SOUTHEAST ASIA'S ENERGY TRANSITION

Powering towards the SDGs

ecosperity

CONTENTS

Preface

The International Energy Agency is delighted to make our analysis available for this discussion paper for Temasek. Singapore is an important and highly valued member of the IEA Family, and I am happy to support Singapore and Temasek's efforts to promote reliable, affordable and sustainable energy in Southeast Asia, including through Ecosperity 2019. The IEA conducts extensive engagement with our regional partners such as Singapore, as well as Indonesia and Thailand, and acts as a key advisor to ASEAN on energy policy issues. The IEA plays an important role in helping Southeast Asian nations to tackle their most pressing energy challenges through our world-leading data and analysis, covering all fuels and all technologies.

Demand for energy services in Southeast Asia is growing fast and the agenda facing the region's governments is not a simple one. This analysis sets out some of the choices facing decision-makers, the pathways that can be followed, and the consequences of these choices for energy security and sustainability. It demonstrates the potential to accelerate clean energy transitions, the policies and instruments that can achieve this, and the opportunities that this presents for governments, investors and citizens. I would like to congratulate Temasek for taking this initiative. I trust that Ecosperity 2019 will once again be a great success.

Dr Fatih Birol
Executive Director, International Energy Agency

MAY 2019

EXECUTIVE SUMMARY

There is an urgent need to accelerate and deepen global energy transitions. While there are signs of progress and the costs of key technologies have fallen significantly, the adoption of cleaner and more efficient energy technologies has not been fast enough to slow the growth of carbon emissions. As a result, emissions reached a new historic high in 2018.

Southeast Asia has seen one of the fastest rates of energy demand growth. Factors such as economic growth, urbanisation, industrialisation, expanded access to energy and growing populations have fuelled an 80% increase in energy demand since 2000. Within this, the region's demand for oil and for electricity has grown twice as fast as the global average.

Countries in Southeast Asia have made major improvements in access to modern energy. The share of people with access to electricity increased from 62% in 2000 to around 90% in 2017. However, almost 60 million people still lack electricity access and an estimated 230 million people remain reliant on solid biomass as a cooking fuel.

While deployment of renewables has grown, Southeast Asia is the only region in the world where the share of coal in electricity generation has actually increased in 2018. Today, modern renewables account for almost 20% of power output, but the untapped potential for low-carbon energy remains huge.

The potential to improve energy efficiency is significant. The share of energy consumption covered by mandatory efficiency measures in Southeast Asia remains lower than the global average. This has significant implications for the region's energy outlook. For example, relatively weak fuel efficiency standards pushes up demand for oil; and limited efficiency requirements on appliances mean higher electricity consumption.

Energy projections to 2040 based on existing or stated policies reveal some serious challenges linked to increased reliance on imported fuels and rising emissions. Governments in the region are therefore taking steps to meet rising demand in a secure, affordable and sustainable manner.

The IEA's Sustainable Development Scenario (SDS) provides a blueprint for energy development consistent with the Paris Agreement and the United Nations Sustainable Development Goals (SDGs). Achieving this scenario would require a step-change in policy focus and investment flows, and would bring multiple benefits for energy access, air quality, greenhouse gas (GHG) emissions and energy security.

Nearly $3 trillion of cumulative energy investment is needed between today and 2040 in Southeast Asia to realise a sustainable pathway. This represents a huge opportunity although allocation of this investment across different sectors will depend on how policies and business strategies evolve.

Moving towards the SDS for Southeast Asia would require concerted action across all parts of the energy sector. Multiple technologies and approaches would be required. This discussion paper highlights five key areas of opportunity for policy-makers and investors:

Investment in renewable energy

The IEA estimates that this could be the most significant decarbonisation lever in Southeast Asia. By 2040, renewables are estimated to account for up to 70% of power generation in the SDS, up from 30% in the New Policies Scenario (NPS). Rising shares of wind and solar PV would also require increased flexibility in the region's power system, via increased regional interconnection, energy storage and demand-side response.

A major focus on energy efficiency

While significant improvement potential remains in all sectors, energy efficiency in the transport sector can improve the most, and will likely attract almost half of all efficiency-related investments in the region.

Getting prices right by phasing out fossil fuel subsidies

Southeast Asia has made progress on reducing fossil fuel subsidies, reducing subsidies by about half to $20B in 2017 compared to the first half of the decade. However, this process is not yet complete.

Sustainable models for the region's bioenergy potential

Southeast Asia's transitions can be helped by its large potential for modern bioenergy: in addition to today's technologies, the development of advanced biofuels could contribute significantly to emissions reduction in the transport sector.

Tackling emissions from coal, starting with the least-efficient coal-plants

A changing power mix, deployment of advanced technologies, and investment in carbon capture, utilisation and storage, can all help to reduce coal sector emissions.

This discussion paper is produced for Ecosperity 2019 by Temasek, drawing upon analyses and data from the IEA.

The discussion paper includes references to the NPS and SDS from the IEA's World Energy Outlook.

The NPS aims to provide a sense of where today's policy ambitions appear likely to take the energy sector. It incorporates not just the policies and measures that governments have already put in place, but also the likely effects of announced policies, including Nationally Determined Contributions made for the Paris Agreement. It does not speculate as to the future evolution of these policies, and should not be considered a forecast.

The SDS sets out an ambitious but pragmatic vision of how the global energy sector may evolve in order to achieve the objectives of the Paris Agreement and the United Nations energy-related SDGs.

Definitional note to the tables

Total primary energy demand (TPED) is equivalent to power generation plus other energy sectors excluding electricity and heat, plus total final consumption (TFC) excluding electricity and heat. TPED does not include ambient heat from heat pumps or electricity trade. Sectors comprising TFC include industry, transport, buildings (residential, services and unspecified other) and other (agriculture and non-energy use). Projected gross electrical capacity is the sum of existing capacity and additions, less retirements.

CHAPTER I

Global Energy Transition

The demand for energy resides at the core of human activities and socioeconomic progress. While promoting universal access to modern energy is important, it is equally important to ensure that this is done in a sustainable manner.

