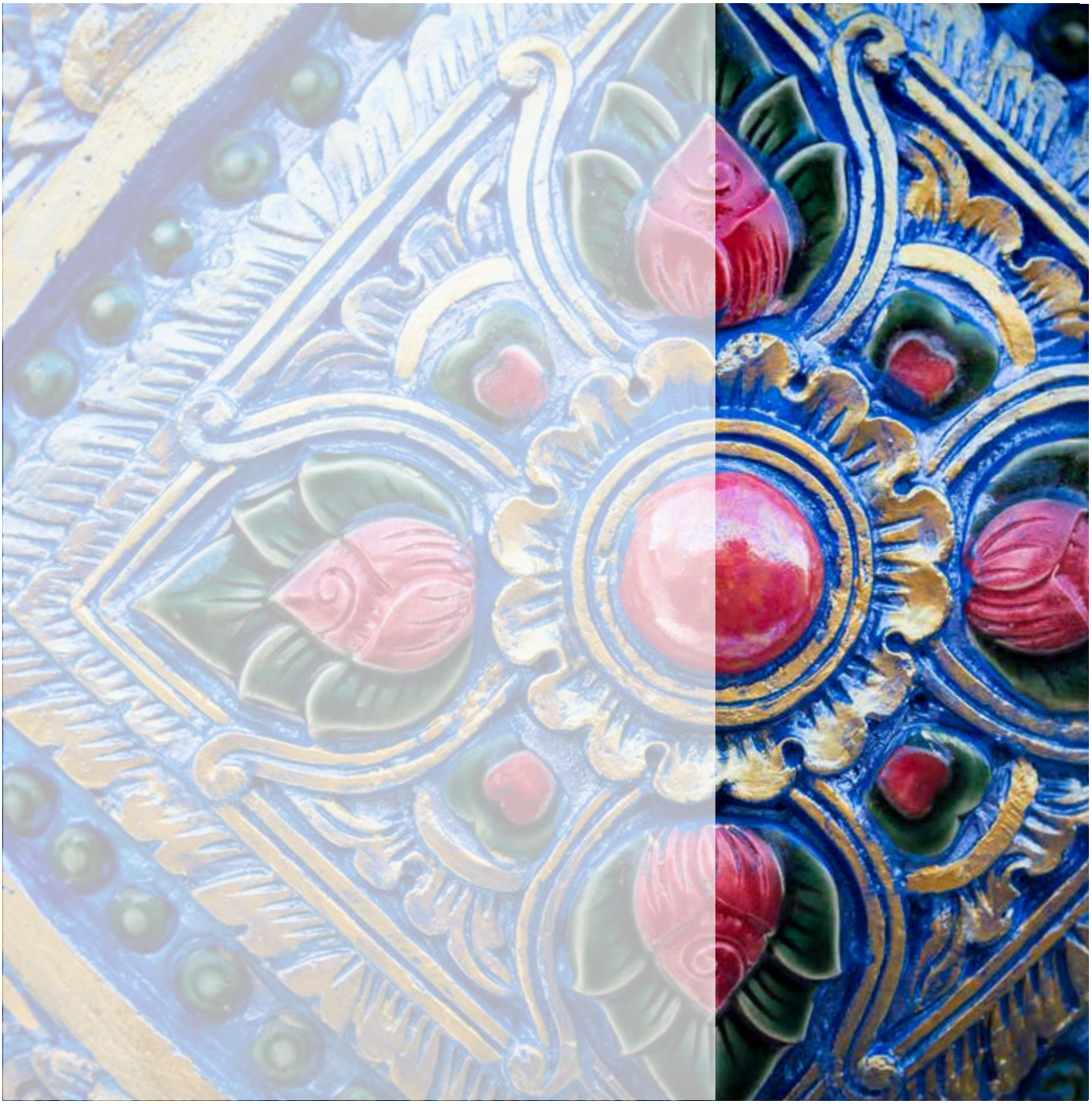
IRENA
International Renewable Energy Agency

EXECUTIVE SUMMARY

RENEWABLE ENERGY MARKET ANALYSIS

SOUTHEAST ASIA



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ABOUT IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

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DISCLAIMER

Southeast Asia has emerged as one of the world's fastest-growing economic regions, a global hub for international trade, manufacturing and financial services, and an outstanding example of regional co-operation. Countries in the region, despite their diversity, are well-positioned to accelerate their growth and pursue broader socio-economic objectives.

Affordable, secure and environmentally sustainable energy will be crucial to underpin Southeast Asia's development over the coming decades. Energy consumption is expected to more than double by 2040. Meeting this growing demand through fossil fuels alone comes at the expense of energy security, environment and sustainable development. The diversification of Southeast Asia's energy supply through investments in renewables offers a viable option to support expansion and also achieve wider socio-economic and environmental benefits.

