2015. The share of fossil fuels in TPES accounted for 80.0 per cent in 2000 and 85.6 per cent in 2013. The share of oil decreased from 30.0 to 23.6 per cent, natural gas remained at the same percentage and coal increased from 32 to 44 per cent. The share of nuclear energy was reduced from 4.0 to 1.9 per cent, hydro increased from 1.7 to 2.1 per cent and renewable energy (excluding hydro) decreased from 14.2 to 10.4 per cent (Asia Pacific Energy Portal, 2016). The prevalent low oil prices, demand for cleaner fuel and increasing reliance on coal generation all contribute to the ongoing domination of fossil fuels expected in the region in the foreseeable future.

The role of energy connectivity, which optimizes and compliments the use of energy resources and links energy supply to demand centres, has been well recognized in Asia and the Pacific. A number of emerging, as well as existing, regional and subregional initiatives are underway in the region. These initiatives will bring opportunities and challenges for regional and subregional energy cooperation and economic integration.

Energy is a cross-cutting and fundamental issue for development. Regional energy security and sustainable use of energy must incorporate the social, economic and environmental dimensions of energy development. SDG 7 of the 2030 Agenda for Sustainable Development requires participants to “ensure access to affordable, reliable, sustainable and modern energy for all”. The Paris Agreement on Climate Change aims at keeping the rise of global average temperatures below 2°C, relative to pre-industrial levels, and the energy sector plays a major role in GHG emission reduction.

This chapter discusses emerging trends on the international energy market and the implications for the Asia-Pacific region, regional cooperation on energy connectivity, and incorporation of social, economic and environmental aspects into energy development.

EMERGING TRENDS ON THE INTERNATIONAL ENERGY MARKET

IMPACT OF LOW OIL PRICES

The prevalent low oil prices present both opportunities and challenges for countries in Asia and the Pacific. International crude oil prices have dropped significantly since 2014; the Brent spot price dropped from \$111.8 per barrel in June 2014 to \$47.8 per barrel in January 2015, rebounded slightly in early 2015, dropped further to \$30.7 per barrel in January 2016 and climbed to \$38.21 per barrel in March 2016 (EIA, 2016a).

The overall impact of falling oil prices will depend on the nature of oil dependence in the given economies. Lower prices will support activity and reduce inflationary, external and fiscal pressures in oil-importing countries, but will affect oil-exporting countries adversely by weakening fiscal and external positions and reducing economic activity (World Bank, 2015). Low international oil prices will boost domestic demand in most countries in the region and provide policymakers with a unique opportunity to push fiscal reforms on energy, which will raise revenues and reorient public spending toward infrastructure and other productive uses, especially in Cambodia, Lao PDR, the Philippines, Thailand and the Pacific island countries (World Bank, 2015). These reforms can improve this region's competitiveness and help the region retain its status as the world's economic growth engine. For many developing countries in this region that depend on imported fossil fuels, ADB estimated an additional 0.5 per cent growth in 2015 GDP if oil prices remained low (ADB, 2014). In fact, energy subsidy reform has emerged as one of the most important policy challenges for developing Asian economies, as expenditures on fossil fuel subsidies impose a huge burden on government budgets (ADB, 2015a). Countries such as India, Indonesia, Malaysia and Thailand are taking the opportunity of lower oil prices to diminish fossil fuel subsidies, cutting the incentive for wasteful consumption (IMF, 2015a). In India, the petrol subsidy was removed in June 2010 with annual savings of \$1 billion; diesel was de-regulated in October 2014 with annual savings of \$10 billion. In Indonesia, fossil fuel subsidy reform reduced budgeted cost to below \$8 billion in 2015 and is expected to reduce it to less than \$4 billion in 2016 (ADB, 2015b). Removal of fossil fuel subsidies is projected to have significant impact on GDP and the energy sector, with the savings reallocated to the poor who are the most vulnerable to the direct and indirect impacts of higher energy prices (OECD, 2015; World Bank, 2015). However, policymakers need to make sure such reforms are credible and enduring, and the redistribution of savings is beneficial to the national economy (OECD, 2015). Governmental savings from removal of fossil fuel subsidies could be redirected to more sustainable infrastructure that supports the provision of energy access, improvement in energy efficiency and accelerated development of renewable energy.

On the other hand, the prevailing oil prices will adversely affect oil-exporting countries, such as the Russian Federation and Central Asian Republics, by weakening fiscal and

external positions and reducing economic activity, depending on the role of the energy sector in the national economy. Exporting countries should reform energy pricing to usher in fiscal policies that are more sustainable and equitable (World Bank, 2015) and take this opportunity to reinvigorate reforms to diversify economics.

On the international oil market, global demand grew by around 1.0 million barrels per day in 2014, while supply – boosted by unconventional sources from the United States – grew by 2.20 million barrels per day (OPEC, 2015). The world's two largest oil producers – the Russian Federation and Saudi Arabia – have been maintaining their crude oil output levels (Wall Street Journal, 2015). The Organization of Petroleum Exporting Countries (OPEC) reaffirmed its market share strategy at its December 2015 meeting. Crude oil prices may drop further as world powers lift sanctions on Iran; that country's oil ministry issued an order in January 2016 to increase production by 500,000 barrels a day (Bloomberg, 2016). On the demand side, slowing down of major economies significantly influenced energy demand (World Bank, 2016a; IEA, 2016). In October 2015, IMF predicted that Brent crude oil prices would be below \$50 per barrel in 2016, but with a 95 per cent confidence interval, the forecast ranges from \$28 to \$98 per barrel (IMF, 2015b). In January 2016, the World Bank cut its forecast for crude oil prices from its October 2015 prediction of \$52 per barrel to \$37 per barrel for 2016 (World Bank, 2016b). Given the many factors that could have an impact on the trends of oil prices, there is huge uncertainty associated with crude oil price forecasts (EIA, 2016b).

DEVELOPMENT OF NATURAL GAS

Demand for natural gas is expected to increase, as a result of continuous economic growth and lower oil and gas prices (IEA, 2015). Through 2020, global gas consumption is predicted to rise 2 per cent annually and usage in developing Asia (excluding China) will rise 2.9 per cent annually, to 355 bcm. Due to China's efforts to reduce emissions and its view of natural gas as a transitional fuel, its domestic demand is expected to rise 10 per cent annually to 314 bcm in 2020 (IEA, 2015). In Asia and the Pacific region, Japan and the Republic of Korea have traditionally been large natural gas buyers, as they use natural gas to make up for power lost from their nuclear energy sectors (Reuters, 2013). India's future demand for natural gas is expected to grow, along with economic growth (World Bulletin, 2014).

The Russia-Central Asia-Middle East region produces 40 per cent of the world's total output of natural gas, and the United States and Canada account for 30 per cent of global production (China National Petroleum Corporation, 2012). The Russian Federation alone accounts for more than one quarter of global pipeline trade. As a cleaner substitute for coal and oil, increasing natural gas demand across Asia is driving Australia, Indonesia, Iran, and Qatar to raise their output. LNG is an important form of fuel in the Asia-Pacific region. This region has an established record for LNG supply: Australia, Indonesia and Malaysia contribute over 30 per cent of global capacity and account for three quarters of global LNG trade and one third of global natural gas trade (EIA, 2016c).

Natural gas buyers in the Asia and the Pacific region are paying higher prices than elsewhere. Pricing in Japan is based on the Japan Crude Cocktail (JCC) in which LNG price is linked to

crude oil prices (with lag) through a set of complicated formulas. While natural gas prices at Henry Hub, the US natural gas benchmark, have hovered around the \$3.00–3.50/MMBtu levels, prices for contracted LNG imports into Japan have exceeded \$14/MMBtu during the same period (Middle East Institute, 2013). The declines of crude oil prices have had a significant effect on Asian natural gas prices, which are still higher than the Henry Hub prices. Natural gas prices fell 15 per cent in the fourth quarter of 2015 globally, but fell 2 per cent in Japan. By the end of 2015, compared to the U.S. gas price of \$2.1/MMBtu, Japan paid \$9.4/MMBtu for gas and \$7/MMBtu for LNG (World Bank, 2016b). Prices for natural gas are projected to fall in 2016, including large declines in Japan (-19 per cent to \$8.5/MMBtu) and Europe (-17 per cent to \$6.0/MMBtu), due to surplus supply and future oil prices (World Bank, 2016b). While traditional LNG buyers – Japan and South Korea – are sufficiently well-off to pay higher LNG prices for consistent supply and energy security benefits, other countries, including China and India, have tried to keep natural gas prices low to boost industry and economy; thus LNG has not been very competitive (The National Bureau of Asian Research, 2011).

Pricing structure reform for natural gas is becoming a critical concern for countries in the region. Many countries have expressed interest in moving towards a regional gas market-indexed price and away from an oil-indexed system for imported gas (Enerdata, 2014). In September 2014, Japan launched an LNG future contract on Japan's over-the-counter exchange; in June 2015, Singapore's Stock Exchange launched the Singapore SGX LNG index group; in July 2015, China launched the Shanghai Oil and Gas Exchange, which trades both pipeline gas and LNG. So far, trading volume has been low for these trading hubs (EIA, 2016c).

IMPORTANCE OF COAL FOR ELECTRICITY GENERATION

Coal has been, and, without major policy and investment shifts, will continue to be an important fuel for the Asia-Pacific region, which includes major coal importers – China, India, Japan and the Republic of Korea – and top coal exporters –Australia and Indonesia.

Global coal demand growth halted in 2014 for the first time since the 1990s, as a result of economic rebalancing, lowering electricity intensity, and plummeting coal-intensive industries in China, where half of the global coal is used, and a decline in OECD coal demand. IEA lowered a previous forecast of coal demand by over 500 million metric tons of coal equivalent (Mtce), to 5.814 Mtce through 2020. Half of the growth, or 149 Mtce, will occur in India, and one quarter of the growth, or 79 Mtce, will occur in the ASEAN region (OECD/IEA, 2015). Strong growth of coal use in India and Southeast Asia offset the decline, but could not match the rise seen over the last decade in China.

Coal is the major fuel for power generation in Asia and the Pacific. As of 2013, coal-fired generation accounted for 55.6 per cent of electricity production, up from 32 per cent in 1990. In absolute terms, coal-fired generation increased from 1,207 terrawatt hours (TWh) in 1990 to 6,306 TWh in 2013. In countries such as Mongolia, Kazakhstan, China, India, Australia, and Indonesia, the percentage of coal-fired electricity generation reached as high as 93, 81, 76, 73, 65, and 51 per cent, respectively, in 2013.

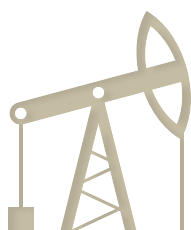
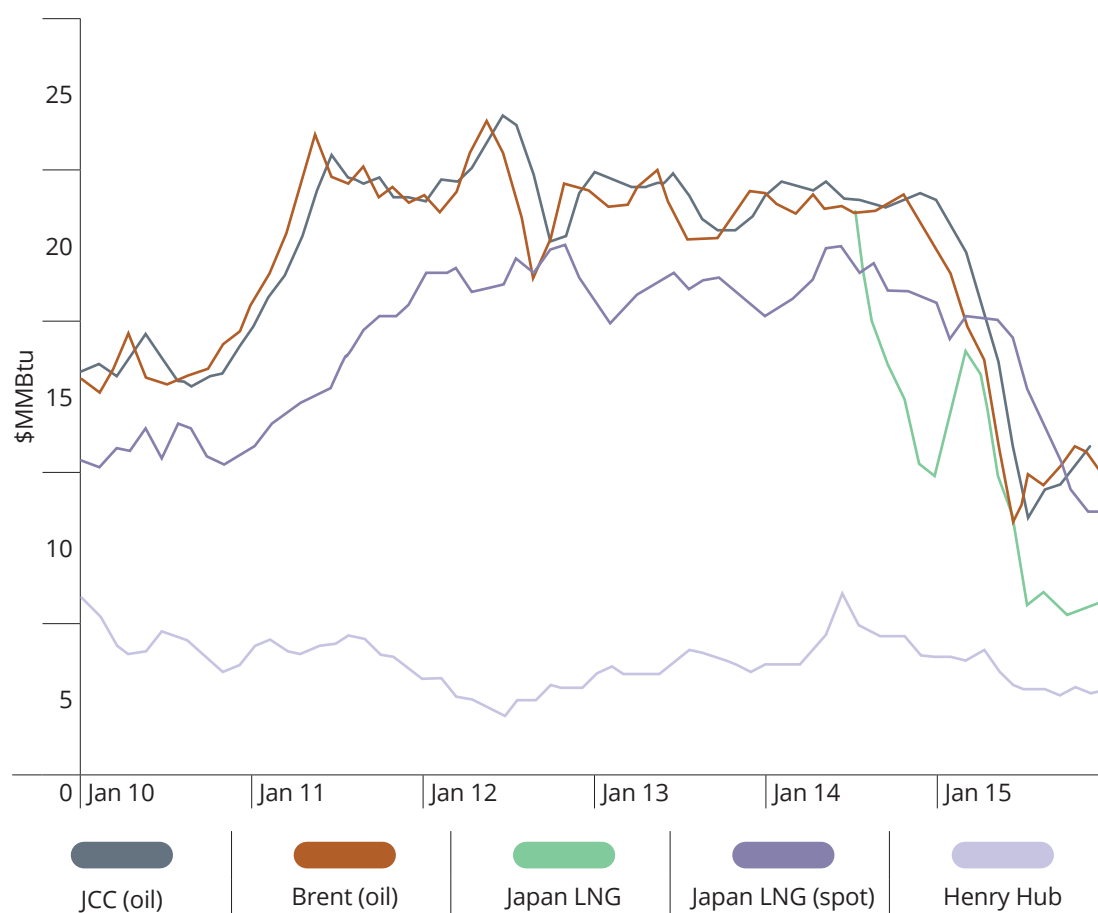


Figure 2.1 Global crude oil, LNG and natural gas prices



Note: Values for North Sea Brent and Japanese Customs-cleared crude (JCC) oil prices converted to \$/MMBtu on an energy-equivalent basis. The official reporting of Japan spot LNG price statistics began on March 2014, so no prior data exist.

Source: US Energy Information Administration, Petroleum Association of Japan, Japan Ministry of Finance International Trade Statistics, Japan Ministry of Economy, Trade and Industry, Bloomberg LP. <https://www.eia.gov/todayinenergy/detail.cfm?id=23132>

GHG emissions and other air pollutants resulting from coal combustion are a major concern. In 2012, 8 million deaths were resulted from indoor and outdoor air pollution, of which the low and middle-income countries in Asia and the Pacific had the largest share of 5.9 million deaths (WHO, 2014). The share of coal in the region's GHG emissions from fuel combustion grew from 51.5 per cent in 2000 to 62.9 per cent in 2012 (Asia Pacific Energy Portal, 2016). Right before COP21 in Paris, France ended subsidies for overseas coal-fired power stations without a carbon capture system. In a consultation meeting in September 2015, the European Commission tried to ensure that OECD member States would hold the same policy towards coal, but some member States, including Japan and Republic of Korea, are opposed to any agreement to end export credits. In fact, pressure for phasing out coal started in May 2013, when environmental groups began asking export credit agencies to end their coal investment. The World Bank and European Investment Bank both responded by putting limits on their lending for coal, as have the governments of the United Kingdom, Denmark, Finland, Norway and Sweden. The European Bank for Reconstruction & Development ended its support for coal except under special circumstances in December 2013. The United States placed similar limits on the US Export-Import Bank that month (Bloomberg, 2015).

Coal has played a critical role in bringing affordable and reliable electricity to millions of people in developing Asia. In August 2015, Indonesia pledged to significantly increase investment in coal-fired power plants (Financial Times, 2015). In Jakarta, a \$1 billion loan from ADB will finance development across the country, including Indonesia's coal-fired power plant projects, which would account for one half of the country's additional power capacity planned for the next four years (JakartaGlobe, 2016). World Coal Associations reports that many countries in the APEC region are using coal to develop their countries and will continue to do so (World Coal, 2015). Power generation for India, ASEAN countries and China is mostly dominated by coal and, considering the anticipated future economic growth in these countries, coal dominance is expected to increase in coming years despite their efforts to promote renewables and despite the slowing down of demand growth from China.

The challenge of balancing increasing environmental and health concerns and continuing reliance on coal requires a transition to cleaner coal technologies that include both high efficiency and low emissions. Raising the average efficiency of the global coal fleet from the current 33 per cent to 40 per cent, achievable with off-the-shelf technology, would save 2 gigatons of CO₂ emissions (Financial Times, 2015). Despite the fact that continued reliance on coal-fired power generation is incompatible with Paris Agreement commitments for decarbonization by mid-century, coal-fired generation currently comprises more than half of electricity production in Asia and the Pacific; as such, addressing more efficient coal-fired generation in the short-term is a necessity.

RENEWABLE ENERGY DEVELOPMENT

Despite the prevailing low fossil fuel prices, there is no evidence indicating negative impact on renewable energy development at present. In fact, global investment in renewable energy rebounded in 2014 to \$270 billion; a 17 per cent increase from 2013 (UNEP, 2015). The

year 2015 was the highest ever for renewable energy investment and installation; global investment committed to renewables (excluding large hydro-electric projects) rose 5 per cent, to \$285.9 billion, of which \$160.6 billion was in Asia and the Pacific, including \$102.9 billion in China and \$10.2 billion in India (UNEP & BNEF, 2016). In 2015, global investment in renewable energy power capacity was more than double the investment in coal and gas generation, and it was the first time that the newly added renewable power capacity – 134 gigawatts (GW) – accounted for 53.6 per cent of the additional installed capacity (UNEP & BNEF, 2016).

One reason for this is that the cost of renewable energy is declining while the long-term price of oil is uncertain. Also, oil is not a primary source for electricity generation in the Asia-Pacific region and most renewable energy utilization is for power generation. Furthermore, price is not the only driving force for renewable energy development. Concerns such as environmental sustainability, climate change and energy security as well as technology innovation also play important roles in the development of renewable energy.

In Asia and the Pacific region, the aggregate share of renewable energy in final energy demand stood at 24 per cent in 2012 – around the same as in 2010 but lower than the 1990 estimate of 36 per cent (ADB, 2015c). The share of traditional biomass has been decreasing since 1990, while other renewable energy sources are increasing (ADB, 2015c).

Distributed renewable energy technologies help to improve energy access in remote and rural areas across the developing world, which has remained a major challenge; energy poverty is acute in the region, impeding development process and economic growth (REN 21, 2015). In this region, 455 million people live without access to electricity and 2.06 billion people rely on solid fuels for cooking and heating. Rural populations in the region are deprived of energy access primarily due to unaffordability, low per capita consumption, lack of technological capacity and the high capital investment required. Distributed renewable energy technologies have a role to play in locations where off-grid systems are appropriate.

Indigenous renewable energy development is important for the Pacific island countries, as they currently rely heavily on imported fuels for commercial energy. Population of the Pacific island countries totals almost 10 million people, who rely mostly on distributed and isolated generation and have difficulty in extending the grid. In 2004, 18 Pacific island countries and territories, together with regional and international development agencies, developed the Pacific Islands Energy Policy and a Framework for Action on Energy Security in the Pacific 2010-2020. The Framework calls for increasing investment in proven renewable energy technologies (including biomass), to supplement and replace petroleum fuels as the predominant source of energy. The SIDS Accelerated Modalities of Action (SAMOA) Pathway 2014 urges relevant stakeholders to conduct technical studies and gather information on grid stability and management, including maximizing the integration of renewable energy and innovative storage mechanisms. The SAMOA Pathway call for the use of locally available sources of energy appropriate to national circumstance. In response, the Republic of Kazakhstan has partnered with ESCAP, Youth With A Mission and Secretariat for the Pacific Regional Environment Programme to pilot Biogas technology for the production of energy, income and nutrition while managing solid and water waste in a safe and useful manner. Pilots are working in three of the countries (Samoa, Tonga, and Solomon Islands) with plans to expand to the rest of the target countries by the end of 2017 with the engagement of

an additional NGO-partner organization in Micronesia. A key feature of the project is the hands-on training of and use of Pacific islander expertise for replicating the technology. The Pacific island countries have aggressive objectives for renewable energy generation; for example, Fiji aimed at increasing the share of renewable energy in electricity generation to 67 per cent by 2015, 81 per cent by 2020, and 100 per cent by 2030 and Papua New Guinea planned to reach 25 per cent of electricity generation from geothermal, wind and biomass, and 52 per cent of electricity from hydro by 2030, and to achieve 100 per cent power generation from renewable energy sources by 2050. In Pacific island countries, infrastructure relies heavily on donor funds and technical assistance, so energy agendas are heavily influenced by donors. Lack of human resource capacities, high maintenance costs, and lack of appropriate technology and know-how are also among the challenges of energy development in the Pacific island countries.

REGIONAL COOPERATION ON ENERGY CONNECTIVITY

The importance of energy connectivity, with its potential for optimizing the use of all energy resources, connecting energy supply to demand centres and facilitating energy security, sustainable use of energy and economic integration, has been well recognized in the region. Regional energy connectivity provides the physical means to support more diversified opportunities for countries to achieve energy security by accessing energy resources. ASEAN countries initiated regional cooperation on transboundary power trade and natural gas pipelines. In early 2015, SAARC countries signed a regional cooperation agreement on electricity trade so that India and Bangladesh would be able to import electricity from hydropower-rich Nepal and Bhutan. Countries in the GMS are working together on transboundary power trade.

The Russian Federation, a major energy exporter, has been driving its Pivot to the East policy to re-establish itself in the Asia-Pacific region through increased economic integration and energy trade, which will diversify its energy customer base through exporting to the Asian market, as well as developing the untapped oil and gas fields in Eastern Siberia (The Energy Collective, 2014). On the other hand, China, a major energy importer, conceptualized the Belt and Road initiative, with the aim of creating stronger integration of energy, transport, infrastructure and information along the historical Silk Road and the Maritime Silk Road. The initiative will stimulate the market, facilitate trade and unleash infrastructure development that offers huge growth potential (Global Infrastructure Initiative, 2015). Total investment is expected to reach \$1.6 trillion (Global Europe Anticipation Bulletin, 2015), while ADB estimates that there is an \$800 billion annual shortfall for infrastructure needs in Asia-Pacific countries. The newly established Asian Infrastructure Investment Bank and the BRICS New Development Bank will add to existing investments in infrastructure construction, including for the energy sector.

Energy connectivity through transboundary power trade improves reliability, secures electricity supply, reduces investments in additional generating capacity, diversifies supply sources and enhances energy access. Strengthening energy connectivity between regions or countries in Asia and the Pacific could help countries with energy and power deficits to extend the distribution network to non-electrified areas using the power available from neighbouring countries, although the cost should be evaluated against the cost of investment and operation of off-grid options such as mini-grids. Transboundary power trade is also important for improving the quantity and quality of energy services in locations which have already gained access. Electricity consumers who are in Tier 1 or Tier 2 of electricity consumption (see Annex 1) can be provided access to additional energy supplies through interconnection in order to increase energy consumption levels and to graduate to higher tiers of electricity consumption.

INCORPORATING SOCIAL, ENVIRONMENTAL AND ECONOMIC DIMENSIONS

Energy is a fundamental and cross-cutting issue for development. Regional energy security and sustainable use of energy need to incorporate the social, economic and environmental dimensions of energy development. Affordable, reliable, sustainable and modern energy services are a crucial input to supporting provision of basic needs such as food, lighting, use of appliances, water sanitation, essential health care, education, communication and transport. They are also a necessary input into income generation and fuel-productive activities such as agriculture, industries, and mining, as well as alleviating poverty, gender discrimination and inequality.

SE4ALL INITIATIVE AND THE SUSTAINABLE DEVELOPMENT GOALS

In September 2015, the 2030 Agenda for Sustainable Development and the SDGs were adopted. Goal 7 is specifically to “ensure access to affordable, reliable, sustainable and modern energy for all”, for which there are three targets:

- by 2030, ensure universal access to affordable, reliable and modern energy services;
- by 2030, increase substantially the share of renewable energy in the global energy mix;
- by 2030, double the global rate of improvement in energy efficiency.

As a basic and necessary input, energy also contributes to other SDGs. For example, low-cost, low-power technologies for cold storage and water pumping are critical for Goal 2, which focuses on food security. Goal 3 addresses improving health, for which energy access can play a role through reducing indoor air pollution from kerosene lamps and cooking fires and providing energy for health clinics. Energy use for communications and productive activities contributes significantly to Goal 8, which is to promote sustained, inclusive and sustainable economic growth. Goal 13 focuses on climate change; a large share of GHG emissions comes from fuel combustion.

These SDGs will guide the development agendas and budgets of governments, foundations, development banks and many other organizations and individuals over the next 15 years. At the regional level, ESCAP will continue to work with UN specialized agencies, funds and programmes, regional and subregional organizations, such as ASEAN, as well as development banks, such as ADB, to implement the SDGs, and will engage member States in regional cooperation for energy security and sustainable use of energy.

ENERGY AND CLIMATE CHANGE

In December 2015, COP21 in Paris brought governments together to find a new direction for keeping the rise in global average temperatures below 2°C, relative to pre-industrial levels. Although fossil fuels will still play an important role in the region for years to come, the INDCs made through the Paris Agreement serve to emphasize real and ambitious emission reductions from across the region and a commitment to transitioning to low-carbon economies.

The outcomes of the Paris Agreement saw 195 countries recognize the need to address anthropogenic climate change. This included the contribution of INDCs from 47 countries in the Asia-Pacific region, 44 of which submitted GHG emission reduction targets. Countries such as Bangladesh, Bhutan, Indonesia, Kazakhstan, the Philippines, Tajikistan, Thailand and Viet Nam committed to absolute emission reductions from BAU levels. Other significant mitigation targets in line with the 2°C target included reduction of emission intensity growth by China, India and Malaysia, and an increased share of renewables in the energy mix put forward in the INDCs of China, India, Lao PDR, and Papua New Guinea (ADB, 2016).

Energy accounts for two thirds of the world's GHG emissions. Emission reductions from the energy sector will be at the core of climate change mitigation. There are already signs of decoupling the global economy from energy consumption and emissions; in 2014, global energy-related emissions stayed flat, whereas the world economy grew by 3.4 per cent and energy consumption increased by 0.9 per cent (IEA, 2015b). Global energy intensity decreased by 1.8 per cent in 2014 and it is expected to improve by at least 27 per cent by 2030, mainly from the building sector, which will create 2 million local jobs by 2020 and save more than 40 billion US dollars (IEA, 2015b). There are huge potentials for research and innovation in renewable energy development, as current investment in renewables is still quite low compared to investment in oil, natural gas and coal (IEA, 2015b). All these factors provide the challenges to the energy sector, which needs to make deep cuts in emissions,

while sustaining economic growth, boosting energy security and providing affordable and reliable modern energy to billions of people who currently lack it (IEA, 2015b).

IEA (2015b) analysis indicates that full implementation of all INDCs will require \$13.5 trillion investment in energy efficiency and low-carbon technologies through 2030. Climate financing, to support the transition to low-carbon economies and implement adaptation measures, was a clear outcome of the Paris Agreement. Developed states committed to continue to mobilize \$100 billion per year from 2020-2025; while developing states can contribute on a voluntary basis (UNFCCC, 2015b). Viet Nam has already pledged funds to the Green Climate Fund (GCF) (UNFCCC, 2015b) and China has pledged \$3.1 billion for South-South cooperation between developing states (UNFCCC, 2015c). Additionally, contributions are expected to be supplemented by the private sector in order to overcome potential funding gaps. This financing will contribute to bridging the gap in capacity-building, and technology transfer on which many countries in the region have premised the conditionality of their INDC targets.

ENERGY – POVERTY NEXUS

Sustainable energy development improves livelihoods, alleviates poverty and brings opportunities for development. As the perspective on poverty is becoming multidimensional, energy poverty is described as lack of access to resources, denial of opportunities and lack of choice in access to energy that is adequate, safe and reliable for economic and human development (UNDP, 2012). People who live in energy poverty are deprived of development opportunities because they lack access to reliable, affordable and modern energy services, which in turn makes it difficult for the poor to pull themselves out of poverty and so the cycle perpetuates.

Without access to the services that modern energy enables, poor people remain trapped in low-productivity subsistence tasks. This inability to improve livelihoods and living standards results in poor people remaining unable to afford improved energy technologies and other critical assets and inputs that could enhance their incomes and welfare. Data from 21 countries show that lack of access to modern energy is most acute for the poorest households. As seen in Figure 2.2, for all countries, households in the median wealth quintile have far better access to electricity than those in the poorest quintile (Pachauri et al., 2013).

The poor are less likely to have access to electricity and non-solid fuel; they are generally geographically dispersed, far from urban areas, and cannot easily be connected to existing electricity grids or distribution networks for modern fuels like liquefied petroleum gas (LPG). The access issue is compounded by the fact that rural populations, whose livelihoods are typically based on agriculture, have limited disposable income to finance the initial costs of grid connection, wiring and the monthly payment of energy bills. The result is that resource-constrained utilities find the costs of extending grids prohibitive and consider such investments unattractive and risky. The poor end up paying more for the same unit of energy than other income groups. On average, 20-30 per cent of annual income in poor households is spent on energy services and fuels. In addition, these households spend

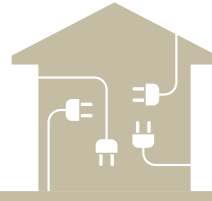
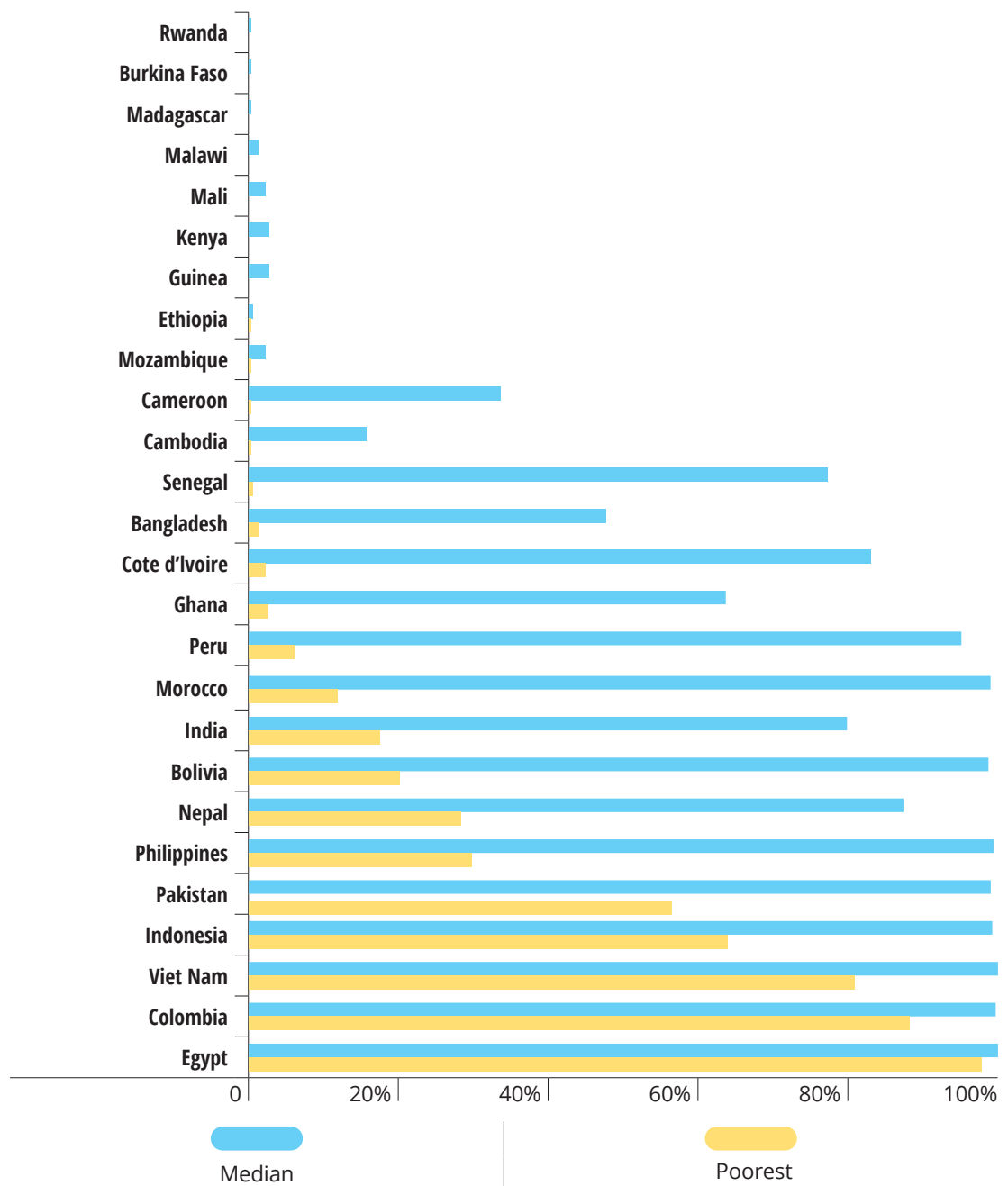


Figure 2.2 Household access to electricity for the median and poorest wealth quintiles



Source: Pachauri S., Scott A., and others (2013), Policy Guide 3. Energy Policy Guide: Energy for All: Harnessing the Power of Energy. www.chronicpoverty.org

up to another 20-40 per cent on indirect expenses associated with collecting and using that energy, such as health-care costs related to indoor air pollution and injuries linked to biomass fuel use or costs related to loss of time. Data even show that, in extreme cases, some of the poorest households spend 80 per cent of their income directly obtaining cooking fuels (Sovacool, 2013). This segment of the population also provides a market opportunity for energy service providers.

To break the energy-poverty nexus, ensuring universal access to affordable, reliable, sustainable and modern energy for all will be a prerequisite. Enabling productive use of energy that brings income-generating opportunities will facilitate poverty alleviation and help to achieve sustainable development.

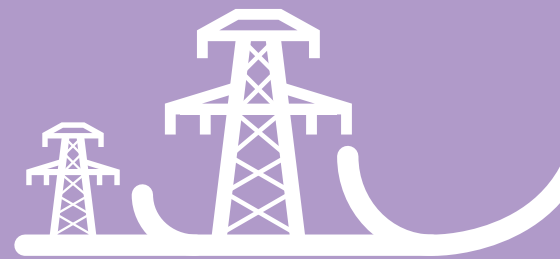
CONCLUSIONS

In the Asia and the Pacific region, fossil fuels (oil, natural gas and coal) are dominating energy sources. Total amount of oil supply in Asia and the Pacific grew from 1,019 Mtoe in 1990 to 1,604.7 Mtoe in 2014, while the share of oil in TPES for the region decreased from 30.4 per cent to 23.7 per cent (Asia Pacific Energy Portal, 2016). The supply of natural gas in the region grew from 601 Mtoe in 1990 to 1,227.6 Mtoe in 2014 while the share of natural gas in TPES almost stabilized (Asia Pacific Energy Portal, 2016). Coal as a primary source for energy supply almost tripled; from 1,067 Mtoe in 1990 to 2,939.5 Mtoe in 2014, resulted in the share of coal in TPES for the Asian Pacific grew from 31.9 to 43.4 per cent (Asia Pacific Energy Portal, 2016).

Lower prices will have significant implications for many countries. Low international oil prices provide policy makers a unique opportunity to implement reforms on energy taxes and fuel subsidies, which may raise revenues and reorient public spending toward infrastructure and other productive uses. Demand for natural gas is expected to grow in Asia and the Pacific. Reform of the pricing structure of natural gas is becoming a critical concern for countries in the region as they are paying higher prices compare to other markets. Coal has been a supporting fuel for the region. Coal is likely to continue its critical role in providing affordable and reliable electricity to countries in the region, one issue that need to be focused on is the resulted air pollution and GHGs emissions.

One good fact is that despite low international oil prices, renewable energy remains strong growth in terms of both investment and installed capacity, driven by a combined force of declining cost of renewable energy technology, concerns over environmental sustainability, climate change and energy security, and the importance to use indigenous energy resources.

The 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change will shape the future energy profile. It is recognized that energy is fundamental for sustainable development, and the social, environmental and economic aspects of energy need to be incorporated when addressing energy issues. Alleviating environmental pollutions, climate change, breaking the energy-poverty nexus, and facilitating regional cooperation on energy connectivity are all important for enhancing regional energy security and sustainable use of energy.



TRANSBOUNDARY POWER TRADE

**FOR INCREASING POWER
SECTOR SUSTAINABILITY &
REGIONAL CONNECTIVITY**

KEY MESSAGES



- With energy demand in Asia and the Pacific forecast to increase by 60 per cent from 2010 to 2035 (ADB, 2013), access to reliable and sufficient energy services along with economic development will remain a focus for decades to come. Energy system development must focus on affordability, efficiency and environmental soundness, while the policies that promote these increases must maintain a focus on sustainable and equitable development. In order to meet these criteria, transboundary power trade will become increasingly important due to its ability to link dispersed supply and demand centres while also effectively integrating sizeable shares of VRE generation, which will continue to grow as a share of power generation.
- In order to attain the long-term goal of increased sustainability of the power generation sector, near-term benefits (including economic gains) increased adequacy of electricity and increased reliability of electricity should be seen as priorities in order to convince policymakers to pursue transboundary connectivity initiatives. By linking energy supply centres with large demand centres, the power supply can increase and become more efficient, while larger balancing areas enable intermittent sources of renewable energy (such as wind and solar) to be efficiently integrated at much higher shares due to the smoothing ability of geographically diverse generation and demand centres, as well as uneven utilization patterns.
- Obstacles to promoting transboundary power trade include political, technical, regulatory and financial barriers. No single barrier is insurmountable; however, the combination often proves difficult to overcome, as evidenced by the lack of regionally integrated power markets within Asia and the Pacific. While technical, regulatory and financial barriers can be overcome through effective policymaking, this requires political will, which can be challenging due to numerous factors. Energy security concerns have led some countries to discourage the increase in transboundary trade – e.g. through introduction of local content requirements. Fundamentally, a shift in thinking is needed, from one based on the idea that energy security requires self-sufficiency of domestic energy supply towards one based on the principle that energy security requires diversity and redundancy of domestic energy supply

through both maximization of domestic supply and fluid trade with regional suppliers. Stable policy environments with long-term predictability and favourable investment conditions to minimize risk are needed to attract international investment with lower return on investment (ROI) requirements.

- In terms of implementation, understanding the benefits of and barriers to transboundary power trade is useful; however, a focused strategy for realizing energy connection is essential. Bilateral power trade agreements are the first step in moving towards a coordinated and integrated regional power pool, and should be promoted as a first step towards building trust between subregional and regional member States.
- Experience from existing integrated power markets around the world can provide lessons and best practices to be emulated in Asia and the Pacific. The Southern African Power Pool (SAPP), for example, shows that engaging in transboundary power trade through integrated power pools can be undertaken without substantial change from a domestic perspective. Countries in southern Africa have established a regional power pool without unbundling national power transmission (vertically de-integrating generation, transmission, distribution and retail sales) by simply trading excess power reserves when they are not needed to meet power demands locally. This allows for greater utilization of generation resources during times of low load in countries with adequate supply, while increasing power supply in countries lacking power, without requiring costly investment in increased generation.
- A broad regional agreement built upon subregional agreements and other existing initiatives can lay the foundation for a focused dialogue aimed at promoting regional energy connectivity and transboundary power trade. Focused and ongoing dialogue will be needed in order to ensure that benefits and costs are distributed evenly on a subregional and regional level. The establishment of a mechanism charged with monitoring and ensuring that benefits are realized while creating neutral institutions to regulate project implementation and benefits will also be essential.

OVERVIEW

Transboundary power trade is an essential aspect of regional connectivity and long-term goals within Asia and the Pacific involve reducing the region's carbon footprint through increasing the sustainability of power generation. The power generation sector continues to evolve, specifically with regard to effectively integrating increased shares of VRE within the electricity mix, although without large and diverse balancing areas, integrating higher shares of VRE becomes increasingly less feasible from an economic and technical perspective. From a near-term perspective, however, the benefits of transboundary power trade lie within the scope of increased energy security, including reliability, adequacy and flexibility, as well as economic gains associated with the generation economies of scale achievable with access to larger markets and the decreased need for generation reserve margins.

DRIVERS AND BENEFITS

Through connectivity, countries within the region can exploit the complementarities in resource endowments and seasonal/daily differences in supply and demand patterns. This would allow for the enhancement of energy security, increased economic benefits and substantial environmental benefits. The enhancement of energy security can be seen in several ways: a) improved access to existing and new generation capacities; b) increased operational efficiency and quality of transmission and distribution networks; c) reduced vulnerability to localized disruptions. The main tangible economic benefits resulting from increased regional energy trade and integration include: a) lower cost of energy supply as a result of optimized use of existing/potential primary energy resources; b) increased investment in power generation and transmission capacities facilitated by economies of scale of generation; c) reduced costs of generation due to shorter reserve margins; d) reduced dependence on expensive oil-generated power for some oil-importing countries; e) economy-wide productivity gains from improved electricity access. Regional power integration may also have significant environmental benefits, including: a) higher utilization of existing hydro and thermal capacities in the short term through replacement of traditional fuels and oil-based generation; b) establishment of larger integrated power pools allowing for greater incorporation of intermittent renewables and larger, more efficient thermal generation.

BARRIERS

Barriers to increased transboundary power trade vary by country; however, common hurdles to connectivity do exist and can be addressed with a common but differentiated strategy. This report focuses mainly on political, security, regulatory, economic and financial and technical barriers. Political barriers to be discussed revolve around: lack of political support to promote interconnections; government policy that does not support interconnections;

and national priorities that focus primarily on domestic issues without considering regional power trade and connectivity. Regulatory barriers to be discussed include: investment restrictions; trade barriers; lack of competition in the power sector; lack of stability and predictability in energy policies; and lack of a legal or regulatory framework. Regarding energy security, rather than describing how to overcome energy security as an obstacle to increased connectivity, this report presents evidence that increased transboundary power trade can lead to greater energy security, making transboundary power trade an asset rather than a liability when it comes to power adequacy and reliability. Economic and financial barriers described include: uncoordinated planning; incompatible technical standards; lack of expertise; lack of political and economic stability; cost and availability of finance; and unfavourable investor climate (i.e. ease of doing business), thereby discouraging private sector investment (E&Y Methodology). Technical barriers to be discussed include: diverse grid codes and voltages; and the presence of electricity subsidies which discourage competition.

