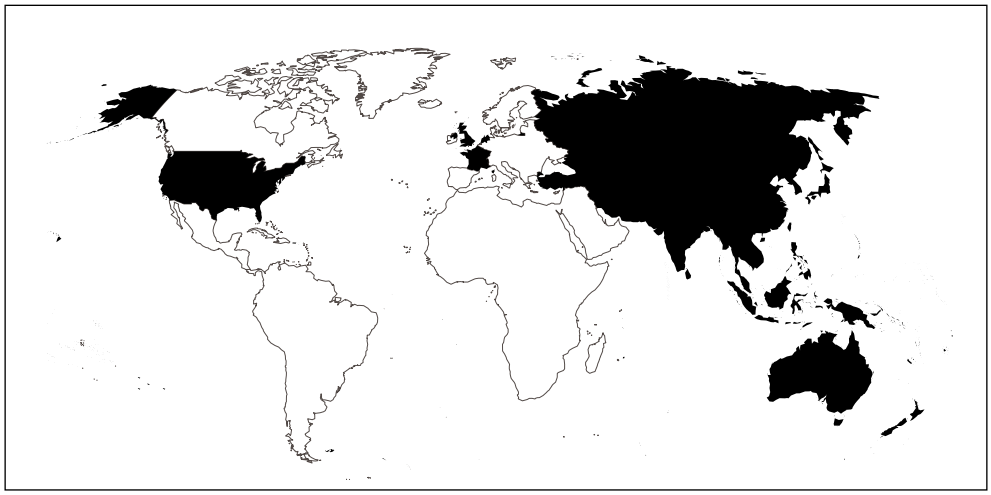
Closing the gap for SDG 7 in the Asia-Pacific region

REGIONAL TRENDS REPORT ON ENERGY FOR SUSTAINABLE DEVELOPMENT 2023

APEF
THE ASIAN AND PACIFIC ENERGY FORUM

ESCAP
Economic and Social Commission for Asia and the Pacific



*The shaded areas of the map indicate ESCAP members and associate members.**

The Economic and Social Commission for Asia and the Pacific (ESCAP) is the most inclusive intergovernmental platform in the Asia-Pacific region. The Commission promotes cooperation among its 53 member States and 9 associate members in pursuit of solutions to sustainable development challenges. ESCAP is one of the five regional commissions of the United Nations.

The ESCAP secretariat supports inclusive, resilient and sustainable development in the region by generating action-oriented knowledge, and by providing technical assistance and capacity-building services in support of national development objectives, regional agreements and the implementation of the 2030 Agenda for Sustainable Development.

**The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.*

Closing the gap for SDG 7 in the Asia-Pacific region

REGIONAL TRENDS REPORT ON ENERGY FOR SUSTAINABLE DEVELOPMENT 2023

United Nations publication
Sales no.: E.23.II.F.10

ISBN: 9789210029292
e-ISBN: 9789213584828
ISSN: 2618-107X
e-ISSN: 2618-1088
ST/ESCAP/3097

Photo credits:
forrest9 / iStock (884637972)
fokkebok / iStock (1215198520)
Kat72 / iStock (50727777)
aapsky / iStock (1397078816)
Ralf Hahn / iStock (464326357)
SCM Jeans / iStock (1621949846)
DKsamco / iStock (507305500)
SlobodanMiljevic / iStock (1211557085)
Thinnapob / iStock (1310384629)

Acknowledgements

This report was developed by the Energy Division of the Economic and Social Commission for Asia and the Pacific (ESCAP) under the overall direction and guidance of Hongpeng Liu, Director of the Energy Division, and Michael Williamson, Chief of Sustainable Energy Development and Utilization Section, the Energy Division, ESCAP.

The principal authors of the report were David Ferrari, Michael David Waldron and Kimberly Roseberry. The contributors from the Energy Division were Michael Williamson and Sergey Tulinov. The peer review and valuable suggestions were provided by Sustainable Energy for All and the International Renewable Energy Agency.

Alan Cooper edited the manuscript. The cover and design layout were created by Lowil Espada. Administrative and secretarial support was provided by Korakot Chunprapaph, Prachakporn Sophon, Nawaporn Sunkpho and Thiraya Tangkawattana.

The Communications and Knowledge Management Section (CKMS) of ESCAP coordinated the dissemination of the report.

Foreword

As the world faces multiple overlapping crises, countries of the Asia-Pacific region continue their efforts to implement the 2030 Agenda for Sustainable Development. In this final decade of action on the Sustainable Development Goals (SDGs), these efforts have a particular urgency. While all the SDGs are important, making progress towards SDG 7 on affordable and clean energy is critical, as energy is at the centre of the sustainable development process, presenting linkages across many other SDGs. As energy sector emissions are the key drivers of climate change, the success of the Paris Agreement hinges on the speed of energy decarbonization in this region.

The past few years have taught us that energy is a sector in which many negative impacts stemming from the current global crises are experienced, such as rising prices and energy security concerns. Sustainable energy, however, holds many solutions ¬ from renewable energy to energy efficiency and cross-border power system connectivity – that can lead to lower costs, diversified portfolios and enhanced security.

Against this backdrop, this flagship report, part of the annual Regional Trends series, is an important contribution towards understanding these challenges and opportunities. The report examines progress made by Asian and Pacific countries towards achieving SDG 7 and reviews the ways in which countries of the region can prepare to reach net-zero emissions by mid-century. By assessing progress at country and regional levels, it presents a comprehensive regional picture of the principal SDG 7 gaps and outlines key policy directions for member States to consider.

Much more needs to be done to bridge these gaps and bring SDG 7 achievement closer. ESCAP is committed to working with all member States to build an energy system that is more sustainable, resilient, secure and interconnected.

The report is being released prior to the Third Asian and Pacific Energy Forum (APEF3) in October 2023 to support deliberations on regional cooperation on energy. The theme of APEF3 – "Building a secure, sustainable and interconnected energy future for Asia and the Pacific" – encapsulates a vision that brings together sustainability, regional cooperation and resilience for the region's energy future. It is hoped that this report can provide a stepping stone towards achieving this vision.

Armida Salsiah Alisjahbana
Under-Secretary-General of the United Nations and Executive Secretary of ESCAP

Contents

CHAPTER 4

CHAPTER 5

List of Figures

List of tables

List of boxes

Abbreviations and acronyms

ADB	Asian Development Bank
AIMS	ASEAN Interconnection Masterplan Study
APEC	Asia-Pacific Economic Cooperation
APEF	Asia and Pacific Energy Forum
APG	ASEAN Power Grid
CCUS	carbon capture utilisation and storage
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
CRM	critical raw materials
ESCAP	Economic and Social Commission for Asia and the Pacific
ESCOs	energy services companies
ESMAP	Energy Sector Management Assistance Program
EVs	electric vehicles
FiT	feed-in tariff
GDP	gross domestic product
IEA	International Energy Agency
IMF	International Monetary Fund
IPP	independent power producer
IPCC	International Panel on Climate Change
IRENA	International Renewable Energy Agency
ISO	International Organization for Standardization
JETP	Just Energy Transition Partnership
JODI	Joint Organisations Data Initiative
kg	kilogram
koe	kilogram oil equivalent
kWh	kilowatt-hours
LCOE	levelized cost of electricity
LPG	liquid propane gas
LNG	liquified natural gas
MEPS	Minimum Energy Performance Standards
Mtoe	million tonnes of oil equivalent
MWh	megawatt-hours
NDCs	nationally determined contributions
NEXSTEP	National Expert SDG Tool for Energy Planning
OPERA	Office of the Pacific Energy Regulators Alliance
OECD	Organisation for Economic Co-operation and Development
PV	photovoltaic
RBF	results-based financing
SDGs	Sustainable Development Goals
SPC	Pacific Community
STEM	scientific, technology, engineering and mathematics
TFEC	total final energy consumption
TES	total energy supply
TWh	terawatt-hours
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VRE	variable renewable energy
WHO	World Health Organization
Wp	watt-peak

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

Executive summary

Asia and the Pacific is at a critical juncture of the energy transition. The region is home to more than half of the world's population, consumes more than 40 per cent of global energy, produces more than 50 per cent of global greenhouse gas emissions and is undergoing rapid development. It is experiencing rapid growth in energy demand, which will continue in the coming years. This creates financial challenges, applies pressure on natural resources, strains the environment and makes it difficult for the region to meet its climate change commitments.

Given recent experience, the achievement of Sustainable Development Goal 7 (SDG 7) – ensuring access to affordable, reliable, sustainable, and modern energy for all by 2030 – is challenging for the region.

Delivery of the SDG 7 targets on universal access to modern energy, energy efficiency and renewable energy hinges on scaling up investments in clean energy technologies and diverting investment away from fossil fuels. While significant progress has been made in recent years, much of the investment has been concentrated in a relatively few countries. One of the most critical remaining SDG 7 challenges is the lack of access to modern energy services. Millions of people in the region still do not have access to electricity or clean cooking fuels, which produces a series of negative consequences, including, among them, health impacts, environmental degradation and economic hardship.

The region's energy mix is dominated by coal, oil and natural gas. This reliance contributes towards climate change and air pollution, and ongoing investment in fossil fuels will likely lead to financial burdens, including the risk of stranded assets. The phasing down of fossil fuels, particularly of coal, in a controlled and equitable manner, is central to ensuring the overall success of the energy transition.

Delivering the multiple targets under SDG 7 in all countries of the region by 2030 requires a concerted effort from the stakeholders. Governments, businesses and civil society must work together to ensure universal energy access, ramp up renewable energy use and enhance energy efficiency.

The objective of this report is to examine the progress made by Asia-Pacific countries towards achieving SDG 7 in the decade of action on the SDGs. In it, key energy trends are examined, immediate challenges are reviewed and the preparation of more ambitious agendas towards net-zero emissions are assessed to give recommendations of the steps needed to be taken by stakeholders and policymakers to achieve the goal of access to affordable, reliable, sustainable, and modern energy for all.

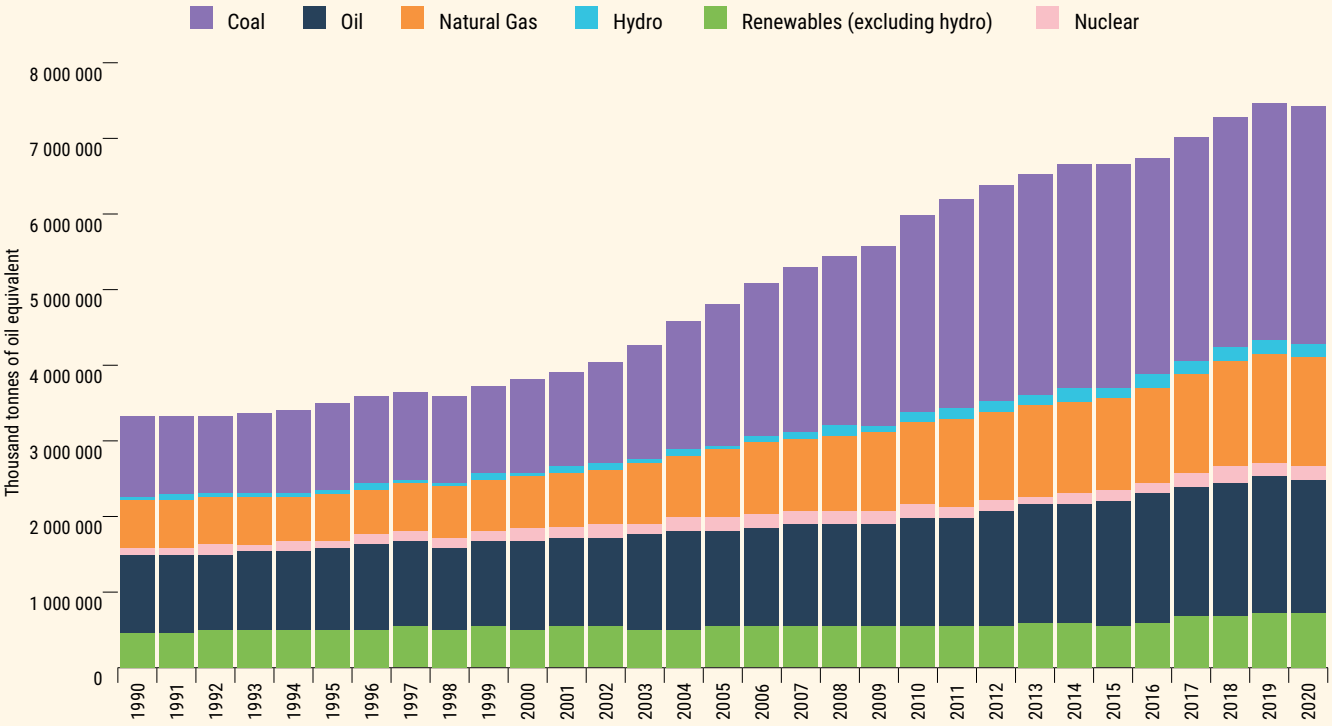
Status and challenges to the sustainable energy transition agenda

Following a period of rapid growth over the past two decades, the Asia-Pacific region's energy supply remains dominated by fossil fuels. In 2020, coal made up 42.2 per cent of the total energy supply, oil 23.4 per cent and natural gas 19.1 per cent (figure ES1). With the energy sector accounting for approximately 80 per cent of the region's greenhouse gas emissions, a shift away from fossil fuels, the phasing down of coal use and a broad-based move towards reaching net-zero emissions by mid-century across Asia and the Pacific are critical steps for putting the region and the world on track to avoid destructive climate change.

Unfortunately, as the region's energy demand has increased, coal, gas and oil have been the resources of choice to underpin most of the growth over the past three decades. However, in recent years the renewable energy component of the total energy supply has also grown, and technology maturity and cost declines have spurred an acceleration in the deployment of clean technologies, which is expected to continue in the coming years.

The total energy supply is dominated by coal, but the renewable energy component is growing

Figure ES1. Energy supply by product in Asia and the Pacific



Source: ESCAP based on International Energy Agency (IEA), World Energy Statistics and Balances

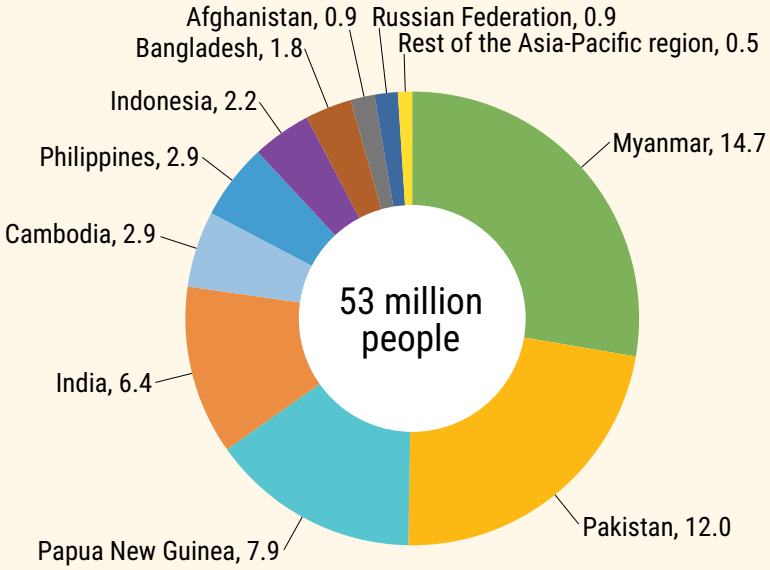
An encouraging sign of improvements in energy efficiency over the same period is the steady decline in energy intensity. However, overall regional progress in this regard falls well short of the global target of doubling the historical rate of improvement under SDG 7. Furthermore, the rate of improvement is highly varied across the region and over time, with only three ESCAP member States (China, Indonesia and Japan) recording rates in excess of the global target for energy intensity under SDG 7. Although a wide range of opportunities for improvement are available, more effort must be directed towards boosting energy efficiency by enhancing the energy efficiency of appliances, buildings and industries.

Meanwhile, 53 million people remain without access to electricity. A large proportion of those lacking access to electricity live in one of a small number of countries (figure ES2), implying an opportunity for attaining a significant impact from a small number of interventions in those locations. The possibilities for successful programmes have been widely demonstrated. For example, enormous impacts have been achieved in Afghanistan where the electrification rate was raised from 1.6 per cent in 2000 to 97.7 per cent in 2021 through grid extensions and the deployment of off-grid technologies with innovative financing.

The greatest obstacle to achieving SDG 7 in the Asia-Pacific region is in delivering the target of universal access to clean cooking fuels and technologies. Nearly 1.2 billion people from the region remain reliant on traditional biomass, such as wood, animal waste and traditional charcoal, for their cooking and space heating needs. This dependence on traditional fuels compounds existing hardship, affecting gender equality, health and the environment, and cementing vast populations in ongoing poverty.

Most people without access to electricity live in just a few countries.

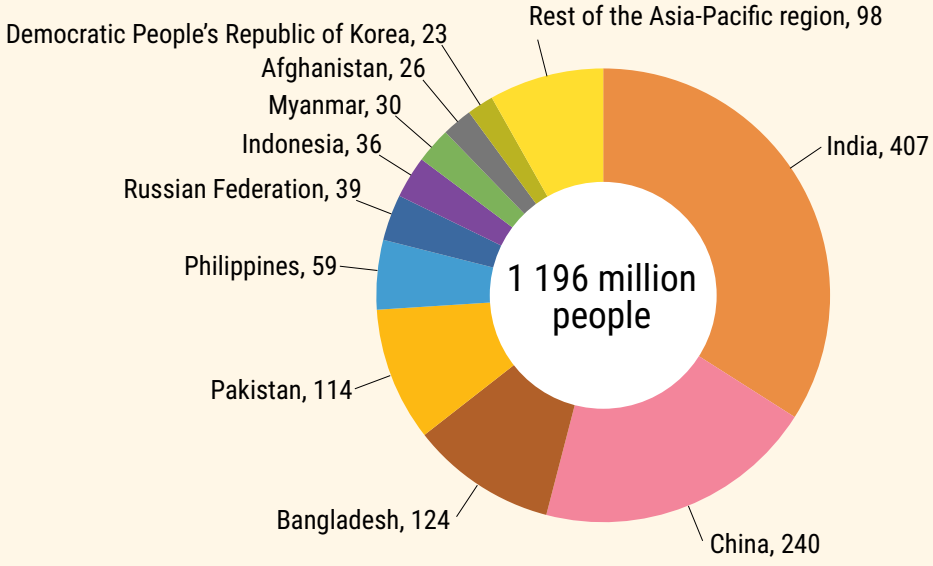
Figure ES2. Population without access to electricity (millions), 2021



Source: World Bank, United Nations Statistics Division

After almost two decades of accelerating improvement from the start of the millennium, the number of people gaining access to clean cooking peaked in 2018 and has since been declining. If current trends were to continue, well over one billion people from the region would remain without access to clean cooking by the end of the decade.

Figure ES3. Population without primary reliance on clean cooking fuels and technologies, 2021



Source: WHO, United Nations Statistics Division

Best practices for sustainable energy development

There are multiple opportunities for the promotion and acceleration of sustainable energy development in Asia and the Pacific. The regional experiences of policymakers, project proponents and communities have produced numerous lessons learned and best practices, which will guide ongoing improvement.

Because of the diversity of economic and natural resources, political will and other variables, policy solutions for sustainable energy development must be tailored and calibrated to the local context. Nevertheless, the analysis presented in this report supports the experience of policymakers that solutions can be effective when designed in close collaboration with private and public stakeholders, leaning towards regulated mandates on the one hand or supportive interventions on the other. Successful policy relies on a solid foundation of planning for an energy transition that is environmentally sound, secure and equitable.

As the renewable energy supply increases and headway is made in improving efficiency, technical solutions offer opportunities for maintaining reliability. High levels of variable renewable energy (VRE) will present challenges to grid management that can be resolved through a range of measures, ranging from changes in operating procedures to developing new infrastructure, including storage, smart grids and cross-border connectivity.

Increased levels of finance will need to be mobilized in the coming years, with the majority coming from the private sector. This is contingent on a pipeline of bankable projects, supportive and enabling environments for project delivery and appropriate commercial arrangements (including risk allocation) between public and private actors. Reforms in financing the energy sector, the implementation of carbon pricing and the deployment of innovative business models and new financial instruments will all play an important role in drawing international finance to the region.

Critical raw materials (CRMs) are an increasing source of challenges to the energy transition. The Asia-Pacific region offers significant potential to contribute solutions to effectively manage CRMs, but an alignment of extractive industries with the SDGs requires a holistic approach and effective policy measures. Local manufacturing industries are a major driver of demand, but with a quarter of the world's mineral reserves found in Asia and the Pacific, the region is well-positioned to meet increasing global needs. Supply chain resilience can be reinforced through the management of trade, while some additional strategies are supporting domestic exploration, securing overseas resources and diversifying the supply, all of which must be achieved while ensuring protection of the environment. Both CRM-surplus and CRM-deficit countries can benefit from international cooperation, innovation and circular economy approaches.

It is important to ensure that the energy transition is just and equitable, taking into account the full impacts on all aspects of society and the environment. Energy affects a wide range of other issues across the sustainable development and climate agendas. Policymakers, therefore, must consider the alignment of the transition with these interlinked agendas.

Amid these challenges, the region faces new risks and opportunities from the emergence of two consecutive global crises: the COVID-19 pandemic, which began in 2020, and the war in Ukraine which started in 2022. While the impacts are still playing out, the crises have already affected energy trade and security. Accordingly, these crises can also reinforce the need for governments to adopt greater levels of energy efficiency and drive the diversification of national energy systems away from fossil fuels. They have also highlighted the need for countries to ensure that energy systems are ever more resilient to new challenges in a more volatile world.

Opportunities for regional acceleration of progress in achieving Sustainable Development Goal 7

In summary the current status and trajectory of the region's sustainable energy development is not compatible with realizing the Sustainable Development Goals or the pledges of the Paris Agreement. At the midway point of the SDGs, it is now more important than ever to accelerate efforts towards the energy transition.

In this year's Regional Trends Report, policymakers and other stakeholders are called on to work towards putting the region on a path towards delivery of SDG 7 and to aim for net-zero emissions around the middle of the century. In the report, the following actions are recommended in support of those efforts:

1. **Improve enabling environments for clean energy development** through a holistic approach to planning and policymaking, which charts a pathway for the energy transition and supports deployment of clean, modern energy technologies.

2. **Increase private sector engagement** by reforming markets and regulatory frameworks to enhance private participation and increase competition.

3. **Deploy a range of risk allocation and investment mobilization strategies** to ensure that private finance – which is needed make up the bulk of finance driving the energy transition – is available for projects and sectoral development.

4. **Employ energy connectivity as a tool for supporting the energy transition** by working towards setting harmonized regulations and operational policies that allow for the integration of power systems.

5. **Manage access to CRMs to enable the energy transition** by supporting efforts to improve legal and regulatory practices, establishing inclusive management practices and strengthening regional coordination.

6. **Ensure a just energy transition** that ensures no one is left behind across all geographic subregions and all parts of society.

INTRODUCTION

Setting the sustainable energy transformation agenda for Asia and the Pacific

The Asia-Pacific region is home to approximately 60 per cent of the world's population, consumes about 44 per cent of the primary energy supply and contributes more than 55 per cent of the annual global greenhouse gas emissions (United Nations Department of Economic and Social Affairs, Population Division, 2023; ESCAP, 2022; IEA, 2020). Increasing incomes and economic growth indicates that the region's energy demand and associated emissions are growing rapidly, further heightening the importance of regional contributions towards global efforts on sustainable energy and clean energy transitions.

The objective of this report is to examine the progress made by Asia-Pacific countries towards achieving Sustainable Development Goal 7 (SDG 7) in the final decade of action on the SDGs. In it, the key energy trends across the Asia-Pacific region are examined, while in addition to analysing the immediate challenges in delivering SDG 7, the preparation of more ambitious agendas to reach net zero emissions by mid-century are discussed.

Sustainable Development Goals 7 was adopted in 2015 as part of the 2030 Agenda for Sustainable Development with the aim of ensuring access to affordable, reliable, sustainable, and modern energy for all by 2030 through delivery of the following targets:

- **Target 7.1**: Ensure universal access to affordable, reliable and modern energy services. The purpose of this target is to ensure that everyone has access to modern and sustainable energy services, such as electricity, clean cooking fuels, and technologies.

- **Target 7.2**: Increase the share of renewable energy in the global energy mix. This target is intended to increase the use of renewable energy sources, such as solar, wind and hydropower, in the global energy mix to reduce greenhouse gas emissions and mitigate climate change.

- **Target 7.3**: Double the global rate of improvement in energy efficiency. This target aims to increase the rate of improvement in energy intensity in terms of primary energy and gross domestic product (GDP), with energy efficiency playing a critical role. This is essential for reducing energy consumption, lowering greenhouse gas emissions, and promoting sustainable development.

- **Target 7.a**: 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.

- **Target 7.b**: Expand and upgrade energy services for developing countries, especially least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support.

Given the interlinkages that energy holds with the health of the environment and with economic and social development, achievement of SDG 7 is crucial for the overall delivery of the global goals. Furthermore, for the Asia-Pacific region, achievement of the SDG 7 is important to spur progress across many other SDGs as follows:

- Asia and the Pacific is one of the most vulnerable regions in the world to the impacts of **climate change**. By realizing SDG 7, countries in the region can reduce their climate impacts as well as dependence on fossil fuels by shifting

to renewable energy sources and energy efficiency measures. This would significantly reduce greenhouse gas emissions and mitigate the impacts of climate change, in line with commitments under the Paris Agreement, while also supporting the implementation of the Sendai Framework for Disaster Risk Reduction through enhancing the resiliency of the energy system.

- Access to affordable, reliable, and sustainable energy is essential for **poverty reduction** and economic development. By achieving SDG 7, countries in the region can improve energy access for the poor and marginalized communities, which can help reduce poverty and promote inclusive economic and social development through providing access to basic services and enhanced opportunities for economic activities.
- Lack of access to modern energy services, such as electricity and clean cooking fuels, is a major **health, gender and education** issue in the region. By achieving SDG 7, countries in the region can improve access to clean energy to improve quality of life, reduce adverse health impacts and gender inequalities, and enhance education options that are hampered by indoor air pollution and other energy deficit-related issues.

Many countries, however, are still facing major challenges related to energy access, energy security and environmental sustainability. Profound changes in the energy systems of the region are required to deliver on these goals. Asia and the Pacific is the centre of growth for global energy production and consumption, but the region continues to depend on fossil fuels in a manner that is not compatible with SDG 7, nor with the targets of the Paris Agreement.

Purpose and structure of this report

This report, released in the lead-up to the ministerial level Asian and Pacific Energy Forum (APEF), will support intergovernmental deliberations on regional energy cooperation by informing discussions on the progress of ESCAP member States towards the achievement of SDG 7. It looks to subregional targets and objectives that further inform the regional picture; by highlighting the principal SDG 7 gaps, the report offers potential solutions to these challenges with a focus on the sectors and subregions in which accelerated progress is required.

The report sheds light on some key trends and emerging issues that member States are confronting in their energy sectors along with the potential for those trends to support or hinder achievement of the sustainable energy and climate goals. It includes an assessment of the interlinkages between SDG 7 and the other SDGs, highlighting areas where synergies and co-benefits can be realized and, examining the bigger picture beyond SDG 7 targets, such as climate change, air pollution, poverty eradication, sustainable industrialization, and the phase out of coal.

The emerging landscape of energy security is explored and the role of regional cooperation in strengthening regional energy security is discussed in the report. Through this analysis and by drawing on initiatives of ESCAP, such as SDG 7 road maps and other analytical and normative work, policy recommendations for countries to bridge these gaps and bring SDG 7 achievement closer are outlined. Where possible, subregional insights are presented with a view to developing subregion-specific recommendations. The focus of each chapter is as follows:

- **Chapter one** provides an overview of the energy situation in Asia and the Pacific and overall progress towards realizing SDG 7 through a description of the region's contribution to the global energy transition. It gives an outline on how the SDG 7 targets are linked to other SDGs and to the Paris Agreement, which includes a focus on vulnerable groups and communities. Also reviewed in the chapter are the status of nationally determined contributions (NDCs) along with the pledges towards net-zero emissions by mid-century and other national and subregional targets and policies, and the roles of the COVID-19 pandemic and the war in Ukraine in shaping the region's energy system and transition are examined.
- **Chapter two,** a data-driven approach is taken to evaluate regional progress towards each SDG 7 target, exploring subregional perspectives on energy resources, costs and consumption

trends alongside the state of existing policies and political ambition. In addition, the gender impacts of the energy transition and the role of women in the delivery of the target is reviewed.

- **Chapter three** provides an outline of the solutions in policy, technology and finance that can help to accelerate progress in meeting SDG 7 targets. Among other priorities, the importance of regional power grid interconnection as an avenue for renewable energy integration and the steps the region is taking with the support of ESCAP to realize this long-term vision for energy cooperation are highlighted.

- **Chapter four** includes a description on how the emergence of two consecutive global crises – the COVID-19 pandemic in 2020 and the ongoing war in Ukraine, which commenced in 2022 – have affected energy markets and the energy transition efforts of member States. Country responses to these crises are highlighted and the effect of the strategies towards attaining SDG 7 targets are assessed, drawing lessons learned for supporting secure and sustainable development in a more volatile world.

- A summary of conclusions is presented in **chapter five**, bringing together the key findings and outlining recommendations for ESCAP and its member States to accelerate progress towards universal access to clean, modern energy services in the region and manage the impacts of overlapping crises both now and into the future.

Quantitative information for the report is largely drawn from the Asia-Pacific Energy Portal and includes data up to 2021. In addition, the more recent market indicators and analysis are highlighted, where possible.

CHAPTER 1.

Sustainable Energy Development: Situation and Trends

The energy situation: a status update for the Asia-Pacific region and across the globe

The Asia-Pacific region's energy systems have evolved based on geography, the distribution of natural resources, economic development at the local scale and historic sequence of policy decision-making.

As shown in figure 1 the total energy supply (TES) for Asia and the Pacific expanded rapidly in the recent two decades alongside the region's economic development. TES remains dominated by coal (42.2 per cent of TES in 2020), oil (23.4 per cent) and natural gas (19.1 per cent), while renewables (including hydro) comprise only 12.3 per cent of the mix. The subregional picture (figure 1, lower half)[1] provides some indication of the geographic distribution of supply and resources: the highly populous areas of East and North-East Asia, and to a lesser extent South and South-West Asia, were the major drivers of growth and continue to be the largest consumers of conventional and renewable energy.

While coal (and to a lesser extent natural gas and oil) have fuelled most of the growth in supply in the twenty-first century, great strides have been made towards the region's sustainable energy transition. The proportion of the population with access to modern energy services continues to increase steadily, while the energy intensity of the regional economy has dropped almost continuously for the last ten years. Over the same period, the share of primary energy from fossil fuels has decreased gradually as renewables (including hydro) outpaced the growth in energy demand. This is reflective of global trends: the renewable component of total energy supply has expanded from 29.2 per cent in 2011 to 38.2 per cent in 2020, as the proportional share of fossil fuels first stabilized, then diminished (IEA, 2023c). In fact, renewable energy technologies are being deployed at rapidly increasing rates and this trend is expected to continue to drive a rising renewable share in the coming years.

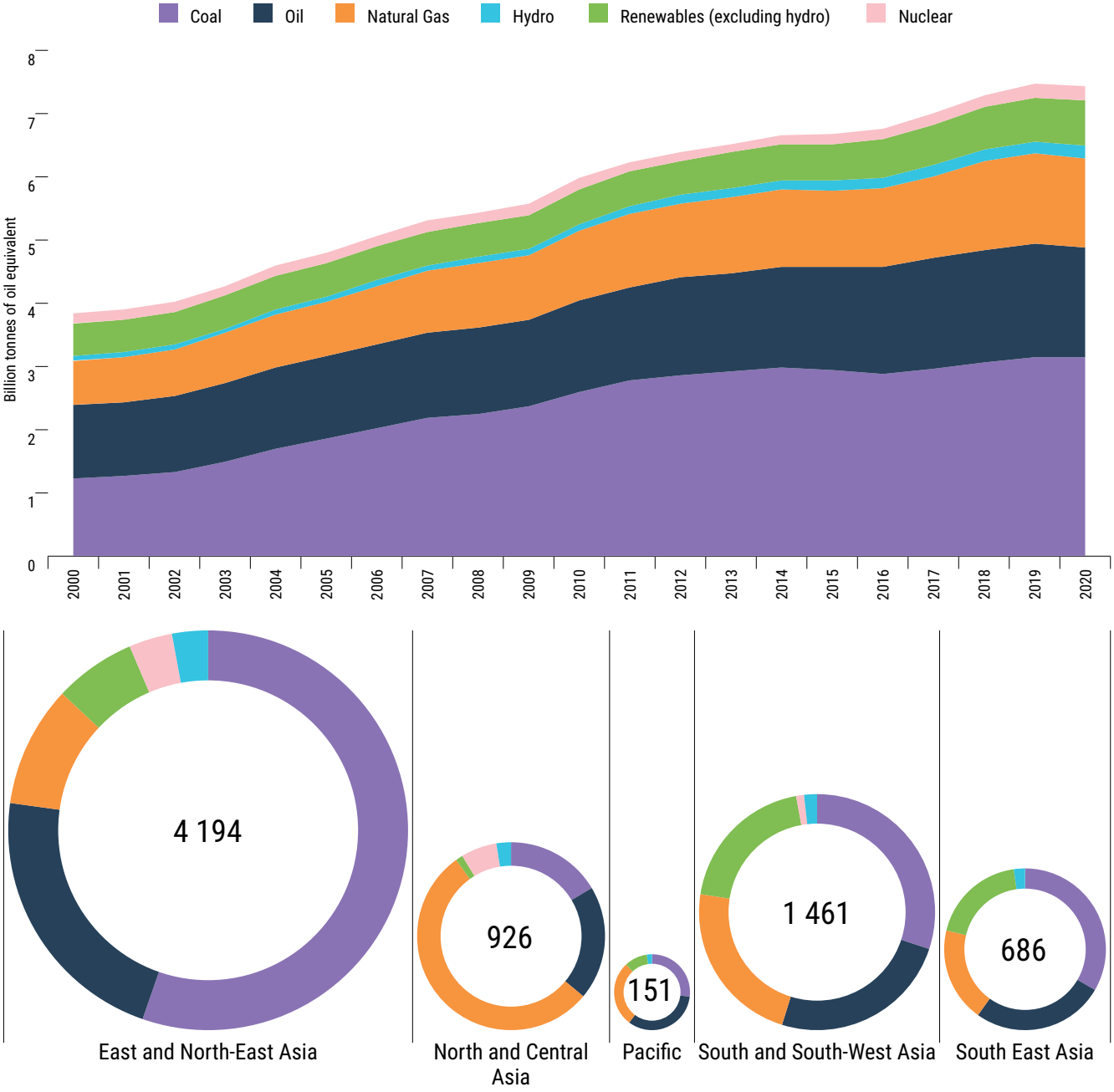
Despite this, progress is not on track to ensuring achievement of access to affordable, reliable, sustainable, and modern energy for all by 2030 in the Asia-Pacific region or globally. In the *Tracking SDG 7: The Energy Progress Report*, published in 2023, the following was written: "Despite some progress across the indicators, the current pace is not adequate to achieve any of the 2030 targets. As in previous years, rates of progress vary significantly across regions, with some regions making substantial gains and some slowing their progress or even moving backward." (IEA and others, 2023). Delays are especially notable in vulnerable countries where emerging markets and developing economies have been unable to access the investment that is needed.

Figure 2 presents the final energy consumption for the region broken down by sectors of the economy. It shows that over the past two decades, there has been steady growth in energy demand from industry as factories in Asia cemented their role as the world's core provider of manufactured goods. A significant increase in energy consumption occurred in the industrial sector, with usage more than doubling and the share of total final energy consumption rising from 32.0 per cent to more than 39 per cent over this period. The region's consumption in the transport and commercial sectors grew by 91.5 and 80 per cent, respectively, over the past two decades, roughly in step with overall increases in energy demand. The increase of consumption in the transport sector can in part be attributed to the region's rapidly growing middle class, which. especially in East and North-East Asia and South and South-West Asia, has long been associated with urbanization and motorization: as more people move to cities and become more affluent, the number of vehicles on

[1] Further detail of each subregion is presented in annex 1.

The total energy supply remains dominated by coal and oil, but most of the growth in the past few years has been in natural gas and renewables

Figure 1/ Energy supply by product in Asia and the Pacific

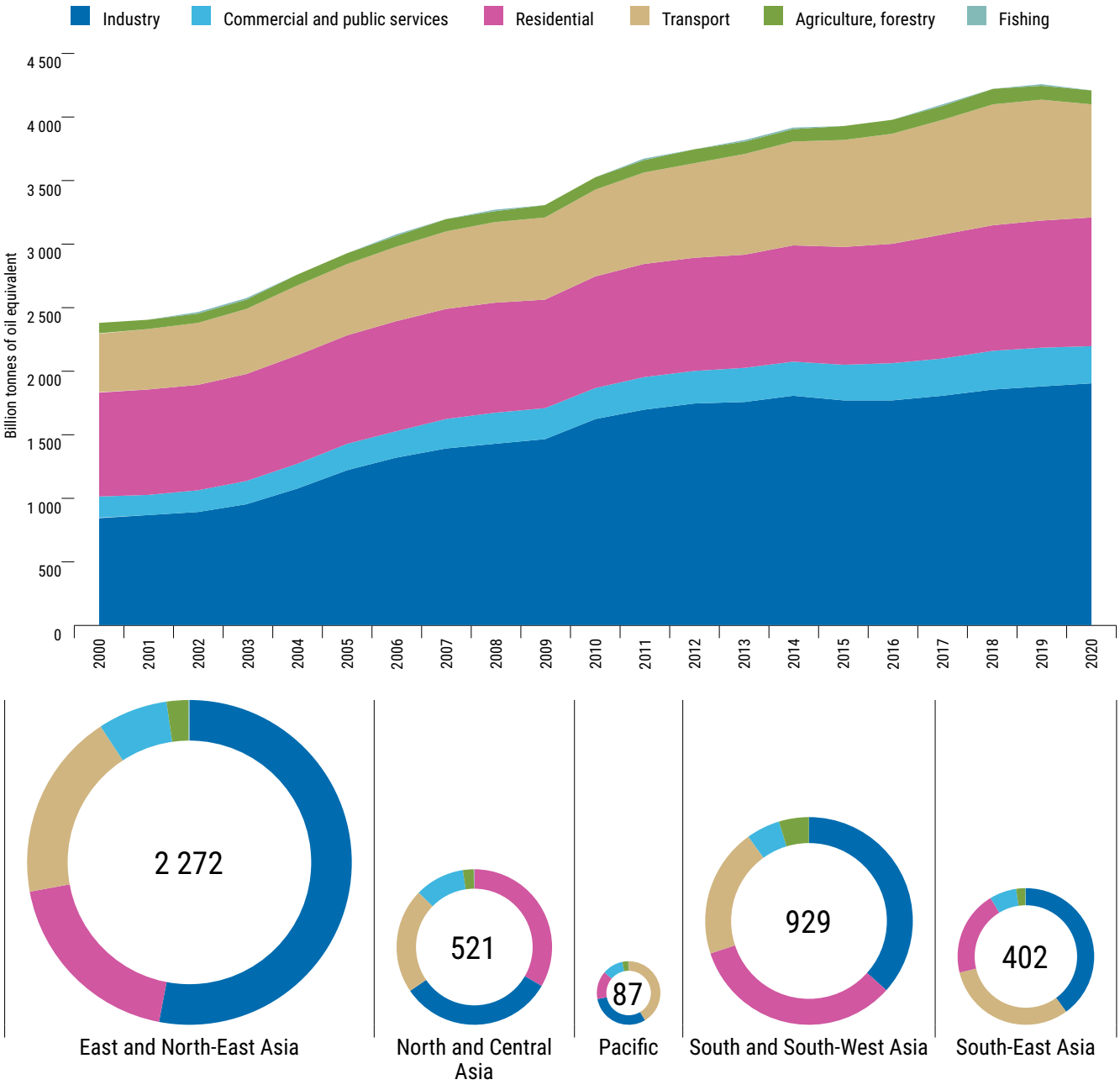


Source: IEA, World Energy and Statistics Balances (https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances).

the road has increased significantly. Challenges in transportation infrastructure have resulted in traffic congestion and greater energy use per unit of transport – an inefficiency, which, combined with a heavy reliance on fossil fuels for transportation, has contributed towards the growth in energy consumption in the region. By contrast, residential consumption increased by just 22.6 per cent, indicating commendable progress in enhancing energy efficiency.