Encouragingly, all countries in the region have taken steps to tap into this immense opportunity. The adoption of national and regional renewable energy targets, combined with active efforts to reduce carbon emissions under the 2015 Paris Agreement, signal the region's firm commitment to transforming the energy sector. To translate targets into deployment, several countries have adopted policy and investment frameworks that are driving the growth of nearly all forms of renewables, ranging from hydropower, geothermal and bioenergy to increasingly cost-competitive solar PV and wind installations.

The analysis presented in *Renewable Energy Market Analysis: Southeast Asia* comes at a crucial juncture. While the seeds of the region's energy transformation have been sown, they require sustained policy support. To reach the aspirational target of 23% renewables in the region's primary energy mix by 2025, Southeast Asian countries will have to substantially scale-up their deployment of renewables in the power sector, as well as in heating, cooling and transport.

The report brings to the fore the critical considerations for effective policy-making to accelerate the energy transition. It analyses trends in energy supply and consumption at the regional and national level, drivers for renewable energy, resource potential, costs, benefits, policies and investment. The report considers utility-scale, roof-top as well as off-grid applications for expanding energy access.

Earlier editions in the *Renewable Energy Market Analysis* series – covering the GCC and Latin America – have provided a valuable reference point for a range of stakeholders both within those regions and beyond. I am confident that this study will provide comparable insights on Southeast Asia's energy future. It forms an integral part of our regional engagement which has included national-level Renewables Readiness Assessments and REmap country roadmaps. IRENA also continues to co-operate closely with the Secretariat of the Association of Southeast Asian Nations (ASEAN) and the ASEAN Centre for Energy (ACE) to support the region's energy transition.

Adnan Z. Amin
Director General, IRENA

RENEWABLE ENERGY MARKET ANALYSIS

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EXECUTIVE SUMMARY

Southeast Asia is seeing rapid economic growth and development, combined with increasing populations and urbanisation, as well as improving access to basic services[1]. Regional gross domestic product (GDP) reached USD 2.5 trillion in 2016 – triple what it was in 2005. However, this impressive growth trajectory creates staggering energy challenges and raises acute concerns about environmental sustainability.

The regional economy is growing at more than 4% per year, among the highest rates in the world, with considerable variation between countries. Countries are also undergoing structural transformations, moving from agriculture to extractive industries, manufacturing and services in different ways and at varying speeds. Backed by a strong influx of foreign direct investment, some countries have emerged as hubs for a wide variety of industries and services.

The region has also made strides over the past decade on several socio-economic indicators. Based on the USD 1.25 purchasing power parity (PPP) per day threshold, the poverty rate has fallen considerably, from 47% in 1990 to 14% in 2015. Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar and Viet Nam have achieved the fastest reductions. Significant progress has also been made in lowering malnutrition, increasing life expectancy and improving access to education, clean water and sanitation.

Growing populations, rising incomes and rapid rate of urbanisation have combined to boost consumption levels for energy and other resources across the region. By 2050, the region's population is expected to grow by another 25%, putting pressure on national and local governments to keep pace with rising needs for housing, transportation, water and sanitation, and other infrastructure. Governments also need to ensure the creation of jobs and provision of social services.

All these factors have depended upon, and have in turn accelerated the demand for, access to affordable and reliable energy.