The energy-related SDGs, reliable, sustainable and modern energy for all (SDG7), tackling climate change (SDG13) and reducing health impacts due to energy-related air pollution (SDG3) are useful yardsticks against which we can steward our energy systems and guide our actions going forward.

2018 saw energy-related carbon emissions reach a historic high of 33.1 Gt CO_2 on the back of the fastest annual energy demand growth rate this decade. Efforts to decouple energy demand growth from emissions have resulted in emissions levels growing 25% slower than the growth in energy demand, but more needs to be done for us to achieve our sustainability goals.

IEA analyses indicate that investments in new fossil fuel supply increased slightly in 2018, while only 7 out of the 39 technology indicators of decarbonisation monitored by the IEA are on track to meet sustainability goals[1]. Change is needed to rebalance energy investments in favour of clean energy deployment and to intensify efforts to decarbonise our energy system across all sectors.

[1] www.iea.org/tcep/


Wind farm, the Philippines

Annual CO_2 emissions rose to record levels in 2018 on the back of fastest energy demand growth this decade

Rise in global energy demand in 2018 was largely met by fossil fuels

Global energy demand rose by 2.3% in 2018, its fastest rate of annual growth this decade. Approximately a fifth of this growth can be attributed to weather conditions. Demand for air-conditioning during the summer jumped last year, which ranked as the fourth hottest year on record. Likewise, colder-than-average winters in North America increased heating demand.

Demand for all fuels increased in 2018, with fossil fuels contributing to nearly 70% of the growth. The biggest gains came from natural gas, which accounted for nearly 45% of the increase in total energy demand. Fuel switching from coal to gas, driven by economics and policies, was a key contributor to this growth, particularly in the United States (US) and China.

Global electricity demand in 2018 increased by 4%, or 900 TWh, growing nearly twice as fast as the overall demand for energy. In China, electricity demand rose by 8.5%, a notable uptick compared to recent years. This was led by the industrial sector, including iron, steel, cement and construction. India's power demand also increased by 5.4%, albeit at a slower rate than the previous year. This was driven by higher electricity demand in buildings, especially for air conditioning, and better access to electricity. Last year, India completed the electrification of all its villages, with electricity connections extended to around 30 million people in the last two years.

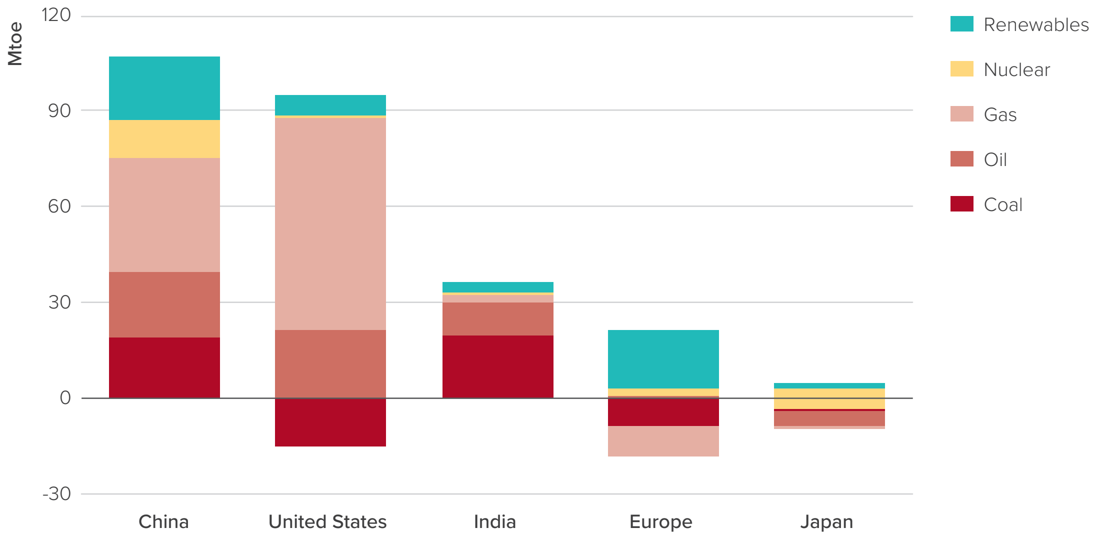


Figure 1.1
Global primary energy demand growth by fuel and selected regions, 2018

Corresponding to the rise in global energy and electricity demand, CO_2 emissions rose to a historic high. The increase in renewable energy generation and energy efficiency only partially offset the rise in overall energy demand.

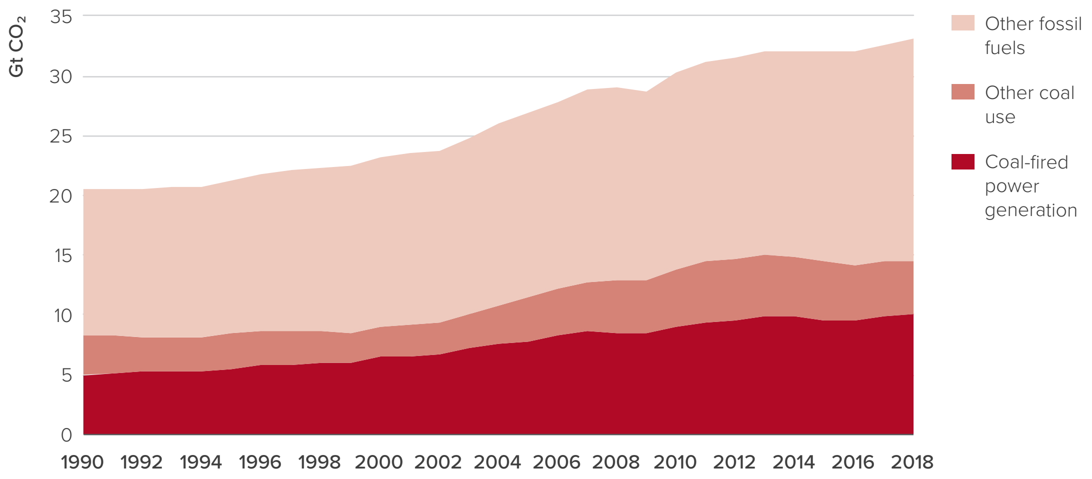


Figure 1.2
Global energy-related CO_2 emissions by source, 1990-2018

As a result of higher energy consumption, global-energy related CO_2 emissions rose 1.7% from 2017 to 2018, reaching a historic high of 33.1 Gt CO_2. Low carbon options did not scale up fast enough to meet the rise in demand. As a result of industrialisation and urbanisation, emissions from electricity generation have doubled over the past 27 years. Coal-fired power plants in Asia are responsible for most of the increase in emissions.