Growth in demand has been driven by industry and transport sectors

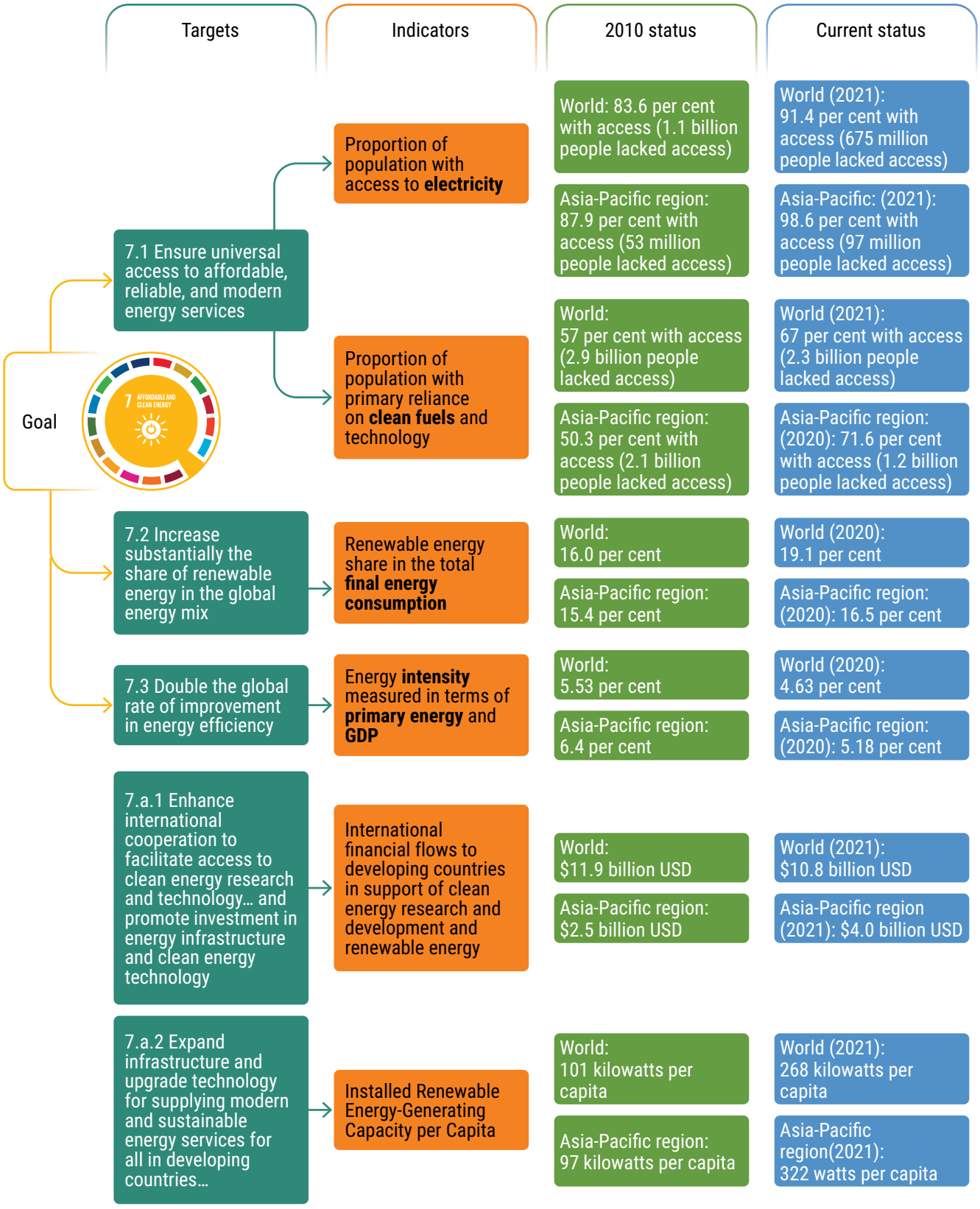
Figure 2/ Final consumption by sector in Asia and the Pacific



Source: IEA, World Energy and Statistics Balances (https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances).

As the region moves towards a modern energy future, policymakers face the complex and challenging task of achieving the 2030 Agenda and the objectives of the Paris Agreement. This includes ensuring sustainable economic growth, responding to increasing energy demand and reducing emissions, while capitalizing on the interlinkages between the energy transition and other aspects of development. SDG 7 provides a framework to ensure modern energy that is accessible, affordable, reliable and sustainable for all. Progress towards realizing SDG 7 is measured by the system of targets and indicators presented in figure 3.

Figure 3/ Sustainable Development Goal 7 progress globally and in the Asia-Pacific region



Sources: World Bank, WHO, IEA, IRENA and UN Statistics Division

Overview of energy situation by subregion

The Economic and Social Commission for Asia and the Pacific is comprised of 53 member States and 9 associate members. Asia-Pacific regional members are divided into subregional groupings as follows:

- **East and North-East Asia**: China; Democratic People's Republic of Korea; Hong Kong, China (associate member); Japan; Macao, China (associate member); Mongolia; and the Republic of Korea.

- **North and Central Asia**: Armenia; Azerbaijan; Georgia; Kazakhstan; Kyrgyzstan; Russian Federation; Tajikistan; Turkmenistan; and Uzbekistan.

- **Pacific**: American Samoa (associate member); Australia; the Cook Islands (associate member); Federated States of Micronesia; Fiji; French Polynesia (associate member); Guam (associate member); Kiribati; Marshall Islands; Nauru; New Caledonia (associate member); New Zealand; Niue (associate member); Northern Mariana Islands (associate member); Palau; Papua New Guinea; Samoa; Solomon Islands; Tonga; Tuvalu; and Vanuatu.

- **South and South-West Asia**: Afghanistan; Bangladesh; Bhutan; India; Islamic Republic of Iran; Maldives; Nepal; Pakistan; Sri Lanka; and Türkiye.

- **South-East Asia**: Brunei Darussalam; Cambodia; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Singapore; Thailand; Timor-Leste; and Viet Nam.

Non-regional members States are France, the Netherlands, the United Kingdom of Great Britain and Northern Ireland, and the United States of America. Non-regional members are not included in data presented in this publication.

Each subregion faces unique development challenges related to poverty, inequality, environmental sustainability and conflict. ESCAP provides a platform for member countries to work together to address these challenges and promote sustainable development in the region.

While the Asia-Pacific region is at the centre of the global stage, it is defined by diversity. The region is home to three of the five largest economies, and three of the five smallest economies, and its countries span from some of the world's wealthiest to among the poorest.[2] There is also widespread diversity in terms of energy needs, natural resources, infrastructure and challenges for delivery of the sustainable energy transition. Areas of South Asia are endowed with some of the best hydro power resources in the world and parts of East- and North-East Asia contain wind and solar resources that are sufficient to power great swathes of the region, while much of South-East Asia and the Pacific offers an excellent solar resource, among other renewable energy endowments, that awaits the required investment in order to supply the growing economies of the subregion.

In **East and North-East Asia**, China predominates as the world's second largest economy and the most populous country. It is the world's largest consumer of coal but is making efforts to reduce its dependence on fossil fuels and increase the use of renewables, such as wind and solar. in line with a policy for zero emissions by 2060. Japan, the world's third largest economy, has set a target of carbon neutrality by 2050, and is transitioning away from nuclear power following the Fukushima disaster by making substantial ongoing investments in renewables and energy efficiency. The Republic of Korea is expanding its renewable energy capacity with a goal of reaching 20 per cent renewables by 2030. The fourteenth five-year plan of China set a target of reducing energy intensity by 13.5 per cent between 2021 and 2025, while Japan has set an ambitious policy of 40 per cent improvement in energy intensity from 2013 to 2030, starting from an already low base. China, Japan and the Republic of Korea have also established major markets for electric vehicles (EVs) supported by ambitious growth targets.

In **North and Central Asia**, the Russian Federation and Kazakhstan are major oil and gas producers and have been relatively slow to transition to renewables, while Uzbekistan has set a target to generate 25 per cent of its electricity from renewables by 2030 and decrease its energy intensity by 10 per cent from 2010 to 2030. Kazakhstan and Turkmenistan have implemented mandatory energy auditing schemes

[2] According to data from the World Bank World Development Indicators Database, World Bank,, updated 2 March 2023 (https://data.worldbank.org/indicator/NY.GDP.MKTP.CD).

Box 1 Sustainable Development Goal 7 road maps

The Economic and Social Commission for Asia and Pacific has been supporting many countries in the region in their efforts to meet the ambitious SDG 7 targets through an integrated energy planning approach. In 2018, ESCAP released a publication titled Energy Transition Pathways for the 2030 Agenda in Asia and the Pacific in which it was highlighted that under the current policy settings in place at the time, the region would not achieve all the SDG 7 targets by 2030.

The achievement of the SDG 7 targets requires an integrated system approach by considering the synergies among its constituent elements – universal access to affordable, reliable and modern energy services, improving energy efficiency, substantially increasing the share of renewable energy and international financial flows to developing countries in support of clean energy. Constraints, such as resources availability and the emission reduction targets under NDCs, need to be considered. In the report, it is suggested that national SDG 7 implementation road maps that provide guidance for policymakers on the policy and technology options to achieve SDG 7 and NDC targets could play a transformational role in the region.

With the agreement and support of its member States, ESCAP has developed the National Expert SDG Tool for Energy Planning (NEXSTEP) framework to support the development of national SDG 7 road maps. This framework enables policymakers to make informed policy decisions in supporting the achievement of the SDG 7 and emission reduction targets. Following requests for support from member States to implement NEXSTEP, ESCAP has partnered with 16 countries in the region to produce national SDG 7 road maps. The NEXSTEP work has been expanded to the subnational level through partnerships with six cities and three provinces across the Asia-Pacific region to create sustainable energy transition plans. These plans articulate energy strategies for these cities and provinces to leverage their fiscal and policy influence in order to contribute to effort aimed at meeting the national level SDG 7 targets.

While the countries that have developed SDG 7 road maps are diverse, there are some common findings emerging across the different analyses. Clean cooking solutions using electric cooking are an increasingly viable option. Refocusing efforts on energy efficiency through measures, such as minimum performance standards for appliances, are essential to put energy efficiency gains back on track. In the power sector, phasing down the use of coal in favour of renewables and energy efficiency has emerged as a recommendation for countries that have significant levels of coal-fired power generation in their energy mix. More information, including completed road map national and subnational reports, is available at https://www.unescap.org/projects/nexstep

with the goal of improving the energy efficiency of large businesses, while the energy strategy of the Russian Federation for the period up to 2035 targets a 56 per cent reduction in energy intensity by 2030 from a 2005 baseline.

In **South and South-West Asia**, the energy transition is being led by larger countries. India is investing heavily in renewable energy, particularly solar, and has set a target of achieving 450 GW of renewable energy capacity by 2030, while Pakistan is expanding its renewable energy capacity with a goal of achieving 30 per cent renewables capacity by 2030. India has set a target of 30 per cent electric vehicle penetration by 2030 through subsidies, tax breaks and support for charging infrastructure. Afghanistan, Bangladesh and Nepal are prioritizing off-grid solutions to increase energy access in rural areas, while enormous opportunities are being made available to some of the smaller countries through the export of renewable electricity through interconnected power grids.

In **South-East Asia,** Indonesia and Viet Nam are among the world's largest coal producers, but they are also investing in wind, solar and hydro power infrastructure. The Association of Southeast Asian Nations (ASEAN) has set a collective renewable energy target for its 10 members of 23 per cent by 2025. Thailand has set a target of achieving 35 per cent renewables by 2037, and Singapore is investing in natural gas and exploring the potential of hydrogen as an alternative fuel source. Governments across the subregion have made progress in energy efficiency through interventions, including, among them, green building codes, mandatory energy labelling and mandatory energy management systems for large businesses.

The context in the small island economies of the **Pacific** is dominated by a heavy reliance on imported fossil fuels for electricity generation and transport. However, with its relatively high proportion of demand coming from buildings (the subregion contains relatively low levels of heavy industry), the potential for the rapid uptake of renewable power and the improvement of energy efficiency is vast. Sustainable transport poses greater challenges in the subregion, but Fiji and Samoa have set ambitious goals for electric vehicle deployment this decade. The Cook Islands, Fiji and Samoa have set a 100 per cent renewable energy targets for electricity generation in their nationally determined contributions (NDCs). Meanwhile, as the largest country of the subregion, Australia is a major coal producer, consumer and exporter, but the country is also investing in renewables and has set a target of reaching net-zero emissions by 2050.

Synergies between Sustainable Development Goal 7 and the rest of the Sustainable Development Agenda

In this section, progress toward achieving SDG 7 is compared with the progress in realizing other SDGs and the relationship between progress on the energy transition and attainment of the rest of the sustainable development agenda is discussed.

Energy has long been recognized as a key enabler of sustainable development, playing a vital role in economic growth, social development and environmental sustainability. Much of the related existing work has focused on the many interlinkages among SDGs, including efforts of the SDG 7 Technical Advisory Group convened by United Nations Department of Economic and Social Affairs with contributions to the High Level Dialogues on Energy in 2018 and 2022 (United Nations Department of Economic and Social Affairs, 2018). In this connection, it can be noted that the delivery of SDG 7 clearly supports the overall achievement of the 2030 Agenda and implementation of the Paris Agreement, contributing to the other SDGs in the following ways:

Table 1 Relationships between Sustainable Development Goal 7 and the other Sustainable Development Goals

	**Poverty eradication and economic development**: Access to affordable and reliable energy is essential for eradicating poverty and promoting economic development. SDG 7 aims to ensure that everyone has access to affordable and clean energy, which can improve food security by increasing access to energy for cooking, heating, and refrigeration while enhancing productivity by stimulating economic growth in a way which creates job opportunities (particularly in rural areas).
	**Health and well-being**: Reliable and sustainable energy access is crucial for providing access to clean water, sanitation, and health-care services, all of which are essential for promoting health and well-being. Improving access to clean energy – especially access to clean cooking fuels and technologies –also helps to reduce indoor air pollution, which is a major cause of respiratory diseases, particularly among women and children.
	**Education**: Access to electricity – and, importantly, the utility it provides through electrical appliances and digital technologies – is vital for promoting education and learning opportunities, particularly in rural areas. With reliable energy access, schools and other educational institutions can provide lighting and power for devices, such as computers, which can improve the quality of education and enhance learning outcomes.
	**Gender equality**: Women and girls are disproportionately affected by the lack of access to energy, particularly in rural areas. SDG 7 aims to ensure that everyone has equal access to energy services, which can improve gender equality by reducing the time and effort required for household chores, such as cooking and collecting firewood.

Access to affordable and reliable energy is a fundamental contributor to **economic growth and job creation**. The transition to clean and sustainable energy sources can promote the growth of green industries and reduce environmental pollution, improving the sustainability of these benefits and potentially leading to the development of new technologies and innovations, which, in turn, can create further employment opportunities.

Renewable energy and energy efficiency can reduce the overall costs of energy, particularly for small and medium-sized enterprises, which can increase their competitiveness and promote economic growth.

Industry, innovation, and infrastructure: Achieving SDG 7 targets can also support the achievement of SDG 9, which focuses on building resilient infrastructure, promoting sustainable industrialization and fostering innovation. The use of renewable energy sources and energy efficiency measures can support the development of sustainable infrastructure and industries.

Climate action: Energy production and consumption are major contributors to greenhouse gas emissions, which are driving anthropogenic climate change. SDG 7 aims to promote the use of renewable energy sources and increase energy efficiency, which can help to reduce greenhouse gas emissions and mitigate the impacts of climate change. This is in line with the goals of the Paris Agreement, which seeks to limit global warming to well below 2°C above pre-industrial levels, while pursuing efforts to limit the temperature increase to 1.5°C.

Life on land: Sustainable energy directly benefits the health and well-being of ecosystems and their ability to sustain life. This is not just through the mitigation of climate change, which is a major threat to terrestrial ecosystems and biodiversity, but through the conservation and restoration of ecosystems through sustainable land use practices. This can help sequester carbon, mitigate the effects of climate change and support the development of sustainable energy systems.

Vulnerable groups, including women, children, persons with disabilities, rural communities and low-income households, may face barriers to accessing energy services. In many cases, these groups are disproportionately affected by energy poverty and may face additional challenges related to health, education, and economic opportunities as a result. The energy transition pathways adopted by member States must embody the concept of the "just energy transition" by considering socioeconomic priorities and mitigating the impacts of shifts in energy production and consumption on vulnerable groups and specific geographical regions that are adversely affected.

Sustainable Development Goal 7 explicitly accounts for the needs and challenges of vulnerable groups through its targets of universal access to electricity (SDG 7.1.1) and universal access to clean cooking fuels and technologies (SDG 7.1.2), but more nuanced needs arise within the attempts to achieve the desired outcomes. For example, efforts to increase access to energy in rural areas must consider the unique needs of those communities and may require decentralized and off-grid solutions; efforts to increase access to clean cooking technologies must consider the needs of women and children, who are often responsible for household cooking and may be disproportionately affected by indoor air pollution.

Accordingly, the inclusive and equitable delivery of outcomes from SDG 7 is not assured only by providing universal access to electricity and clean cooking. Success also hinges on ensuring that vulnerable parts of the community are able to afford and use the services that are enabled by energy access. Consequently, overall progress on the energy transition must prioritize the fair distribution of benefits across the whole spectrum of age, wealth, geography and gender. This challenge is spread across multiple dimensions:

- Ensuring that all individuals and communities have access to sustainable energy services can improve their quality of life and health, and well-being. Access to energy services, such as electric lighting, efficient heating and cooling, and clean cooking technologies, can improve indoor air quality, increase thermal

comfort, reduce the risk of respiratory diseases, and enhance educational and economic opportunities. Efforts to increase access to energy services must focus on reaching marginalized communities, including low-income households, rural and remote communities, and women and girls, who often face the greatest barriers to accessing energy services. This could involve targeted policies and programmes that support energy access for those communities, such as subsidies or financing programmes that make energy more affordable and accessible.

- Collaboration involving governments, private sector entities and civil society organizations can help drive progress towards achieving SDG 7 by pooling resources, expertise, and innovation to create more inclusive and sustainable energy systems. Partnerships can also help ensure that the needs of marginalized communities are prioritized in the development of energy infrastructure and services.

- Decentralized energy solutions, such as off-grid renewable energy systems, can provide reliable and affordable energy services to communities that are not connected to the grid. These solutions can be particularly effective in rural areas where it is not economically viable to extend the grid. Investments in decentralized energy solutions should prioritize communities that are currently underserved by energy services.

- Data collection and the monitoring of progress on energy access is important in ensuring that efforts are targeted effectively, and that progress is being made towards achieving SDG 7. Data should be disaggregated by gender, income level and other relevant factors to ensure that progress is inclusive and equitable.

- Communities can be empowered to participate in the development and implementation of energy policies and programmes, and to take ownership of energy solutions. This should involve governments engaging with vulnerable and marginalized sectors of the community, which are often overlooked, the delivery of training programmes that provide the skills and knowledge required to operate and maintain energy systems, or the implementation of community-led initiatives to promote energy conservation and efficiency.

Further evidence from academic literature suggests that there are strong correlations between progress towards achieving SDG 7 and indicators across the range of goals listed in table 1. A recent systematic review used the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (Moher and other, 2009) method to examine trends in the policy and academic discussions on the linkages between energy, SDGs and the Paris Agreement, and found that most of the studies on the subject recommend further integration and cross-sectoral energy planning and targeted policy approaches (Akrofi, Okitasari and Kandpal, 2022).

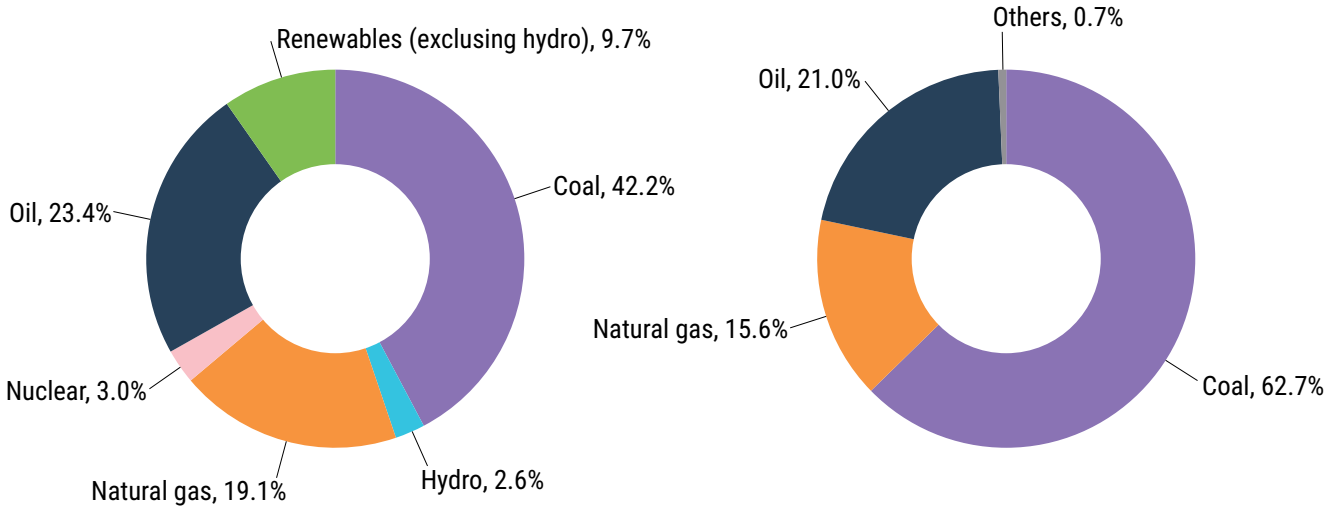
Progress in emissions and climate ambition

To keep the world well below a 2°C temperature rise and within the 1.5°C rise in accordance with the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement, the International Panel on Climate Change (IPCC) has called for a reduction of 45 per cent in global greenhouse gas emissions by 2030 compared to 2010 levels. The region's contribution to such a greenhouse gas emissions reduction is critical to achieving carbon neutrality by the period 2050–2060 and maintaining a global 1.5°C development pathway (ESCAP, 2023a). With the energy sector accounting for approximately 80 per cent of the region's greenhouse gas emissions, the achievement of SDG 7 targets in Asia and the Pacific represents a critical lever for putting the world on track to avoid destructive climate change.

Apart from a modest reduction following the onset of the COVID-19 pandemic in 2020, emissions from fuel combustion in Asia and the Pacific have outpaced those of the rest of the world, growing almost continuously over the past three decades (albeit at a reduced rate in recent years). Meanwhile, global energy emissions have also increased, but at a slightly lower rate such that the Asia-Pacific region accounted for 58.7 per cent of the world's greenhouse emissions from energy in 2020 compared with 50.1 per cent in 2010 (IEA, 2021). This growing share of global emissions largely stems from the region's heavy reliance on coal, which now accounts for more than 62 per cent of emissions from energy in the region, despite only delivering approximately 42 per cent of its energy needs.

Although coal accounts for 42 per cent of primary energy supply in Asia and the Pacific, it accounts for more than 62 per cent of CO_2 emissions from fuel combustion

Figure 4/ (a) Asia-Pacific primary energy supply by product, 2020; and (b) Carbon dioxide from fuel combustion, 2020



Source: IEA, World Energy and Statistics Balances (https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances).

The growth in the region's emissions relates to a surge in energy demand, which is the result of economic growth. However, emissions are increasing at a slower rate than energy use, reflecting the trend towards cleaner sources of energy and the reduction of energy intensity. The combination of cleaner energy sources and enhanced efficiency in energy demand has resulted in a decrease in emissions intensity from 730 tons CO_2-e per million 2015 USD in 2000 to 591 tons CO_2-e per million 2015 USD in 2020.

Such improvements have in part been driven by commitments and policies for sustainable energy development and by NDCs under the Paris Agreement. The United Nations Development Programme (UNDP) report, *State of Climate Ambition*, evaluates NDCs to garner insights into whether the Paris Agreement is working to deliver on climate change targets, to recognize and appreciate those doing the work, and to understand which countries are leading the way on ambition and which are falling behind (Baumgartner, Carman and Liu, 2022).

The analysis shows that the majority (76 per cent) of Asia-Pacific countries have raised their mitigation ambitions under their recent enhanced NDC submissions. The number of member States in the region making carbon neutrality pledges reached 39 by August 2022. However, under existing climate policies, regional greenhouse gas emissions are projected to rise from 27 gigatons of carbon dioxide (CO_2) equivalent in 2020 to 35 gigatons in 2030 and 52 gigatons in 2060, which is nearly double the level from 2020 (ESCAP and others, 2022).

Some countries have pledged to achieve net-zero emissions,[3] setting national net-zero target dates around mid-century for the achievement of this goal as presented in the ClimateWatch Net Zero Tracker (ClimateWatch, 2023). At the time of publication, three ESCAP member States (Australia Japan and the Republic of Korea) had signed the net-zero targets into law, 16 had net-zero targets as official national policy, and four had issued political pledges of commitment.

The foundational work for delivering on these commitments is progressing, but at a far from unsatisfactory pace: financing appears to be insufficient, key data and statistics on progress indicators are fragmented, and significant further

[3] The difference between "carbon neutrality" and "net zero" is subtle but important: Carbon neutrality refers to achieving a balance between the amount of CO_2 emitted and the amount removed from the atmosphere. This can be achieved through measures, such as carbon offsets, which involve investing in projects that reduce or remove greenhouse gas emissions to compensate for the emissions generated elsewhere. Net zero, on the other hand, refers to achieving a balance between the amount of greenhouse gas emissions produced and the amount removed from the atmosphere locally, and can be achieved through a combination of reducing emissions and removing greenhouse gases from the atmosphere, such as through carbon capture and storage technologies or reforestation.

Under current NDCs and net-zero pledges, regional greenhouse gas emissions are set to decline this decade, but the trajectory remains far from the 45 per cent reduction required to avoid the worst effects of climate change.

Figure 5/ Greenhouse gas emissions scenario with compounded nationally determined contributions and carbon neutral pledges for the Asia-Pacific region, ($GtCO_{2e}$), 1990–2030

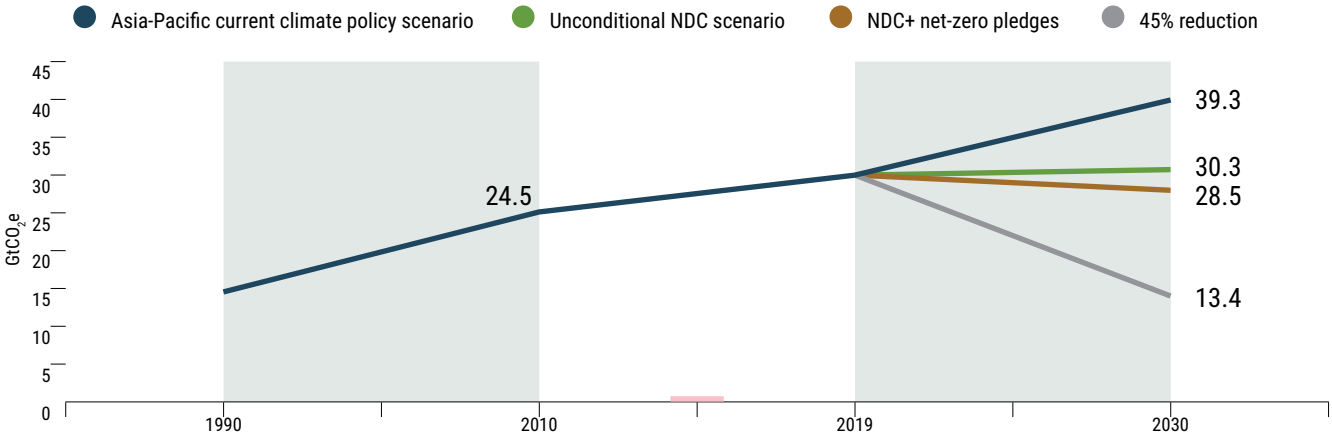


Image source: ESCAP (2023).
Data source: IPPC (2023).

technical cooperation and coordination is required among national government agencies.

Under current NDCs and net-zero pledges, greenhouse gas emissions in Asia and the Pacific are set to fall gradually over this decade to approximately 28.5 Gt CO_2-e by 2030 from 31.6 Gt CO_2-e in 2020. This, however, represents a 16 per cent increase from 2010 levels, which is far from the global average of the 45 per cent reduction needed by 2030 to limit warming to 1.5°C. Fulfillment of conditional finance commitments under NDCs and a more widespread roll-out of net-zero targets could help shift this emissions pathway downwards. Despite this, a large share of emissions reductions can be achieved using existing technologies.

Energy pathways to support the achievement of ambitious emissions reduction goals depend on a massive scale up of renewable energy and energy efficiency, along with widespread electrification and the roll-out of low-carbon fuels, enabled by supportive policy design and implementation. Sector-specific dynamics are discussed more in chapter 2. Various trade-offs will determine the socioeconomic impacts, but one core consideration is the importance of delivering a just transition to ensure that the full scope of benefits is shared equitably. Regional cooperation plays a key part in this, supporting planning and implementation as an avenue for the sharing of experience and development of capacity, enabling technology transfer and providing financiers with pathways to investment in areas where it is most in need.

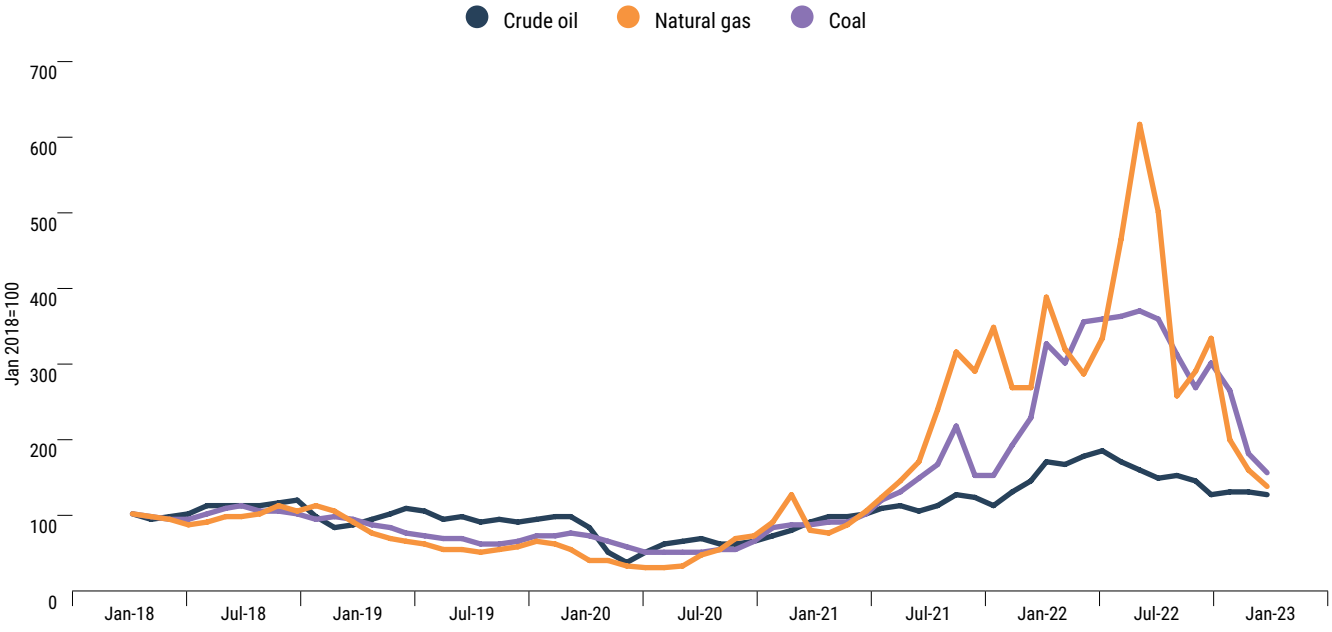
Renewed energy security concerns amid a volatile economic and energy market backdrop

Progress in achieving sustainability goals should also take into account recent global crises, which have led to considerable volatility in economic performance and energy markets.

While the economic impacts from the COVID-19 pandemic depressed energy prices caused by lower demand, the subsequent economic rebound tightened energy markets throughout 2021, resulting from supply chain constraints, weather-related events and persistent underinvestment. The start of the war in Ukraine in early 2022, and energy impacts arising from efforts by mostly European countries to rapidly

Recent global energy crisis led to surging prices for natural gas, coal and oil, prompting economies around the world to refocus efforts on energy security and affordability

Figure 6/ Indexed price trend for global energy commodities



Source: IMF (2023b)
Notes: Crude oil is the simple average of three spot prices: Dated Brent, West Texas Intermediate, and the Dubai Fateh; Natural gas includes European, Japanese and American natural gas price indices; Coal includes Australian and South African coal.

reduce exposure to energy supply from the Russian Federation, exacerbated an already tight global energy market situation and prompted dramatic shifts in prices and trade patterns.

Compared with pre-pandemic levels, global average prices for natural gas jumped by up to sixfold during the summer of 2022, while those for coal rose by nearly fourfold and crude oil prices nearly doubled. While existing fuel supply contracts and oil indexation – in the case of some liquified natural gas (LNG) contracts – provided some relief for end-users, this dramatic increase put upward pressure on fuel consuming sectors, resulting in higher electricity prices and fuelling economy-wide price inflation. Prices of CRMs key for clean energy technologies also rose.

While energy commodity prices have come down from their highs in mid-2022, the pandemic and subsequent global energy crisis have raised new risks to clean energy transitions in the Asia-Pacific region. They have also created new pressures on affordability and access, particularly among the most vulnerable. The effects of these crises and uncertainties over how future markets will evolve are prompting Asia-Pacific countries to refocus their efforts on energy security.

Some Asia-Pacific countries have responded to these challenges by implementing wide-ranging measures to improve energy efficiency and accelerate the shift towards domestic renewable energy development. Others with ready availability of domestic fossil-fuel supply have invested further in the development of these energy resources, while trying to buffer populations from energy price rises. These market dynamics, the implications for meeting SDG 7 targets and the responses taken by Asia-Pacific countries are touched upon throughout the publication, with more extensive analysis found in chapter 4.

CHAPTER 2.

The Asia-Pacific Region's **Sustainable Energy Progress and Outlook at the Halfway Point** of the 2030 Agenda for Sustainable Development

Progress towards realizing Sustainable Development Goal 7

The Asia-Pacific region has made great strides towards realizing SDG 7, including success in expanding access to electricity.[4] Despite this, countries are falling short on delivering many aspects of the goal: The remaining gap in universal access to electricity by 2030 needs to be closed and e aspects related to energy service quality, reliability and affordability must be addressed. A greater push is needed to promote clean cooking fuels and technologies; accelerate the deployment of renewable energy and increase its share in the national energy mix; and scale up energy efficiency and electrification in end uses.

More than 98 per cent of the regional population had access to electricity in 2021, up from 87.2 per cent in 2010. That progress, at a rate more rapid than the global average (see figure 7(a)), can largely be attributed to expansions and upgrades of national power grids and the roll-out of decentralized solutions in remote areas. During the same period, the proportion of people with access to clean cooking fuels and technologies increased from only 50 per cent to more than 70 per cent – a substantial improvement, but still far from the rate needed to deliver universal access by 2030. In 2021, a total of 53 million people still lacked access to electricity and nearly 1.2 billion lacked access to clean cooking across the region. The vast majority of them were in rural areas and in lower-income countries.

Fiscal difficulties arising over the past two years present financial and political challenges and test the resolve of policymakers to close the gap over the remainder of the decade.

Renewable electricity generation, in particular, hydropower, wind, solar photovoltaics (PVs) and biomass, has increased rapidly across the Asia-Pacific region in recent years. The overall share of modern renewables, which excludes the use of traditional biomass, in total final energy consumption rose from 6 per cent in 2010 to 10.4 per cent in 2020. The share of all forms of renewable, including traditional biomass, in the region's energy mix remained relatively static at approximately 15 per cent over the same period; it fell below the global average in 2009 and has remained below it. Despite rapid growth in modern forms of renewable energy, this stable overall share stemmed from a decline in the use of traditional biomass and a large increase in the demand for energy.

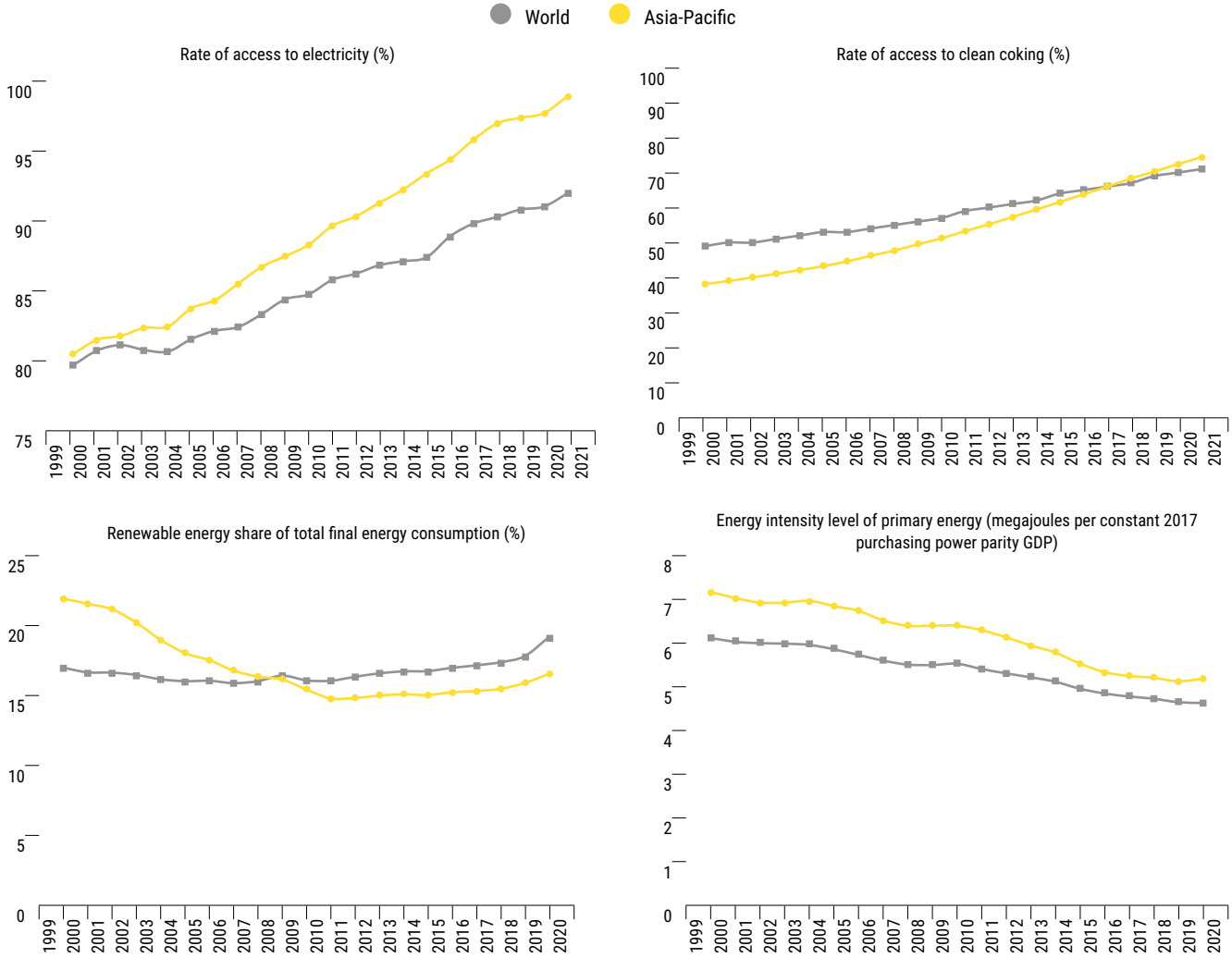
As the economic situation in some countries has improved dramatically over the past two decades, the deployment of renewable electricity has surged. China, India and Viet Nam are prime examples of this, as they boosted their renewable electricity generation by a factor of 7.3, 4.2 and 5.8, respectively. Nevertheless, and despite ambitious targets, many low-income countries have struggled to deploy renewable energy capacity, in part due to developer and financier perceptions of investment risks, low technical capacity and lack of favourable policy implementation, including with regard to remuneration schemes and grid connectivity.

Meanwhile, progress towards increasing the share of renewables in heating and transport remains insufficient and requires policy attention. Momentum in the indirect uptake of renewables is seen through the electrification of end uses, notably transport. Several countries, including, among them, China, India, Indonesia and Malaysia, are promoting the use

[4] Data on the progress of Asia-Pacific countries towards SDG 7 targets presented in this chapter is taken from ESCAP's online database the Asia-Pacific Energy Portal (www.asiapacificenergy.org), unless stated otherwise.

Over the past two decades the Asia-Pacific region has outpaced the rest of the world in terms of improvements against three of the four Sustainable Development Goal 7 indicators

Figure 7/ Sustainable Development Goal 7 indicators (a) 7.1.1 rate of access to electricity; (b) rate of access to clean cooking; (c) renewable energy share of total final energy consumption; and (d) energy intensity of primary energy – progress in the Asia-Pacific compared to global progress



Sources: (a) World Bank, United Nations Statistics Division; (b) WHO, United Nations Statistics Division; (c)) IEA, United Nations Statistics Division; (d) IEA, United Nations Statistics Division

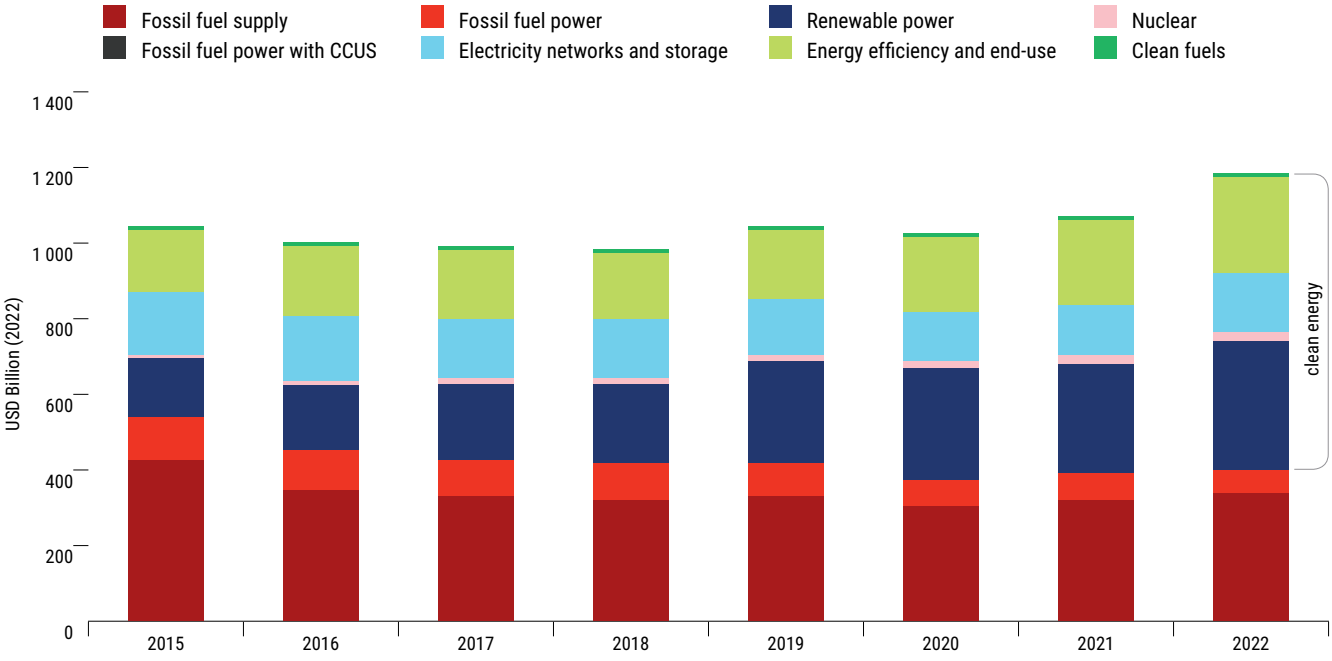
of EVs. These efforts include the roll-out of charging infrastructure and the manufacture of EVs, including two- and three-wheelers.