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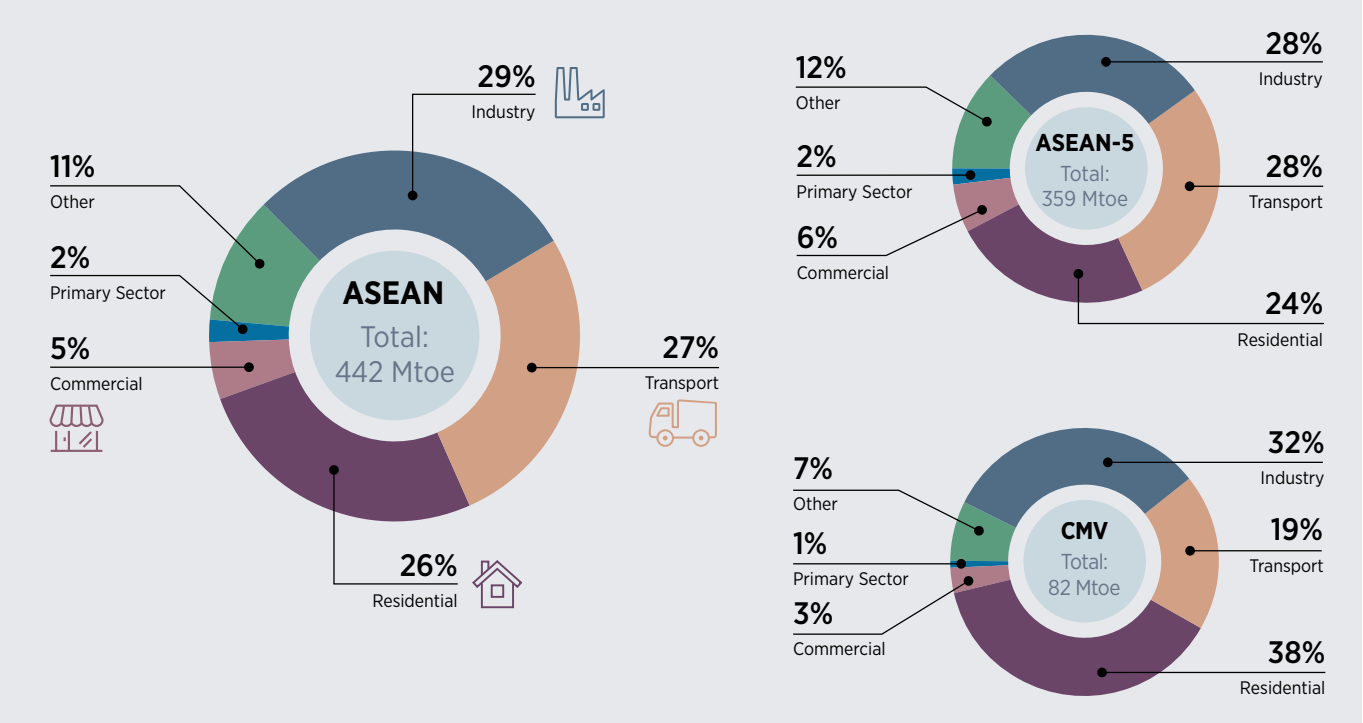
1 | This report covers the Member States of the Association of Southeast Asian Nations (ASEAN): Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam. The terms 'ASEAN' and 'Southeast Asia' are used interchangeably to refer to this set of countries unless otherwise mentioned.

RISING DEMAND FOR ENERGY WITH SOCIO-ECONOMIC DEVELOPMENT AND URBANISATION

Energy consumption in Southeast Asia nearly doubled between 1995 and 2015, growing at an average pace of 3.4% annually. This has fuelled economic growth and permitted higher living standards. Over the past decade, the most rapid growth came from Brunei Darussalam, Cambodia and Viet Nam. In 2015, Indonesia, Malaysia, Thailand, and Viet Nam accounted for most of the region's total final energy consumption (TFEC). That year, the industry, transport and residential sectors accounted for roughly similar shares of region-wide energy consumption, although differences emerge at the sub-regional level (Figure ES.1). Industry was the largest consumer, with shares of the total consumption ranging from around 12% in Myanmar to nearly 40% in Viet Nam.

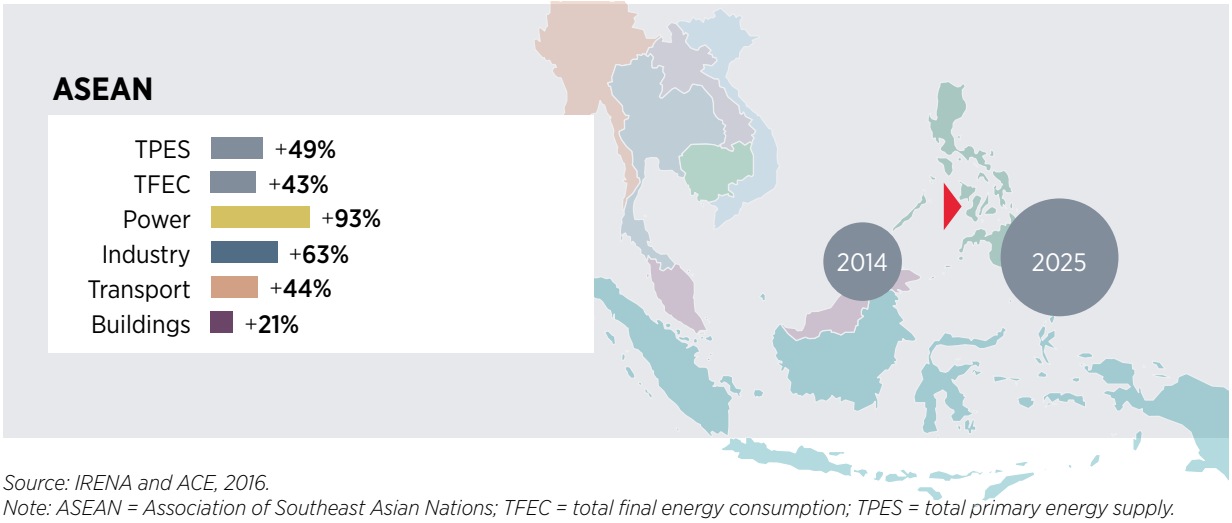
Fossil fuels, led by oil and natural gas, account for more than half of the region's energy supply. Crude oil and its derivatives are predominantly used in the transport sector, where fuel demand has grown rapidly. While the share of natural gas in the total primary energy supply (TPES) has risen considerably over the past two decades, the fastest growth has been registered by coal, especially with the commissioning of numerous coal-fired power plants since 2000. Natural gas contributed the largest share (41%) to the power generation mix in 2015, followed by coal (33%) and hydropower (16%). In line with the region's continued rapid economic expansion, energy demand is expected to grow by an average of 4.7% per year in the period to 2035. Growth in energy demand will be highest in the power sector, followed by industry, transport and buildings (Figure ES.2).