> Global energy-related CO_2 rose to a historic high of 33.1Gt CO_2 in 2018

Nevertheless, clean energy technologies and energy efficiency have made an impact in 2018: Emissions grew 25% more slowly than energy demand and global energy intensity fell by 1.3%. In recent years, a decrease in carbon intensity for the largest economies contributed to a reduction in global carbon intensity. This is driven by improvements in power plant efficiency, switching away from fossil fuels and greater penetration of low-carbon sources.

Today, the average carbon intensity of electricity generation is 475 gCO_2/kWh, a 10% improvement from 2010. Without this improvement, global CO_2 emissions would have been 1.5Gt higher. In addition, there has been commendable growth in renewable energy. Modern renewable energy accounts for over 10% of total final energy consumption globally. This growth is concentrated in the power sector, although the rapid expansion in solar PV, wind and hydropower was only enough to meet 45% of the rise in global electricity generation in 2018. China contributed to over 40% of the growth in renewable-based electricity generation, followed by Europe, which contributed 25%. The US and India combined contributed to another 13%.

The Paris Agreement specifies that, in order to strengthen the world's response to the threat of climate change, global GHG emissions should peak as soon as possible, and then decline so that they reach 'net zero' in the second half of this century. It sets the aim to limit the increase in global average temperatures to well below 2°C, with efforts to limit this further to 1.5°C. The scientific community, in successive Intergovernmental Panel on Climate Change (IPCC) reports, have underlined the imperative for early and determined action to mitigate severe impacts on natural and human systems from global warming.

Given that energy-related activities are responsible for the bulk of CO_2 emissions and energy demand is forecasted to rise further, it is imperative that the world decouples the two.

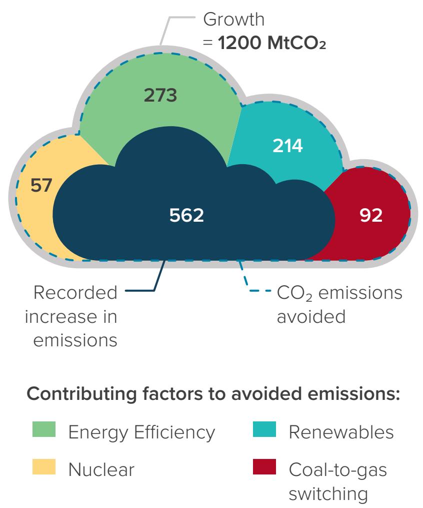


Figure 1.3
Change in global energy related CO_2 emissions and avoided emissions, 2017-18 ($MtCO_2$)

We are making progress towards affordable, reliable, sustainable and modern energy for all, but not fast enough to achieve the world's SDGs by 2030

A sustainable energy system provides a clean and inclusive energy future

A sustainable energy system brings about the benefits of prosperity, health, environment and energy security. This will require progress in ensuring universal access to modern energy, reducing the severe health impacts of air pollution, and tackling climate change. As a framework, energy features prominently in the SDGs. This includes targets to ensure access to affordable, reliable, sustainable and modern energy for all (SDG7), tackling climate change (SDG13), and reducing health impacts due to energy-related air pollution (SDG3) by 2030. Achieving all three objectives in parallel is important in order to achieve a sustainable global energy system.

Providing access to modern energy is a critical enabler for socio-economic development

Electricity provides the best and most efficient form of lighting, extending the day and providing extra hours for study or work. Electricity is also required by household appliances, opening up new possibilities for communication, entertainment, and heating amongst others. Electricity enables water to be pumped for crops, and allows food and medicine to be refrigerated. Modern energy can directly reduce poverty by raising a country's productivity and extending the quality and range of its products, thereby increasing the wages of the less privileged. For instance, mechanical power can benefit workers by increasing the efficiency of otherwise laborious and time-consuming jobs such as farming, textiles manufacturing and other processes.

There has been significant global progress towards ensuring access to affordable, reliable and modern energy for all in line with SDG7. As a result, the number of people without access to electricity fell below 1 billion in 2017. Many developing countries in Asia have been making strong progress towards universal access to electricity and – as of today – more than 90% of the population in developing Asian countries have access to electricity. The share of the global population without electricity access is increasingly concentrated in parts of sub-Saharan Africa.

	Rate Of Access						Population without access (million)
	National				Urban	Rural	
	2000	2005	2010	2017			2017
WORLD	**73%**	**76%**	**80%**	**87%**	**95%**	**76%**	**992**
Developing Countries	**64%**	**69%**	**74%**	**83%**	**93%**	**73%**	**992**
Africa	**35%**	**39%**	**43%**	**52%**	**74%**	**36%**	**603**
North Africa	90%	96%	99%	100%	100%	99%	**<1**
Sub-Saharan Africa	23%	28%	32%	43%	67%	28%	**602**
Developing Asia	**67%**	**74%**	**79%**	**91%**	**98%**	**85%**	**351**
China	99%	99%	99%	100%	100%	100%	**-**
India	43%	58%	66%	87%	98%	82%	**168**
Indonesia	53%	56%	67%	95%	100%	89%	**14**
Other Southeast Asia	68%	76%	84%	88%	97%	82%	**44**
Other Developing Asia	38%	45%	58%	76%	88%	68%	**125**
Central and South America	**86%**	**90%**	**94%**	**96%**	**98%**	**86%**	**20**
Middle East	**91%**	**80%**	**91%**	**92%**	**98%**	**78%**	**18**

Figure 2.1
Global rate of access to electricity

In 2017, for the first time, the number of people worldwide without access to electricity dipped **below 1 billion.**

More can be done to achieve the three main objectives of a sustainable global energy system

The SDGs of interest are closely interlinked. Achieving the renewable-generation and energy efficiency targets of SDG7 will significantly advance the progress towards reduction in health impacts due to energy-related emissions (SDG3) and advance climate action (SDG13).