Regarding energy efficiency, while the rate of primary energy intensity improvement has been slightly higher in the Asia-Pacific region compared to the global average over the past ten years, both rates have mostly stagnated over the past five years. At the same time, the energy intensity of the Asia-Pacific region is higher than in other regions, indicating that more energy is used to produce one unit of GDP. The region has improved at a rate that is not in line with the global pace required to achieve the SDG 7 target, indicating the need for the uptake of energy efficiency across sectors.

Achieving SDG 7 targets hinges on scaling up investments and dramatically shifting capital allocations towards clean energy (in power, fuels and end-use) and energy efficiency, and away from fossil fuels. Asia-Pacific economies have boosted investments in the energy sector in recent years, despite a downtick in 2020, to close to $1.2 trillion in 2022. This increase was led by investments in renewable power for which capital spending has more than doubled since 2015, and in the end-use sector, including in efficiency and EVs. Investment in clean energy comprises approximately two thirds of total energy investment, up from less than 50 per cent in 2015. The region accounted for 45 per cent of global energy investment and nearly 50 per cent of world clean energy investment.

While clean energy comprised two thirds of regional energy investment in 2022, to realize SDG 7, this share must comprise 90 per cent by 2030 and be more evenly distributed across economies

Figure 8/ Energy investment by technology in Asia-Pacific countries



Source: ESCAP calculations based on IEA (2023c).
Notes: Energy investment in Asia-Pacific countries is estimated based on IEA region groups for "Asia-Pacific" and "Eurasia", which are not fully aligned with the ESCAP Asia and Pacific region groupings; as such, this analysis should be treated as indicative; CCUS, carbon capture utilization and storage.

Despite this supportive trend, underlying dynamics remain insufficient for meeting region-wide sustainability goals. Notably, investment in enabling electricity networks – crucial for the integration of variable renewables and supporting reliable access to electricity – have declined over the past decade. Much of the progress in clean energy investments has also been concentrated in relatively few markets. For example, in China, clean energy accounts for more than 70 per cent of energy investments, while in the rest of the region it comprises less than 60 per cent on average.

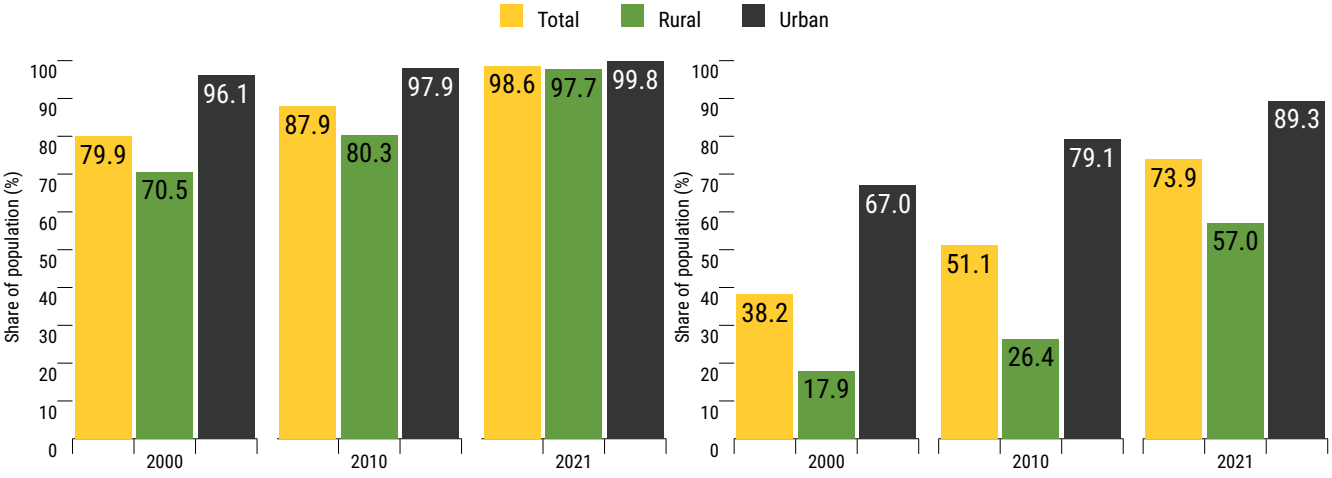
Baseline projection estimates for Asia and the Pacific – from IEA and the International Renewable Energy Agency (IRENA) scenarios based on current and planned policies – point to an increase in regional annual energy investment to approximately $1.5-1.6 trillion by 2030.[5] Meeting SDG 7 targets and aligning economies with net-zero emissions objectives requires regional annual energy investment to increase to $2.2–2.4 trillion by 2030 with 90 per cent of this in clean energy, depending on the pathway and ambition level. Compared with 2022 investment levels, capital spending would need to roughly double by 2030 to meet ambitious climate goals. While the bulk of the requirement is for renewable capacity development, electricity networks and efficiency and electrification projects, delivering universal energy access by 2030 would also require annual global investment of $41 billion in electricity access and 44.5 billion in clean cooking (IEA and others, 2021).

[5] These estimates are derived by downscaling global investment projections from IEA (2022) and IRENA (2023), using recent Asia-Pacific shares.

Progress towards universal energy access

While universal access to electricity is on track to be achieved by 2030, progress in access to clean cooking facilities is falling short, especially in rural areas

Figure 9/ Regional progress in energy access: (a) access to electricity; and (b) access to clean cooking fuels and technologies



Source: ESCAP based on World Bank, United States Statistics Division

Source: ESCAP based on WHO

The share of the region's population with access to electricity rose from 87.2 per cent in 2010 to 98.6 per cent in 2021, enabled by power grid extensions and the deployment of decentralized technologies to remote and rural communities (figure 9). In 2021, approximately 53 million people still lacked access to electricity; there is, however, a reasonable expectation that most of them will have basic access by 2030 (IEA, 2020). In contrast, the proportion with access to clean cooking fuels and technologies increased from 51.1 per cent to 73.9 per cent in the same period – a notable improvement, but still nearly 1.2 billion people were reliant on traditional biomass for cooking and cemented in hardship related to fuel collection, gender, health and the environment.

Access to electricity

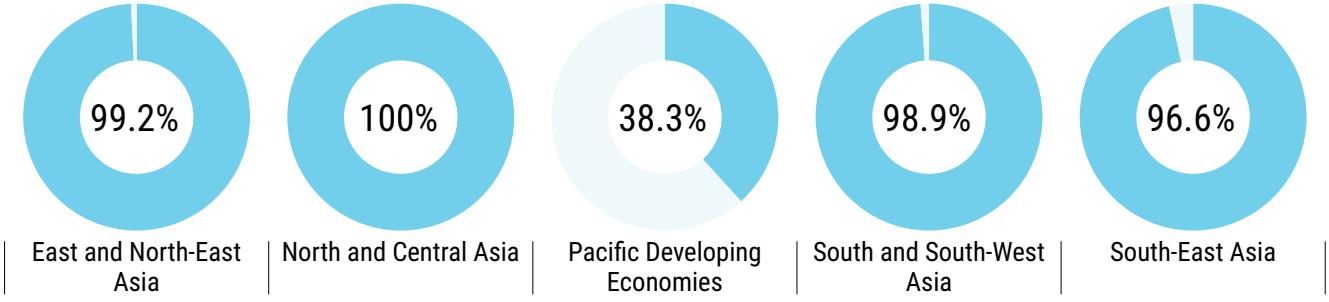
The provision of access to electricity has improved the most strongly in the Asia-Pacific region for which steady growth was recorded growth from 79.9 per cent in 2000 to 98.6 per cent in 2021. The communities still lacking access to electricity are among the poorest and hardest to reach, including remote islands and areas that are logistically or economically difficult to connect to the region's major grids.

At a 90.5 per cent rate of access to electricity, the Pacific is the furthest behind, while for South and South-West Asia, there has been an acceleration the success rate in this regard over the past two decades. Notable achievements have been made in India where 450 million people gained access over the past two decades, while Afghanistan stands out for improving its access rate from 1.6 per cent in 2000 to 97.7 per cent. The access to electricity rate in Bangladesh increased by 25 percentage points between 2015 and 2021 to reach 99 per cent, helped by programmes driven by off-grid solar photovoltaic (PV) systems and the provision of subsidies and loans, which made these systems affordable to more than 80 million people.

Figure 11 (a) shows that largest shares of the estimated 53 million people from across the region who lack access to electricity are in Myanmar and Pakistan, followed by Papua New Guinea, and India. Although the numbers are lower in absolute terms, Papua New Guinea has an access rate of just 20.9 per cent, the region's lowest, which pulls down the regional access rate for Pacific Island developing economies. Notwithstanding this, most of the Pacific island States have reached 100 per cent access to electricity.

Pacific developing economies are struggling to provide access to electricity

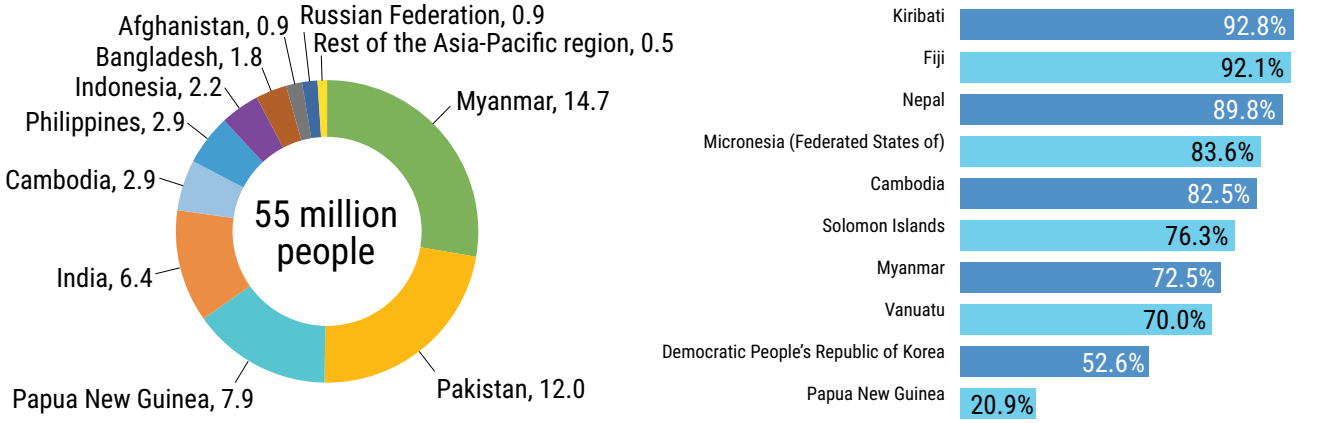
Figure 10/ Share of population with access to electricity, by subregion, 2021[6]



Sources: ESCAP based on World Bank, United Nations Statistics Division

The remaining electrification deficit exists in lower-income and high-population countries

Figure 11/ (a) Population without access to electricity (millions), 2021; and (b) Economies with lowest rates of electrification, 2021



Sources: ESCAP based on World Bank, United Nations Statistics

A raft of technical solutions is available, and experts anticipate the achievement of universal access during this decade. System designers may choose based on local contextual needs from a range of proven mini-grid and off-grid solutions powered by renewable energy. Supply options include off-grid and distributed solar PV, small wind generators, storage using chemical batteries or pumped hydro power, and biomass gasification. Deployment of high-efficiency lighting and appliances can help to deliver essential services while managing demand requirements.[6]

These cost-effective and sustainable solutions can be further supported by novel approaches, such as "pay-as-you-go" finance (including microfinance) under which households can pay as and when they can afford it. Smart metering and the "Internet of things" enables lease-to-own or usage-based models of payment under which consumers carry out transactions using mobile credit and the utility or hardware provider is able to monitor the system remotely (IRENA, 2020). These models can operate at the level of individual households or at the scale of precincts or neighbourhoods, enabling economies of scale along with a variety of technical benefits, such as load smoothing.

6 Further detail including time series are included in annex 1

Table 2 Multi-Tier Framework for Measuring of Electricity Access

Attributes		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Capacity	Power capacity ratings (W or daily Wh)	Less than 3 W	At least 3 W	At least 50 W	At least 200 W	At least 800 W	At least 2 kW
		Less than 12 Wh	At least 12 Wh	At least 50 W	At least 200 Wh	At least 3.4 kWh	At least 8.2 kWh
	Services		Lighting of 1 000 lmhr per day	Electrical lighting, air circulation, television, and phone charging are possible			
Availability	Daily availability	Less than 4 hours	At least 4 hours		At least 8 hours	At least 16 hours	At least 23 hours
	Evening availability	Less than 1 hour	At least 1 hour	At least 2 hours	At least 3 hours	At least 4 hours	
Reliability		More than 14 disruptions per week			At most 14 disruptions per week or at most 3 disruptions per week with total duration of more than 2 hours	> 3 to 14 disruptions/ week or ≤ 3 disruptions/ week with > 2 hours of outage	At most 3 disruptions per week with total duration of less than 2 hours
Quality		Household experiences voltage problems that damage appliances				Voltage problems do not afect the use of desired appliances	
Affordability		Cost of a standard consumption package of 365 kWh per year is more than 5% of household income			Cost of a standard consumption package of 365 kWh per year is less than 5% of household income		
Formality		No bill payments is made for the use of electricity				Bill is paid to the utility, prepaid card seller, or authorized representative	
Health and safety		Serious or fatal accidents due to electricity connection				Absence of past accidents	

Source: Bhatia and Angelou (2015).

Looking beyond the mere provision of an electrical connection, it is important that policymakers recognize that the benefits of electricity access arise through the amenities that it supports. Policy attention must be paid to assuring equitable and high-quality access. Even if a household is considered electrified, the quality and affordability of the energy service may fall short of levels needed to meet social and economic development needs. Experts and other interest groups have proposed the setting of minimum standards to improve the reliability and quality of electricity supplies, including the adoption of a new target for a modern energy minimum (consumption of at least 1,000 kWh per person per year, with at least 300 kWh at home and 700 kWh consumed in the wider economy) and consideration of the Energy Sector Management Assistance Programme (ESMAP) Multi-Tier Framework for Energy Access, which evaluates availability, capacity, reliability and affordability (Energy for Growth Hub, 2021; ESMAP, n.d.).

Consumers who can only afford to use residential electricity for lighting will benefit slightly compared to those who also have access to appliances and modern communications technologies. At the same time, access to high-quality energy services also underpins the provision of critical services in the broader economy, such as health care (WHO and others, 2023). Accordingly, bundling electrification services with other offerings, such as access to finance, the provision of information and

Box 2 Defining "clean cooking"

The World Health Organization (WHO) categorizes cooking fuels and technologies into clean, transitional and polluting according to fine particulate matter (PM2.5) and carbon monoxide (CO) levels, as recommended in the WHO global air quality guidelines[a] and incorporated into International Organization for Standardization (ISO) voluntary performance targets.[b] Fuels and technologies considered to be clean are solar, electric, biogas, natural gas, liquefied petroleum gas (LPG), and alcohol fuels, including ethanol.

A biomass cooking system is classified as clean if it meets the emission rate targets in the *WHO Guidelines for indoor air quality*.[c] Generally speaking, solid fuel-based improved or gasification cookstoves can improve fuel use efficiency and reduce indoor air pollution, but fall within the transitional category. Only one biomass gasifier stove model[d] has attained clean cooking status according to performance standards.

[a] World Health Organization (WHO) (2021). WHO global air quality guidelines. Geneva.
[b] Available at: https://www.iso.org/standard/73935.html.
[c] WHO (2014) WHO guidelines for indoor air quality. Geneva.
[d] The Mimi Moto is a Tier 4 of 5 forced air gasifier stove. A list of stoves and their performance ratings is available at http://catalog.cleancookstoves.org/.

communication technologies, investment in human capital and development of complementary infrastructure can help unleash the full potential of electrification.

One clear opportunity arising with electrification is for the provision of access to electric clean cooking. However, analysis of successful previous clean cooking interventions indicates that many programmes have struggled to achieve sustained use due to user preferences, maintenance issues and lack of repair facilities (see box 2).

Access to clean cooking

Transitioning households to clean cooking methods is critical to achieving universal access targets and improving public health in the Asia-Pacific region. Traditional biomass remains the primary cooking fuel in many Asia-Pacific countries, while coal is still used in North-East Asia, charcoal in South-East Asia and biomass and kerosene in the Pacific (figure 12). Countries with natural gas supplies, particularly in North and Central Asia, have larger shares of populations using gas, while LPG canisters are prevalently used in other areas, particularly in urban areas.

As Asia-Pacific countries work to expand and strengthen their power supplies and distribution, electric cooking is emerging as an increasingly feasible and convenient option. By reducing indoor emissions and associated health risks, electric cooking is gaining increased government support from such countries as Bhutan, Indonesia and Nepal.

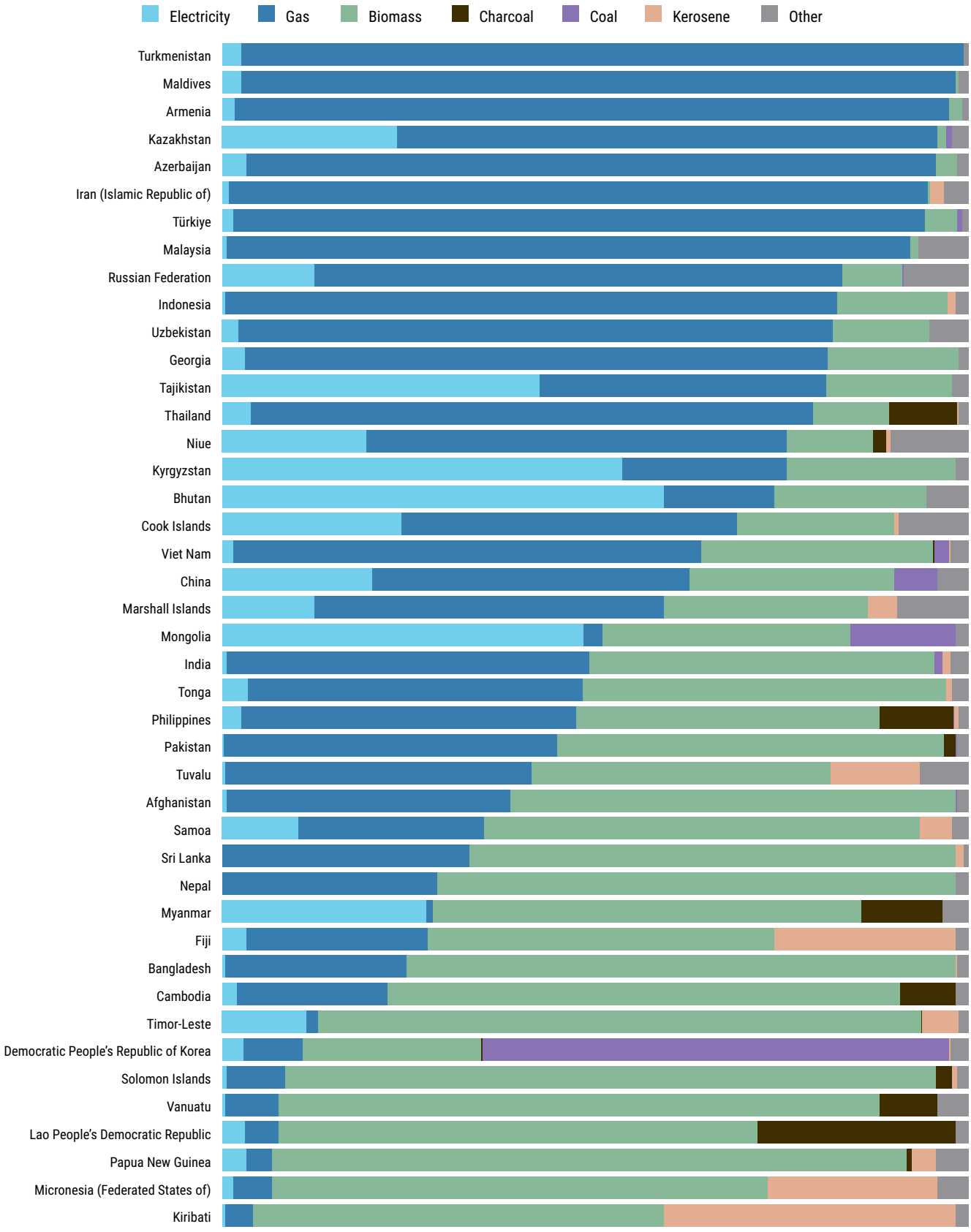
However, challenging consumer behaviours, weak power distribution systems and the low-capacity household electrical systems often found in rural areas can hinder the uptake of electric cooking. Programmes that employ a "one size fits all" approach are often undertaken based on a single promising technology, and do not account for all the cultural and cooking variations between households and communities. Furthermore, users abandon new technologies due to malfunction, inconvenient maintenance requirements and/or lack of long-term repair facilities.

Addressing consumer education alongside the capacity and reliability of grid systems is needed to simultaneously increase energy access tier levels and establish a foundation for a transition to electric cooking. Barriers to adoption can often be overcome through field testing with active feedback loops. Monitoring and evaluation as part of an agile programme design can also support better understanding among policymakers, improving the effectiveness of future efforts.

In rural areas where agricultural and livestock wastes are abundant, biogas is playing a growing role in providing waste-to-energy solutions. Despite its potential, the application of biogas is largely constrained to on-site usage and areas where low-cost waste feedstock is being produced.

Access to LPG, biogas, and electric cooking solutions needs to be expanded across countries

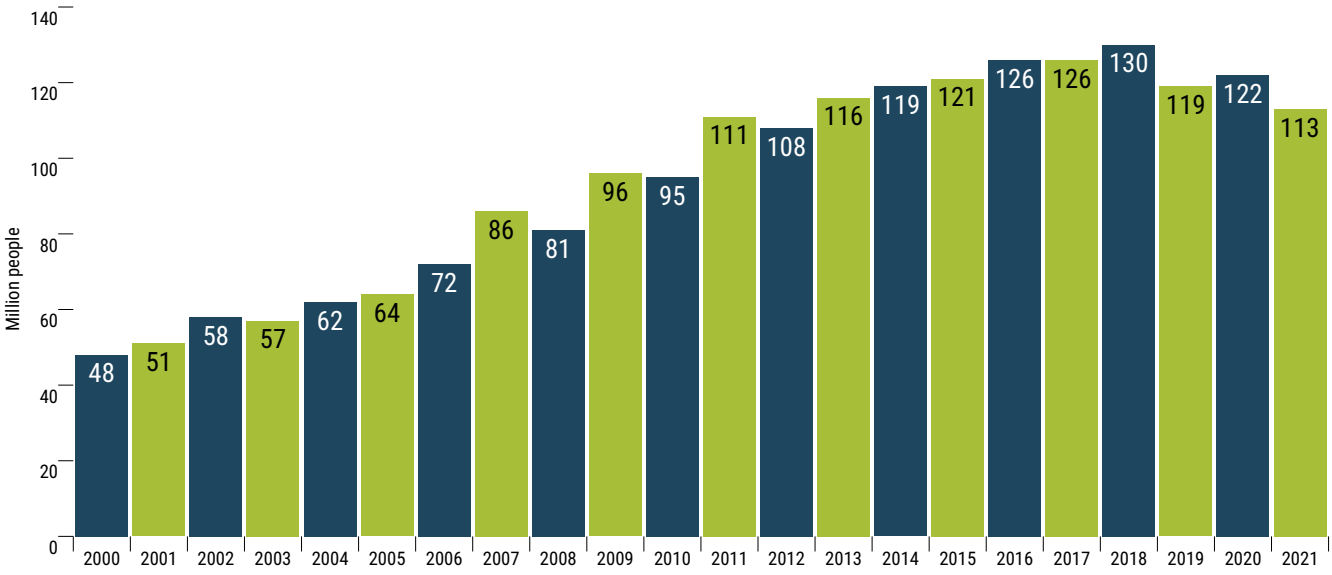
Figure 12/ Cooking fuels, by type, 2019



Source: ESCAP, based on WHO

The annual number of people gaining access to clean cooking has been decelerating recently.

Figure 13/ Annual gains in population with access to clean cooking, 2000-2021



Source: ESCAP calculation based on WHO

While access to clean cooking is increasing in the Asia-Pacific region, recent data reveal a concerning annual decline in the number of people who have gained access to clean cooking solutions, such as LPG, biogas, and electric cooking (figure 13). Despite efforts to accelerate uptake, financial and logistical barriers, exacerbated by the pandemic and increased fuel prices, have impeded progress. In 2018, an estimated 130 million people made the transition, but by 2021, that gain had dropped to 113 million. Without a dramatic increase in efforts, tens of millions of people from the region will remain reliant on polluting and unhealthy cooking methods in 2030.

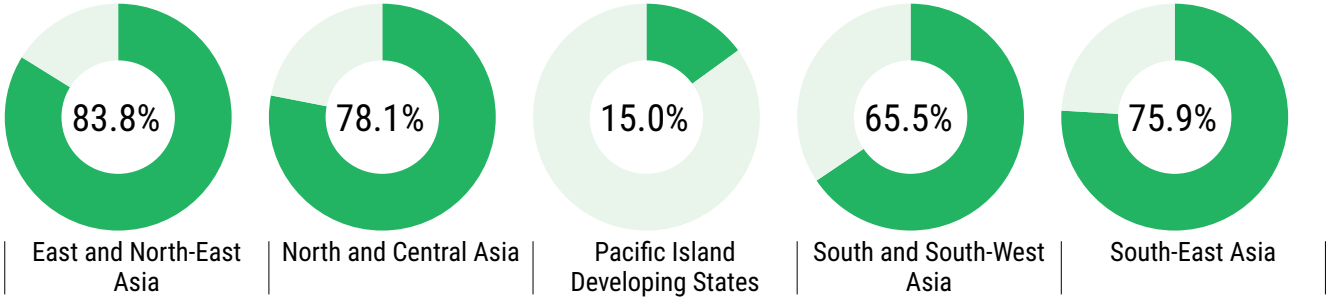
A strong link exists between the access rates to clean cooking and such factors as a country's development level, urbanization rate and geographic features. In general, populations in urbanized and higher-income economies have wider access to clean cooking, while those in more rural, poorer economies experience significant deficits. The access rate in upper-middle-income economies has been improving steadily, reaching 82.9 per cent in 2021. The most significant rate of progress in this regard is occurring in lower-middle-income economies, but they still face a large deficit, with a 66.9 per cent access rate. Low-income economies are dealing with the greatest access gap at 26.5 per cent, and progress has been slow in addressing the challenges faced by small, dispersed populations with low energy demand.

Small island developing States are confronted with some very difficult challenges in their efforts to improve clean cooking access, namely dispersed populations, high energy import prices and constrained power grid capacities, resulting in limited access and slow progress (figure 14).

Despite the critical role of appliance efficiency in operational affordability, lowered emissions, and health benefits, insufficient attention has been directed to the development, promotion and distribution of highly efficient and affordable clean cooking appliances. Government support is needed to establish robust supply chains for clean cooking fuels and technologies, and to encourage public-private partnerships to ensure that clean cooking energy and technologies are accessible in a reliable, affordable, and convenient manner.

Clean cooking access falls short across all subregions, but particularly in Pacific island developing States

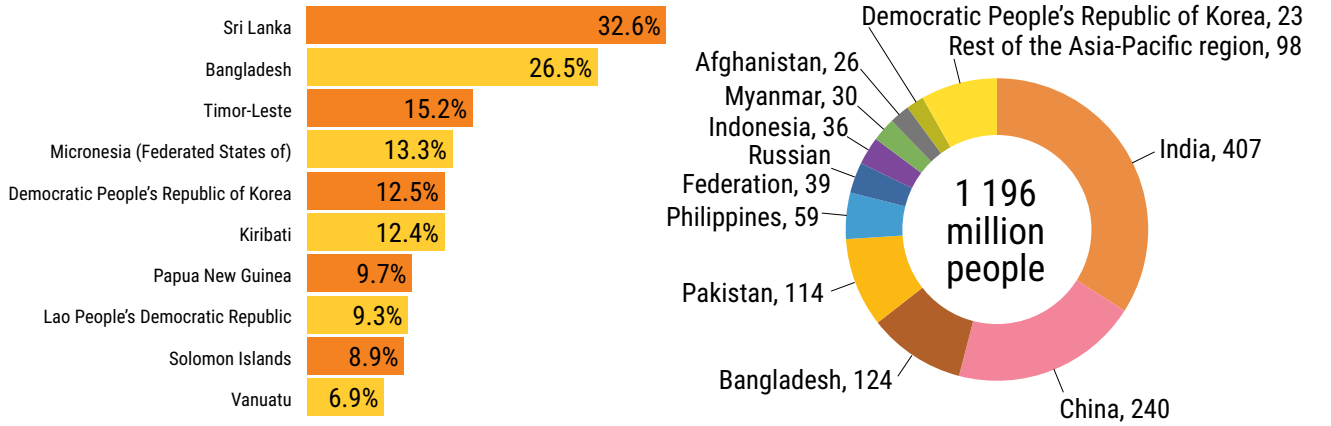
Figure 14/ Percentage of population with primary reliance on clean fuels and technologies, by subregion, 2021



Source: ESCAP based on WHO

The clean cooking deficit remains large in many countries

Figure 15/ (a) Economies with lowest rates of clean cooking reliance, 2021; and (b) Population without primary reliance on clean cooking fuels and technologies, 2021



Source: WHO

Box 3 Gender impacts of Sustainable Development Goal 7

The ongoing transformation of the energy sector has implications for global efforts to address gender inequalities. Below two key intersections of gender and energy are addressed.

First, energy access, or the lack thereof, can exacerbate existing gender inequalities. This is evident in the Asia-Pacific region through lack of access to clean cooking. While lack of access to electricity has gender impacts, particularly by depriving women of economic opportunities, clean cooking stands out because of its health impacts. As of 2020, approximately 28 per cent of the region's population, or approximately 1.3 billion individuals, lacked access to clean cooking fuels and technologies, resulting in consequent effects on health and gender equality. The gender-biased division of labour in the region implies that women bear the brunt of this deficiency, enduring higher exposure to pollution during cooking. Despite the enormity of this problem, the allocation of investment and policy attention devoted to clean cooking is significantly short of what is needed. At the current pace, the target of universal access by 2030 will not be reached.

Second, gender discrepancies in energy sector employment can further perpetuate gender disparities. The sector employs fewer women than men and remunerates them less. According to IEA, in 2018, women made up only 16 per cent of the global energy workforce, compared to 39 per cent of the overall global workforce.[a] Furthermore, salaries in the energy sector were reported to be 16 per cent lower for women than men. These statistics reflect the gender-diversity deficit in the traditionally dominant fossil fuel sector. The renewable energy sector has made strides in improving gender representation, with women comprising 32 per cent of this workforce, according to IRENA. While for certain industries within the sector, such as solar PV, representation is greater, with a 40 per cent female share in the workforce, for others, such as the wind sector, the numbers are similar to those for the oil and gas industry, as only about 20 per cent of the workforce are women.[b] It is important to note, however, that the role of women in the renewable energy sector varies significantly. In science, technology, engineering, and mathematics (STEM) positions, women hold much fewer jobs, whereas they hold a larger share of the administrative positions. Moreover, the representation of women in senior management positions remains relatively low compared to their male counterparts. As a result, women tend to be concentrated in lower-paying jobs, leading to a persistent gender pay gap within the renewable energy sector similar to the broader energy sector. As countries transition to new energy paradigms dominated by clean energy, their efforts to create greater opportunities for women to participate in these industries will be key to addressing this challenge. This is of utmost importance not only at the operational level, but also for management and decision-making roles. Enhancing women's participation can spur innovative and diverse thinking and foster more constructive social engagement in public debates on energy transition.[d]

For these reasons, it is essential to integrate a gender strategy into national energy transition plans. The clean cooking agenda calls for higher policy commitment, especially considering its gender implications, which accentuate the sense of urgency and labour market policies, as well as including women in decision making is key. Progress towards attaining clean cooking can be expedited by attracting innovative climate finance – using novel monitoring and verification methods – and leveraging new technologies, such as electric cooking, which are becoming available due to wider changes in the energy system. For a successful, human-centric energy transition, increased participation of women in the energy workforce is paramount.

[a] International Energy Agency (IEA) (2022). Gender and Data Explorer. Available at https://www.iea.org/data-and-statistics/data-tools/gender-and-energy-data-explorer?Topic=Employment&Indicator=Gender+employment+gap
[b] International Renewable Energy Agency (2022). *Solar PV: A Gender Perspective*. Abu Dhabi.
[c] Pearl-Martinez and Jennie Stephens (2017). Toward a gender diverse workforce in the renewable energy transition. *Sustainability: Science, Practice and Policy*, vol 12, No. 1.
[d] Ibid.

Progress in renewable energy

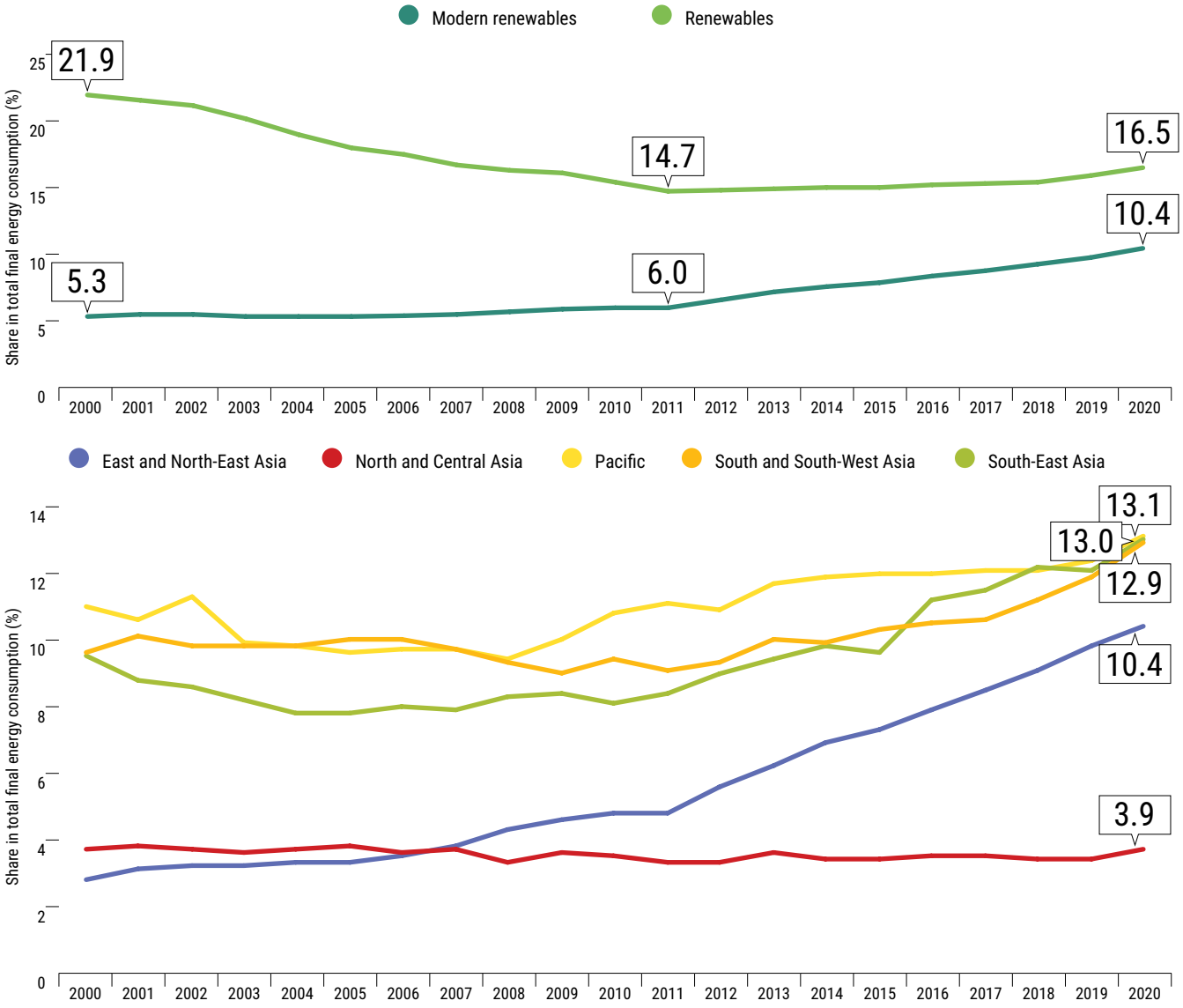
The region is facing major challenges in raising the share of renewable energy as a proportion of total final energy consumption (TFEC) as defined by SDG 7 indicator 7.2.1. Figure 16 shows that the share across Asia and the Pacific declined rapidly in the first decade of the millennium from 21.9 per cent in 2000 to 14.7 per cent in 2011, reflecting a shift away from traditional biomass, before a steady, albeit gradual rise to 16.5 per cent in 2020, which was largely driven by the accelerated uptake of modern renewables. Biofuels, the vast bulk of which is solid biomass, make up the lion's share, at 54.1 per cent (489 million tons of oil equivalent), of renewable supply being drawn from the resource in 2020.[7]

These data, however, obscures the meteoric rise of modern renewables. Record levels of year-on-year growth are being recorded for solar PV, and to a lesser extent wind, while more broadly the share of "modern" renewables (hydro power, wind, solar, liquid biofuels, biogas, geothermal, marine and waste energy) in TFEC climbed from 6.0 per cent in 2010 to 10.4 per cent in 2020.

[7] ESCAP calculation based on data from the IEA Renewables Information Statistics (https://www.oecd-ilibrary.org/energy/data/iea-renewables-information-statistics_renewab-data-en).

Progress in increasing the use of modern renewable energy as a share of TFEC looks promising for most of the region, although it appears to be lagging in North and Central Asia.

Figure 16/ (a) Renewable energy and modern renewables as a share of total final energy consumption in Asia and the Pacific (b) Modern renewable energy share in each of the Economic and Social Commission for Asia and the Pacific subregions



Source: IEA, UNSD, IRENA

Considerable renewable development in the highly populated East and North-East Asian subregion is a major factor behind progress pertaining to renewable energy. The share of modern renewables has more than tripled since 2000 (figure 16(b)). An uptick also occurred across all other subregions, except for North and Central Asia, where the share has remained almost static at under 4 per cent for the past two decades. An uptick in solid biomass use occurred in East and North-East Asia and South and South-West Asia, but again the underlying story is the surge in hydro power, wind, solar PV and (to a lesser extent) geothermal power.

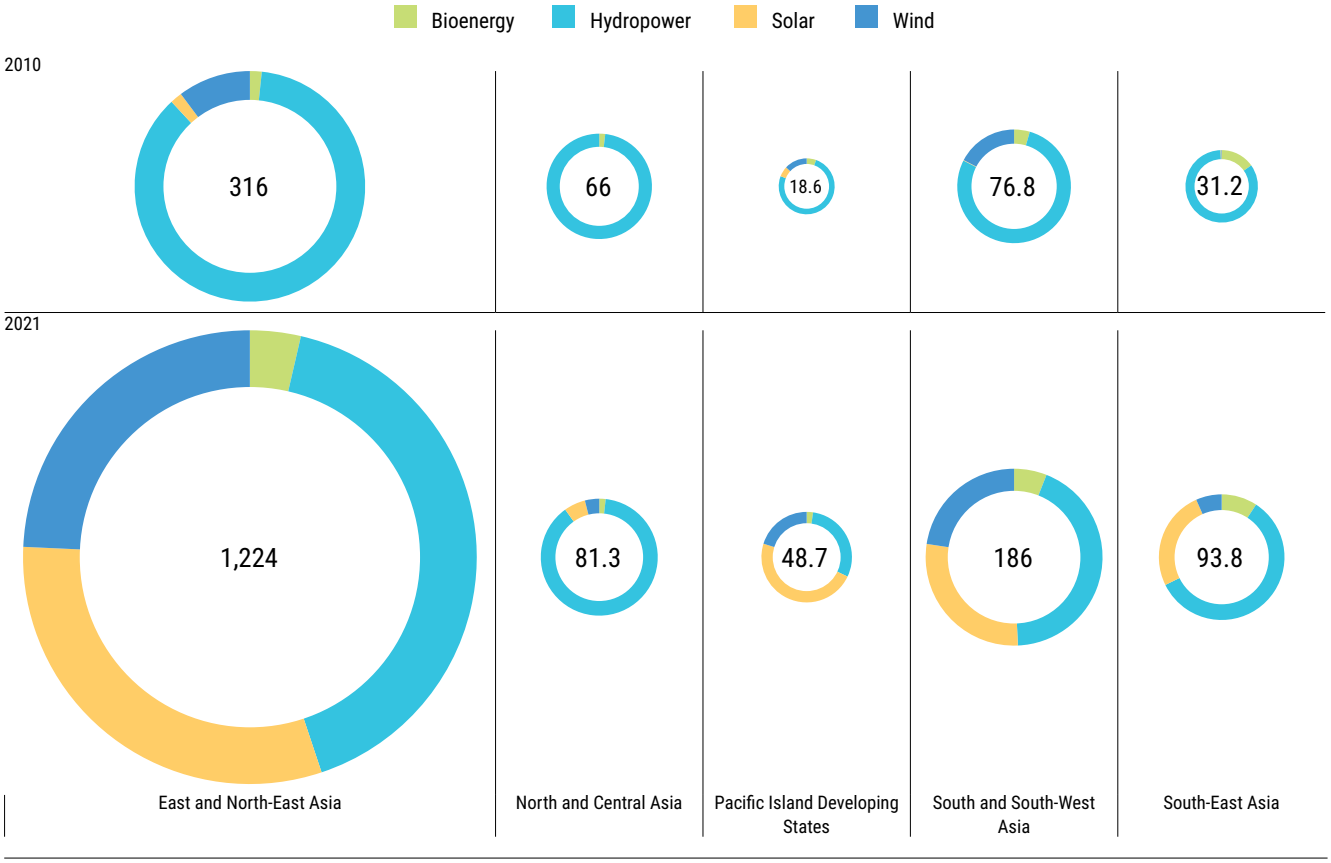
Renewable electricity

In 2010, more than 85 per cent of Asia-Pacific renewable energy capacity was hydro power (figure 17). A notable level of solar PV was only recorded in the Pacific subregion, namely slightly more than 1.1 gigawatts operating, which was mostly in Australia, while East and North-East Asia, the Pacific and South and South-West Asia each recorded significant deployments of wind power.