STRATEGY

Electricity is an inherently strategic commodity, as its trade faces additional obstacles compared to other commodities due to energy security concerns. Efforts to engage in deep integrated electricity trading thus face not only technical, financial and regulatory issues, but also strong political concerns based on the energy security dilemma. Establishment of an integrated regional power market should therefore be pursued gradually and requires a broader commitment to trade and economic cooperation to create the necessary enabling environment. The establishment of bilateral or trilateral trade (through building transmission interconnectors and negotiating long-term PPAs) has proven to be a successful basis for existing integrated power pools and will be discussed through case studies.



General strategies to increase interconnection and promote bilateral power trade include:

- Previous trade agreements to promote establishment of trust that is essential for power trading.
- Development of deeply integrated trade relationships, with a range of competitive markets and regional regulatory bodies.
- Expansion of interconnectors, allowing other countries to join the network and develop short-term markets and harmonized rules, grid codes and tariffs.

Box 3.1

Increasing sustainability through connectivity - Nord Pool

Without domestic coal or hydroelectric resources or nuclear generation, Denmark sought to increase and diversify its electricity balancing area by joining three of its neighbouring countries in the creation of an international power exchange. This power exchange not only increased the availability of dispatchable capacity in Denmark, but also increased the efficiency and flexibility of each respective country's domestic grid by reducing bottlenecks and allowing electricity to flow more freely based on cost. This deregulation allowed for increasing shares of variable wind energy in Denmark due to the availability of dispatchable hydroelectric capacity as well as other sources of electricity from Finland, Norway and Sweden, in order to balance the system. This change can be seen from 1990 onwards, with 33 per cent of Denmark's electricity consumption coming from wind in 2013, up from 2 per cent in 1990.

In 1990, newly deregulated markets in the Nordic region integrated, removing cross-border tariffs and establishing a common power exchange. The combined generation capacity of geothermal, solar and wind subsequently rose from 34 MW in 1990 to 3,970 MW in 2011. This power exchange is jointly owned by the four national system operators of Denmark, Finland, Norway and Sweden and is used to trade over 70 per cent of the total consumption of electrical energy in the Nordic market (Nord Pool, 2016).

DRIVERS AND BENEFITS

INCREASING ENERGY SECURITY AND RELIABILITY

According to IEA, energy security is defined as the uninterrupted availability of energy sources at an affordable price. Energy security has many aspects and long-term energy security is mainly linked to timely investments to supply energy in line with economic developments and environmental needs. Short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance. There is no single indicator for energy security but some commonly discussed aspects include diversity of the supply mix, reliability criteria, reliance on imports from a single source and, in hydropower systems, the impact of droughts. Diverse energy systems that rely on multiple sources of primary energy are more robust when faced with shocks, constraints and crises that affect forms of supply (IEA, 2015).

Inadequate power supply imposes the burden of unserved energy costs on many countries in Asia and the Pacific. A World Bank enterprise survey revealed that companies in South Asia considered electricity to be the second most important constraint on operation and growth of businesses in the region. For instance, in 2010 Nepal experienced over 226 hours of power outages per month on average, leading to businesses losing 27 per cent of sales value. In Bangladesh, power outages have been estimated to cost the country \$1 billion and the Ministry of Finance in Pakistan estimated that the energy crisis cost the country around 2 per cent of its GDP (World Bank, 2012).

In order to pool the more costly capacity resources required to maintain reserve margins, market integration over large geographic areas can be seen as an essential tool. Ensuring access to a broader portfolio of power plants makes it easier to find the capacity needed to replace a power plant when it becomes unavailable due to a planned maintenance, unscheduled outage or safety concerns. This, in turn, reduces the cost of maintaining adequate capacity, thereby increasing the reliability of the electric system (IEA, 2014).

The adequacy of generation capability depends upon various factors, such as the installed capacity, unit size, plant reliability and demand forecasting error. Exporting countries end up with higher reserve levels, as would be expected. Reliance on imports, however, may be beneficial if there is effective regional integration, although naturally most countries would prefer not to rely solely on a single neighbouring country, as that increases the importing country's exposure (IRENA, 2013).

QUANTIFYING THE ECONOMIC BENEFITS OF MARKET INTEGRATION

According to IEA, there is little debate that integrating electricity markets offers benefits; however, very few studies quantifying these benefits are available. In order to efficiently coordinate the growing number of generators and consumers, large integrated markets have proven effective and numerous studies illustrate these potentially high benefits. When moving from fragmented markets to highly integrated markets, savings estimates range from hundreds of millions to billions of dollars per year. According to Booz & Co, in Europe the potential benefits of market integration range from \$14 billion to \$45 billion per year, or roughly 1 to 10 per cent of system costs. This also translates to a median value of \$7.8/MWh of consumed electricity (Booz & Company, 2013). According to Mott MacDonald estimates, in a report for DG Energy, operational cost savings of approximately \$3.26 billion per year and up to 40 per cent less reserve capacity requirement can be achieved through the integration of balancing markets and the exchanging and sharing of reserves (Mott MacDonald, 2013).

Gains from achieving economies of scale in power generation capital costs are also a significant aspect made possible through grid interconnection. This becomes feasible when the interconnection allows for larger power plants to be developed due to increased demand. Increasing the unit size reduces the unit investment cost, increases efficiency and reduces labour cost per kWh generated by the unit (UNDESA, 2006).

INCREASING ENVIRONMENTAL SUSTAINABILITY THROUGH CONNECTIVITY¹

As long-term goals within Asia and the Pacific focus on reducing the region's carbon footprint through increasing the sustainability of power generation, renewable energy will play a prominent role. Given this aim, as well as the current trend of increasing integration of VRE into grids and meeting INDCs agreed to at COP21, transboundary power trade can establish its role as an effective enabler of increased integration of renewable energy. In fact, several studies focused on grid integration of variable renewables enumerate the

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Box 3.2 The Single Electricity Market (SEM) in Ireland

Until the creation of the SEM in 2007, the island of Ireland was divided into two distinct electricity markets. In Northern Ireland there was a small market with approximately 700,000 customers and a peak demand of around 2000 MW, interconnected with both Scotland and the Republic of Ireland. In the Republic of Ireland, peak demand is around 5000 MW and there are around 1.8 million customers. The system has recently been connected to Wales in Great Britain. The emergence of wind as a major source of generation across the island has also significantly increased the value of interconnection. Wind now accounts for 20-25 per cent of energy generation in Northern Ireland and 40 per cent in the Republic of Ireland, with the share being much higher at certain times (Oseni, M. and Pollitt, M. 2014).

The SEM is overseen by the SEM Committee, which includes representatives from Ireland's electricity gas and water utility regulator, the Commission for Energy Regulation and other independent members. It gathers marginal cost-based bids from all generators on the island, which are then aggregated and matched to electricity demand to give a single half-hourly trading price. There is also a capacity payment. This is fixed in total each year as the total required MW forecast by the transmission system owner (which is now EirGrid for the whole of Ireland) multiplied by the cost of 1 MW of new peak capacity. This amount is then divided among generators on the basis of their half-hourly availability. The use of marginal cost-based bidding is significant because research prior to the opening of the market predicted that price-based bidding would give rise to the ability of some firms to exercise significant market power in the SEM (McCarthy, 2005). Short-run marginal cost bids with a capacity payment were shown to reduce wholesale prices significantly relative to average cost bidding or medium-run cost bidding (FitzGerald et al., 2005, p.73). Overall the SEM has been judged to be working efficiently (O'Mahony and Denny, 2013).

Nera Economic Consulting (2006) conducted a cost-benefit analysis of SEM over a period of over 10 years covering 2005-2016. The estimates also show that the majority of the social net benefits of SEM implementation, \$165¹ million out of \$202 million (net present value), goes to consumers. The SEM is increasingly integrated with the market in Great Britain and the East-West interconnector between Dublin and North Wales, which opened in 2012 after receiving a grant from the European Commission and project financing from the European Investment Bank. It is estimated to bring annual benefits of \$86 million at a cost of \$514 million, making it worthwhile from an economic standpoint (de Nooij, 2011, Oseni, M. and Pollitt, M. 2014).

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¹ Calculation based on 2006 exchange rate 1 Euro = 1.3 US dollars. Data retrieved from <http://www.x-rates.com/average/?from=EUR&to=USD&amount=1&year=2006>

benefits of further geographic market integration and argue that further market integration is actually required to leverage the spatial diversity of VRE sources (IEA, 2014).

Regions with abundant wind and solar resources are often located far from demand centres. The Atacama Desert in South America, for example, has some of the highest solar potential in the world, with little local demand for electricity. In China, wind resources are generally most abundant in the west, far from population centres in the east. In Inner Mongolia where wind power generation is high, the Inner Mongolia Power Company exports wind-generated power to Mongolia, where demand is higher. In the United States, wind resources are most abundant in the mid-west and solar potential is highest in the south-west, while demand for electricity is higher on the east and west coasts. Additionally, huge potential exists for large hydropower generation in Asia and the Pacific, which remains underutilized due to high investment requirements and/or low per capita electricity demand near hydropower resources. For example, power generation in Bhutan and Nepal could help to meet huge energy demands in India or Bangladesh, power generation in Afghanistan could help to satisfy demand in Pakistan, and power generated in Lao PDR and Myanmar could be consumed in Thailand. These issues could be resolved with the establishment of an appropriate mechanism to facilitate transboundary trade and financing, thereby reducing inefficiencies and promoting the linkage of demand and supply centres across borders. In essence, power generation and demand centres are often dispersed geographically and, increasingly, vast interconnected power grids are capable of efficiently linking generation to demand.

Vast interconnected grids also allow for the increased integration of VRE sources by leveraging large balancing areas to smooth generation intermittency. Market integration is essential to accommodate renewable energy at minimum cost and to ensure that the cost of decarbonization remains affordable. This is in part due to the fact that differences in policies on renewables lead to uneven deployment and complementary generation

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Box 3.3 Integrating increasing shares of renewable energy – Southern African Power Pool

Substantially increasing the global share of renewable energy by 2030 lies at the heart of SDG 7. Regional and subregional connectivity initiatives can provide the technical capacity through larger and more diverse balancing areas, as well as funding requirements for increased integration of renewable energy into power systems (IRENA, 2013).

Figure 3.1 shows the shares of renewable-based generation in total electricity generation in 2010 and 2030 within the members of SAPP under IRENA's Renewable Promotion scenario. The regional average would increase from 12 to 46 per cent over this twenty-year period, based on IRENA's scenario. Hydro generation would contribute 10 per cent of this increase from 2010 to 2030, and the remainder would be contributed by non-hydro-based variable renewable sources, which currently account for negligible shares (IRENA, 2013).

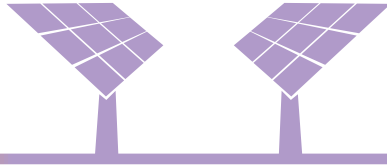
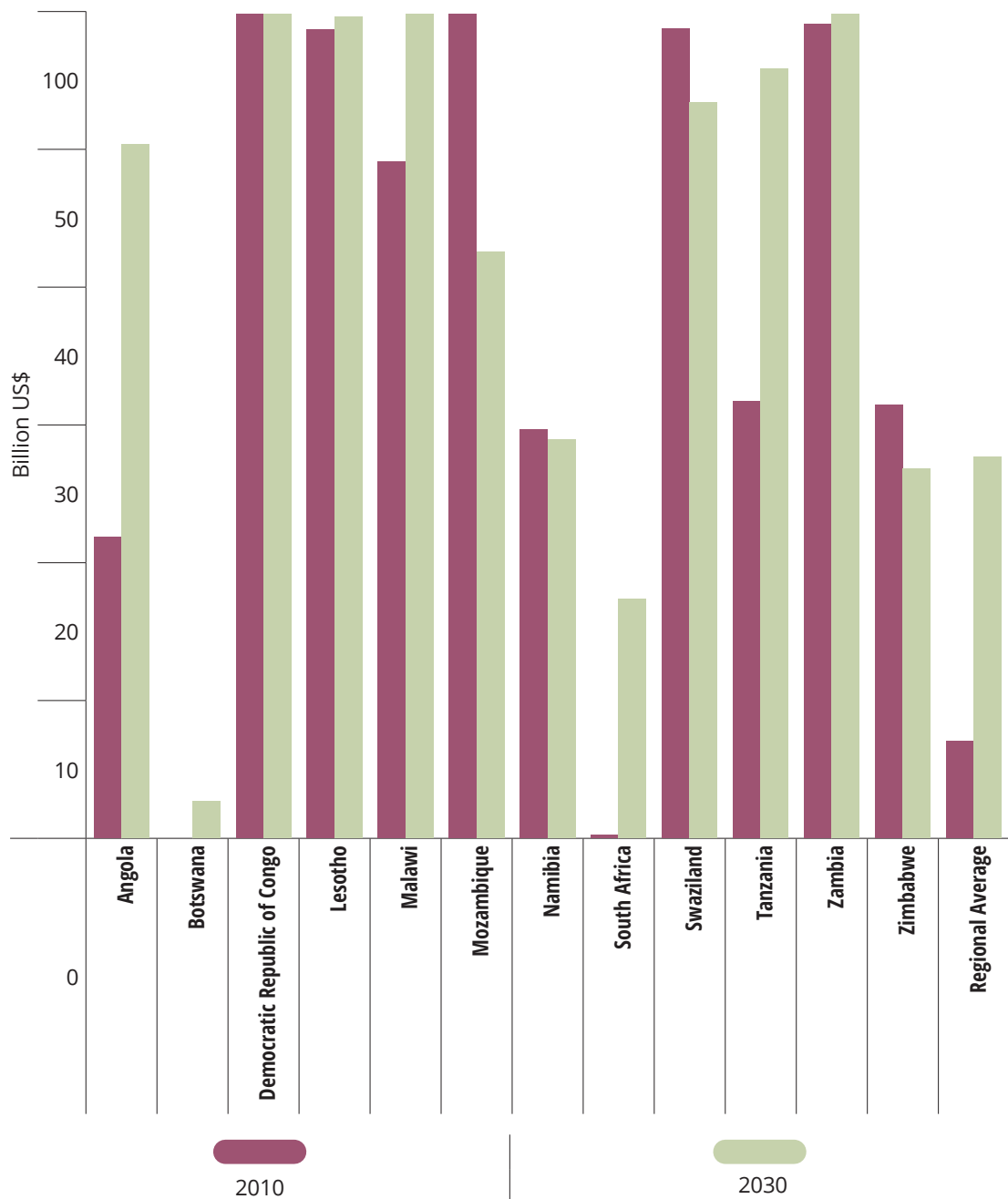


Figure 3.1 Share of renewable-based generation in total electricity generation



Source: ESCAP, based on IRENA data

mix and, as mentioned, abundant renewable energy resources tend to be located far from consumption centres. According to the IEA, the deployment of VRE is a major driver for further interregional integration and represents an opportunity for further market integration rather than a threat to it.

The introduction of SAPP has led to rising investments in capacity-building, and spurred trading activities between member States. For instance, according to SAPP, the potential lost wheeling revenue that could have been generated in November 2013 alone was estimated at \$316,312. In addition, only around 20 per cent of desired trades actually took place in 2012. The South African utility, Eskom, is the dominant supplier for SAPP, because of its extremely low power generation prices. In 2008 it was charging just 1.7 US cents/kWh for its thermal power exports (ECA, 2009), which is well below the cost of new fossil-fueled power and hydropower. This has been seen as the reason that the potential regional projects originally planned to supply South Africa have so far not been accomplished (IRENA, 2013).

INCREASING SYSTEM FLEXIBILITY TO ENABLE HIGHER SHARES OF VRE INTEGRATION

Integrating sizable shares of VRE requires flexible baseload capacity in order to smooth fluctuations in generation. Without flexible power generation sources, such as hydropower or natural gas-fired power plants, geographic smoothing can aid in the integration of VRE sources such as wind and solar. According to IEA, “integrating markets over large distances has the potential both to smooth output variability and reduce the forecasting errors associated with wind and solar power.” Geographic smoothing effects are generally greater for wind than for solar power, as wind resources tend to vary more significantly over a geographic area than solar resources. Wind and solar generation can also complement one another and further smooth variability if used in tandem. For example, wind power is often most readily available at night when solar power is not being generated. As such, the negative correlation between wind and sun can be beneficial in some cases. Larger balancing areas can act as an effective tool to increase shares of VRE through this geographic smoothing effect. However, without sufficient transmission capacity over thousands of kilometres, the smoothing effect remains modest. The larger and more diverse the balancing area is (in terms of generation and demand schedules) the more effective the geographic smoothing effect is at integrating substantial shares of VRE sources (IEA, 2013).

When considering the impacts of increased VRE integration, grid instability is a commonly cited barrier. However, recent experience in Germany and Denmark suggests that high levels of grid stability with increased shares of VRE are possible. In 2010 and 2011, these countries, behind only Luxembourg, boasted the lowest rates of system disruption – 15.91 and 14.75 minutes per year, respectively – while integrating some of the highest shares of VRE electricity generation in the European Union at 12 and 20 per cent, respectively (CEER, 2014). A number of factors enable this outcome, including advanced weather (wind and sun) forecasting, power generation spread over a large geographical area, large system balancing areas achieved through the use of international power markets and the use of advanced transmission system operators.

SUMMARY OF BENEFITS

The need for energy trading and connectivity emerges from the fact that large energy generation sources are geographically separated from demand-growth centres, in some cases by multiple international borders. Seasonal hydroelectric production does not match demand in generating countries, but can be complementary to seasonal demand in other countries in the region. (ECA, 2007) Regional trading can especially benefit countries with diverse generation sources, as seen in SAPP with large thermal power capacity in South Africa and large hydropower generating capacity available in neighbouring countries to the north. Thermal generation capacity can provide baseload while hydropower capacity can provide peak loads through storage during off-peak hours, as is seen with Bhutan and Nepal selling power to India. Transboundary power trade can be used to reduce the required capacity of thermal generation while maximizing the potential of hydropower generation.

Additional scope for trade in electricity occurs when fuel costs for power generation are lower in one country than in a neighbouring one, which justifies the construction of power plants dedicated to exports that use this cheaper fuel. Further impetus for electricity trade can stem from the presence of environmental regulations (related to emissions from thermal generation) in one country that are not present in neighbouring countries, leading to coal-fired power plants being built across borders solely for the purpose of electricity export. An example of this can be seen in Lao PDR, where Hongsa Power Plant (an 80 per cent Thai-owned 1.9 GW lignite coal-fired power plant) has been constructed primarily to export electricity to Thailand (Wall Street Journal, 2014). Further advantages of electricity trade include the attainment of enhanced power supply reliability with lower reserve margins than are necessary when operating independently. Additional economies may also occur where utilities face different system load shapes or experience peak loads at different times of the day/year. In this situation, the output of peak load plants may be shared between countries. In general, the widening gap between energy demand and supply among nations is creating greater opportunities for regional trade and connectivity that includes adoption and use of energy-efficient technology and integration of VRE technologies.

BARRIERS

POLITICAL, REGULATORY, TECHNICAL, ECONOMIC/ FINANCIAL

Despite the many benefits of regional power trading and connectivity, many barriers and challenges to its implementation exist. National interests take priority over regional and subregional interests and consensus needs to be built at the national level through a series of discussions and interactions. Energy demand patterns in the Asia-Pacific region continue to grow along with economic growth, for which energy is the primary commodity required. Many opportunities for bilateral and multilateral energy trade exist among member States; however, vast opportunities for mutually beneficial trade remain unrealized. Regional forums such as the ASEAN, Asia-Pacific Economic Cooperation (APEC), Electric Power Council of the Commonwealth of Independent States (EPC CIS), Greater Mekong Subregion (GMS), South Asian Association for Regional Cooperation (SAARC), South Asia Subregional Economic Cooperation (SASEC), Energy Charter and others emphasize energy trading as one of the key aspects of a cooperation framework; however, energy trading remains largely stalled due to a number of factors.

Electricity requires large investments in production and transmission networks and energy markets are traditionally dominated by state ownership so private investment is difficult to come by. Commodity trade has largely been initiated by multinationals with well-defined value chains but the overall benefits of better power connectivity remained undefined. With clear economies of scale and scope, regional clusters have grown for most products and the stakeholders have benefited from this integration in a relatively short period of time; however, the payback period for energy connectivity is long and uncertain. Finally, there are large positive and negative externalities inherent to energy connectivity, so rules and regulations need to be in place, ensuring a fair distribution of costs and benefits among stakeholders. Striking a balance between beneficiaries is a substantial challenge to energy connectivity.

In order to address the barriers to connectivity, there is a need for accelerated and productive dialogue at the bilateral and multilateral levels, which should be facilitated by a third party in order to yield concrete outcomes. Member States need to plan for required infrastructure development to enhance connectivity.

Some of the key barriers and challenges for regional energy trade and connectivity include:

- Developing political consensus at the bilateral and multilateral level: In most countries, any bilateral or multilateral agreement needs to be endorsed by the legislative parliament. Numerous diverse political ideologies may exist within countries, where some support these initiatives – citing economic development – and others oppose this trade – citing the importance of national sovereignty, specifically for energy. Sometimes countries agree on a framework agreement at periodic regional events

or bilateral dialogues but then fail to achieve any meaningful results on the ground. Short-term bilateral trading to meet energy demands for particular periods is being carried out through ministerial or secretarial negotiations but when it comes to long-term agreements, mistrust, corruption, internal disputes and various interest groups need to be addressed in order to build national consensus. Multilateral trading is even more challenging than bilateral as it requires multiple countries to reach consensus.

- Formulating appropriate policy and institutional structures: National policy exists to meet demand at the national level; however, international energy trading requires clear policy and an institutional framework that facilitates investment and fairness in terms of costs and benefits. Regional cooperation efforts require harmonization of energy policies and the promotion of legal and regulatory frameworks conducive to regional trade. Effective policy must address the pricing or tariff of energy trade as a commodity, subsidies provided by the government, right of way, power wheeling charges, and the establishment of independent grid operators. Review of existing legal and regulatory frameworks within the region should be carried out and regional trading and interconnection must be analysed properly. In some cases, it may require restructuring of existing institutional arrangements, creation of new institutions, capacity development and information sharing at regular intervals. This entails thorough analysis of country approaches to private investment, tariff-setting principles, various interconnection issues and ways to harmonize energy regulation and standards throughout participating countries with respect to energy trade.
- Removing technical barriers: Countries involved in multilateral trading may have different resource bases and rely on different technologies, grid codes and standard technical parameters. One challenging aspect can be establishment of a required transmission network and substations required for electricity trading. This requires sophisticated technological capacity at the regional level. Transmission voltage levels and capacity may need to be enhanced to allow for energy trading across borders. Safety and protection systems, energy metering systems, seasonal demand and supply variations are some of the technical parameters that need to be matched. Other technical barriers that may require alteration to allow for energy trading include load patterns existing in the network, load sharing by various kinds of equipment, improved frequency control and maintaining spinning reserves within the network.
- Analysing market, investment and financial barriers: Trading is market-guided and regional energy trading is feasible only when there are potential sustainable financial transactions with positive cash flow. For example, power-starved South Asian countries such as Pakistan and Afghanistan could provide ample markets for Central Asian power exports, and the thermal- dominated power system in India has the potential to complement hydro-based power systems in Nepal or Bhutan. These high voltage transmission and distribution systems for power trading require substantial investment, long-term commitments and assurances for the public as well as the private sector. Regional or national banks may be needed to provide credit or grants while analysing the risks associated with projects and imposing various conditions that need to be implemented at the national level. At times, fixing or adjusting tariff systems may be required, as well as increasing utility transparency

through international accounting standards and accountability, and adopting best practices regarding corruption abatement.

- Ensuring energy security: There are fundamental differences between renewables and fossil fuels that make security features of predominantly low-carbon systems different from those of current systems. It is difficult to generalize the concept of energy security for a region with so many different definitions and indicators; however, it is possible to adopt generic approaches to energy security where physical or economic threats to energy security are common to most countries in a region. Some examples of generic energy security concerns include: effects of energy systems on the climate; physical safety of energy systems, including in terrorist attacks or conflicts; free trade and secure transportation routes; resource depletion; cost escalation; and supply disruptions. Energy growth in the Asia-Pacific region will be accompanied by increasing dependence on oil imports, while China, India, Indonesia and Australia are expected to collectively account for over 70 per cent of global coal output by 2040. Such concentration of energy demand and supply frontiers raises energy security concerns, not only for individual countries, but for the entire region. Politicians emphasize protecting energy resources and infrastructure from various disruptions while using energy to propel economic growth and employment. Import dependence is a major energy security challenge for about 3 billion people globally in nations that import more than 75 per cent of oil and petroleum products; 95 per cent of transport energy comes from oil-based fuels. Many developing countries face energy security stresses emanating from low resource endowments, growing energy demand-supply gaps, high energy intensity and macroeconomic vulnerabilities with binding fiscal constraints. Energy security is also dynamic, and long-term energy security is about stable and predictable prices, whereas affordability would be a prime concern over the short term (Terway, A. and Nangia, R. 2016).

Some of the barriers to transboundary trade can be addressed through proper information dissemination, ongoing dialogue, analysis of existing power pools, and analysis of national characteristics among neighbouring states. Expert task forces representing participating countries could present their situations and mutually agree on time frames and actions required, including technology transfer, due diligence and any other conditions that facilitate regional energy trading. The countries could potentially work together to create the required infrastructure for energy trade while facilitating private sector investment and foreign direct investment for those projects which are viable for investment.

CURRENT INITIATIVES

There are insightful cases of energy trading across numerous countries within Asia and the Pacific, including: between India and its South Asian neighbours – namely Nepal, Bhutan and Bangladesh; between Central Asian countries and the Russian Federation; among ASEAN countries; and between Central Asian countries and Afghanistan, Iran and Pakistan. Most of these agreements are limited to bilateral trade, however lessons can be learned from these select examples of connectivity from within the Asia-Pacific region.

ASEAN TRANSBOUNDARY POWER GRID

The ASEAN region is rich in energy resources, with great diversity in large hydropower potential and huge oil and natural gas and coal reserves. Given the growing demand for energy in the region, ASEAN countries have agreed to advance energy connectivity by supporting the ASEAN Power Grid (APG) and the Trans-ASEAN Gas Pipeline (TAGP).

APG is a flagship programme mandated in 1997 by the ASEAN Heads of State/Governments under the ASEAN Vision 2020, aimed towards ensuring regional energy security while promoting the efficient utilization and sharing of resources. APG is expected to provide greater economic generation and transmission of electricity, greater reliability and security of electricity supply in member countries, and a platform for future energy trade. The Heads of ASEAN Power Utilities/Authorities, which is responsible for cross-border issues for APG development, has estimated that there will be up to 19,756 MW of cross-border power purchase and 3,000 MW of energy exchange through the cross-border interconnections by 2025, which will result in a net saving of \$788 million and a reduction in installed capacity of 2,013 MW. Figure 3.2 shows the proposed projects and timelines.

Five strategies have been determined for APG development:

- Accelerate the development of APG interconnection projects;
- Establish APG institutions;
- Synchronize power development plans and optimize the generation of electricity;
- Encourage and optimize the utilization of ASEAN resources; and
- Encourage third-party participation.

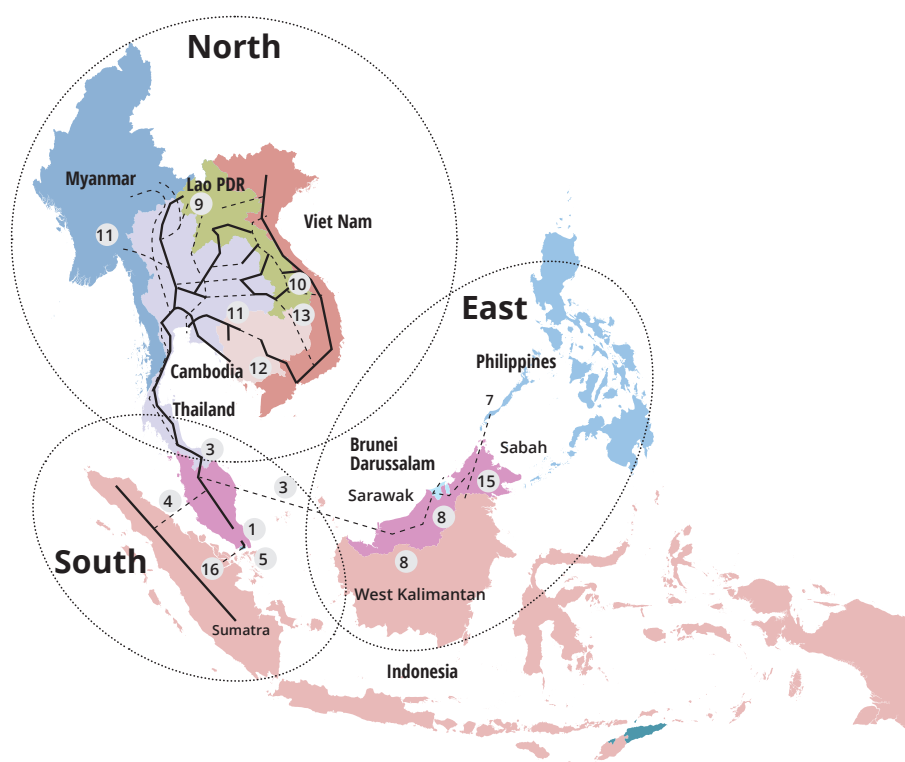
DEVELOPING SUBREGIONAL PERSPECTIVES ON REGIONAL ENERGY CONNECTIVITY: NORTH AND CENTRAL ASIA

The countries of North and Central Asia used to form a single, unified energy system and had been interconnected since 1960 under the Soviet Union through the creation of unified energy and resource management principles. The break-up of the Soviet Union in December 1991, along with the formation of the Commonwealth of Independent States (CIS) and division of energy property among the States, led to a drastic change in management mechanisms for the energy sector. At that time, creation of an energy infrastructure that could maintain energy independence of the individual countries became paramount.

The North and Central Asian region has a clear outlook and particular objectives at the subregional level due to the past influence of the Soviet Union and the continued existence of the unified energy system. At present, 8 of the 11 national power systems of the CIS countries have synchronized parallel operation and it is economically feasible to restore full parallel operation of all power systems of the North and Central Asian countries.



Figure 3.2 **ASEAN Energy Connectivity – electricity projects**



	Earliest COD post 2020	Earliest COD Existing
1. P. Malaysia - Singapore (New)		
2. Thailand - P. Malaysia		
• Sadao - Bukit Keteri	Existing	
• Khlung Ngae - Gurun	Existing	
• Su Ngai Kolok - Rantau Panjang	TBC	
• Khlung Ngae - Gurun (2nd Phase 300MW)	TBC	
3. Sarawak - P. Malaysia	2025	
4. P. Malaysia - Sumatra	2020	
5. Batam - Singapore	2020	
6. Sarawak - West Kalimantan	2015	
7. Philippines - Sabah	2020	
8. Sarawak - Sabah - Brunei		
Sarawak - Sabah	2020	
Sabah - Brunei	Not Selected	
9. Thailand - Brunei		
• Roi Et 2 - Nam Theum 2	Existing	
10. Lao PDR - Viet Nam		2019-2023
11. Thailand - Myanmar		2016 TBC
12. Viet Nam - Cambodia (New)		2018-2026
13. Lao PDR - Cambodia		TBC
14. Thailand - Cambodia (New)		2017
15. East Sabah - East Kalimantan		post 2020
16. Singapore - Sumatra		post 2020

Existing

Under construction

Priority projects

Disclaimer: The boundaries and names shown and designations used on this map do not imply official endorsement or acceptance by the United Nations.

Source: ASEAN Plan of Action for Energy Cooperation (APAEC) 2016 – 2025. September 2015.

A number of initiatives in the region are economically feasible, socially acceptable and environmentally sound. However, there are some political aspects which prevent the practical implementation of such projects, as well as impeding mutually beneficial cooperation in other areas. The region has a very complicated geopolitical scenario and, as a result, lack of political trust remains among some countries.

Asia-Pacific regional cooperation could facilitate the acceleration of subregional initiatives through the sharing of lessons learned and information gained from North and Central Asia, through:

- Harmonization of financial, technical and legal standards and requirements;
- Sharing of technical expertise and human resources with other member States;
- Sharing of experience in regional connectivity at all levels;
- Development of a common database of investment projects (currently in development).

SAARC ENERGY RING

The SAARC Energy Ring, conceptualized in 2004, is an intergovernmental programme to reduce power supply disruptions and delivery. It was established to address the realization that the gap between supply and demand is widening in this subregion. It has been estimated that primary commercial energy demand in South Asia will increase from primary commercial energy supply of 655 million tons of oil equivalent in 2011 to more than 2,200 million tons of oil equivalent by 2030. To fill the gap, international energy trade and cooperation is a key solution. A SAARC Energy Centre was constituted to support the implementation of the Energy Ring and to facilitate interregional energy cooperation among neighbouring countries in West Asia, Central Asia, East Asia and South-East Asia. The Centre developed a strategic and operational plan that identified five thematic areas:

- Energy trade;
- Technology transfer and sharing best practices;
- Energy and environment;
- Energy efficiency and fuel substitution; and
- Rural energy accessibility.

Besides the Centre, four intergovernmental expert groups are engaged in studying oil and gas, electricity, renewable energy and technology transfer.

Within the region, Nepal and Bhutan have hydroelectric resource potential that could be traded. Central Asian countries have huge gas reserves that can be imported through

pipelines. Electricity trade with Tajikistan, Kazakhstan, Uzbekistan, and Turkmenistan may be expanded through Afghanistan to Pakistan and India. It is planned that trade would develop initially in clusters of east and west, with the ultimate goal of integrating into one South Asian energy network.

However, the progress of development of the Energy Ring is very slow. Specific barriers include mistrust among countries, especially between India and Pakistan, which have an impact in the regional context of South Asia. Unequal tariffs constitute another barrier that prevents regional energy trade. Security threats, terrorism, especially in Pakistan and Afghanistan, also hamper investment.

REGIONAL SUPER GRID IN EAST AND NORTH-EAST ASIA

East and North-East Asia accounts for around one-third of the world's energy consumption and encompasses some of the most resource-rich and most resource-dependent countries in the world. In particular, China, Japan and the Republic of Korea are ranked among the top five importers of major fossil fuels, while the Russian Federation is the major exporter. Considering the significant potentials of complementarities among the countries as well as the increase of energy demand, countries have explored options for bilateral and multilateral grid interconnections since the 1990s. However, grid interconnections for power trade are still limited to bilateral connections between China-Mongolia, China-Russian Federation, and Mongolia and the Russian Federation, and the scale of bilateral trade is also relatively low. For example, electricity import of China from the Russian Federation in 2015 was 3,299 GWh, accounting for 0.05 per cent of China's total electricity generation (ESI, 2016). While countries continue to expand the existing bilateral connections, since the early 2010s both importers and exporters have actively explored options for multilateral grid interconnections, in particular, in a way to meet energy demand with cleaner energy by utilizing vast potentials of renewable resources, solar and wind in Mongolia, wind in China and hydro in the Russian Federation. In particular, the subregional-level discussions have been promoted by the initial idea of filling the Japanese energy gap by a multilateral grid interconnection (Asia Super Grid) after the Fukushima nuclear disaster in 2011, and the recent initiative of China to mitigate domestic air pollution as well as greenhouse gases emissions. As a result, governments, power companies and research institutions have come forward with various initiatives based on renewable energy such as "Asia Super Grid", "Gobitec Initiative", "Northeast Asia Super Grid", and "East Asia Super Energy Ring". In support of these initiatives, power companies of China, Japan, ROK and the Russian Federation in 2016 stated conducting joint technical studies on power interconnection, developing a business model and formulating a master plan.

ENERGY CHARTER

At the Dublin European Council of 25 June 1990, the Prime Minister of the Netherlands proposed a conference for negotiations on an Energy Charter. On 17 December 1991, in the Hague, the European Energy Charter – a political declaration on international energy

cooperation – was adopted, followed by the legally binding Energy Charter Treaty, which was signed in 1994 and entered into force in 1998.

The Energy Charter is based on the recognition that all countries stand to benefit from a balanced framework for cooperation in the energy sector. Countries with natural resources receive a means to attract investment, to protect their interests downstream and to ensure reliable transportation for their energy exports to consumers. Energy-importing countries receive protection for their outward energy investments and mechanisms to promote security of supply. All countries benefit from measures to encourage the efficiency of energy production and use and to minimize their environmental impacts.

The Energy Charter establishes a framework for international cooperation between European countries and other industrialized countries with the aims of developing the energy potential of Central and Eastern European countries, ensuring the security of energy supply for the European Union, promoting energy efficiency policies that are compatible with sustainable development, encouraging more efficient and sound use of energy and promoting cooperation in the field of energy efficiency. Although the Charter was conceived as a European initiative with a focus on “East-West” cooperation, its scope is now considerably broader, as many Asian countries (China, Republic of Korea, Iran and Pakistan) have taken on observer status in recent years.

Goals of the Energy Charter include the following:

- Protecting the interests of the investors by creating a stable and transparent investment climate and insulating foreign energy investors from risks;
- Promoting reliable international transit flows, which is a particularly important issue for Eurasian energy security, since a high proportion of oil and gas in Eurasia is delivered through long-distance pipelines that cross multiple national borders and jurisdictions;
- Minimizing the harmful environmental impacts of energy-related activities and the improvement of energy efficiency by all member States.

The Energy Charter aims to become an international instrument that will strengthen energy cooperation and set out common principles for international cooperation in the field of energy. The Charter also reflects new energy challenges for the twenty-first century – in particular:

- The full scope of multilateral documents developed over the last two decades;
- The growing weight of developing countries in global energy security;
- The “trilemma” between energy security, economic development and environmental protection;
- The role of enhanced energy trade for sustainable development;

- The need to promote access to modern energy services, reduce energy poverty and achieve clean technology and capacity-building;
- The need for diversification of energy sources and routes; and
- The role of regional integration of energy markets.

STRATEGY

FROM ISOLATION TO CONNECTIVITY

While there is a general recognition of the benefits of regional energy connectivity at the subregional level in the Asia-Pacific region. Many of these initiatives are very much in their early development stages, with the vast majority of current energy trading existing on a bilateral level. There are several energy connectivity initiatives in the region, but most of these have yet to move up the integration ladder. The GMS is perhaps the most advanced of all subregional programmes in terms of harmonization of power policies and technical standards (Atkinson, 2015). In terms of subregional market creation, the region lags behind Africa or South America, where power pools and market integration are at an advanced stage, though on a much smaller scale (Terway, A. and Nangia, R. 2016; ADB 2010 data).

Institutional capacity development is critical in order to achieve progress in regional integration, particularly in the energy sector where more comprehensive engagement is required in terms of technical and regulatory harmony regarding the connectivity of assets and the establishment of mutual dependencies in energy markets. However, there are significant developments in the region's energy sector and a more collective approach to development is likely to ultimately deliver the most sustainable end result.

Using the power sector as an example, sufficient levels of technical and regulatory standardization are required for interconnectivity, depending upon the depth of integration necessary to facilitate the desired transaction. In this regard there are three general phases of development within which regional power trade is established and allowed to progress: (i) initial shallow interconnection and bilateral exchange of power between neighbouring countries as negotiated under a PPA; (ii) shallow trading achieved by involving multiple parties and associated harmonization of grid systems and planning; and finally; (iii) deep integration of energy systems, involving the establishment of fully integrated and functional electricity markets, where spot pricing mechanisms are established and trade is coordinated and dispatched by an independent body (Atkinson, 2015). An example of this can be seen in Nord Pool, where 380 companies from 20 countries currently trade on day-ahead and intraday electricity markets in the Nordic and Baltic regions, and on Nord Pool's United Kingdom market (Nord Pool, 2016).

ENABLING ENVIRONMENT

Harmonization of rules for competitive market-based price-setting mechanisms is not necessarily a prerequisite for initial levels of regional power network integration, but it is required for deeper levels of cross-border integration. Countries in the Asia-Pacific region have historically spent vast amounts on supporting domestic energy consumption and production through direct and indirect subsidies. In recent years, several states have taken advantage of historically low oil prices to reduce or eliminate direct fossil fuel energy subsidies. Between 2013 and 2015, China, Malaysia and Thailand eliminated direct subsidies, while Azerbaijan, Bangladesh, India and Indonesia significantly reduced them. Nevertheless, when indirect costs associated with subsidies are taken into account, in several countries in the region, including Iran, Kyrgyzstan, Tajikistan, Uzbekistan and Viet Nam, such post-tax subsidies for electricity alone cost more than 2 per cent of their respective GDPs (IMF, 2015). The efforts to eliminate fossil fuel subsidies have positive implications not only for the development of cross-border power trade networks, but also for increasing the possibility of integrating greater shares of VRE into the power system.

BROADER INTEGRATION

Over the past two decades there has been a clear tendency to liberalize trade conditions in the region and many countries have entered into free trade arrangements, including the Asia-Pacific Trade Agreement, ASEAN Free Trade Area, CIS Free Trade Area, Eurasian Economic Union and others, in addition to numerous bilateral free trade agreements between Asia and the Pacific member States (ADB, 2016). Nevertheless, there are vast differences between subregions and individual countries and the majority of the signed and implemented free trade agreements are bilateral, with large regional agreements – such as the Regional Comprehensive Economic Partnership involving ASEAN+6 economies and the Trans-Pacific Partnership – so far proving elusive. The differences in trade liberalization are also demonstrated in the share of intrasubregional trade. While around 25 per cent of total trade for ASEAN members took place within the subregion, for SAARC countries it was only about 5 per cent. In East and North-East Asia, 35 per cent of the total trade value was traded within the subregion. There are, however, also striking differences within the subregions; while Lao PDR and Nepal exchanged over 55 per cent of their trade value within their respective subregions, for India, Pakistan and Viet Nam it was only 5, 7 and 15 per cent, respectively.

On a regional level, Asia's intraregional trade accounted for 54 per cent of its total share (in comparison, for the European Union this figure was 64 per cent) (ADB, 2014). The increase in the share of intraregional trade in Asia has flattened in the past few years, partly as a result of targeted increases in the flows of foreign direct investment from China, Japan and the Republic of Korea to other countries in the region, most notably the ASEAN countries. The subregional differences are also reflected in the intrasubregional energy trading share, which is higher in subregions with higher total intrasubregional trade – South-East Asia and North-East Asia – than in those with low levels of total intrasubregional trade – South and South-West Asia, North and Central Asia and the Pacific. In terms of portfolio investment, the intraregional share has increased only marginally in the past few years, with

investor preferences shifting from intraregional equity holding (declining from 25 to 23.2 per cent) towards debt instruments (increasing from 14.6 to 16 per cent), amid the rising uncertainties resulting from the so-called “taper tantrum”. These developments further highlight the need for greater harmonization and liberalization of regional financial markets, in order to strengthen domestic investor bases and facilitate intraregional investment flows (Atkinson, 2015).