Today, energy-related outdoor air pollution leads to around 2.9 million premature deaths globally. Household air pollution, mostly from smoke due to cooking, is linked to more than 2.6 million premature deaths. Increased access to modern cooking facilities can reduce household air pollution while increased renewable power generation and other advanced technologies, together with energy efficiency, can reduce outdoor air pollution.

Unfortunately, progress in increasing access to clean cooking has been very limited. Nearly 2.7 billion people still lack access to clean cooking facilities, relying instead on biomass, coal or kerosene. On the upside, this number started declining for the first time in 2017.

In addition, the share of modern renewables (which exclude the traditional use of biomass) in total final energy consumption has been growing since the 2000s, reaching over 10% in 2017. However, under current policies, this share is expected to reach only 15% by 2030, well below the 22% required renewable generation share as estimated by the SDS.

Moreover, to achieve the targets of SDG7, global energy intensity needs to achieve annual average reductions of 2.6% per annum until 2030. However the world is falling short of this goal, with the rate of improvement in energy intensity slowing down to around 1.7% per annum in 2017. Each passing year of missed targets will mean that subsequent annual energy intensity targets will become increasingly challenging to meet.

Efforts to tackle climate change (SDG13) have also fallen far short of what would be required. The global annual concentration of CO_2 in the atmosphere averaged 407.4 ppm in 2018. This is a major increase from pre-industrial levels, which ranged between 180 and 280 ppm. IEA's assessment of the impact of fossil fuel use on global temperature increase found that CO_2 emitted from coal combustion was responsible for over 0.3°C of the 1°C increase in global average annual surface temperatures above pre-industrial levels.

Alongside investment in a range of other clean and efficiency technologies, there is also the need for capacity development in Carbon Capture, Utilisation and Storage (CCUS). Almost all the global scenarios that model outcomes consistent with the Paris Agreement have a role for CCUS, in power generation and in industry. It is important to start investing in these capabilities now and to build a conducive environment that supports carbon pricing mechanisms, in turn allowing for the commercial viability of CCUS.

Energy investments are not shifting towards low-carbon energy choices fast enough to meet sustainability goals

Low carbon energy spending was flat in 2018, just at a moment when it needs to pick up

Global energy investment was stable in 2018 at just over USD 1.8 trillion. A slight slowing of the power sector investment was offset by rises in oil and gas and energy efficiency. Falling capital costs of some electricity generation technologies contributed to the observed fall in power sector investments.

A 4% rise in upstream oil and gas spending was underpinned by a higher oil price, although project approvals would need to pick up further to match a continued robust outlook for demand. Spending continued to shift towards shorter-cycle projects as the industry seeks to manage market and policy risks in a changing energy system.

Investment in coal supply, mainly concentrated in China, increased by 2%, the first such rise since 2012 but Final Investment Decisions (FIDs) for new coal-fired capacity fell to their lowest level this century.

Low-carbon power generation such as renewables and nuclear accounted for nearly three-quarters of new spending on electricity generation. The overall investment in renewables-based power edged down by 1% in 2018 compared to the previous year. Despite this, a dollar of renewables spending continues to buy more capacity than in the past, as costs continue to fall. In 2018, capital cost continued to decline for solar PV (-75% since 2010), onshore wind (-20%) and battery storage (-50%). Adjusting the time series to 2018, cost levels shows a rising trend in renewables capacity over time, with renewables investment activity up 55% since 2010.

Energy efficiency spending was stable for the second year in a row, led by the industry and transport sectors. Examples of such spending include fiscal or financial incentives to encourage consumers to adopt high efficiency appliances or financial support for electrification of various transport modes. Growth was tepid compared to three years ago, although prices for some efficient goods such as LEDs and electric vehicles continue to fall, and many energy efficient investments are already cost-effective with relatively short pay-back periods. The relatively weak energy efficiency policy environment, with slow progress both on the implementation of new efficiency policies and on increasing the stringency of existing policies, acted as a barrier to increased spending on efficiency.

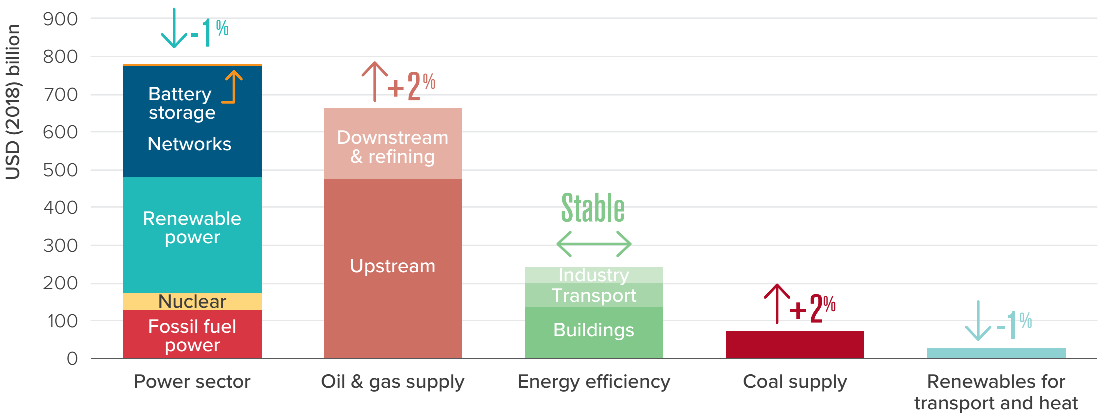


Figure 3.1
Global energy investment by sector in 2018 (% change in relation to 2017)

There is a need to rebalance investments towards low-carbon options and some developing economies

Several mismatches are emerging between current trends and future needs, reflecting variations in pathways towards energy security and sustainability goals. Notably, current market trends are not spurring the major reallocation of capital from fossil fuels to low-carbon energy that would align with sustainability goals. In the SDS, the low-carbon share of spending would need to rise to 65% by 2030, from 35% today.