The current picture tells a story of growth. Between 2010 and 2021, the region's installed wind capacity

Hydro power holds the largest share of capacity in absolute terms, but the rate of growth in wind and solar suggests that these technologies will dominate new development in the coming years

Figure 17/ Renewable energy capacity by resource in 2010 and 2021, in gigawatts



Sources: ESCAP, based on IRENA[4]
Note: Value in Gigawatt (GW)

grew from 48 gigawatts to 397 gigawatts, while solar PV increased from less than 7 gigawatts to more than 500 gigawatts. The total installed renewables capacity more than tripled between 2010 and 2021, from 468 gigawatts to more than 1,568 gigawatts. Most of this growth was in the East and North-East Asian subregion where the renewable power generating capacity grew by almost a factor of four over the period, adding 908 gigawatts.

In terms of technology, solar PV and wind generation were the source of most growth, adding 497 gigawatts and 348 gigawatts, respectively, followed by hydro power (236 gigawatts). Wind and solar PV together currently comprise 55 per cent of renewable energy power generation capacity across the region.

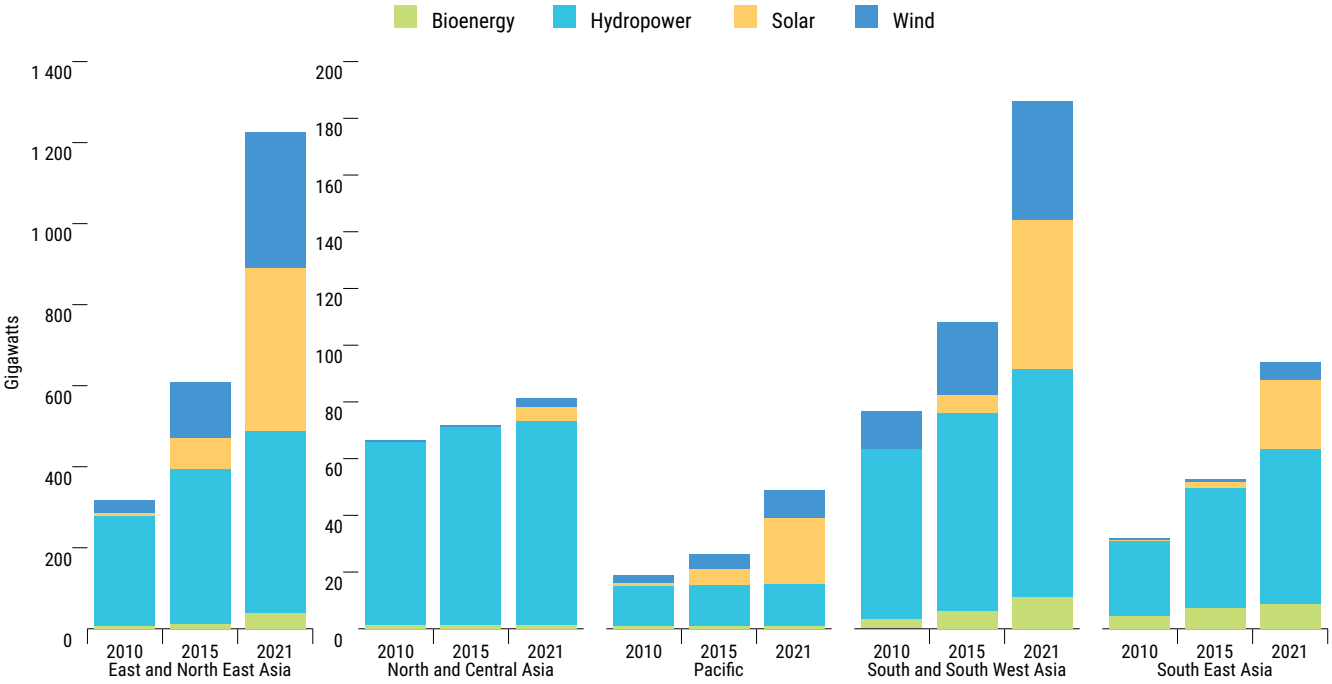
Solar PV has outpaced other forms of new renewable energy capacity addition growth, in absolute terms. In addition, the highest year-on-year growth of capacity has been posted for it across all energy sources in most subregions, reaching a total capacity 76 times what it was in 2010 (figure 18). In this regard, South-East Asia has been an outlier, posting relatively modest growth in solar power (13 per cent) compared to wind (53 per cent) and hydro power (29 per cent) over the period, in part due to a challenging regulatory environment for small-scale and behind-the-meter generators.

One key element to rapid growth has been in the adoption of policies, such as national targets that have supported deployment at scale and dramatic improvements in project economics. For example, feed-in tariffs (FiTs), which were adopted in many countries, guaranteed long-term contracts and attractive prices for renewable electricity producers, ensuring a stable and favourable investment environment. Auctions are also being used to provide a transparent and competitive procurement

[8] Further detail including time series data are included in annex 1

Wind and solar have dominated new development in recent years

Figure 18/ Annual renewable energy capacity additions by resource in 2010, 2015 and 2021



Source: ESCAP, based on IRENA

process for renewable energy projects, while also allowing the market to determine the price at which renewable energy projects can be financially viable. The Renewable Portfolio Standard set by the Republic of Korea obliges electricity utilities to procure a proportion of their wholesale energy supply from renewable sources. Reverse auctions also have proven to be effective in in China, India and Thailand by successfully helping to attract private investment while driving down the cost of renewable power. In India, these processes have been combined with renewable energy zones, which were created to support developments through a supportive planning and approvals process along with enabling transmission infrastructure.

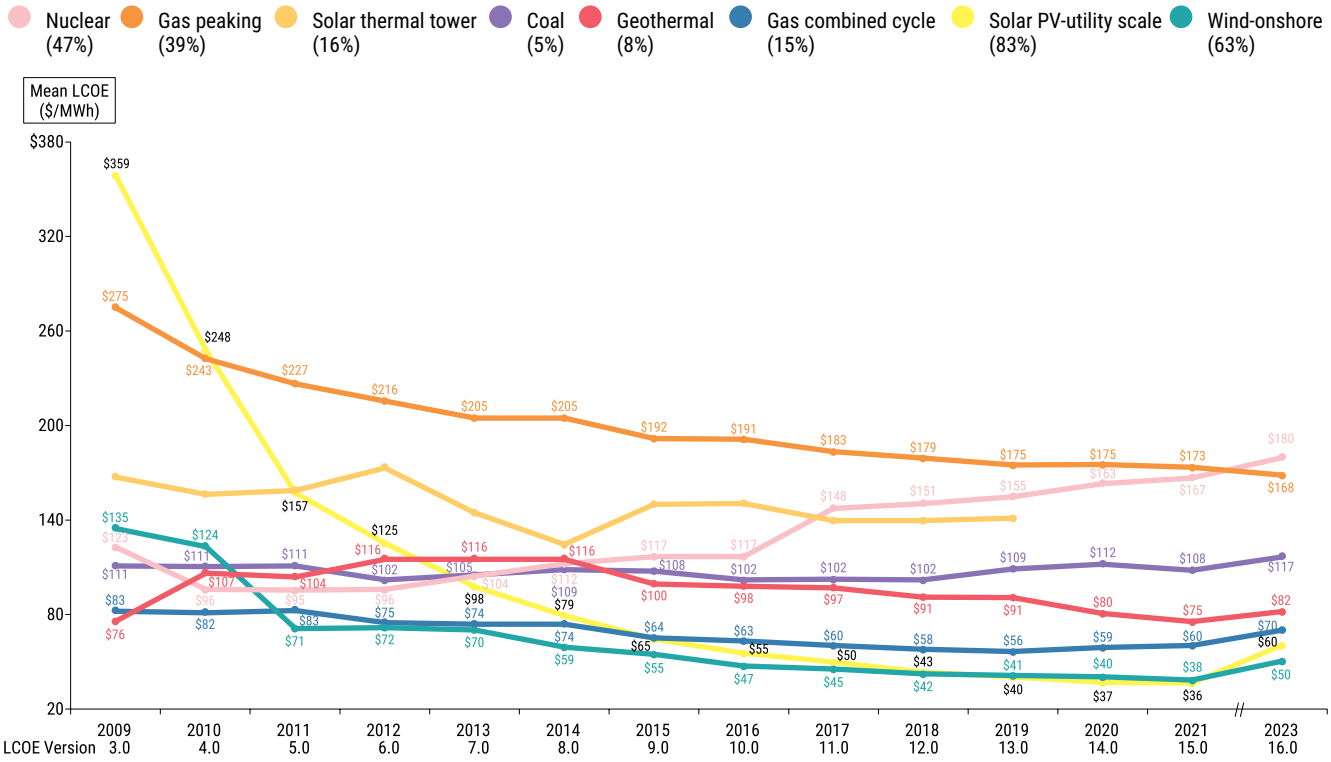
Globally, the levelized cost of electricity (LCOE) from solar PV fell from an average of $0.417 per kilowatt-hour in 2010 to $0.033 per kilowatt-hour in 2021 – a reduction of 88 per cent – compared to reductions of 60 per cent in offshore wind, 67 per cent in concentrating solar power and 68 per cent in onshore wind (IRENA, 2022). Since at least 2018, LCOE of solar PV and onshore wind has been comparable or lower than new fossil-fuel electricity generation in many locations. In cases in which renewable sources are abundant, or the costs of fossil fuel imports are high, renewable generation even outcompetes the operating costs of existing conventional sources. Still, such comparisons on an LCOE basis do not capture the full system value or costs of different generating options.

Due to challenges in the renewable energy supply chain, prices of many components have increased since the start of the COVID-19 pandemic. This has been further compounded by macroeconomic forces raising the cost of capital. One industry benchmark has estimated that the global average LCOE for new onshore wind is likely to increase from $38 per megawatt hour in 2021 to $50 in 2023, while utility-scale solar PV is expected to rise from $36 per megawatt hour to $460 per megawatt hour in the same period (Lazard Corporation, 2023).,[9] At the same time, due to dramatically rising prices for fossil fuels, LCOE of combined cycle gas is projected to rise from $60 per megawatt-hour in 2021 to 470 per megawatt hour in 2023, while coal may increase from $108 per megawatt hour to 4117 per megawatt hour.

[9] Note that the LCOE indicated here does not include the cost of managing intermittency. The cost of firming varies by region, technology and various other parameters.

Renewable technologies have quickly become the cheapest form of new generation, but recent cost increases will present some challenges to the energy transition

Figure 19/ Estimated global average levelized cost of energy from various sources



Source: Lazard Corporation (2023)

Going forward, this pattern of rapid growth is expected to continue. The cost of renewable electricity will continue to decline dramatically on the back of incremental technological advancements, economies of scale and supportive policies. A shift to larger-scale solar farms and to offshore wind projects is also expected, enabling further acceleration in the scale-up and potential for sharp reductions in cost, taking advantage of economies of scale. One challenge presented is the requirement to manage variability, which becomes more significant as the region's grids move to higher proportions of variable renewable energy in the supply mix. This subject is explored further in chapter 3.

Renewable heat and transport

While progress in renewable electricity has gained much attention, great strides are also being made in the renewable heat and transport sectors. Heat demand accounts for almost 50 per cent of the world's total final energy consumption (IEA, 2022j). Fifty-three per cent of it is consumed in industrial processes, while 44 per cent is used in buildings for space heating, water heating and cooking. Around the world, including in Asia and the Pacific, most heat is supplied by fossil fuels. Transport is another major user of energy, consuming about 21 per cent of final energy in 2020 under a broadly growing trend.

While there has been some progress in increasing the use of renewable heat in the region – approximately 11 per cent of heat is supplied by modern renewables (excluding traditional biomass) – the level of application varies widely. China and Japan have made significant progress towards the adoption of solar thermal technologies for water heating and space heating, while Indonesia, Malaysia and Thailand have focused on the deployment of biomass energy for cooking and heating. In many other countries in the region, the use of renewable heat technologies remains limited as there are significant barriers to adoption, including a lack of policy and regulatory support, limited access to financing, and low awareness and knowledge of renewable heat technologies.

Global heat demand increased by 4 per cent from 2020 to 2021, as the world's economies rebounded from the initial stages of the COVID-19 pandemic, but modern renewables accounted for only 13 per cent of that growth. Notably, international policy attention is being directed towards renewable options for providing heat. This is driven by a combination of environmental considerations and energy security concerns in the face of elevated gas prices. These issues are discussed further in chapter 4.

While very few countries, such as India and Thailand, have explicitly implemented policy interventions aimed at expanding the renewable heating and cooling sector, policies in countries, such as Australia, China, Japan and the Republic of Korea, that are aimed at boosting the broader renewable energy sector or reducing greenhouse emissions also provide support for the installation of technologies that deliver renewable heat.

Heat pumps have been put forward as a technical solution, which enables a shift from fossil-fuel driven heat supply to electricity (feasibly provided from renewable sources). They can reduce electricity demand by up to 80 per cent for low- and medium-temperature processes (up to around 70°C), which make up the vast majority of heat demand. In a similar vein, solar thermal technologies are being applied widely for the provision of domestic hot water and are becoming more common for combined space and water heating in single family homes, solar district heating networks and applications

Box 4 Hydrogen development in Asia and the Pacific

Widespread deployment of renewable power and electrification of end-uses are critical for achieving SDG 7 targets. However, reaching net-zero emissions will be aided by the development of hydrogen and other low emissions fuels to support decarbonization of sectors that cannot be fully electrified, such as heavy industry and freight transport. Holistic planning that considers the role of hydrogen can also help to optimize energy systems, enhance flexibility and facilitate the integration of renewables.

Hydrogen is mostly produced from unabated fossil-fuel processes in refining and the chemicals sectors. However, there is strong policy momentum for development of low-emissions hydrogen – from renewable power with electrolysis or natural gas processing with carbon capture – and related end-use applications. More than twenty-five countries globally have adopted hydrogen as part of their clean energy transition strategy, and nine of them, which account for approximately 30 per cent of global energy emissions, released national hydrogen strategies over 2021-22.[a] In Asia and the Pacific, New Zealand and Uzbekistan have adopted hydrogen strategies.

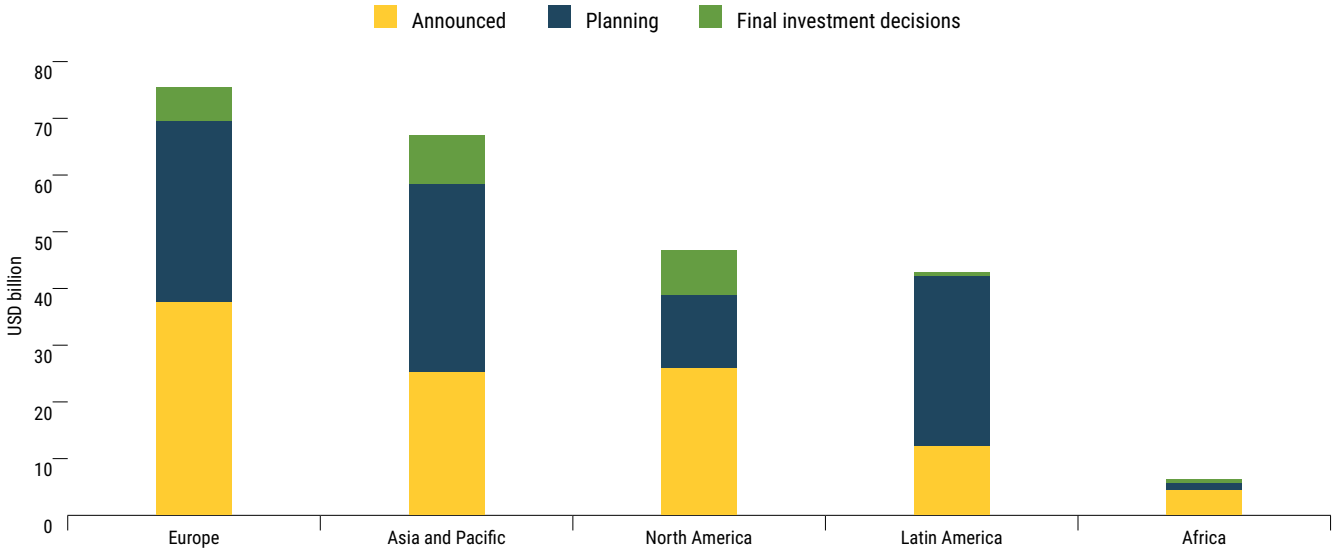
Such momentum has supported development of a global pipeline that exceeds 680 large-scale hydrogen projects, with planned investment of $240 billion and production capacity of more than 26 million metric tons by 2030. Yet, only 10 per cent of these projects have reached the final investment decision due to high upfront capital requirements and uncertainties over demand and policy support.[b]

The Asian and Pacific region accounts for nearly 30 per cent of planned investments, lagging only Europe where 13 per cent of its projects have reached final investment decision. Australia has the region's largest pipeline of projects under construction and feasibility studies are under way at several large renewables-based "hub" projects. In China, a strong renewable power base and a diverse array of deployment and purchase incentives for hydrogen production, storage, transportation, and refuelling support the region's second largest construction pipeline.[c,10] Japan and the Republic of Korea are deploying hydrogen-based fuel cell systems for combined heat and power and road vehicles. Singapore is developing certification frameworks around hydrogen trade, while the first cargo of liquified hydrogen was shipped from Australia to Japan in 2022.

[a] IEA (2022) ***Global Hydrogen Review***. Paris.
[b] Hydrogen Council, and McKinsey and Company (2022). Hydrogen Insights 2022. Available at https://hydrogencouncil.com/wp-content/uploads/2022/09/Hydrogen-Insights-2022-2.pdf.
[c] Fitch Solutions (2023) Asia Green Hydrogen Index:

Asia and the Pacific comprises nearly 30 per cent of planned hydrogen investment, but only 13 per cent of projects have reached final investment decision due to high upfront costs and demand and policy uncertainties

Figure 20/ Planned investments in large-scale hydrogen projects, by stage of investment



Source: Hydrogen Council and McKinsey and Company (2022).
Note: As of May 2022; includes projects focused on low-emissions hydrogen supply, end-use and transmission and distribution.

to industrial process heating. Solar cooling using thermal technologies (such as absorption chillers) is another application with the advantage that daily and seasonal peaks in the solar resource aligns closely with the demand for cooling.[10]

In 2020, solar thermal technologies delivered heat to approximately 35 million tons of oil equivalent in 2020 (about 14.5 per cent of heat demand) across Asia and the Pacific. Almost 73 per cent of the world's 500 gigawatts of total installed capacity of solar thermal collectors was operating in China, while almost 5 per cent was in operation elsewhere in the region (Weiss and Spörk-Dur, 2022).

Bioenergy makes up the region's largest source of renewable energy, contributing 489 million tons of oil equivalent to the Asia-Pacific energy supply in 2020. Modern bioenergy technologies include liquid biofuels, bio-refineries, biogas (derived from gasification, pyrolysis or anaerobic digestion) and wood pellet heating systems, which can be fed from a range of sources, including energy crops grown specifically on land for use as biofuel, algae, agricultural and forestry residues, and municipal or industrial wastes. Traditional bioenergy is the combustion of biomass forms, such as wood, animal waste and traditional charcoal for cooking and space heating.

Solid biomass makes up the vast bulk of bioenergy consumed (473 million toe in 2020) with applications in the heating of buildings and in traditional cooking in the Asia-Pacific region. Liquid biofuels provided another 16 million tons of oil equivalent towards the region's consumption, displacing oil-derived products in most of their applications in line with policies mandating ethanol or biodiesel blending for transport usage.[11] Biogas delivered 12 million toe and a further 63 million toe was derived from municipal and industrial waste – again, for a mixture of heat and electricity generation with liquid biofuels also being used for extensively for transport (World Bioenergy Association, 2022).

Biofuels are broadly considered a sustainable alternative due to their lower emissions of greenhouse gases, especially in transport, in which fuel density plays a crucial role. However, the dependence on feedstocks, such as sugar, palm oil, soy and other crops, to produce them often creates a complex interrelationship with food production, as fuel crops may compete for land, water and other resources. Thailand reduced its mandatory biofuel

[10] Fitch, Asia Green Hydrogen Index (2023).

[11] Relevant policies include those in China (E10, B5 in 2020), India (E20, B5 by 2030), Indonesia (B35 from February 2023) and the Philippines (E10, B2 from 2009).

diesel blending ratio in response to high vegetable oil prices in 2022. To mitigate the negative impact on food production, experts. including the World Bioenergy Association, have called for the exclusive use of non-food feedstocks, such as agricultural waste, forest residues, or non-edible parts of plants, and proponents should be cautious of the potential impacts of biofuel production on food security and sustainability.

The global energy crisis provides a further driver for hydrogen as a way to diversify fuel supply and leverage output from lower marginal cost renewable electricity. Still, renewables-based hydrogen costs remain high, at $4-5 per kilogram (kg). Efforts to decrease electrolyser costs by 80 per cent and bring renewable electricity costs to approximately $20/MWh over the next two decades are critical to narrow the competitiveness gap with fossil-fuel based hydrogen ($1-2 per kg).[12]

Enhancing the commercial viability of hydrogen requires the building of enabling transport and storage infrastructure and deploying, at scale, new manufacturing and production capacity. Carbon pricing would help renewables-based hydrogen to become more cost-competitive with fossil fuels. However, enhanced efforts are required to create markets for hydrogen use, purchase and trade through policy incentives, standards, and certification schemes, particularly in sectors critical for development in Asia and the Pacific, such as steel and cement manufacturing, shipping, freight, and power.

Progress in energy efficiency

The SDG 7 target for energy efficiency uses the rate of improvement in energy intensity, a measure that quantifies the ratio of energy supplied to the economy per unit of economic output. While energy intensity does not fully capture the complexities of efficiency, making it an imperfect proxy,[13] trends in intensity are a widely accepted and useful indicator for measuring progress towards energy efficiency as a prerequisite to reaching the target of SDG 7.3.

The Asia-Pacific region accounts for nearly 40 per cent of the world's GDP and nearly half of its energy consumption, and it continues to gain shares in both of these measures, Accordingly, it plays a critical role in the achievement of the global target of doubling the rate of energy intensity improvement by 2030. However, while the rate of improvement (figure 21) has varied greatly across countries and over time, the regional average has been short of the projected improvements necessary for Asia and the Pacific achieve the SDG 7 target. In the most recent decade, China, Indonesia and Japan were the only countries in the region that exceeded the global target rate of 2.6 per cent average annual rate of improvement for the period 2010-2030 initially projected as a prerequisite for achieving the target of SDG 7.3. In the light of insufficient and slowing improvement in energy intensity around the world, experts have had to regularly recalculate the required rate. Presently, to achieve SDG 7 a global improvement rate of 3.4 per cent is required for the period 2021–2030. To align with global net zero by 2050 ambitions, a 4.3 percent average annual rate of improvement is needed (IEA and others, 2023).

The Asia-Pacific region is well short of SDG 7 and net-zero aligned energy intensity targets; improvement within the most recent five-year period was less compared to the baseline 1990-2010 period. To pivot towards alignment with these objectives, the region requires an approximate tripling of the pace of improvement leading up to 2030.

Energy intensity improvements observed in the region to date have primarily been driven by the following:

- Improvements in **energy efficiency** as advances in technology and changes in consumer behaviour have led to significant improvements in energy efficiency across various sectors, including industry, transportation and buildings.

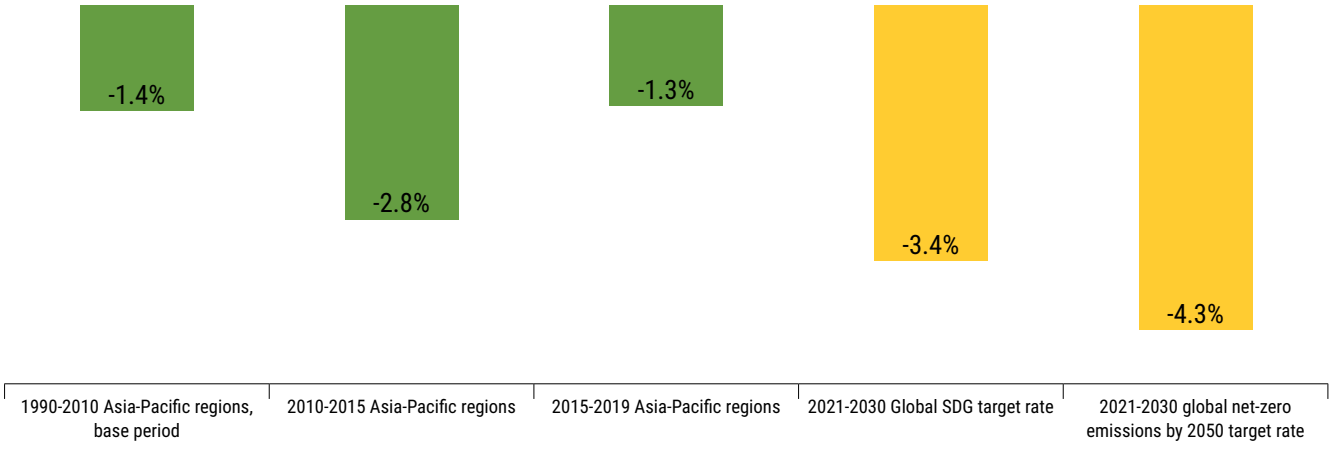
- The **economic restructuring** experienced by many countries in the region, with a shift away from energy-intensive industries towards less

[12] IRENA, *Hydrogen: Electrolyser costs* (2022). (https://www.irena.org/Energy-Transition/Technology/Hydrogen/Electrolyser-costs)

[13] Energy must be examined in relation to various factors that affect energy supply and economic output. Energy intensity masks several underlying factors, such as economic structures, the nature of economic activities, geography, exchange rates, climate, and global energy prices. It is not always the case that an economy with low energy intensity is highly energy efficient, or vice versa.

While the rate of improvement in energy intensity has varied greatly across the Asia-Pacific region and over time, current progress is well short of the global target

Figure 21/ Asia-Pacific growth rate of primary energy intensity, by period, and global 2021–2030 Sustainable Development Goals and net-zero targets



Sources: ESCAP based on IEA and UN Statistics Division

energy-intensive service sectors, for example from manufacturing to services.

- Changes in the **energy supply mix**, with shifts to less energy-intensive fuels, such as moving from thermal coal (typically with around 38 per cent primary energy efficiency when converting to electricity) to combined-cycle natural gas (approximately 50 per cent efficient) or to renewable energy sources, such as solar and wind power (100 per cent efficient).

- Changes in **energy pricing and subsidies** that incentivize consumers to use energy more efficiently and encourage the adoption of renewable energy.

Energy efficiency can reduce consumption and energy costs, boost economic productivity and enhance energy resilience by freeing up energy supply and facilitating economic growth in supply-constrained markets with growing demand. It can improve personal comfort, personal productivity in education and employment, mental and physical health, reduce household energy poverty and is a central pillar of decarbonization plans, taking the largest share of savings in scenarios limiting global warming to 1.5°C.

However, despite these benefits, sufficient policy attention has not been directed towards the implementation energy efficiency initiatives at the scale needed. One of the challenges behind this is that processes for energy utilization are enormously diverse, creating challenges for standardization of technology, services, policy, and financial solutions.

One policy solution delivering a degree of success has been the introduction of Minimum Energy Performance Standards (MEPS) and labelling to raise awareness of efficiency among consumers. By setting benchmarks that allow for easier comparisons between products and appliances, labelling informs consumers who, in turn, drive demand for higher efficiency options and pushing manufacturers to improve the energy performance of their products. Labelling and MEPS are scalable, meaning they can be applied across different products and industries, and aligned between countries, with the added benefit of bringing economies of scale.

Countries in Asia and the Pacific have a long history of successful implementation of MEPS and labelling, starting with air conditioners in the 1980s and extending to a wide range of residential, commercial and industrial appliances, lighting products and other equipment. Globally, MEPS are increasingly being adopted for a broader range of appliances. Residential refrigerators and freezers, for instance, are subject to MEPS in approximately 80 countries, which covers about 80 per cent of the final energy consumed globally for residential refrigeration. MEPS coverage, however is lower for other appliances, such as washing machines (more than 50 countries, 78 per cent per cent coverage), televisions (less than 50 countries, almost

75 per cent coverage), and computer monitors (less than 40 countries, 43 per cent coverage). There is also an increasing trend towards mandatory labelling; approximately 80 countries require labels for refrigerators, 60 for washing machines, and more than 40 for dishwashers.

Intergovernmental cooperation plays an important role in promoting energy efficiency. Organizations, such as the International Electrotechnical Commission and IEA, provide technical guidance on standardization for the development of MEPS and labelling programmes, while regional and subregional organizations, such as ASEAN and the Asia-Pacific Economic Cooperation (APEC), support coordination of the development and implementation of MEPS and labelling programmes among their member States. These efforts allow countries to share best practices, harmonize standards, and can enable economies of scale by creating a level playing field for manufacturers and consumers and standardization of design and improvements in the pathway for new product development. For example, Australia and New Zealand harmonize their product standards through the Equipment Energy Efficiency programme under an agreed policy framework, while ASEAN has been supporting member States through the ASEAN Standards Harmonization Initiative for Energy Efficiency Program.

Technology solutions to improve the energy efficiency of the region's economies include the electrification of end uses. Electrification enables the use of a more efficient electric devices, such as EVs and heat pumps, in place of their fossil fuel-powered counterparts. For example, EVs save 70 to 80 per cent of the energy in fuel consumed by an internal combustion engine vehicle; and a heat pump domestic water heater uses one quarter of the energy of a gas boiler. Electrification also facilitates the integration of renewable energy sources into the energy system (as electricity used typically has a component generated by renewables), enables the application of smart technologies and contributes towards improvements in air quality.

Solutions are emerging in energy efficiency services, in part enabled by new technologies for data acquisition and analysis. This includes, for example, route optimization based on data analytics and the Global Positioning System to optimize transportation routes and reduce fuel consumption, improved building energy management through smart automation and controls, and industrial optimization through energy audits, advanced real-time monitoring, and control and predictive maintenance.

Finally, the financing of energy efficiency continues to be important, and innovation in financing continues to present new opportunities. Bulk procurement and pre-approved technologies can streamline deployment, reduce transaction costs and deliver economies of scale, attract favourable financing terms, ensure quality assurance and streamline implementation. For example, the Green Public Procurement of the Republic of Korea has been hailed as a best practice programme for its promotion of sustainable (including energy efficient) products and services with criteria across a range of categories and driving market demand. Separately, energy service companies (ESCOs) play a pivotal role in promoting energy efficiency, offering expertise and financing solutions to identify energy-saving opportunities and proposing and delivering projects that optimize systems and upgrade equipment. They often use energy performance contracts, which guarantee savings and enable clients to repay project costs through savings and can provide ongoing operations and maintenance services to ensure sustained performance.

As the region moves to higher rates of electrification among end uses, the proportion of electricity in final energy consumption has accelerated. This proportion jumped from 10.1 per cent to 13.6 per cent in the decade to 2010. By 2020, electricity had reached 19.0 per cent of final energy consumption.

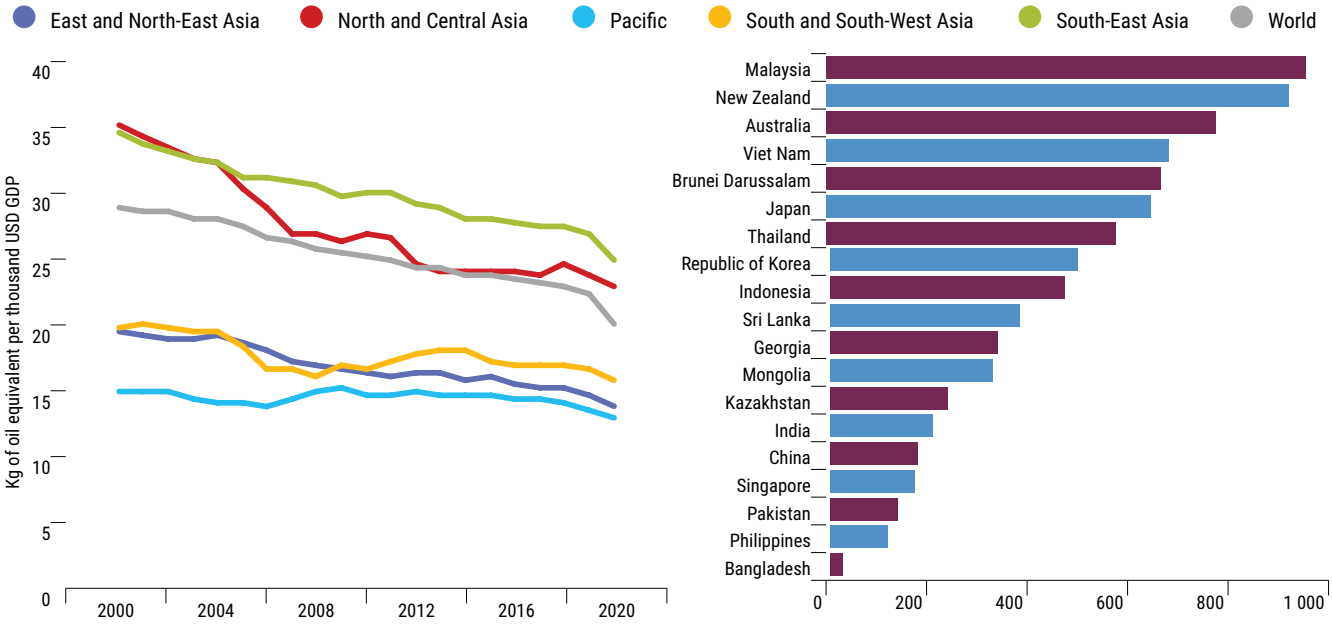
Transport

The transport sector is responsible for approximately 20 per cent of energy consumption in Asia and the Pacific; in some areas, such as South-East Asia, the sector is rapidly growing on the back of the rising population and incomes. Road transport accounts for nearly 90 per cent of transport demand and has expanded by more than 30 per cent over the past decade. More than 90 per cent of transport demand is met by oil products. Despite efforts to improve performance and shift to more sustainable modes, transport comprises a growing share of the region's CO_2 emissions, at 27 per cent.

The evolution of energy intensity for transport has been mixed. In the East and North-East Asia, South and South-West Asia and Pacific subregions, energy intensity is lower than the global average; in South-East Asia and North and Central Asia,

Excluding the 2020 downturn, recent annual transport intensity improvements were only 1.5 per cent and rising vehicle adoption rates are likely to play a strong role in driving future demand

Figure 22/ Final energy intensity of transport in Asia-Pacific subregions (left) and motorization rate of select countries (right)



Sources: ESCAP calculations based on IEA, World Energy Balances (https://www.iea.org/data-and-statistics/data-product/world-energy-balances); ADB., Asian Transport Outlook (https://asiantransportoutlook.com/).
Notes: Transport sector energy intensity is measured as transport final consumption per unit of GDP billion USD 2017 prices and purchasing power parities); motorization rate includes the rate of adoption for total passenger and freight vehicles.

transport intensity is higher. Annual improvements across the Asia-Pacific region were at 2.6 per cent over the period 2015-2020, more rapid than recent improvements in overall primary energy intensity, and in line with the global target rate improvement needed to meet target 7.3. Still, excluding the COVID-19 pandemic-related downturn in 2020, the annual improvement has been only 1.5 per cent since 2015. There is also significant variation across the subregions, with intensity improvements are occurring more rapidly than the regional average in East and North-East Asia, but have been lower in North and Central Asia, South and South-West Asia and South-East Asia.

Rising passenger vehicle ownership and expansion of road freight, presents challenges for shifting to a more sustainable transport sector. The Asia-Pacific region has become the largest market for new vehicles, accounting for nearly 50 per cent of global sales in 2019 (ADB, 2022). Many countries in the region are at early stages of vehicle adoption, portending stronger growth ahead. Combined with the region's increasing share of global surface freight flows, at almost 40 per cent, Asia and the Pacific is set to account for most of the global transport demand and emissions growth over the next few decades (ITF, 2021).

Aligning the transport sector with a low-carbon pathway depends on progress in the following areas:

1. Improving the design, operations and planning of transport systems;

2. Electrification, powered by renewable electricity and enabled through grid integration;

3. Use of low-carbon fuels;

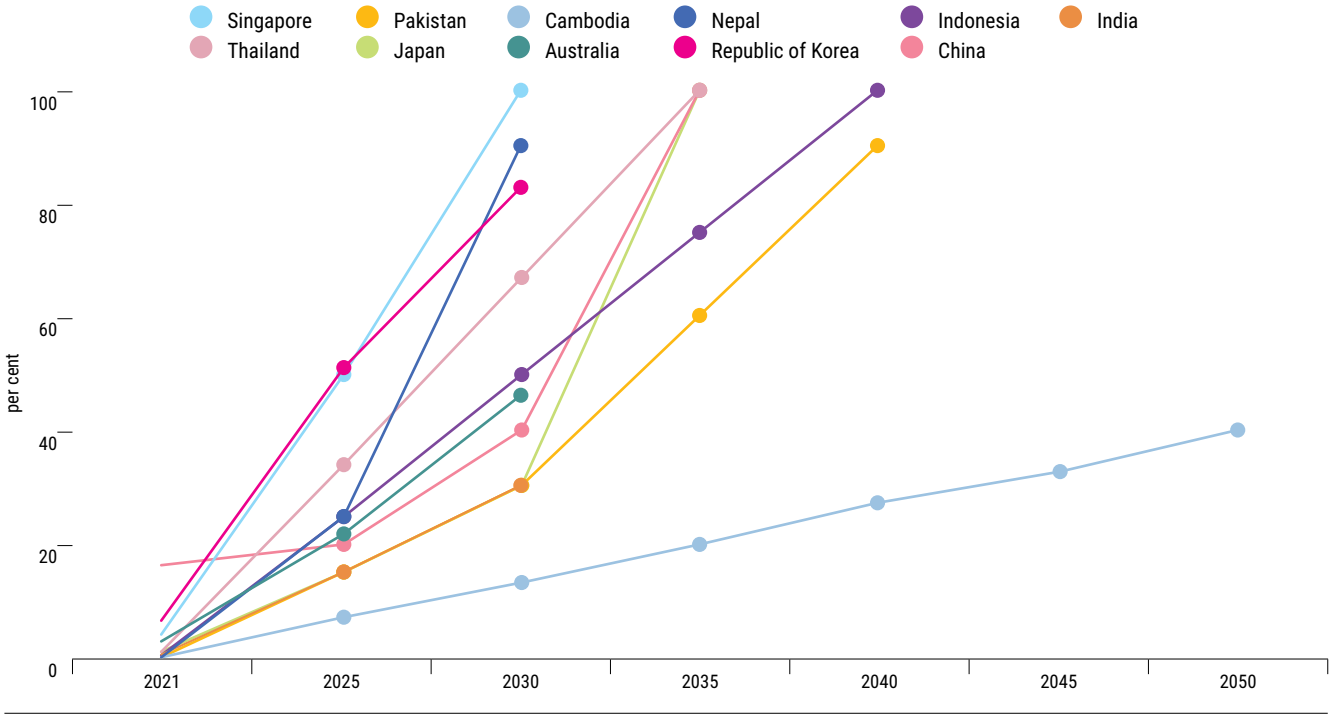
4. Encouraging different modes of transport and better management of demand;

5. Innovating and upscaling transport solutions (ESCAP, 2023a).

The most common strategies among countries in the region, as mentioned in NDCs, are to promote greater adoption of public transport, especially buses, and switching towards cleaner fuels, such as biofuels and electrification (ESCAP, 2019).

Asia-Pacific countries have announced ambitious EV sales targets, with an expected surge over the next two decades, though challenges remain over charging infrastructure and economics

Figure 23/ Share of electric vehicles in 2021 passenger vehicle sales compared with announced share ambitions for select countries



Sources: ESCAP calculations based on government and industry reporting and IEA (2022f).
Note: Includes passenger light duty vehicles.

In terms of electrification, the production and sale of electric vehicles, including buses, commercial vans, and trucks, two-wheel transport and marine vessels, has surged in recent years. In 2022, EVs comprised 14 per cent of global vehicle sales, up from 9 per cent in 2021 (IEA, 2023b). In 2021, they accounted for 16 per cent of sales in China and 6 per cent in the Republic of Korea. Improved batteries and targets and incentives for purchase and manufacturing have supported rapid market growth.

Many Asia-Pacific countries have announced ambitious electric vehicle sales targets, with an expected surge in activity over the next two decades. Asia-Pacific countries also have strong potential in the uptake of 2- and 3-wheeled electric vehicles. But, achieving these ambitions depends on the parallel roll-out of EV charging infrastructure, the scale up of renewable electricity; effective grid and system integration of EVs and variable renewables; the scale up of domestic manufacturing plans and effective management of CRMS, which are key for the production of batteries. While the total cost of ownership for passenger electric vehicles is approaching parity with internal combustion vehicles in more mature Asian markets – China, Japan, the Republic of Korea – a stronger push to boost deployment is required to improve the adoption of EVs electric vehicles in India, countries in South-East Asia and other emerging and developing countries (Farmer and others, 2022).

Buildings

For many countries in the Asia-Pacific region, buildings account for approximately one third of total energy consumption. In terms of electricity consumption, this share significantly increases to more than 50 per cent for many countries. Despite this, some countries have yet to introduce building energy codes – in 2021, only 79 out of 196 (40 per cent of countries globally) had building energy codes that are either mandatory for a part of the building stock or have a voluntary component, while enforcement is weak in many places where they do exist.

Governments have a crucial role to play in the development and enforcement of building energy

codes and standards that mandate energy-efficient designs and construction practices aligned to the national net-zero targets and their NDCs. Codes should include requirements for efficient lighting systems, insulated building envelopes, low-carbon materials, energy-efficient HVAC (heating, ventilation, and air conditioning) equipment, and other energy-saving features. At the same time, passive design strategies suitable for the local climatic conditions can lower overall demand for heating, cooling and lighting, and should, therefore, be promoted through urban planning regulations.

Governments can lead by example in the public sector by implementing energy-efficient practices in government buildings. This includes setting energy efficiency targets for public buildings, retrofitting existing government facilities and ensuring energy-efficient procurement practices. Government programmes can help set the direction for energy efficiency markets for the building sector and serve as a testing ground for introducing new technologies and practices. Smart building systems, advanced insulation materials, energy-efficient lighting and renewable energy integration in buildings are important areas for innovation. Investing in research and development programmes focused on energy-efficient building design approaches, technologies and materials is essential.

Regular monitoring and evaluation of the energy performance of buildings can help identify underperforming buildings, track progress towards energy efficiency goals, and inform future policy decisions. To support the improvement of energy efficiency in the building sector, building owners and managers should be encouraged to regularly conduct energy audits to identify areas for improvement through regulations, reporting requirements and incentives.