STEP-BY-STEP APPROACH

The current status of connectivity development in the Asia-Pacific region is mostly at the interconnection level in terms of existing and developing bilateral trading arrangements across energy sectors. It can be noted from the subregional analysis, however, that multiple plans to progress towards deeper integration within subregional initiatives do exist across

Table 3.1 **Typical phases in power market integration**

	Interconnection	Shallow integration	Deep integration
Regional connectivity architecture	Typically starts with two countries, later a wider interconnected grid	Interconnected grid involving a number of neighbouring countries	Operation of a fully synchronous, multi-country, interconnected power system
Cross-border trading arrangements	Long-term bilateral PPAs	Long-term PPAs supplemented with short-term markets	Electricity pricing competition achieved through a range of market mechanisms (spot, day-ahead, transmission capacity auctions, etc.)
Technical and/or regulatory harmonization	Simple rules agreed upon for the operation of the interconnected system	Harmonization of rules, grid codes, and transmission tariffs	Harmonization of rules, grid codes, and transmission tariffs
Planning and investment coordination	National planning and investment	Some coordination of national investments with optimized regional investment plan	Regional integration body empowered to require investments in agreed upon regional plan to be implemented

Table adapted from: World Bank (2010) Solving energy challenges through regional cooperation, Energy Sector Management Assistance Programme (ESMAP) Briefing note 004/10. Washington DC.

the region – most notably the developing APG and associated GMS Power Market and the proposed SAARC regional electricity market and its proposed further connectivity to the Central-Asian Unified Electricity System through the CASA-1000 project.

As connectivity progresses further towards integration, such developments require improved levels of harmonization between regional participants in order to ensure effective operation and management of physical energy trading ties, as shown in the Table 3.1. From a technical perspective, such issues include relevant harmonization of operational codes covering infrastructure management, specification, servicing and maintenance. The subregional analysis has outlined that codes and standards are already in the early phases of development by subregional initiatives within the region, and an opportunity is therefore available to ensure that appropriate levels of harmonization develop as these initiatives progress (Atkinson, 2015).

In order to promote regional energy connectivity and transboundary power trade, a broad regional agreement can lay the foundation for a focused dialogue with this aim. A focused dialogue will be needed in order to ensure that benefits and costs are distributed evenly on a subregional and regional level. The establishment of a mechanism charged with monitoring and ensuring that benefits are achieved, while creating neutral institutions to regulate project implementation and benefits, will also be essential.

FINANCING

Integrated regional and subregional power transmission networks, as well as the large power generation plants that vast power grids allow, require large capital investment. In order to attract private sector investment for these large projects, a certain ROI is required, contingent upon the amount of risk present and the length of time needed to recoup investment. As a means to mitigate these risks, thus lowering the ROI required by investors, certain legal, financial, economic and political parameters must be ensured, along with the establishment of solid legal systems that allow foreign investors to seek damages, due to breach of contract or other issues, through legal means (Chen, K., Chen, Z. and Wei, K.C. 2009). Private sector investment requires, in part, effective risk allocation that lets parties focus on core competencies and helps drive down transaction and project costs. As for the integration of renewables, strategic risk allocation through PPPs may prove to be the most effective way to bring forward new utility-scale generation and optimize the economic benefits of emerging renewable technologies as part of increased transboundary power trade (E&Y, 2016). When an influx of foreign investment for transmission and power generation projects is required, mitigation of risk, whether economic or political, is essential. Also needed is the establishment of a sound investment climate complete with bankable and steady incentives, such as feed-in tariffs, that face little risk of retroactive reduction.

A number of options exist with respect to financing, including the creation of funds that can be boosted partly by diverting some of the benefits attained through energy connectivity infrastructure projects, as well as creating multi-country, multi-investor initiatives for projects with high upfront costs. To ensure the effectiveness of such a programme, a long-term planning horizon should be used – keeping in mind that decisions and changes made in one

area will have ripple effects on optimal investment elsewhere. Multilateral development agencies would need to finance a significant part of the required investment – including technical assistance for institutional and regulatory reforms, as well as management and accountability systems. Regional programmes aimed at energy efficiency and renewable energy sources can go a long way to channel investments in these vital areas (Terway, A. and Nangia, R. 2016).

The World Bank, European Bank of Reconstruction and Development, European Investment Bank and Eurasian Development Bank are multilateral financial institutions that strongly support regional cooperation, including energy connectivity. The ADB, Asian Infrastructure Investment Bank, BRICS National Development Bank and Islamic Development Bank also have specific provisions for providing technical assistance to entities in the region for developing infrastructure.

Appropriate and transparent allocation of costs to beneficiaries can help to build wider community acceptance for transboundary connectivity initiatives. Cost-benefit assessments should also specifically address net incremental benefits and costs associated with the deployment of renewables. Furthermore, the proportional and accurate allocation of network costs and benefits between beneficiaries can strengthen incentives to help determine least-cost system-wide developments. (IEA, 2013) Cost allocation for interconnectors can stumble against missing incentives for network investors and a lack of consumer or regional acceptance. Inaccurate cost allocation represents a significant cross-border investment barrier. In some cases, interconnectors or electricity flow across a jurisdiction without offering it any benefits. A correct allocation would not allocate any cost to countries or states that do not benefit. However, the jurisdiction might have to bear the licensing, siting and environmental costs (IEA, 2014).

As argued by IEA, costs should be allocated to the beneficiaries. One of the advantages of this approach is to avoid overinvesting if the combined jurisdictions do not provide enough cumulative benefits. Another advantage of the “beneficiary pays” principle is informing each group of stakeholders during the planning and assessment process to gain acceptance for new interconnector investments. These cost allocation approaches are already applied in Australia and are being developed in the United States and Europe.

No matter how desirable a regional infrastructure project is from the viewpoint of providing public service, it has to be bankable so the developers can raise capital. It should be able to attract both equity and loans. Equity holders have a higher appetite for risks since the expected rewards are also high. However, lenders’ returns are linked to interest rates so they have to be confident that the project cash flow will be adequate to cover debt service obligations during the loan tenure. When structuring a PPP regional project, the government – or governments – will need to balance the risks and rewards; the payment to the private sector party will have to be linked to performance and risk assumed by it over the life of the asset, but guarantees should not insulate the company for all eventualities. Furthermore, transnational projects attract close scrutiny from international civil society and therefore have to be built according to high standards so the risk to reputation is lower for international financial institutions that support such projects (Terway, A. and Nangia, R. 2016).

Box 3.4

A deeper look into an existing power market – The Southern African Power Pool (SAPP)

The SAPP, formally established in 1995, comprises 12 member countries: nine operating members (Botswana, Democratic Republic of Congo, Lesotho, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe) and three non-operating members (Angola, Malawi and Tanzania) that have not yet been connected to the regional grid (as of February 2016). The SAPP was built on pre-existing bilateral and multilateral connections and primarily trades power reserves when loads are below peak in the generating country. SAPP serves 280 million people with a peak demand of 50 GW and an installed generation capacity of 53 GW – a very thin margin which contributes to power outages within the region. Transmission constraints within SAPP continue to limit transactions. The level of electricity traded in 2013-2014 amounted to 8 TWh out of a total power generation of 277 TWh, or about 3 per cent of total power generation, with nearly all trade coming from bilateral trade agreements (SAPP Annual Report 2014). SAPP is a cooperation of the national electricity companies in Southern Africa under the auspices of the Southern African Development Community, spurred partly by the extreme drought in 1991-1992, which severely affected hydropower production in the Zambezi basin, leading to economically and socially disruptive load shedding (ECA, 2009). The underlying political and economic force behind the evolution of SAPP has been South Africa's desire to meet future increases in demand by importing low-cost hydropower from its northern neighbours (ECA, 2009).

The bulk of the power consumed within the SAPP is generated from coal, concentrated in the northern provinces of South Africa, eastern Botswana and western Zimbabwe. Among the rest of the member countries, generation is predominantly hydro-based, with power stations located in Zambia, Zimbabwe, Mozambique, Malawi, Democratic Republic of Congo, Angola, Namibia and Tanzania. The current operational statistics give the following generation mix for SAPP: 74.3 per cent coal, 20.1 per cent hydro, 4 per cent nuclear and 1.6 per cent diesel and gas. The trading arrangements between members have continued to operate predominantly under the pre-SAPP types of bilateral and multilateral contracts (ECA, 2009).

Vision:

- Facilitate the development of a competitive electricity market in the Southern African region;
- Give the end user a choice of electricity supply;
- Ensure that the Southern African region is the region of choice for investments by energy-intensive users;
- Ensure sustainable energy development through sound economic, environmental and social practices (SAPP Index).

Objectives:

- Provide a forum for the development of a world class, robust, safe, efficient, reliable and stable interconnected electrical system in the Southern African region;
- Coordinate and enforce common regional standards for quality of supply, measurement and monitoring of systems performance;
- Harmonize relationships among member utilities;
- Facilitate the development of regional expertise through training programmes and research;
- Increase power accessibility in rural communities;
- Implement strategies in support of sustainable development priorities;
- Improve the reliability and security of the existing regional grid;
- Facilitate the expansion of the grid to connect non-operating members;
- Introduce a short-term energy market to facilitate the trading of surplus energy not committed under existing contracts (SAPP Index).

Financing of large-scale transmission infrastructure in Asia and the Pacific is largely handled by the public sector and international development banks, rather than the private sector. Some form of framework will be needed in order to facilitate this infrastructure development. A regional survey is being conducted by the secretariat and ESCAP member States on energy connectivity and transboundary power trade in order to establish a baseline framework to facilitate the acceleration of project financing by reducing risks and soft costs associated with energy infrastructure development.



Figure 3.3 SAPP member countries and the interconnected grid



Disclaimer: The boundaries and names shown and designations used on this map do not imply official endorsement or acceptance by the United Nations.

Source: Southern African Power Pool, 2016

SAPP, for example, has received funding from the World Bank and the European Investment Bank that is designated for transmission and distribution, energy generation (large hydro), and energy efficiency. The following case elaborates on SAPP and the basis for its foundation.

Most of the generation and transmission infrastructure of SAPP predates the formation of the power pool and was developed to fulfil the power demands of the two major power markets in Southern Africa, South Africa and the Democratic Republic of Congo copper belt. The underlying political and economic force behind the evolution of SAPP has been South Africa's desire to meet future increases in demand by importing low-cost hydropower from its northern neighbours (ECA, 2009). In order to attain sufficient generation capacity, additions within the power pool have been regular, with net capacity of 1,700 MW added in 2007, 1,442 MW in 2008 and 1,061 MW in 2012. The region is expected to have sufficient capacity by 2017.

Bilateral contracts dominate the trading arrangements in SAPP and often account for between 90 and 95 per cent of the energy traded. These bilateral agreements usually cover a period of 1-5 years or more and guarantee the security of supply but are not flexible enough to accommodate varying demand profiles and prices. In order to ensure a more competitive electricity trading platform, a Day Ahead Market was introduced in 2009. Between 2012 and 2013, however, only about 6 per cent of energy demand in the Day Ahead Market was traded. Transmission constraints remain a major issue within SAPP, with the African Development Bank funding new feasibility assessments (Oseni, M. and Pollitt, M. 2014).

CONCLUSIONS

In order to attain the long-term goal of increased sustainability of the power generation sector, near-term benefits, including economic gains, increased adequacy of electricity and increased reliability of electricity, should be seen as a priority in order to convince policymakers to pursue transboundary connectivity initiatives. These operational steps are an essential aspect of a long-term vision for energy connectivity within Asia and the Pacific as power trade evolves from bilateral to multilateral to integrated regional markets.

The established framework for planning, building, regulating and operating electric power systems is evolving. Demand, cost and fuel are no longer the only inputs on which power system regulators can base their decisions. Focus has begun to shift to a complex dynamic focused on outputs, including affordability, reliability, sustainability, resilience and environmental and sociopolitical goals. While the integration of VRE sources continues to increase, thereby making the supply of energy more volatile, power demand is becoming more dispatchable via demand response. The fundamental transformation currently taking place requires a rethinking of policies, business models and operations with respect to power systems. It also requires maintaining a vibrant global dialogue about policy design and governance mechanisms, and the deep engagement of the finance and investment

community. Sharing of critical knowledge and adaptation of best practices will help to make the transition more viable and successful (Brazilian, M. et al., 2013).

A review of existing regional energy connectivity initiatives in the Asia-Pacific region indicates that the benefits of energy connectivity have been acknowledged to varying extents in the region and important physical and institutional linkages are either in place or in developing phases. There are also prominent axes around which this connectivity is developing: the ASEAN economic community is an emerging and integrating energy demand block; gradual progress is being made in both SAARC and CASA renewable energy markets, with particularly large demand growth projected for India; and finally, North-East Asia is a highly import-dependent subregion, with China a dominant growing subregional and regional demand hub, but also with somewhat limited subregional energy cooperation at this stage.

Linkages are also already developing and further opportunities are being identified between these interconnecting hubs. ASEAN (through the GMS electricity market programme) is developing infrastructure ties with Southern China and, conversely, China is developing gas and oil trading links into ASEAN through Myanmar, which has also been considered by Bangladesh and India for gas trading.

However, while intraregional energy trading initiatives are developing and opportunities for reduced dependence on extraregional energy resources are emerging, established energy demand profiles are also ensuring that the region on the whole remains dependent for the foreseeable future upon external global energy supply chains – most notably, oil from the Middle East – and the increasingly liquid markets of LNG trading. These two markets pose different challenges and opportunities in the region because the increasing dependence on oil, especially on increasingly limited geographical supplies, significantly influences resource insecurity in the near term.

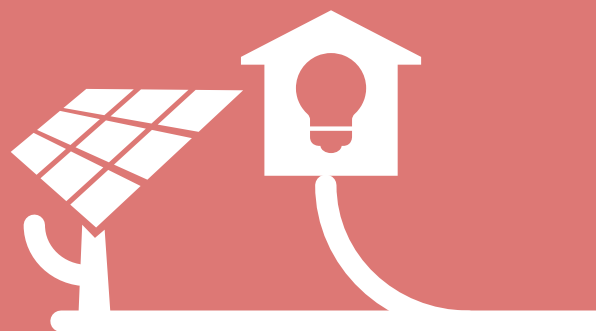
Most importantly, while there is general recognition of the benefits of regional energy connectivity at the subregional level in the Asia-Pacific region, many of these initiatives are very much in their early development stages, with the vast majority of energy trading existing on a bilateral level. In this regard, some patience will be required, as institutional capacity development is critical in terms of progress for regional integration, particularly in the energy sector, where more comprehensive engagement is required in terms of technical and regulatory harmony and the establishment of mutual dependencies in energy markets. However, there are currently significant movements happening in the region's energy sector and a more collective approach to development is likely to ultimately deliver the most sustainable end result (Atkinson, 2015).

Common issues and challenges regarding transboundary power trade on a regional, subregional and bilateral level include, inter alia, numerous barriers to be highlighted in ESCAP's National Energy Connectivity Survey, aimed at isolating the most critical barriers to regional and subregional energy connectivity on the national level. These common challenges, present in the majority of member States, include political, technical, regulatory and financial barriers. No single barrier is insurmountable; however, the combination often proves difficult to overcome, as evidenced by the global lack of regionally integrated power markets. While technical, regulatory and financial barriers can be overcome through effective policy, this requires political will, which is often lacking due to a number of factors.

Other challenges identified by participants of ESCAP's workshops and expert group meetings on transboundary power trade include: (a) understanding barriers to regional power trade and integration that differ from country to country and region to region; (b) removal of tariff and non-tariff barriers on trade in energy products and services; (c) energy networks becoming natural monopolies under public ownership; (d) investment required to build capacity; (e) large transaction costs for subregional projects; (f) subsidy issues and lack of sector reforms; (g) sustainability issues and phased approaches; (h) lack of institutional mechanisms for sharing of mutual gains between countries; (i) lack of technology and institutional matches; (j) weak political and technical leadership; (k) trust deficits; (l) difficult business environments for attracting private investors; and (m) governance issues.

Certain visions and objectives of each subregion regarding energy trade are clear; however, political commitment is needed from member States in order to achieve these objectives. Among subregions, social, economic and environmental benefits are the main drivers for increased connectivity. Obstacles vary by subregion but those most commonly cited include: lack of some form of trust; energy security concerns; investment concerns; lack of harmonized policies and clearly defined integration mechanisms; and communication issues among potential trading partners. These are challenges to be overcome in order to accelerate transition into a regional energy market. A number of subregions have experience with transboundary power trade and these initiatives should be learned from, by replicating successful aspects and properly addressing the barriers that provide substantial obstacles to interconnection. The common vision of sustainable and optimal use of available, affordable and reliable energy resources can be promoted through further transboundary power trade. Strong, transparent government commitments to broaden regional partnerships are a priority to address these obstacles and promote subregional initiatives. Cooperation could be accelerated on a subregional level through engaging major connectivity stakeholders, such as government, academic, private sector and technical experts.

In order to address the common challenges associated with increased transboundary power trade and the creation of an integrated regional power market, a regional mechanism is needed, with the goal of facilitating increased transboundary power trade through streamlining of contracts, increasing the availability of financing, reducing risk and accelerating project development through the building of established norms and mutual trust among parties. Key aspects for this way forward include: promoting energy interdependence; expanding supply and ensuring robust, reliable energy supply; unlocking large regional renewable energy resources; mainstreaming technologies that limit ecological footprints; attaining additional resources from the private sector; improving regional governance; and accessing thought leadership and knowledge-pooling within the region to underpin the sustainable development of the energy sector.



DEVELOPING EFFECTIVE POLICIES FOR WIDENING ACCESS TO ENERGY SERVICES

KEY MESSAGES



- To achieve SDG 7 – ensuring access to affordable, reliable, sustainable and modern energy for all – targeted policies and financial support are needed in many countries within Asia and the Pacific. Significant progress has been made but efforts are still not sufficient. Compared with improving access to electricity, improving access to non-solid fuels has been slower; this goal has not received adequate attention and continues to have severe socioeconomic impacts for the poor, particularly women and children.
- Current indicators of energy access fail to capture the quantity and quality of energy services provided, ignoring the concepts of affordability, reliability and sustainability, as well as the opportunities for development and productive use of energy. Modern energy services provide multidimensional benefits that include economic opportunity, gender equality, livelihood enhancement and environmental sustainability. Adopting a development-oriented approach is key to engaging partners and mobilizing technical and financial resources that will enable productive use of energy and sustain the energy access efforts.
- Appropriate institutional arrangements are necessary for planning, coordinating and implementing energy access policies and programmes, expanding policy dialogue, sharing knowledge, engaging relevant partners and mobilizing financing to ensure universal access to affordable, reliable and sustainable modern energy services.
- Stakeholder engagement for partnership-building is critical, as there are multiple roles to play and every stakeholder/partner must be responsible for the tasks for which they have a comparative advantage. Capacity-building of the government for communicating information, policymaking and implementation is essential, as well as capacity-building of the public with regard to costs, benefits, safety, deployment, operation and maintenance.
- Expansion of energy services requires significant investment and financing. An incremental annual global investment of \$40 billion is required to ensure universal energy access. Public finance alone would be insufficient to achieve universal energy access by 2030, and there is a need to leverage private finance, using appropriate structures and enabling environments. Innovative financing mechanisms include reallocation of public finance, issuance of “green bonds”, climate finance, crowdfunding and remittances; innovative business models and financial structures are also needed.

OVERVIEW

Universal energy access is one target of SDG 7 and an essential input for achieving other SDGs, such as those addressing equality, climate change, education, public health, clean water and sanitation. Widening access to affordable, reliable, and modern energy services requires working on two paths concurrently: achieving universal electricity access through accelerating both grid and off-grid programmes and increasing access to modern cooking fuels.

This chapter will outline the status of energy access in Asia and the Pacific, discuss issues and challenges, investigate policies and effective institutional frameworks for successful programmes on energy access and strategies to mobilize financing that engage various stakeholders, and propose policy recommendations.

ISSUES AND BARRIERS WITH ENERGY ACCESS

TRACKING ENERGY ACCESS AS A FOUNDATION FOR UNDERSTANDING AND ACTION

Energy access remains a prevalent issue in Asia and the Pacific; in 2012, despite significant progress, 455 million people lived without access to electricity and 2.06 billion people relied on solid fuels for cooking and heating (Asia Pacific Energy Portal, 2016).² In the past two decades, some countries have substantially expanded rural electrification through grid extension and off-grid energy systems. China, Lao PDR, Mongolia, the Philippines and Viet Nam had the highest growth rates for electricity access. Five countries – Bangladesh, Malaysia, the Philippines, Thailand and Viet Nam – have been most successful in grid extension, while off-grid systems, especially micro-hydro, solar lanterns and solar home systems, are apt to meet the needs of remote communities, and micro- and mini-grids can play an instrumental role in electrification efforts (UNDP, 2013). The electricity access challenge is most noticeable in South and South-West Asia, where 368 million people do not have access to electricity, and in South-East Asia, where 61 million people lack access (Asia Pacific Energy Portal, 2016).

Timely and accurate tracking is the basis for understanding and acting on energy access. SDG 7 provides two indicators for tracking: population with access to electricity and population with access to non-solid fuels. However, these definitions do not take into account the quantity and quality of energy access, if electricity access is only defined as a

² The calculation is based on population of ESCAP member States and GTF 2015 report. Off-grid systems account for the difference from the 621.5 million previously cited by IEA, because IEA uses utility data while GTF 2015 uses household surveys.

household electricity connection, an electric pole in the village, and an electric bulb in the house, because connected households may receive electricity at low voltages, for limited hours, during odd hours of the day (or night) and/or with poor reliability. Furthermore, people who get connected may not be able to benefit if they cannot afford the tariffs and necessary electrical appliances and technologies for better energy services. Hence, a binary measure of energy access, one that measures simply “having” or “not having” electricity, does little justice to the notion of energy access. Defining energy access based on household electricity connection also ignores energy needs for cooking and heating, as well as for productive engagement and community facilities.

A multi-tiered framework has been piloted in a few locations, and plans are under way to launch a global access survey that will allow such data to be available in a standardized format for many countries (World Bank and SE4All, 2015). The multi-tiered framework, illustrated in Annex 1, distinguishes types of appliances and annual consumption levels, in order to measure access to household electricity services based on type of appliance used and consumption. The multi-tiered framework works on the premise that the services provided by energy are critical ingredients for socioeconomic development, recognizing that access to energy services is useful only to the extent that people, especially the poor, are actually able to use and benefit from them, and that there are numerous attributes of the energy supply that affect the usability of energy, such as adequacy, capacity, availability, reliability, affordability, quality, legality, health impact, safety and convenience, among others.

TRANSITIONING TO NON-SOLID FUEL

Compared to progress on access to electricity, improving access to non-solid fuel for cooking has been slower; this goal has not received adequate attention and continues to have severe socioeconomic impacts for the poor, particularly for women and children. Of the 53 member States of ESCAP, 21 had reached 100 per cent electrification by 2012: Armenia, Australia, Azerbaijan, China, Georgia, Iran, Japan, Kazakhstan, Kyrgyzstan, Malaysia, Maldives, New Zealand, Republic of Korea, Russian Federation, Samoa, Singapore, Tajikistan, Thailand, Turkey, Turkmenistan and Uzbekistan, but only five countries relied fully on non-solid fuel: Australia, Brunei Darussalam, Japan, New Zealand and Singapore (Asia Pacific Energy Portal, 2016). From 2010 to 2012, there was negligible overall progress, with annual growth in access to non-solid fuels falling globally by 0.1 per cent, well short of the 1.7 per cent target growth rate required to reach universal access by 2030.

In 2012, 2.06 billion people in the region still relied on traditional biomass fuels such as firewood, charcoal, animal dung and agricultural residues for cooking and heating, with most of this population located in rural areas; 78 per cent of rural population, compared to 12 per cent of urban population, lacked access to non-solid fuels for cooking and heating (Asia Pacific Energy Portal, 2016). Large parts of these populations live in Cambodia, India, Indonesia, Lao PDR, Myanmar, the Philippines and Viet Nam. Among solid fuel users, improved biomass cookstoves are used by only 11 per cent of the population in South Asia, 21 per cent in South-East Asia and 85 per cent in East Asia (ADB, 2015).

Transitioning to non-solid fuels reduces indoor air pollution, promotes public health and increases gender equality. Because of their central role in food preparation, women have more exposure to indoor air pollutants. Children, who often assist their mothers in their household roles, also bear some of the disease burden. Furthermore, gathering cooking fuel requires huge amounts of time and effort, thus depriving women and children of the chance to rest, get an education or engage in entrepreneurial ventures that could increase the family's income and purchasing power. Each year, about 165,000 premature deaths in Indonesia can be attributed to indoor air pollution linked to smoke emitted from solid cooking fuels (ASTAE, 2013). Women in rural Gujarat spend up to 40 per cent of their waking time collecting fuel for cooking (World LP Gas Association, 2014). Unguarded candles and wick lamps are intrinsically unsafe and lead to injury and deaths, particularly among women and children. During 1998 and 1999, 151 of 487 patients (31 per cent) aged 12 years and older who were admitted to the National Hospital in Colombo had accidental burns from kerosene lamps (Practical Action, 2014).

Although the indicator for SDG 7 measures the percentage of population with access to non-solid fuel, many of the programmes focus on improved cookstoves, which increase energy efficiency, produce less smoke than traditional stoves, reduce costs and are easy to install. However, recent research also shows that the available range of improved cookstoves can mitigate these harmful effects only to some extent and that only the cleanest cooking solutions can truly bring about transformational health and environmental outcomes (ESMAP and GACC, 2015). In addition to the technical performance of the cookstove, other factors that should be considered for transitioning to non-solid fuels include local cooking habits and cultural backgrounds (Global Alliance for Clean Cookstoves, 2016). One initial question may be whether it is possible to cook all types of traditional food in this way. Another issue may be whether traditional fuels – usually solid fuels – make local food taste better. The acceptance and comfort level of using non-solid fuels in local communities needs to be assessed. Fuel availability in local communities also needs to be ensured to guarantee long-term use of the programme fuels and reliability of the transition to non-solid fuels, considering that most of these areas are rural areas where transportation is neither convenient nor affordable. Other concerns include: is the design of the cookstove easy to operate and maintain, can the user sit or stand in a convenient posture in front of the stove, and is it safe to use in the proximity of children and the whole family? In addition, the stove needs to be durable and easy to maintain, preferably made with locally available good quality material so that it can be repaired using local materials.

ENSURING AFFORDABILITY, RELIABILITY AND SUSTAINABILITY

Ensuring affordability, reliability and sustainability is key to achieving SDG 7 and other energy-relevant SDGs; however, policy interventions and financial assistance are required to overcome barriers. Affordability refers to the ability of energy-poor households to pay for needed energy services. It can be measured in terms of the share of a household's energy-related expenditures in its total expenditure of income. Assessment of affordability considers variations in acceptable minimum levels of basic energy services, corresponding energy service costs, and income levels across countries and subnational regions, rather

than requiring a common set of values for these parameters (ADB, 2015b). Historically, the main obstacles to wider LPG use in developing countries have been affordability and availability (Global Alliance for Clean Cookstoves, ENERGIA and SE4All, 2014). Caught in an energy poverty trap, poor people cannot get enough income to pay for energy access, which in turn keeps their productivity low, keeping energy access unaffordable (IDS and Practical Action Consulting, 2015). Governments in Indonesia, Thailand and Viet Nam have, through deliberate policy, promoted the establishment of LPG infrastructure as well as pricing and equipment packages that make LPG accessible to middle- and sometimes low-income households in urban, suburban and even rural areas. It is clear that, of the three billion households worldwide without access to clean cooking energy, there are many that could afford to switch to LPG if other obstacles could be reduced (Global Alliance for Clean Cookstoves, ENERGIA and SE4All, 2014). When there are financial barriers for the end users, it is important for policymakers to formulate business models and financial mechanisms that can bring down the costs and make energy services affordable. On the other hand, globally, the poor already spend \$37 billion on poor-quality energy solutions to meet their lighting and cooking needs each year (IFC, 2012). More than 90 per cent of households without access to clean lighting and cooking solutions could technically afford improved products and services, since they already spend more on traditional energy than the commercial cost of superior, more modern energy. Based on current spending patterns and the cost of modern alternatives, some 256 million households could afford improved lighting and 394 million could afford cleaner cooking solutions (IFC, 2012).

Energy access is also an issue of adequacy, reliability and quality (World Bank Independent Evaluation Group, 2015), which is often the major concern for off-grid and isolated systems. Adequacy is the ability of the system to meet consumer needs for electricity use and reflects the available electricity generation capacity. Reliability is measured, from the consumer's perspective, by the frequency and duration of power sector outages, the extent of advance notification about service interruptions and the time required for service restoration. Reliability also relates to the condition and management of the transmission and distribution network; it is measured, from the electricity producer's perspective, in terms of equipment and service breakdowns. The quality of electricity supply is measured, to the extent possible, in terms of data relating to voltage and frequency variations within specified standards of service, as well as impacts on equipment and quality of life (World Bank Independent Evaluation Group, 2015). Operation and maintenance of the systems can be a problem, which interferes with availability and reliability of modern energy where and when they are needed. In areas that are connected, electricity supply is a serious issue, as many locations suffer from frequent blackouts and power shortages (ESMAP and SE4All, 2015). There is evidence to show that the quality of the electricity supply is a significant determinant of how people use it, for consumption and for achieving poverty reduction outcomes. Blackouts or fluctuating voltage cause damage to appliances and products, which can lead to losses and force enterprises to stop operation. For example, in 2013, the average number of power outages in a typical month was as high as 64.5 in Bangladesh, 6.0 in Cambodia, 8.7 in Nepal, 75.2 in Pakistan, 6.1 in Tajikistan, 1.7 in Turkey and 5.7 in Uzbekistan; in 2014, the average number of power outages in a typical month was 11.5 in Afghanistan, 13.8 in India and 12.5 in Myanmar (World Bank, 2016). It was estimated that increasing average availability of electricity at the village level by one hour increases the rate of household adoption by 2.7 percent and electricity consumption by 14.4 per cent (IDS and Practical Action Consulting, 2015).

Box 4.1 **Key factors that influence household fuel choices**

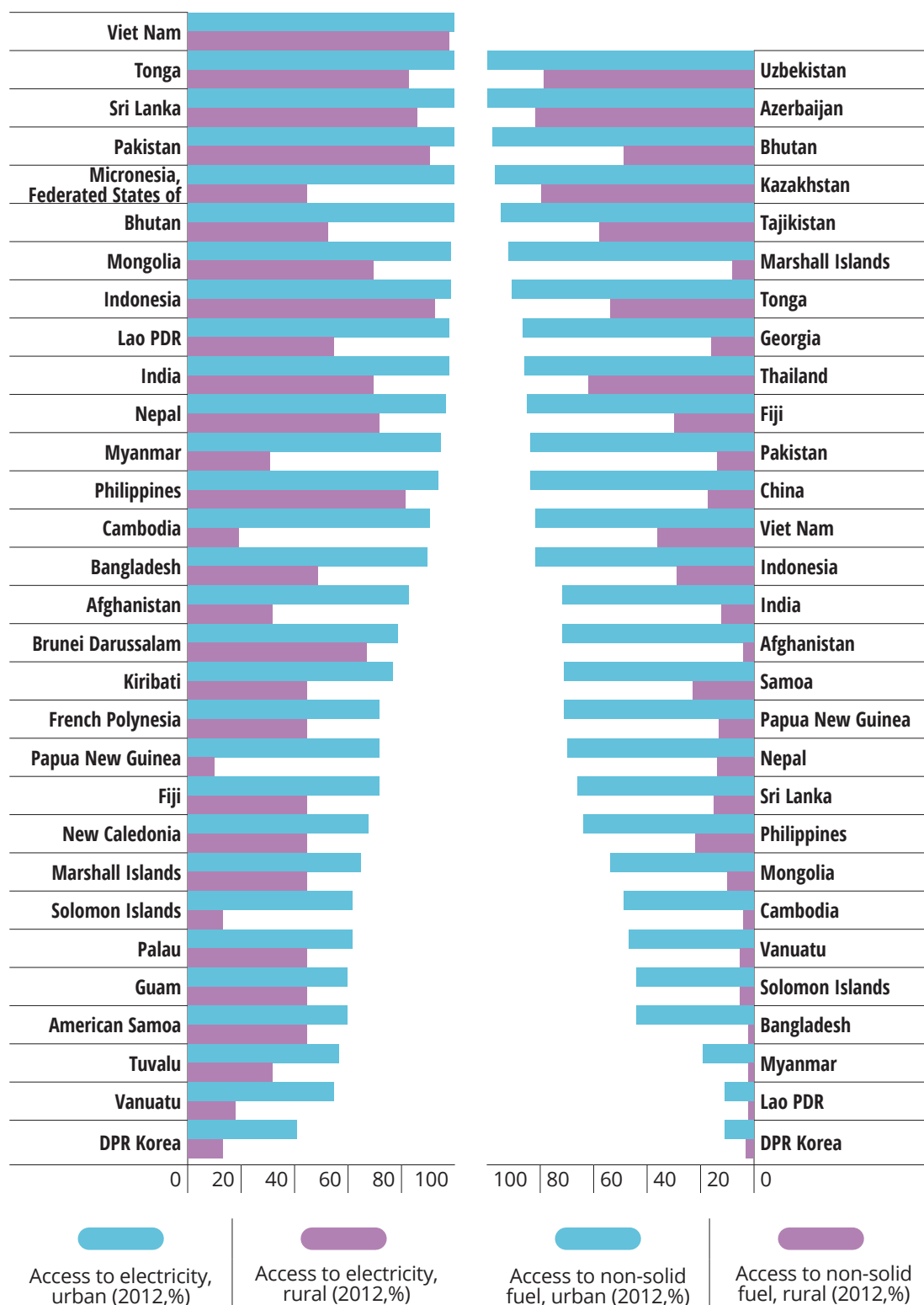
In 2009, a household survey was conducted in selected districts of Central Java and DI Yogyakarta, Indonesia, to examine the factors that influence household fuel choices and fuel switching. Fuel cost was identified as the main reason for changing fuels; firewood is available locally at little or no cost, aside from the time and labour spent collecting it. Nearly one third of respondents reported switching fuels because of changes in fuel subsidies, while more than one quarter said they were looking for cheaper fuels. Fifteen percent said they were seeking fuels that were easier to obtain, because LPG distribution networks tend to be limited to urban and peri-urban areas. Others reported a desire for better-tasting food, a cleaner cooking environment and greater ease of use. Most households also rely on a mix of cooking fuels rather than a single one, especially when alternative fuels are available at an affordable price (ASTAE, 2013).

Sustainability encompasses the economic, technical, social or ethical, environmental, and organizational or institutional dimensions of sustainable development (ADB, 2015b). In fact, the benefits of rural electrification continue to accrue to non-poor households and productive application of electricity is rare (World Bank, 2008). As electricity is mostly used for meeting basic energy needs, its direct impact on income generation or economic growth is limited. The quality of supply is often unsatisfactory and rural consumers do not receive reliable supply when they need it. Providing sufficient quantity and quality of reliable and affordable electricity is an essential part of breaking the energy poverty trap. Maximizing the socioeconomic benefits of energy access requires extending energy services to the underserved, to provide sustainable livelihood opportunities and income-generation activities. Providing access to improved energy services is one necessary condition for achieving poverty reduction, economic growth and the full range of social benefits that energy services make possible – e.g. pumping water for drinking and irrigation, enabling informal or home-based enterprises, such as mini grocery stores and small food kiosks, to operate in the evening, enabling children to study at night, giving women greater flexibility and helping them organize their work better and enabling health clinics and hospitals to attend to regular needs and make lifesaving interventions, even at night.

INEQUALITY

Economies have been growing unevenly between countries as well as within countries – e.g. between urban and rural areas, between rich and poor, between women and men. Inequalities between countries remain greater than those found within them, although inequalities within many countries have widened increasingly. On a per capita basis, households in Australia or New Zealand consume 100 times more electricity than those in Bangladesh and Myanmar (Asia Pacific Energy Portal, 2016). Between 2010 and 2012, electrification covered 222 million people globally, out of which only 46 million people

Figure 4.1 **Urban and rural energy access rates, selected countries, 2012**



Source: Global Tracking Framework Report 2015. <http://www.se4all.org/sites/default/files/l/2013/09/GTF-2105-Full-Report.pdf>

were in rural areas — about 36 million of them in South Asia. Furthermore, within each country, there is obvious inequality in electrification between urban and rural areas, and this is also the case for access to non-solid fuel.

Lack of access to modern energy sources is both the result of and a cause of poverty, as numerous inequalities interact and reinforce each other. The poor are less likely to have access to electricity and clean cooking fuels, due to such various factors as small and dispersed consumption levels, inconvenient geographical locations and costly grid extensions, and they end up paying more for the same amount of energy than other income groups. Generally, 20 to 30 per cent of annual income in poor households is spent on energy services and fuels, and another 20 to 40 per cent is spent on associated indirect expenses, such as health-care costs related to indoor air pollution and injuries linked to biomass fuel use, or the costs of lost time. In extreme cases, some of the poorest households spend 80 per cent of their incomes obtaining cooking fuels (Sovacool, 2013).

Access to clean energy for cooking affects women and children in myriad ways. Some of the burdens affecting women in particular include: physical injuries from collecting fuelwood; health impacts of indoor air pollution caused by use of solid fuels; costs of fuel, stoves and health care; and time required for collecting fuel and water and for cooking, which reduces potential time and opportunity for gainful employment and leisure. The majority of fuel collection and transport is carried out by women and girls; head loads of 20 kg or more and distances of up to 12 km travelled are not uncommon (Global Alliance for Clean Cookstoves, ENERGIA and SE4All, 2014). In some developing countries, girls spend more than 7 times as many hours collecting wood and water as adult males and 3.5 times as many hours as boys the same age. In India, a woman may spend 40 hours per month walking to collect fuel on 15 separate trips that can each be over 6 km round trip. Cumulatively, this amounts to 30 billion hours annually (82 million hours per day) spent on collecting fuelwood, with an economic burden (including time invested and costs of illnesses) of \$6.7 billion (300 billion rupees) per year (Sovacool, 2013).

POLICIES AND EFFECTIVE INSTITUTIONAL FRAMEWORKS FOR SUCCESSFUL ENERGY ACCESS

Remote locations, susceptibility to natural disasters, and small and dispersed energy consumption are some of the challenges to universal energy access. Further challenges arise from the lack of economies of scale, high transportation and communication costs, expensive public administration and infrastructure, and the lack of skilled human capital, all of which seriously challenge the affordability, reliability and sustainability of widening access to energy services. The lack of institutional, human, technical, fiscal and material resources serves as a barrier to policymaking and implementation; thus political commitment

and adequate institutional architectures are prerequisites. To be successful, policies and programmes on energy access must address these issues and barriers. General strategies include: emphasizing energy access for productive purposes; recognizing country-specific needs; developing knowledge-sharing strategies; integrating renewable energy and poverty reduction as key goals; strengthening institutions; setting up technical guidance, quality standards and codes; and refinancing facilities to engage civil society and private companies (UNDP, 2013b).

In the Asia-Pacific region, most countries have set up national priorities, plans and targets for energy access; some countries even have legislation addressing energy access. Annex 2 provides an overview of these policies.

ADOPTING A DEVELOPMENT APPROACH FOR ENERGY ACCESS

Adopting a development approach is a prerequisite for energy access, as lack of energy access deprives people of a modern way of life, productive activities and development opportunities, as well as leading to deteriorating environments, biodiversity loss, air pollution, health problems and gender inequality. Because energy access is a development issue, a sector-wide approach needs to be adopted. The persistent challenges are how to provide electricity to the poor, who are currently deprived and, more importantly, how to help them strengthen livelihoods and escape poverty. In addition, a successful policy considers not only the appropriateness of the technology for the needs of the target communities, but also how these needs will change and grow over time, requiring larger capacity or different technologies (Sovacool, 2013).

Universal electrification of Central Asia through a unified energy system provides one example. Countries like China and Thailand have been successful in providing reliable access to electricity through grid extension, while distributed generation through mini-grids and stand-alone systems can serve as either interim or long-term solutions to provide electricity access. Significant growth for renewables has been observed in countries like China and India and this trend is expected to continue across the Asia-Pacific region.

When good quality electricity is available, it provides social and gender equality benefits. It enhances the efficiency of domestic chores such as cooking, thereby encouraging participation by women in the labour force (Rama et al., 2015). Electricity is a factor that affects women's literacy and reading in Bangladesh and India (Barkat et al., 2002; Barnes and Sen, 2004). Access to electricity and modern forms of energy can facilitate the provision of adequate food, shelter, clothing, water, sanitation, medical care, education and access to information (UNDP, 2013a). In principle, electricity can lead to both direct and indirect impacts, including higher profitability and income for owners of businesses, higher employment and higher wages, which could help to raise poor people out of poverty.

In reality, however, current access to electricity supply is insufficient to trigger productive uses, which depend on a number of other enabling factors. These include: financial circumstances of businesses; appliance/equipment ownership; pre-existing productive

activities; and skills to identify the new business opportunities created by electricity, to use electrical equipment efficiently, to access new markets to absorb additional production, etc. Other conditions also need to be in place, including: roads that allow access to external markets; access to credit to purchase end-use technologies; training programmes and professional support for enterprise creation, business promotion and development; demonstration projects on the use of electrical appliances for irrigation and for industries; and technical assistance in converting enterprises to electricity.

Viet Nam provides an example of an electrification programme designed to support local economic and social growth. Viet Nam's electrification system is characterized by central governmental planning, with major provincial inputs and initiatives, all within the framework of a comprehensive rural development programme. The prioritization of economic concerns guided Viet Nam's electrification programmes from the start. Linking urban/industrial areas to the grid early on enabled enterprise development and the growth of key industries, and increased government revenues through taxes. The later policy shift, to spread electrification among communities, created a second tax base for the government, even as standards of living rose at the household level. Coordination of rural development zones and infrastructure by local governments ensured the provision,

Box 4.2

Combining rural electrification with local economic growth: the Viet Nam Rural Electrification Programme

Viet Nam rapidly expanded its rural electrification to more than 80 million people over the course of three decades, from no more than 2.5 per cent in 1975 to 99 per cent of the population in 2012.

In the post-war period of the 1970s, Viet Nam was a rice-producing country, which determined the priorities for electrification. Early rural electrification programmes connected the rice-producing areas of the Red River Delta in the north to the Mekong River Delta in the south, bringing modern industrial processes to rice production, supporting local industries and boosting local economies. Electrification was also tied to the objectives of national economic programmes focusing on commercial aspects, such as production of food, consumer goods and export commodities. In the initial period, connecting agricultural areas, industry and transport took precedence over residential connection in rural areas.