Figure ES.1 Total final energy consumption by sector in Southeast Asia, 2015



Source: Based on IEA, 2017c.
Note: The ASEAN figure does not include Lao PDR due to non-availability of data; CMV = Cambodia, Myanmar and Viet Nam. ASEAN-5 comprises Indonesia, Thailand, the Philippines, Singapore and Malaysia.

Figure ES.2 Increase in energy demand by 2025 over 2014 levels



Source: IRENA and ACE, 2016.
Note: ASEAN = Association of Southeast Asian Nations; TFEC = total final energy consumption; TPES = total primary energy supply.

STRENGTHENING THE CASE FOR ENERGY DIVERSIFICATION THROUGH RENEWABLES

Over the long-term, meeting growing consumption through fossil fuels alone will come at the expense of energy security, with related economic costs for both exporters and importers, in addition to damaging the environment. Energy security concerns are rising as indigenous fossil fuels are depleted or are unable to meet growing demand. With some net exporting countries already turning into net importers, ensuring the security of fuel supply for long-term energy infrastructure is a high priority for all of Southeast Asia. Meanwhile, the concerns about the environmental impact of fossil fuels, from the local to the global level, combined with the lack of modern energy services for a large proportion of the population in several countries, have contributed to the pursuit of a diversified energy mix.

The diversification of energy supply through investments in renewable energy, coupled with improvements in energy efficiency, offers a viable option to expand the energy system and simultaneously realise substantial socio-economic and environmental benefits. The costs of generating electricity from hydropower, geothermal and bioenergy are already within the estimated range of fossil-fuel costs in Southeast Asia. Indeed, solar photovoltaic (PV) and onshore wind power have seen the most significant cost reductions – a 45% decline in installed costs for PV and an 11% decline for onshore wind between 2012 and 2016. Renewable power technologies offer substantial opportunities for future cost reductions as domestic markets mature. The potential for cost-effective renewable energy deployment in the heating/cooling and transport sectors is also immense, especially in industry.

Analysis by the International Renewable Energy Agency (IRENA) has shown that pursuing a renewable-driven energy transition reinforces the regional economic growth agenda. Renewable energy deployment would have a small, but positive, impact on the region's GDP. The renewable energy sector is already creating jobs across Southeast Asia, estimated at 611 000 jobs in 2016. Most of these jobs were in liquid biofuels, followed by large hydropower and solar PV (Figure ES.3). Analysis in this report shows that employment in Southeast Asia's renewable energy sector could reach

1.7 million by 2030 based on current plans and policies (the REmap Reference Case), rising to 2.2 million with accelerated deployment (REmap Options).

Countries in Southeast Asia have already taken important steps in diversifying their energy mix and have begun to reap wide-ranging socio-economic benefits as a result. All countries in the region have set national renewable energy targets. The ten Member States of the ASEAN, furthermore, have agreed to aim for the aspirational target of 23% renewables in their total primary energy supply (including large-scale hydropower but excluding traditional biomass) by 2025.

GROWING DEPLOYMENT OF RENEWABLE ENERGY TECHNOLOGIES

Renewable energy sources accounted for 17% of the region's total electricity generation in 2015. Large hydropower comprised over three quarters of the renewable generation mix, although its share in total installed capacity decreased from 80% in 2000 to 75% in 2016. Bioenergy and geothermal energy are the other major contributors (Figure ES.4), with geothermal facilities being concentrated in Indonesia and the Philippines.

Non-hydropower renewables have grown rapidly as a power source, with their installed capacity more than doubling in a decade, from 6 GW in 2006 to 15 GW in 2016. Despite rapid capacity additions, solar and wind power still account for a small share of the generation mix. Electricity trade, mainly of hydropower, is increasing as interconnection infrastructure is developed for the ASEAN Power Grid initiative. Lao PDR more than quadrupled electricity exports from 2.8 terawatt-hours (TWh) in 2000 to 11.5 TWh in 2015, with Thailand as the main destination.