Several Asia-Pacific Governments have introduced mandatory audits for various building typologies, and phased in requirements to include more typologies, and to increase energy performance. However, the practice needs to be expanded, and mandatory performance standards are often lacking for much of the residential sector, which represents the highest growth sector for much of the region.

Efforts targeting energy performance in the residential building sector is critical to managing future energy demand. In particular, cooling has emerged as a key driver of energy demand in the buildings sector. In many parts of the Asia-Pacific region, climate change, the increased frequency of heat waves and climbing average temperatures are increasing cooling demand. At the same time, rising income levels are enabling the rapid uptake of space cooling appliances. Although end-use data are lacking for many countries, recent analysis suggests that cooling accounts for between one third and more than one half of total electricity demand for countries with hot and humid climates, despite low levels of cooling equipment penetration (IEA, 2018).

To accelerate the adoption of energy-efficient practices, cooperation, collaboration and knowledge-sharing are needed among governments, practitioners, industry stakeholders and research institutions to share best practices experiences, and success stories related to energy-efficient building design, construction, and operation. In addition to introducing building energy performance standards, raising awareness about the benefits of energy efficiency among building owners, occupants, and the general public is important. Educational campaigns can promote energy-saving practices, energy-efficient technologies and sustainable building design.

CHAPTER 3

OPPORTUNITIES FOR PROMOTING SUSTAINABLE ENERGY DEVELOPMENT IN THE ASIA-PACIFIC REGION

This chapter presents an outline of learnings from good and best practice interventions, which have enabled the development of energy in the region and can facilitate further improvements. Solutions for the energy transition are characterized by their interdisciplinary nature and emphasize that no single issue can be considered in isolation. That is, each solution needs to address various factors that cut across multiple sectors and portfolios. Accordingly, it is critical to develop solutions comprehensively and in collaboration with experts and stakeholders from diverse backgrounds, who contribute to and benefit from the energy transition.

The following subsection provides an overview of the status and role of national energy policy in delivering the sustainable energy transition across Asia and the Pacific. This is followed by an assessment of some of the challenges and opportunities in making more efficient use of power grids for enabling higher penetrations of renewable energy through systems integration and cross-border grid connectivity. In the fourth subsection, the need for investment in energy and the important role of finance in delivering the energy transition is considered. The fifth subsection contains an outline of the growth in demand for CRMs, while in the sixth and seventh subsections, some of the threats, challenges and opportunities that the clean energy transition presents in terms of social justice, equity, and other needs of the community are investigated.

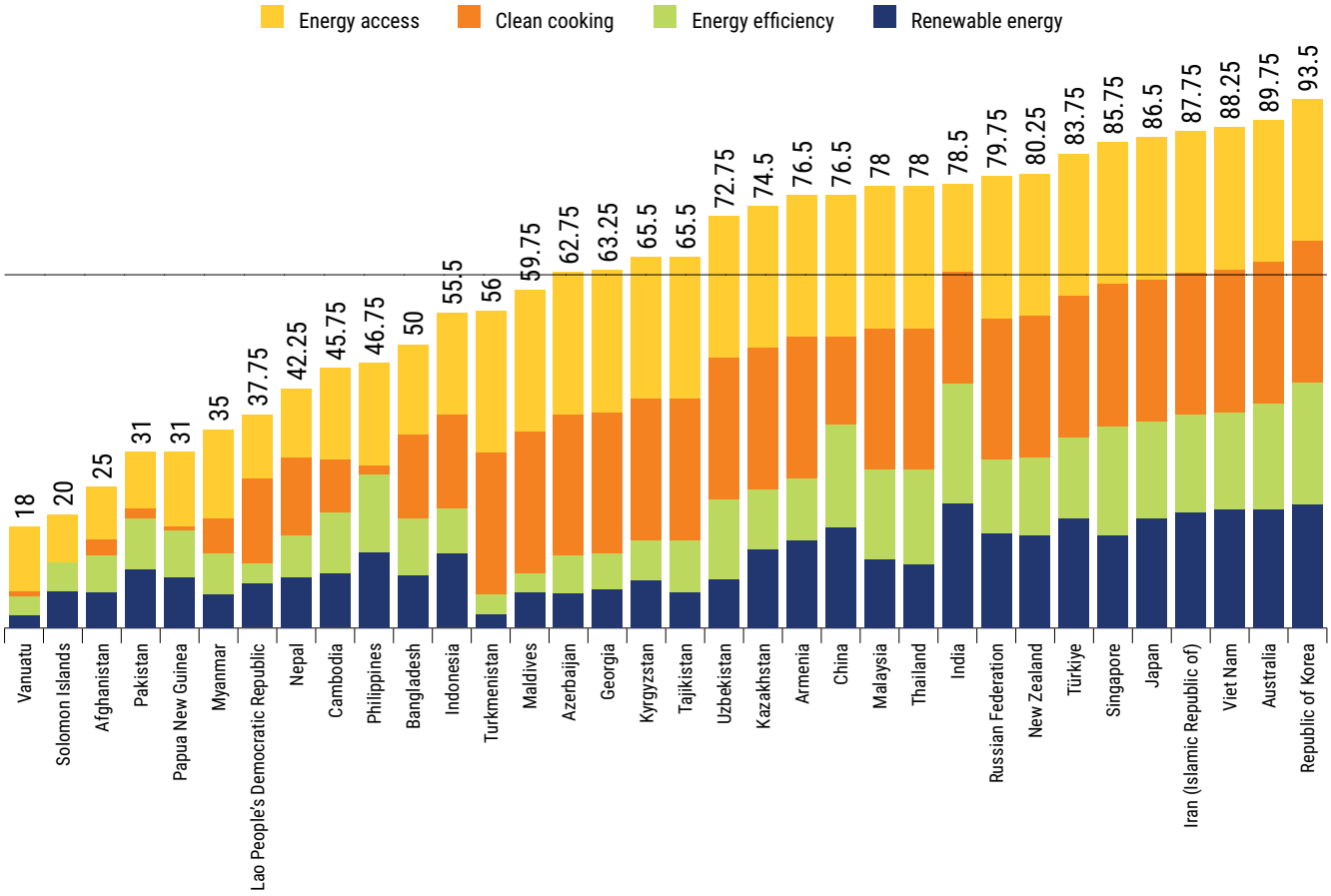
Overview of policy solutions for sustainable energy development

Diversity in terms of political appetite, natural resource availability and economic status of countries across Asia and the Pacific has resulted in a wide range of policy solutions for advancing sustainable energy. Countries with abundant solar, wind, geothermal and hydro power resources have focused on promoting renewable energy through interventions, such as FiTs, renewable portfolio standard, and net metering policies. On the other hand, those reliant on fossil fuels have prioritized energy efficiency and conservation through building codes and standards, energy audits, MEPS and energy labelling, or changes to their energy supply, such as the phasing-out of fossil fuels in favour of modern, cleaner technologies.

For example, Tonga provides a valuable case-study as it has abundant solar resources and (to a lesser extent) a potential for wind and hydropower. Data prepared for the development of the country's SDG 7 road map using the ESCAP National Expert SDG 7 Tool for Energy Planning (NEXSTEP) showed that in 2020, Tonga was on-track to achieve universal access to electricity in 2021, but that the rate of improvement was insufficient to deliver universal access to clean cooking by 2030 (with a projected shortfall of approximately 8 per cent of the households) (ESCAP, 2021). The country has since committed to generating 70 per cent of its electricity from renewable sources by 2030 through the creation of an energy commission with broad authority to regulate petroleum imports and usage, electricity and renewable energy (Tonga, 2021). The organization will oversee a range of programmes, including the Outer Islands Renewable Energy Project, which will provide a secure, renewable electricity supply to

Many countries of the region remain below the global average score against the RISE benchmark

Figure 24/ Regulatory Indicators for Sustainable Energy scores for countries of the Asia-Pacific region



Source: World Bank

remote communities and the Tonga Wind Power Project, which will construct 2.25 megawatts of wind generation capacity. However, despite these efforts in the electricity sector, the renewable energy share of TFEC (including biomass) is still expected to decline from 25.2 per cent in 2018 to 17.7 per cent by 2030 due to growing demand and declining use of traditional biomass. The current trend of energy intensity reduction indicates that Tonga will achieve its energy efficiency target (annual improvement of 0.07 per cent of primary energy intensity to achieve the SDG 7 target of 2.94 MJ/$ by 2030) by 2030.

As an economy reliant on fossil fuels for more than 73 per cent of its energy, Indonesia has set an ambitious target of reaching net zero by 2060.[14]

IEA has worked with the country's Ministry of Energy and Mineral Resources to develop "an energy sector road map to net-zero emissions, which plots one of the many pathways to achieving this policy goal, proposing short-term prioritization of building and appliance energy efficiency, expanding the renewable electricity supply – from 0.4 gigawatts today to 25 gigawatts in 2030 and reaching more than 600 gigawatts in 2060 – and electrifying the transport sector (IEA, 2022a).

The scale of finance required for the energy transition is enormous. In Indonesia, the current plans amount to more than $21 billion in commitments from G7+ countries, the Asian Development Bank (ADB), the World Bank and the Islamic Development Bank. All sources of private, public, local and international capital are needed throughout the region and the world in order to realize the transition (IEA, 2021b). In many countries, this will create a significant shift

[14] Asia Pacific Energy Portal. Energy Supply by Product in Indonesia, 2020. (https://asiapacificenergy.org/apef/index.html#main/lang/en/graph/5/type/1/sort/0/time/[min,max]/indicator/[1295-M:834]/geo/[IDN]/legend/1/inspect/0)

away from public sources toward private capital. While energy investments can often provide a strong value proposition to financiers, the shift requires an improved mutual understanding among regulators and stakeholders throughout the energy system in order to address risk and other barriers to investment.

In some countries, market-based approaches, such as carbon-pricing mechanisms and emissions-trading schemes, have been applied successfully. A summary of these instruments covering (APEC) member States is provided in the APEC Stocktake of Carbon Pricing Initiatives (APEC, 2022). In others, focusing on promoting public-private partnerships and blended finance have enabled a shift away from traditional assistance, which multiplies the impact of development finance. For example, India has been the target for a large number of blended finance transactions; meanwhile, Indonesia has established the "Energy Transition Mechanism Country Platform" as a pathway for blended finance from public and private financial institutions to fund the energy transition.

Box 5 New frontiers of cooperation on energy

Many benefits can be reaped from intergovernmental cooperation on energy. Among them are the opportunity to share knowledge and resources and harmonize policies and actions, procure shared services to enhance energy security and access, and generally promote renewable energy and energy efficiency. By working together, countries can reap significant benefits in addressing common challenges to energy transitions.

Additionally, intergovernmental cooperation can facilitate international trade and investment in the energy sector, foster innovation and technology transfer, and support the implementation of international agreements and targets related to energy and sustainable development.

There are a number of organizations and initiatives operating at the regional and subregional scale across the Asia-Pacific region, as well as initiatives at the global level that governments within the region participate in. These include the following:

First announced at the 26th United Nation Climate Change Conference of the Parties (COP 26) in Glasgow, Scotland, the **Just Energy Transition Partnership (JETP)** is a financing cooperation mechanism that aims to help selected heavily coal-dependent emerging economies make a just energy transition. South Africa, Indonesia, India, Senegal and Viet Nam have announced their willingness to partner in the JETP approach, and more are expected to join.[a]

The **Office of the Pacific Energy Regulators Alliance (OPERA)** was established in 2016 by the energy regulators of Samoa, Tonga, and Vanuatu with the assistance of the Pacific Community (SPC) to provide a forum for energy regulators in the Pacific islands region to enhance regulatory decision-making skills and technical capacities.[b]

In 2019, ESCAP developed the **National Expert SDG Tool for Energy Planning (NEXSTEP),** which enables policymakers to make informed policy decisions to support the achievement of the SDG 7 targets as well as NDCs emission reduction targets through the creation of SDG 7 road maps.

The region plays host to a number of multilateral cross-border power grid connectivity initiatives, including, among them, CASA-1000 in Central and South Asia and the ASEAN Interconnection Masterplan Study AIMS) III in South-East Asia, which may facilitate the integration of larger shares of variable renewable energy.[c] This subject is discussed in further detail in the coming pages.

The **Asian and Pacific Energy Forum (APEF)** was established by the ESCAP Commission in 2011 as the ministerial level platform for promoting regional cooperation for enhanced energy security and the sustainable use of energy in region. Its third meeting was held in Bangkok in October 2023.

[a] Kramer, Katherine (2022) Just Energy Transition Partnerships: an opportunity to leapfrog from coal to clean energy. International Institute for Sustainable Development, 7 December. Available at https://www.iisd.org/articles/insight/just-energy-transition-partnerships.
[b] See https://gem.spc.int/projects/opera.
[c] See www.casa-1000.org/.

Overall, the key challenge for policymakers in Asia and the Pacific is to design policies that are tailored to the specific needs and circumstances of their countries, while also taking into account the needs of international investors along with global energy trends and commitments to reducing greenhouse gas emissions.

The World Bank Regulatory Indicators for Sustainable Energy (RISE) provides a set of objective metrics used to compare national policy and regulatory frameworks for delivering SDG 7 (ESMAP 2022). The RISE scoring system is based on a set of 27 indicators that cover four pillars: (1) energy access, (2) energy efficiency, (3) renewable energy, and (4) power sector regulation. Countries are assigned scores ranging from 0 to 100, with a higher score indicating a more supportive policy and regulatory environment for sustainable energy. Overall, RISE provides a valuable tool for assessing the policy and regulatory environment for sustainable energy and promoting the adoption of best practices across different countries and regions. The latest studies include analyses of 12 years of data (to the end of 2021) across 30 indicators covering the four pillars.

Data collected at the end of 2021 indicates consistent improvement over recent years. The global average RISE score across all indicators and countries worldwide increased from 57 in 2019 to 60 in 2021, with continuous growth shown in all energy pillars. However, the East Asia and the Pacific and South Asia World Bank regions scored well below the global average, at 50 and 48 points, respectively, with a notably below-average performance in electricity access via mini- and off-grid systems, planning for clean cooking deployment, a significant number of indicators for progress in energy efficiency and most components of renewable energy. As noted in chapter 2, while the provision of access to electricity is an area in which the Asia-Pacific region has improved strongly, progress related to clean cooking appears to face particular challenges with a large number of indicators in these areas falling into the RISE “red zone”, indicating underdeveloped policy frameworks.

Promoting system integration through digitalization

Countries with high proportions of VRE in their electricity supply face a continuous challenge of maintaining grid stability, reliability and the balance between supply and demand.

Notably, some degree of balancing and flexibility is required in all power grids. Management systems for balancing voltage, frequency and power dispatch against demand are necessary at timescales of seasons, to years, down to periods of sub-second duration. System modifications and enhancements are needed as the deployment of VRE grows to significant portions of the generation mix – typically a few per cent or more of annual generation, depending on the local context – compounding the variability in demand with variability in supply.

At low levels of VRE deployment, flexibility can be managed through changes to operational procedures and settings. As VRE penetration grows, additional requirement may include investment in systems to enhance system flexibility through modernization of transmission and distribution controls, equipment and connections, solar and wind forecasting, mandating or incentivizing VRE flexibility, developing new dispatchable generation (such as batteries and pumped hydro power) and ancillary services, and deploying “smart grid” technologies and demand response.

This creates challenges for policymakers as the evolution of regulatory frameworks and codes is at risk of being overtaken by the fast pace of technology deployment. Policymakers, therefore, play a critical role in supporting or even accelerating the energy transition by ensuring that power system standards, regulations and codes are effectively reviewed, and their currency maintained. For instance, grid planners should conduct proper long-term adequacy assessments to highlight anticipated shortages and plan for interventions that ensure sufficient capacity and flexibility on the demand and supply sides. Policies for enhanced grid connectivity across borders can also improve security of supply by allowing countries to share generating capacity and by increasing resource diversity. This is discussed further in the following subsection.

Grid connection codes can enhance VRE flexibility in various ways including, among them, by mandating

"downward dispatch" mechanisms, which reduce generation when demand is low, requiring operation with "overhead capacity" that reduces generator output except at peak times, or specifying that a proportion of output be supported by storage to enable arbitrary dispatch of the variable generation. Separately, incentives may be offered to VRE proponents to design and operate their assets in certain ways. For example, sliding premium FiT can be used to encourage generation at certain times, while ancillary services payments can be used to remunerate generators for supporting the grid through voltage and frequency control, offering additional revenue streams in addition to payments for energy. One leading example of this is the 300 megawatt/450 megawatt-hour Victorian Big Battery in Australia, which draws a large proportion of its revenue from frequency control and ancillary services, and a capacity reserve contract with the regulator; the remainder of its income is generated from price arbitrage of energy on the national electricity market.

Demand-side management is also becoming more prominent as a solution to renewables integration and for better grid management. Demand response provides a pathway for residential, commercial and industrial electricity consumers to contribute to grid management by shifting their energy usage to times when renewable energy production is high, helping to avoid the need for expensive and carbon-intensive backup dispatchable power sources. Once again, such approaches can be built into grid connection codes, incentivized through market mechanisms, or a combination of the two.

Smart grids allow for the collection and analysis of real-time data from various sources, such as energy generators, transmission lines and end-users, integrating this with advanced forecasting and scheduling technologies to predict demand and renewable energy production more accurately. Grid operators are, therefore, able to optimize operations by adjusting dispatchable generation or triggering demand response to improve efficiency, reliability and resilience. With digitalization, smart grids can automatically adjust to changes in supply and demand, making it easier to manage renewable energy sources and intermittent or highly dynamic changes in demand. Additionally, digitalization allows for more accurate and timely billing, improved outage management, and enhanced customer engagement through smart meters and other technologies.

The digitalization of the energy system is creating new sources of data, facilitating novel approaches to energy management, and potentially supporting new and novel business models for proponents of sustainable energy solutions. One of the simplest approaches is time-of-use pricing: charging customers different rates for electricity depending on the time of day. This offers a price incentive for consumers to shift their usage to off-peak hours and optimize the local dynamics of supply and demand, using smart meter data to inform the billing system.

The analysis in this report has highlighted demand response programmes and sliding FiT, which rely on smart meter data. These tariffs provide customer incentives to reduce energy consumption or increase energy export during periods of high demand or low generation. Other approaches use smart meter data to provide businesses with insights into their energy usage and help them optimize their operations by identifying energy-intensive processes and finding ways to reduce consumption, or targeting high-usage homes and businesses with offers of energy-efficient products and services to help reduce their consumption. The last of these is an enormous opportunity for energy efficiency, which is known to have strong benefits, but is challenging to implement across millions of homes and businesses. These new data sources can enable better targeting of engagement, help to improve energy efficiency programmes and greatly improve the benefit to cost ratio.

For distributed renewable energy generation, digitalization (in combination with an enabling regulatory framework) can facilitate peer-to-peer energy trading, allowing customers to buy, store and sell energy directly with each other. Smart meter data are used to determine how much energy is being produced and consumed and prices are set accordingly, thus promoting the use of renewable energy while reducing impacts on the broader power grid system.

Finally, new data sources and digital tools are also influencing the way that policy is developed, and the potential exists to further leverage these opportunities to provide better outcomes for the energy transition and the public. IEA and IRENA have written in detail about a range of digital technologies and tools, which can provide benefits at all stages of the policy life cycle of design, implementation and monitoring (Sung, Troilo and Howarth, 2021).

Focus on cross border connectivity

As countries seek to develop modern power systems in their efforts to meet SDG 7, they must find an appropriate balance between three main development priorities: affordability; security; and sustainability. For an individual country, to overcome resource constraints and other obstacles trade-offs may be required, which could limit their ability to meet all three goals simultaneously.

Power system connectivity is a key strategy that can help resolve the tension between these three objectives. Transnational power grids can provide access to lower-cost resources, including renewable energy resources, which may be far away from demand centres. It can improve system adequacy and the security of supply by allowing countries to share generating capacity and by increasing resource diversity. It can also improve sustainability by enabling the integration of higher shares of variable renewable energy resources, such as wind and solar PV.

Accordingly, cross-border connectivity efforts are complex endeavours that can take many years to be fully implemented. Their development hinges on a wide range of considerations spanning technical and geopolitical challenges, alignment of policies and regulations across two or more countries, and the availability of significant funds for deployment of transmission infrastructure. Even mature efforts elsewhere in the world continue to evolve in response to technological and market changes. As a starting point, political support for connectivity initiatives is a fundamental prerequisite for driving collaboration and ensuring that sufficient resources can be brought to bear to develop regional power system master plans and supportive institutional arrangements. While cross-border power system connectivity initiatives can take many forms, successful efforts are generally developed in a stepwise process based on voluntary principles, which seek to harmonize rules and regulations, develop necessary infrastructure and enable cross-border power trade.

In 2021, ESCAP member States endorsed the Regional Road Map on Power System Connectivity (Road Map). The Road Map contains a vision, a set of principles and nine strategies that together provide a useful framework for enabling the further development of connectivity initiatives, while also ensuring their alignment with sustainable development.

The overarching vision of the Road Map is that transnational power system connectivity can, if properly guided, enable the development of interconnected grids that are more reliable, affordable, and sustainable. Integrating power systems across borders allows countries to leverage their diversity in terms of supply and demand to lower the cost of power system development and operations while simultaneous improving reliability and decreasing carbon emissions. Transnational power system connectivity, therefore, contributes to achieving SDG 7 and other Goals.

The nine strategies of the Road Map are listed in figure 25.[15] While all nine strategies are important for countries to achieve increased power system connectivity, this section is focused on strategy 9: Ensure a coherence of energy connectivity initiatives and the sustainable development goals.

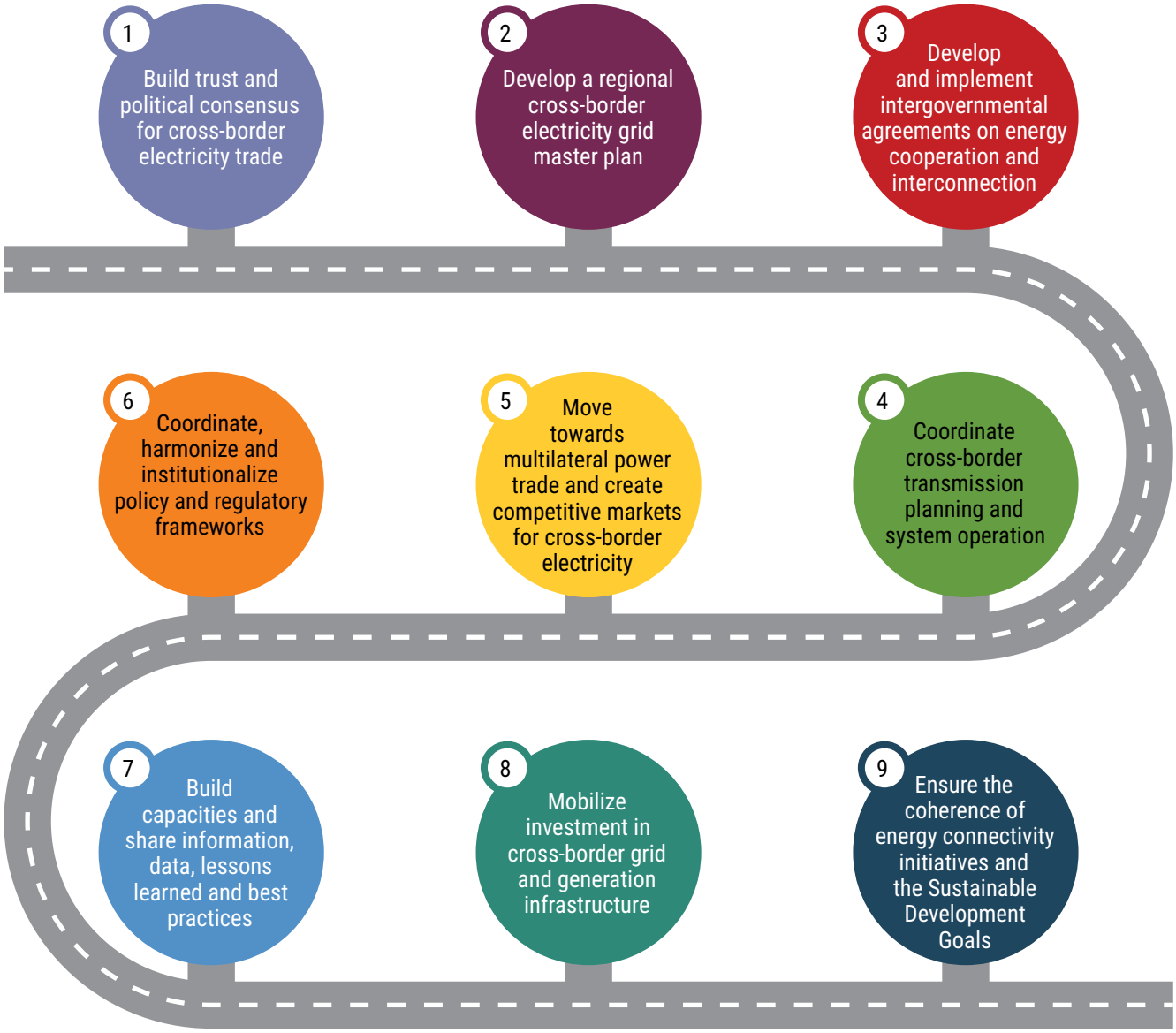
Power system connectivity does not in itself guarantee sustainable power systems. Grids are by their nature only as green as the underlying power sector and will transport any electrons that are fed into them without discrimination. However, grids are necessary to develop power systems that are clean, affordable and secure. As renewable resources are typically far from demand centres, grids are needed to transport the renewable energy. Additionally, grids are required to increase balancing areas, which helps with increasing security, as larger balancing areas makes it easier to smooth out the variability that for example can come from renewable technologies, such and wind and solar PV.

Strategy 9 in the Road Map calls for the development of a set of principles to enable the assessment of connectivity projects against economic outcomes, efficiency and sustainability criteria. An example of a study that does this is AIMS III, which studies the implementation of the ASEAN Power Grid (APG) and the effects of the development of the Grid to enable the ASEAN member States achieve their target of

[15] Source for figure https://www.unescap.org/our-work/energy/energy-connectivity/roadmap

The Road Map could enable the development of interconnected grids that are more reliable, affordable, and sustainable

Figure 25/ The nine strategies of the Regional Road Map on Power Grid Connectivity



23 per cent renewable energy in total primary energy consumption by 2025.[16]

While the ASEAN group of countries are not on track to meet the 23 per cent renewable energy target, the ability of AIMS III for the first time in the AIMS studies to specifically link the development of the Grid to the achievement of renewable energy targets is a massive step in the direction of aligning renewable energy targets with the achievement of the APG vision. This is because it allows ASEAN to understand which grid developments have the highest impact on the ability to integrate higher shares of renewable energy into the power system.

The ASEAN example is relatively unique in Asia and the Pacific. Many studies across the region show that power system connectivity, especially creating transnational regional grids, is beneficial to integrate larger shares of variable renewable energy. Accordingly, only a few initiatives have been taken by national governments that investigate the effects of a

[16] To view the ASEAN target, see https://asean.org/our-communities/economic-community/asean-energy-cooperation/priority-areas-of-cooperation/.

regional grid on renewable integration in a regionally coordinated way.

Often, the motivating factor towards studying regional power system integration is economic development. While economic development can and should be a driving motivation, it is important to study and recognize the ability of regional grids to enable governments to achieve sustainability targets in a more cost-effective and secure way. In the Asia Pacific region, many regional connectivity projects are in the pipeline, but most of them are still at the study stage. For the regional initiatives to progress to the implementation stage, the ESCAP Road Map encourages member States to include sustainability criteria in all studies and considerations on how to develop regional connectivity.

In South Asia for example, Bhutan and Nepal can benefit from more regional integration to develop their vast hydro resources, which can be used to supply neighbouring countries with renewable energy and support the integration of other variable renewable energy technologies, such as solar PV. Nepal and Bhutan can bid into the Indian power exchange to export their hydro resources. However, there is no current methodology for the two countries to sell their hydro power, for example, to Bangladesh, as this requires wheeling through the Indian grid. As such, South Asia should consider increasing the sustainability of the grid by allowing multilateral and bidirectional trade among more countries, as their trade is dominated by bilaterally negotiated trades.

Similarly, in Central Asia, Kyrgyzstan and Tajikistan and Kyrgyzstan have ample hydro resources during summer. These hydro resources can be developed and help serve power systems struggling with deficiencies in the summertime, such as the Pakistani power system. The CASA 1000[17] interconnection project is under development, which will allow for this. However, it is important to create frameworks, which will allow CASA 1000 or a regional Central Asian grid to support Kyrgyzstan and Tajikistan in winter, when hydro is less abundant and when there power shortages occur (IEA, 2021a). This can increase the overall sustainability and security of the Central Asian and South Asian systems.

The catalytic role of finance to mobilize private sector investment for Sustainable Development Goal 7

To put the world on a path to meet ambitious sustainability goals, global clean energy investments need to increase by three- to four-times by 2030, compared with the 2021 level. This would entail the reallocation of capital from fossil fuels towards renewables, efficiency, electrification and low-carbon fuels (IEA, 2022i; IRENA, 2022). While some countries in the Asia-Pacific region – notably China, India and the region's high-income economies – have been successful at scaling-up capital for energy transition investments, significant challenges and barriers remain for financing clean energy in many other countries.

Mobilizing higher levels of clean energy investment to meet SDG 7 targets is dependent on creating pipelines of bankable clean energy projects, diversifying financing sources and reducing the cost of capital. Mobilization is more challenging when interest rates are rising (see chapter 4), underscoring the role of good policies that address sectoral fundamentals and financial system issues.

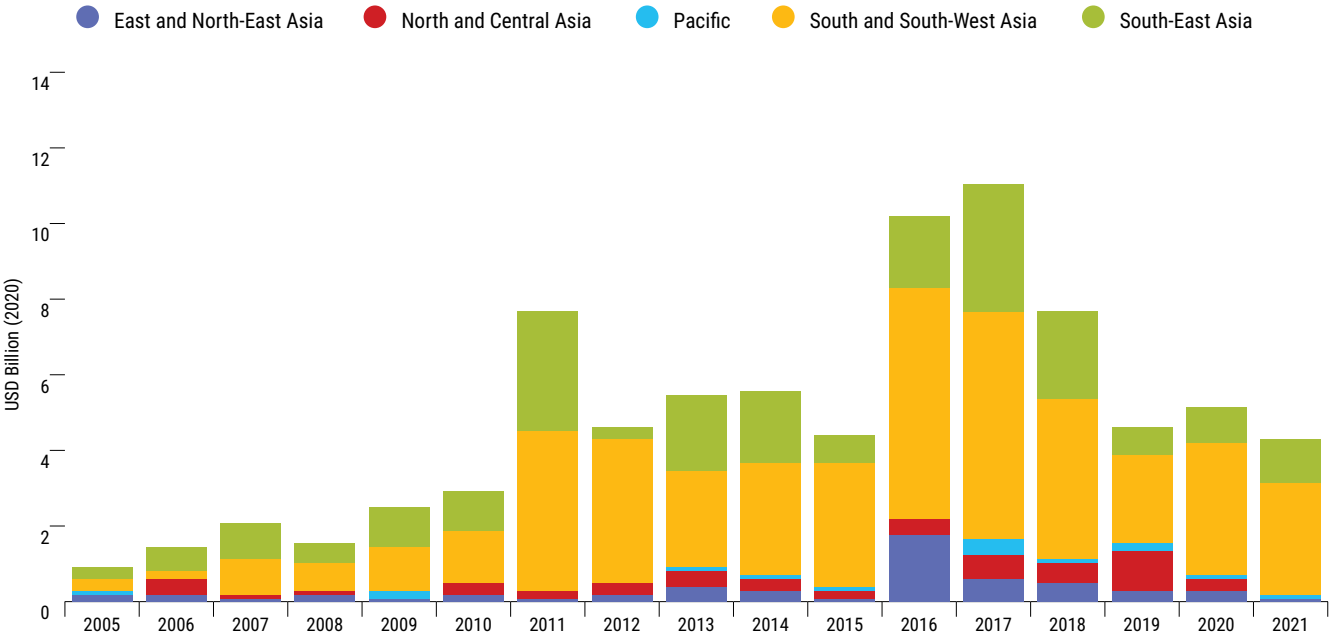
Well-designed commercial arrangements and remuneration schemes, with appropriate risk allocation between public and private actors, are critical to creating profitable investment opportunities that provide investors with an adequate and reasonable return on capital. In some cases, this requires new ownership and operating models for generators and transmission grids. The roll-out of competitive auction mechanisms with these features has supported utility-scale renewable power investments at reduced costs, in diverse markets, such as Cambodia, India and Kazakhstan.

Funding at early development stages, when projects and companies face elevated risks, is critical but remains in short supply. Resources available in the early stages of project preparation are often insufficient to carry out the pre-feasibility and feasibility studies, contract negotiations, land acquisition, permitting, resource assessments and energy audits needed to reach a final investment decision. Inadequate regulatory frameworks can contribute to this by causing delays and cost overruns.

[17] To learn more about the CASA 1000 project, see https://www.casa-1000.org/.

While enhanced access to public finance for clean energy is critical to catalyse developing country transitions, international flows to the region have decreased by 60 per cent since 2017

Figure 26/ International public financial flows to developing countries in Asia and the Pacific in support of clean energy research and renewable energy production, by subregion



Source: ESCAP calculations based on OECD, DAC Statistics Database (https://data.world/datasets/dac-statistics-database) and IRENA, Public Finance Database (https://www.irena.org/Data/View-data-by-topic/Finance-and-Investment/Renewable-Energy-Finance-Flows).
Note: Includes loans, grants and equity investments received by developing countries from all foreign governments, multilateral agencies and development finance institutions for clean energy research and development and renewable energy production, including hybrid systems.

One solution is to address the domestic regulatory environment for development, including through the creation of government "one-stop shops" that integrate administrative and planning services, making it easier to speed projects along. Another approach is through international project preparation facilities, which can channel international capital and valuable technical assistance. Examples of such facilities include InfraCo Asia, Infrastructure Asia and the Southeast Asia Clean Energy Facility. Creating a regional "small ticket" financial mechanism that brings together project developers and financiers and provides grants to defray upfront risks could further catalyse investment in Asia and the Pacific (ESCAP, 2023a).

On the part of governments, greater capacity is needed to support efforts aimed at ensuring that State-owned enterprises operate on a firmer financial footing. This is especially the case when they must act as creditworthy purchasers of power or fuels, such as for State-owned utilities or large industrial players. Furthermore, considering the volume of manufactured goods that are exported from the Asia-Pacific region and investment in manufacturing industries, policy interventions directed towards climate-smart trade and investment are a key approach to decarbonizing industry. Governments also play a role in fulfilling the large potential to harness foreign direct investment for cleaner products and processes, which, to date, has been unevenly distributed across the region (ESCAP, 2023a).

In many developing countries in the region, there are constraints on the availability of long-term debt and debt financed in the local currency, especially for small-scale investments in energy efficiency and distributed solutions. Domestic banking sectors need to build their capacity and financial regulators require assistance to better evaluate clean energy opportunities and integrate sustainability standards within standard lending and investing practices and norms.

Governments can further catalyse investment through targeted use of public finance. This includes a stronger role for international development finance and enhanced deployment of blended finance – the use of catalytic capital from public or philanthropic sources to increase private sector investment in sustainable development. This is critical to enhance project bankability, manage complex transitions and support transformations at early stages of technology readiness, such as industrial decarbonization, especially in emerging and developing economies where financial conditions are very challenging.

Accordingly, a gap remains to be filled by international technical and financial support. International public finance flows in support of SDG target 7.a.1 have trended downward in recent years, declining by 60 per cent since 2017, despite an uptick in 2020. Moreover, as global blended finance for climate investment declined over the period 2019–2021 versus the period 2016–2018 (in part due to the COVID-19 pandemic), the share of Asia and Pacific declined from more than 40 per cent to close to 30 per cent (Convergence, 2022).

International capital markets could offer large pools of low-cost capital for clean energy projects. Sustainable instruments (such as green and sustainability-linked bonds) are in high demand from investors; sustainable debt issuance was valued at $1.5 trillion globally in 2022 (IMF, 2023b). Renewable energy continues to dominate the use-of-proceeds categories for green bonds. Approximately 62 per cent of all green bond issuances to date have included renewable energy, while approximately 15 per cent of green bonds are earmarked solely for renewable energy, followed by green buildings (11 per cent) and clean transport (5 per cent) (Environmental Finance, 2022).

In the Asia-Pacific region, China and Japan led sustainable debt issuance in 2022. This type of debt issuance has been limited in emerging and developing economies to those countries with relatively advanced domestic capital markets and investment-grade sovereign credit ratings (such as India, Indonesia, Malaysia, the Philippines, Thailand and Türkiye). In general, developing countries require the elaboration of more robust frameworks for labelled instruments and taxonomies for sustainable finance. In South-East Asia, for example, issuance of a regional taxonomy for sustainable finance seeks to harmonize language and to guide borrowers and investors in capital allocation, climate risk assessments, and sustainability evaluations (ASEAN, 2021).

Governments also need to consider ways to enable private investment in sectors traditionally reliant on public spending. One example is the financing of grids. In Asia and the Pacific, some countries have successfully deployed private finance for power grid investment, but this has been the exception, not the rule. Understanding the various models for enabling the use of private finance in grid investment is key to successfully integrate larger shares of variable renewable energy resources and support grid-related technologies, such as EV charging (Randi, 2022)

Another example is access to electricity and clean cooking. In addition to reforms that improve financing for centralized power grids, innovative business models and new financial instruments would help to accelerate financing for the mini-grid and off-grid sectors (Sustainable Energy for All, 2021). Such investments could be coupled with investments for electric cookstoves. A more programmatic approach to financing is required to scale up a range of clean cooking applications in access deficit markets. This financing can have co-benefits and synergies with other SDGs, such as gender equality (see chapter 2).

Implementation of carbon pricing can provide clearer signals for clean energy investment and improve public finances. The implementation of well-designed carbon border adjustment mechanisms, similar to the ones in Europe, can create a competitive advantage for businesses investing in decarbonization. Financing emissions reductions can also be enabled through the purchase of high-quality carbon credits, as offered in Thailand, where the international acquisition of such credits by a European country is helping fund the roll-out of electric buses in Bangkok.

Finally, mobilizing investment also involves taking a system-wide approach to energy planning and financing that addresses legacy fossil-fuel assets, helps fund transitions for emissions-intensive sectors and supports a just transition for affected workers and ,as discussed later in this chapter.

Managing access to critical raw materials to enable energy transition

Clean energy transitions involve a shift from a fuel-intensive system to a material-intensive energy system. Many clean energy technologies, such as renewable energy generation, EV and energy storage systems, require considerably more minerals than their fossil fuel-based counterparts. For example, solar PV systems require up to 40 times more copper, while wind power plants need up to 14 times more iron per unit of generation than conventional fossil generation on a life-cycle basis (Hertwich, 2014). Consequently, as a result, as the transition towards a clean energy future deepens, the energy sector is transitioning from a fossil-intensive to a mineral-intensive sector. CRMs will, therefore, be indispensable for global development in the coming decades.

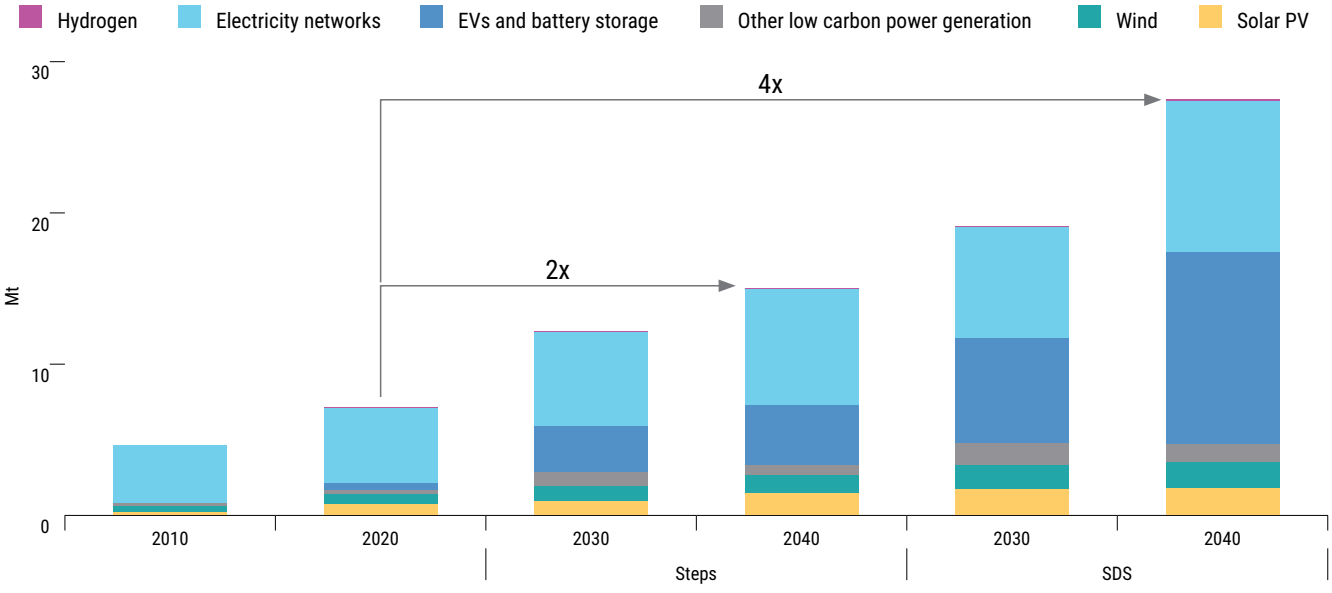
Demand for CRMs is expected to grow multi-fold as a result of increased deployment of low-carbon technologies. These CRMs, however, are more concentrated on production and processing, and have less transparent markets than fossil fuels, raising supply security concerns.

There is no single definition for which minerals and other materials qualify as CRMs, but broadly speaking they include any raw materials considered to have a high-level of economic importance and the potential for supply risks. While developing CRMs creates significant economic opportunities, their extraction and processing – as for other extractive industry products – may lead to additional environmental, social and governance challenges.

The issues faced by the development of CRMS during the energy transition are significant for the Asia-Pacific region. Understanding the implications, impact and magnitude of the energy transition are prerequisites for the region to align the development of its CRM resources with the SDGs.