Within the decade, Viet Nam started to tap into its renewable energy sources, setting up hydropower plants in the northern highland areas, followed by construction of high voltage transmission and distribution lines that connect hydropower sources with the industrial base to meet the rising power demand of industries. Viet Nam prioritized irrigation systems and small rural industries for rural electrification, ensuring that power was not only flowing to major cities, but countrywide in support of local economic development. However, the low prioritization of households created fully electrified districts that were full of non-electrified households.

The state utility, EVN, led the widespread sector reforms, rationalized power sector institutions and functions, and adopted a planned approach for rural electrification, which jumped from a pre-reform rate of less than 50 per cent to 77 per cent electrification by 2001. Targets and priorities were then shifted from electrification for agricultural areas and businesses towards electrification for poor households. The government has set a target for 100 per cent electrification of rural households in mountainous areas by 2025.

Source: ADB, 2011; World Bank, 2011; Asian Pacific Energy Portal, 2016.

maintenance and staffing of rural electrification along with the establishment of schools, clinics and roads, resulting in key development synergies.

China presents another example of this multisectoral approach, having extended electricity access to more than 900 million people over a period of 50 years. China relied on a pragmatic approach involving multiple technologies (small hydro, coal and renewable energies), multiple delivery options (central grids, local grids and hybrid systems), and an emphasis on rural development and a strong role for local government (Bhattacharyya, 2012). China promoted industrial activities through town and village enterprises (TVEs) after economic reforms in 1978. China's focus on agricultural development in the planned economy phase and on TVEs in the reform era highlighted the recognition that rural energy supply is closely linked to economic development. Through sustained rural economic activities, China was able to rapidly reduce rural poverty and improve the living conditions of its population by widening access to energy services.

STRENGTHENING INSTITUTIONAL DEVELOPMENT

Appropriate institutional arrangements are necessary for planning, coordinating and implementing energy access policies and programmes, expanding policy dialogue, sharing knowledge, engaging relevant partners and mobilizing financing to ensure universal energy access. A sector-wide development approach to energy access can lead to longstanding and substantial engagement of governmental agencies and development donors. Sound institutional frameworks and timely, effective intergovernmental coordination are prerequisites for channelling donor funding, planning development strategies and cooperating with neighbouring states on cross-border power trade, as well as regulating efforts towards long-term sustainable development. A competent and responsive national institution, accountable for delivering results in terms of reliability, quality and timeliness, is required. These criteria are interrelated and depend on governmental actions and policies. For instance, reliability and quality depend on the actions taken to augment the capacities of the grid operator, potential mini-grid operators and household system installers. Reliability and quality of service provided by the grid also depend on actions taken to add and maintain adequate generation capacity and maintain the network.

To satisfy country-specific development priorities, national governments should effectively manage funds and resources for targeting national development goals. Prioritization and regional initiatives could resolve competition between sectors for limited public funding. A positive and open environment for dialogue and cooperation with the development partner community to finance national electrification programmes, as well as knowledge exchange to help the government carry out sector reforms, will strengthen institutions and improve sector performance and efficiency (World Bank, 2011).

Strengthening institutional capacity involves: reviewing the mandates of relevant government sectors to identify their constraints as well as technical and financial capacities; streamlining the government sectors to promote cooperation and coordination; promoting collaboration between governments in planning and implementing; ensuring appropriate legislative frameworks; establishing an appropriate regulatory framework; developing a legal and institutional framework; and formulating policy frameworks (ADB, 2015c).

Box 4.3   Institutional development of Alternative Energy Promotion Centre (AEPC) Nepal

The Alternative Energy Promotion Centre (AEPC) was established in 1996, under the then Ministry of Science and Technology, with the objective of developing and promoting renewable/alternative energy technologies in Nepal. Working with external development partners and domestic stakeholders, AEPC has emerged as a capable and strong governmental institution for rural energy development.

AEPC has gone through several development phases. Initially, AEPC worked with donors on institutional development and programme implementation. The Energy Sector Assistance Programme (ESAP I&II), funded by the Danish and Norwegian governments, the Rural Energy Development Programme, funded through UNDP and the World Bank, and the Renewable Energy Programme, funded by the European Union, built up the institutional capacity of AEPC to manage sizable energy programmes. After implementation of a few projects, the Government of Nepal and development partners entrusted AEPC to manage the National Rural and Renewable Energy Programme (NRREP 2012-2017), a \$170 million multi-donor-funded programme for promotion and expansion of rural energy services in remote areas. ADB, the World Bank, ESCAP, UNDP, GEF, UNCDF, the German government, and Netherlands Development Organization (SNV) have partnered with AEPC on different aspects of rural energy development.

Through outreach by Regional Service Centres and District Energy and Environment and Climate Change Section/Units, AEPC supports project developers (communities, households, manufacturers, installers and distributors) in preparing bankable projects. AEPC has succeeded in establishing the Central Rural Energy Fund as a key financial institution, to select banks to administer subsidies and facilitate soft credit to developers for rural and renewable energy promotion. AEPC pre-selects subsidy applications and is responsible for technical verification before submitting to the handling bank for financial verification and payment in accordance with the government's Subsidy Policy and Delivery Mechanism. Currently, AEPC is working with development partners to develop its Strategic Organizational Development plan, promulgating AEPC action for further organizational strengthening to tackle emerging development needs while responding to increasing demands for expanding energy services. AEPC has earned recognition as an apex body for renewable energy technologies promotion.

At a broader level, Nepal has developed good policy and institutional frameworks, introducing the Rural Energy Policy 2006, Renewable Energy Subsidy Policy 2013 and Renewable Energy Subsidy Delivery Mechanism 2013, which describe technical standards for various technologies. The Government of Nepal is prioritizing the renewable energy sector and attracting more external development partners to scale up renewable energy technologies in various locations.

As a result of AEPC's efforts, nearly 3.5 million households in Nepal have benefited from various kinds of renewable energy technologies. AEPC support has contributed to around 30 MW of electricity generation through microhydro systems, 700,000 solar home systems and 350,000 biogas systems. The biogas, improved cookstoves and microhydro programmes from AEPC have been successfully registered as Clean Development Mechanism projects that generate revenues from carbon trading.

BUILDING PARTNERSHIPS

Engaging relevant stakeholders to build partnerships is critical, as there are multiple roles to play and each stakeholder/partner must be responsible for the tasks for which they have a comparative advantage. The existence of different stakeholders with clear roles and mechanisms for interaction and coordination across the value chain is a key factor in building partnerships. Leveraging business as much as possible to increase energy access should be a priority, as this allows energy access to be directed towards reaching the “last mile”.

Governments play a central role in planning, regulating, measuring, policymaking and implementation, but the private sector or public institutions also balance the costs and revenues at affordable levels and ensure long-term operation of systems. For example, the ESCOs in Fiji are allowed to adjust tariffs to ensure that reliable performance is viable on a site-by-site basis and to ensure that adequate financial incentives are in place for expansion of supply in rural areas (Asia Pacific Energy Portal, 2016).

Participation of local communities, investors and consumers in the design and delivery of energy services is essential (Sovacool, 2013). A success factor identified in the Vietnamese rural electrification effort has been the building of effective partnerships among the state utility, local authorities and communities, specifically through the sharing of costs and responsibilities among stakeholders. The role of different players varies from project to project and evolves from one stage to another within a project. In some places, introduction of new actors or networks such as cooperatives and associations further intensifies cooperation and initiates coherence with the larger community in the area.

Building partnerships with communities ensures provision of appropriate energy services, promotes community ownership and responsibility, increases contributions of labour, time and other resources, and encourages participation in decision-making, planning and implementation (Sovacool, 2013). It is also critical for daily operation and maintenance. Engaging local stakeholders can make it possible to reach poor, difficult-to-reach communities with modern energy and offer opportunities for scale-up. A growing number of entrepreneurs are demonstrating – often at a relatively small but rising scale – that profitable ventures can be built in low-income markets (IFC, 2012). Local small and medium-sized enterprises (SMEs), social enterprises, non-governmental organizations (NGOs) and conglomerates are succeeding in selling modern lighting and cooking devices, off-grid electrification and, to a smaller degree, grid extension services to the poor.

Box 4.4 The Pro-Poor Public-Private Partnership Model

The Pro-Poor Public-Private Partnership (5P) approach, championed by ESCAP, is an innovative approach for widening access to energy services for rural development. Drawing on the logic of traditional PPPs, the 5P approach aims at mobilizing private-sector financing to develop rural energy utilities that are technically sustainable and ultimately financially self-sustaining. In this regard, 5P lies between profit-oriented public-private partnerships and socially oriented grant-based projects. The 5P model differs from a traditional public-private partnership in three ways: 1) 5P is participatory and involves a broad number of stakeholders; 2) while profit is not disregarded, the core of the 5P approach is rural development through livelihood enhancement of the rural poor; 3) 5P is inherently cooperative rather than competitive. Rural communities are not viewed solely as consumers of energy utility, but also as partners, through utility co-ownership and management. These partnerships are characterized by sharing investment, responsibilities, risks and rewards among partners. The role of the public sector is to facilitate these partnerships through enabling policy frameworks.

However, rural energy projects are still perceived as high-risk investments, typically with high up-front costs and low rates of return. To diminish the perceived risks in rural energy, 5P attempts to redefine the roles of energy project stakeholders, focusing on community participation and management, ownership and enterprise development. Beyond the private sector, community mobilizers, NGOs and civil society, among others, can be engaged to assist the project stakeholders in understanding the potential income-generating activities gained from productive energy use and to support livelihood development and sustainability of the energy utility.

Community-based management of rural energy utilities is not a novel concept. However, lack of appropriate training for operation and maintenance, along with minimal monitoring, has often led to long-term equipment failure, particularly in microhydro plants. The risk of long-term utility failure creates a large disincentive for rural energy investment. The 5P approach attempts to alleviate this risk, by engaging the private sector beyond the role of investor, as a key stakeholder in the project. A private sector stakeholder has incentive to ensure the long-term operation of the energy utility in order not to jeopardize the potential revenue generated.

The role of women and their networks in household energy access is increasing. As end users, women know more about everyday energy needs and are in a position to drive demand and to catalyse more consistent and sustained adoption and use. Their input contributes greatly to the design and manufacture of cookstoves that are more appropriate for the target market. Many women are engaged in SMEs, especially those are home-based, informal and likely to gain the most from energy productivity gains. Women can leverage their networks to promote adoption of new technologies and use their firsthand experience to market clean energy solutions effectively. They can serve as spokespersons for the use of clean energy, endorsing marketing messages and taking advantage of woman-to-woman communication strategies. The Sakhi Unique Rural Enterprise (SURE) in India, for example, works with over 1000 women entrepreneurs in clean energy products. In doing so, it directly connects the women entrepreneurs to public and private institutions that can provide them with the funding and technical assistance they need. SURE emphasizes customer service and works closely with the women entrepreneurs to provide high-quality after-sales service. In Indonesia, Kopernik, a social enterprise, sells clean technologies through a women's workforce. Empowering women for universal access requires a willingness to create a level playing field for women as energy entrepreneurs, as well as systems and mechanisms that will help them overcome the additional constraints they face, which requires sustained investment support.

CAPACITY-BUILDING

Capacity-building is critical on numerous fronts: for the government to track energy access and to communicate, make and implement policies; for the public to understand costs, benefits, safety, deployment, operation and maintenance of energy facilities; and for the private sector to understand and act on energy access. At the regional level, ESCAP launched the Asia Pacific Energy Portal, an innovative energy platform combining nearly 200 statistical indicators and over 2,000 policy documents for ESCAP member States, offering a comprehensive view of the region's energy dynamics. Similar information platforms are needed at the national and local levels, to provide stakeholders with accurate, easily accessible and regularly updated information about the status, technology, policies, measurement and progress of energy access.

At the national level, it is necessary for member States to build capacity for tracking energy access using the multi-tier framework for more accurate measurement and to be able to align energy access with other national development priorities. Capacity-building is also needed for policymaking, implementation, monitoring, intergovernmental coordination and institutional strengthening. Training, workshops and dialogues at the regional level could enhance the planning, research, statistical and implementing capacities for national governments.

Consumer education and awareness play an important role in transition to electricity access and cleaner fuels, such as LPG. A recent study found that households in India currently prefer more expensive traditional fuels over subsidized LPG; even though 72 per cent of these households believe traditional fuels have adverse impacts on their health, only 59 per cent believe that LPG has positive health benefits over traditional biomass-based cooking (CEEW, 2015). Involving women in capacity-building, as well as in lobbying for better regulation and enforcement, can empower them with knowledge and control of cleaner fuels. Technology innovations also need to be pursued that will make LPG stoves and the entire supply chain safer and more convenient for users.

Effective capacity-building also includes strengthening the technical or managerial capacity of private and public firms, and educating villagers and communities about productive energy use (Sovacool, 2013). Technical failures are frequent complaints about off-grid systems, as it is a challenge to retain experienced and trained staff for regular system operation and maintenance. Undertaking capacity-building initiatives, with particular focus on operation and maintenance, can help to ensure reliable energy supply. Involving utilities in assessing grid stability issues, in order to better understand the constraints and identify solutions, can help to ensure utility system stability.

ENSURING AFFORDABILITY FOR CONSUMERS

Ensuring energy access, especially when off-grid systems are the least-cost options in remote areas – which means the electricity generated is often expensive – is an issue not only about affordability, but also about equity, reliability and sustainability. The development of mini-grid and off-grid systems is particularly important in rural areas and small islands in the Asia-Pacific region. In Indonesia, the “1000 Islands” programme aims to expand electricity access in the outer islands using solar-diesel hybrid systems (IEA, 2015). Micro-grids and household energy systems are least-cost and they are effective for low load areas that are far from the grid. However, the electricity provided by off-grid systems is often too expensive for poor customers to afford; thus subsidies are necessary to ensure that electricity is affordable and perceived to be fair in rural areas (World Bank, 2011). In most countries in the region, a substantial share of public spending goes into subsidies – mostly for food, fertilizer, gas and electricity. Energy subsidies in India and Sri Lanka amount to about 2 per cent of their respective GDPs; Pakistan and Bangladesh spend well over double that amount (Rama et al., 2015). Six economies in Asia subsidize fossil fuels by more than 25 per cent of their supply cost. In principle, subsidies can provide a much needed safety net for the poor against price fluctuations. However, unless well-targeted, they can end up benefiting the relatively rich more than the poor (ADB, 2015d), thereby missing the very point of providing subsidies. In the case of subsidies for LPG in India, the government did not differentiate between the rich and the poor and the subsidy scheme benefited the relatively better-off segment of the population. The average household in the poorest quintile has a less than 20 per cent probability of using LPG, compared to almost 100 per cent probability for an urban household in the richest quintile (Rama et al., 2015). Because of the high initial cost of connection and cooking appliances for LPG, and the availability of cheap alternative fuels for cooking, LPG use among the poor remains limited. In Pakistan, the poorest 40 per cent of households receive less than 30 per cent of total electricity subsidies, while the richest 20 per cent receive close to 40 per cent of total subsidies. Targeting of energy subsidies remains a critical socioeconomic issue for energy planners.

New business models can provide viable solutions to reach poor, difficult-to-reach communities with modern energy and offer opportunities for scale-up. Local SMEs, social enterprises, NGOs and conglomerates are succeeding in selling modern lighting and cooking devices, off-grid electrification and, to a lesser degree, grid extension services to the poor. In Myanmar and Cambodia, for example, a fee-for-service model allows the poorest to pay for a very small amount of electricity. Customers can choose various packages – for example, for just enough electricity to power two fluorescent light bulbs for about \$4/month. This “pay-as-you-go” scheme has successfully provided first-level electricity access to low-income households. In Cambodia, a Rural Electrification Fund was created with the goal of providing electricity access to 70 per cent of the population by 2030. The fund provides interest-free loans to households to help increase connections and also provides financial support for solar home systems.

STRATEGIES TO MOBILIZE FINANCING THAT ENGAGE VARIOUS STAKEHOLDERS

Significant financial resources will be needed to address the energy access challenges in Asia and the Pacific. The focus of these investments will need to be in South and South-West Asia, South-East Asia and the Pacific, where energy access challenges are particularly severe (SE4All, 2015). SE4All estimates that \$49.4 billion will be required annually to meet universal energy access, out of which \$40.3 billion will be incremental (SE4All, 2015). However, considering the current baseline investment levels, investments in non-solid fuel access will need to increase by a factor of 44 by 2030 to ensure universal access, compared to a factor of 5 for electricity access by (SE4All, 2015).

Government resources, even augmented by loans, carbon finance and development assistance, will not be enough to provide such high levels of investment and there is a role for private finance to play. To engage the private sector, Asia-Pacific countries need: strong financing institutions and ecosystems that can develop and implement energy access projects; national finance architecture, consisting of national development banks, commercial banks, capital markets and structures to lower the risks of investments; and progressive policy and regulatory frameworks that encourage private sector participation and investment. Due to the high initial investments and low returns associated with energy access investments, Asia-Pacific governments have either directly financed energy access efforts or used regulatory instruments and incentive frameworks to encourage energy access investments by energy utilities. International development agencies such as the World Bank, ADB, UN agencies and NGOs, as well as philanthropic and impact financing, have all contributed in varying degrees to increasing energy access in Asia and the Pacific.

In the Asia-Pacific region, the role of the private sector in energy access has been generally limited to electricity generation through Independent Power Producers (IPPs) or as equipment manufacturers and suppliers. The private sector has been less involved in the transmission and distribution verticals in the electricity sector. The private sector may be useful in making distribution infrastructure investments in areas with high concentrations of consumers, where the return on investments is likely to be better. This is likely to be a challenge, however, for electrifying peri-urban and rural locations in the Asia-Pacific region, where the concentration of households and commercial or industrial consumers is likely to be lower and electricity demand levels are also low, leading to low return on investment prospects. The government's role is to provide incentive frameworks, such as performance-based subsidies, that encourage private sector electricity distribution companies to invest in low-voltage electricity distribution infrastructure to provide energy access to that segment of customers for which there is no clear business case.

Availability of finance at an unprecedented scale, business and implementation structures to deploy that financing to provide electricity and non-solid fuel-based thermal energy

access, and a conducive policy and regulatory environment will be required to achieve universal energy access in Asia and the Pacific by 2030 and achieve the universal energy access target of SDG 7.

EXISTING MECHANISMS FOR PUBLIC SECTOR FINANCING

The major initiatives in energy access in the Asia-Pacific region have been supported through public finance from governments, often targeted at large-scale electrification and at transition to LPG. Governments have historically used their budgets to support rural electrification, but progress has been slow. Often rural, non-electrified locations offer very low return rates and long return periods, due to low levels of expected energy demand and limited economic opportunities, which discourages participation of the private sector. Public finance is therefore often the only financing option available for energy access. However, public finance may not be sufficient for addressing the energy access challenge and thus often scarce public financing should be used to leverage private sector funds in order to fill the financing gap.

Domestic borrowing has played an important role in the energy sector. Infrastructure bonds issued by governments and public bonds issued by institutions such as the Renewable Energy Certificate (REC) in India and Agricultural Development Bank in China have been used to finance rural electrification. These bonds often have a long tenure and low returns but also low risks. Some of the bonds, such as the REC bonds for electrification in India, were tax free. Such incentives have resulted in high investment interest – the 20-year \$100 million bond with a return of 7 per cent, issued by REC in 2015, was oversubscribed by 400 per cent (The Financial Express, 2015). However, domestic borrowing to finance energy access has been limited to Asia-Pacific countries where bond markets and regulatory frameworks are established.

External borrowing from development agencies offering concessional and large-scale financing has been one of the key financing sources for energy access in Asia and the Pacific. Multilateral financial institutions such as the World Bank and ADB have been major financiers for energy access. In least-developed countries (LDCs) and SIDS in particular, where availability of local finance is limited and of low creditworthiness, special funds from the World Bank and ADB – such as the International Development Association and the Asian Development Fund, respectively – provide long-term, low-interest finance. Bilateral development agencies also provide financial resources but are often conditional, with the source of equipment and services limited to the country providing external finance.

Development assistance routed through multilateral development agencies, bilateral development agencies, NGOs, etc. has also supported energy access in the Asia-Pacific region. Development assistance has been in the form of grants and technical assistance. Some of the development assistance focuses on policy and capacity-building aspects that will enable an environment for promoting energy access and build human and institutional capacity. Others support projects and programmes through which electrical energy or thermal energy access was provided to communities and institutions. However, due to the limited availability of grant resources, development projects and programmes have

concentrated on piloting and demonstrating specific technologies, models and approaches. Still, development assistance initiatives have played an important role in financing energy access in Asia and the Pacific.

Climate finance has played a significant role in supporting energy access initiatives through renewable energy development. Through the Clean Development Mechanism, many Asia-Pacific countries received revenue from Certified Emission Reductions (CERs) to improve the financial viability of a number of energy access projects before 2012, the final year of the first commitment period of the Kyoto Protocol. The Programme of Activities was instrumental in bundling small projects together to obtain financing from the sale of CERs. A voluntary carbon finance market exists to offset emission reductions at institutional and individual levels through Verified Emission Reductions (VERs). However, the combined demand for CERs and VERs is currently at a low level which limits the ability of the carbon market to influence energy access efforts.

The Global Environmental Facility (GEF) has financed the incremental costs³ for a number of energy access projects that supported renewable energy-based energy access in Asia and the Pacific. The Climate Investment Fund finances low-carbon development and climate change adaptation initiatives, offering resources to support renewable energy-based energy access projects. In particular, the Scaling up Renewable Energy Programme (SREP) currently supports renewable energy investments in countries such as Maldives, Nepal, Solomon Islands and Vanuatu in the Asia-Pacific region, with plans to support other low-income countries.

EXISTING MECHANISMS FOR PRIVATE SECTOR FINANCING

The private sector role has been limited primarily to manufacture and supply of systems and equipment for energy services. However, a number of initiatives have encouraged the private sector to go beyond this limited role. Governments and development agencies have employed a number of mechanisms to attract private finance for energy access.

SUBSIDIES

Subsidies are an important financial mechanism to leverage private finance. In Asia and the Pacific, the most common type of subsidy has been capital subsidy as a share of the capital cost of investments. The 60-85 per cent capital subsidies to private distribution companies under the Deen Dayal Gram Jyoti Yojana in India are one example. Capital subsidies have also been part of the Bangladesh Infrastructure Development Company Limited (IDCOL) programme, as grants to buy down the initial costs. These subsidies are aimed at capital cost reduction to allow private investors to invest in energy access infrastructure that is otherwise not financially viable. Subsidies are also useful to induce fuel-switching to modern

³ The additional costs for pursuing a low-carbon energy access technology or approach compared to the baseline business-as-usual approach.

energy options, such as the Indonesian government providing 100 per cent subsidy for the initial switch from kerosene to LPG.

Another form of subsidy is based on delivered energy services, rather than investment costs. The qualified third party (QTP) model for electrification of Barangays in the Philippines is an example of such a performance subsidy, in which the subsidy is administered based on the electricity supplied. In this model, investors need to both invest in and deliver energy services before subsidies are made available. This provides an incentive to increase and improve performance levels and utilize energy access assets more efficiently.

Another form of subsidy is the direct tariff subsidy, whereby consumers are provided with subsidies for energy consumption. In this model, energy consumers are provided with coupons to purchase energy. India has had such a direct benefit transfer scheme since January 2015; LPG consumers are subsidized directly to their bank accounts by the government (Tripathi et al., 2015). To facilitate transformation, sale of subsidized LPG was discontinued and consumers pay the market price, with low-income consumers eligible for direct payment of the LPG subsidy. This direct cash transfer mechanism is expected to save about 15 per cent, or \$1.1 billion, of the amount spent annually by the Indian government on LPG subsidies (Tripathi et al., 2015).

TAX INCENTIVES

Tax incentives have also been used to mobilize private investments for energy access. One common tax incentive in the Asia-Pacific region is exemption from import and customs duties for energy access equipment, which reduces capital costs of imported systems and equipment. For example, Nepal has exempted microhydro power generators for off-grid rural electrification of remote villages from import duties (Williams et al., 2015). There are also exemptions from sales tax, or value added tax, for components or complete systems for energy access. Such exemptions are prevalent in China and India to incentivize private sector investment. Tax holidays encourage start-ups in energy access and private investment in new enterprises. India has established a five-year tax holiday for renewable energy enterprises. Another tax incentive is the use of accelerated depreciation, which allows private enterprises to claim 60-100 per cent depreciation for capital equipment in the first year. This reduces income tax payable for private companies. India has also accelerated depreciation for renewable energy equipment that can be used by private companies.

SOFT LOANS

Soft loans have loan parameters like interest rates, loan tenures and moratoria⁴ that are more favourable to the private sector than commercial loans. The availability of soft loans for energy access investments can help to improve the financial viability of such investments. Soft loans can be made more attractive to the private sector by increasing the loan tenure

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⁴ The initial grace period during which the loan repayments need not be made.

or the moratorium compared to commercial loans. For example, the Bangladesh IDCOL solar home system programme offers interest rates in the range of 6-9 per cent, compared to the prevailing interest rate of 16 per cent, and also offers a loan tenure of 5-7 years, compared to the prevailing term of 3 years.

GUARANTEES

Guarantees help private investors get debt financing from commercial banks and financial institutions. Such mechanisms are relevant where potential commercial finance is available but financing of energy access investments is considered to be risky by prospective financiers. Loan guarantees are offered by development agencies or through a guarantee mechanism by which part of any loan default will be compensated by the guarantor. Loan guarantees have been used in the Asia-Pacific region during early stages of market development to create track records and build confidence in the banking and finance institutions. The International Finance Corporation (IFC) offered a loan guarantee to electrify parts of eastern

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Box 4.5 Case Study: Husk Power Systems

Husk Power Systems (HPS) is a private company that operates micro-grids on rice husk-based gasifiers, targeting non-electrified rural areas with availability of biomass residues. HPS has operations in India, Nepal, Tanzania and Uganda and operates 90 mini-grids that service 35 villages (Schnitzer et al., 2014). The company originally provided 14-16 hours of electricity a day and in late 2015 moved to a hybrid energy technology model that utilizes biomass and solar energy to provide 24 hours of electricity a day.

HPS initially used financing models such as Build-Own-Operate-Maintain (BOOM) and Build-Own-Maintain (BOM), where the ownership of the micro-grid was with HPS (Schnitzer et al., 2014). The company then started using Build-Maintain (BM) models, where the ownership and operation of the micro-grid lies with a local entrepreneur. Consumers have to pre-pay for electricity and are metered through a pre-pay meter. To ensure steady availability of rice husk, HPS has installed rice mills next to the power plants and offers free de-husking of paddy in return for the rice husks. Customers initially pay \$2.2-2.3/month for a basic electricity connection with two lamps and a phone-charging point, but as electricity use increases with more appliances, the consumers end up paying more.

During the early stages, HPS was financed with venture capital from impact investors,⁵ such as Acumen Fund, Bamboo Capital, Shell Foundation, among others, supplemented with finance from government subsidies, prize monies, etc. During this phase HPS deployed BOOM and BOM models, where finance for investment had to be generated by HPS, before moving on to the BM model where the capital investments are from a local entrepreneur. In 2015, HPS started implementing a hybrid model integrating solar energy and has brought in a strategic investor – First Solar – which has picked up an equity stake in HPS and is providing preferential pricing for solar PV modules. HPS is a case of a private sector initiative using venture capital investments and incentives to establish and refine a for-profit business model and then scaling up and rolling out using a franchising model and private finance.

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⁵ Investments made with an objective of generating social and/or environmental impacts alongside financial returns, often below market returns.

India through the Photovoltaic Market Transformation Initiative (IEA, 2003). Similarly, partial-risk guarantees can also be offered; in cases where the government or the public agency is unable to fulfil the payment obligations, the guarantor will do so. Such guarantees have been used by Multilateral Development Banks (MDBs) to lower the risk for private sector investments in energy access, allowing them to have access to commercial finance sources and often to obtain financing on more favourable terms, as the risk is mitigated.

BARRIERS, BOTTLENECKS AND LESSONS

A more than four-fold increase from the current annual investments in energy access will be needed to achieve the universal energy access targets under SDG 7.⁶ Such a scale-up of resources would require major changes in current finance architecture. However, levels of financing need vary among Asia-Pacific countries. The emphasis of energy access financing so far has been primarily on electrification and not enough investments are being made in non-solid fuel access for thermal energy use and progress on this has lagged behind. The level of investment in energy access to non-solid fuel remains the biggest financing challenge, as this investment needs to increase by a factor of 44. A major bottleneck for financing non-solid fuel is that the current business models and financing mostly focus on supporting cooking and space heating devices at a smaller scale than large-scale service or fuel sales-based models.

A number of Asia-Pacific countries have low credit ratings, limiting the ability of their governments to raise resources that are low-cost and long-term, which affects available investments for energy access. Absence of a local finance ecosystem of financial institutions and banks, microfinance institutions, rural and agricultural development banks, as well as local debt and equity markets in some Asia-Pacific countries, constrains the ability of both the public and private sector to raise local finance for infrastructure investments including energy access. Both are particularly challenging for SIDS and LDCs.

The role of the private sector and the leverage of private finance for energy access investments in the Asia-Pacific region have been limited. The private sector and PPPs have been leveraged in electricity generation as IPPs but not significantly in electrification and non-solid fuel access. Lack of capability for developing and structuring energy access projects that can attract direct private finance or PPPs is likely to be a bottleneck in many Asia-Pacific countries. Such capability will be important to reach the financial resource mobilization requirements to achieve the SDG 7 goal on energy access. While a number of innovations have been attempted to engage private sector investments in energy access, these haven't been scaled up or replicated to significant levels at the country or regional levels.

A number of lessons may be observed from existing experience in financing energy access in the Asia-Pacific region. Domestic financial sources such as public finance and government subsidies are the major sources of finance for energy access investments in the region, followed by external borrowing assistance from MDBs, development assistance and climate

⁶ Calculated from SE4All (2015) Advisory Board's Finance Committee Report on *Scaling up Finance for Sustainable Energy Investments*.

finance. Public finance through subsidies and grants is limited by government budgets and not sustainable in the long term. External financial sources such as loans, development aid and climate finance have played an important role in demonstrating technologies and business and financial models and in providing policy support.

Given the wide range of government and public sector capabilities, local financial institutions, private sector capabilities and local finance ecosystems, the type of resource mobilization models required in Asia-Pacific countries is likely to vary. The role of the private sector needs to increase significantly; however, low returns from such investments and the absence of a progressive policy and incentive framework have constrained investment. Private sector participation and finance in energy access can be increased through lowering risks for these investments and improving financial returns and capital recovery. Risk transfer instruments such as guarantee funds, as well as mechanisms such as incentives, soft loans, etc. to improve the investment prospects have been used and hold promise. The PPP structure has been used effectively for infrastructure financing in water and sanitation, transport, communications and energy generation but has had a limited role in energy access. Under the right conditions, PPPs could play an increased and highly significant role in enhancing energy access in Asia and the Pacific. There appears to be a need to look beyond existing structures, business models and financing mechanisms for energy access to scale up finance for achieving universal energy access by 2030 in the Asia-Pacific region. Alternative and innovative financing mechanisms, in Asia and beyond, may offer possibilities.

ALTERNATIVE AND INNOVATIVE FINANCING MECHANISMS

A number of alternative and innovative approaches are being tried out to finance and implement energy access initiatives, some of which may offer potential for application to scale up energy access finance in Asia and the Pacific. Some of these are discussed in the following section.

CROWDFUNDING

Crowdfunding uses contributions from a large number of people. Crowdfunding has been in existence for a considerable period of time, but in the past few years, Internet platforms have been used to expand reach, increase transparency and reduce transaction costs. Depending on project details and finance demand, investors commit to providing equity or loans. When the financing target is met, the funds are made available to the promoter for the project to be implemented. Upon successful completion of the project or initiative, the promoter pays returns to the equity investors or pays back the loans with interest. It is estimated that the volume of global crowdfunding in 2015 was \$16 billion, of which the share for renewable energy was \$170 million, supporting more than 300 projects (Versteeg, 2015).

Initial crowdfunding focused on creative endeavors such as music, movies and technology ventures. Increasingly, crowdfunding platforms are also supporting clean energy and energy access issues. Many of the platforms are based in Europe and the United States, such as Trillion Fund, Abundance, Village Power, Solar Schools, etc., which mainly crowdfund

energy projects in the countries where they are located. However, there are sites like SunFunder, which focuses on off-grid solar for renewable energy and has raised \$7 million of investment in 58 loans supporting 368,000 people (SunFunder, 2016). The \$700 million invested in Kiva microloans, which support microloans in developing countries, also offers green loans that include solar lighting and home systems and clean cookstoves. Kiva is also active in a number of Asia-Pacific countries through its field partners. The financial regulatory frameworks for crowdfunding are emerging.

While the crowdfunding platforms are growing as an alternative means of finance for projects and initiatives which may not be supported by commercial banks, the crowdfunding share of energy access projects so far has been quite small. However, crowdfunding of energy access projects and initiatives in Asia and the Pacific could be a significant prospect for the future. Small-scale financiers in Asia-Pacific and elsewhere could use such platforms to support energy access projects in their countries or others. The role of crowdfunding will be determined by private sector entrepreneurs and public sector agencies. If integrated into policy and institutional frameworks for energy access, crowdfunding could provide significant supplementary resources to support universal energy access in Asia and the Pacific (SunFunder, 2016).

CARBON FINANCE

Carbon finance in the form of CER and VER revenues did support a number of energy access projects in Asia and the Pacific. But given the current low demand and low price scenario after 2012, very few projects are being supported by carbon finance. The outlook for carbon markets is unclear, although the Paris Agreement has established a new market-based mechanism that will come into effect after 2020. This new mechanism may create a demand for Internationally Transferred Mitigation Outcomes. The impact of the proposed new mechanism will depend on the demand and the rules that will be developed but, in the short term, the voluntary carbon market for VERs may provide some limited finance for energy access projects in Asia and the Pacific.

The Paris Agreement aims at limiting the increase of global average temperature to well below 2°C above pre-industrial levels. It is committed to mobilizing \$100 billion/year to support climate change mitigation and adaptation in developing countries by 2020, with a bigger resource mobilization goal by 2025.

The Green Climate Fund (GCF) has already mobilized over \$10.5 billion for strategic priority areas including energy. GCF funding can be accessed by organizations through a “direct access” route and by the private sector through the Private Sector Facility. GCF also uses a range of financial instruments – grants, loans, equity and guarantees – to support climate change projects in developing countries, while prioritizing investments in LDCs and SIDS. Electricity access and non-solid fuel access initiatives in the Asia-Pacific region using renewable energy and low-carbon energy sources such as LPG have the potential to benefit from GCF at scale. The emergence of the GCF could be of importance to LDCs and SIDS, as there will not be a cap on resources that are allocated to smaller countries. However accessing large-scale resources from the GCF for energy access will require mobilization of strong national institutions including the private sector and the ability to structure and develop a pipeline of projects that can take advantage of loans, equity and guarantees.

GREEN BONDS

Green bonds are debt instruments for raising financial resources from the markets for “green” projects. Bonds have traditionally been used by both public and private entities to finance infrastructure projects, including energy access projects. Green bonds constitute a new global effort to establish a labelling system by a number of organizations such as Climate Bonds Standard and Ceres Green Bond Principles, as well as national regulators such as China Central Bank’s green bond guidelines. It is estimated that only 11 per cent of bonds that could be classified as “green” are actually labelled and the major locations where bonds are green-labelled are in Europe and North America (Climate Bonds Initiative, 2015). The MDBs and bilateral development banks active in the Asia-Pacific region, such as the World Bank, ADB and KfW, have issued green bonds, as have private companies, commercial banks and municipalities.

Green bonds represent a small segment of the global bond market. The “green” projects being supported by proceeds of green bonds totaling \$65.9 billion include energy, buildings and industry, transport, water and waste management (Climate Bonds Initiative, 2015). However, even the local currency-denominated bond market in Asia was \$8.6 trillion in 2015 (ADB, 2015e). There are no obvious financial advantages to be gained by labelling a bond “green,” although it may attract environmentally conscious investors. Existing Asian green bonds targeting renewable energy investments are consistent with the global trend. It is possible that proceeds of green bonds issued by the World Bank, ADB, KfW, etc. are supporting energy access projects in Asia and the Pacific. Indeed, it is possible to label local currency and foreign currency-denominated bonds that target renewable energy-based energy access projects as green bonds. If such green bonds result in additional foreign or local currency resources and increase the scale of resources mobilized, they could augment the financial resources needed for universal energy access in Asia and the Pacific. Green bonds are more relevant in countries that are creditworthy and have a strong financial ecosystem and are more challenging in LDCs and SIDS, although it is possible for MDBs and bilateral development agencies to use green bonds from the European and North American markets to support energy access projects in Asia-Pacific LDCs and SIDS. A similar approach is applicable to bilateral development agencies from countries such as Australia, Japan and Korea, which may use domestic or internationally issued green bonds to support energy access investments in other Asia-Pacific countries including LDCs and SIDS.

EXPATRIATE REMITTANCES

Many nationals from Asia-Pacific countries work outside their countries and send remittances back to their home countries to support their families. The value of global remittances to developing countries has been increasing steadily; they overtook development assistance flows in 1997 and were estimated at \$435 billion in 2015 compared to about \$160 billion in total development assistance. These remittances are considered to be more stable than private capital flows (World Bank, 2015). A number of countries in the Asia-Pacific region receive high levels of remittances as a share of GDP, including Tajikistan (42 per cent), Kyrgyzstan (30 per cent), Nepal (29.9 per cent), Bangladesh (8.6 per cent) and Pakistan (6.9 per cent), as well as Cambodia, Indonesia, Kiribati, Philippines, Samoa, Timor-Leste, Viet Nam, among others (World Bank, 2015). The scale and predictability of the remittances offers an opportunity to supplement public and private resources to finance energy access investments. An example of such an initiative is the “3 x 1 programme” in Mexico, where

remittances were used to support infrastructure development, such as roads, water supply and sanitation. For every peso contributed by remittances, the government contributed three pesos – one each from the federal, state and municipal budgets. Between 2003 and 2011, the programme supported over 2,500 projects.

It is estimated that South Asia, East Asia and the Pacific received close to \$250 million in remittances in 2015 (World Bank, 2015). Even if a small share of these remittances could be used to support energy access they could be a significant resource. It is likely that a large share of remittances is being used for subsistence, including payment for electricity and fuels. In many Asia-Pacific countries a significant share of migrants are from locations without energy access and could be encouraged to contribute to providing electrification and non-solid fuel supplies in their home towns and villages. The \$50 million UNDP project in Afghanistan – Afghanistan Sustainable Energy for Rural Development (ASERD) – aims at capturing these remittances to support rural energy access in Afghanistan. In 2012, remittances to Afghanistan were estimated to be \$445 million (Parthan, 2015). The ASERD project will be implemented between 2016 and 2019, piloting a rural energy model using public funding and remittances in one of the migrant corridor villages in Afghanistan.

Attracting migrant finances for energy access can be achieved through programmes like ASERD or through government policies that offer tax and other incentives. If implemented strategically, diaspora finance could be a significant factor in achieving universal energy access in Asia and the Pacific by 2030.

INFERENCES ON NEW AND ALTERNATIVE MECHANISMS

Some alternative and innovative mechanisms such as remittances and GCF offer potential to be important finance mechanisms for energy access in the Asia-Pacific region. Others, such as green bonds, offer some prospects and crowdfunding could be a potential future mechanism. Crowdfunding could have an impact on financing energy access in Asia and the Pacific in the medium to long term, although experience is currently limited. However, carbon finance may not be able to play a significant role in the near future. Carbon finance will continue to be limited due to anticipated low demand and low prices for CERs and VERs. There may be some revival in prospects for international emissions trading in the long term, once the new mechanism envisaged under the Paris Agreement is established. The GCF offers finance for supporting universal energy access in Asia and the Pacific, while strong national institutions and capacities to structure and develop projects will be important to access these resources. Green bond issues in the mature financial markets in Europe, North America and the Asia-Pacific region can raise higher levels of resources to support energy access in Asia and the Pacific. Remittances from the Asia-Pacific diaspora offer a significant resource opportunity which has not yet been utilized. Pilot efforts to attract such remittance flows are being implemented.

Governments have an important role to play in attracting finance from these new mechanisms by establishing policy frameworks that expand the role of non-governmental stakeholders in energy access, especially the private sector. Lowering risks for mechanisms supported by the government or development agencies will be important to establish investment track

records and to develop the capability and confidence of international and local financiers. LDCs, in particular, may directly benefit from the GCF and remittances, provided the right policy frameworks are in place and institutional and project development capacity are established. LDCs may also benefit from green bonds and crowdfunding by working in partnership with development banks and crowdfunding platforms, respectively.

RECOMMENDATIONS FOR FUTURE FINANCING MECHANISMS

In most Asia-Pacific countries public finance alone would be insufficient to achieve universal energy access by 2030 and there is a need to leverage private finance using appropriate structures including PPPs. Governments need to establish progressive policy and regulatory frameworks to engage the private sector and international finance and raise the level of resources in order to achieve universal energy access by 2030. Integration of SDG 7 and use of the SE4All tools could enable many Asia-Pacific governments to attract development finance to support national plans in energy access.

Reallocation of public finance within the energy sector in Asia and the Pacific should be able to provide the required financial resources. Current government expenditures on energy subsidies primarily support consumption and production of fossil fuels. In 2014, total annual global expenditure on fossil fuel subsidies was \$510 billion, of which the share for Asia was \$120 billion, only 8 per cent of which reached the poorest 20 per cent of population in these countries. A share of 20 per cent, or over \$24 billion, of the current subsidies on fossil fuels in Asia and the Pacific is needed annually for universal energy access. However, at the country level, the level of subsidies may not always correspond to investment requirements on energy access, as some countries spend more on fossil fuel subsidies than others.

Labelling domestic or international debt as “green bonds” in mature financial markets could be an interesting resource mobilization option for development agencies raising resources to invest in LDCs and SIDS. The Asia-Pacific region has a large local currency-denominated bond market of \$8.6 trillion in the second quarter of 2015. Energy utilities and renewable energy companies are using local currency bonds and in 2014 the total bond issuance by renewable energy companies was \$18.3 billion, which is comparable to the \$20.2 billion incremental investment required annually in Asia and the Pacific for universal energy access. Issuance of green bonds is gaining momentum and several Chinese and Indian financial institutions and banks were actively issuing green bonds in 2015. Green bonds are a segment of the larger bond market and many more bonds are issued in Asia that could be classified as green but are not actually labelled. The early green bond issuances in Asia seem to be targeting renewable energy than energy access, although the market is at a nascent stage.