Figure ES.3 Renewable energy jobs in Southeast Asia in 2016, by technology

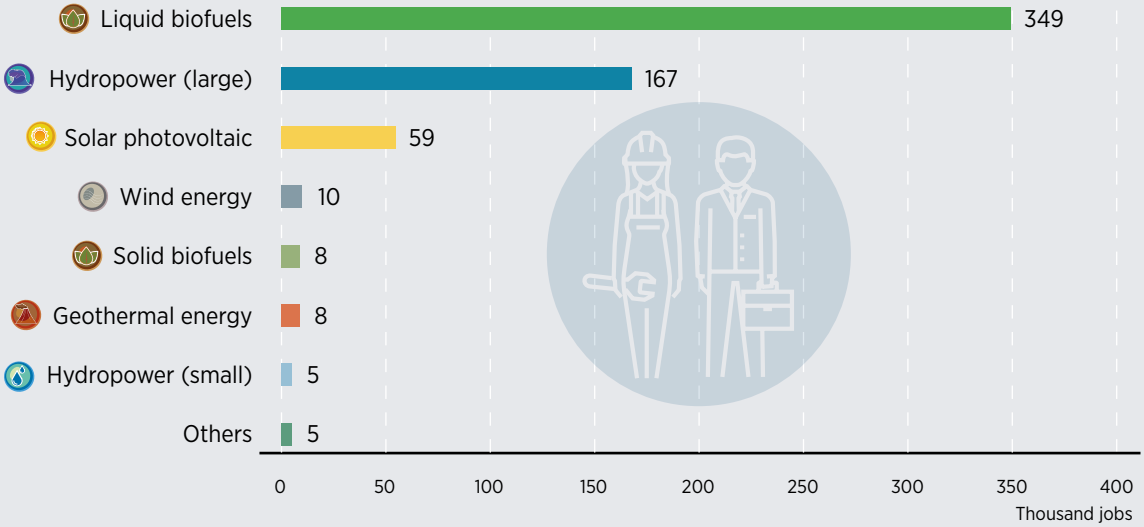
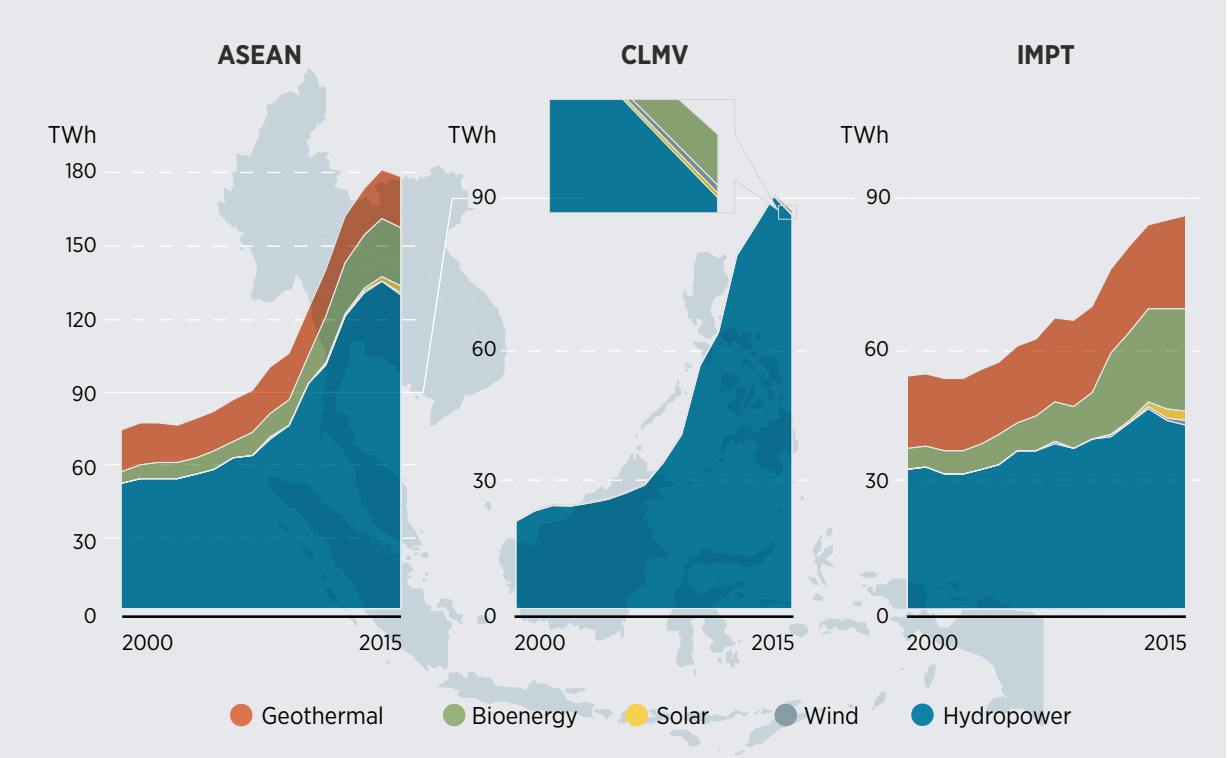


Figure ES.4 Renewable electricity generation in Southeast Asia, 2000–2015 (TWh)



Source: Based on IRENA, 2017f.
Note: CLMV comprises Cambodia, Lao PDR, Myanmar and Viet Nam. IMPT comprises Indonesia, Malaysia, the Philippines and Thailand.