Demand for CRMs is growing – and will continue to do so – throughout the energy transition

Figure 27/ Total critical raw materials demand for clean energy technologies by scenario



Source: EA (2021c).
Note: STEPS – IEA's Stated Policies Scenario; SDS – Sustainable Development Scenario

The region is well placed to serve the increased demand for CRMs, as it has approximately 25 per cent of the world's total reserves of mineral resources. As no country possesses sufficient quantities of all the CRMs required for the energy transition, such as lithium, nickel, cobalt, copper and rare earth elements, and given that countries occupy different positions in the clean energy supply chain, trade is necessary. Ensuring the supply of CRMs and the resilience of the supply chain is essential to the economic prosperity of countries in the Asia-Pacific region.

The region's importance in the future of CRMs is due not only to their resource abundance but also to them growing demand for them from manufacturing within the region. Its potential economic benefits and importance for the energy transition, on the other hand, also require that robust institutions be set in place to minimize social and environmental costs and transfer mining revenue into sustainable development.

Asia-Pacific countries have formulated different sustainable development strategies, such as strengthening domestic mineral exploration and exploitation, securing overseas resources, restricting exports and production and enforcing legal regulation. Environmental protection is on the agenda of every CRM-producing country. For CRM-deficit countries, there have been some attempts to diversify imports and increase indigenous supply. For those that have no CRM resources, their strategies include investing overseas, recycling and developing alternative materials. Both CRM-surplus and CRM-deficit groups would benefit from international cooperation, innovation and the circular economy as key means to ensure the security of supply. However, they have differences in priorities, with CRM-surplus countries focusing on environmental protection and processing of CRMs, while CRM-deficit countries focus on innovation to reduce demand or identify sufficiently affordable and available alternatives. The two groups have great potential for cooperating on investment, information-sharing and technical support.

Aligning the Asia-Pacific region's extractive industries sector with SDGs and the Paris Agreement requires adoption of a holistic and life-cycle approach underpinned by supply sufficiency and affordability, fair revenue-sharing, a people-centred and just process and environmental integrity. This would further lead to policy measures in related to research and development, lower emission, mining and circular economy, revenue management, governance, workforce upskilling, and data and transparency. Three immediate priority actions for the CRM industry, CRM-surplus and CRM-deficit governments and the international communities, respectively, are suggested: prioritizing work to establish common operational rules for markets; green finance and standards; sharing knowledge and experiences among regions and countries; and creating regional and international coordination institutions.

Ensuring transitions are just and people-centered as countries shift from coal

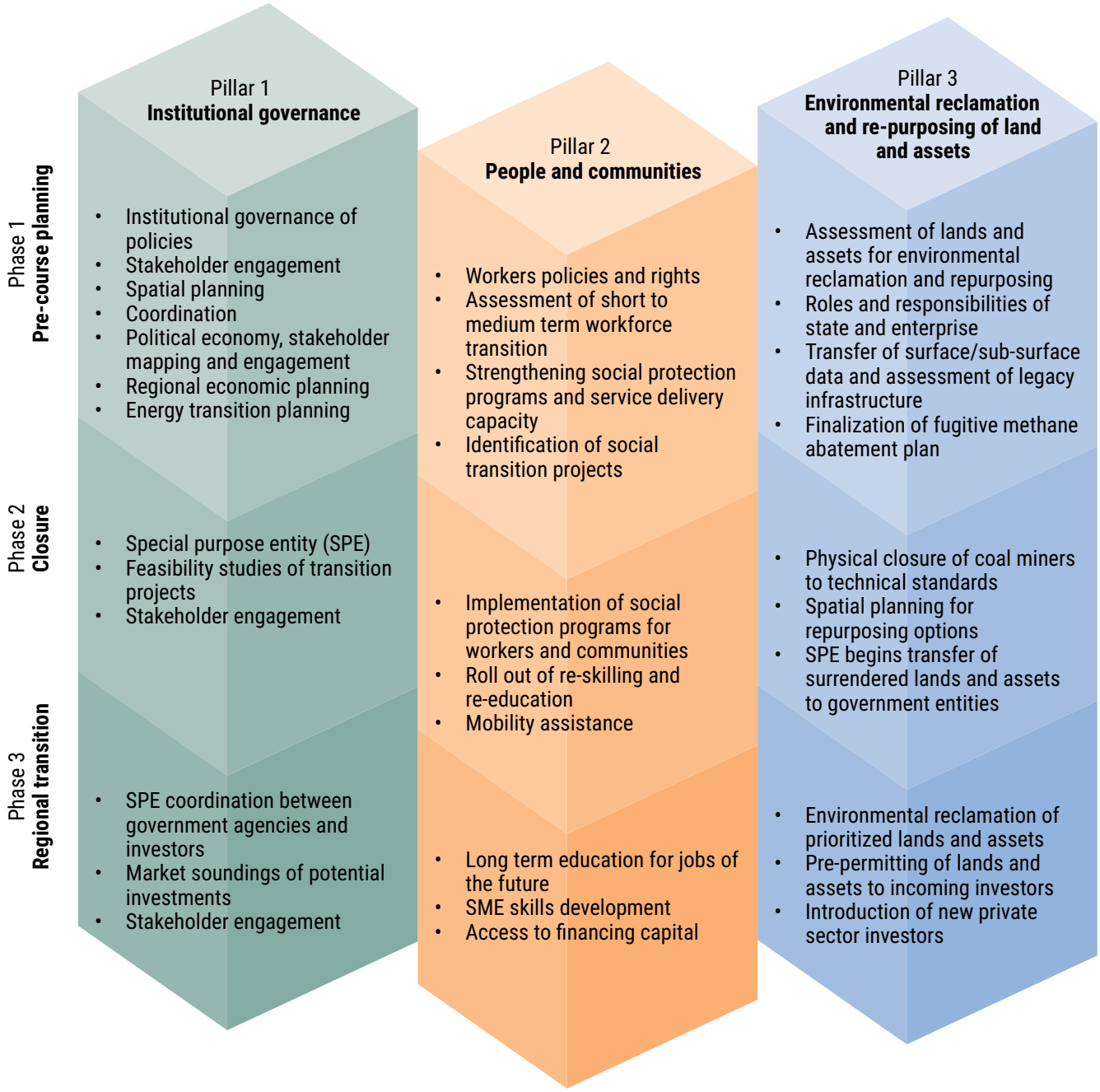
It is important to ensure that the energy transition is just and equitable, taking into account the full social and environmental impacts from shifting away from coal and developing renewable energy, as well as potential influences on other objectives of the SDG and climate agendas.

Transforming the energy system to meet sustainability goals involves reducing reliance on fossil fuels – notably coal – in addition to scaling up clean energy in an inclusive manner. The Asia-Pacific region is by far the largest user of coal, accounting for approximately 80 per cent of the world's consumption in 2021. To date, the ready availability of cheap coal has underpinned economic growth models, and coal-related industries have emerged as major sources of employment.

In many emerging and developing economies of the region, coal has formed the central pillar for the expansion of power generation capacity and economic development. Despite the United Nations calling urgently for an end to coal-fired generation, more than 180 gigawatts (GW) of capacity are now under construction in the Asia-Pacific region, notably in Bangladesh, Cambodia, China, India, Indonesia, Japan, Pakistan, the Philippines, the Republic of Korea and Viet Nam. This presents a serious risk of

The World Bank had developed a framework for coal regions provides a framework for planning and delivering a transition away from coal

Figure 28/ International Framework for Supporting Energy Transition in Coal Regions



Source: Adapted from World Bank (2018) .

overinvestment and the potential creation of future stranded assets in a carbon constrained world.

Decision makers increasingly recognize the diversification and environmental benefits of shifting away from coal; global investment decisions for new coal power plants have fallen by more than 60 per cent in the past decade. Shifting from coal depends on halting expansions, and initiatives such as the United Nations No New Coal Compact, can help countries make commitments and support implementation. However, successful transitions also depend on finding ways to manage the phase-out of existing coal-fired power. Notably, meeting ambitious global goals for net-zero CO_2 emissions by 2050

requires the phasing out of unabated coal power by 2040.

As countries consider policy and financial options to manage transitions from coal from an energy system and economy-wide perspective, concerted efforts are required to ensure that the transitions are just and people-centred. The roles of workers from the fossil fuel sector will change as assets are repurposed or retired early. Coordinated, long-term engagement is needed both within and across countries and regions to ensure that affected workers and communities are part of the transition, are rained with skills for the future needs of the economy and not left behind.

The World framework for supporting energy transition in coal regions provides a template for realizing such opportunities based on experiences in Europe, North America and a few ESCAP member States. Governments can support fossil fuel workers and communities affected by clean energy transitions through reskilling and retraining; planning and activities for local economic development and diversification; broader economic activities for facilitating worker participation in the clean energy economy; and measures for environmental rehabilitation of closed mines and infrastructure to make them fit for other purposes. Such support is most effective as part of long-term, integrated strategies to help legacy regions and communities to transition.

Integrated policy and financing, such as JETP, have the potential to ramp up clean energy, while phasing out coal power plants, many before the end of their useful life. In Indonesia and Viet Nam, recently announced JETPs offer the prospect of catalysing transitions by using international blended finance to address the multifaceted nature of the phase out of coal, including support for vulnerable groups.

Furthermore, energy system transformation can generate multiple economic benefits, including creation of new industries and jobs in clean energy. Analysis by the International Renewable Energy Agency shows that South-East Asian countries are becoming major solar PV manufacturing hubs and biofuel producers, and the subregion could experience annual GDP growth to 2050 that is on average 3 per cent higher by transitioning to an ambitious 1.5˚C climate scenario compared with a trajectory based on today's planned policies. Under a net-zero emissions pathway, IEA projects that almost 40 million new jobs in clean energy supply chains would be created globally by 2030, far exceeding job losses in fossil fuel-related industries (IEA, 2022j).

Aligning clean energy development with local environmental and community priorities

As countries scale up clean energy, there are further considerations to align transitions with the welfare of local communities. In the Asia-Pacific region, these considerations often take the form of managing the potential water and land use implications associated with the rapid deployment of large-scale infrastructure.

For example, hydropower has long dominated the Asia-Pacific region's renewable energy deployment, and much attention has been paid over past decades to developing appropriate safeguards to minimize negative social and environmental impacts. Large hydropower installations, in particular, present risks for community displacement and impacts to agricultural lands, fisheries, and river ecosystems. Upstream and downstream communities and ecosystems can be affected and the introduction of energy production adds a potential competing use for water resources, which, in some cases, creates cross-border management challenges.

To address these matters, guidelines have been developed to support the design of hydropower systems that present lower risks to river ecosystems, and the communities and industries that rely on them.[18] At the same time, basin-wide and cross-border institutional frameworks have supported integrated water resource management. While not all risks have been mitigated and efforts must continue to further ensure just approaches to hydropower development, a wide awareness of impacts exists and the knowledge base on how to avoid potential negative impacts is broad.

[18] Examples include ADB (2023).and IFC (2015).

As countries seek to rapidly scale-up investment in wind and solar installations, alongside enabling grid infrastructure, the responsible acquisition and use of land and project sites represents another critical development issue, with potential implications for SDGs related to food, land and water systems.

Renewable power can be more land intensive than fossil-fuel based power, but the impacts are project-specific and can vary by technology and by type of installation. For example, wind farms can operate compatibly with grazing or cropping, but extensive areas are needed; while the modular and distributed nature of solar PV means it can be installed in urban areas and on unutilized areas, such as rooftops, more easily than other forms of power. Estimates of land use requirements for electricity generation vary widely and depend not just on the technology under consideration, but also on how the land use is measured. The Economic Commission for Europe (ECE) has estimated that, on a life-cycle basis (including fuel extraction and processing), coal power requires between approximately 9 and 24 m^2 of land per megawatt-hour; hydropower between 25 and 40 m^2, ground-mounted solar PV 7-34 m^2; rooftop PV between 2-5 m^2; natural gas with CCS 0.5-4 m^2 per megawatt-hour, and onshore wind less than 0.5 m^2 per megawatt-hour (ECE, 2021).

Significant land requirements can pose challenges related to land ownership (which is often fragmented or unclear), rights to access land and ocean territories, and community displacement. Densely populated geographies without large areas of non-arable lands are at risk for land use competition. In such areas, utility-scale renewables installations are often installed on land that could be used for agriculture or forestry (van de Ven and others, 2021). Offshore wind developments can create perceptions of risks to fishing territory access, which have raised concerns for fishing communities. Biofuel plantations have in some cases replaced agricultural crops with potential impacts on food security, biodiversity loss due to monocropping or the conversion of natural habitats, or community access to forests. Local disputes related to developments have arisen in some cases.

Land use changes can also affect the structure of local labour markets and economies. As land is transitioned, local populations may lose access to agricultural employment or the use of forest land, and in some places, a facilitated transition of agricultural sector workers will be needed in the same way that the labour markets of the conventional energy sector will need to adjust. While landowners may benefit from the reliable income of a lease arrangement or the sale of land, the landless are at highest risk. In many developing countries, women comprise the larger share of the agricultural workforce and also engage in activities, such as weaving, for supplemental income, which depend on access to forest lands for gathering material stocks. Female land ownership is much lower than male ownership. Women also have greater difficulties accessing employment opportunities (ILO, 2023) and are often not fully included in household decisions to sell or lease land. Accordingly, women are at particular risk during land use changes.

Policymakers and developers are developing innovative approaches to address these issues, with new renewables system designs and efforts to better integrate infrastructure with local ecosystems (IRENA and FAO, 2021).

For example, “agrisolar” or “agrivoltaics” – which involves the co-location of solar PV and agricultural products or services – can help manage potential displacement of food production. These applications are being piloted in countries, such as China, India, Japan, the Philippines, and the Republic of Korea. Dual use of land for renewables and agriculture or grazing also mitigates the negative carbon impacts of land conversion. Another strategy to address land constraints is to place solar PV in the built environment – for instance, on parking lots and industrial rooftops – or to develop floating solar on bodies of water, as what is being done in Indonesia, Singapore and Thailand. Solar aquaculture farms have the dual benefit of reducing evaporation losses and protecting fish stocks.

Two of the barriers for agrivoltaics projects are more complex system designs and higher upfront costs. Most markets lack regulations for the dual use of land. The presence of solar panels requires adaptations of farming practices and logistics, while lower crop yields may affect economic viability (Dawnbreaker, 2022). However, they also may be able to boost food production in less productive areas through the installation of solar-powered greenhouses, solar-powered water pumps, cold storage or by providing shade in high solar intensity regions.

Further effort is required to better understand the interplay between wind power and marine ecosystems. Some research has shown that offshore

wind farm installations can support the development of artificial reefs that provide new habitats and strengthen fish populations (Wilhelmsson, Malm and Öhman, 2006; Degraer and others, 2020). However, other research has pointed to potential negative impacts to marine life from habitat disturbance and noise during construction (Jarriel and others, 2023; Solé and others, 2022). The science is incomplete and studies acknowledge the need for more research across regions and the spectrum of marine life. For example, recent assessments of offshore wind in India found that, while institutional frameworks are in place, there is a dearth of studies on the associated environmental and social challenges of this type of infrastructure (Sarangi, 2022) (Krishnan and others, 2022).

Overall, energy policy and planning frameworks that integrate long-term environmental and social considerations, alongside best practice engagement with affected stakeholders, would enhance prospects for successful and inclusive clean energy transitions. The financial system can also play an important role – for example, the ASEAN Taxonomy for Sustainable Finance is intended to align investment decisions for climate action with the protection of healthy local ecosystems and biodiversity (ASEAN, 2023). To support all these efforts, more research is also needed on the costs, benefits and long-term impacts from the interplay of renewable energy and agriculture and fisheries.

CHAPTER 4

IMPACTS OF OVERLAPPING CRISES ON ENERGY TRANSITIONS

The emergence of two consecutive global crises – the COVID-19 pandemic from 2020 and the war in Ukraine from 2022 – has raised new risks to clean energy transitions in the Asia-Pacific region. These crises also present an opportunity to accelerate sustainability efforts. By encouraging diversification away from fossil fuels, these efforts can foster stronger energy security and result in economic benefits. The impacts of the crises on markets, policies and investments are still playing out, and their effects vary across countries. Despite this, lessons learned have emerged on how Asia-Pacific economies can thrive in a more volatile world. The analysis in this chapter assesses these issues across the following milestones:

- **Energy impacts of the early COVID-19 pandemic:** The initial stages of the pandemic led to an economic slowdown across almost all countries, with stark implications for the energy system across demand, supply, investment and employment. In many countries, more people started working from home and spending a greater amount of time indoors, shifting consumption patterns and supply-demand pressures across parts of the energy system. Border closures resulted in dramatic reductions in transport demand. Constraints in developing energy projects from supply chain and labour disruptions also emerged, raising questions for the progress related to longer-term energy and SDG 7 targets.

- **Challenges for a sustainable recovery – economic constraints and a fossil fuel-led rebound:** As societies managed the effects of the pandemic, the mobilization of fiscal and financial resources to support economic recovery varied considerably. A rebound in energy demand in 2021 was met by increased reliance on existing fossil fuels, putting the Asia-Pacific region back on a path of rising CO_2 emissions. The pandemic and the subsequent rebound also exposed significant clean energy supply chain vulnerabilities, which need to be dealt with to meet SDG 7 targets.

- **Challenges for a sustainable recovery – energy crisis and new energy security risks:** Impacts arising from the war in Ukraine has exacerbated the already tight energy market situation, resulting in shifting trade patterns, and high and volatile energy prices. The exposure, impacts and responses across the Asia-Pacific region have varied widely by geography and an economy's energy resources. In particular, the Asia-Pacific region has borne the brunt of a global reorientation in trade for natural gas, raising questions over the role of that fuel in secure and sustainable transitions.

- **Implications for just and inclusive transitions – new affordability pressures:** The pandemic has highlighted the importance of ensuring modern energy services for the well-being for all. But the crises have created new pressures on affordability and access, particularly among the most vulnerable. As Asia-Pacific Governments have sought to buffer populations from volatile energy markets, strains on public budgets have emerged. Shifting economic conditions have further pressured access to the private finance required for sustainable transitions.

- **Opportunities for secure and sustainable development – policy and planning strategies:** Some Asia-Pacific countries have responded to these challenges by implementing wide-ranging measures to improve energy efficiency and accelerate the shift to renewable energy. Others with ready availability of domestic supply have reinforced fossil fuel-based energy systems. This chapter provides an assessment of how these strategies affect efforts to attain SDG 7 targets and lessons are drawn for supporting secure and sustainable development in a more volatile world.

Energy impacts of the COVID-19 pandemic

The Asia-Pacific region was heavily affected by economic contraction during the onset of the COVID-19 pandemic in 2020. Since that period of negative growth, an initial period of economic recovery, driven by robust demand for exports, was followed closely by a period of moderation in late 2021, as renewed lockdowns and other restrictions led to supply disruptions. Data for Asia and the Pacific (excluding China) from early 2022, on average, indicate that a gradual rebound is occurring.

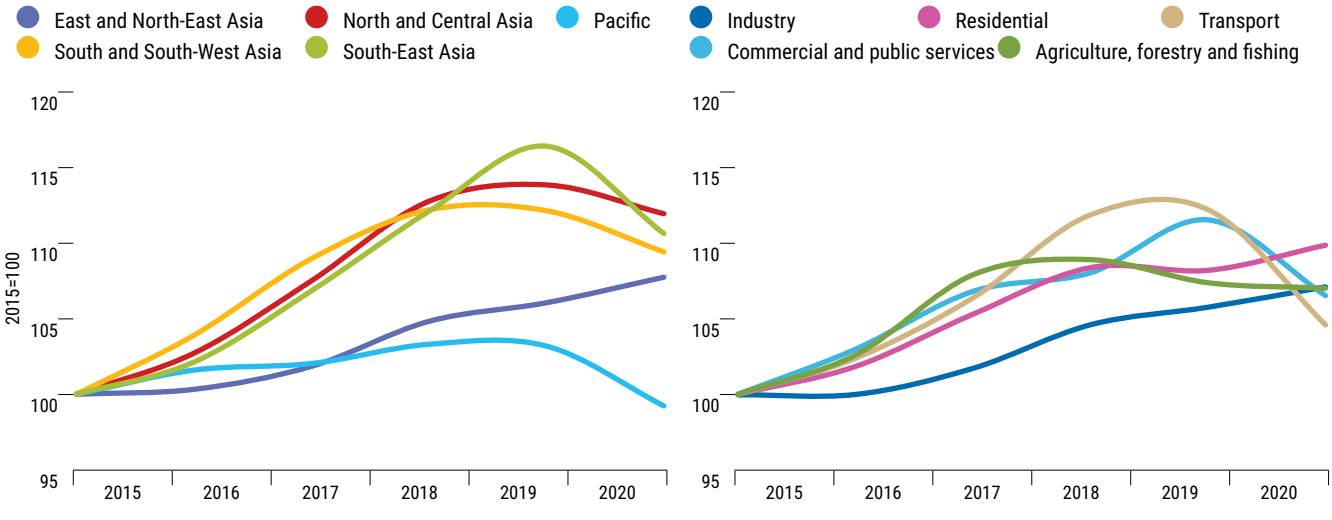
Real GDP in Asia and the Pacific decreased by 0.8 per cent in 2020. A few countries in the region – notably China and Viet Nam – bucked the trend of an economic downturn due to initial efforts to manage the impacts of the pandemic and maintain higher levels of industrial output. However, across most subregions and countries, industrial activity slowed considerably, unemployment rates rose and vulnerable segments of society experienced an uptick in economic hardship. Reversing a trend of declining poverty, the share of the population living below the national poverty line increased in Georgia, Indonesia, Kyrgyzstan and Thailand, among other countries.

Following several years of rapid growth, energy consumption declined by 0.5 per cent across the Asia-Pacific region in 2020. While the regional picture was more resilient compared to global demand, which fell by 4.3 per cent, the decline was comparable to that experienced in 1998 on the back of the Asian financial crisis. Demand fell across all subregions, except for East and North-East Asia, where China, whose consumption grew by more than 3 per cent, provided support (figure 29). In the Asia and Pacific outside of China, energy consumption was far less robust, falling by 3.2 per cent in 2020. Among the subregions, demand fell most rapidly in South-East Asia (-5.0 per cent) followed by the Pacific (-3.8 per cent), where energy consumption declined to pre-2015 levels.

The pandemic has had a profound effect on the way consumers use energy. In many countries more people started working from home and spending more time indoors, which caused residential demand to increase. The support provided from maintaining industrial output in some countries, notably China, has caused demand from the industrial sector to also rise. By contrast, with the closure of public spaces due to pandemic-related lockdowns and restrictions on mobility, the commercial and transport sectors bore the brunt of the contraction in 2020 with recorded declines in energy demand of 4.5 per cent and 6.8 per cent, respectively.

Asia-Pacific energy consumption declined by 0.5 per cent in 2020. This trend was starker outside of China, where energy consumption fell by more than 3 per cent; the commercial and transport sectors bore the brunt of the declines

Figure 29/ Trends in Asia-Pacific total final consumption by sub-region (left) and by sector (right)



Source: ESCAP calculations based on IEA, World Energy Statistics and Balances (2022d).

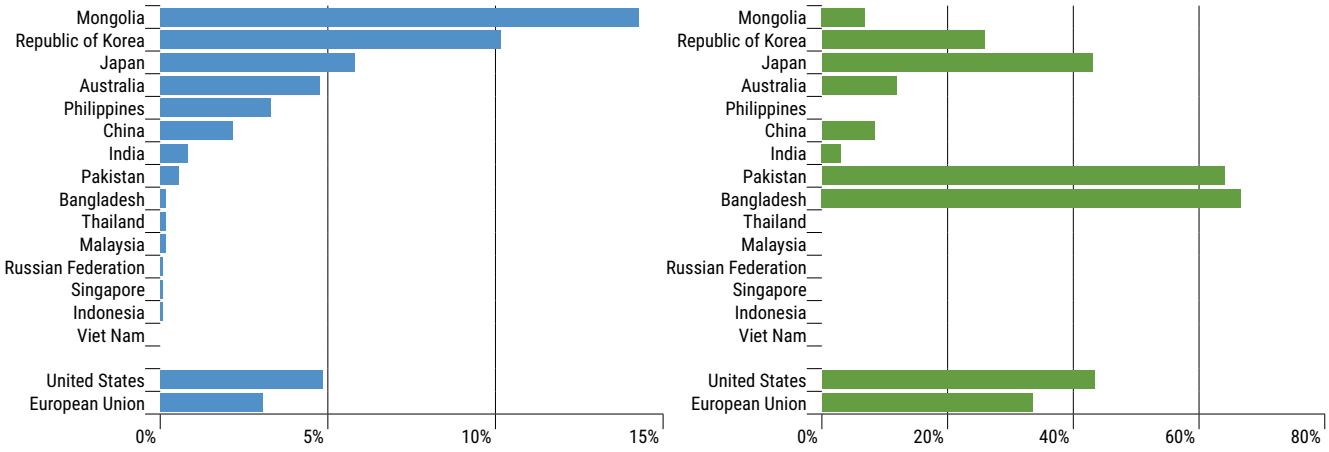
New project development constraints have also emerged. In Asia and the Pacific, energy investment, at more than $900 billion, declined by approximately 2 per cent in 2020, after rising during the previous two years (IEA, 2022i). This decrease was largely driven by fossil fuels and fossil-fuel based power generation, as investors reacted to a lower energy price environment and more uncertain demand prospects.

By contrast, investment in clean energy remained relatively resilient (+4 per cent), led by renewable power (+6 per cent) and spending on energy efficiency (+2 per cent), in part due to the stabilizing effect of climate-related policies in some countries. The resilience in clean energy investment stemmed largely from China, and from the solar PV sector in Viet Nam, bolstered by generous, and a few other markets, such as Cambodia. However, outside of China, regional clean energy investment in 2020 declined by more than 3 per cent, slowing efforts for meeting longer-term SDG 7 targets.

Challenges for a sustainable recovery – economic constraints and fossil fuel led rebound

Fiscal responses to the pandemic have varied widely across the Asia-Pacific region. Commitments to fund a sustainable recovery were generally greater in advanced economies

Figure 30/ Recovery fiscal spending in 2021as a share of gross domestic product (left) and green component of spending (right) for select economies



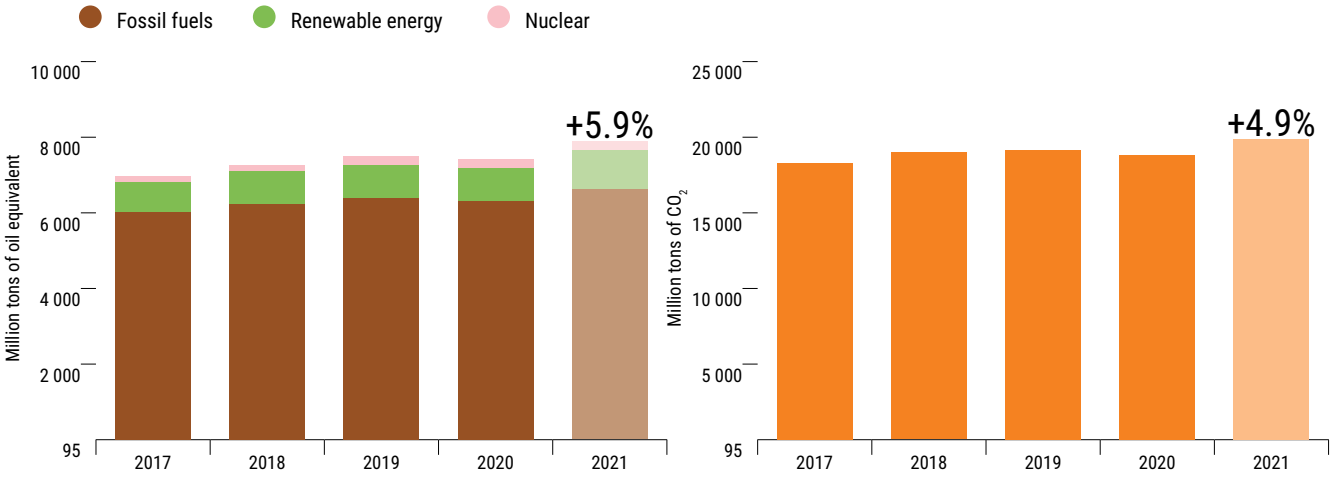
Source: ESCAP calculations based on Korean Environment Corporation and Republic of Korea, Ministry of Environment (2023).

As Asia-Pacific countries grappled with the health and human impacts of the pandemic and commercial disruptions, questions emerged over the economic recovery and opportunities to make the outcome more sustainable, inclusive and resilient. With the start of the war in Ukraine in 2022 and an ensuing global energy crisis, these questions became even more critical.

The fiscal resources mobilized to support the economic recovery have varied considerably across the region (figure 30). In general, government commitments to funding a sustainable recovery were greater among the Asia-Pacific high-income economies, countries in Europe and the United States. Recovery spending as a share of 2021 GDP was led by Mongolia, the Republic of Korea, Japan, Australia, and the Philippines. However, many Asia-Pacific countries, for which data were available, devoted less than 1 per cent of GDP on recovery spending. In only a few economies, such as Bangladesh, Pakistan and Japan, the sustainable, or "green", component of spending exceeded 30 per cent.

Asia and the Pacific accounted for 45 per cent of the world's carbon-intensive growth in 2021, as three quarters of new demand was met by fossil fuels; renewables, however, also grew at a record pace

Figure 31/ Total energy supply by product (left) and CO_2 emissions from fuel combustion in Asia and the Pacific (right)



Sources: ESCAP calculations based on IEA, World Energy Statistics and Balances (2022d), IEA, CO_2 Emissions from Fuel Combustion Statistics (https://www.oecd-ilibrary.org/energy/data/iea-co2-emissions-from-fuel-combustion-statistics_co2-data-en) (IEA (2022e).
Notes: Data for 2021 are estimated based on regional annual growth rates from the IEA World Energy Outlook and should be treated as preliminary until final data are available through the ESCAP Asia Pacific Energy Portal.

The responses reflect the differing economic impacts from the pandemic and varied availability of domestic public resources. Public debt distress worsened during the crisis, particularly for those countries with the greatest development needs, such as small island developing States. The recovery measures indicate that governments have, to date, not leveraged the window of the crisis to advance SDG 7 targets or to prioritize climate and environmental objectives more broadly. Nevertheless, ESCAP research highlights that efficiently and effectively investing in sustainable development can provide a powerful long-term debt management tool (ESCAP, 2023b).

As Asia-Pacific countries recovered from the effects of the pandemic, rebounding energy demand was met by increased reliance on fossil fuels, putting the region back on a path of rising CO_2 emissions, following a dip in 2020 (figure 31). Preliminary estimates point to regional energy demand increasing by approximately 6 per cent in 2021 – the fastest rate in nearly two decades. Three quarters of the increase was met by fossil fuels, while renewable energy comprised only one-fifth of the rise.

This reliance on fossil fuels had the effect of driving an annual increase in regional CO_2 emissions of approximately 5 per cent. Compared with a global rise in energy-related CO_2 emissions of 2.1 gigatons from 2020 levels, Asia and the Pacific accounted for nearly 45 per cent of the world's carbon-intensive energy growth in 2021 (IEA, 2022e). Within the region, this increase in emissions was roughly split in half between China and the rest of the region.

In terms of growth rates, renewable energy in the Asia-Pacific region is estimated to have expanded by more than 10 per cent in 2021, its fastest rate of growth ever for renewables and double that for fossil fuels. Half of this increase came in China, where wind and solar PV deployment remained at historically high levels.

Nevertheless, the pandemic and the rebound in demand has exposed significant supply chain vulnerabilities, which need to be addressed in order to meet SDG 7 targets. At present, most of the world's manufacturing of renewable energy technologies and products is in the Asia-Pacific region (UN Global Crisis Response Group on Food, Energy and Finance, 2022). Constraints have emerged pertaining to the availability of technology equipment manufacturing and CRMs vital to clean energy transitions – lithium, cobalt, nickel, aluminium, and copper. From January 2021 to May 2022, increases in global price for these materials eclipsed the largest annual increases seen in the 2010s (Kim, 2022) as mining and processing capacity grew more slowly than demand (Gielen, 2021).

Challenges for a sustainable recovery – energy crisis and new energy security risks

The start of the war in Ukraine in 2022 and the associated global energy crisis exacerbated existing energy system pressures brought about by the economic rebound in 2021, as trade patterns changed, and prices increased and become more volatile. The crisis further disrupted fossil fuel supplies, for which the Russian Federation is the leading global exporter of natural gas and the second largest exporter of oil. These pressures have fed into elevated energy security concerns, creating new questions over fossil fuel dependency, and adding new risks to progress in meeting SDG 7 targets. Although pressures have eased somewhat in 2023 amid signs of economic slowing, prices and markets have remained volatile.

The exposure, impacts and responses across the Asia-Pacific region have varied strongly by geography and product. Coming into the crisis, approximately two thirds of Asia-Pacific countries were net-energy importers. Oil accounted for more than 60 per cent of the region's imports followed by coal and natural gas (figure 32) and net imports accounted for more than 80 per cent of total primary energy supply in such countries as Singapore, Japan, the Republic of Korea, and Georgia. In contrast, Mongolia, Azerbaijan, Brunei Darussalam, and Bhutan export far more energy than they use domestically.

Prior to the crisis, approximately 55 per cent of energy exports from the Russian Federation were directed to Europe and 40 per cent were shipped to the Asia and Pacific region. Most of the energy imports to Asia-Pacific countries were crude oil, oil products and coal, while natural gas imports were limited.

Efforts to reduce reliance on Russian supplies have been carried out mostly by European countries; a few Asia-Pacific markets have taken a gradual approach to decreasing exposure. These actions have global implications. In Europe, governments have sought to accelerate energy savings measures, including energy efficiency, behavioural changes and the incentives for the uptake of more efficient end use electrification options, such as heat pumps. Countries have also taken measures to rapidly secure and diversify fossil fuel supplies, which is putting pressure on wider energy fundamentals.

The interconnected nature of global energy markets, knock-on effects from trade actions and the presence of climate-related shocks – such as heatwaves – created a perfect storm of high fuel prices, supply disruptions and domestic energy shortages for Asia-Pacific economies in 2022, which continues to play out across markets and in responses by public and private actors.

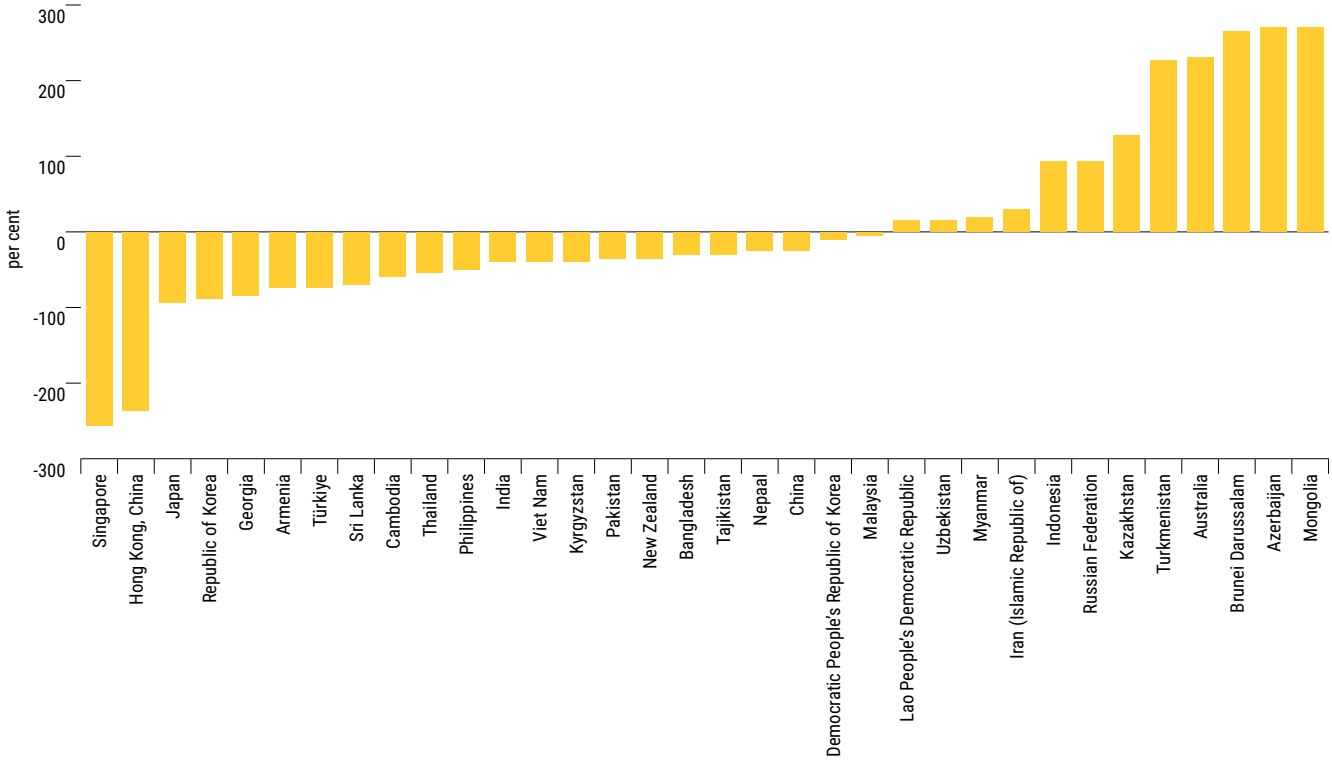
First, the Asia-Pacific region has borne the brunt of a global reorientation in trade for **natural gas**, which comprises one fifth of its primary energy supply. As European economies sought to reduce dependence on Russian pipeline gas, their imports of liquified natural gas (LNG) surged in 2022, which significantly tightened the LNG market that had previously been in oversupply (figure 33). Average LNG spot prices imported into Japan rose from $5 per million metric British thermal units (MMBtu) in 2019-20 to $19 per MMBtu in 2021 and $33 per MMBtu in 2022.

As buyers bid up LNG prices, some spot cargoes that would have supplied Asian markets were redirected to Europe and net imports into Asia-Pacific countries fell compared to 2021. While part of this decline stemmed from pandemic-related demand weakness in China, some economies in South and South-East Asia faced acute challenges in filling demand requirements. For example, call for tenders by Pakistan to supply gas to the power sector from 2023 to 2029 failed to receive any bids (Stapczynski, 2022). Across the region, higher gas prices have had knock-on effects on electricity prices and agricultural markets due to lower fertilizer production.

The situation has raised questions over the role of gas in meeting the region's growing demand and emissions reduction goals. For some countries, gas was viewed as a key transition fuel, with the ready availability of LNG imports underpinning a shift from inefficient and polluting coal power plants and industrial boilers. Asia accounts for 60 per cent of LNG importing terminals under development, equivalent to half of the global import capacity and nearly $120 billion of investment (Global Energy Monitor, 2022a). The Asia-Pacific region is viewed as the largest driver, as it is projected to account

Two thirds of Asia-Pacific countries are net-energy importers, with oil accounting for more than 60 per cent of energy product imports by countries across the region, followed by coal and natural gas

Figure 32/ Energy trade balance (net exports/imports) as a share of total energy supply for select Asia-Pacific economies, 2019



Source: ESCAP calculations based on IEA (2022d).
Notes: Positive values correspond to net exporters and negative values correspond to net importers.

for nearly 50 per cent of the growth in global gas demand over the next five years (IEA, 2022d). However, this outlook has been downgraded in recent years and considerable downside risks have emerged for demand and for investments in gas infrastructure and gas power generation amid a price environment that remains elevated, with Asian LNG prices exceeding $13 per MMBtu as of March 2023.

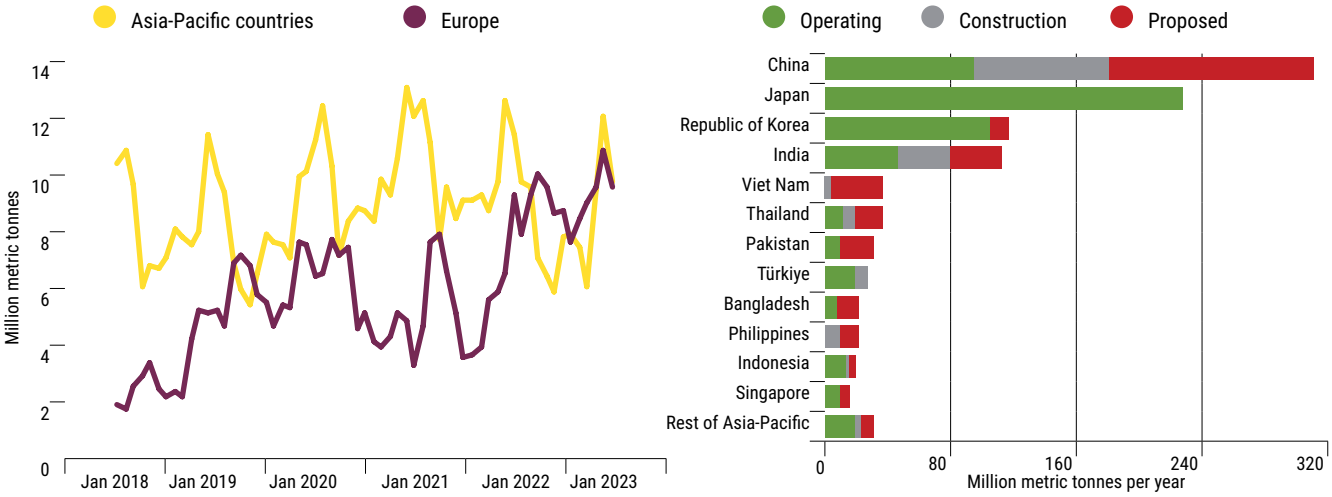
Second, the Asia-Pacific region remains heavily exposed to volatility in **coal**, which comprises more than 40 per cent of primary energy supply. The announcement by the European Union that it would no longer import Russian coal from August 2022, and signals of reduced purchasing from Japan and utilities in the Republic of Korea, led those economies to search for alternative-origin supplies (Median and others, 2022). Prices for coal from South Africa, Australia and Indonesia rose sharply, tightening even those markets with access to discounted Russian coal, which was subject to rising transaction costs (Median and others, 2022).

For some countries, such as India, the energy crisis, combined with record summer temperatures, exacerbated domestic coal shortages, and led to power outages and expensive coal import bills. Coal producers, such as China and Indonesia, focused on reinforcing domestic supply. But for countries with more limited purchasing power and domestic supply options, such as Bangladesh, Pakistan and Sri Lanka, the situation prompted severe energy rationing.