There is a need to improve governance, regulation and management of the electricity sector in order to increase the level of financing available to achieve universal energy access by 2030. Investments in expanding existing electrical grids in Asia and the Pacific will likely involve governments and energy utilities playing a central role. Providing electricity access

to meet tier 1 of the multi-tier framework requirements of 12 Wh/day may only require relatively low levels of resources providing electricity access; however, tier 2 requirements of 200 Wh/day and higher would require much higher levels of resources. A critical factor in the financing of grid-based electrification in Asia and the Pacific would be the creditworthiness of the electric utilities. Many of the electricity utilities in the Asia-Pacific region, which are often vertically integrated, are financially and operationally inefficient. Many utilities operate like government departments, often at a loss or with low return on their investments owing to low levels of bill collection and high levels of losses. The high levels of losses for utilities result from a combination of technical losses due to poor quality equipment and unchecked pilferage and theft of electricity at the distribution network level. Another reason for operational losses for energy utilities in the Asia-Pacific region is that electricity tariffs do not reflect the cost of supply and investments. In order to ensure that electricity tariffs are cost-reflective, electric utilities are financially sustainable and the interests of all other stakeholders are balanced, there must also be an independent electricity regulator. Adequate capacity of government and regulatory agencies in Asia and the Pacific is important to ensure that policy and regulatory frameworks ensure financial viability of electricity utilities, thereby enhancing the creditworthiness of the utilities and associated stakeholders.

A particular challenge in many Asia-Pacific LDCs and SIDS is to develop a robust pipeline of projects and to syndicate local and external financial resources to support universal energy access. Countries where domestic financial resources are inadequate may need to attract external development assistance or external loans. This could pose a challenge for a number of countries in Asia and the Pacific that are not considered investment grade and is particularly unfavourable to LDCs and SIDS. Many Asia-Pacific LDCs and SIDS tend to have less-developed project development and implementation ecosystems and limited national finance architecture and institutions as well as limited policy and regulatory frameworks for energy and finance.

Many countries that have relatively low levels of energy access will need to establish enabling investment environments to attract financing for expanding energy access. Although many Asia-Pacific countries are considered investment grade, many others are not attractive for investments. Levels of financial market development and business sophistication vary among Asia-Pacific countries, as does the ease of doing business and levels of transparency, which are important factors in countries being able to attract investments. In addition to the enabling environment, energy access programmes and projects will need to be conceived and developed and enterprises will need to be strengthened or even developed to develop electrification and non-solid fuel-based thermal energy access solutions. There is a clear role for innovation in financing structures and business models in this effort.

Climate finance from GCF offers a new and significant source for energy access in Asia and the Pacific, especially for LDCs and SIDS. However, accreditation by strong national organizations from the Asia-Pacific region and development of strong project pipelines will be needed to take advantage of this opportunity. While carbon finance from international emissions trading may not have a significant impact in the short and medium term, crowdfunding could turn out to be a useful source of finance.

Remittances from the Asia-Pacific diaspora offer a hitherto untapped, steady and significant finance stream that is very relevant to Asia-Pacific infrastructure and energy access investment. Government policies and development programmes need to leverage this financing stream for energy access investments.

More effort is needed to develop business models and financing structures for a transition to non-solid fuels for thermal energy. The financing challenge is likely to be significant in this effort due to limited government policies and the absence of models and track records in this area.

Including productive use opportunities when considering investments in electrification schemes and taking a regional and programmatic approach could result in better utilization of energy for productive purposes, sustainability and rural and local area development. Business and financial management skills are often limited in areas without energy access and many newly introduced economic opportunities fail for this reason. When financing productive use opportunities along with energy access programmes, emphasis should be placed on the role of entrepreneurs and enterprises. Franchising options could also be relevant in many locations where the productive enterprise follows a simple, standardized business/revenue model. Financing for supporting productivity increases and expansion of existing economic and social development opportunities should be included as part of the energy access programmes in Asia and the Pacific. Financing of market assessments for the proposed products and services as well as marketing and market linkage costs is also recommended. It is recommended to focus on using electricity and modern fuels to increase productivity and expand existing businesses and government services. The projected utilization factor, or Plant Load Factor (PLF), of the off-grid electrification systems such as mini-grids is often a good indicator for financial viability. Efforts focused only on household electrification have PLFs of about 0.2 whereas the ones which integrate productive uses and government services have PLFs of 0.5 and above. It is recommended to use the PLF as an indicator of integration of productive use and financial viability in financing decisions on mini-grid electricity systems.

Energy connectivity and transboundary electrification could offer cost-effective solutions for border area electrification as well as increasing electricity consumption and progression in electrified areas to higher tiers of electrification.

CONCLUSIONS

The Asia-Pacific region has the largest number of people without energy access and there is significant variation across countries. Energy access programmes are capital-intensive. Successful practices require effective policies and supporting institutional frameworks, as well as attractive financing strategies that involve various stakeholders. Asia-Pacific governments will need to lead these efforts in partnership with the private sector and supported by the development assistance ecosystem to significantly increase the current level of finance for energy access to achieve universal energy access by 2030.

It is important to ensure that energy access extends beyond basic energy needs to include productive use for development. Viet Nam's inclusion of agriculture and China's inclusion of TVEs in their respective rural electrification programmes have led to higher rural development, employment and income generation. A programmatic approach that integrates productive use of energy access into policymaking and financing frameworks for energy access should be encouraged.

Economic opportunities in areas without energy access are often limited. Even with energy access there will be multiple factors that constrain rapid economic growth. Efforts should be made in energy access initiatives to identify "anchor customers," who could consume a major share of the electricity or the modern fuel and ensure demand and financial viability. Possible anchor customers in Asia and the Pacific include mobile phone towers, large agroprocessing establishments,⁷ minerals and mineral processing industries,⁸ etc. The financing frameworks and associated revenue models for energy access should integrate energy use opportunities with public service and government establishments such as schools, hospitals, police stations and government offices as opportunities to improve financial viability and increase demand for energy services. Consideration of productive use opportunities should be done at the planning or programmatic level rather than at the individual project or initiative level.

Ensuring affordability, reliability and sustainability are important dimensions of energy access. It is not enough to have initial energy connection if the quantity and quality of delivered energy services are not satisfactory. It is not enough to finance the initial cost of infrastructure if the recurring costs of energy service delivery, such as operation and maintenance, fuel costs and replacement costs, need to be financed as well. These aspects of energy service delivery have been captured in the multi-tier framework for energy access, but need to be taken into account for policymaking, institutional arrangements, and engaging financing.

Raising public awareness on energy access and building capacity on technical and institutional aspects to ensure reliability and sustainability of the energy systems are required. When financing energy access projects, it is crucial to ensure that mechanisms are established for collection of fees or tariffs that will ensure continued operation of the energy services. The

⁷ Sugar mills, rice mills, oil mills, etc.

⁸ Mines and other mineral extraction and processing industries.

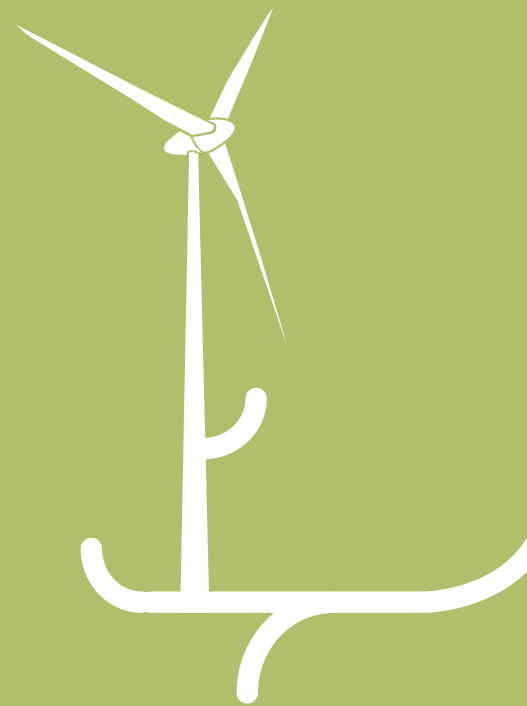
fees or tariffs should, at minimum, recover operation and maintenance, replacement and fuel costs, if relevant. In situations where subsidies need to be provided for energy access systems, it is recommended that the subsidies be output or performance-based rather than capital subsidies. Performance-based subsidies such as the QTP in the Philippines ensure that the energy services are sustainably delivered.

Various PPP and private sector models that have been utilized for energy access in the Asia-Pacific region, such as Build-Operate-Transfer (BOT), Build-Own-Operate-Transfer (BOOT), Build-Own-Operate (BOO), BOOM, BM, etc., are more sustainable, as the revenues for the private sector are contingent on continued operation. Therefore, energy access models in which the private sector has responsibility for operation and the revenues are linked to operations are likely to be more sustainable.

The SDGs provide a significant opportunity to increase the level of technical, financial and human resources for achieving energy access in the Asia-Pacific region, as well as an opportunity for development assistance agencies to increase their investments in energy access projects in the region. It is therefore important to put policies in place that ensure national efforts towards energy access by governments and the private sector are aligned with the SDGs and to try to leverage development assistance. This is particularly relevant for LDCs and SIDS.

Asia-Pacific countries may also utilize various tools available under the SE4All framework, such as Rapid Assessment and Gap Analysis, development of country action agendas and development of investment proposals. Preparations using the SE4All tools could help countries take advantage of international and development assistance to achieve universal energy access.

The SDG 7 also calls for enhanced international cooperation on clean energy research and technologies that offer an opportunity for Asia-Pacific countries to collaborate. This presents an opportunity to collaborate in the area of financing mechanisms and business models for energy access. Agencies such as ESCAP could play a facilitating role in such international cooperation efforts.



SUSTAINABLE ENERGY:

**SNAPSHOTS OF PROGRESS
ON THE ASIAN AND
PACIFIC ENERGY FORUM'S
REGIONAL PLAN OF ACTION**

OVERVIEW

Energy is fundamental to development, yet many nations in Asia and the Pacific struggle to meet their basic energy needs. Today, not only do countries face the economic challenges of obtaining energy resources and building the infrastructure needed to fuel development, but environmental and social considerations demand ever more attention. Energy is intricately tied to household and national levels of economic growth, global and local ecosystems, and social inclusion and progress.

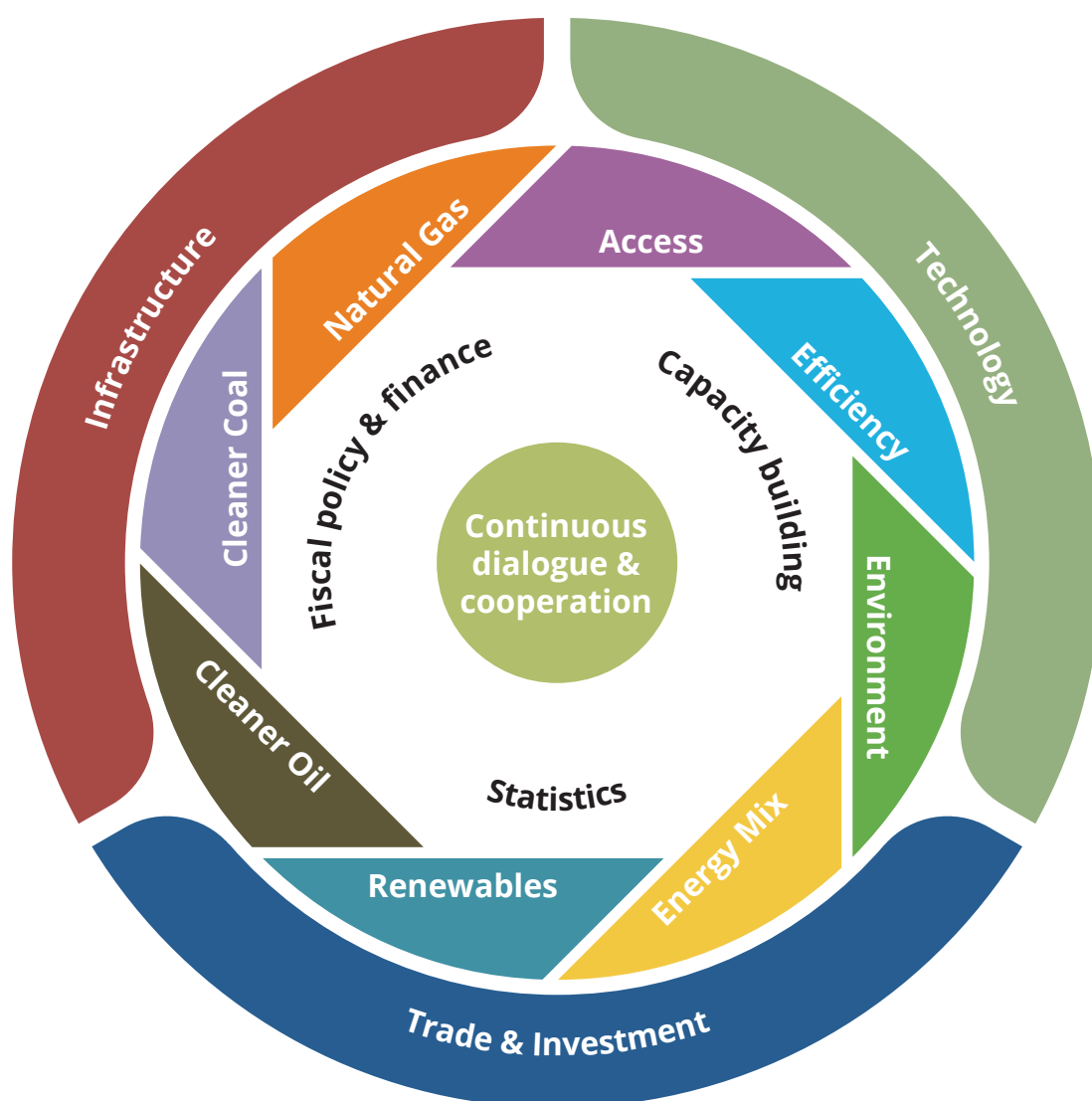
Recognition of the interconnectivity between energy and many facets of development is increasing, along with the demand for more sustainable energy production, distribution, and use. The Sustainable Energy for All (SE4All) initiative, and now the Sustainable Development Goals (SDGs), have set global targets for energy development that, if achieved, will serve to increase and expand socioeconomic benefits while reducing environmental impacts, in contrast to business as usual. In addition, Intended Nationally Determined Contributions (INDCs), the commitments emerging from the 2015 Paris Climate Conference of the Parties (COP21), begin to frame energy use within the wider context of the global effort to fight climate change, and are already catalysing new efforts to redirect energy systems towards a more sustainable path.

In line with global movements, Asia-Pacific countries met under the Asian and Pacific Energy Forum (APEF) in 2013 and issued two outcome documents, including a ministerial declaration and the Asian and Pacific Energy Forum's 2013-2018 Plan of Action. Ministers set forth a vision of a more secure, sustainable and equitable energy future and outlined 15 focus areas under which countries agreed that efforts are needed to enhance energy security and promote the sustainable use of energy.

The APEF Plan of Action offers a highly comprehensive approach to energy development. While SE4All, the SDGs, and INDCs are based primarily on achievement of discrete indicators, the APEF Plan of Action offers an expansive set of action areas covering access, renewables and efficiency, as well as energy investment, trade, technology and more. The scope outlined in the Plan of Action prescribes an integrated approach to improving the sustainability of the regional energy situation, and sets the foundation from which more aligned efforts, cohesive policy frameworks and cooperation mechanisms can emerge.

The ESCAP secretariat, as a coordinating body and contributor to global and regional initiatives, is well positioned to integrate the various regional and global objectives under a common support framework that can assist member States to progress towards a more sustainable energy path. Furthermore, actions taken under the APEF focus areas can directly support realizing targets under SE4All, the SDGs, and INDCs, creating alignment and linkages between national, regional and global efforts.

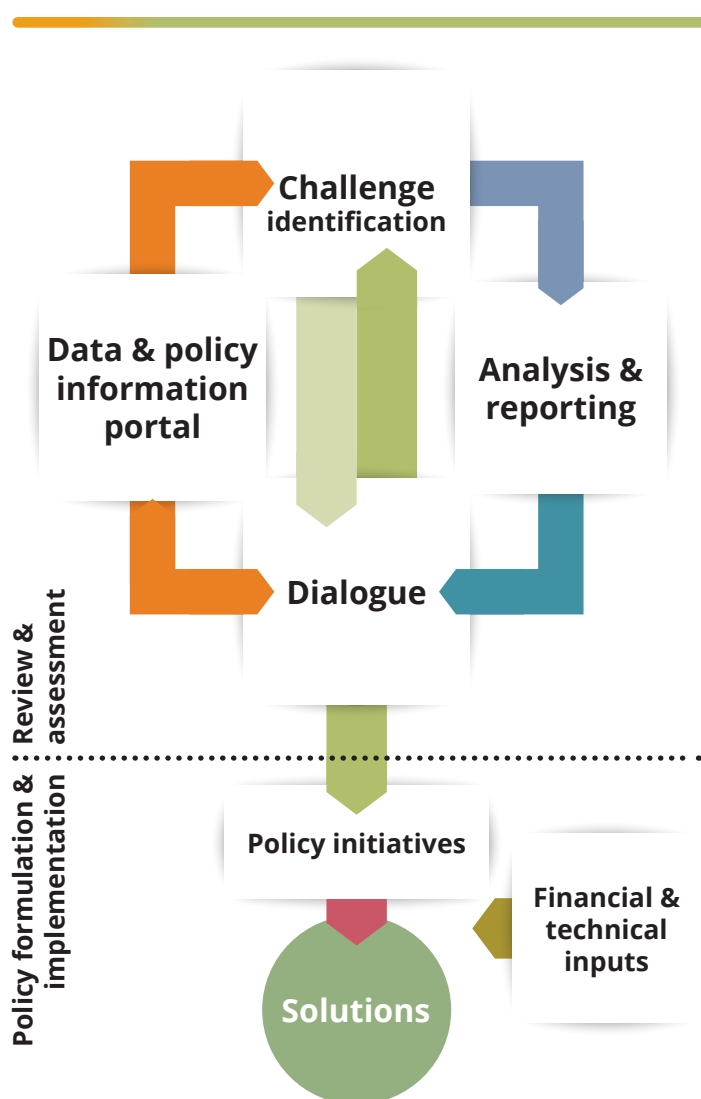
Under the APEF mandate, the secretariat is tasked with reviewing efforts and progress towards achieving the Asia-Pacific vision of a sustainable energy future. This chapter offers snapshot insights into the regional energy situation, presented from the 15 focus areas (A through O) identified in the APEF Plan of Action. Although not a comprehensive review, it provides a summary of research by the secretariat that will feed into a more extensive APEF Final Review, which will be conducted in cooperation with ESCAP member States.



THE 15 FOCUS AREAS



ESTABLISH A PLATFORM FOR FACILITATING CONTINUOUS DIALOGUE AND COOPERATION AMONG ESCAP MEMBER STATES ON ENHANCED ENERGY SECURITY AND THE SUSTAINABLE USE OF ENERGY



The Asia-Pacific region took a decisive step towards identifying and meeting its energy challenges by calling upon the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) to convene the first Asian and Pacific Energy Forum (APEF) in 2013. The year-long preparatory process leading up to the forum served to identify the key barriers to energy security and the sustainable use of energy, as well as actions required to move the region towards a sustainable energy path. The ESCAP member State-driven process resulted in two key outcomes, the *Ministerial Declaration* and the *Plan of Action on Regional Cooperation for Enhanced Energy Security and the Sustainable Use of Energy in Asia and the Pacific, 2014–2018*. The documents were negotiated at a preparatory meeting and agreed to by energy ministers present at the May 2013 Forum. ESCAP member States adopted the outcomes with the signing of Resolution 70/11 at the 70th Commission Session, endorsing a landmark instrument for regional cooperation in energy.

In response to the extensive efforts leading to the APEF outcomes and momentum gained from the establishment of the SDGs, the ESCAP secretariat, in active cooperation with member States, established the APEF Implementation Support Mechanism. First presented to member States as a concept at the 2013 Policy Dialogue in December 2013, and then as a framework undergoing implementation at the 2014 Policy Dialogue, this mechanism has the explicit role of supporting efforts under the

APEF agenda. The three pillars of the mechanism – 1) a web-based regional energy Data & Policy Information Portal; 2) Dialogues; and 3) Analysis & Reporting – form the core of a broader effort to identify common challenges and policy solutions, and open the door to new multilateral initiatives.

To date, a number of achievements have been realized, including the launch of the Asia Pacific Energy Portal (asiapacificenergy.org), hosting data and policy information for the region, and the publication of the new Regional Energy Trends Report. Dialogues, in the form of annual policy dialogues and expert group meetings, are ongoing, and the planning process for the 2nd APEF (2018) has begun. Through a platform offering knowledge, analysis, and dialogue, the secretariat aims to encourage cooperation among member States in the form of new policy initiatives and solutions to meet regional energy challenges.

B

WORK TOWARDS UNIVERSAL ACCESS TO MODERN ENERGY SERVICES ENERGY

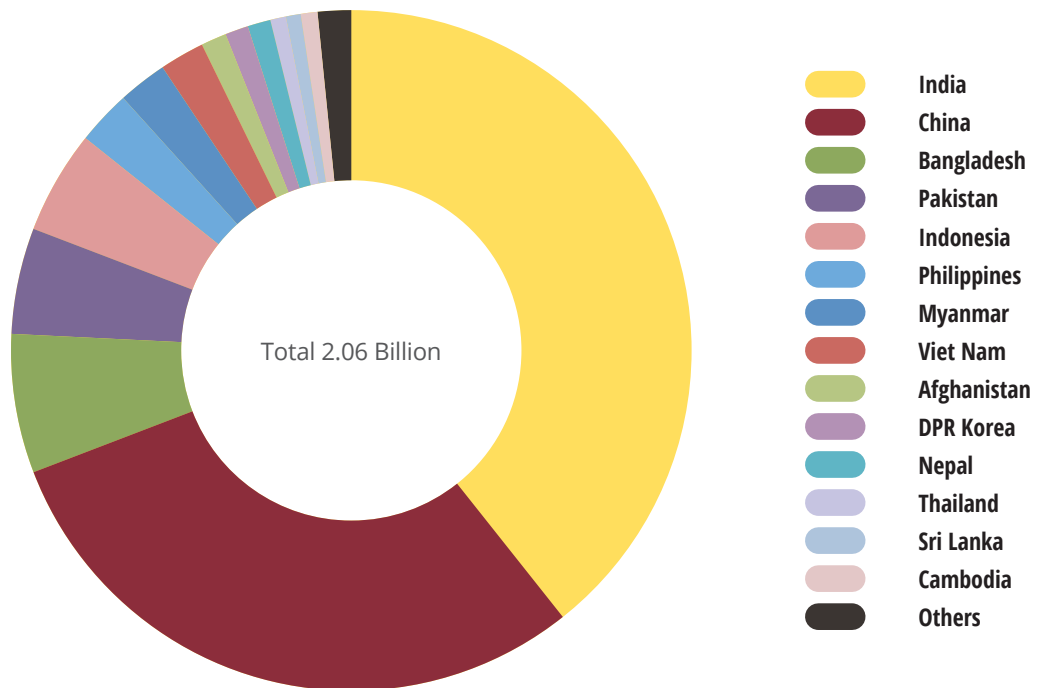
Access to modern energy services is fundamental to promoting economic opportunity, education, health, gender equality and environmental sustainability. As of 2012, 455 million people in the Asia-Pacific region lack access to electricity, and approximately 2.1 billion people continue to rely on solid fuels for cooking.⁹ The majority of these people are located in the ESCAP subregions of South and Southwest Asia and Southeast Asia. Recent national efforts across the region have helped reduce gaps in access, but much remains to be achieved, particularly for rural populations, which in many countries have access levels lagging well behind their urban counterparts.

On the positive side, increasing focus by policymakers on addressing this development challenge is evidenced by the expansion and deepening of national energy access policies and programmes. Already, the policy trend within the region exhibits an evolution from a narrow focus on electrification and clean cooking to more comprehensive approaches that increasingly emphasize affordability, reliability and rural-urban parity. Additionally, programmes and projects are placing greater weight on the productive use of energy, guiding electrification efforts to address poverty reduction, particularly in rural areas that have much lower rates of access and energy consumption. Increasingly, renewable energy sources are being utilized to power distributed energy systems. The Asia-Pacific country that has the largest population without electricity, India, is ramping up efforts in off-grid areas, targeting capacity additions of 130MW in FY2015-2016. With the recent adoption of Goal 7.1 of the SDGs, which targets universal access by 2030, efforts to address the challenges of energy access are given additional momentum and potential new financing options, which can build upon existing efforts by governments and the SE4All initiative.

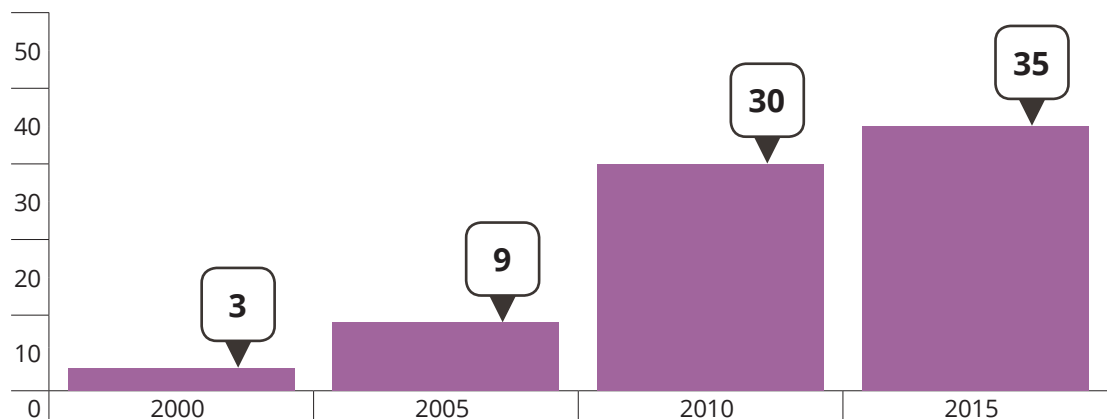
Underpinning the expansion of energy services is the significant investment and financing needed to bridge infrastructure gaps. The SE4All Finance Committee estimates that \$45 billion per year is needed to achieve universal access (IEA and World Bank, 2015). Other estimates fall higher and lower, based on varying assumptions and the level of access achieved. Increasingly, governments are turning to the private sector to help meet investment requirements and deliver innovative energy service solutions. Improved, predictable and reliable policy frameworks that reduce risks and enable returns on investment are key to increasing investment interest. As Asia-Pacific countries continue to strengthen their supporting policies, the market for provision of energy solutions can be expected to continue to expand, particularly for electrification, where the private sector has in recent

⁹ Source: Data based on Sustainable Energy for All database

Population relying on solid fuels in Asia and the Pacific, 2012



Number of Asia-Pacific countries with energy access targets within policies or programmes



Source: Policies identified from the content of the Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

years become active in developing new models through strictly private as well as public-private partnership (PPP) investment and projects. The success of some of these models has had positive impacts on the lending policies of national financial institutions, increasing investment opportunities.

On the other hand, the provision of clean cooking solutions remains primarily reliant on grant funding, microlending and tapping of carbon credit markets, leaving investment levels lower than required to meet needs. According to IEA, of the \$13.1 billion invested globally in energy access in 2013, only 3 per cent was directed at clean cooking solutions (IEA, 2015).

However, this market is also evolving and within the region examples of comprehensive approaches to supplying clean cooking solutions are emerging, such as in Bangladesh, where emphasis has been placed on cookstove supply chain development. With more developed policy frameworks in place to support the development of industries that can provide solutions to access shortfalls, the potential for expanding market opportunities, scaling delivery models, and developing new commercially viable enterprises will be increased.

Sample Policy and Programme Approaches from the Region

AFGHANISTAN: Afghanistan Rural Renewable Energy Strategy (Draft), 2013

Guidelines on establishing mini-grids: Establishes standards for mini-grids, such as division of household, productive and public use.

BANGLADESH: Country Action Plan for Clean Cookstoves, 2013

Cookstove industry: Addresses increasing supply and demand, developing supply chains.

CAMBODIA: Programme for the Development of Rural Electrification of Department of Rural Electrification Fund Electricité du Cambodge, 2015

Access programme consisting of three components: 1) Programme for Power to the Poor; 2) Programme for Solar Home Systems; 3) Programme for Providing Assistance to Develop Electricity Infrastructure in Rural Areas. Interest free loans are provided to enable household power connectivity.

NEPAL: National Rural and Renewable Energy Programme, 2012

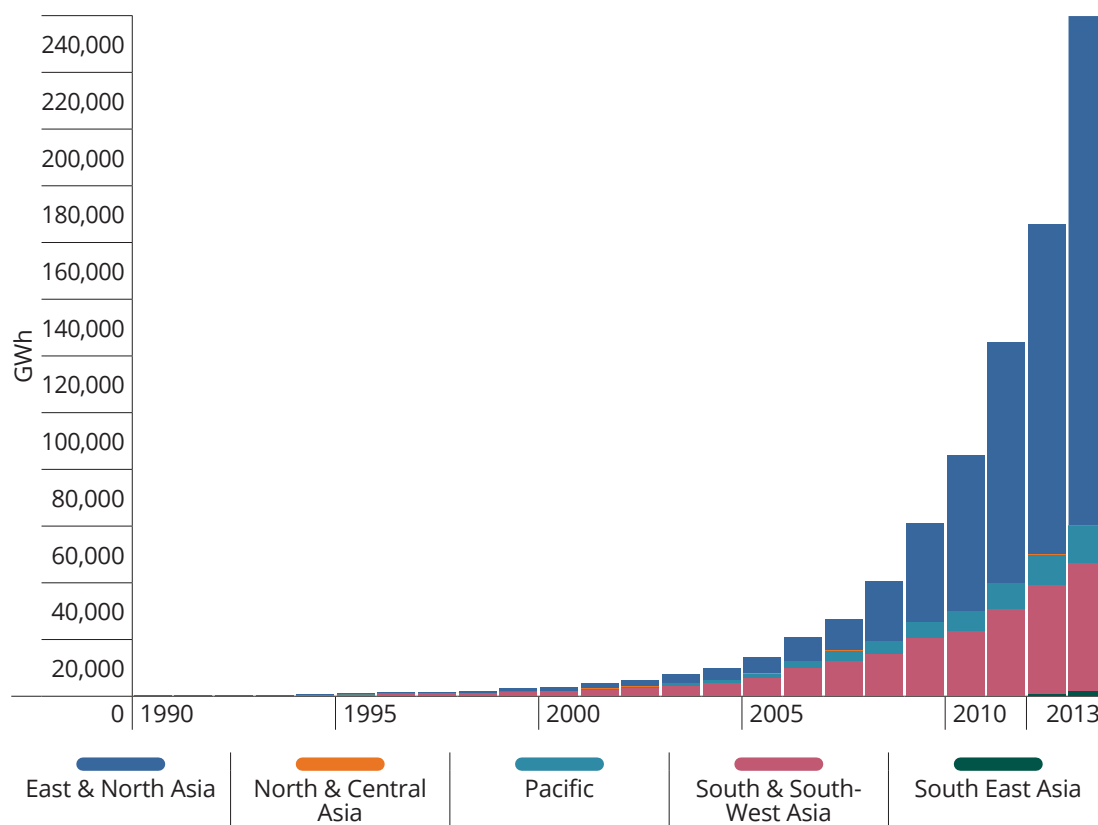
Poverty mapping to prioritize grid extensions to the more remote and poorest parts of the country. Supports use of energy for productive purposes leading to income and employment increase. Includes implementation of a revised subsidy delivery mechanism, contracting of Regional Service Centres in the most poverty-affected areas and the use of a cluster approach in selection of prioritized districts.

TIMOR-LESTE: Programme of the Sixth Constitutional Government, 2015

The government will build upon the recent upgrade and expansion of the electrical grid in Timor-Leste to provide reliable electricity supplies to the entire country. Renewable energies and complete rural electrification will form the two pillars of the electricity agenda.



Electricity production from solar/wind/tide in Asia and the Pacific, 2000-2013



Source: International Energy Agency (IEA), World Energy Statistics and Balances. Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

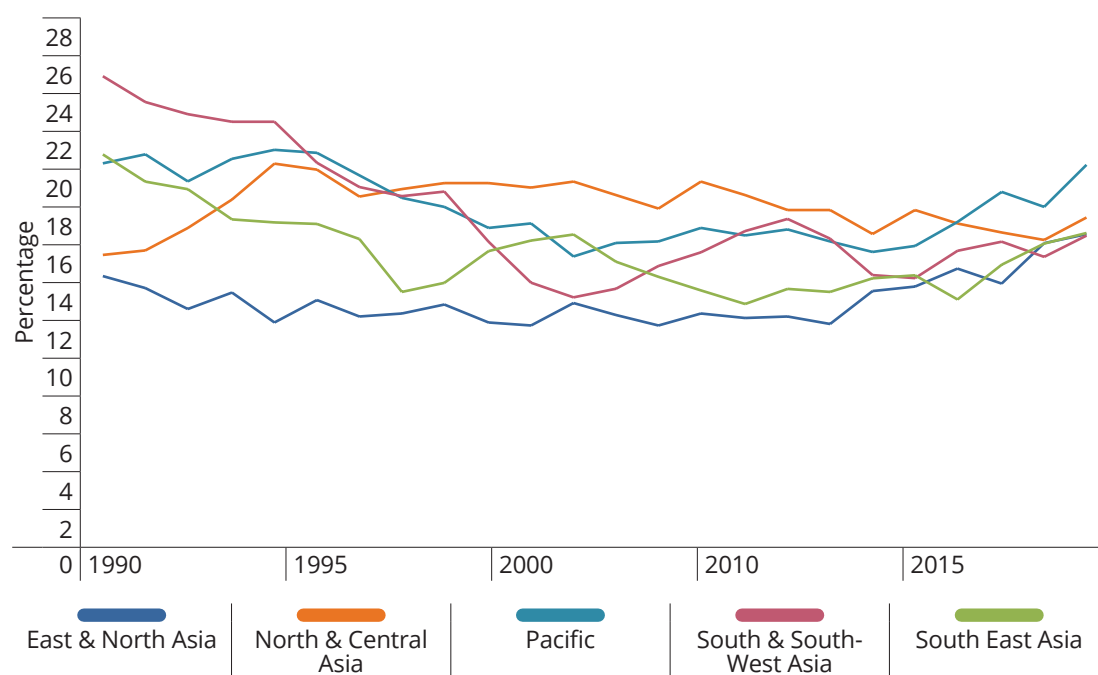
Countries of the Asia-Pacific region, through policy, technology and market innovation, have in recent years become some of the globally dominant players in renewable energy. The most rapid growth has occurred in the renewable power generation sector, which has not only experienced overall expansion, but also diversification, with the addition of wind, solar photovoltaic (PV), biofuels and others to a hydro-dominated mix.

The adoption of modern renewables has surged forward at exponential rates despite lower oil prices that were predicted by some to hinder the growth of the renewables industry. Global clean energy investment reached a new record in 2015, at \$329 billion, despite additional restraining factors including declines in the cost of solar PV, the strength of US currency, reducing the dollar value of non-dollar investment, and the continued weakness of the European economy, formerly the powerhouse of renewable energy investment. China accounted for one-third of investment, at over \$110.5 billion, and India increased

its investment to \$10.5 billion for the year. The majority of investment was in solar and wind, though small hydro and waste-to-energy projects demonstrated growing interest in these technologies. Utility-scale installations are growing in number. Examples include an \$850 million offshore wind farm with a design capacity of 399 MW financed by China (Bloomberg, 2016) and the newly commissioned 132.5 MW solar project in the Philippines developed by a Singapore developer and investor. For distributed energy, small-scale solar, such as rooftop installations, accounted for nearly 42 per cent of global spending on solar, with Japan representing the largest market (Bloomberg, 2016).

In 2013, more than 2,000 TWh of electricity were generated from renewable energy sources (including hydro) within the Asia-Pacific region. Although China stands out as a regional monolith for investment, integration and manufacturing of renewable energy technology, the Asia-Pacific region as a whole can be credited with tremendous growth in this sector, with countries such as India, Indonesia, Pakistan, the Philippines, Thailand, Turkey and Viet Nam making significant capacity additions in recent years in both grid-tied and distributed renewable energy systems. Backing these developments are rapidly expanding regulatory policies, financial incentives and public financing measures, in addition to plummeting systems costs due to more efficient manufacturing as economies of scale increase with the growth of renewable energy integration. As costs decline, the levelized cost of electricity is increasingly competitive from a purely economic standpoint.

Renewable percentage of electricity generation in Asia and the Pacific, 1990-2013



Source: International Energy Agency (IEA), World Energy Statistics and Balances. Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

However, energy demand within the region is accelerating at rates that surpass the added supplies from renewable energy sources, and the share of renewables within the region's primary energy supply dropped from nearly 17 per cent to approximately 12 per cent between 1990 and 2013. To a certain degree, this can be attributed to the positive shift away from traditional biomass. When examining the renewable share of electricity generation, differences can be found among the subregions, although the regional average, following a drop, has reached 18 per cent, barely surpassing the 1990 level of 17.8 per cent.

Specific targets catalyse the uptake of renewable energy as well as the development of supporting policies and incentives. Outside of the pledges under the Paris Agreement, 45 ESCAP member States were identified as having renewable energy targets in their national policies, up from 17 in 2010. In addition to targets, the scope of instruments being introduced is rapidly expanding, demonstrating the commitment of regional policymakers, who cite energy security, energy access and minimization of environmental impacts as principal objectives behind expanding the use of renewables.

As renewable energy technology is increasingly integrated into energy systems, the barrier to implementation in many areas and for many potential power producers is increasingly a financial rather than a technical one. Policy regulations and financial mechanisms such as feed-in tariffs have played a fundamental role in promoting the rapid deployment of renewable energy resources and, if properly implemented, have been shown to encourage increased investment, energy deployment and local job creation while stabilizing electricity rates. Of the 58 member States in the Asia-Pacific region, 25 have adopted some form of feed-in tariff policy (REN21, 2015). Energy resources supported by feed-in tariffs are increasing, with examples from across the region, including technologies such as small-scale distributed PV, and offshore wind, biomass and small hydropower. However, feed-in tariffs require significant upfront administrative commitments and costs, causing their implementation to be difficult for less-developed countries.

Japan provides an example of how tariff rates are closely linked to investment, with a generous feed-in tariff rate introduced in 2012. Although not without challenges, the tariff unleashed investment into solar PV projects that in 2014 reached \$34.3 billion, about 82 per cent of the country's total investment volume (REN21, 2015). The tariff introduction, however, resulted in a flood of applications to grid utilities causing them to become overwhelmed and dis-incentivized to share access to the grid until the reliability of new producers was settled. This in turn caused a backlog of new renewable energy projects. This case points to the need for feed-in tariffs that are effectively synergized with other policies and employ proper mechanisms for digression to generate investor interest and maintain confidence, particularly as markets expand due to renewable technology's continually dropping prices and increasing cost competitiveness with fossil fuels. Additionally, experience from the region demonstrates the need to streamline procedures to avoiding backlogs in applications for – and delays in permitting – grid connections and feed-in tariff payments.

Bilateral and multilateral cooperation mechanisms are playing an increasing role in the integration of renewable energy. In 2014, China and India signed bilateral commitments with the United States that included provisions for scaling up clean energy and renewables (REN21, 2015). For India, this included a pledge of \$2 billion to support the country's renewable energy and climate goals (ibid). Moreover, negotiations around an Environmental

Goods Agreement through the World Trade Organization could stand to greatly benefit the competitiveness of East Asian renewable energy technology firms, and encourage a greater level of renewables production through technology deployment in the region (ibid). Many of the Pacific Island States are also working towards renewable targets set out in multilateral agreements, such as The Majuro Declaration for Climate Leadership (2013), the Barbados Declaration (2012) and the Samoa Pathway (2014). An important trend to note is the adoption of national policies based on regional agreements and the linkages being made between national renewable energy objectives and larger regional and global issues related to energy security and climate change.

Sample Policy and Programme Approaches from the Region

JAPAN: Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities, 2011

Outlines measures for prices, periods, etc. with regard to procurement of electricity from renewable energy sources by electricity utilities. The Minister of Economy, Trade and Industry determines the price per kilowatt of electricity from renewable energy sources and the period of procurement based on a procurement price every business year, as demonstrated by Japan: Settlement of FY 2015 Purchase Prices and FY 2015 Surcharge Rates under the Feed in Tariff Scheme for Renewable Energy.

KAZAKHSTAN: Plan of Action for the Development of Alternative and Renewable Energy, 2013-2020

The policy seeks to strengthen measures for proliferating finance mechanisms and attracting private investment in renewable energy projects.

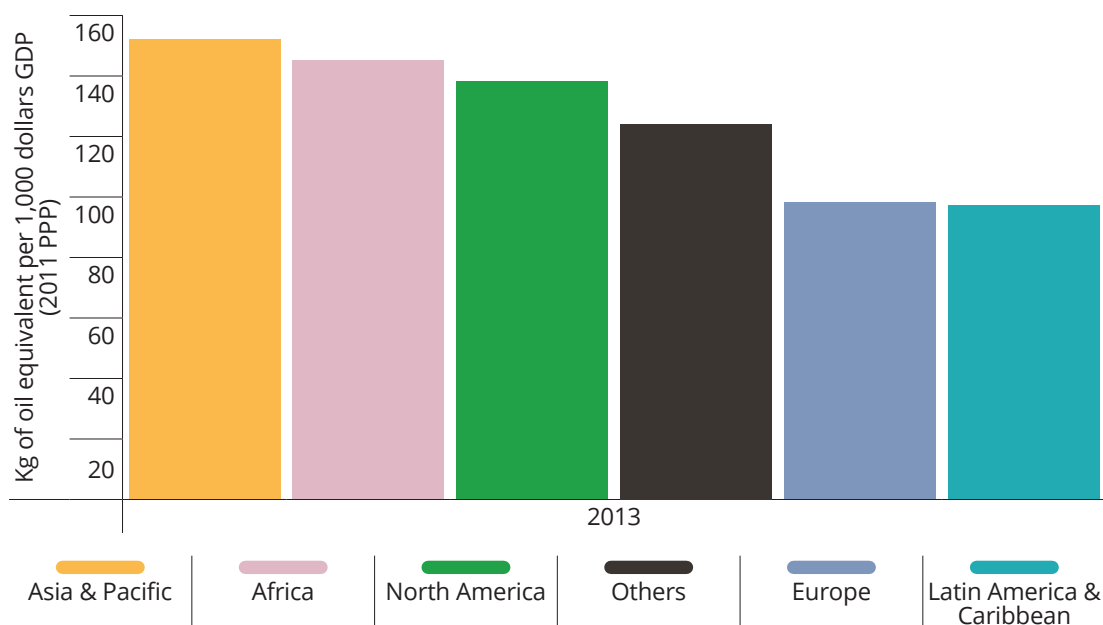
THAILAND: The 10-Year Alternative Energy Development Plan, 2012-2021

A roadmap showing renewable and alternative energy development strategy through 2021, including target value of cumulative capacity, framework and development plan for each type of renewable energy.