Asia enjoys a large share of global energy investments; China remains the largest market for investment in energy while more than two dollars in every ten invested worldwide in energy goes towards the electricity sector in Asia. India saw the fastest growth in energy investments in 2018, and has seen strong increases in renewable spending in recent years: in 2018, renewable spending in India continued to exceed that for fossil fuel-based power, supported by tenders for solar PV and wind.

However, a broader rebalancing of capital is needed towards low-income economies, especially in sub-Saharan Africa, if the SDGs are going to be met. With good policies and financing, there is a chance for tomorrow's social and economic development models to rely much more on clean energy technologies than in the past.

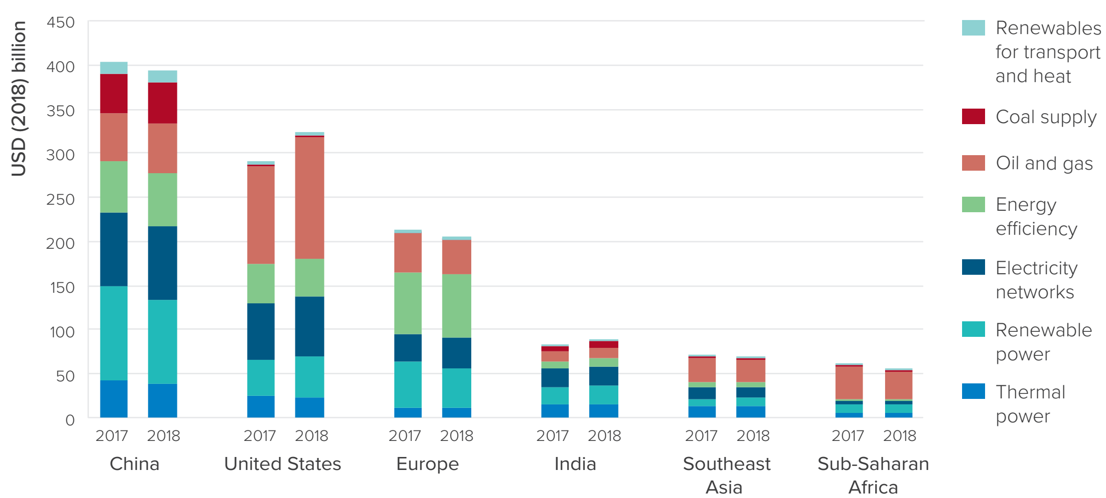


Figure 3.2
Energy investment by sector in selected markets, 2017 and 2018

Most clean energy technology progress are not on track to meet sustainability goals

Tracking the global energy transition at the technology and sector levels allow for informed and directed strategy formulation in support of a sustainable energy future

The IEA's Tracking Clean Energy Progress (TCEP) provides a comprehensive assessment of a full range of energy technologies and sectors that are critical in a global clean energy transition. It includes up-to-date information of current technology status and where they need to be to meet long-term climate, energy access and air pollution goals, in line with the IEA's SDS.

The TCEP tracks 39 energy technologies across six areas. Progress for each technology is uniquely defined by the intended outcome required for a sustainable energy future. For example, in the case of power generation, assessment of progress in renewable power generation is done by tracking its share in the overall generation capacity against what is required to achieve the SDG targets. In the case of fuel economy for transportation, one way of tracking progress is to measure the fuel economy of light-duty vehicles against the pathway set by the Global Fuel Economy Initiative (GFEI), which has defined a pathway towards a fuel economy target by 2030 to meet the SDGs.