The crisis also tightened global oil markets, for which prices were rising starting in late 2021. Crude oil prices increase by 33 per cent during the first half of 2022, surpassing $100 per barrel for the first time since 2014. Approximately 40 per cent of crude oil from the Russian Federation is imported by Asia-Pacific countries; China alone accounts for 25 per cent. The region plays a smaller role in oil products imports. Some countries, such as China and India, have accessed discounted Russian oil, effectively increasing their import levels, but these

Asia and the Pacific bore the brunt of a global reorientation in gas trade as LNG prices soared in 2022; still, the region continues to develop 60 per cent of the world's new LNG import capacity

Figure 33/ Monthly liquefied natural gas net imports by region (left) and top Asia-Pacific countries developing liquefied natural gas import terminals (right)



Source: ESCAP calculations based on the JODI (2023) and Global Energy Monitor (2022a).
Notes: Monthly net imports analysis is based on countries providing complete data to the Joint Organisations Data Initiative (JODI) Gas World Database for the period of analysis; Europe includes the European Union countries, Norway, and the United Kingdom.

import can carry increased transaction costs (Median and others, 2022). While crude oil prices have remained volatile and elevated in 2023, in part due to announced production cuts from Organization of Petroleum Exporting Countries, the softening of the global economy has brought them closer to pre-pandemic levels (more than $75 per barrel as of March 2023).

Implications for just and inclusive transitions – new affordability pressures

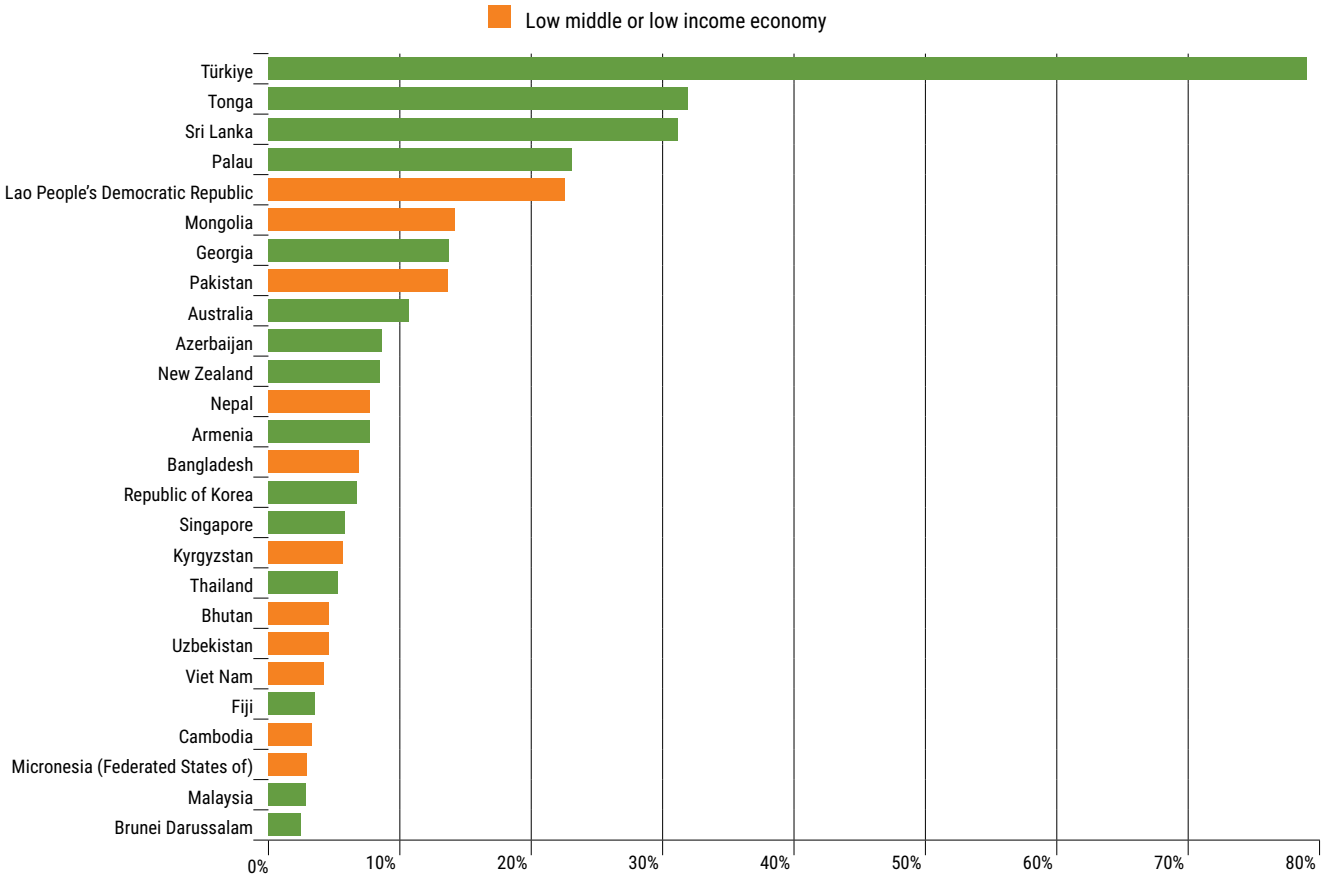
While the COVID-19 pandemic has highlighted the importance of ensuring modern energy services for the well-being for all, the pandemic and energy crisis has created new affordability pressures. As Asia-Pacific economies seek to create more inclusive, resilient and sustainable societies, they are now confronted with increased economic risks, including price inflation, greater constraints on public finances, and imbalances in the cost and availability of capital, which affect prospects for funding efforts to meet SDG 7 targets.

Rising prices for energy commodities during 2022 partly fed into higher consumer prices in many countries. The International Monetary Fund (IMF) index of energy, water and housing prices provides an indicator of consumer-level movements across a range of countries (figure 34). Most Asia-Pacific countries recorded increases in prices of 5 to 15 per cent during the second half of 2022 compared with the same period in 2021. Producer economies, such as Brunei Darussalam and Malaysia, recorded modest inflation. In some countries (Lao People's Democratic Republic, Pakistan, Sri Lanka, and notably Türkiye) inflation was greatly exacerbated by a depreciating domestic currency, which boosted the cost of imported commodities priced in U.S. dollars.

Rising energy prices tend to have a disproportionate impact on the welfare of lower-income countries and vulnerable segments of society. Households around the world typically spend approximately 7 per cent of their incomes on energy; however, that figure is often higher for poorer households, even though they consume less energy than wealthier ones (IEA, 2022j, p. 195). IMF has found that most countries around

Rising energy prices during 2022 fed into higher prices for consumers; consumer price in most Asia-Pacific countries rose 5 to 15 per cent during the second half of 2022 compared with the first half of 2021

Figure 34/ Annual change in average consumer energy, water and housing prices in select Asia-Pacific countries, second half of 2022



Source: ESCAP calculations based on IMF Consumer Price Index Data (https://data.imf.org/?sk=4FFB52B2-3653-409A-B471-D47B46D904B5)
Notes: Energy includes electricity and fuels; data for Sri Lanka are through September; data for Mongolia and Nepal are through October.

the world have sought to buffer their populations from volatile energy markets and limited the pass-through of higher international fuel prices to domestic consumers through interventions, such as price caps, income transfers, tax reductions and trade measures. Due to such measures in emerging and developing Asia, for example, consumers absorbed less than 60 per cent of international diesel fuel price rises in 2022, compared with nearly 70 per cent in 2021 (Amaglobeli and others 2022).

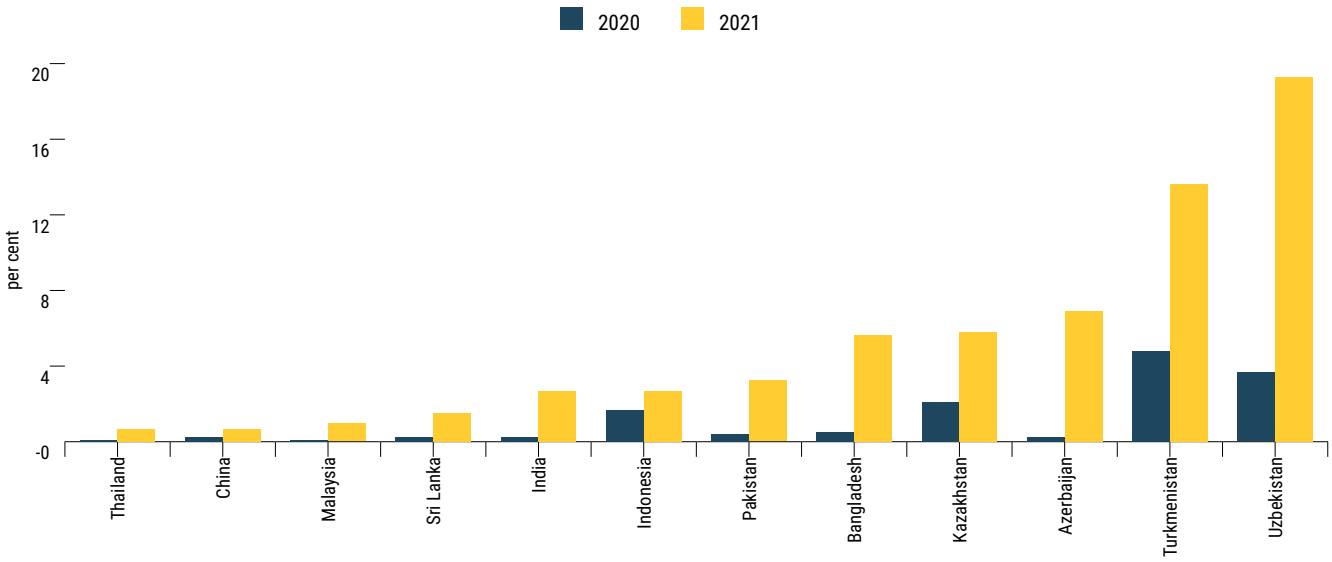
A combination of high and volatile energy prices, and policy measures to shield consumers from the brunt of price increases has increased the strain on public budgets. IEA estimated that global fossil fuel consumption subsidies soared to a record of more than $1 trillion in 2022, and that the consumption of natural gas and electricity more than doubled and oil subsidies shot up by approximately 85 per cent (IEA, 2023a).

In recent years, the subsidy burden in the Asia-Pacific region has increased (figure 35). In countries in the North and Central Asia and South and South-West Asia subregions, fossil fuel subsidies as a share of GDP soared in 2021. While 2022 country-level data were not available at the time of publication, higher international prices and interventions by some governments suggest that subsidy burdens likely increased. In Malaysia, MYR 5 billion (about $1 billion) was spent in June 2022 alone on gasoline subsidies (IEA, 2023a), while the government expected to spend MYR 6.5 billion in electricity subsidies for the year (Dermanwan, 2023). The Philippines provided income of 500 pesos ($9) per month to the bottom 50 percent of households (about 12 million families) for six months starting in April 2022 (IEA, 2022c).

With notable exceptions, fossil fuel subsidies are often not directed to those in most need. While most Asia-Pacific consumption subsidies are in

In an effort to buffer populations from volatile energy markets, Asia-Pacific subsidy burdens have increased, particularly in North and Central Asia and South and South-West Asia countries

Figure 35/ Fossil fuel subsidies as a share of gross domestic product in select Asia-Pacific countries



Source: ESCAP calculations based on IEA, Fossil Fuels Subsidies Database (https://www.iea.org/data-and-statistics/data-product/fossil-fuel-subsidies-database).
Note: Includes consumption subsidies for coal, oil, gas and electricity.

emerging and developing economies, the distribution within countries is often weighted toward heavy energy users and limited for those outside supply chains, such as communities lacking energy access. Some countries, however, are trying to address the drawbacks of these inefficiencies: for example, Malaysia is looking to reform its gasoline and electricity subsidies to be more targeted, while Indonesia partly reduced its broad-based gasoline subsidies and is considering targeted social assistance to lower income segments.

Ultimately, reducing economic burdens from fossil fuels and enhancing energy affordability for all depend on investments in cost-effective energy efficiency, electrification and renewable energy, which can better help to keep energy bills manageable and shield consumers from energy price shocks. Removing price distortions associated with fossil fuel dependency is one way to level the economic playing field for clean energy. Such investments depend on the significant mobilization of private capital, but again the benefits are skewed away from those most in need: the cost of finance is often higher in countries that are most in need, especially those in emerging and developing economies. Based on this, shifting global financial conditions present another economic risk to meeting SDG 7 targets in the Asia-Pacific region (box 7).

Energy transitions involve a shift from spending on fossil fuels to investments in capital-intensive clean energy technologies, whose economics are more sensitive to the cost of finance (IEA, 2021b). Rising interest rates result in a higher cost of financing, which can undermine the economics of clean energy projects. In countries, such as Australia, the Republic of Korea and Viet Nam, changes in benchmark interest rates in 2022 could translate into a 10-25 per cent increase in LCOE for a new onshore wind farm investment, depending on local conditions (figure 36).

The task of financing the SDG 7 targets under tightening financial conditions would benefit from a multi-pronged approach. Governments have the opportunity to reduce fiscal burdens from costly fossil fuel subsidies. They can also better address the specific risks associated with clean energy project development, which can help to limit increases in financing costs, and support development of local supply chains, which can help to provide a buffer against currency volatility.

Box 6 How could changing macrofinancial conditions affect financing for Sustainable Development Goal 7 targets?

Following a decade of historically low interest rates, borrowing costs around the world surged in 2022 as central banks sought to stem economy-wide inflation. In Asia-Pacific economies, ten-year government bond yields rose by one to three percentage points in China, India, Indonesia, Malaysia, the Republic of Korea, and Thailand, among others. As rates increased more rapidly in the United States, some national currencies depreciated significantly against the U.S. dollar. Amid persistent capital flight and depreciation risks, central banks may look to keep interest rates relatively high.

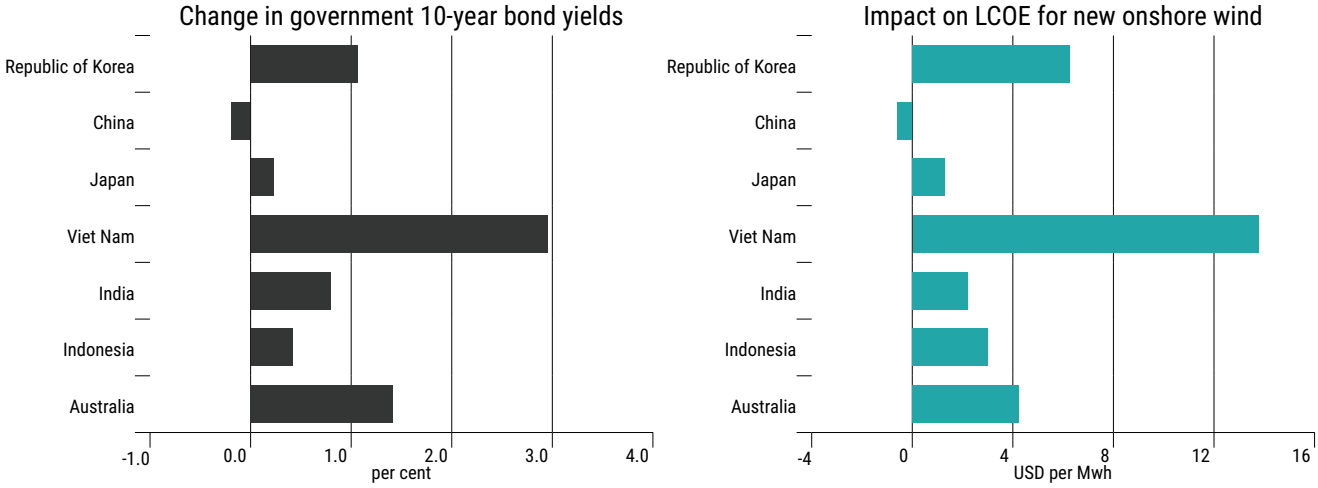
Such changes pose a challenge to financing SDG 7 targets, particularly for emerging and developing economies and vulnerable populations. Across the region, rising rates are exacerbating public debt burdens, which are the highest since 2008. Nineteen Asia-Pacific countries are now rated at high risk of debt distress.[a] Governments may, in turn, face pressure to limit clean energy incentives for private-led developments, including cross-border development assistance, and to slow direct investments in electricity grids and energy access, which often depend on public sources of capital.

[a] United Nations, Economic and Social Commission for Asia and the Pacific (2023). *Economic and Social Survey of Asia and the Pacific 2023: Rethinking Public Debt for the Sustainable Development Goals. United Nations publication.*

For creditors and borrowers, there may be an opportunity to restructure debt terms and link them to enhanced sustainability action through instruments, such as climate-linked loans or debt-for-climate swaps (Bueno, 2022). For development finance institutions, there is an opportunity to better target risk capital to maximize impact, such as through blended finance mechanisms and development of new facilities to manage currency volatility. More comprehensive data covering the cost of capital for clean energy projects, especially in emerging and developing economies, would support all these efforts (IEA and Centre for Climate Finance and Investment, Imperial College Business School, 2023).

For some Asia-Pacific countries, changes in benchmark interest rates in 2022 could translate into a 10-25 per cent increase in levelized generation costs for a new onshore wind farm investments

Figure 36/ Changes in interest rates and impact on levelized cost of electricity for new onshore wind for select countries, 2021–2022



Source: ESCAP calculations.
Note: LCOE, levelized cost of electricity; MWh, megawatt-hour.

Opportunities for secure and sustainable development – policy and planning strategies

As countries respond to recent crises, they are at a crossroads in terms of energy choices. Over the past decade, global investment in clean energy transitions, including in the Asia-Pacific region, has been insufficient to achieve SDG 7 targets and put energy systems on a secure path towards the transformation required (IEA, 2022j). At the same time, investment in fossil fuels has trended lower since the middle of the previous decade, raising risks of supply-demand imbalances in the face of market shocks (IEA, 2022i).

This investment dilemma raises the question over how Asia-Pacific decision makers can balance energy security and climate change goals while enhancing societal welfare. Some Asia-Pacific countries have responded to the crises by implementing wide-ranging measures to improve energy efficiency and accelerate the shift towards renewable energy. Others have reinforced fossil fuel-based energy systems. This chapter includes an assessment on the implications of these strategies towards attaining SDG 7 targets and lessons for supporting secure and sustainable development in a more volatile world.

In keeping with the approach by the United Nations Global Crisis Response Group on Food, Energy and Finance, the analysis below structures such assessments by short-, medium- and long-term time horizons (UN Global Crisis Response Group on Food, Energy and Finance, 2022).

Short term (3-12 months)

Much of the short-term focus in the Asia-Pacific region has been to manage energy demand, boost energy purchasing options and address the impacts of crises on consumer economics. Many quick-win and cost-effective efficiency measures are available to manage heating and cooling and mobility energy demand. As noted above, few economies have set sustainable recovery spending plans or have rolled out integrated energy approaches.

The short-term responses by advanced economies included greater emphasis on energy savings, contracts for fuel purchase and supplier diversification, albeit at a price premium. The *Setsuden* Program of Japan, which promotes utility-run demand response schemes with economic incentives for consumers based on electricity savings, has emerged as a model for demand-side crisis management. The people of Japan also adjusted thermostats for space cooling, heating, and hot water. Australia also took extraordinary steps to cap gas prices and intervene in power markets to manage the financial fallout from the energy crisis. Some of the emergency measures taken by the Republic of Korea included demand curbs, higher gas and electricity prices, securing LNG supply and supporting importers.

Emerging and developing economies in the region often have less flexibility in terms of crisis and demand management, particularly with domestic economic pressures from energy price inflation. These countries have emphasised the provision of emergency fuel subsidies or instituted energy rationing. Measures to ensure affordable energy in the near term can also make it more difficult to reduce reliance on fossil fuels. For example, in 2022, Thailand introduced a diesel price cap of THB 30 ($0.85) per litre and temporarily curbed excise taxes for diesel and fuel oil for power, while Mongolia provided price subsidies to help sustain household consumption of coal briquettes.

Blanket price management efforts and untargeted energy rationing undermine SDG 7 targets and can exacerbate existing crisis conditions, as in Pakistan, which was subject to power blackouts and load shedding when demand continued to outstrip supply. However, some well-designed measures, such as the *Pradhan Mantri Ujjwala Yojana* subsidy scheme, implemented by India, which supports access to LPG for the poorest segments, can have positive impacts on progress towards realizing challenging targets, such as access to clean cooking fuels and technologies.

Medium term (1-4 years)

Combined with the roll-out of broader energy efficiency strategies, ramping up renewable energy and low-carbon fuels would help to fill supply gaps and support security and transition goals. Such technologies can often be rolled out faster, and at a lower cost than fossil fuel-based supply, but such developments require good policy

design and implementation to send clear signals for investment.

In terms of demand-side strategies, the Government of Australia has allocated fiscal support for small and medium enterprises to carry out energy efficiency upgrades, while it seeks to develop a national energy performance strategy and to expand the Greenhouse and Energy Minimum Standards programme and the Nationwide House Energy Rating Scheme. To help address growing energy security concerns, in 2022, the Republic of Korea announced an ambitious energy efficiency plan to reduce national energy intensity by 25 per cent over the following five years through 15 major tasks across sectors.

India recently amended its Energy Conservation Bill, which boosts the scale and scope of its energy conservation with new building codes and enforcement measures. The Philippines also started policy discussions around behaviour change, including shorter work weeks and work-from-home options. All told, however, the roll-out of comprehensive strategies is lacking in many Asia-Pacific countries.

On the supply side, the alignment of crisis-related developments with SDG 7 targets has been mixed. Despite continued improvements in the economics of solar PV and wind – the most dynamic renewable energy technologies for cost reductions – recent deployment has been uneven across markets. While capacity additions accelerated in some areas, less than 45 per cent of Asia-Pacific countries deployed more solar PV and wind power in 2022 compared with pre-pandemic years (figure 37).

The large demand needs and resources in China and India have led to authorities following any opportunity for new supply and seeking to boost both fossil fuels and renewables. In 2022, both country's investments in coal production was set to increase, while the final investment decisions of China for new coal power plants was set to rise (IEA, 2022b). Both these countries also recorded near-record renewable power additions in 2022, buoyed by supportive policies for wind and solar PV.

Some countries, such as Indonesia and Pakistan, appear to favour medium-term approaches that prioritize the development of local coal supply, though such approaches may ultimately be tempered by longer-term climate strategies and financial commitments (see below). Meanwhile, while many countries retain plans to increase the use of gas in their energy systems, increased investment risks and challenges in obtaining financing have led to delays or a scaling-back of some LNG and gas power generation projects in Bangladesh, Pakistan and the Philippines

Indicative of the resilience of clean energy through the crises, global financing for energy transition supply and demand technologies rose to record levels, exceeding $1.1 trillion in 2022 (BloombergNEF, 2023). China accounted for nearly 50 per cent of this, and the Asia-Pacific economies of Japan, the Republic of Korea and India were among the top 10 countries globally engaging in energy transition investment. In 2022, in its NDCs, Fiji reiterated its goal of 100 per cent renewable electricity and decarbonized transport by 2030, while Thailand set new incentives for renewables deployment.

Despite recent developments, policy and investment activity in support of a more diverse and sustainable energy supply based on renewables remains insufficient across most Asia-Pacific countries, suggesting the crises have yet to spur comprehensive medium-term actions required to achieve SDG 7 targets.

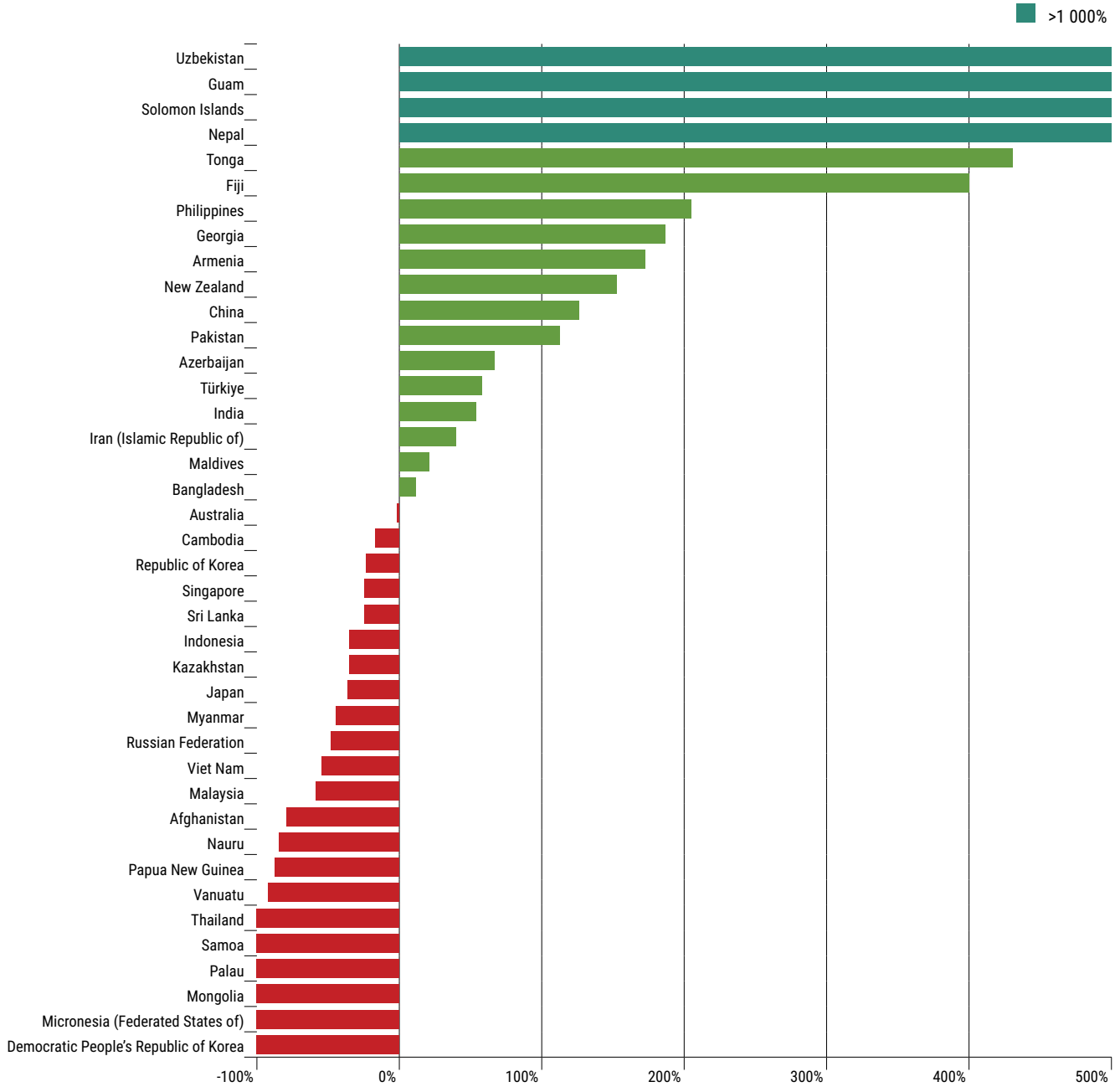
Long term (5 years and beyond)

Energy security and sustainability goals must be comprised of long-term strategies in order to transform the energy system with comprehensive national planning that integrates the power sector, electrification of end uses, alternative fuels and demand-side measures. Measures for domestic planning, international cooperation, technology development and just transitions for workers and communities are all critical enablers, but progress has been mixed in these areas during the crises.

In 2022, the number of Asia-Pacific member States making long-term carbon neutrality pledges rose to 39, up from 34 in 2021 (ESCAP, 2023a). However, the widespread roll-out of sectoral plans and policy design to support the implementation of such ambitions is lagging across the region. The pandemic and global energy crisis have accentuated the limitations of national capabilities and resources. There is also a large gap between non-conditional energy-related commitments and the conditional commitments on phasing out fossil fuels and scaling up renewable energy and energy efficiency that are tied to the receipt of international technical and financial support, which has yet to materialize.

While renewable power capacity additions accelerated through the crises in some countries, less than 45 per cent of Asia-Pacific countries deployed more solar PV and wind in 2022 versus 2019

Figure 37/ Per cent change in annual wind and solar photovoltaic capacity net additions, 2022 versus 2019, for select countries



Source: ESCAP calculations based on IRENA, IRENASTAT (https://www.irena.org/Data/Downloads/IRENASTAT2023).
Note: The chart excludes countries with no solar PV and wind capacity additions in 2019 and 2022.

Accordingly, economies should examine opportunities to reallocate government expenditures and strengthen domestic policy environments to mobilize more private finance. Engaging in South-South knowledge exchange and regional cooperation platforms can be a valuable strategy to learn from based on the experiences of other economies in these areas.

Example of cooperative efforts include work by ASEAN member States on regional MEPS for lighting, appliances and equipment, which has the potential to reduce electricity demand by nearly 10 per cent by 2030, as well as a fuel economy road map for light duty vehicles. In support of the Asia-Pacific regional road map on power system connectivity, the North-East Asia subregion is developing a green

power corridor road map, which would help countries meet national emissions reduction and renewables development goals and enhance electricity security and resilience (ESCAP, 2023a).

As countries scale up clean energy deployment, they should further consider the steps to manage existing fossil fuel infrastructure. Efforts are required to ensure that transitions are just and people-centred, with coordinated, long-term engagement for affected workers and communities, within and across countries and regions.

Given the Asia-Pacific region's heavy reliance on coal, there are significant opportunities to remediate, restore and repurpose coal-related assets, land, and communities, and to support shifts towards more sustainable development models. In 2022, Indonesia and Viet Nam announced JETP deals with international partners, committing $20 billion and $15 billion respectively. This presents the prospect of catalysing transitions by using international blended finance to address the multifaceted nature of the phaseout of coal including reinforced support for vulnerable groups.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

At the midway point of the SDGs, the region is at a critical phase in the implementation of SDG 7. Progress against the SDG 7 targets has been strong in some areas but mixed in many others. Major strides have been recorded in some countries, while many others are lagging. As the region confronts several overlapping crises. it is now more important than ever to redouble efforts to close the gaps on all the SDGs to recover better and build resilience against future crises.

In this context, the sustainable energy transition is critical to help the economies of Asia and the Pacific grapple with the challenges of securely and affordably meeting the demand for energy. Realizing the ambitious sustainability goals required a dramatic transformation of the region's energy systems, with efforts across the value chain of clean energy development, including the policy and regulatory enabling environment, public-private engagement, investment and finance. To ensure the continued progress of the sustainable energy transformation set in motion by SDG 7, countries in the region must focus on long-term strategies to ensure a just transition and the sustainable extraction and use of CRMs.

As the region is already a third of the way into the decade of action of the Sustainable Development Agenda, the window of opportunity to realize the SDGs is narrowing. The economic prominence of the Asia and Pacific region makes it essential to deliver the SDGs. Because of its rapidly growing demand for energy, the region's sustainable energy transition underpins the success of the global transition. However, a successful energy transition and the socioeconomic advantages it could offer are far from assured.

Despite widespread resolve, the region is still not on a path to achieve all of the SDG 7 targets. While national efforts towards universal access to electricity are largely on track, and early signs of progress in increasing the share of renewable energy are found in some countries, sufficient policy focus is not being extended to energy efficiency and clean cooking,

Regional decision makers must step up efforts to not only realize the global SDG targets, but also to advance national development objectives. Many economies in the region, as net energy importers, remain exposed to global energy market volatility, but the strong potential of local renewable resources creates an opportunity for the region to leapfrog to a cleaner and more resilient development model. Expanded energy efficiency measures would reduce the pressure on national energy systems to meet the growing demand, while the transition to clean cooking lowers the disease burden and supports efforts to attain more equitable societies.

Asia-Pacific economies have demonstrated innovation and ambition, as well as a willingness to cooperate at the regional level. Many examples of successful SDG 7-aligned policies and initiatives that have not only made advanced progress towards realizing the Goal targets, but they have also catalysed new areas of economic development and created additional social and environmental benefits. Now is the time to expand on the lessons learned to accelerate the energy transition and to strengthen Asia-Pacific leadership in the global effort to realize the SDGs.

The shift to new renewable sources will in some cases require a rethink of the way energy is distributed, stored and consumed. Many applications of energy, such as the transport system and heat-driven industrial processes, rely on fossil fuel combustion. The electrification of these end uses, or transitioning these to renewable energy, presents many challenges. Proven technical solutions, including sustainable biofuels, electric vehicles and heat pumps, are already available, while further enhancements of existing technologies, such as solar PV and wind are moving forward. Meanwhile, the integration of variable renewable generation into the region's power grids offers another set of challenges, requiring approaches ranging from updated system operational procedures through to the deployment of demand-response measures and storage.

Interventions are needed at various stages of the energy transition, and solutions will have to incorporate a range of actions from the local scale – such as distributed generation and small-scale batteries – through to national and international levels – including extensions of transmission networks, seasonal storage, development of markets for the production, and trading of green hydrogen and cross-border grid connectivity.

While a transition of the energy system is economically advantageous in the long term, the investment required for the development of new capital-intensive renewable energy resources, energy efficient infrastructure and the provision of modern energy services is an enormous financial challenge. Public and private sources of finance need to be drawn from a wide variety of sources, but the bulk of financing for clean energy transitions relies on mobilizing investment from private actors, who are sensitive to risk and return.

The sheer scale of upfront costs, investment risks and long-term investment horizons require coordination and the implementation of a variety of solutions by government, financial institutions, investors and private-sector proponents.

The Asia-Pacific region will play an important global role in the supply and consumption of CRMs for the energy transition. Growth of the region's extractive and processing industries will undoubtedly lead to environmental, social and governance challenges, while the economic opportunities arising in mineral extraction and processing abound.

As demand grows, countries will need to continue to refine their industrial development strategies to ensure alignment with the SDGs and the Paris Agreement. CRM producers should ensure that environmental protection remains high on the agenda, while CRM-deficit countries need to diversify their sources of imports, enhance their recycling systems and invest in research into alternative materials. International cooperation, innovation and circular economy thinking will be key.

The complexities and challenges of the energy transition include phasing out fossil fuel industries, which are the major employer in many locations and transitioning workers to new industries. Meanwhile, the transition will generate multiple economic benefits, including the creation of high-growth industries and high-quality jobs in clean energy. The success of the transition is dependent on managing the phaseout in a way that is just, equitable and people-centred.

Concerted efforts are required to support the affected workers and communities. Governments can support these groups through reskilling and retraining, planning and activities for local economic development and diversification, and measures for environmental rehabilitation. Focus should also be placed on ensuring that the vast opportunities offered by the energy transition for improving the economic and social well-being are accessible to all, including women and other marginalized groups. Decision-making should rest on strong social dialogue and public consultations. By taking a just and equitable approach, the region can ensure that the transition benefits all.

To ensure SDG 7 progress is on track and to accelerate the energy transition in the Asia-Pacific region, the following recommendations are offered:

1. Improve enabling environments for clean energy development

Policymakers and government play a critical role in coordinating the transition. Comprehensive national planning is needed to provide a framework for changes throughout the power sector, shift to electrified end uses, drive the uptake of alternative fuels and facilitate demand-side measures. A holistic approach should be used to optimize the energy system development pathway. This includes attention on opportunities to increase sector coupling and supporting the decarbonization of hard-to-abate end uses, while considering the potential role of emerging technologies, such as smart grids, batteries and the use, production and transmission of hydrogen.

Clear policies and plans allow governments to make it easier to develop clean energy projects by improving the processes for issuing licences and permits, and for land acquisition. Clear and robust frameworks should also be put in place for environmental and social impact assessments and to address potential impacts. Red tape, lack of coordination and slow decision-making processes are harmful to project development, reducing the speed at which work can be completed, which adds to the cost of the development and increases the cost of financing.

Furthermore, the implementation of carbon pricing and the removal of fossil fuel subsidies can produce benefits, such as improvements to public finances, that are additional to the energy transition. To reap those benefits, it is advantageous to improve and harmonize approaches across countries and improve the capacities of governments to implement carbon-pricing policies.

Underpinning all these areas, governments must ensure policy coherence and to attract investment. Good governance, especially with regard to political stability, rule of law and the effectiveness of governing bodies, has a significant impact on risk perceptions and investment protection. Asia-Pacific Governments often face capacity constraints in designing and implementing complex energy system transformations. Engagement within regional and international bodies is essential to enhance knowledge and domestic capacity for policymaking.

2. Increase private sector engagement

Meeting the SDG 7 targets relies on the private sector playing a major role in project development and providing the majority of investment funds.

Governments must support and enable this by reforming market structures and ownership rules in a way that enhances private participation and increases competition. Private participation can be greatly enhanced through the design of effective regulatory frameworks to support public-private partnerships in infrastructure development. Examples of this are the roll-out of competitive auctions for renewable power procurement, and new ownership and operating models for the development of transmission grids.

Technology development and sectoral decarbonization pathways can benefit greatly from increased joint ventures and partnerships between public and private players related to research, development and demonstration, especially with regard to battery storage, low-carbon fuels and the abatement of emission-intensive sectors. Such engagement has the potential to lead to innovation spillover effects and the development of new industries, which can simultaneously support efforts to achieve SDG 7 and national industrial strategies.

3. Deploy a range of risk allocation and investment mobilization strategies

The energy transition across the Asia-Pacific region requires financing in the order of trillions of dollars this decade. Meeting SDG Goal 7 targets and aligning economies with net-zero emissions objectives requires that regional annual energy investment increase to $2.2 trillion–2.4 trillion by 2030, from nearly $1.2 trillion today, with 90 per cent of this to be related to clean energy, depending on the pathway and level of ambition. The ability to mobilize such funding is contingent on accessing a diverse range of finance, offering a pipeline of bankable clean energy projects and lowering the cost of capital by ensuring a supportive enabling environment.

Understanding the various models for enabling the use of private finance in energy investment is key if governments are to scale up the infrastructure investments required to successfully integrate larger shares of variable renewable energy resources. Governments must consider enabling private investment in sectors that are traditionally dominated by public ownership, such as the financing of grids. The development of well-designed commercial arrangements and remuneration schemes, with appropriate risk allocation between public and private actors, is critical to creating profitable investment opportunities that provide investors with an adequate and reasonable return on capital. Reverse auction schemes are one way to achieve this: the buyer (usually the government) invites sellers (project proponents) to bid for the lowest possible price. This allows the buyer to discover the market price while also ensuring that the seller is compensated fairly for their risk.

Funding support is needed for investments at stages in which capital is in particularly short supply – such as early-stage project development – and is also critical to spur deployment. Governments can play an important catalytic role and lead by example by directing the investment bodies under their control to reorient their funds towards businesses and projects at these critical stages. In some cases, demonstration funding for new technologies or novel applications can support the emergence of new sectors.

More robust and better-harmonized frameworks for sustainable finance are also required with regard to labelled instruments and taxonomies to help guide capital allocation. Improvements are needed in the capacity of domestic banking sectors and financial regulators to evaluate clean energy opportunities and integrate sustainability standards within standard lending and investing practices and norms.

A stronger role also awaits the international development finance community. Institutions can apply their experience to enhance project bankability and help to manage complex financial transitions, such as the phasing out of coal, and transformations at early stages of technological readiness, such as industrial decarbonization. There is also important work to be done in quantifying the climate benefits of enabling infrastructure, such as grids, and building the case to unlock climate finance for investment here.

Finally, prudent risk allocation and management should pave the way for governments to put State-owned enterprises on a firmer financial footing for cases in which these enterprises must act as creditworthy purchasers of power or fuels, such as for State-owned utilities or large industrial players.

4. Employ energy connectivity as a tool for supporting the energy transition

Energy connectivity enables the secure, affordable and sustainable development of power systems by supporting the integration of variable renewable energy sources and enabling access to more diverse and cheaper resources. The opportunity for increased power system connectivity in the Asia-Pacific region is significant; there are numerous examples across the region of efforts to increase cross-border power system connectivity, but those efforts remain primarily in the development stage.

Governments should take steps to increase regional cooperation on connectivity initiatives by creating harmonized regulations and operational policies that allow for the integration of power systems. To that end, governments should ensure that there are appropriate subregional and regional institutions to support the development and harmonization of regulatory frameworks and that regulators have mandates to participate in regional initiatives.

Efforts to create subregional and regional grid development plans require ongoing support as these will act as a guiding principle for national and regional grid development efforts. In order to establish coordinated grid planning, it is imperative that governments support efforts to enable data-sharing and transparency, as planning activities must be based on credible and timely national data. Access to these data can also improve cross-border power trade and help countries align connectivity initiatives with domestic policy goals.

5. Manage access to critical raw materials to enable the energy transition

The clean energy transition involves a shift from a fuel-intensive system to a material-intensive energy system, creating significant demand for the CRMS, which will underpin wind, solar PV and batteries. Dramatic increases in the demand for CRMS raise concerns regarding security of supply. Significant investments are needed to ensure that the supply of CRMs is sufficient to reduce energy security concerns and lower prices.

As both a primary producer and source of demand for CRMs in manufacturing, the Asia-Pacific region will play an important role in the flow of materials required for facilitating the transition. This will pose both opportunities and challenges. The development of CRM industries will create significant economic opportunities, but extraction and processing will inevitably lead to additional environmental, social and governance challenges. It is, therefore, necessary to adopt a holistic, whole of life-cycle approach to align the extraction of CRMs with sustainable development and the protection of human rights and prevent resource wealth from undermining economic stability.

Governments should support efforts to improve legal and regulatory practices, establish inclusive social management practices and strengthen regional coordination. It is imperative that overarching frameworks guiding resource management be established, and that capacity of governments be improved to ensure that these frameworks can be implemented and enforced.

Three priority actions can help align the efforts of the diverse range of stakeholders in this sector with sustainable development: establish common operational rules for CRM markets, green finance and standards; share knowledge and experiences among regions and countries; and create regional and international coordination mechanisms and institutions.

6. Ensure a just energy transition

A just and equitable energy transition is dependent on accounting for the whole scope of social, economic and environmental impacts, including the full range of benefits and challenges that will arise in the coming years. The costs of clean energy must be controlled in order to ensure affordability for all, the phaseout of existing fossil-fuel dependent industries managed so that workers in declining industries are supported, and the benefits of the transition – including new employment opportunities and environmental advantages – are harnessed to the maximum extent with the benefits shared among all.

The surge in fossil fuel and electricity prices experienced across the region in 2022 has placed pressure on consumer finances but expanding energy generation from renewables offers the most affordable options for new power generation capacity in many contexts. The deployment of cost-effective measures for energy efficiency and electrification can further help to keep energy bills manageable and shield consumers from energy price shocks, enhancing the benefits of energy access and helping to ensure that the maximum advantage is derived from energy utilization.