For industry, bioenergy is the most common renewable energy application. Other sources of direct renewable heat suitable for industrial uses are solar and geothermal. In the residential sector, bioenergy represents 69% of TFEC, although the share is decreasing as modern fuels (*e.g.*, liquefied petroleum gas) become more available. The use of traditional bioenergy still represents a significant share of residential energy consumption, notably in Cambodia, Indonesia, Lao PDR, Myanmar and Viet Nam. The share of renewables in transport fuels is small (equivalent to 3%) and primarily comprises liquid biofuels. Indonesia, Malaysia, the Philippines and Thailand are the major markets where biofuel use has grown, mainly driven by blending mandates.

Based on current plans and policies, the share of renewables in TPES would increase to just under 17% by 2025 (compared to less than 10% in 2014). Therefore, the region must overcome a six-percentage-point gap to reach its goal of 23%. This requires further efforts to develop enabling policy and investment frameworks for renewable energy.

ENABLING POLICY AND INVESTMENT FRAMEWORKS FOR ACCELERATED DEPLOYMENT

Most countries in Southeast Asia have set renewable energy targets and have adopted some form of national renewable energy policy to meet them. Indonesia, Malaysia, the Philippines, Thailand and Viet Nam are comparatively more advanced in the region in terms of policy maturity and comprehensiveness.

In the power sector, policies that have catalysed deployment have focused on dedicated financing schemes to support projects; permitting and licensing mechanisms and technical standards to facilitate grid interconnection; and guaranteed purchase of renewable power at attractive tariffs. Most countries have introduced technology-specific feed-in tariffs, often combined with other deployment policies such as net metering, like Malaysia did for roof-top solar power generation.

With the falling cost of technologies, especially for solar PV and onshore wind, and increasing maturity of the sector as a whole, policies that support the deployment and integration of renewables are evolving. New mechanisms, such as the auctions now seen in Indonesia, Malaysia and the Philippines, are being introduced to supplement the traditional instruments that have driven the region's renewable energy growth. Recent experience has shown that adaptations in the policy and regulatory landscape need to be well-communicated and managed, particularly to minimise the investment uncertainty and risk perceptions.

Beyond power generation, many countries still lack comprehensive frameworks for the end-use sectors, meaning energy for heating/cooling and transport. The region has enormous potential to scale up modern bioenergy for sustainable, efficient cooking, for industrial heat generation and in co-generation of power and heat. Solar thermal offers great potential for low-temperature industrial processes. Some countries have introduced dedicated policies to support deployment, including specific heating targets in Lao PDR and a feed-in tariff for co-generation in Viet Nam.

The transport sector currently has the lowest share of renewables in the region. However, it offers high potential for deployment, through a combination of liquid biofuels, electric vehicles and urban mass transit systems. More than half the countries in the region have adopted liquid biofuel blending mandates, which are being steadily increased. Indeed, a programme to maximise bioenergy use in transport and industry needs to safeguard environmental, social and economic sustainability. Fuel standards and incentives for electric mobility adoption and manufacturing are also increasingly common in the region.

Deployment policies represent part of a broader mix of policies that also address education and training, research and development, industrial policy and the broader national investment climate. These are important considerations for countries looking to attract foreign capital and technology, while maximising the socio-economic benefits of renewable energy, including the development of a local industry. In supporting local products and services, some countries, such as Indonesia and Malaysia, have adapted deployment policy design

by offering a premium tariff for projects meeting a specified minimum local content or capping foreign participation in auctions.

While strong policies are essential, a robust regulatory and institutional framework provides the basis for overcoming some of the most prevalent deployment barriers. The strong correlation between policy and investment flows in solar PV (Figure ES.5) illustrates the importance of maintaining a stable, yet adaptable, policy environment that underpins long-term investments in the sector.

Between 2006 and 2016, USD 27 billion was invested in the renewable power sector in the six major Southeast Asian markets of Indonesia, Malaysia,

Figure ES.5 Investments in solar PV in selected countries driven by feed-in tariff policy, 2007-2017