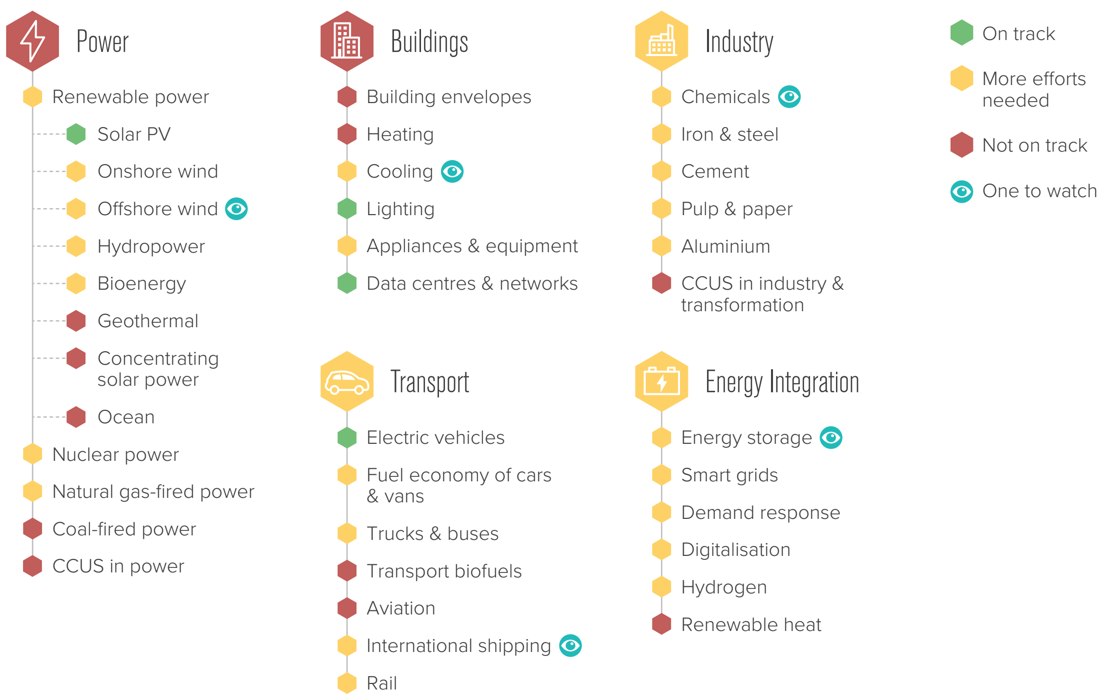


Figure 4.1
Progress of 39 energy technologies as tracked by TCEP

Accelerated progress is required in almost every part of the energy system

Power Sector

In 2018, 42% of all energy-related CO_2 emissions came from the power sector, making it still the largest source of energy-related CO_2 emissions. It is therefore increasingly critical that the power sector delivers the access, air pollution and climate outcomes of the SDS for the clean energy transition to be successful. Of all technologies surveyed by the IEA across the power sector, only solar PV and bioenergy are on track to achieving sustainability goals. Other power sector technologies are lagging behind. Unabated coal electricity generation, responsible for around 70% of power sector emissions, grew for a second year in 2018 after falling over the previous three years.

Fuel Supply

Oil and gas extraction, processing and transportation were responsible for 5.2 gigatonnes of CO_2 equivalent ($GtCO_2$-eq) emissions in 2017 – nearly 15% of global energy sector GHG emissions. Half of these emissions (2.6 $GtCO_2$-eq) are from flaring and from methane released during oil and gas operations. In the SDS, these flared and vented emissions are estimated to fall to less than 1.2 Gt CO_2-eq by 2025. Quantitative emissions reduction targets by some companies and governments are a welcome first step to achieving this level, but an immediate step-change in policy ambition and industry buy-in is needed, along with technological progress on detecting, measuring and avoiding emissions.

Building Sector

In the building sector, two areas have been identified to be on track to achieving sustainability goals. First, lighting is experiencing strong positive momentum, with residential lighting sales of LEDs reaching the same share of sales as florescent lamps in 2018. In addition, energy demand for data centres and transmission networks are also on track to meet sustainability goals. Despite rapid growth in data centre traffic and workloads, global data centre energy demand is forecasted to remain flat. Nevertheless, two-thirds of countries around the world still lack mandatory building energy codes and sales of AC units is expected to rise three times faster than efficiency improvements. Cooling is the fastest growing driver of energy demand, and is expected to keep growing with climate change looming on the horizon. With proper planning, solutions such as district cooling have the potential to significantly reduce cooling energy requirements in an urban environment. This can provide savings in power infrastructure spending for greenfield projects.

Transport Sector

Although the share of electric vehicles (EVs) in the global passenger car stock stood at less than 1% in 2018, important policy announcements and strong forecasts of electric car sales puts it on track to achieve a share of 15% by 2030 (as in the SDS). Separately, existing measures to increase efficiency and reduce energy demand in the transport sector must be deepened to reach sustainability goals. For instance, average fuel consumption of light-duty vehicles improved by only 0.7% in 2017, slowing from the 2005-16 rate of 1.8% per year. To get on track with the 2030 SDS target, which aligns with the GFEI target, annual improvements of 3.7% are needed. To this end, it may require transportation to be more fuel efficient, efficient engines to be more affordable, and existing vehicle fleets to be electrified.

Industrial Sector

Progress in industry also remains relatively slow. Direct industrial CO_2 emissions rose 0.3% to 8.5 $GtCO_2$ in 2017 (24% of global emissions), a rebound from the 1.5% annual decline during 2014-16. Expanding CCUS is crucial in achieving ambitious climate targets, considering that it is one of the few technology options capable of significantly reducing direct CO_2 emissions from industrial sectors that are otherwise hard to decarbonise. CCUS is also important in the power sector as a retrofit option for existing plants, given the young age of the global coal fleet.

Energy Integration

A variety of “energy integration” technologies – such as smart grids, energy storage, and hydrogen – need to play an increasingly important role to maximise the collective impact of individual technologies and bring the world onto a sustainable trajectory. Some areas like battery storage and smart girds are seeing signs of progress, but more innovation and policy focus is needed overall. Although still small at global scale, 2018 was a bumper year for battery storage, as annual deployment nearly doubled from 2017 to reach over 8 GWh. Lithium-ion battery storage continued to be the most widely used, making up nearly 85% of all new capacity installed. Technology costs for battery storage continue to drop quickly, largely owing to the rapid scale-up of battery manufacturing for electric vehicles, stimulating deployment in the power sector.