IMPROVE ENERGY EFFICIENCY AND CONSERVATION AND OBSERVE SUSTAINABILITY IN THE SUPPLY, DISTRIBUTION AND CONSUMPTION OF ENERGY

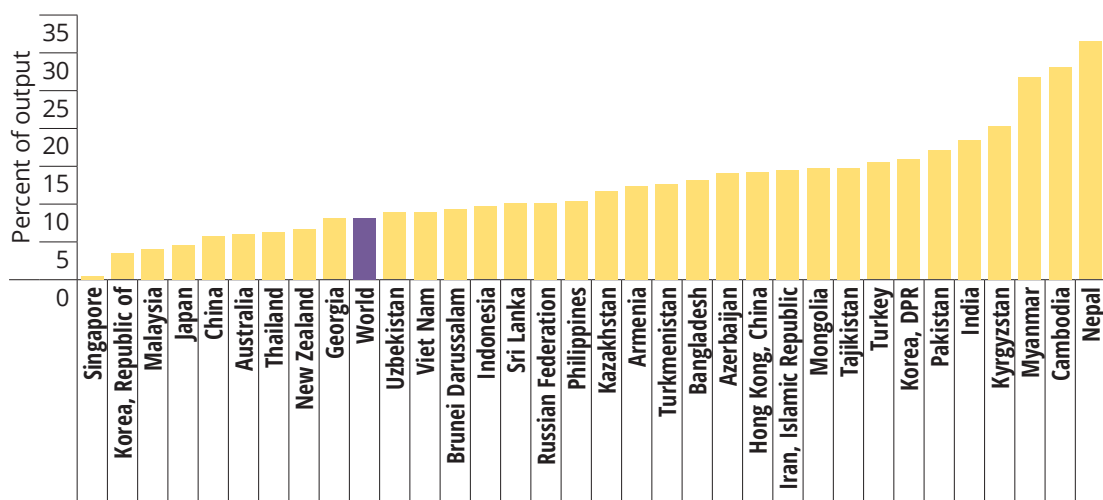
At a regional level, Asia-Pacific primary energy intensity dropped 30 per cent between 1990 and 2013, showing increased economic value production from the use of energy. Although GDP growth has in recent years outpaced global and other regional averages, this growth remains dependent on high levels of energy consumption. While the energy demands of the Asia-Pacific region have increased dramatically in the last two decades, the region exhibits lagging efficiency levels when compared with the rest of the world, as indicated by primary energy intensity. With rapidly rising demand, energy efficiency is recognized as a means to meet that demand, reduce investment needed for capacity additions and minimize both local and global environmental impacts. However, the regional final to primary energy ratio, a high-level measure of energy supply efficiency, has experienced a decline from

Primary energy intensity (global), 2013



Source: ESCAP based on the data from International Energy Agency (IEA), The GDP figures are sourced from World Development Indicators (WDI). Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

Electric power transmission and distribution losses (% of output) in select Asia-Pacific countries, 2013



Source: World Bank. World Development Indicators data from IEA

70 to 64 per cent between the years 2000 and 2013. In 2013, electric power transmission and distribution losses within the region ranged from 30 to less than 2 per cent, with the majority of ESCAP countries experiencing loss levels above the global average, indicating that investment in power distribution infrastructure upgrades is imperative.

With advanced energy efficiency, the region could save 35 per cent of its energy consumption over business as usual by 2035 (Shamsad Akhtar, 2016). Efficiency is often touted as the “fifth fuel”, a virtual energy supply which can be used to meet energy demand, thereby increasing energy security and lowering expenditures while also reducing environmental impacts. As an example, IEA estimates that Japan has avoided 30 million tons of oil equivalent in imports and realized more than \$10 billion in savings in 2014 due to energy efficiency investments made since 1990 (OECD and IEA, 2015). Key to achieving higher efficiency levels will be targeting investments at smarter, more technologically advanced energy systems, particularly for those countries in need of significant infrastructure development to meet current and future demand. Accelerating the introduction of advanced technologies, power grid upgrades and retrofitting of existing power plants is essential. Therefore, planning and early investments in energy efficiency and non-fossil power generation are needed to avoid getting locked into inefficient and emission-intensive infrastructure. Additionally, smarter buildings and transportation systems need to be integrated into the expanding urban environment. Japan stands out as a nation that has decreased its energy consumption in the transportation sector while increasing passenger-kilometres.

As the Asia-Pacific region grows and urbanizes, examples of national low carbon approaches – through energy-innovative and efficient urban planning, transportation systems and buildings – are appearing. Energy Service Companies (ESCOs) are playing an increasing role in managing energy demand. Furthermore, actions at the individual level are beginning to take hold as many countries have adopted consumer-targeted programmes introducing efficiency and conservation awareness through campaigns and labelling.

At the regional level, harmonization of efficiency standards and labelling increases market opportunities. At the end of 2015, the Association of Southeast Asian Nations (ASEAN) and Japan committed to defining performance standards for products manufactured in ASEAN (ASEAN, 2015). Considering the diversity of approaches and experiences to energy efficiency already present within the region, further opportunities for knowledge-sharing, technology exchange and human capacity development are plentiful. Capitalizing on these opportunities to push for the coordinated early adoption of energy efficiency standards across sectors can offer growing and long-term economic, environmental and social advantages for individual nations and the region as a whole.

Sample Policy and Programme Approaches from the Region

INDIA: India’s Intended Nationally Determined Contribution: Working Towards Climate Justice, 2015

Transportation efficiency is targeted through increasing reliance on improved rail systems and integrated waterways to improve transportation networks, as well as adoption and manufacturing of hybrid and electric vehicles.

JAPAN: Top Runner Programme, 2015

The Top Runner standards have been in continuous evolution since 1998. The Programme of 2015 aims to provide effective measures to achieve energy conservation in residential, commercial and transportation sectors, as well as improvements in the energy consumption efficiency of machinery and appliances.

REPUBLIC OF KOREA: Korea Energy Master Plan - Outlook and Policies to 2035, 2014

Provides an overarching master plan that covers all energy sectors and coordinates energy-related plans from a macro perspective.

SINGAPORE: E2 Singapore, 2012

A multi-agency committee has been set up to centralize and integrate the overall efforts of the public, private and people sectors to improve energy efficiency.

PAKISTAN: National Power Policy, 2013

Supports energy conservation and product labelling standards that would ban the import of inefficient electronics into the country and bring the local industry into compliance.

RUSSIAN FEDERATION: State Programme on Energy Efficiency and Power Sector Development, 2013-2020

Policy provides support for establishment of ESCOs and financial support for projects.

TURKEY: Strategic Plan, 2015-2019

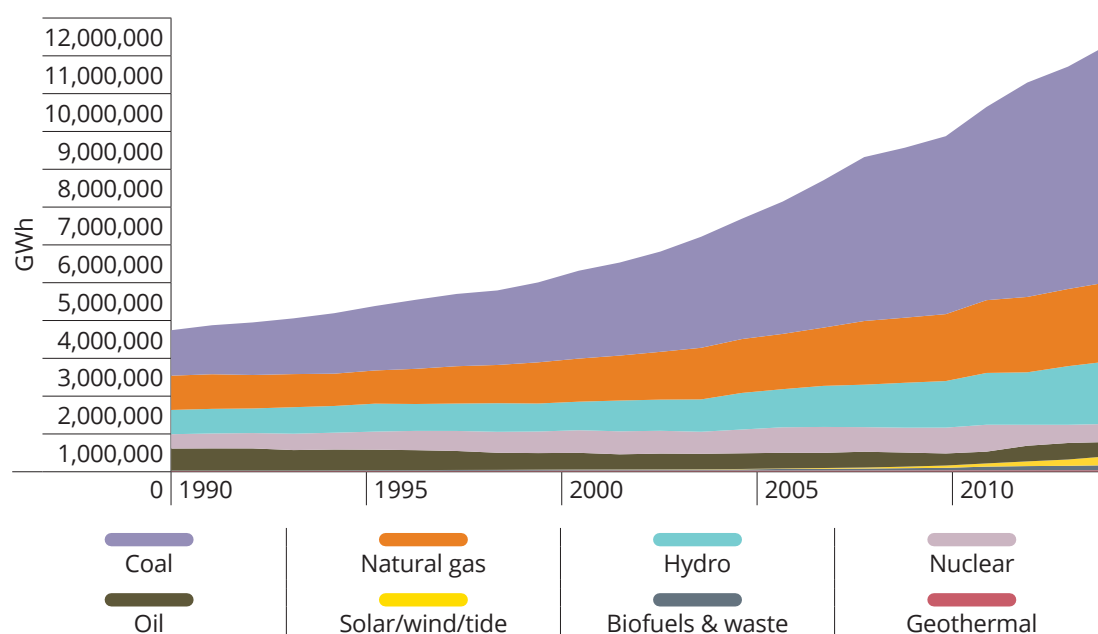
Scoring Building Energy Efficiency: Energy Identity Cards introduced for central and district buildings of the Ministry and related institutions, requiring that energy identity card class shall be minimum "C" for purchase and leasing procedures.

E**DIVERSIFY THE ENERGY MIX AND ENHANCE ENERGY SECURITY**

The Plan of Action identified the diversification of economically viable, socially acceptable and environmentally responsible energy resources and increasing the share of cleaner energies as priority actions. However, due to the availability and lower costs of developing coal for power generation and industry, much of the region has experienced an increased reliance on coal, particularly in the subregions of East and North-East Asia, South and South-West Asia, and South-East Asia. As a result, coal's share of the Asia-Pacific primary energy mix grew from 32 to 42 per cent between 2000 and 2013. Within the power mix, the share of coal grew from 44 to 56 per cent between 2000 and 2013. One significant exception lies in South-East Asia, where natural gas is playing a more important role in supplying electricity to the subregion's fast-growing economies. Although fossil fuels currently dominate the power mix, and will continue to do so for the near future, renewables in the form of solar, wind, geothermal, biofuels and waste-to-energy are gaining a small but rapidly increasing foothold, together increasing in share from less than 1 per cent in 2000 to over 3.5 per cent

in 2013. With hydro included, renewables accounted for 18 per cent of power generation, up from 15.1 per cent, in the same period. Countries are tapping into renewable energy to meet a variety of objectives including increasing domestic production levels, increasing the reliability of the energy supply, reaching remote areas and enhancing overall energy security. Particularly for those countries heavily reliant on energy imports, renewables are increasingly viewed as a means of increasing overall energy security.

Electricity production by product in Asia and the Pacific, 2013



Source: ESCAP based on the data from International Energy Agency (IEA), World Energy Statistics and References. Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

Following the Paris Agreement, energy plans are adjusting to meet national commitments, signaling new directions in energy development that will shift the energy mix. In a January 2016 announcement, Viet Nam's prime minister announced a reversal of plans to construct new coal-fired power plants in favour of further developing the natural gas and renewable power supply (Green, 2016). In 2015, the growth rate of wind and solar power capacity additions outpaced fossil fuels in the region's largest power producer, China, and hydro, wind and solar together accounted for 32.6 per cent of total capacity additions (National Bureau of Statistics of China, 2015). Recent developments in energy storage are further shaping the landscape for renewable energy production. According to new research, installed energy storage capacity is expected to increase dramatically between 2015 and 2025, with Australia, China, India, Japan, and the Republic of Korea making the top 10 in one

Percentage above or below energy self-sufficiency, 2013



Source: PPI Database, World Bank and PPIAF

global forecast (Navigant Research, 2015) for storage capacity additions. Energy storage can increase the stability of grid systems, as well as provide additional energy security by buffering against costly power outages, which lead to economic losses. Already, policies and programmes are reflecting these new trends in several Asia-Pacific countries, such as Australia, China and Thailand, demonstrating investment into research, development and deployment of commercially-viable storage systems.

Furthermore, diversification of the energy mix is also leading to diversification of ownership in power production, once dominated primarily by large utilities. Independent power producers are playing an increasing role and contesting conventional approaches to the development of the power supply, which is shifting to include households and communities. This trend creates new challenges around access to and liberalization of power markets, as well as new policy requirements around grid access and net metering.

Sample Policy and Programme Approaches from the Region

ARMENIA: Scaling Up Renewable Energy Programme (SREP), 2014

Armenia's investment plan for renewables to improve energy security and reliability, and reduce the future cost of supply.

AUSTRALIA: Renewable Energy Venture Capital Fund, 2012

The Renewable Energy Venture Capital Fund Programme was created to provide venture capital and active investment management to encourage the development of Australian companies that are commercializing renewable energy technologies.

CHINA: 12th Five-Year Plan on Energy Development, 2013

The energy development plan is drafted in accordance with the 12th five-year period (FYP) for social and economic development, with an aim to facilitate a change of energy production and utilization, adjust the energy structure, and construct a safe, stable, economic and clean modern energy system. It serves as the blueprint and action plan for energy development in the 12th FYP of China.

KAZAKHSTAN: Concept for the Development of the Fuel and Energy Sector until 2030, 2014

The policy proposes further steps to enhance Kazakhstan's energy security. The focus is on the following areas: energy efficiency and energy conservation; development of the coal, oil and gas industries; nuclear energy; and the electric power sector. It contains cross-sectoral analysis that brings out existing vulnerabilities in these fields and designs policy responses to emerging and persistent challenges

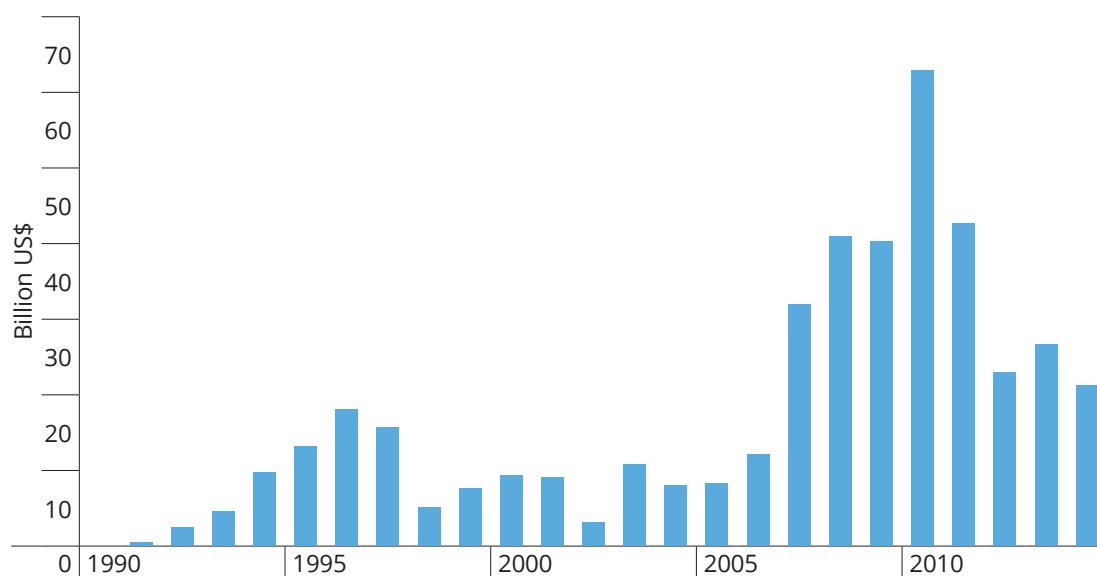
REPUBLIC OF KOREA: Korea Energy Master Plan – Outlook and Policies to 2035, 2014

The plan promotes projects for small-scale energy distribution to meet the daily energy demand of homes, villages, schools and others with renewable energy.

THAILAND: The 10-Year Alternative Energy Development Plan (2012-2021)

Aims to reduce import dependency and risk through increasing renewable energy production. Targets are set for individual resources for power generation and the transport sector.

Asia-Pacific investment in energy with private participation, 1990-2014

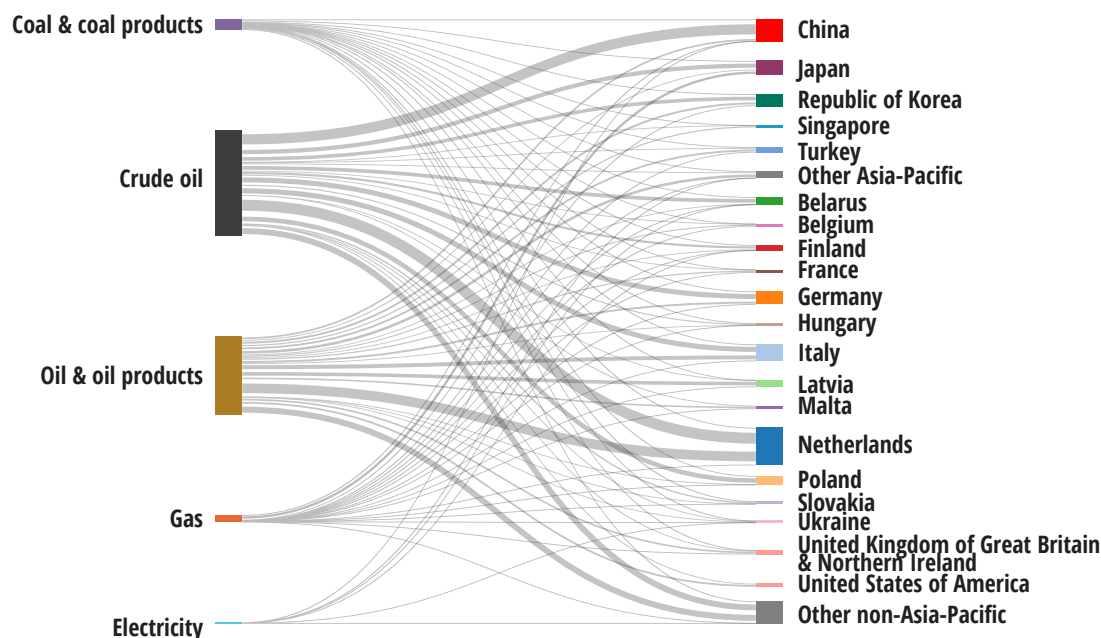


Source: ESCAP calculated from World Bank, Private Participation in Infrastructure Project Database (<http://ppi.worldbank.org>)

Cross-border electricity trade and investment patterns have differed among individual subregions of the Asia-Pacific region. Energy sharing and transport networks among countries of North and Central Asia have been historically well-established but over the past few years the region has experienced a sharp decline in intraregional electricity trade. In contrast, countries of South-East Asia, China and India have increasingly engaged in cross-border energy and electricity trade in the past few years. Countries involved in the two most comprehensive integrated network initiatives – the Greater Mekong Subregion (GMS) Power Market and ASEAN Power Grid (APG) – have been particularly active, with three projects planned for the period 2016-2020.

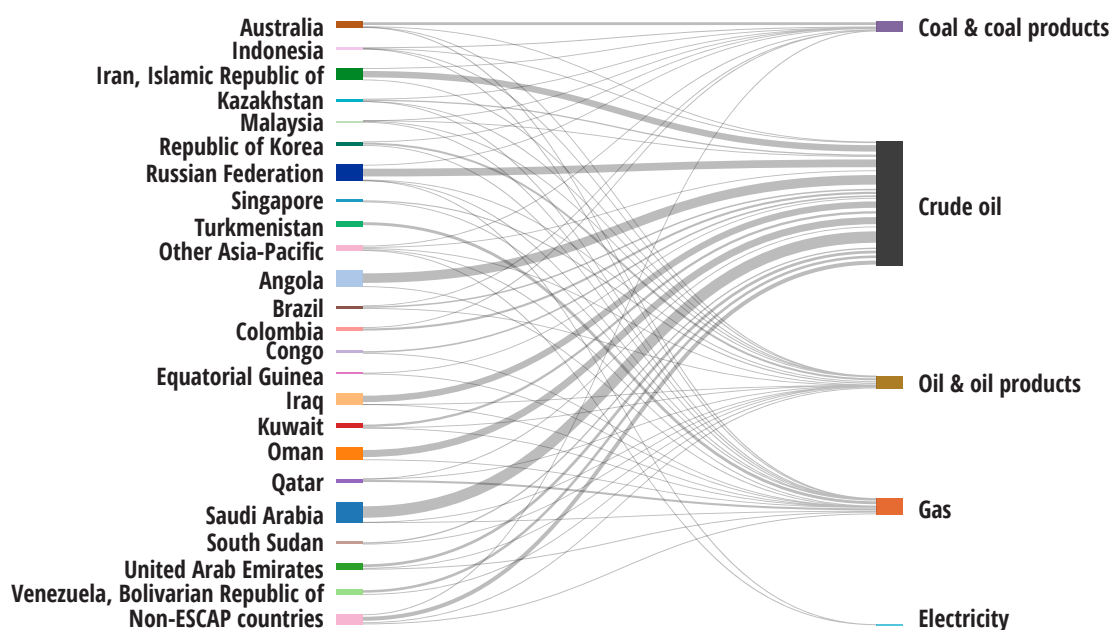
Asia-Pacific power trade is mostly limited to bilateral agreements. Progress on the ambitious regional integrated Asian Super Grid and Gobitec have so far remained slow. The development of regional markets is challenged by massive investment requirements and the need for coordinated planning and harmonized policy development. Several countries in the Asia-Pacific region have made significant progress in eliminating trade barriers. Nevertheless, despite clear overall efforts to liberalize and internationalize energy markets, the differences in trade institutions among individual countries have hindered the required foreign and private investment in cross-border infrastructure.

Russian Federation energy exports, 2014



Source: UN Comtrade (<http://comtrade.un.org>). Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

China energy imports, 2014



Source: UN Comtrade (<http://comtrade.un.org>). Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

The region's largest energy exporter, the Russian Federation, has exhibited a shift towards Asia and the Pacific. In 2000, Russian exports to ESCAP countries comprised only 6 per cent of the country's total energy exports, amounting to \$2.18 billion in trade value. In 2014, ESCAP countries accounted for 28 per cent of Russian exports, at \$70.97 billion, with China, Japan and the Republic of Korea being the largest importers.

China, the region's largest importer, is increasingly relying on imports from outside the Asia-Pacific region. Imports from ESCAP countries accounted for 35 per cent of 2014 energy imports, down from 43 per cent in 2000. The trade value of China's 2014 energy imports from ESCAP countries amounted to \$105 billion out of a total of \$301 billion. Japan, the region's second largest importer, demonstrates a similar trend, with ESCAP country imports holding steady at around 60 per cent between 2000 and 2014.

Considering the vast energy resources and the scale of growing energy demand within the region, current trade patterns suggest significant opportunities in trade that could provide large economic boosts within the region. The existing and planned bilateral cross-border projects and agreements can establish a good foundation for more comprehensive subregional market integration. This will require further elimination of tariff and non-tariff trade barriers, however, as well as institutional and technical harmonization. Regional coordination in terms of energy pricing, regulatory mechanisms, development planning and project operation and design standards can further reduce development costs, increase efficiencies, lower environmental impacts and provide socioeconomic benefits.

Sample Policy and Programme Approaches from the Region

ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025, Phase I: 2016-2020

Phase I will cover the period 2016-2020 for the implementation of short to medium-term measures to enhance energy security cooperation and to take further steps towards connectivity and integration. In 2018, there will be a follow-up on the progress of Phase I, which will guide ASEAN in charting the pathways and directives for Phase II (2021-2025).

RUSSIAN FEDERATION: General Scheme for the Development of Gas Industry until 2030, 2011

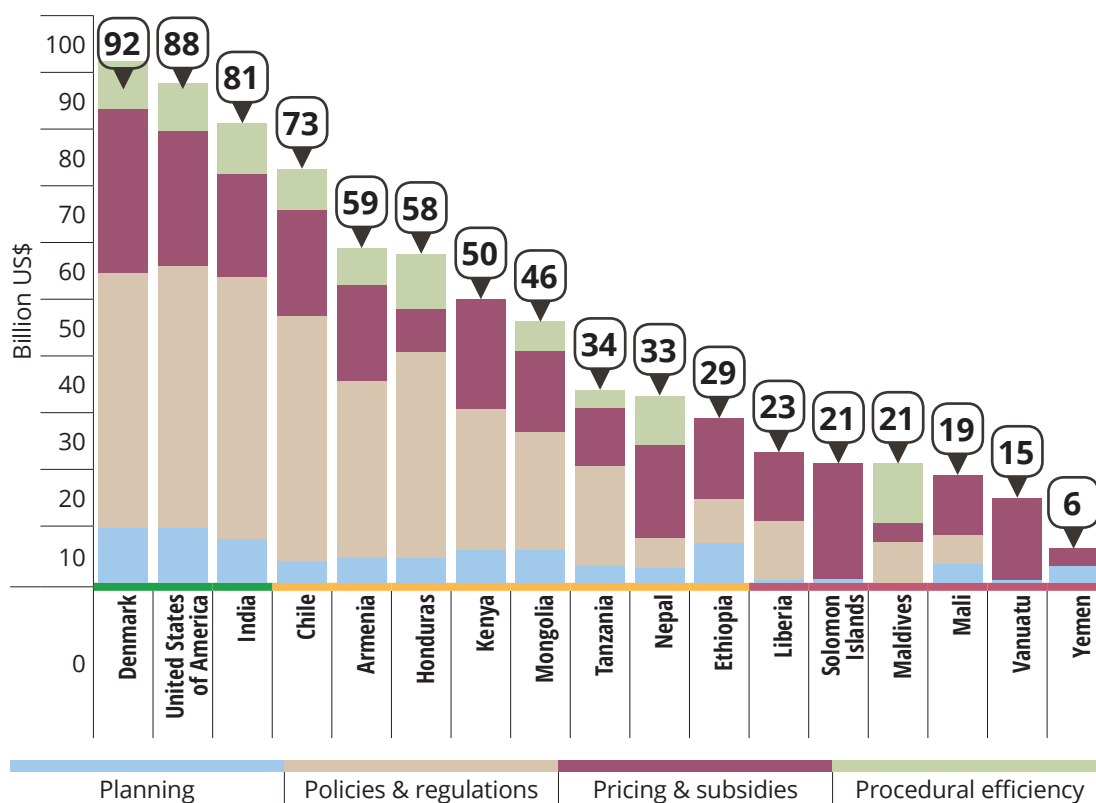
Stated objective is to enhance energy security through greater transboundary collaboration in Asia and the Pacific. The policy calls for the strengthening of mutually beneficial and long-standing cooperation with China, Japan and the Republic of Korea.

SAARC Framework Agreement for Energy Cooperation (Electricity), 2014

Member States may enable the transmission planning agencies of the governments to plan cross-border grid interconnections through bilateral/trilateral/mutual agreements between or among the concerned States based on the needs for trade in the foreseeable future, through studies and sharing technical information required for the same.

IMPROVE FISCAL POLICY AND FINANCING MECHANISMS TO INCENTIVIZE AND STRENGTHEN MARKETS FOR SUSTAINABLE ENERGY

Readiness for renewable energy investment in selected countries, 2014

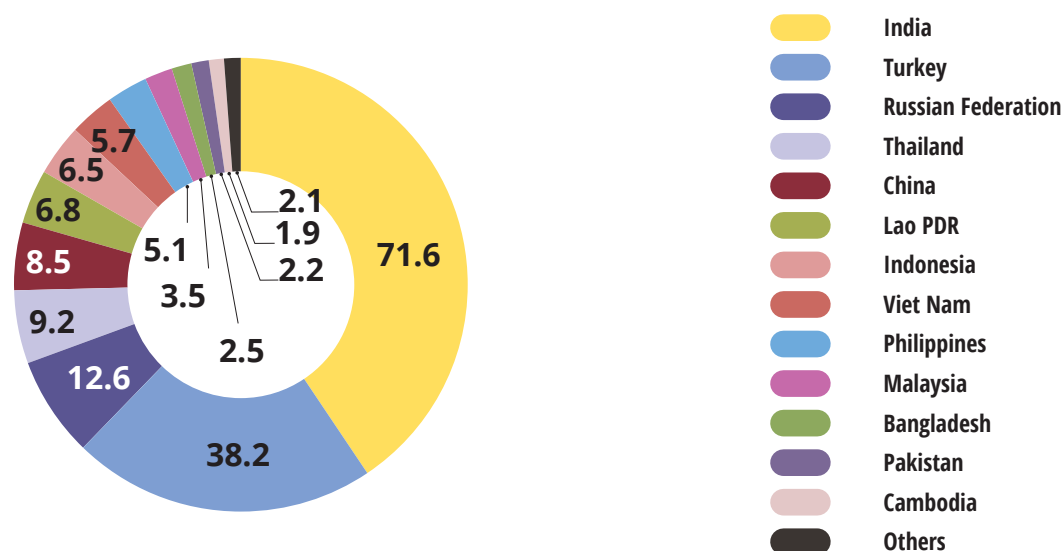


Source: World Bank, *Readiness for Investment in Sustainable Energy*, 2014.
Available at <http://rise.worldbank.org/>

The Asia-Pacific region is not only the world's biggest consumer, but also the largest producer and investor in renewable energy, with global leaders in solar PV markets, wind, geothermal power generation and tidal energy. Countries in the region are working towards integration of renewable energy and feed-in tariffs have emerged as the policy of choice to try to foster private investment in the renewable energy sector. Much progress has been made in strengthening sustainable energy markets, but a number of barriers remain, including fossil fuel subsidies, which, despite recent efforts in some countries to reduce them, still present a major obstacle to attracting private (particularly foreign) capital, as do high start-up costs, shallow capital systems and often unpredictable regulatory regimes.

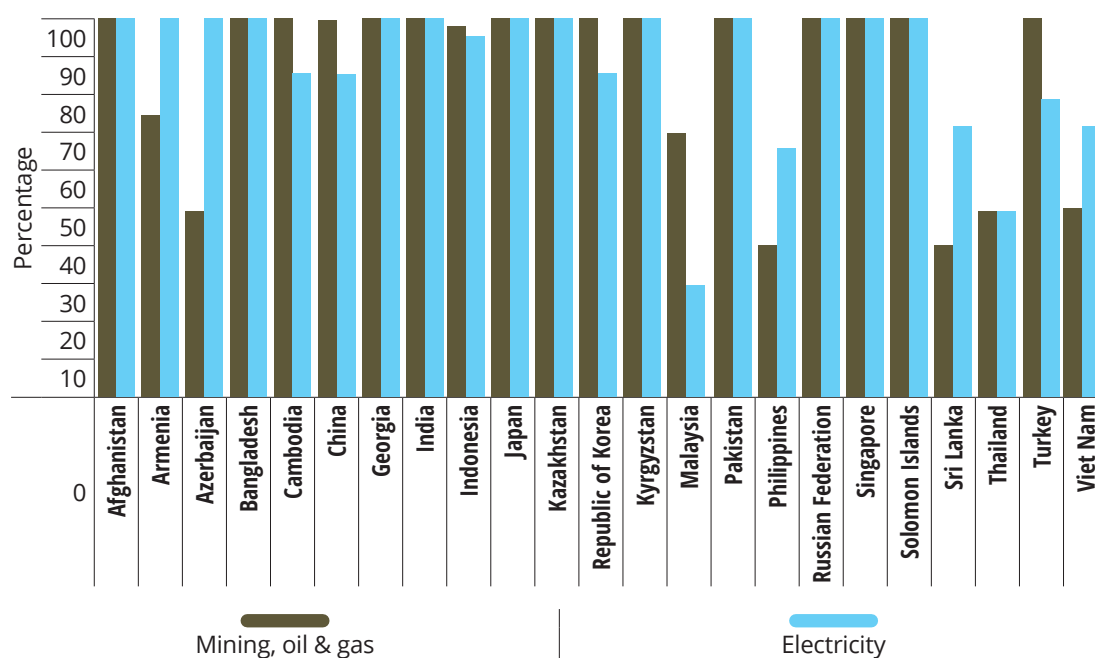
A recent World Bank study, *Readiness for Investment in Sustainable Energy*, ranked the investment climate in 17 pilot countries. Among the top-ranked countries from the study was India, which exhibited high levels of planning, policy and regulation; these

Investments in energy with private participation in Asia and the Pacific, 2010-2014 (Billion USD)



Source: ESCAP calculated from World Bank, Private Participation in Infrastructure Project Database (<http://ppi.worldbank.org>)

Shared of foreign ownership allowed, 2012



Based on data from World Bank, Investing Across Borders IAB

have translated into the Asia-Pacific region's largest investments in energy with private participation, amounting to \$71.6 billion between 2010 and 2014. Turkey ranked second with \$38.2 billion in investment over the same period.

Both India and Turkey have put in place highly favourable policies to encourage private investment, and have developed detailed plans that provide longer-term energy development perspectives. However, it is clear that many countries in the Asia-Pacific region have yet to create an enabling environment and therefore lack robust long-term institutional investors. Several countries in the region prohibit majority foreign ownership in power generation, and almost all countries do so in power transmission and distribution, which disincentivizes investment in these sectors (OECD, 2014). Furthermore, in recent years several countries in the region have imposed local-content requirements, which have been found to have significant negative effects on international investment flows. Overall, enabling fiscal policies and financing mechanisms are inadequate in most countries to attract investment required for the energy sector. In many cases, procedural delays, multiple layers of taxation and unattractive risk levels for investors hamper investment flows.

Provision of financial incentives and public support in the form of increased long-term feed-in tariffs and expanded guarantees, as well as open and transparent regulatory frameworks, are essential to incentivize multiple international stakeholders to engage in large-scale sustainable energy infrastructure projects.

Sample Policy and Programme Approaches from the Region

INDIA: Strategic Plan for New and Renewable Energy Sector for the Period 2011-2017

Outlines subsidies, risk guarantees and feed-in tariffs for grid and off-grid renewable energy projects for the period of 2011-2017.

TURKEY: Electricity Market Law (No. 6446), 2013

Policy provides 85 per cent deduction on the value of renewable energy power generation investments and permits for the first ten years of their operating period.

TURKEY: Strategic Plan 2015-2019

Promotes PPPs to develop domestic energy sources and outlines measures to improve the investment environment.

RUSSIAN FEDERATION: Strategy for the Development of Russia's Power Grid, 2013

The Strategy underlines that power infrastructure investments are considered a means of ensuring overall sectoral competitiveness and introducing advanced management practices to Russia's energy sector. The ultimate objectives, thus far, are focused on improving operational efficiency by involving forms of foreign proprietorship, improving risk management and increasing national budget revenues.

THAILAND: Announcement of the Board of Investment No. 2 /2557: Policies and Criteria for Investment Promotion, 2015

Outlines investment promotion policies, including domestic and overseas investment across sectors, to “enhance the nation’s competitiveness, to overcome the middle income trap and to achieve sustainable growth in accordance with the philosophy of sufficiency economy.” The policy lists activities eligible for investment promotion and criteria for granting of specified financial incentives.

H**IMPROVE ENERGY STATISTICS AND FACILITATE DATA AND INFORMATION SHARING**

Data and analytics regarding past trends, current status and future scenarios are essential to support evidence-based policymaking. However, Asia-Pacific policymakers often lack timely and reliable information needed for effective decision-making processes. In this age of “big data” many countries lack even basic levels of data regarding their energy supply and use, as well as lacking the tools to effectively use them.

When it comes to the generation of data, several layers exist that affect the quality and usability of the data generated. Regular data collection requires significant resources, which are limited in some member States. The methodology applied to data collection is inconsistent in many cases or varies between countries, rendering the data usable for national applications but not comparable with data from other states. In some cases, data are largely estimated. Furthermore, accessing data can be challenging, and the capacity to apply data and information effectively to policymaking requires further strengthening across the region.

In order to assess national development within a regional context, data standardization and comparability are essential. Several institutions do produce energy data for the region; however, much of this information is proprietary and not freely accessible to regional decision makers. In addition, the methodology applied by these institutions has been criticized for lack of transparency, leading to mistrust among member States who feel the data do not accurately reflect their national situation. Open data sources available for the region do not provide complete energy balance and use data, are limited in their country coverage, or are not timely enough to hold adequate value for decision makers. However, at the subregional level a number of efforts exist.

ASEAN has arguably the most advanced data and information sharing platform for its members, the ASEAN Centre for Energy, which produces statistics and extensive analyses, including outlook scenarios. Backing the success of this platform are the close partnerships among countries from within and outside of ASEAN. The SAARC Energy Centre offers another example of data centralization for its members to facilitate cooperation in development. The Pacific Regional Data Repository is another notable effort to generate statistics which have been largely absent for Pacific island countries, hampering efforts to develop the energy sector.

Regionally, ESCAP has initiated the Asia Pacific Energy Portal, in order to bring data for all member States into one centralized location, as well as offer access to national and regional policies. The platform continues to expand, but currently offers approximately 200 indicators and over 2,300 searchable policy documents. Future development plans include the mapping of energy infrastructure.

Increasingly opening access to more energy information can build transparency and trust and create economic value within the energy sector. Further efforts to generate reliable, comparable and timely data and policy information are needed, although existing frameworks offer good examples upon which larger, broader and more accessible platforms can be built.

Sample Policy and Programme Approaches from the Region

Asia Pacific Energy Portal: www.asiapacificenergy.org

ASEAN Centre for Energy: www.aseanenergy.org

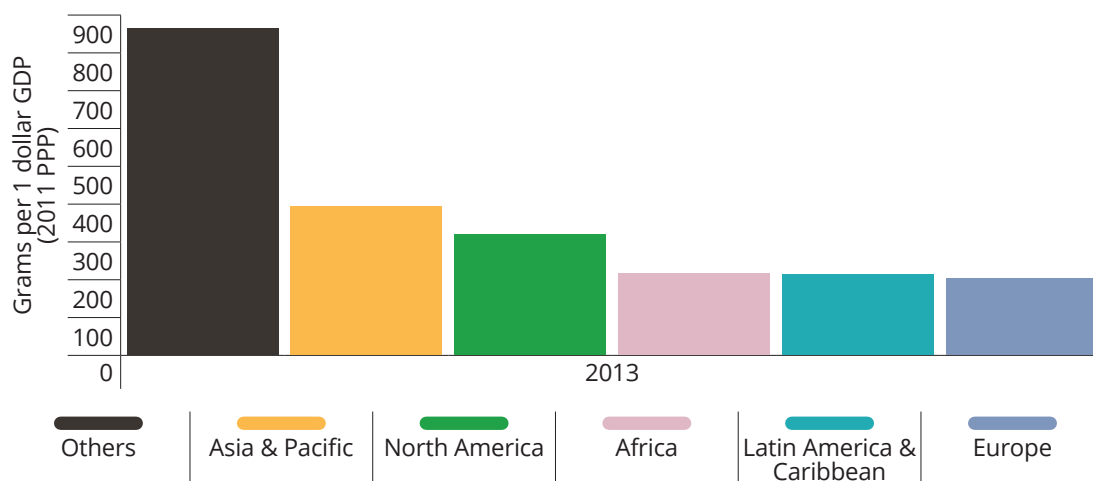
Pacific Regional Data Repository: <http://prdrse4all.spc.int/production/list/data>

SAARC Energy Centre: www.saarcenergy.org

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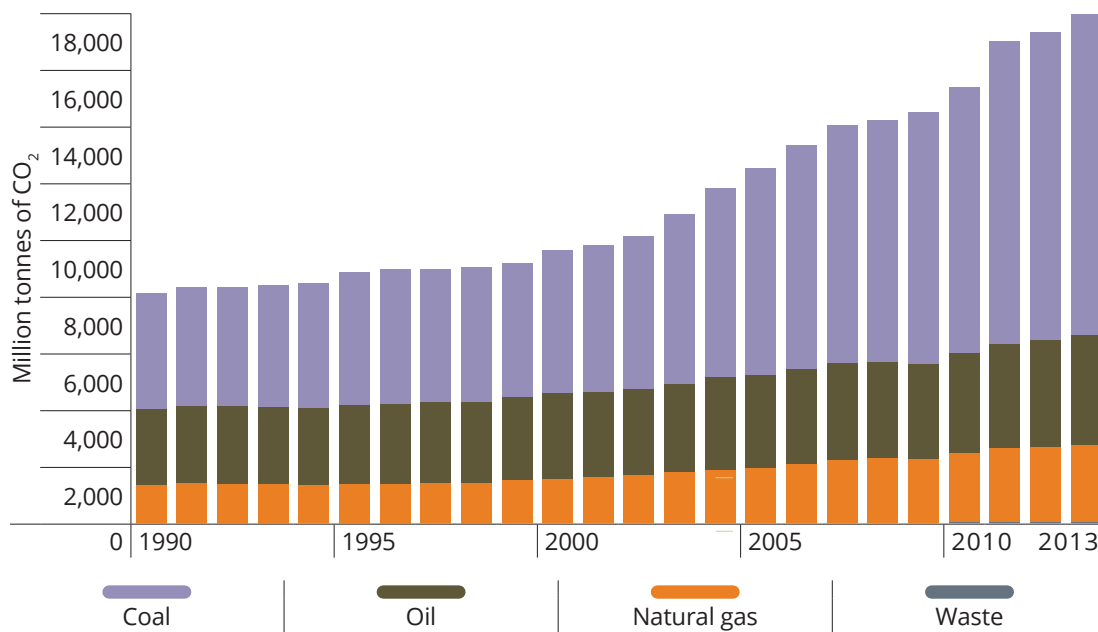
MINIMIZE THE ENVIRONMENTAL IMPACT OF THE ENERGY SECTOR

Carbon intensity of the economy in world, 2013



Source: ESCAP based on the data from International Energy Agency (IEA) and World Bank. Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

CO₂ emissions, by fuel source in Asia and the Pacific, 1990-2013



Source: World Bank. World Development Indicators data from IEA

As many nations within the region continue to make significant headway in economic terms, these gains are paired with setbacks to global and local environmental conditions. Carbon intensity here remains highest among all global regions except for the Middle East. Indeed, the region's per capita emissions remain low when compared to developed regions, including North America and Europe, but while the per capita emissions of those developed regions are in decline, emissions from the Asia-Pacific region are increasing rapidly.

Between 2000 and 2013, Asia and the Pacific's global share of emissions from fuel combustion grew from 40 to 54 per cent. During that same period, coal's share of emissions from the region rose from 52 to over 63 per cent. Given that coal made up 44 per cent of the regional primary energy supply in 2013, it is clear that the development of the energy sector has followed a carbon-intensive path.

However, uncertainty around the future of coal is rising. IEA reports that global coal demand has stalled for the first time since the 1990s, primarily due to a drop in demand from China (IEA, 2015), while other experts suggest that global coal use may have peaked in 2013, sooner than expected (Brady & SNL, 2015). Commitments made at the 2015 climate negotiations in Paris have added to negative sentiments regarding coal reliance.