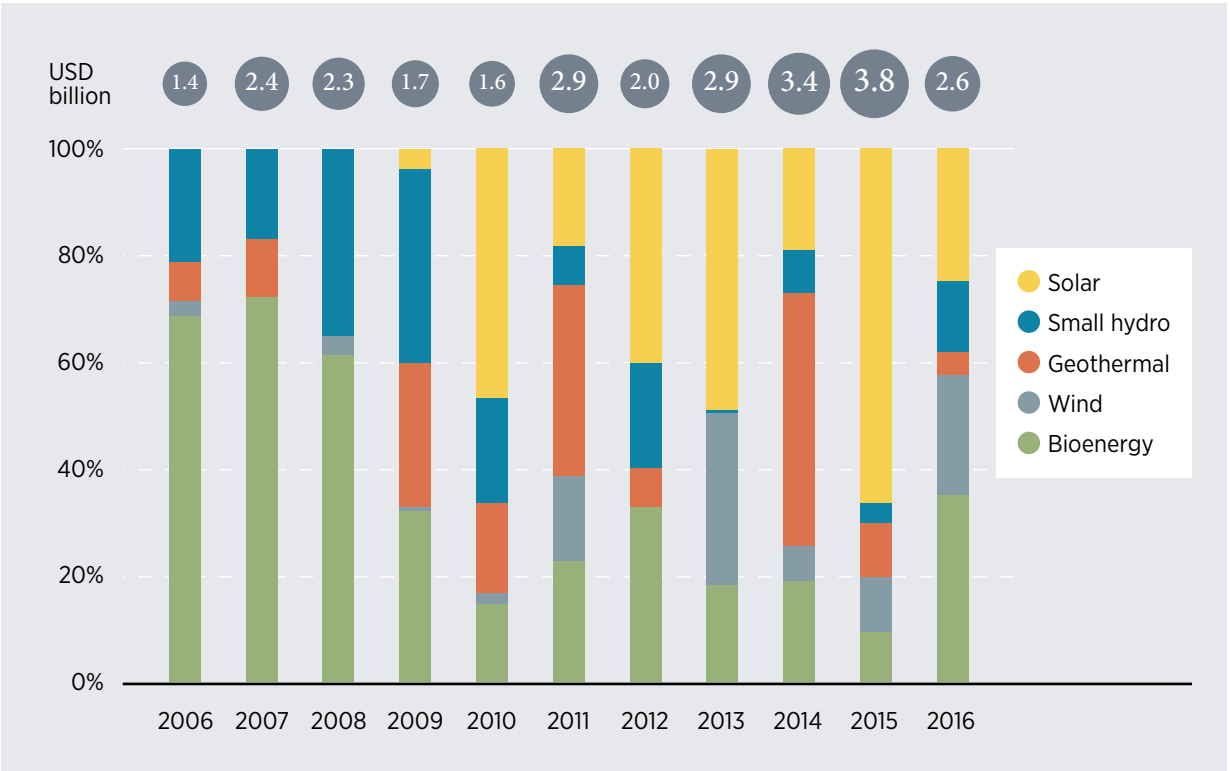
Source: Investment data from BNEF, 2017.
Note: FiT = feed-in tariff; FiP = feed-in premium.

the Philippines, Singapore, Thailand and Viet Nam. Thailand attracted the largest share of that financing, with over USD 10 billion invested, followed by Indonesia and the Philippines. Bioenergy received most of the investment in the region (32%), followed by solar PV and geothermal energy (Figure ES.6).

As the renewable energy sector has grown, the capital mix and the range of financing institutions engaged has also evolved. Development finance has been crucial in backing large hydropower, geothermal and bioenergy projects, followed by rising private sector investments, supported through public-private partnership models and carbon markets. Financial actors in the sector have become more diverse in recent years, providing equity and debt financing and setting the stage to unlock more capital through new avenues, such as green bonds and climate funds.

Public finance will continue to have an important role, especially in countries with less mature financial markets and renewable energy sectors. Around USD 6 billion has been invested cumulatively by development banks in renewable energy between 2009 and 2016. To reach the region's aspirational renewable energy target, annual investment would need to be significantly scaled up to an estimated USD 27 billion. This calls for serious efforts to catalyse private investment, requiring a focus on project readiness and attractiveness, improving access to capital at the local level, and mitigating investment risks.

Figure ES.6 Investment in renewable power by technology, 2006–16 (USD billion)



Source: Based on BNEF, 2017.
Note: Based on power sector asset finance data for Indonesia, Malaysia, the Philippines, Singapore, Thailand and Viet Nam.

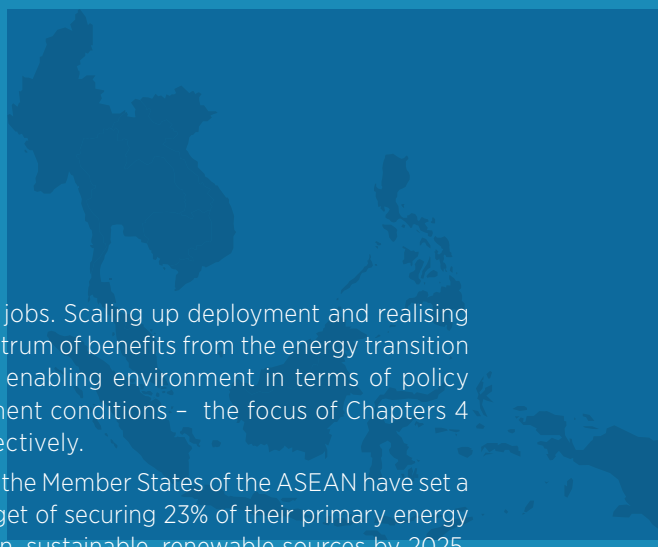
HARNESSING RENEWABLE ENERGY TO MEET MULTIPLE SUSTAINABLE DEVELOPMENT GOALS

The value of renewable energy goes well beyond providing energy services. The deployment of renewables to meet the Sustainable Development Goals (SDGs) set by the United Nations would transform the global energy system. However, fulfilling SDG 7 (on energy) would also help countries meet other key goals, including the SDGs on poverty alleviation, health, water, nutrition, cities and climate. This holds true both in terms of expanding energy access and in other contexts.