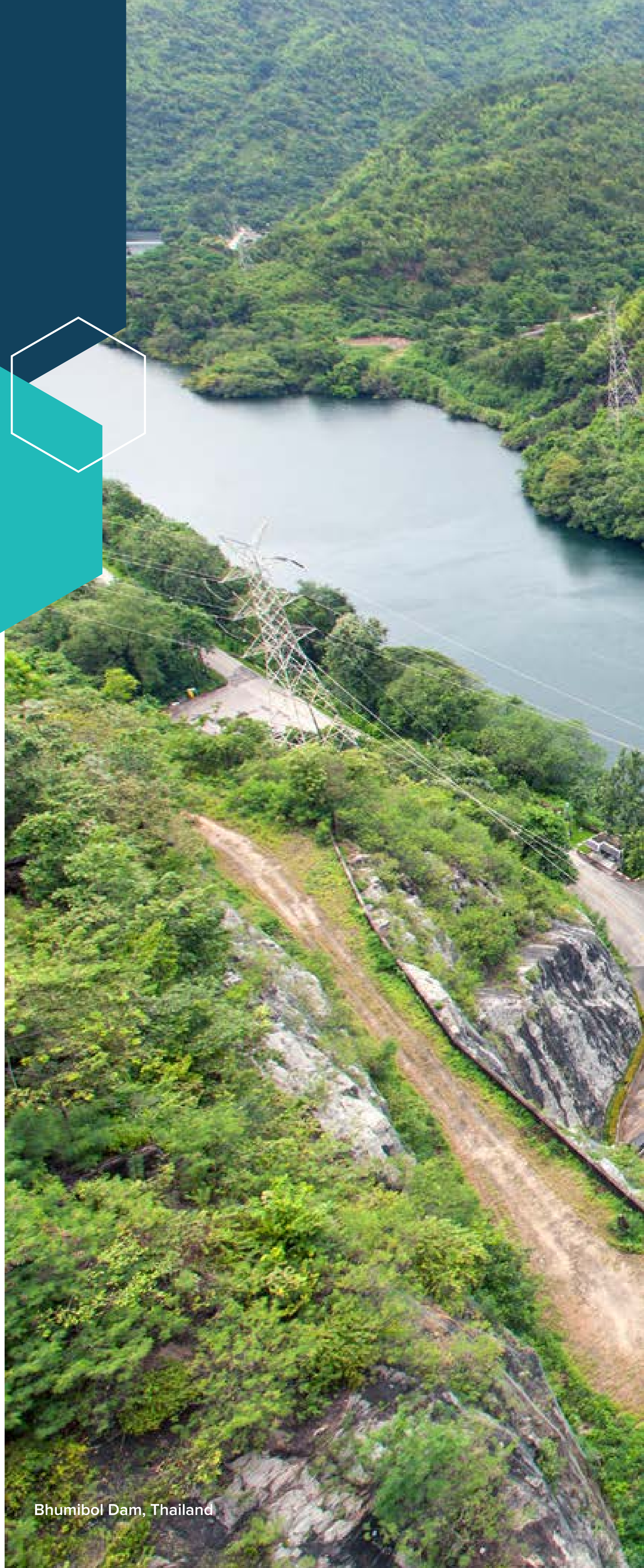
CHAPTER 2

Current State of Energy Transition in Southeast Asia

Southeast Asia is witnessing an intensification of electrification, urbanisation and industrialisation as reflected in its strong economic growth. Approximately 70% of the associated energy demand growth has been fuelled by fossil sources.

As energy demand continues to grow (by about two thirds over the next 20 years), IEA's analyses suggest that a continuation of today's policy and investment environment will see fossil fuels retain its dominant role in the bloc's energy mix up until 2040. This exposes the region to higher socioeconomic risks associated with negative effects of elevated emission levels and increasingly erratic weather patterns, as well as calling into question the region's long-term energy security.

The total cost of the longer-term risks associated with over-reliance on fossil fuels should be weighed against policy inertia and shorter-term benefits of lower cost energy to motivate the transition towards a more sustainable energy future.



Bhumibol Dam, Thailand

Electrification, urbanisation and industrialisation have led to the rise of fossil fuel usage in Southeast Asia

Electrification, urbanisation and industrialisation have underpinned the growth of modern energy in Southeast Asia

In the period between 2000 and 2017, the Southeast Asian bloc of nations saw a doubling of its GDP per capita from about $6,000 to about $12,000, an increase in urbanisation rates from 38% to 48%, and correspondingly, a rise in national electrification rates from about 60% to 90%. This period of strong economic and demographic growth, together with industrialisation, rising incomes and higher levels of urbanisation in Southeast Asia, fuelled an 80% increase in energy demand between 2000 and 2017.

Electricity is the fastest growing energy source in the region. Since 2000, electricity demand in Southeast Asia has grown at an annual average rate of 5.3%, roughly twice the world average. Among all end-use sectors, transport and electricity use for buildings experienced the most remarkable growth, accounting for more than 40% of the final energy consumption increase. This trend underscores the significance of urbanisation to the region's energy landscape. Indeed, large inflows of population to capitals, coupled with rising incomes, are leading to higher rates of motorisation and penetration of household appliances.

Although electricity access in Southeast Asia rose from 62% in 2000 to 91% in 2017, electricity's share in total final energy consumption remained around 15% as of 2017, as compared to the world average of 19%.

The share of bioenergy in the mix has been in decline. Solid biomass accounted for about 26% of the energy mix in 2000 versus 20% in 2017, reflecting a welcome shift towards use of modern energy such as electricity for lighting and liquefied petroleum gas (LPG) for cooking.

Southeast Asia's energy demand growth has largely been fuelled by fossil fuels

Fossil fuels supply around three-quarters of the region's energy mix. Oil continues to be the dominant source of energy, although its share of total energy demand has decreased by around six percentage points to 34% since 2000. Nevertheless, oil demand grew by almost half over this period on the back of the region's rapid motorisation.

Meanwhile, growing industrialisation and economy-wide electrification have increased the importance of coal, which increased its share in the region's energy mix from 8% in 2000 to 19% in 2017. Gas also benefited from increased use in the power and industry sectors, increasing its share in the energy mix from 19% to 21% over this period.

Renewable power generation, dominated by hydropower and geothermal, has doubled its volume from 2000, maintaining its share in total primary energy demand at 6%.