Fossil fuel subsidy reform is a policy area receiving much attention in recent years, which could lead to greater competitiveness for renewable energy and a shift in energy mixes. IEA estimates for 2014 suggest overall energy subsidies totaling \$165 billion for 15 ESCAP member States, a decline from 2012 figures totaling \$219 billion. According to another estimate by the International Monetary Fund (IMF), fossil fuel and electricity pre-tax subsidies in Asia and the Pacific reached an estimated total of \$152 billion in 2015; however, based on the broad notion of post-tax subsidies – which incorporate pre-tax subsidies and also reflect environmental impacts and foregone consumption tax revenues – the total is much higher and rising, reaching more than \$3.4 trillion in 2015 (IMF, 2015). IMF data suggest that subsidization is actually on the rise when externalities are incorporated into the equation.

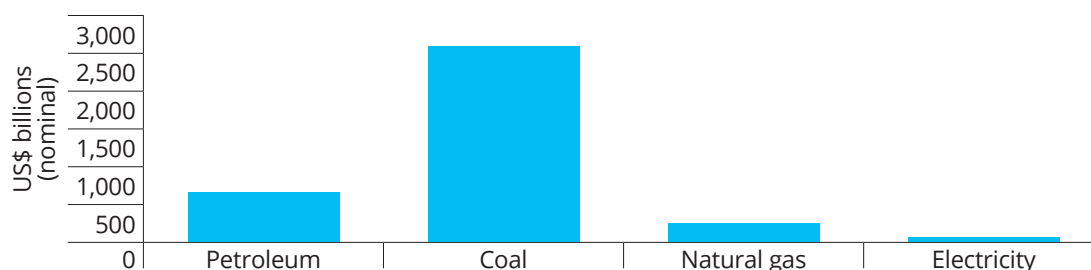
Although governments are slow to put dollar values on environmental degradation, global economic damage from the negative impacts of climate change is estimated by insurance agencies at hundreds of billions of dollars each year (IFAD, 2009). Consideration for the externalities of energy use is increasing, particularly as nations have made new strides in climate agreements, and local air pollution has reached critical levels in a number of Asian cities. The costs of addressing air pollution are rising within the region, which has some of the highest global concentrations of particulate matter (PM), as well as associated death rates (WHO, 2015). Governments can no longer ignore these externalities, and in one 2015 study, the estimated annual cost of implementing Chinese policies aimed at curbing pollution ranges in the tens of billions of dollars annually (Rand Corporation, 2015).

When it comes to air quality, the Asia-Pacific region's record is dismal. Of the 1,622 global cities listed in the 2014 World Health Organization (WHO) Ambient (Outdoor) Air Pollution Database, Asia-Pacific cities represented 85 of the top 100 polluted cities, ranked according to annual average levels of PM10 and PM2.5. Average PM10 and PM2.5 levels among these cities ranged from 5 to 27 times higher than WHO air quality guidelines.

De-linking economic growth and environmental degradation is essential for sustainable development, and will require multisectoral and comprehensive planning approaches, as well as introduction of both incentives and disincentives. India has recently taken a more aggressive approach to taxation by doubling the clean energy tax on coal, which could help curb its use and aid the push for greener energy.

The new international climate deal, the Paris Agreement, includes the goal of limiting global temperature rise to 2°C, which will cost an estimated \$1 trillion annually (Climate Policy Initiative, 2015). With potential GDP losses in the tens of trillions of dollars (Citigroup, 2015), early investments in clean energy are needed to set the sector's development path. INDCs, if ratified and implemented, would reduce emissions sufficiently to limit warming to an estimated 2.7°C by 2100. The Asia-Pacific region represents some of the world's most vulnerable nations, as well as some of the strongest determinants of success for curbing climate change. The targets set forth in the INDCs (see table below) demonstrate significant commitment by Asia-Pacific nations to supporting this global objective. Already, regional examples of advanced technology uptake, low-carbon development strategies and pollution abatement efforts are present and can be built upon to further the development goals of the region while ensuring minimization of environmental impacts.

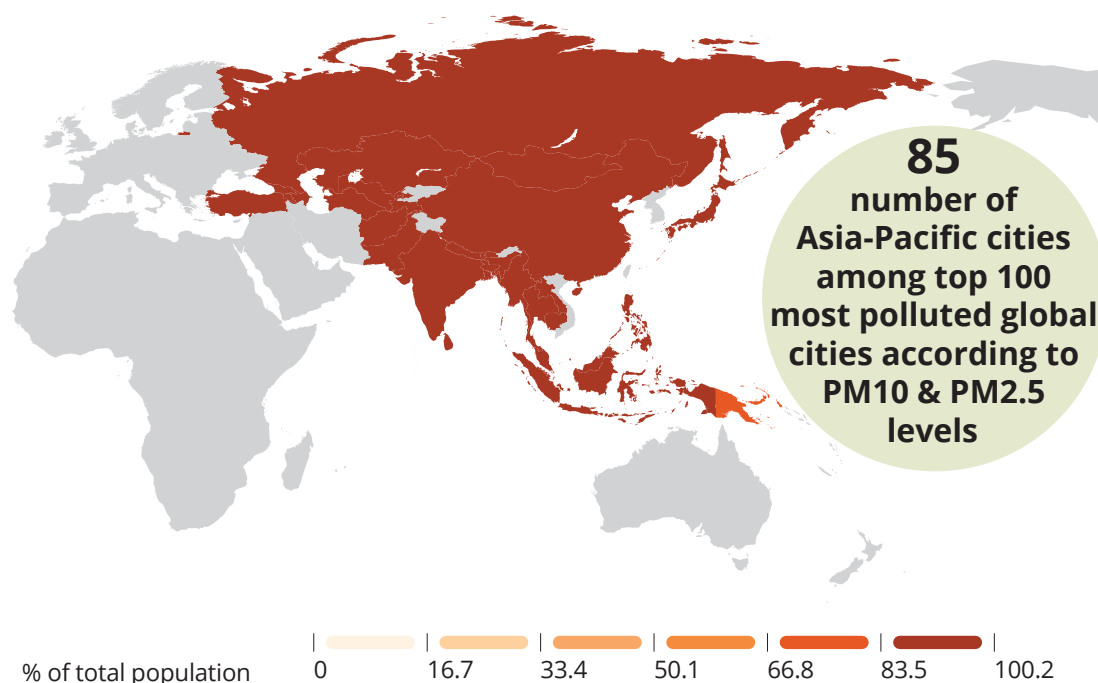
Asia-Pacific post-tax energy subsidies in 2015



Note: The energy subsidy estimates reported here are based on the broad notion of post-tax subsidies which arise when consumer prices are below supply costs, plus a tax to reflect environmental impacts and an additional tax applied to all consumption goods to raise government revenues.

Based on data from IMF (2015) *Counting the Cost of Energy Subsidies* available from <http://www.imf.org/external/pubs/ft/survey/so/2015/NEW070215A.htm>

PM2.5 air pollution, % of total population exposed to levels exceeding WHO Guideline value in Asia and the Pacific, 2013



Source: World Bank. World Development Indicator. Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

Sample Policy and Programme Approaches from the Region

REPUBLIC OF KOREA: Clean Air Conservation Act, 2015

Limiting transportation emissions: Details standards and procedures for reducing transportation emissions, including provision of subsidies and loans to enable compliance.

RUSSIAN FEDERATION: State Programme on Industrial Development and Improving Industrial Competitiveness, 2014-2020

Points the way to the next big leap in industrial development, towards improving sustainability of the energy, transport, agriculture and other essential sectors of economy. It targets a 25 per cent reduction of air pollutants by 2020.

CHINA: 12th Five-Year Plan on Energy Development, 2013

Targets cutting back sulphur dioxide and nitrogen oxide emissions from coal use and achievement of a 30 per cent reduction in PM2.5 emission intensity due to energy development and utilization.

GHG reduction targets as stated in INDCs for top 10 emitters in Asia and the Pacific

China "China has nationally determined its actions by 2030... To lower carbon dioxide emissions per unit of GDP by 60 to 65 per cent from the 2005 level"

India "To reduce the emissions intensity of its GDP by 33 to 35 per cent by 2030 from 2005 level."

Russian Federation "Limiting anthropogenic greenhouse gases (GHG) in Russia to 70-75 per cent of 1990 levels by the year 2030 might be a long-term indicator, subject to the maximum possible account of absorbing capacity of forests."

Japan "Japan's INDC towards post-2020 GHG emission reductions is at the level of a reduction of 26.0 per cent by fiscal year (FY) 2030 compared to FY 2013 (25.4 per cent reduction compared to FY 2005)"

Islamic Republic of Iran "On the basis of national capabilities, financial resources available and requirements of the national development programme, taking into account GHG emission scenarios, the Islamic Republic of Iran intends to participate by mitigating its GHG emission in 2030 by 4 per cent compared to the business-as-usual (BAU) scenario."

Republic of Korea "Korea plans to reduce its GHG emissions by 37 per cent from the BAU level (850.6 MtCO₂eq) by 2030 across all economic sectors."

Indonesia "Indonesia has committed to reduce unconditionally 26 per cent of its GHG against the BAU scenario by the year 2020...Indonesia is committed to reducing emissions by 29 per cent compared to the BAU scenario by 2030."

Australia "Under a Paris Agreement applicable to all, Australia will implement an economy-wide target to reduce GHG emissions by 26 to 28 per cent below 2005 levels by 2030."

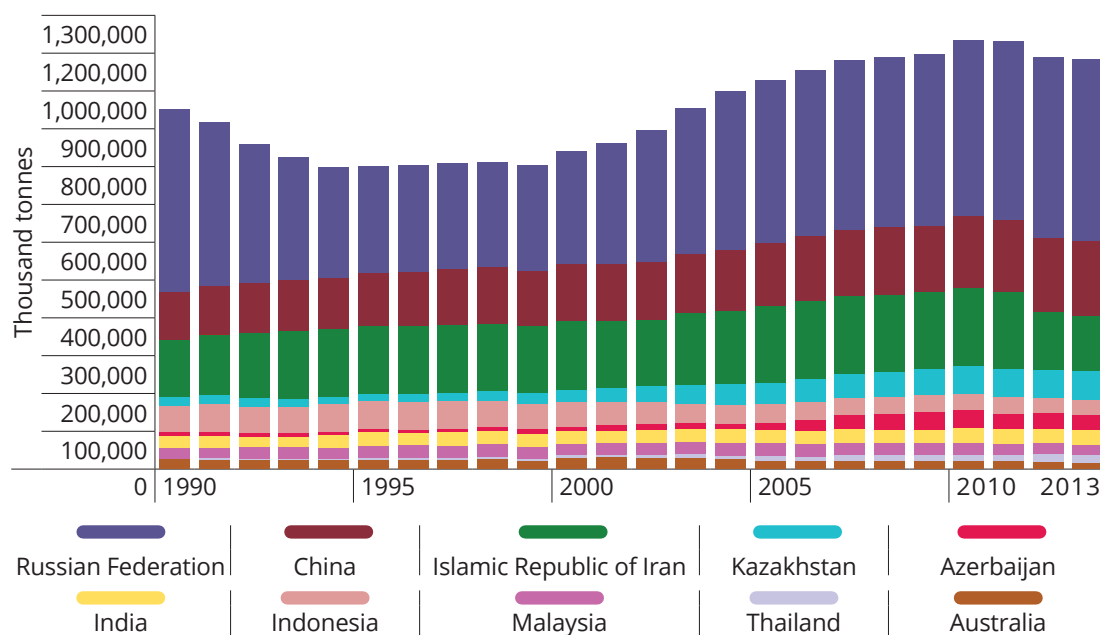
Turkey "Up to 21 per cent reduction in GHG emissions from the BAU level by 2030."

Thailand "Thailand intends to reduce its GHG emissions by 20 per cent from the projected BAU level by 2030. The level of contribution could increase up to 25 per cent, subject to adequate and enhanced access to technology development and transfer, financial resources and capacity-building support through a balanced and ambitious global agreement under the United Nations Framework Convention on Climate Change (UNFCCC)."



PROMOTE MORE EFFICIENT AND CLEANER USE OF OIL

Top 10 oil producing countries in Asia and the Pacific, 1990-2014



Source: ESCAP based on data from the International Energy Agency (IEA), Oil Information Statistics. Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

Oil production from ESCAP member States has been on a general upswing since the mid-1990s, reaching a high in 2010, to fall modestly in recent years primarily due to declining oil prices and a drop in Iranian production. Low oil prices have had the effect of depressing

overall upstream investment in the oil sector. However, rising fuel consumption has supported significant downstream investment and the Asia-Pacific region is expected to see large expansions of its refining capacity (BMI Research, 2015). The Russian Federation, the region's largest oil producer, has seen a steady increase in oil production, but while crude exports have leveled off, refined oil product exports are on the rise. Investment in the country's downstream oil sector has increased since a 2011 agreement to upgrade or construct 124 processing plants (EY, 2014).

China has aggressively pushed forward oil technology with its *12th Five-Year Plan for Energy Science and Technology Development*, effective between 2011 and 2015, which aimed at advancing technologies for fuel extraction, achieving breakthroughs in crude oil processing, raising the standards of oil production and achieving higher recovery rates of refined light oil.

In an effort to reduce the environmental impacts of oil production, the Russian Federation, Kazakhstan, Turkmenistan and Uzbekistan have joined the World Bank "Zero Routine Flaring by 2030" initiative to end gas flaring at oil production sites, along with a number of oil companies operating within the region. Gas flaring accounts for an estimated 140 billion cubic meters of natural gas lost and 350 million tons of CO₂ added to the atmosphere each year (World Bank, 2015). In Kazakhstan, the application of flaring limitations and penalties has led to the pioneering application of gas-to-liquid technology (GTL) fed by flared gas. Expectations are high that flared gas will become a preferred feedstock for GTL to produce products such as diesel and gasoline, as lower oil prices demand lower-priced feedstocks and environmental concerns have led to increasing pressure to limit flaring (Fleisch, 2015).

Sample Policy and Programme Approaches from the Region

CHINA: 12th Five-Year Plan for Energy Science and Technology Development, 2011

The plan covers four key technology areas: exploration and exploitation; processing and conversion; power generation, transmission and distribution; and new energy technology, prioritizing efficiency improvement through plan and implementation process of all key technologies. According to energy development and structure adjustment, the plan clarifies targets for development of energy technologies and determines 19 important energy application technologies and major engineering demonstration projects.

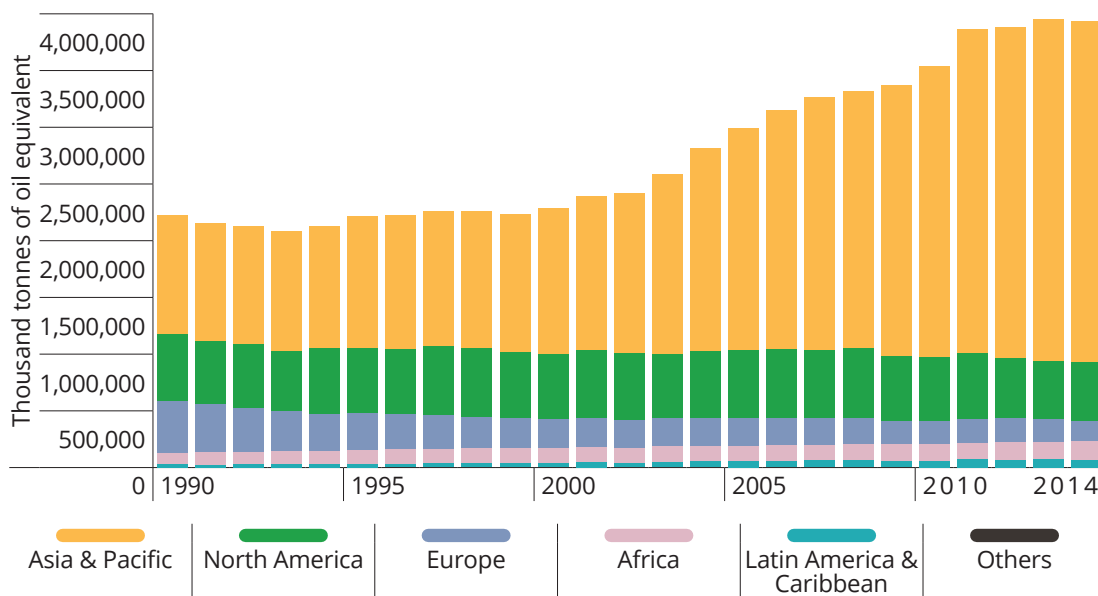
AUSTRALIA: Carbon Credits (Carbon Farming Initiative—Oil and Gas Fugitives) Methodology Determination, 2015

This determination provides for facilities to reduce their emissions through re-routing fugitive emissions to a flare instead of allowing them to be vented to the atmosphere. Abatement from a re-route to flare project under this determination is credited based on the quantity of emission reduced from combusting the re-routed gas.

KAZAKHSTAN: Law on Gas and Gas Supply, 2012

As provided by this policy, the state shall own the associated gas, which shall be processed into sales gas, liquefied petroleum or liquefied natural gas. Priority is given to the supplies of the above-mentioned fuel types; provisions comply with the General Scheme for Gasification of the Republic of Kazakhstan.

World coal production, 1990-2014



Source: ESCAP based on the data from International Energy Agency (IEA), Electricity information statistics database. Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

Between 1990 and 2013, the Asia-Pacific energy mix underwent a dramatic shift towards coal to meet rapidly growing energy demand. The region holds nearly one third of global coal reserves and in 2013 was responsible for more three quarters of global coal production. China drives the regional trend but India's demand continues to increase, and that nation overtook the United States as the world's second-largest consumer in 2014 (IEA, 2015).

Coal rose from 32 to 56 per cent of the Asia-Pacific electricity mix between 1990 and 2013 and, given the sufficiency of supply, coal is expected to continue as the dominant energy resource in the Asia-Pacific electricity mix for the near future. Data from a recent estimate of newly operating coal-fired power plants installed between 2010 and 2015 suggest that the Asia-Pacific region added 418,217 MW of capacity, comprising 92 per cent of global capacity additions during that time period (CoalSwarm and Sierra Club, 2015). However, growing recognition of coal's significant environmental impacts, which carry heavy social and economic costs, is pushing many nations to consider adoption of cleaner coal technologies. Emphasis on High-Efficiency Low-Emissions (HELE) technologies has been incorporated into mid- to long-term policies of an increasing number of countries in the Asia-Pacific region, identifying the development of supercritical (SC) and ultra-supercritical (USC) technologies as priorities to increase generation efficiency.

The deployment of SC and USC technologies has expanded rapidly in the region's dominant coal user, China, where policy dictates that, unless new plants are constructed for co-generation, only SC or USC units are permitted, and often with the requirement that aging capacity must be retired (IEA, 2015). Several countries are following this trend, with policy measures dictating higher efficiency requirements for new plants and retrofitting of older units – including India, which has stated that all new coal-fired capacity additions shall be through SC units beginning in 2017, under the country's 13th Five Year Plan. Malaysia has installed the first USC coal power plant in South-East Asia, capable of handling a variety of coal types, and is in the process of adding a second unit (Overton, 2015).

However, many challenges remain for the deployment of advanced technologies. High capital costs for new plants are prohibitive, as is premature retirement of existing power plants. Additionally, in the case of China, many advanced units are forced to run at loads significantly lower than design to maintain grid balance, resulting in higher coal consumption and efficiency loss (China Energy Fund Committee, 2014). Despite these barriers, the incorporation of long-term perspectives into comprehensive energy planning, knowledge-sharing, and mobilization of finances can offer opportunities to increase the efficiency of coal use and to lower its environmental impacts.

Sample Policy and Programme Approaches from the Region

AUSTRALIA: Generator Efficiency Standards – Technical Guidelines, 2006

Covers the application of Generator Efficiency Standards, measured in terms of greenhouse intensity, to Australian fossil fuel-based electricity and steam producers, and sets out recommended practices.

CHINA: 12th Five-Year Plan for Energy Development, 2013

Low-emission and cleaner coal technology: Speed up coal mine upgrades, implement coal mine safety production standardization, construct digital coal mine automation, utilize technologies such as USC, circulating fluid bed, high-efficiency water-saving technologies in Central and West regions with rich coal resources.

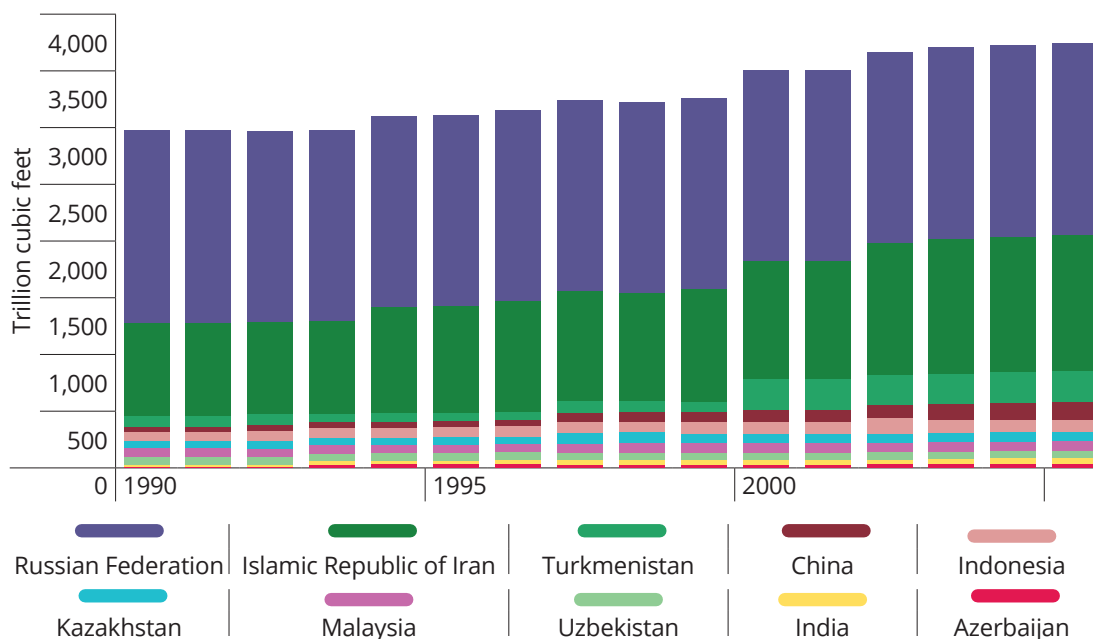
RUSSIAN FEDERATION: Long-term Programme for Coal Sector Development until 2030, 2014

Modernization of coal industry: Sets long-term objectives for modernizing the coal industry, with emphasis placed on broader deployment of coal gasification and SC coal combustion technologies.



PROMOTE EXPANDED PRODUCTION, TRADE AND USE OF NATURAL GAS AS A LOW-EMISSION FUEL

Proved natural gas reserve in top 10 Asia-Pacific countries, 2000-2015



Source: US Energy Information Administration, International Energy Statistics. Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

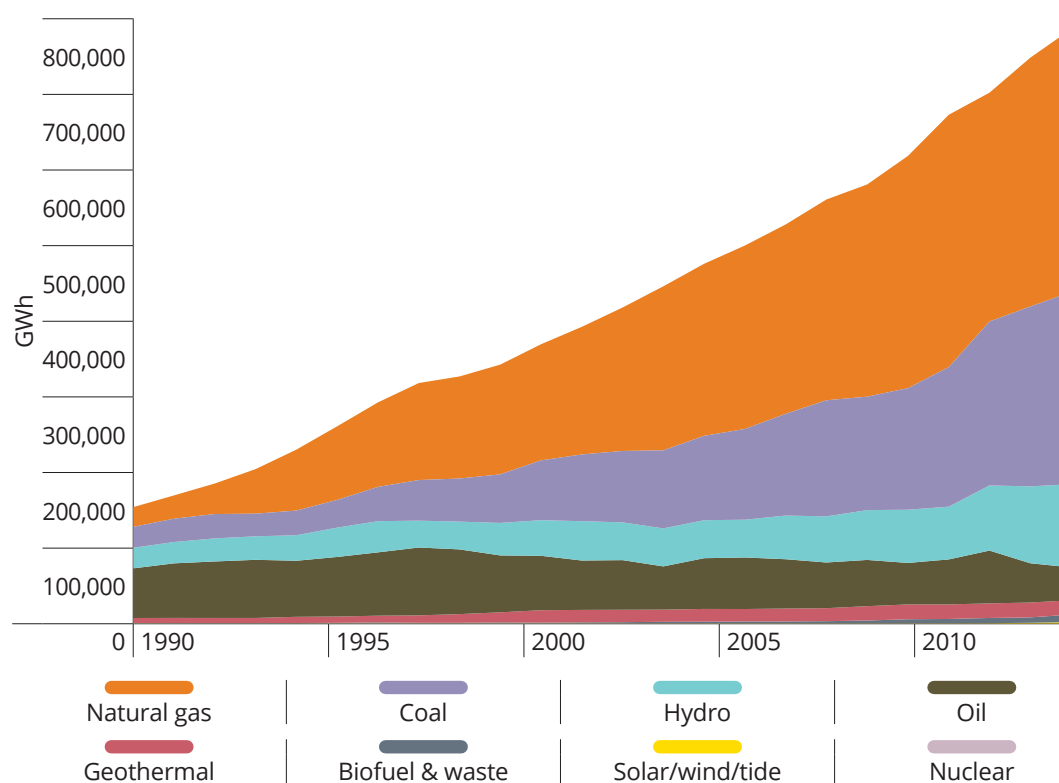
In the Asia-Pacific region, demand for natural gas has increased steadily over the past few years and has almost doubled relative to the 1990s. According to one forecast, by 2040, Asian natural gas consumption will be nearly triple 2012 levels, and liquid natural gas (LNG) imports are expected to double them.

The role of natural gas in the overall energy mix of the region has remained mostly unchanged over the past two decades, constituting around 18 per cent of regional total primary energy supply (TPES), with just a few countries demonstrating significant share increases. The nominal growth in gas consumption in the region has been driven by increased demand in the power, heat and industry sectors, where it faces strong competitive pressure from coal. Known as the “Asian Premium”, LNG prices are higher in Asia and coal, in the absence of carbon taxation, is generally cheaper than gas in terms of energy equivalence. High gas prices have led to prioritization of coal in power sector and even to limiting of power production below potential levels (IEA, 2015).

However, natural gas has made modest, although unevenly distributed, gains within the power generation mix since the 1990s, most significantly in South-East Asia, which has realized an increase from 17 to 44 per cent between 1990 and 2013.

Over the past two decades, regional production of natural gas increased significantly, particularly as a result of new discoveries and rapid expansion of production capacities in China and Iran. The region is relatively rich in natural gas, with the Russian Federation, Iran and Turkmenistan together sitting on around 45 per cent of world's proven reserves and the rest of the region controlling some further 10 per cent. Despite this relative abundance of reserves of conventional and unconventional gas, the regional consumption is projected to outgrow production, as expansion of regional production capacities faces significant challenges above and below the ground. The geological conditions in the region are generally less than favourable for extraction. Moreover, many existing and potential gas production areas in the region are located far from the demand centres and thus require investment in either transmission or LNG liquefaction and regasification infrastructure.

Electricity production by product in South-East Asia, 1990-2013



Source: ESCAP based on the data from International Energy Agency (IEA), World Energy Statistics and Balances. Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

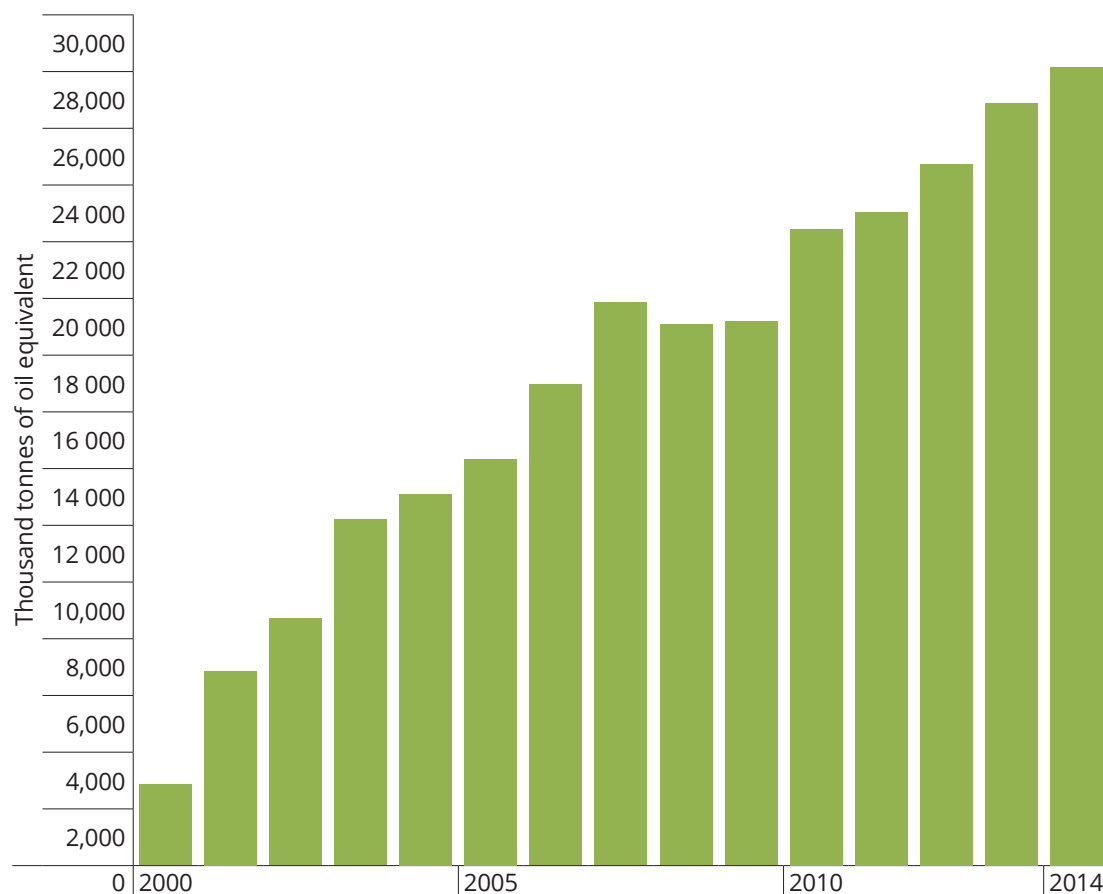
Despite regional efforts to promote development of domestic conventional and unconventional gas production, progress has been slow, as investors and operators face a range of “above-ground” obstacles in the form of ownership and procurement restrictions, complex regulation and bureaucratic processes and incompatible licensing, thus rendering many countries within the region dependent on imports from other regions of the world. Unconventional natural gas supply has been expected to represent a significant share for many Asia-Pacific countries over the next few decades; however, recent unfavourable market conditions are leading some large players to shift away from gas production, such as was seen recently in Australia with the abandonment of coal seam gas production (Thomson, 2016).

Due to geographical as well as political and financial constraints, the pipeline network in the region is relatively underdeveloped, as only countries in South-East Asia, North and Central Asia, Turkey, Iran and recently, China, trade significant amounts of gas through pipeline networks.

The bulk of natural gas in the region is transported in the form of LNG. Despite the challenges, natural gas imports in the region have increased significantly over the past two decades, and Japan, the Republic of Korea, and India now rank as the world’s largest LNG importers respectively, while Australia is projected to become the world’s largest LNG exporter. This reliance on LNG and the pricing mechanism through which it is linked or indexed to oil, have in recent years kept gas prices in Asia much higher than in the rest of the world. LNG contracts are long-term to reduce investment risk, which is high due to high costs of infrastructure and transportation. It has been estimated that more than 50 per cent of the LNG price in Asia is the flexible component of the cost of supply – shipping and suppliers’ margins (Bhattacharya et al., 2014). Contracts include “take or pay” clauses, which help to secure new project investments, but disadvantage buyers who are required to pay even if they cannot take the supply. Destination clauses fix the shipping path of LNG, and restrict buyer resale. Introducing flexibility within contracts has been a recently developing response, though more efforts are needed to enable flexibility for importers in the gas trade to follow demand and to better balance the benefits between importers and exporters. Appropriate price formations, based on Asian market fundamentals, are needed to improve accuracy and timeliness to support increased security and supply flexibility.

As environmental priorities grow, strengthened by the Paris Agreement, natural gas stands to increase its share in the energy mix, replacing coal in a trend such as that seen in Viet Nam. At present, high gas prices mean policymakers have limited trust in the fuel as a replacement for coal, but as the price between the two sources narrows, and valuation of environmental benefits (or avoided environmental costs) increases, natural gas is poised to gain a further foothold within regional power systems. Further transparency and consistency of policy, liberalization of domestic markets and promotion of third party access to infrastructure can increase upstream and downstream investments. Meanwhile, flexible trade combined with long-term contracts can lead to more responsive regional markets.

Natural gas imports in South-East Asia, 1990-2014



Source: International Energy Agency (IEA). Chart generated from Asia Pacific Energy Portal. Available at www.asiapacificenergy.org

Sample Policy and Programme Approaches from the Region

CHINA: 12th Five-Year Plan for National Economic and Social Development, 2011

Focuses on increasing development and utilization of unconventional gas resources, strengthening the exploration and development of natural gas resources, promoting the rapid growth of natural gas output, and the development and utilization of unconventional oil and gas resources, such as coal-bed gas and shale gas. Extended by the 12th Five-Year Plan for Energy Science and Technology Development.

RUSSIAN FEDERATION: Energy Strategy of the Russian Federation until 2035, 2014

Emphasizes cooperation with Asia-Pacific countries with emphasis on exporting gas, in particular LNG, to the region.

Science, technology and innovation are essential to overcoming current technological and economic challenges associated with ensuring a secure and sustainable energy supply. Globally and regionally, there is a need to build collaboration and partnerships among the broad range of stakeholders involved in the value chain from development to commercialization of energy technologies – e.g. government agencies, research institutes and venture capital providers. Additionally, the transfer and uptake of advanced and cleaner energy technologies is essential to promoting a more integrated and stronger region as a whole.

Although progress on adopting advanced energy technologies varies across ESCAP member countries, emerging regional policy strategies, road maps and demonstration projects have the potential to integrate, improve and shape national policies supporting the development and dissemination of clean energy technologies while creating a more favourable environment for investment and innovation.

Numerous examples from the region demonstrate important steps being taken in technology development and dissemination achieved through cooperation. The ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 aims to enhance the research and development (R&D) network for renewable energy technology development and utilization, engaging research facilities and promoting the exchange of researchers to facilitate knowledge transfer. Joint demonstration projects have cropped up across the region, such as a number of projects focused on Myanmar, involving collaborations with China, Japan and Thailand. The SAARC Framework Agreement for Energy Cooperation on Electricity took effect in 2014, with a focus on sharing of knowledge among the member States. In alignment with these objectives, institutions in India are actively promoting solar technology dissemination through programmes engaging other countries in the immediate region (IT Power Group, 2016). R&D is further enabled through bilateral cooperation in countries such as Bangladesh and India on solar, wind energy and bioenergy technology development and deployment, and Australia and China with the Australia-China Joint Coordination Group on Clean Coal Technology. The Republic of Korea has actively supported international joint R&D with advanced countries to promote technology exchange. In the North and Central Asia region, the Agreement on Cooperation among CIS Member States was designed for the dissemination and sharing of information on best experiences and practices for energy saving. Finally, there are a few initiatives promoting cooperation on innovative development of the energy sector. The Government of Japan promotes comprehensive bilateral relations with Australia, Indonesia, Malaysia and the Russian Federation for natural gas. Bhutan and India have developed joint ventures in the hydropower sector.

When it comes to cooperation, emphasis lies heavily on enhancing energy security, but R&D combined with road maps based on cooperation among governments and the private sector, also represents an effort to combat climate change. The Pacific island nations have been particularly active in formulating agreements around cooperative

renewable energy technology development and deployment to achieve energy security with minimal environmental impacts. A recent important achievement is the Samoa Pathway through which the Small Island Developing States (SIDS) have committed to sustainable development based on an integrated approach among members and also promoted international intervention within an investment-friendly environment. The trickle-down effect of such initiatives has been the creation of national road maps to develop modern energy technologies and the initiation of new partnerships.

Sample Policy and Programme Approaches from the Region

ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 – Phase I: 2016-2020

The initiative aims at harmonization of standards and codes, promotion of best practices for renewable energy and increased R&D for energy technologies.

JAPAN: Strategic Energy Plan, 2014

Plan to support the development and deployment of technology including fuel-cell vehicles, floating offshore wind power systems and large-scale storage batteries.

Small Island Developing States Accelerated Modalities of Action - or SAMOA Pathway, 2014

Multilateral agreement on the development of a strategy and targeted measures to promote energy efficiency and foster sustainable energy systems, including facilitating access to existing financing mechanisms for renewable energy and energy efficiency projects and international collaboration for establishing and strengthening innovative energy road maps in SIDS.

Strategy and Work Plan (2016–2020) for Regional Cooperation in the Energy Sector of CAREC Countries, 2016

Central Asia Regional Economic Cooperation (CAREC) will support new technology adoption during the 2016-2020 Energy Work Plan through regional technical assistance to pilot new technology projects. It is envisioned that such activities could combine small markets and attract investors and companies for clean energy technologies such as off-grid and on-grid power storage solutions, solar power, efficient lighting and appliances, and electric cars.



DEVELOP COMMON INFRASTRUCTURE AND HARMONIZED ENERGY POLICIES WITH A VIEW TO INCREASING REGIONAL ECONOMIC INTEGRATION

The overall gap between energy production and demand in the ESCAP Asia-Pacific region is projected to widen significantly in the upcoming decades. Given the relative abundance and high variance in distribution of natural resources in the region, transborder gas and electricity trade have the most potential for further development to help meet the demand. The Central Asia-China gas pipeline, commissioned in 2009 to deliver natural gas from Turkmenistan to China through Uzbekistan and Kazakhstan, has significantly altered the composition of imports for one of the largest importers in the region; in 2009 China imported

all of its gas in liquefied form, but three years later gas from Turkmenistan accounted for over half of its gas imports. Continuing its search for supply diversification, China signed an agreement to purchase natural gas from Russia through a Power of Siberia pipeline, to be commissioned in 2018 (Breaking Energy, 2015).

Despite the rapid development of LNG capabilities in the past five years, many countries in the region have revived plans for an integrated pipeline network, mainly due to volatility and inefficiencies of global LNG markets (Corbeau, 2014). The Trans-ASEAN Gas Pipeline (TAGP), which aims to connect and develop existing pipeline connections and connect gas reserves in the Gulf of Thailand, Indonesia, Myanmar and the Philippines to the rest of the region, has faced numerous technical and regulatory obstacles. Indonesia's East Natuna gas field has been difficult to develop and different national regulatory and pricing systems proved difficult to harmonize. Nevertheless, promising steps have been taken towards elimination of domestic subsidies and liberalization of energy markets, as several countries took advantage of low global oil prices and, once completed, TAGP has the potential to play a vital role in providing diversity and flexibility of gas supplies, fostering regional energy access and security.

Construction of the Turkmenistan Afghanistan Pakistan India (TAPI) Natural Gas Pipeline is a high priority under CAREC 2020, and, once completed, will export up to 33 billion cubic metres (bcm) of natural gas per year through an approximately 1,800-kilometre pipeline. The project has faced delays but it broke ground in mid-December 2015, representing an important step towards regional integration, increased energy security and stronger market integration through energy trade.

One of the most promising projects in the region hopes to utilize the abundant hydropower resources of Kyrgyzstan and Tajikistan, both of which have surplus electricity production during the summer, and transfer electricity to Afghanistan and Pakistan, both of which suffer chronic shortages. The Central Asian-South Asian (CASA) - 1000 project, for which a Power Purchasing Agreement (PPA) was signed in April 2015, will provide up to 1,300 MW of clean electricity to systemically undersupplied regions and allow the producing and transit countries to raise revenues that can in turn be used to boost local social and economic development.¹⁰ Although, like many other infrastructure projects in the region, CASA 1000 has faced questions about the security situation in the region, it is a promising example of efficient utilization of existing clean energy capacities through transboundary grid integration.

In the power sector, a new vision has been put forth by China's largest grid operator, which is promoting increased connectivity and power trade, moving far beyond bilateral or even multilateral trade to global energy interconnection through ultra-high voltage transmission and smart grid technologies.

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¹⁰ More information on CASA-1000 can be found at: <http://www.casa-1000.org/>

Sample Policy and Programme Approaches from the Region

AFGHANISTAN, BHUTAN, INDIA, MALDIVES, NEPAL, PAKISTAN, SRI LANKA: SAARC Framework Agreement for Energy Cooperation , 2014

This agreement enables SAARC member State transmission planning agencies to plan the cross-border grid interconnections through bilateral/trilateral/mutual agreements between or among the concerned States based on the needs for trade in the foreseeable future, through studies and sharing technical information required for the same. Member States may enable the respective transmission agencies to build, own, operate and maintain the associated transmission system of cross-border interconnection falling within respective national boundaries and/or to interconnect at mutually agreed locations.

ARMENIA, KAZAKHSTAN, KYRGYZSTAN, RUSSIAN FEDERATION: Concept of the Common Power Market of the Eurasian Economic Community, 2015

The policy is directed at the effective function of the common power market of the Eurasian Economic Community. Power trade is explicitly recognized as a means of enhancing economic integration within the Union. The Concept thereby envisages the development of a Programme on the Establishment of the Common Power Market.

CHINA: Vision and Actions on Jointly Building Silk Road Economic Belt and 21st-Century Maritime Silk Road, 2015

The document promotes cooperation in the connectivity of energy infrastructure, working in concert to ensure the security of oil and gas pipelines and other transport routes, building cross-border power supply networks and power transmission routes, and cooperating in regional power grid upgrading and transformation.

INDIA, NEPAL: Agreement on Electric Power Trade, Cross-Border Transmission Interconnection and Grid Connectivity, 2014

An agreement to mutually work out a coordinated procedure for secure and reliable operation of the national grids interconnected through cross-border transmission interconnection(s) and to prepare scheduling, dispatch, energy accounting, settlement and procedures for cross-border power trade and unscheduled interchange.



PROMOTE CAPACITY-BUILDING, EDUCATION AND KNOWLEDGE-SHARING IN THE FIELD OF ENERGY

APEF and the ESCAP member States are supported by the efforts of the secretariat, which convenes frequent policy dialogues and expert group meetings that engage representatives of Asia-Pacific countries, regional and international institutions, civil society and the private sector. The formation of the Energy Committee in 2016 will build upon the current platform for dialogue, and greatly strengthen member State actions in the area of energy.

In the area of information exchange, the recently launched Asia Pacific Energy Portal serves as a key gateway to primary policy information for the region, offering cross-sectional views that facilitate research, review and comparison for a large number of policy aspects. This report draws heavily upon the data and policy resources contained within the portal, offering analysis across the focus areas for action.