As several projects and programmes in the region have demonstrated, decentralised renewable energy solutions, such as micro-hydro and biogas plants based on local entrepreneurship and strong community participation, can greatly improve access to modern energy services. Such solutions in turn bring about substantial economic, social, health and environmental benefits, which contribute to several of the SDGs. In the non-access context, the role of renewable energy in supporting climate mitigation and adaptation, sustainable cities and communities, decent work and economic growth, among other SDGs, cannot be overstated.

Maximising the benefits of renewable energy technologies requires a holistic view. This means considering the impact of renewables both within and beyond the energy sector.

ABOUT THE REPORT



IRENA's *Renewable Energy Market Analysis* series captures the wealth of knowledge and experience embedded in different regions. It identifies emerging trends and themes at the intersection of public policy and market development. The first two editions covered the Gulf Cooperation Council (GCC) countries (2015) and Latin America (2016).

This edition focuses on Southeast Asia, a region characterised by strong economic growth, rising energy demand, growing environmental challenges and concerns about energy security. The countries analysed are the Members States of the Association of Southeast Asian Nations (ASEAN): Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam.

With economic growth exceeding 4% annually, Southeast Asia's energy consumption has doubled since 1995; demand is expected to continue growing at 4.7% per year through 2035. **Chapter 1** describes macroeconomic and social trends in the region, examining the relationship between economic growth and energy demand.

Southeast Asia's rising energy demand encompasses both fossil fuels and some forms of renewable energy, with domestic availability of such resources shaping the energy mix of each country. The region's main fossil fuel sources are coal and natural gas for electricity generation and oil for transportation, while the renewable sources are large hydropower, geothermal and bioenergy for power generation. Yet some 65 million people in the region still lack electricity access, while more than 250 million rely on traditional biomass for cooking. **Chapter 2** analyses the region's energy sector landscape, focusing on trends in supply and consumption. Countries lacking domestic energy resources face questions of security of supply and high cost exposure for energy purchases, while fossil fuel exporters worry about the stability of their revenues. Both groups strive to diversify their energy sources and weigh the role of renewable energy in that context.

Southeast Asia is rich in renewable energy resources, although their potential remains largely untapped. **Chapter 3** explores the region's renewable energy options, analysing the latest trends in costs and deployment as well as the benefits offered by a renewables-driven energy transition in terms of GDP growth and jobs. Scaling up deployment and realising the full spectrum of benefits from the energy transition requires an enabling environment in terms of policy and investment conditions – the focus of Chapters 4 and 5, respectively.

Collectively, the Member States of the ASEAN have set a regional target of securing 23% of their primary energy from modern, sustainable, renewable sources by 2025. Individually, all ASEAN countries have adopted medium- and long-term targets for renewable energy. **Chapter 4** discusses these targets and examines the policy frameworks and institutional setting in place to support the deployment of renewables across the power sector (both on- and off-grid) and end-use sectors, as well as the development of local industries.

The introduction of deployment policies by several ASEAN countries has unlocked growing investments in renewable energy over the past decade. Between 2006 and 2016, cumulative investment in renewable power in Southeast Asia amounted to over USD 27 billion. As the sector has grown, the pool of available capital has expanded. Meanwhile, the role of traditional financiers, such as development banks, is increasingly changing from providing the bulk of finance to making projects attractive for private investments. **Chapter 5** analyses the latest investment trends, the evolution of the capital mix, and remaining finance barriers.

Sustained public and private action to develop renewable energy is closely tied to several of the United Nations' Sustainable Development Goals. Southeast Asia offers compelling examples of the synergies between renewable energy and socio-economic development, whether in rural, urban or island settings. **Chapter 6** discusses the economic, social, health and environmental benefits of decentralised renewable energy solutions.

Renewable Energy Market Analysis: Southeast Asia aims to provide insights for regional and international stakeholders active in the renewable energy sector. The study is part of a wider IRENA initiative in the region, which includes country-level engagement (*e.g.*, REmap analyses and Renewables Readiness Assessments for Indonesia, the Philippines and Thailand) and regional-level initiatives (*e.g.*, with the ASEAN Centre for Energy). The report advances the joint efforts of IRENA and the governments of the ASEAN to accelerate the region's transition to low-carbon, sustainable energy.

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