Synergies between various SDGs should also be taken into account in planning and policy development. The profound benefits in poverty eradication, health and well-being, education, gender equality, environmental sustainability and economic growth should all be considered in the business case for policy interventions. For example, as grids are expanded and modernized to accommodate higher shares of renewables, socioeconomic benefits for businesses and households can be realized through greater power supply availability and reliability. Likewise, opportunities to transition away from traditional fuels to electric cooking and heating can contribute towards improving indoor air quality and reducing adverse health impacts.

Clean energy transitions are marked by a structural change in which jobs in legacy industries are replaced by those in new sectors. Fossil fuel-related industries have emerged over the past several decades as major sources of employment, and in some locations in the Asia-Pacific region, they are the predominant employers. Policies are required to facilitate the transition while cushioning the detrimental impact on vulnerable groups to ensure a just transition.

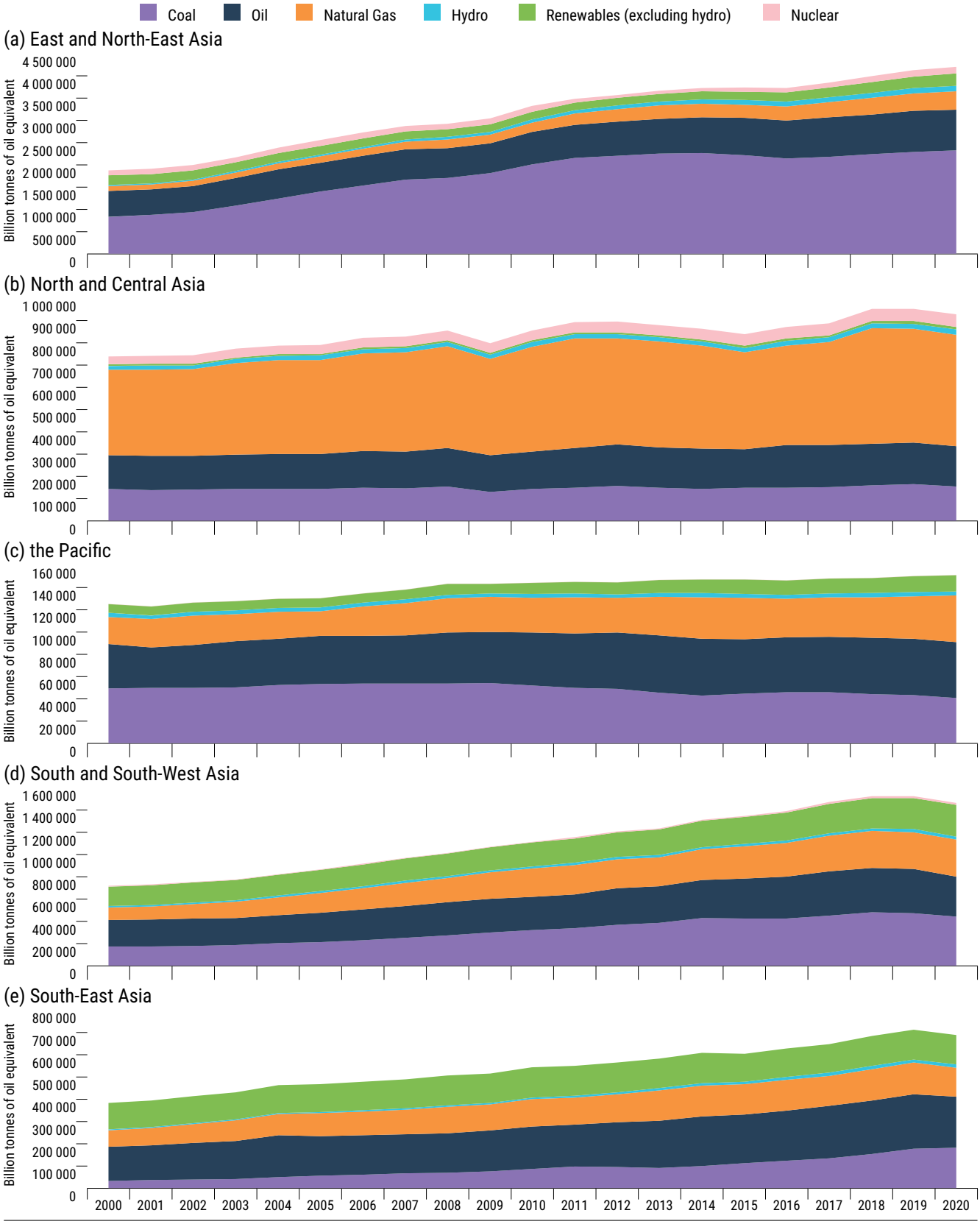
Governments can support fossil fuel workers and communities affected by clean energy transitions through the provision of reskilling and retraining, planning and activities for local economic development and diversification and measures for environmental rehabilitation of closed mines and infrastructure to make them fit for other purposes. Such support is most effective as part of long-term, integrated strategies to help regions and communities with legacy economies to transition. Policies should take a comprehensive approach, incorporating industrial policies, education and skills training, and community and regional economic development measures.

Communities can be empowered to participate in the development and implementation of energy policies and programmes, and to take ownership of energy solutions. This should involve governments engaging with vulnerable and marginalized sectors of the community, which are often overlooked, through the delivery of training programmes that provide skills and knowledge needed to operate and maintain energy systems, or the implementation of community-led initiatives to promote energy conservation and efficiency

International cooperation on exchanging information, sharing knowledge and experience, and the harmonization of policy responses all offer profound advantages to managing the energy transition. Through its intergovernmental platform and technical capacity, ESCAP is ready to support member States, as the Asia-Pacific region advances the energy transition to ensure its success.

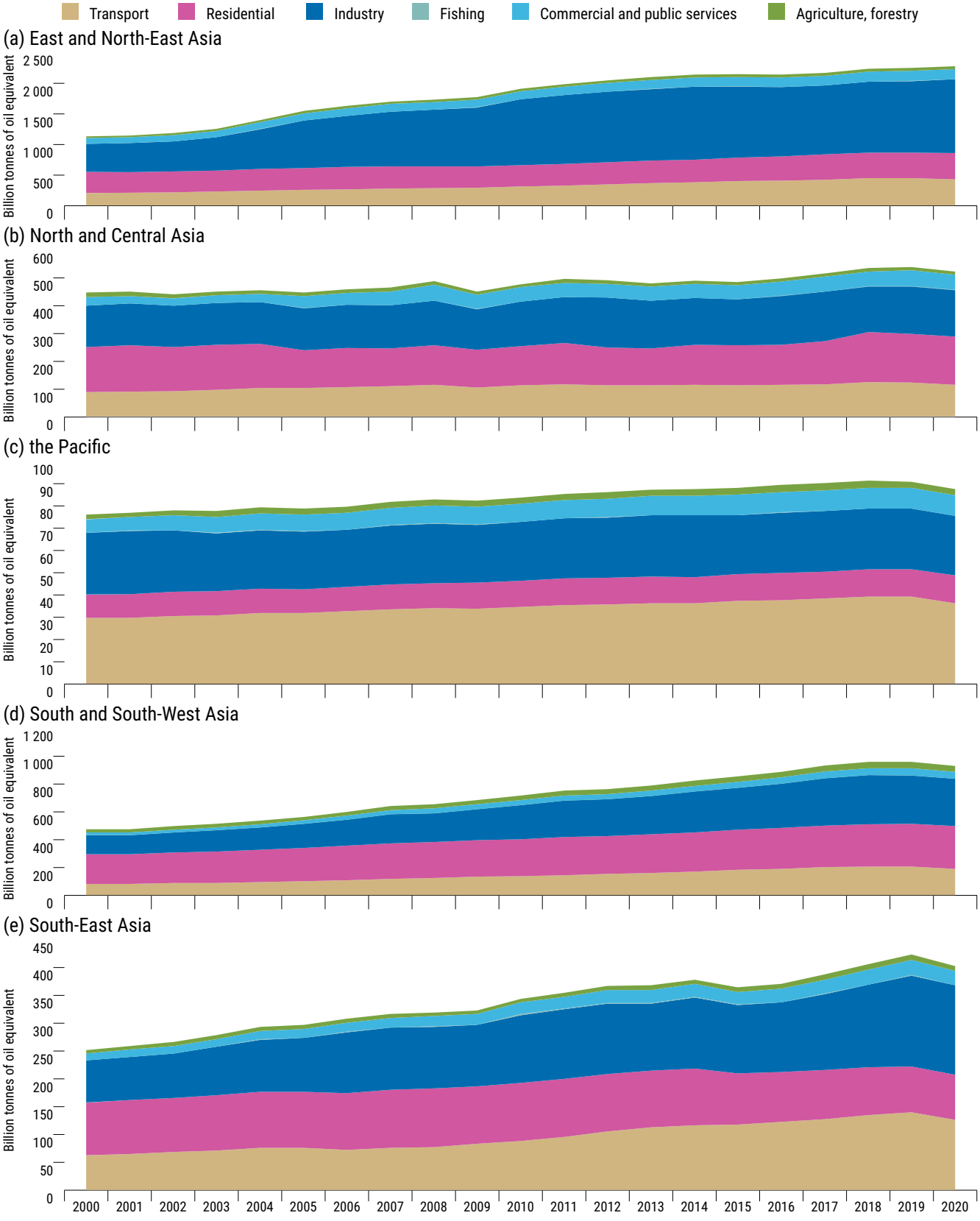
Annex 1: **Key energy indicators by subregion**

Figure 38/ Energy supply by product in East and North-East Asia, North and Central Asia, the Pacific, South and South-West Asia, and South-East Asia



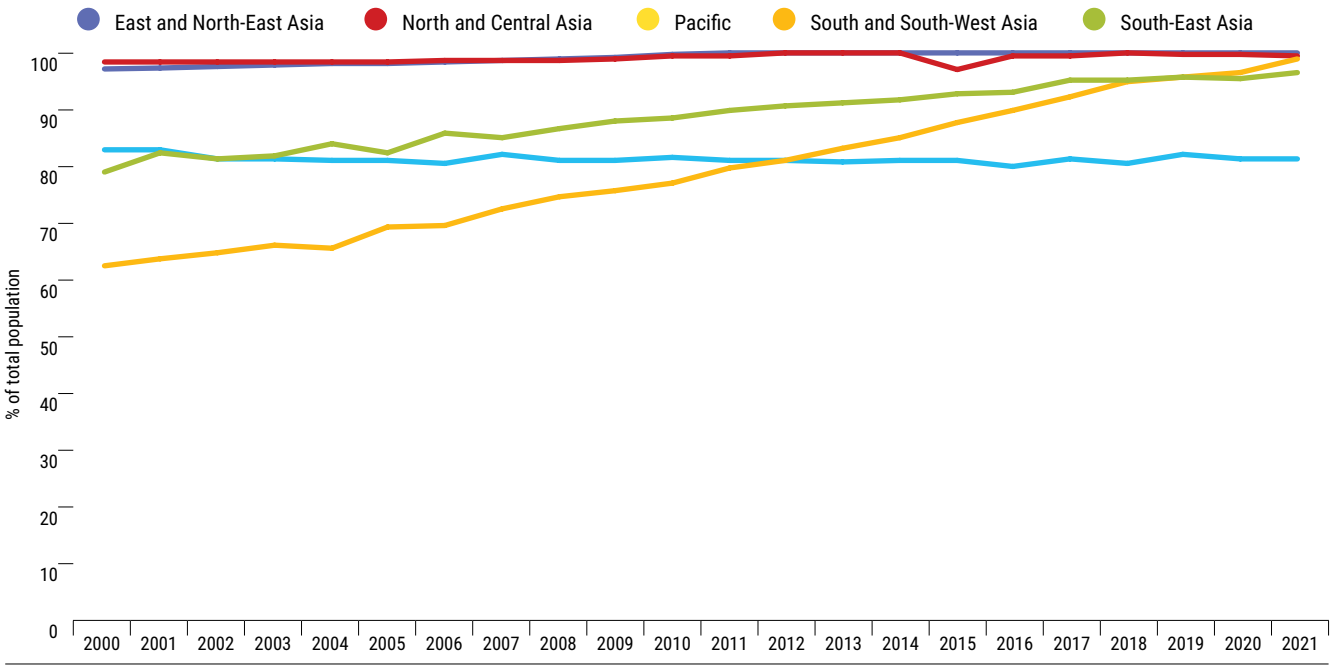
Source: ESCAP based on International Energy Agency (IEA)

Figure 39/ Final consumption by sector in East and North-East Asia, North and Central Asia, the Pacific, South and South-West Asia, and South-East Asia



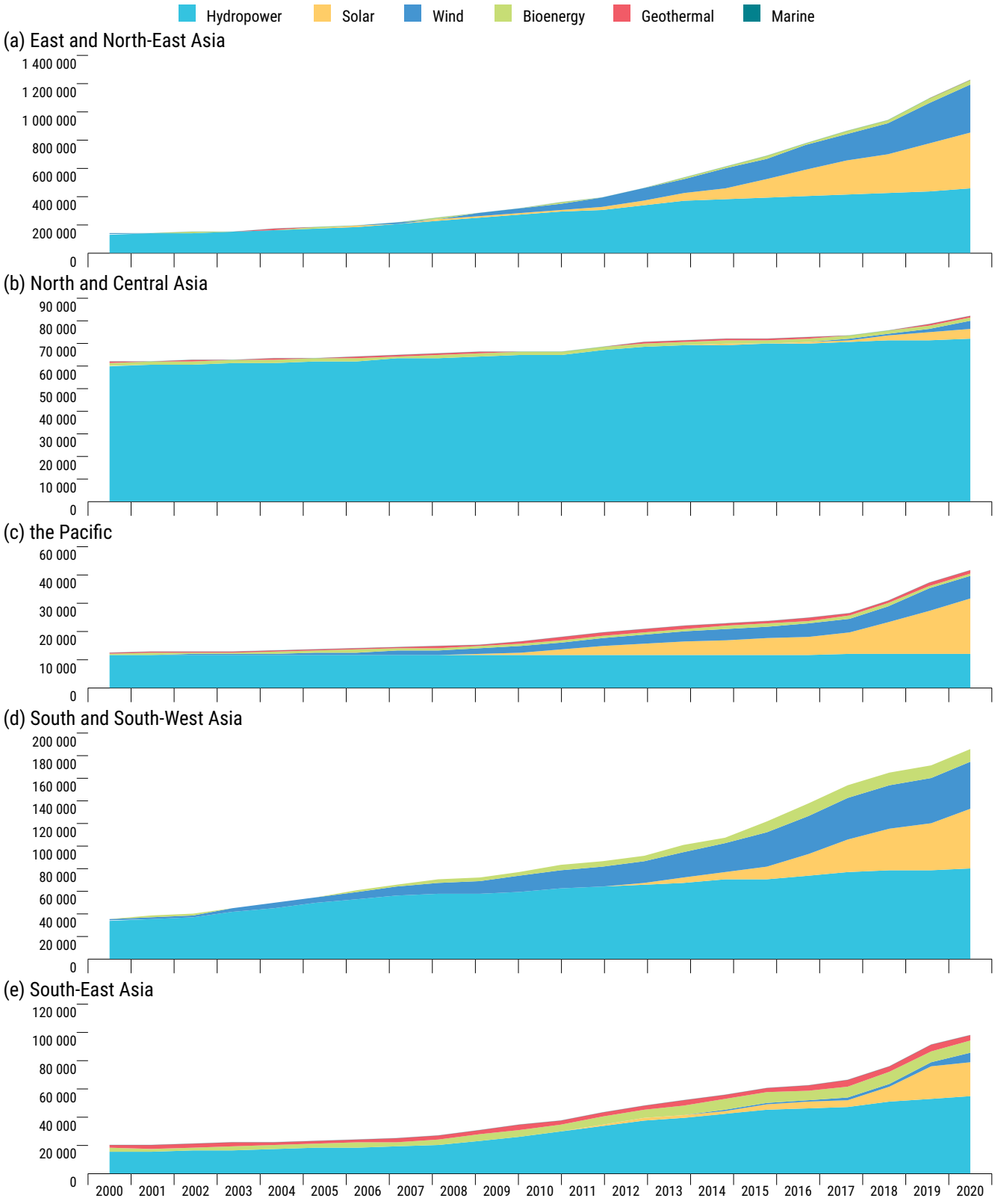
Source: ESCAP based on International Energy Agency (IEA)

Figure 40/ Share of population with access to electricity, by subregion



Source: World Bank, United Nations Statistics Division

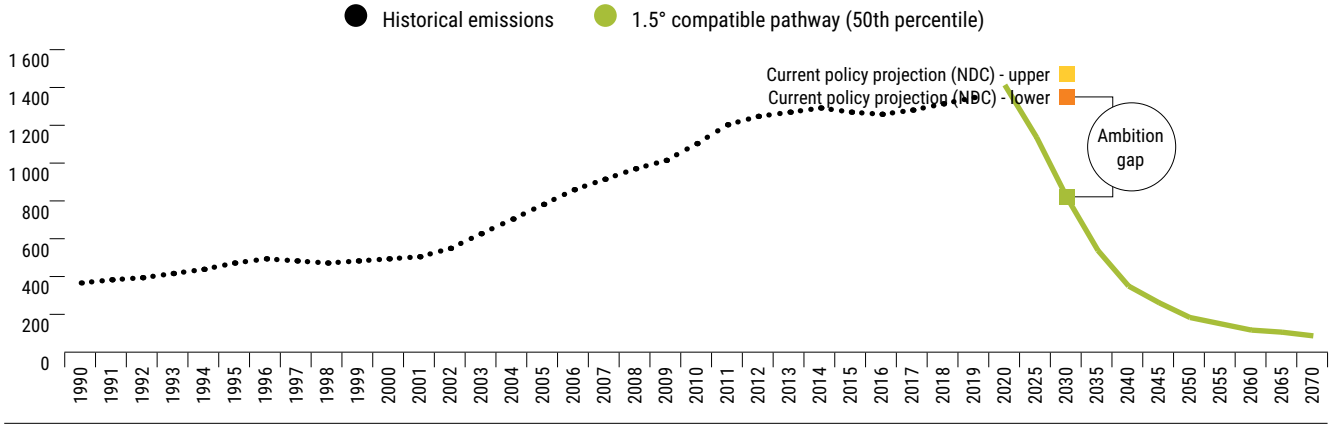
Figure 41/ East and North-East Asia, North and Central Asia, the Pacific, South and South-West Asia, and South-East Asia



Source: ESCAP based on IRENA

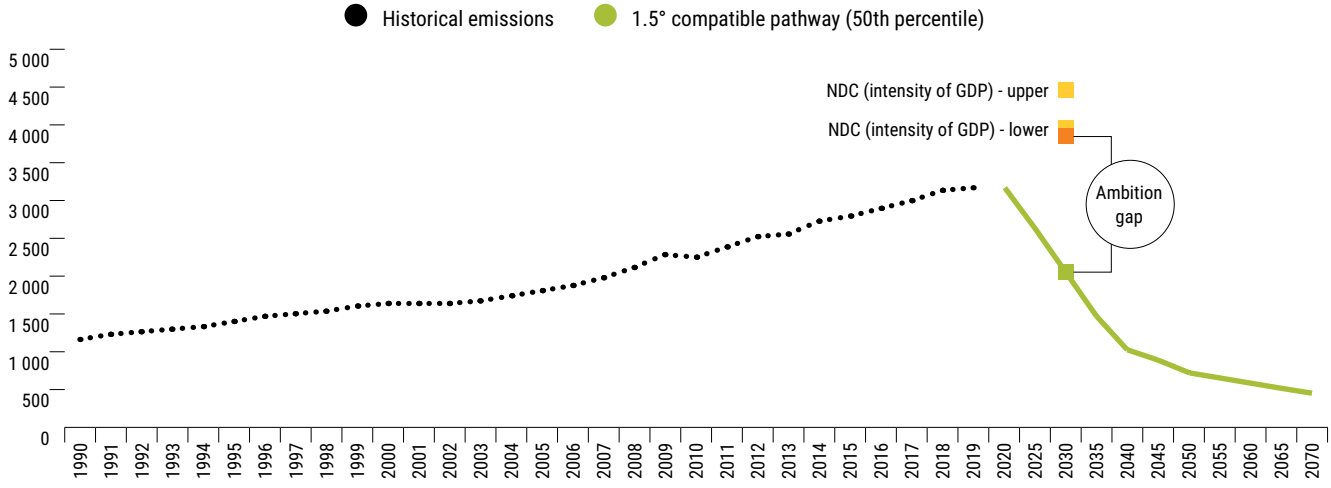
Annex 2: **Pathways to limiting global warming to 1.5°C for the five largest emitters in the region**

Figure 42/ A pathway to delivering China's contribution to limiting global warming to 1.5°C



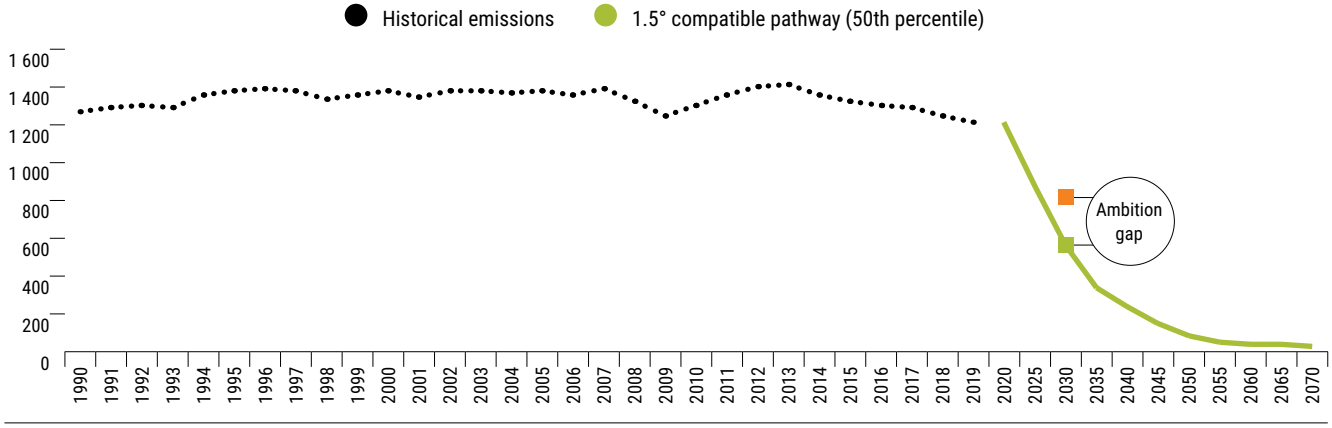
Source: Climate Analytics

Figure 43/ A pathway to delivering India's contribution to limiting global warming to 1.5°C



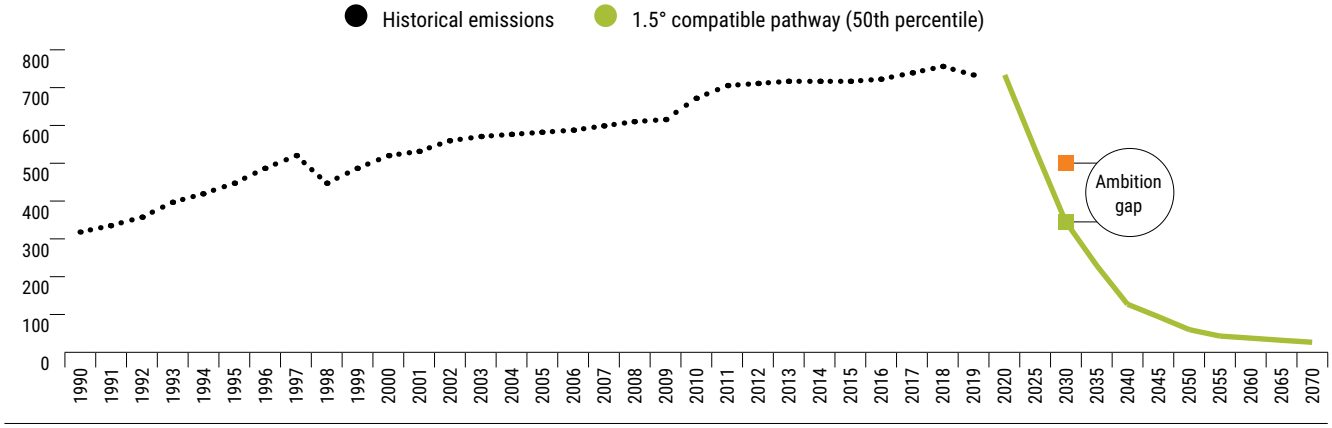
Source: Climate Analytics

Figure 44/ A pathway to delivering Japan's contribution to limiting global warming to 1.5°C



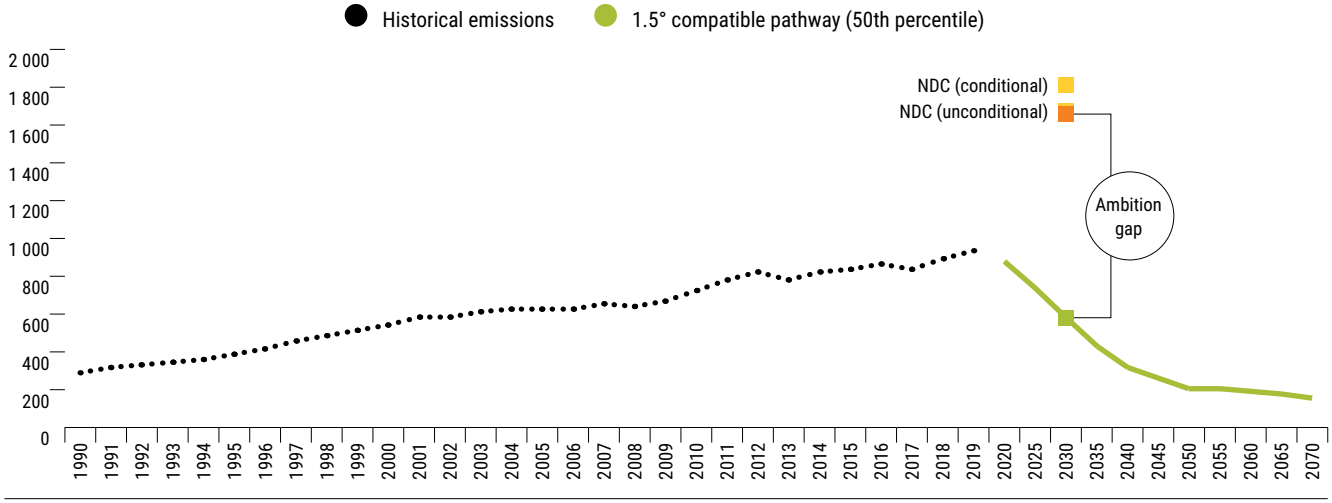
Source: Climate Analytics

Figure 45/ A pathway to delivering Republic of Korea's contribution to limiting global warming to 1.5°C



Source: Climate Analytics

Figure 46/ A pathway to delivering Indonesia's contribution to limiting global warming to 1.5°C



Source: Climate Analytics

Source for figures in Annex 2: Climate Analytics, 2022. 1.5°C National Pathways Explorer. Available at https://1p5ndc-pathways.climateanalytics.org/

References

Akrofi, Mark, Mahesti Okitasari, and Richa Kandpal (2022). Recent trends on the linkages between energy, SDGs and the Paris Agreement: a review of policy-based studies. *Discover Sustainability*,vol. 3, No. 32.

Amaglobeli, David, and others (2022). Fiscal policy for mitigating the social impact of high energy and food prices. I MF Notes No 2022/001. Washington, D.C.: IMF.

Association of Southeast Asian Nations (ASEAN) (2021). ASEAN Taxonomy for Sustainable Finance. Available at https://asean.org/book/asean-taxonomy-for-sustainable-finance/.

_____(2023). ASEAN Taxonomy for Sustainable Finance Version 2. Available at https://asean.org/wp-content/uploads/2023/03/ASEAN-Taxonomy-Version-2.pdf.

Asia Development Bank (ADB) (2022). *Reimagining the Future of Transport Across Asia and the Pacific*. Manila.

_____(2023). Draft guidance note on large hydropower plants. Available at https://www.adb.org/sites/default/files/institutional-document/829416/draft-guidance-note-large-hydropower.pdf.

Asia-Pacific Economic Cooperation (APEC) (2022). *APEC Stocktake of Carbon Pricing Initiatives*. Singapore: APEC Secretariat, Singapore.

Baumgartner, Lisa, Rebecca Carman, and Yihong Liu (2022). *The State of Climate Ambition: Regional Snapshot – Asia and the Pacific*. New York: UNDP.

Bhatia, Mikul, and Niki Angelou (2015). *Beyond Connections: Energy Access Redefined*. Washington D.C.: ESMAP.

BloombergNEF (2023), Energy Transition Investment Trends. Available at https://about.bnef.com/energy-transition-investment/.

Bueno, Manuel (2022). Climate finance innovation in a high interest rate world. ABT Associates Presentation. Available at https://www.youtube.com/watch?v=oNEzqZs8tFs.

ClimateWatch (2023). Net Zero Tracker. Available at https://www.climatewatchdata.org/net-zero-tracker.

Convergence (2022). State of Blended Finance 2022 – Climate Edition. Available at https://www.convergence.finance/resource/state-of-blended-finance-2022/view.

Dawnbreaker (2022). DOE | Market Research Study: Agrivoltaics. Available at https://science.osti.gov/-/media/sbir/pdf/Market-Research/SETO---Agrivoltaics-August-2022-Public.pdf.

Degraer, Steven, and others (2020). Offshore wind farm artificial reefs affect ecosystem structure and functioning: a synthesis. *Oceanography*, vol. 33, No. 4, pp. 48–57.

Dermanwan, Audrey (2023). Malaysia moving in right direction on electricity subsidy. *New Straits Times*, 16 May. Available at https://www.nst.com.my/news/nation/2023/05/910241/malaysia-moving-right-direction-electricity-subsidy.

Energy for Growth Hub (2021). The Modern Energy Minimum. Available at https://energyforgrowth.org/project/the-modern-energy-minimum/.

Energy Sector Management Assistance Program (ESMAP) (2022). *Regulatory Indicators for Sustainable Energy (RISE)*. Washington, D.C: World Bank.

_____(n.d.). *Multi-Tier Framework for Energy Access (MTF)*. Available at https://www.esmap.org/mtf_multi-tier_framework_for_energy_access.

Environmental Finance (2022), Environmental Finance Bond database. Available at www.bonddata.org.

Farmer, Rod, and others (2022) Capturing growth in Asia's emerging EV ecosystem. McKinsey and Company, Future Growth. Available at https://www.mckinsey.com/featured-insights/future-of-asia/capturing-growth-in-asias-emerging-ev-ecosystem.

Gielen, Dolf (2021). Critical Materials for the energy transition. Technical Paper 5/2021. Abu Dhabi: IRENA.

Global Energy Monitor (2022a). Amid market turmoil, Asia's liquified natural gas plans reach a fork in the road. Available at https://globalenergymonitor.org/wp-content/uploads/2022/12/GEM-Asia-LNG-Update-2022-Briefing.pdf.

_____(2022b). Global Gas Infrastructure Tracker. Available at https://globalenergymonitor.org/projects/global-gas-infrastructure-tracker/.

Hertwich, Edgar, and others (2014). Integrated life-cycle assessment of electricity-supply scenarios confirms global environmental benefit of low-carbon technologies. *Proceedings of the National Academy of Sciences*, vol. 112, No. 20.

Hydrogen Council, and McKinsey and Co (2022). *Hydrogen Insights 2022*. Available at https://hydrogencouncil.com/wp-content/uploads/2022/09/Hydrogen-Insights-2022-2.pdf.

International Energy Agency (2018). *The Future of Cooling: Opportunities for energy-efficient air conditioning*. Paris.

_____(2020). Asia Pacific Region Profile. Total energy supply, 2020. Available at https://www.iea.org/regions/asia-pacific#overview.

_____(2021a). *Cross-border Electricity Trading for Tajikistan: A Roadmap*. Paris.

_____(2021b). *Financing Clean Energy Transitions in Emerging and Developing Economies*. Paris.

_____(2021c). *The Role of Critical Minerals in Clean Energy Transitions*. Paris.

_____(2021). *Greenhouse Gas Emissions from Energy Data Explorer*. Paris. Available at https://www.iea.org/data-and-statistics/data-tools/greenhouse-gas-emissions-from-energy-data-explorer.

_____(2022a), *An Energy Sector Roadmap to Net Zero Emissions in Indonesia*. Paris.

_____(2022b) *Coal in Net Zero Transitions: Strategies for Rapid, Secure and People-centred change*. Paris

_____(2022c) *Energy Efficiency 2022*. Paris.

_____(2022d) *Gas Market Report Q3 2022*. Paris.

_____(2022e) *Global Energy Review: CO2 Emissions in 2021*. Paris.

_____ (2022f) *Global EV Outlook 2022*. Paris. _

_____(2022g) Renewables 2022. Paris

_____(2022h) *SDG7: Data and Projections*. Paris.

_____(2022i). *World Energy Investment 2023*. Paris.

_____(2022j) *World Energy Outlook*. Paris.

_____(2022k). World Energy Statistics and Balances. Available at https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances.

_____(2023a). Fossil Fuels consumption subsidies 2022. Available at . https://www.iea.org/reports/fossil-fuels-consumption-subsidies-2022.

_____(2023b) Global EV Outlook 2023: Catching up with climate change. Paris.

_____(2023c). World Energy Investment 2023. Paris.

_____and Centre for Climate Finance and Investment, Imperial College Business School (2023), *ASEAN Renewables: Opportunities and Challenges*. Paris and London.

_____, and others (2020). *Tracking SDG 7: The Energy Progress Report*. Washington, D.C: World Bank.

_____(2021). *Tracking SDG-7: The Energy Progress Report 2021*. Washington, D.C.: World Bank..

_____(2023). *Tracking SDG-7: The Energy Progress Report 2023*. Washington, D.C. : World Bank.

International Labour Organization (ILO) (2023). New data shine light on gender gaps in the labour market. ILO brief. Spotlight on Work Statistics n°12. Available at https://www.ilo.org/wcmsp5/groups/public/---dgreports/---stat/documents/publication/wcms_870519.pdf.

International Monetary Fund (IMF) (2023a) Climate Finance Monitor. 1 February 2023. Available at https://www.imfconnect.org/content/dam/imf/News%20and%20Generic%20Content/GMM/Special%20Features/Climate%20Finance%20Monitor%20Q4%202022.pdf.

_____(2023b). Commodity Data Portal. Available at https://www.imf.org/en/Research/commodity-prices.

International Panel on Climate Change (IPCC) (2023). AR6 Synthesis Report: Climate Change 2023. Available at https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_LongerReport.pdf.

International Renewable Energy Agency (2020) Innovation landscape brief: Pay-as-you-go models. Abu Dhabi

_____(2022). *Renewable Power Generation Costs in 2021*. Abu Dhabi.

_____ (2023) *World Energy Transitions Outlook 2023: 1.50C Pathway*, Volume 1. Abu Dhabi.

_____, and Food and Agriculture Organization of the United Nations (FAO). (2021). Renewable Energy for Agri-food Systems. Abu Dhabi and Rome.

International Trade Forum (ITF) (2015). Hydroelectric power: A guide for developers and Investors. Washington, D. C.: World Bank

_____(2021). *ITF Transport Outlook 2021*. Paris: OECD Publishing.

Jarriel,. Sierra, and others (2023). In situ approach to characterize effects of pile-driving on black sea bass behavior, Centroprisits striata. *Journal of the Acoustical Society of America*, vol. 153, No. 3_supplement, A223.

Joint Organisations Data Initiative (JODI) (2023). Gas World Database. Available at https://www.jodidata.org/gas/.

Kim, Tae-Yoon (2022). Critical minerals threaten a decades-long trend of cost declines for celan energy technologies. IEA commentary, 18 May IEA. Available at https://www.iea.org/commentaries/critical-minerals-threaten-a-decades-long-trend-of-cost-declines-for-clean-energy-technologies.

Krishnan, Deepak, and others (2022). Winds of change: learnings for the indian offshore wind energy sector. Working Paper. National Investment and Infrastructure Fund, WRI India. Available at https://files.wri.org/d8/s3fs-public/2022-08/winds-change-learnings-indian-offshore-wind-energy-sector.pdf?VersionId=bfO3E00waxbaQG6hdyKBX4TwwdO2BoRI.

Lazard Corporation (2023). Lazard's Levelized Cost of – Version 16.0. Available at https://www.lazard.com/media/typdgxmm/lazards-lcoeplus-april-2023.pdf.

Median, Michal, and others (2022). Asian markets following the Russian invasion of Ukraine. OIES Energy Comment. Available at https://www.oxfordenergy.org/publications/asian-energy-markets-following-the-russian-invasion-of-ukraine/.

Moher, David, others (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ (Online). vol 339, No. 7716, pp. 332–336. 2

Randi, Kristiansen (2022). Attracting private finance to transmission in the Asia-Pacific Region. Energy Division Working Paper Series, No. WP/2022/01. Bangkok: ESCAP.

Sarangi, Gopal. (2022). Offshore wind energy as an emergent ocean infrastructure in India: mapping of the social and environmental impacts. ADBI Working Paper 1307. Tokyo: Asian Development Bank Institute.

Solé, Marta. (2022). Commercial cuttlefish exposed to noise from offshore windmill construction show short-range acoustic trauma. *Environmental Pollution*, vol. 312.

Stapczynski, Stephen (2022). Pakistan faces years of fuel shortages after gas tender flop. *Bloomberg News*, 3 October. Available at https://www.bnnbloomberg.ca/pakistan-faces-years-of-fuel-shortages-after-gas-tender-flop-1.1827604.

Sung, Jeremy, Monica Troilo, and Nicholas Howarth (2021). Better energy efficiency policy with digital tools. IEA, 6 August. Available at https://www.iea.org/articles/better-energy-efficiency-policy-with-digital-tools.

Sustainable Energy for All (2021). *Energizing finance: understanding the landscape*. Available at https://www.seforall.org/system/files/2021-10/EF-2021-UL-SEforALL.pdf.

Team CW. (2020, Oct 02). *L&T's Nabha Power wins The IPP of the Year at the Asia Power Awards 2020*. Retrieved from Construction Week Online: https://www.constructionweekonline.in/projects-tenders/15217-lts-nabha-power-wins-the-ipp-of-the-year-at-the-asia-power-awards-2020.

Tonga (2030). Tonga commits to achieve 70% renewable energy target by 2030. Press release, 13 January. Available at https://www.gov.to/press-release/tonga-commits-to-achieve-70-renewable-energy-target-by-2030/.

UN Global Crisis Response Group on Food, Energy and Finance (2022)., *Global impact of war in Ukraine :energy crisis*. Brief No. 3. Available at https://unctad.org/publication/global-impact-war-ukraine-energy-crisis.

United Nations, Economic Commission for Europe (ECE) (2021). *Carbon Neutrality in UNECE Region: Integrated Life-cycle Assessment of Electricity Sources*. United Nations publication.

United Nations, Economic and Social Commission for Asia and the Pacific (2019) Using smart transport technologies to mitigate greenhouse gas emissions from the transport sector in Asia. Available at . https://www.unescap.org/resources/using-smart-transport-technologies-mitigate-greenhouse-gas-emissions-transport-sector-asia.

_____(2021). *Energy Transition Pathways for the 2030 Agenda: SDG 7 Roadmap for Tonga* (ST/ESCAP/2946).

_____(2022). *Protecting Our Planet through Regional Cooperation and Solidarity in Asia and the Pacific*. United Nations publication.

_____(2023a). *The Race to Net Zero: Accelerating climate action in Asia and the Pacific*. United Nations publication.

_____(2023b). *Economic and Social Survey of Asia and the Pacific 2023: Rethinking Public Debt for the Sustainable Development Goals*. United Nations publication.

_____, and others (2022). 2022 *Review of Climate Ambition in Asia and the Pacific: Raising NDC Targets with Enhanced Nature-based Solutions* (ST/ESCAP/3053).

_____, Korean Environment Corporation and Republic of Korea, Ministry of Environment (2023). *Seoul Initiative Network on Green Growth*. Working paper. Available at https://repository.unescap.org/handle/20.500.12870/5457.

United Nations Department of Economic and Social Affairs (2018). *Accelerating SDG 7 achievement: policy briefs in support of the First SDG 7 Review at the UN High-Level Political Forum 2018*. Available at https://sustainabledevelopment.un.org/content/documents/18041SDG7_Policy_Brief.pdf", United Nations.

_____(2022), Policy briefs in support of the High-Level Political Forum 2022: addressing energy's interlinkages with other SDGs. Available at https://sdgs.un.org/sites/default/files/2022-06/Policy%20Briefs%20-2022%20Energy%27s%20Interlinkages%20With%20Other%20SDGs.pdf.

van de Ven, Dirk-Jan, and others (2021). The potential land requirements and related land use change emissions of solar energy. Scientific Reports, vol. 11, No.2907. .

Weiss, Werner, and Monika Spörk-Dur (2022). Solar Heat Worldwide. Available at https://www.iea-shc.org/Data/Sites/1/publications/Solar-Heat-Worldwide-2022.pdf.

Wilhelmsson, Dan, Torleif Malm, and Marcus Öhman. (2006). The influence of offshore windpower on demersal fish. *ICES Journal of Marine Science*, vol. 63, No. 5, pp. 775–784.

World Bank (2018). Managing coal mine closure: achieving a just transition for all. November, issues paper. Available at https://documents1.worldbank.org/curated/en/484541544643269894/pdf/130659-REVISED-PUBLIC-Managing-Coal-Mine-Closure-Achieving-a-Just-Transition-for-All-November-2018-final.pdf.

_____(2018). *Incentivizing a Sustainable Clean Cooking Market: Lessons from a Results-Based Financing Pilot in Indonesia*. Washington: International Bank for Reconstruction and Development/The World Bank.

_____(2023). GDP (current US$). The World Bank Database. Available at https://data.worldbank.org/indicator/NY.GDP.MKTP.CD.

World Bioenergy Association (2022. Global Bioenergy Statistics 2022. Available at https://www.worldbioenergy.org/uploads/221223%20WBA%20GBS%202022.pdf.

World Health Organization (WHO) and others., 2023. *Energizing Health: Accelerating Electricity Access in Health-Care Facilities*. Geneva.

23-00695