The periodic Regional Trends Report was launched under APEF to serve the purpose of offering a broad overview of trends, as well as in-depth analysis around select key topic areas. In 2016, a more extensive Mid-Term Review will be conducted to assist member States in evaluating progress against the APEF agenda. The review process will engage member States in providing inputs regarding successful regional approaches to overcoming energy poverty, enhancing energy security and advancing the sustainable use of energy, which will be shared more broadly to support the APEF objective of information exchange.

Moving forward, ESCAP member States will play the central role in the continued strengthening of institutional frameworks and ongoing information sharing, as well as supporting new research and analysis that can advance regional understanding and drive new means of cooperation. The secretariat will continue to make efforts to actively engage member States and regional and international institutions to gather support for collaboration and help align efforts that share common objectives.



THE WAY FORWARD

Energy is a global priority — both as a foundation for sustainable development and a fundamental requirement of the 2030 Agenda for Sustainable Development and the SDGs, particularly the SDG 7. The Plan of Action on Regional Cooperation for Enhanced Energy Security and the Sustainable Use of Energy in Asia and the Pacific 2014-2018, adopted by Ministers at the first Asian and Pacific Energy Forum (APEF) in 2013, underscores the importance of energy within sustainable development.

APEF provided a mandate for ESCAP to work as a secretariat on tracking progress of the major outcomes of the forum by the member countries. The 2016 edition of the Regional Trends Report (RTR) describes the major achievements and highlights emerging trends and challenges in the specific sectors identified by the member countries. The report discusses the progress made on implementation of the APEF Plan of Action, the current Asia-Pacific energy scene and analyses two highly pertinent aspects of energy in the region: energy access and transboundary energy connectivity/power trading.

PROGRESS ON THE ASIAN AND PACIFIC ENERGY FORUM'S REGIONAL PLAN OF ACTION

In line with global movements, Asia-Pacific countries met under the Asian and Pacific Energy Forum (APEF) in 2013 and issued two outcome documents, including a ministerial declaration and the Asian and Pacific Energy Forum's 2014-2018 Plan of Action. Ministers set forth a vision of a more secure, sustainable and equitable energy future and outlined 15 focus areas under which countries agreed that efforts are needed to enhance energy security and promote the sustainable use of energy.

Next steps involve the publication of the APEF Implementation Review, based on the summary of research by the secretariat presented in Chapter 2, which will be conducted in cooperation with ESCAP member States. This review will feed into the second Asian and Pacific Energy Forum, to be held in 2018, and will offer a review of progress across an expansive set of action areas covering access, renewables and efficiency, as well as energy investment, trade, technology and more. It will also contribute to the implementation of SDG 7 in the Asia and the Pacific region. The scope outlined in the Plan of Action prescribes an integrated approach to improving the sustainability of the regional energy situation, and sets the foundation from which more aligned efforts, cohesive policy frameworks and cooperation mechanisms can emerge, as part of the comprehensive approach to energy development provided by APEF.

REGIONAL COOPERATION FOR SUSTAINABLE ENERGY CONNECTIVITY AND POWER TRADE

The countries in the region have different resource bases and varying load consumption patterns, with geographically sparse generation potential. Improving this generation potential, along with technological advancement in energy transmission and energy trading among countries to enhance their economies, can provide good opportunities for subregional

and regional energy connectivity and transboundary power trading. Increased regional connectivity will allow countries to develop a common platform on energy development, including formulation of regional cooperation frameworks with least-cost generation options and integration of electricity generated from variable renewable energy resources.

Regional initiatives and cooperation in energy connectivity can benefit from seasonal variation to reduce cost, bring economies of scale and provide opportunities for renewable integration regardless of generation points by allowing increased reserve margins and promoting investment. However, the participating countries need to develop relationships of trust and long-term mutual understanding through regular dialogues and communication. Intergovernmental discussions are relevant and useful to provide a platform on the issues and to provide technical and analytical background to forge an understanding for regional cooperation. Establishing the connectivity that will promote energy trading by means of a vibrant and dynamic energy market requires long-term vision and use of strategies that may appear to be against individual country interest. The way forward is for countries to own these initiatives and strive to turn ideas into actions that will yield positive results in long run. Countries need to respond to increasing demand; for example, the Compound Annual Growth Rate in ASEAN countries is around 8 per cent, meaning energy demand is doubling every ten years. The following governmental initiatives will promote energy connectivity among the countries in the region:

- Prepare energy/power sector master plan, examining resource availability in the country, energy demand, future growth and net export-import potential.
- Conduct study on high voltage transmission line and substation capacity in the country to facilitate energy trading between countries.
- Develop national policy to encourage transboundary energy connectivity to address the “energy trilemma,” ensuring that energy sources are affordable, reliable and environmentally friendly.
- Create environment for private sector investment with appropriate feed-in tariffs for renewable energy integration and provide incentives for joint regional projects to be developed for transboundary power trading.
- Develop national capacity through cooperation, knowledge exchange and technology transfer among participating countries.
- Allow creation of an energy market where the private sector can trade freely, with enforced standards and regulatory mechanisms, to create a stronger incentive for international trade partners to reduce costs.
- Carry out power sector reforms that allow for unbundling of the power sector in generation, transmission and distribution, where IPPs are allowed to integrate generation in the system and grid operators can allow for any integration that matches the system parameters and codes facilitated by the regulatory body.

- Engage countries that have potential to create subregional connectivity in dialogue through an established platform in order to receive potential benefits of energy connectivity in the region and enhance energy security in the region as a whole.

ENERGY ACCESS FOR SUSTAINED DEVELOPMENT

There are enormous challenges and barriers to ensuring sustainable energy for all, especially in regions where energy poverty is most concentrated. However, energy service is a requirement for all social and economic development and the multiple benefits provided by energy access are universally acknowledged – such as the positive impacts on health and education, time saved, reduction of drudgery, progress towards gender equality, opportunities for micro-enterprise development and increased productivity for existing businesses.

South Asia and South-East Asia contain countries with the highest levels of energy poverty after sub-Saharan African countries. More than 455 million people in the region lack access to electricity and around 1.9 billion rely on solid fuels for cooking. Lately, significant efforts have been made to enhance energy access through various targeted programmes but population growth is also significant in the region. As an example, in South Asia, as per the Global Tracking Framework 2015, the electrification rate increased from 75 to 79 per cent of the total population during the period of 2010-2012 and during the same time period, population gained energy access outpaced population growth by 54 million. The following governmental initiatives will support widening energy access in the region:

- Define national targets for enhancing energy access (for electrification and cooking energy) and develop and implement strategies.
- Emphasize renewable energy generation and enhance the use of efficient technologies for energy conservation.
- Conduct demand assessment and forecasting and select appropriate technological options after comparison of various alternatives; select financing mechanism for designing energy access programmes at specific locations.
- Devise enabling policy that will create an environment for attracting investment and lowering risk for private sector investments.
- Enhance cooperation and collaboration among countries on technology transfer and engage in knowledge-sharing on innovative models for implementation of energy access programmes.
- Devise effective subsidy mechanisms to address poor people and encourage productive use of energy to enhance livelihoods.
- Work on upgrading and expanding transmission and distribution networks, considering future energy demand and requirements for transboundary energy connectivity.

- Focus on enhancing quality and reliability to provide energy services at affordable cost to move forward in responding to increased demand.
- Develop minigrid-based electrification models to provide reliable energy services required for energy-intensive industries and enterprises.
- Promote innovative financing mechanisms linked with microfinance that can support participation of communities, local governments and the private sector to deliver reliable services at affordable cost, focusing specifically on clean energy technologies.
- Integrate energy development with other cross-cutting and development activities such as multiple uses of water resources and sustainable use of forest resources.
- Develop proposals to secure funding through global funds such as GCF and GEF that support mitigation and adaptation on climate change in order to implement clean energy projects that provide global environmental benefits.

FINAL THOUGHTS

Development trends for next decade will focus on implementation of the 2030 Agenda for Sustainable Development and achievement of the SDGs in particular the SDG 7: “Ensure access to affordable, reliable, sustainable and modern energy for all”, which is also a pre-requisite cross-cutting issue for several other goals. The SE4All initiative has three distinct objectives: 1) enhancing energy access; 2) improving rates of energy efficiency; and 3) increasing the share of renewable energy. These objectives have now emerged as targets with defined indicators for SDG 7. In this context, the focus areas of RTR 2016 – energy access and energy connectivity – provide substantial overviews and baselines for SDG targets as well.

Despite having enormous potential and abundant natural resources, Asia-Pacific countries have been net importers of energy resources in the past few years, with this trend varying among countries. This demonstrates the region’s inability to match supply and consumption patterns in order to meet its growing energy needs with accelerated economic growth. The energy sector of the region is characterized by acute energy poverty in some countries, heavy reliance on fossil fuels, ageing power plants and transmission infrastructures, lack of sufficient capacity in transmission and substation design, and issues related to political, policy, regulatory and institutional dimensions.

Looking at future energy demand and commitment of the countries to meet global targets for SDGs, SE4All and the implementation of the Paris Agreement, Asia-Pacific countries need to take action to utilize their potentials, focus on increasing shares of renewable energy in the total energy mix and work towards developing required transmission infrastructures and enhancing access through grid expansion as well as decentralized generation. APEF and the three pillars of its Implementation Support Mechanism align well with these sustainable development goals and can act as a catalyst to spur progress among Asia-Pacific member States.

GLOSSARY OF TERMS

Key Terms	Explanation	Source
Balancing Area	Power system operators balance electricity supply and demand within geographic boundaries known as balancing areas.	http://greeningthegrid.org/integration-in-depth/balancing-area-coordination
Nord Pool	Nord Pool runs the leading power market in Europe, offering both day-ahead and intraday markets to its customers.	http://nordpoolspot.com
Taper Tantrum	Taper tantrum is the term used to refer to the 2013 surge in U.S. Treasury yields, which resulted from the Federal Reserve's use of tapering to gradually reduce the amount of money it was feeding into the economy.	http://www.investopedia.com/terms/t/taper-tantrum.asp
Wheeling Revenue	Revenue earned from the transmission of electricity from within an electrical grid to an electrical load outside the grid boundaries. (expressed in currency per megawatt-hour amount)	http://www.nrel.gov/docs/fy16osti/65660.pdf

REFERENCES

- Asian Development Bank (2013). *Energy Outlook for Asia and the Pacific 2013*. Manila. Available from adb.org/sites/default/files/pub/2013/energy-outlook.pdf.
- Asian Development Bank (2014). *Asia Economic Integration Monitor*. Manila. Available from aric.adb.org/publications/aeim.
- Asian Development Bank (2014). *Asian Development Outlook 2014 Supplement: Stable growth outlook for developing Asia*. Manila. Available from www.adb.org/sites/default/files/publication/42754/ado-supplement-july-2014.pdf.
- Asian Development Bank (2015a). *Fossil Fuel Subsidies in Thailand: Trends, impacts and reforms*. Manila.
- Asian Development Bank (2015b). *SE4All – Tracking Progress in Asia and the Pacific: A Summary Report*. Manila.
- Asian Development Bank (2015c). *Fossil Fuel Subsidies in Indonesia: Trends, impacts and reforms*. Manila.
- Asian Development Bank (2015d). *Sustainable Energy Access Planning: A Framework*. Manila. Available from www.adb.org/sites/default/files/publication/160740/sustainable-energy-access-planning-fw.pdf.
- Asian Development Bank (2015e). *Power Sector Development in Myanmar*. Manila. Available from www.adb.org/sites/default/files/publication/175801/ewp-460.pdf.
- Asian Development Bank (2015f). *Sustainable Energy for All – Tracking Progress in Asia and the Pacific: A summary report*. Manila. Available from www.se4all.org/sites/default/files/se4all-tracking-progress.pdf.
- Asian Development Bank (2015g). *Key Indicators for Asia and the Pacific 2015*. Manila. Available from www.adb.org/publications/key-indicators-asia-and-pacific-2015.
- Asian Development Bank (2015h). *Asia Bond Monitor September 2015*. Manila.
- Asian Development Bank (2016a). *Asian Development Bank Asia Regional Integration Centre*. Available from <https://aric.adb.org/fta-all>.
- Asian Development Bank (2016). What Does the Paris Climate Deal Mean for Asia and the Pacific?, 14 January. Available from <http://www.adb.org/news/features/what-does-paris-climate-deal-mean-asia-and-pacific>.
- Asian Pacific Energy Portal (2016) <http://asiapacificenergy.org>.
- Association of Southeast Asian Nations Centre for Energy (2015). *ASEAN and Japan Commit to Energy Efficiency Standards & Labelling*. Available from www.aseanenergy.org/news/asean-and-japan-commit-to-energy-efficiency-standard-labeling/.

- Atkinson, D. (2016). *Energy Connectivity in Asia and the Pacific*. United Nations Economic and Social Commission for Asia and the Pacific Publication.
- Barkat, A., Khan, S.H., and others (2002). *Economic and Social Impact Evaluation Study of the Rural Electrification Program in Bangladesh*. Dakar.
- Barnes, D.F. and Sen, M. (2004). *The Impact of Energy on Women's Lives in Rural India*. Washington, DC. World Bank.
- Bhattacharya, A. and Bhattacharya, T. (2014). *ASEAN-India Gas Cooperation: Redefining India's 'Look East' Policy with Myanmar*, Economic Research Institute for ASEAN and East Asia Discussion Paper Series. Jakarta.
- Bhattacharya, S.C. and Ohiare, S. (2012). The Chinese Electricity Access Model for Rural Electrification. *Energy Policy*, 49 October, pp. 676-87.
- Blas J. and Lacqua F. (2016). Oil Prices May Fall Further as Iran Returns, UBS's Weber Says, 20 January. Available from <http://www.bloomberg.com/news/articles/2016-01-20/oil-prices-may-have-not-bottomed-as-iran-returns-ubs-weber-says>.
- Bloomberg New Energy Finance (2016a). Clean energy defies fossil fuel price crash to attract record \$329 billion global investment in 2015, 14 January. Available from <http://about.bnef.com/press-releases/clean-energy-defies-fossil-fuel-price-crash-to-attract-record-329bn-global-investment-in-2015/>.
- Bloomberg New Energy Finance (2016b). *Clean energy investment by the numbers – End of Year 2015*. Available from www.bnef.com/dataview/clean-energy-investment/index.html.
- BMI Research (2015). Rising Fuel Consumption To Support Downstream Investments, 24 December. Available from <http://www.bmiresearch.com/news-and-views/rising-fuel-consumption-to-support-downstream-investments#marketo-pdf-download>.
- Booz & Company (2013). *Benefits of an Integrated European Energy Market*. Available from ec.europa.eu/energy/sites/ener/files/documents/20130902_energy_integration_benefits.pdf.
- Brazilian M., Miller M., and others (2013). Accelerating the Global Transformation to 21st Century Power Systems. *The Electricity Journal*, Vol.26, Issue 6 (July 2013).
- Chen, K., Chen, Z., and Wei K.C. (2009). Legal protection of investors, corporate governance, and the cost of equity capital. *Journal of Corporate Finance*, Vol. 15, No. 3 (June 2009).
- China Energy Fund Committee (2014). *Development of Clean Coal-fired Electricity in China*. Hong Kong.
- China National Petroleum Corporation (2012). The Rapid Growing World and Chinese Natural Gas Markets, 7 June. Available from <http://www.cnpc.com.cn/en/speeches/201407/658c2d0d1abc4624b515aaf0798e91cc.shtml>.
- Citi GPS (2015). ENERGY DARWINISM II Why a Low Carbon Future Doesn't Have to Cost the Earth. Available from climateobserver.org/wp-content/uploads/2015/09/Energy-Darwinism-Citi-GPS.pdf.

- Climate Bonds Initiative (2015). *Bonds and Climate Change: The State of the Market in 2015*.
- Climate Policy Initiative (2015). *Global Landscape of Climate Finance 2015*. Available from climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2015/.
- CoalSwarm and Sierra Club (2015). *Proposed Coal Plants by Country (MW)* - December 2015 (preliminary data). Available from endcoal.org/wp-content/uploads/2015/11/Proposed-Coal-Plants-by-Country-MW.pdf.
- Corbeau, A.S. (2014). A pipeline alternative to Asian LNG. *The Journal of the International Energy Agency*, Issue 7.
- Council of European Energy Regulators (2014). *CEER Benchmarking Report 5.1 on the Continuity of Electricity Supply Data update*. Available from www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Electricity/Tab3/C13-EQS-57-03_BR5.1_19-Dec-2013_updated_Feb-2014.pdf.
- Crane K., and Mao Z. (2015). *Costs of selected policies to address air pollution in China*. California. Available from www.rand.org/content/dam/rand/pubs/research_reports/RR800/RR861/RAND_RR861.pdf.
- Economic Consulting Associates (2009). *The Potential of Regional Power Sector Integration South African Power Pool (SAPP) | Transmission & Trading Case Study*. Available from www.esmap.org/sites/esmap.org/files/BN004-10_REISP-CD_South%20African%20Power%20Pool-Transmission%20&%20Trading.pdf.
- Enerdata (2014). Natural Gas Trading Hub in Asia-Pacific, 28 May. Available from https://www.enerdata.net/enerdatauk/press-and-publication/energy-news-001/natural-gas-trading-hub-asia-pacific_28938.html.
- EY (2016). *Renewable Energy Country Attractiveness Index*. Available from [www.ey.com/Publication/vwLUAssets/RECAI-45-September-15-LR/\\$FILE/RECAI_45_Sept_15_LR.pdf#page=6](http://www.ey.com/Publication/vwLUAssets/RECAI-45-September-15-LR/$FILE/RECAI_45_Sept_15_LR.pdf#page=6).
- Energy Sector Management Assistance Programme, and Global Alliance for Clean Cookstoves (2015). *The State of the Global Clean and Improved Cooking Sector*. Washington DC. Available from openknowledge.worldbank.org/bitstream/handle/10986/21878/96499.pdf.
- Energy Sector Management Assistance Programme and Sustainable Energy for all (2015a). *Beyond Connections: Energy Access Redefined*. Available from www.worldbank.org/en/topic/energy/publication/energy-access-redefined.
- Energy Sector Management Assistance Programme and Sustainable Energy for All (2015b). *Global Tracking Framework Report 2015*.
- EY (2014). *Russia's downstream sector: sights set on modernization*. Available from [www.ey.com/Publication/vwLUAssets/EY-Russias-downstream-sector-sights-set-on-modernization/\\$FILE/EY-Russias-downstream-sector-sights-set-on-modernization.pdf](http://www.ey.com/Publication/vwLUAssets/EY-Russias-downstream-sector-sights-set-on-modernization/$FILE/EY-Russias-downstream-sector-sights-set-on-modernization.pdf).
- Financial Times (2015). Developing economies need power from coal, 20 August. Available from <http://blogs.ft.com/beyond-brics/2015/08/20/developing-economies-need-power-from-coal/>.

- Fleisch, T.H. (2015). *Associated Gas Monetization via mini-GTL Conversion of Flared Gas into Liquid Fuels & Chemicals, 2015: GTL is a commercial reality for flaring reduction*. World Bank Group publication. Available from www-wds.worldbank.org/external/default/WDSPContentServer/WDSP/IB/2015/12/11/090224b083c36a46/2_0/Rendered/PDF/Associated0gas0duction000report0III.pdf.
- Global Alliance for Clean Cookstoves (2016). *The Solutions*. Available from carbonfinanceforcookstoves.org/about-cookstoves/the-solutions/.
- Global Alliance for Clean Cookstoves, ENERGIA and SE4All (2014). *Cooking with Gas: Why Women in Developing Countries Want LPG and How They Can Get It*. Available from esmap.org/sites/esmap.org/files/WLPGA%20-%20Cooking%20with%20LP%20Gas%20Report%20-%20FINAL%20%20PbP_OPTIMIZED.pdf.
- Global Europe Anticipation Bulletin (2015). *Why the "One Belt One Road" Initiative Matters for the EU*. Available from geab.eu/en/why-the-one-belt-one-road-initiative-matters-for-the-eu/.
- Global Infrastructure Initiative (2015). GII Beijing: Navigating One Belt One Road, 7 May. Available from <http://www.globalinfrastructureinitiative.com/article/gii-beijing-navigating-one-belt-one-road>.
- Green ID (2016). PR: Vietnam PM Announces Retreat from Coal Power-Bold Move Signals Further Decline for Global Coal Industry, 22 January. Available from <http://www.globalinfrastructureinitiative.com/article/gii-beijing-navigating-one-belt-one-road>.
- IDS and Practical Action Consulting (2015). *What level of electricity access is required to enable and sustain poverty reduction?* Annex 1 – Literature Review.
- Intergovernmental Panel on Climate Change (2014). *Climate Change 2014: Synthesis Report*. Geneva.
- International Energy Agency (2003). *16 Case Studies on the Deployment of Photovoltaic Technologies in Developing Countries*. Paris.
- International Energy Agency (2013a). *Electricity Networks: Infrastructure and Operations Too complex for a resource*. Paris. Available from www.iea.org/publications/insights/insightpublications/ElectricityNetworks2013_FINAL.pdf.
- International Energy Agency, and Organisation for Economic Co-operation and Development (2013b). *Technology Roadmap: High-Efficiency, Low-Emissions Coal-Fired Power Generation*. Paris. Available from www.iea.org/publications/freepublications/publication/TechnologyRoadmapHighEfficiencyLowEmissionsCoalFiredPowerGeneration_Updated.pdf.
- International Energy Agency (2014). *Seamless Power Markets*. Paris. Available from [/www.iea.org/publications/freepublications/publication/SEAMLESSPOWERMARKETS.pdf](http://www.iea.org/publications/freepublications/publication/SEAMLESSPOWERMARKETS.pdf).
- International Energy Agency (2015). *Financing Energy Access. World Energy Outlook. Paris*. Available from www.worldenergyoutlook.org/resources/energydevelopment/energyforallfinancingaccessforthepoor/.
- International Energy Agency (2015a). *Energy Efficiency Market Report 2015*. Available from www.iea.org/publications/freepublications/publication/MediumTermEnergyefficiencyMarketReport2015.pdf
- International Energy Agency (2015a). *Medium-Term Coal Market Report 2015*. Paris.

- International Energy Agency (2015b). *Medium-Term Coal Market Report 2015*. Paris. Available from www.oecd-ilibrary.org/docserver/download/6115371e.pdf?expires=1487317164&id=id&accname=ocid195767&checksum=8A518EAAF7E7217760584FD95EB45D64.
- International Energy Agency (2015c). *Development Prospects of the ASEAN Power Sector Towards an Integrated Electricity Market*. Available from www.iea.org/publications/freepublications/publication/Partnercountry_DevelopmentProspectsoftheASEANPowerSector.pdf.
- International Energy Agency (2015d). *Medium-Term Gas Market Report 2015: Market Analysis and Forecasts to 2020*. Paris.
- International Energy Agency (2015e). *Medium-Term Gas Market Report: Executive Summary*. Available from www.iea.org/Textbase/npsum/MTGMR2015SUM.pdf.
- International Energy Agency (2015f). *Energy and Climate Change: World Energy Outlook Special Briefing for COP21*. Paris.
- International Energy Agency (2015g). *Energy Security*. Available from www.iea.org/topics/energysecurity/.
- International Energy Agency (2016). *Oil Market Report*. Available from www.iea.org/oilmarketreport/omrpublic/.
- International Energy Agency, and Organisation for Economic Co-operation and Development (2015b). *Southeast Energy Asia Outlook 2015*. World Energy Outlook Special Report. Paris.
- International Energy Agency, and World Bank (2015). *Sustainable Energy for All 2015—Progress Toward Sustainable Energy*. Washington DC.
- International Fund for Agricultural Development (2009). *Climate change impacts in the Asia-Pacific region*. Rome. Available from www.ifad.org/documents/10180/88baa1cf-4661-4077-9292-84dfff5253f0.
- International Monetary Fund (2015a). *Counting the cost of energy subsidies*. Available from www.imf.org/external/pubs/ft/survey/so/2015/NEW070215A.htm.
- International Monetary Fund (2015b). *Counting the cost of energy subsidies*. Available from www.imf.org/external/pubs/ft/survey/so/2015/NEW070215A.htm.
- International Monetary Fund (2015c). *How Large Are Global Energy Subsidies?*
- International Monetary Fund (2015d). *IMF Primary Commodity Prices*. Available from www.imf.org/external/np/res/commod/pdf/cpor/2015/cpor1115.pdf.
- International Renewable Energy Agency (2013). *Southern African Power Pool: Planning and Prospects for Renewable Energy*. Available from www.irena.org/documentdownloads/publications/sapp.pdf.
- IT Power Group (2016). *Access to Energy: Quarterly Bulletin*, Vol. 9, February 2016.

- Jain A., Ray S., and others (2015). *Access to Clean Cooking Energy and Electricity Survey of States*. Council on Energy, Environment and Water Report. Available from ceew.in/pdf/CEEW-ACCESS-Report-29Sep15.pdf.
- Jakarta Globe (2015). AIIB \$1B to Finance Coal Development in Indonesia, 27 November. Available from <http://jakartaglobe.beritasatu.com/business/aiib-1b-finance-coal-development-indonesia/>.
- Japan Times (2015). METI panel to pressure power producers stalking feed-in tariff program, 27 September. Available from <http://www.japantimes.co.jp/news/2015/09/27/business/meti-panel-pressure-power-producers-stalking-feed-tariff-program/>.
- Landberg. R (2015). African Development Bank Defends Lending for Coal Power, 19 March. Available from <http://www.bloomberg.com/news/articles/2015-03-18/african-development-bank-defends-lending-for-coal-power>.
- Lowrey D. (2015). Goldman makes case for 'peak coal,' expects pricing pressure and demand, output fall, 23 September. Available from https://www.snl.com/InteractiveX/Article.aspx?cdid=A-33970119-12844&mkt_tok=3RkMMJWWfF9wsRojvKjOce%2FhmjTEU5z17u8vUa%2B%2Bi4kz2EFye%2BLIHETp odcMSMjiMr3YDBceEJhqyQJxPr3FJNANysRuRhDgCw%3D%3D.
- MacDonald M. (2013). *Impact Assessment on European Electricity Balancing Market*. Available from ec.europa.eu/energy/sites/ener/files/documents/20130610_eu_balancing_master.pdf.
- Manila Bulletin (2016). SEA's largest solar project inaugurated in Cadiz City, Negros Occidental, 4 March. Available from <http://www.mb.com.ph/seas-largest-solar-project-inaugurated-in-cadiz-city-negros-occidental/>.
- Ministry of New and Renewable Energy, India (2015). Physical Progress (Achievements). Available from <http://mnre.gov.in/mission-and-vision-2/achievements/>.
- Middle East Institute (2013). The Asia-Pacific in the "Golden Age of Gas": Implications for Middle East LNG Exporters, 08 April. Available from <http://www.mei.edu/content/asia-pacific-golden-age-gas-implications-middle-east-lng-exporters>.
- Navigant Research (2015). *Country Forecasts for Grid-Tied Energy Storage, Utility-Scale and Distributed Energy Storage System Capacity and Revenue Forecasts for Select Countries*.
- Nord Pool (2016). *Nord Pool Spot - About Page*. Available from <http://www.nordpoolspot.com/About-us>.
- Organisation for Economic Co-operation and Development (2014). *Towards Green Growth in Southeast Asia, Green Finance and Investment*. Paris.
- Organisation for Economic and Co-operation and Development (2015). *OECD Companion to the Inventory of Support Measures for Fossil Fuels 2015*. Paris.
- Organization of Petroleum Exporting Countries (2015). *Annual Report 2014*. Vienna.
- Oseni, M., and Pollitt, M. (2014). *Institutional Arrangements for the Promotion of Regional Integration of Electricity Markets - International Experience*.

- Overton, T.W. (2015) Top Plants: Manjung Unit 4, Perak, Malaysia, 01 October. Available from <http://www.powermag.com/manjung-unit-4-perak-malaysia/?pagenum=2>.
- Pachauri S., Scott A., and others (2013). Policy Guide 3. *Energy Policy Guide: Energy for All: Harnessing the Power of Energy*. Available from www.chronicpovertynetwork.org.
- Parthan B. (2015). *Afghanistan Sustainable Energy for Rural Development*. United Nations Development Programme Project Document.
- Practical Action (2014). *Poor People's Energy Outlook 2014: Key messages on energy for poverty alleviation*. Rugby. Available from policy.practicalaction.org/policy-themes/energy/poor-peoples-energy-outlook/poor-peoples-energy-outlook-2014.
- Press Information Bureau, India (2015). *Initiatives to Improve the Efficiency of Coal-based Power Plants*. Available from pib.nic.in/newsite/PrintRelease.aspx?relid=116893.
- Rama M., Béteille T., and others (2015). *Addressing Inequality in South Asia*. World Bank Group publication, Washington DC. Renewable Energy Policy Network for the 21st Century (2015). *Renewables 2015 Global Status Report*. Paris.
- Renewable Energy Policy Network for the 21st Century (2015). *Global Status Report 2015*. Paris.
- Report of the Asia and the Pacific Regional Preparatory Meeting on Science, Technology, and Innovation for Promoting Renewable Energy Technologies for Sustainable Development in Asia and Pacific for the 2013 Annual Ministerial Meeting of the Economic and Social Council. Available from http://www.un.org/en/ecosoc/newfunct/pdf13/amr_thailand_summary.pdf.
- Reuters (2013). As America Enjoys Cheap Gas, Asia's Top Buyers to Pay More, 15 December. Available from <http://www.reuters.com/article/2013/12/15/asia-gas-idUSL4N0JC1XH20131215>.
- Russian Federation, Energy Systems Institute (2016). *Intergovernmental/multilateral agreement for power interconnection in North-East Asia*, presented to the 4th North-East Asian Energy Security Forum.
- Schnitzer, Daniel, and others (2014). *Micro-grids for Rural Electrification: A Critical Review of Best Practices Based on Seven Case Studies*. United Nations Foundation publication.
- Shamsad Akhtar (2015). Asia Pacific: Response to climate change, 10 December. Available from: <http://www.unescap.org/op-ed/asia-pacific-response-climate-change>.
- Southern African Power Pool (2014). *Southern Africa Power Pool Annual Report 2014*. Available from: www.usea.org/sites/default/files/event-/SAPP%20Overview.pdf.
- Sovacool, B. (2013). *Energy Access and Energy Security in Asia and the Pacific*. Asian Development Bank Economics Working Paper Series No. 383 (December, 2013).
- Southern African Power Pool (2016). *Vision and Objectives*. Available from www.sapp.co.zw.
- SunFunder (2016). *Financing solar beyond the grid*. Available from sunfunder.com/.

Sustainable Energy for All (2015). *Advisory Board's Finance Committee Report on Scaling up Finance for Sustainable Energy Investments*.

Terway A., and Nangia R. (2016). *Building Sustainable Energy Future for Asia and the Pacific Region The Energy Connectivity Perspective*. United Nations, Economic and Social Commission for Asia and the Pacific Publication.

The Economic Research Institute for ASEAN and East Asia, The Institute of Energy Economics, Japan (2015). *Recommendations for a better functioning LNG market in Asia, Research Paper*. Available from eneken.iecej.or.jp/data/6302.pdf.

The Energy Collective (2014). Russia's Turn to the East: Expanded Oil and Gas Exports to East Asia Help Reduce Dependence on European Buyers, 2 December. Available from <http://www.theenergycollective.com/jessejenkins/2165366/russias-turn-east-expanded-oil-and-gas-exports-east-asia-help-reduce-dependence>.

The Financial Express (2015). Despite low yields, public issue of REC tax-free bonds evokes good response, 28 October. Available from <http://www.financialexpress.com/article/markets/indian-markets/despite-low-yields-public-issue-of-rec-tax-free-bonds-evokes-good-response/157637/>.

The Institute of Energy Economics, Japan (2014). *Asia/World Energy Outlook 2014*. Tokyo. Available from eneken.iecej.or.jp/data/5875.pdf.

The National Bureau of Asian Research (2011). The Role of Natural Gas in the Asia-Pacific Energy Future, 24 February. Available from <http://www.nbr.org/research/activity.aspx?id=118>.

Thomson J. (2016). AGL Energy abandons gas production and exploration, 4 February. Available from <http://www.smh.com.au/business/energy/agl-energy-abandons-gas-production-and-exploration-20160203-gml73w.html>.

Tripathi A., Sagar A.D., and Smith K.R. (2015). Promoting Clean and Affordable Cooking. *Economic & Political Weekly*, vol. 48.

United Nations Department of Economic and Social Affairs (2006). *Multi Dimensional Issues in International Electric Power Grid Interconnections*. New York. Available from sustainabledevelopment.un.org/index.php?page=view&type=400&nr=86&menu=35.

United Nations Development Programme (2012). *Towards an Energy Plus Approach for the Poor: A review of good practices and lessons learned from Asia and the Pacific*. Bangkok.

United Nations Development Programme (2013a). Achieving Sustainable Energy for All in the Asia-Pacific, 14 August. Available from <http://www.asia-pacific.undp.org/content/rbap/en/home/library/climate-and-disaster-resilience/APRC-EE-2013-SE4ALL.html>.

United Nations Development Programme (2013b). *Accelerating Energy Access for All in Myanmar*.

- United Nations Environmental Programme (2015). 9th Annual Global Trends in Renewable Energy Investment 2015. Available from apps.unep.org/publications/pmtdocuments/-Global_trends_in_renewable_energy_investment_2015-201515028nefvisual8-mediumres.pdf.pdf.
- United Nations Framework Convention on Climate Change (2015a). *Synthesis report on the aggregate effect of the intended nationally determined contributions*.
- United Nations Framework Convention on Climate Change (2015b). *Conference of the Parties*. Twenty-first Session. Available from unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf.
- United Nations, Economic and Social Commission for Asia and the Pacific (2016). *Economic and Social Survey of Asia and the Pacific 2015: Year-end update*. Bangkok. Available from www.unescap.org/sites/default/files/2015%20Year-End%20Update_0.pdf.
- United States, Energy Information Administration (2016a). *Spot Prices: Petroleum & Other Liquids*. Available from www.eia.gov/dnav/pet/pet_pri_spt_s1_m.htm.
- United Nations, Framework Connection on Climate Change Conference of the Parties (2015). *Synthesis report on the aggregate effect of the intended nationally determined contributions*. Available from unfccc.int/resource/docs/2015/cop21/eng/07.pdf.
- United States, Energy Information Administration (2016b). *Market Prices and Uncertainty Report*. Available from <http://www.eia.gov/forecasts/steo/uncertainty/index.cfm>.
- United States, Energy Information Administration (2016c). Natural gas prices in Asia mainly linked to crude oil, but use of spot indexes increases, 29 September. Available from <https://www.eia.gov/todayinenergy/detail.cfm?id=23132>.
- UNFCCC (2015c). *2nd South-South Cooperation on Climate Change Forum (SSCCC Forum)*.
- Versteeg, K. (2015). Tracking Renewable Energy Crowdfunding, 15 September. Solarplaza. Available from <http://www.solarplaza.com/channels/finance/11417/tracking-renewable-energy-crowdfunding/>.
- Wall Street Journal (2014). Thailand Places a Coal Plant Next Door, 3 December. Available from <http://www.wsj.com/articles/thailand-places-a-coal-plant-next-door-1417643290>.
- Wall Street Journal (2015). Russia and Saudi Arabia to Continue Pumping Oil, 2 October. Available from <http://www.wsj.com/articles/russian-oil-output-rises-to-post-soviet-high-in-september-1443777432>.
- Williams, Nathaniel, and others (2015). Enabling Private Sector Investment in Microgrid-based Rural Electrification in Developing Countries: A review. *Renewable and Sustainable Energy Reviews*, vol. 52 (2015).

- World Bank (2008). *The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefits. An IEG Impact Evaluation*. Washington DC. Available from siteresources.worldbank.org/EXTRURELECT/Resources/full_doc.pdf.
- World Bank (2011). *State and People, Central and Local, Working Together: The Vietnam Rural Electrification Experience*. Washington DC. Available from www.astae.net/sites/astae/files/publication/Viet-Elec-WebReport_0.pdf.
- World Bank (2012). *South Asia Development Matters - More and Better Jobs in South Asia*. Washington DC. Available from siteresources.worldbank.org/INTSOUTHASIA/Resources/223497-1327936304951/MBJSA_ConsolidatedTextWithCover_Revised.pdf.
- World Bank (2013). *Indonesia: Toward Universal Access to Clean Cooking. East Asia and Pacific Clean Stove Initiative Series*. Washington, DC. Available from openknowledge.worldbank.org/handle/10986/16068.
- World Bank (2015a). Bid to End Routine Gas Flaring Gets Huge Boost at COP21, 7 December. Available from <http://www.worldbank.org/en/news/press-release/2015/12/07/bid-to-end-routine-gas-flaring-gets-huge-boost-at-cop21>.
- World Bank (2015b). *Adjusting to a Changing World*, 1 April.
- World Bank (2015c). *Migration and Development Brief 25*. Available from <http://pubdocs.worldbank.org/en/102761445353157305/MigrationandDevelopmentBrief25.pdf>.
- World Bank (2016a). Power Outages in Firms in a Typical Month (number). Available from <http://data.worldbank.org/indicator/IC.ELC.OUTG>
- World Bank (2016b). *Global Economic Prospects*. Available from www.worldbank.org/en/publication/global-economic-prospects.
- World Bank (2016c). *Commodity Markets Outlook. Weak Growth in Emerging Economies and Commodity Markets*. Washington DC. Available from pubdocs.worldbank.org/publicdoc/2016/1/991211453766993714/CMO-Jan-2016-Full-Report.pdf.
- World Bank, Independent Evaluation Group (2015). *World Bank Group Support to Electricity Access, FY2000-2014*. Available from ieg.worldbank.org/Data/reports/chapters/Electricity_Access.pdf.
- World Bulletin (2014). Liquid Natural Gas to Become India's Energy Future, 19 September. Available from <http://www.worldbulletin.net/world/144747/liquid-natural-gas-to-be-become-indias-energy-future>.
- World Coal (2015). Clean coal technologies vital for Asia Pacific, 11 June. Available from <http://www.worldcoal.com/coal/11062015/Clean-coal-technologies-vital-for-Asia-Pacific-2406/>.
- World Health Organization (2015). *Burden of disease from ambient air pollution for 2012*. Geneva.
- World Health Organization (2014). *7 Million Premature Deaths Annually Linked to Air Pollution*. Available from [hwww.who.int/mediacentre/news/releases/2014/air-pollution/en/](http://www.who.int/mediacentre/news/releases/2014/air-pollution/en/).

World Health Organization (2016). *Global Urban Ambient Air Pollution Database*. Available from www.who.int/phe/health_topics/outdoorair/databases/cities/en/.

World LP Gas Association (2014). *Cooking with Gas: Why Women in Developing Countries Want LPG and How They Can Get It*. Available from esmap.org/sites/esmap.org/files/WLPGA%20-%20Cooking%20with%20LP%20Gas%20Report%20-%20FINAL%20%20PbP_OPTIMIZED.pdf.

World Nuclear Association (2015). *'Clean Coal' Technologies, Carbon Capture & Sequestration*. Available from <http://www.world-nuclear.org/info/energy-and-environment/-clean-coal-technologies/>.

ANNEX 1

MULTI-TIER MATRIX FOR ACCESS TO HOUSEHOLD ELECTRICITY SUPPLY

		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Capacity	Power		Very Low Power Min 3 W	Low Power Min. 50 W	Medium Power Min 200 W	High Power Min 800 W	Very High Power Min 2 KW
	AND Daily Capacity		Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kWh
	OR Services		Lighting of 1000 lmhrs/day and phone- charging	Electrical lighting, air circulation, television and phone- charging			
Duration	Hours per day		Min 4 hrs	Min 4 Hrs	Min 8 Hrs	Min 16 Hrs	Min 23 Hrs
	Hours per evening		Min 1 hr	Min 2 Hrs	Min 3 Hrs	Min 4 Hrs	Min 4 Hrs
Reliability						Max. 14 disruptions/ Week	Max 3 disruptions/ week of <2 Hrs
Quality						Voltage problems do not affect the use of desired appliances	
Affordability					Cost of a standard consumption package of 365 kWh/Year is less than 5% of household income		
Legality						Bill is paid to the utility, pre-paid card seller or authorized representative	
Health and Safety						Absence of past accidents and perception of high risk in the future	

ANNEX 2

ENERGY ACCESS POLICYMAKING IN ASIA-PACIFIC COUNTRIES

	Energy access national priorities	Energy access national action plan	Energy access targets	Energy service quality targets	Clean cooking solutions	Bi, multi- lateral mechanisms to expand access
Afghanistan	○	○	○			○
American Samoa	○	○	○		○	○
Armenia	○	○				
Australia	○		○			○
Azerbaijan	○		○			
Bangladesh	○	○	○	○	○	○
Bhutan	○	○	○		○	
Brunei Darussalam	○					
Cambodia	○	○	○		○	
China	○	○	○	○	○	○
China, Hong Kong	○					
Cook Islands	○	○	○		○	○
DPRK						
Fiji	○	○	○	○	○	○
French Polynesia	○	○	○			○
Georgia	○	○	○			○
Guam	○	○	○			○
India	○	○	○		○	○
Indonesia	○					○
Iran, Islamic Republic of						
Japan	○	○				○
Kazakhstan	○					○
Kiribati	○	○	○			○
Korea, Republic of	○	○				○
Kyrgyzstan	○					
Lao People's Dem. Rep.	○	○	○		○	○

	Energy access national priorities	Energy access national action plan	Energy access targets	Energy service quality targets	Clean cooking solutions	Bi, multi- lateral mechanisms to expand access
Malaysia	○	○	○			○
Maldives	○		○		○	
Marshall Islands	○	○	○		○	○
Micronesia, Federated States of	○	○	○		○	○
Mongolia	○	○	○		○	○
Myanmar						
Nauru	○	○	○	○	○	○
Nepal	○	○	○		○	○
New Caledonia	○	○	○			○
New Zealand	○	○	○			
Niue	○	○	○			○
Northern Mariana Islands	○	○	○			○
Pakistan	○	○	○			○
Palau	○	○	○		○	○
Papua New Guinea	○	○	○			○
Philippines	○	○	○	○		○
Russian Federation	○			○		○
Samoa	○	○	○		○	○
Singapore	○					
Solomon Islands	○	○	○		○	○
Sri Lanka	○	○	○	○		○
Tajikistan	○		○	○		
Thailand	○					
Timor-Leste	○	○	○		○	○
Tonga	○	○	○		○	○
Turkey		○		○		○
Turkmenistan	○					
Tuvalu	○	○	○		○	○
Uzbekistan	○					
Vanuatu	○	○	○	○		○
Viet Nam	○	○	○		○	○

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