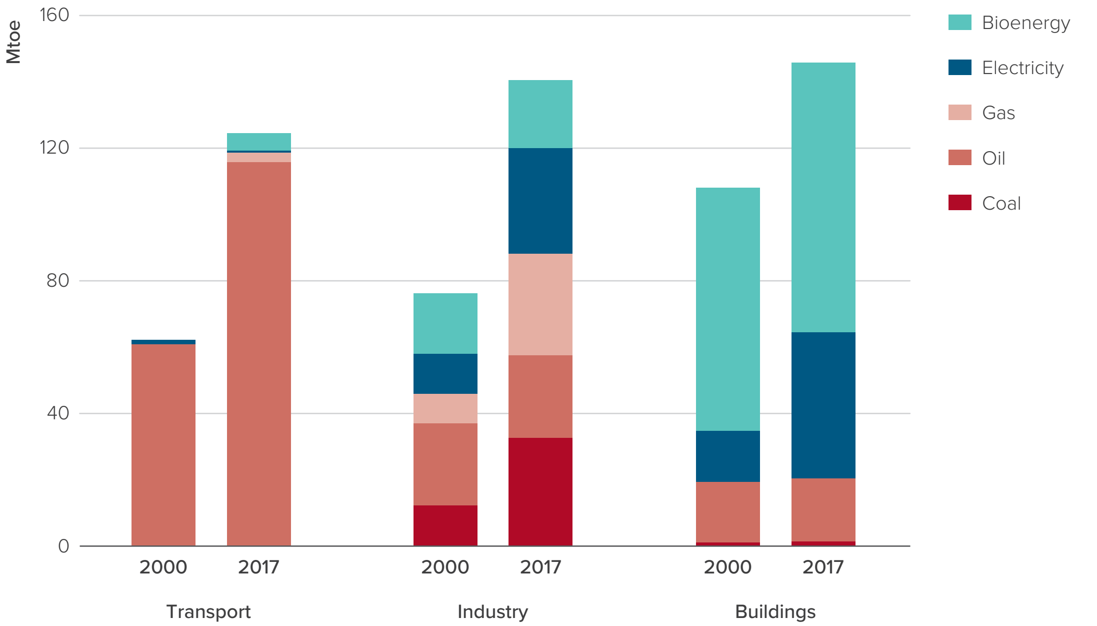


Figure 5.1
Energy consumption by fuel and sector in Southeast Asia, 2000-2017

Southeast Asia's electricity demand from 2000-2017 grew at **an annual average rate of 5.3%,** roughly twice the world average

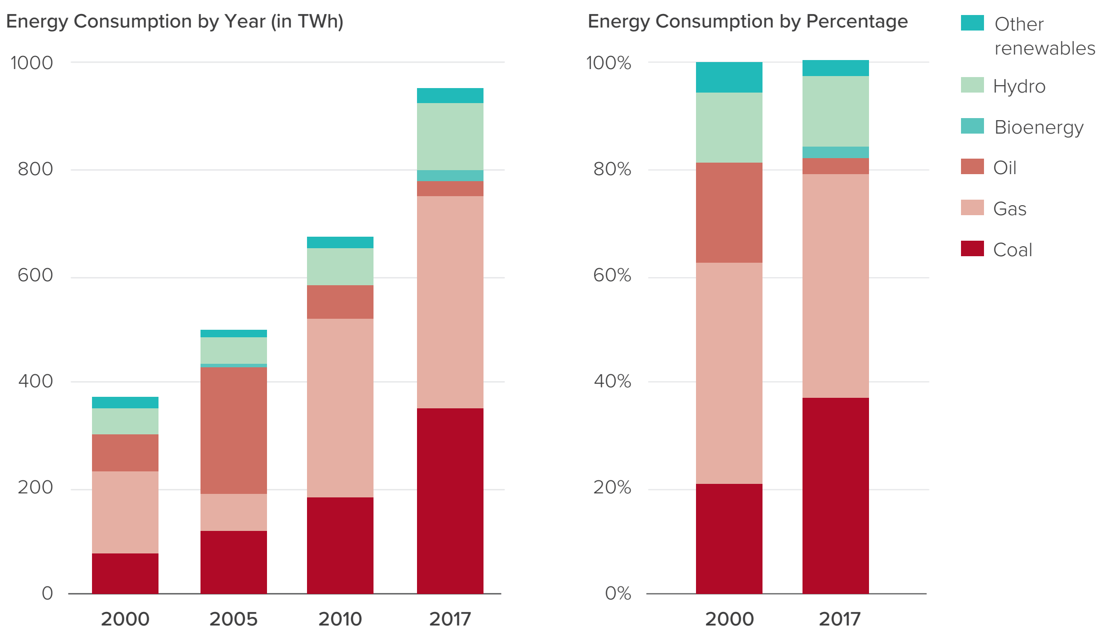


Figure 5.2
Power generation mix in Southeast Asia, 2000-2017

Southeast Asia is making significant progress in expanding access to modern energy

Southeast Asia has been very successful in expanding electricity access, but less so with clean cooking facilities

In developing Asia, over 900 million people have gained access to electricity since 2000. In particular, the share of people with electricity access in Southeast Asia had increased from 62% in 2000 to around 90% in 2017, as Malaysia, Thailand and Vietnam achieved complete access to electricity, while other countries, like Indonesia and the Philippines, have also significantly improved access levels.

However, around 58 million people, roughly 9% of the region's population, still lacked access to electricity in 2017.

In the Southeast Asia Energy Outlook 2017, the IEA evaluated the choices available to expand electricity access in Indonesia, the Philippines, Myanmar and Cambodia. There is no single homogenous pathway to access across the different countries. The least-cost route depends on the relative costs of technologies, as well as local resource availability, topography and population density. Grid-connected generation is often a good way forward; however in many other cases, distributed power generation, often based on renewables, offers an efficient way of providing access in remote or island communities.

Under current and planned policies, all countries are expected to achieve universal electricity access by 2030 (SDG7). This is achieved by developing a range of technologies and approaches, with around 40% connected by extending the grid, one-third via mini-grids, and the remainder via off-grid solutions, like solar home systems or small diesel generators. Changing costs of fuels and technologies – in particular the prospect of continued cost reductions in solar PV – need to be taken into account when assessing strategies for electrification.

Providing access to clean cooking facilities also poses an even greater challenge than improving access to electricity, with almost five times more people lacking clean cooking access than electricity in Southeast Asia. Overall, more than 230 million people relied on biomass for cooking in 2017, approximately 35% of the total population in the region. Using biomass for cooking presents a serious health risk due to poor indoor air quality. In 2015, around 260,000 premature deaths were attributed to poor indoor air quality. Providing clean cooking facilities is less costly than access to electricity, but has been a low priority for many Southeast Asian governments. Myanmar is an exception, as policy-makers are promoting clean cooking in part to prevent the high rate of deforestation.

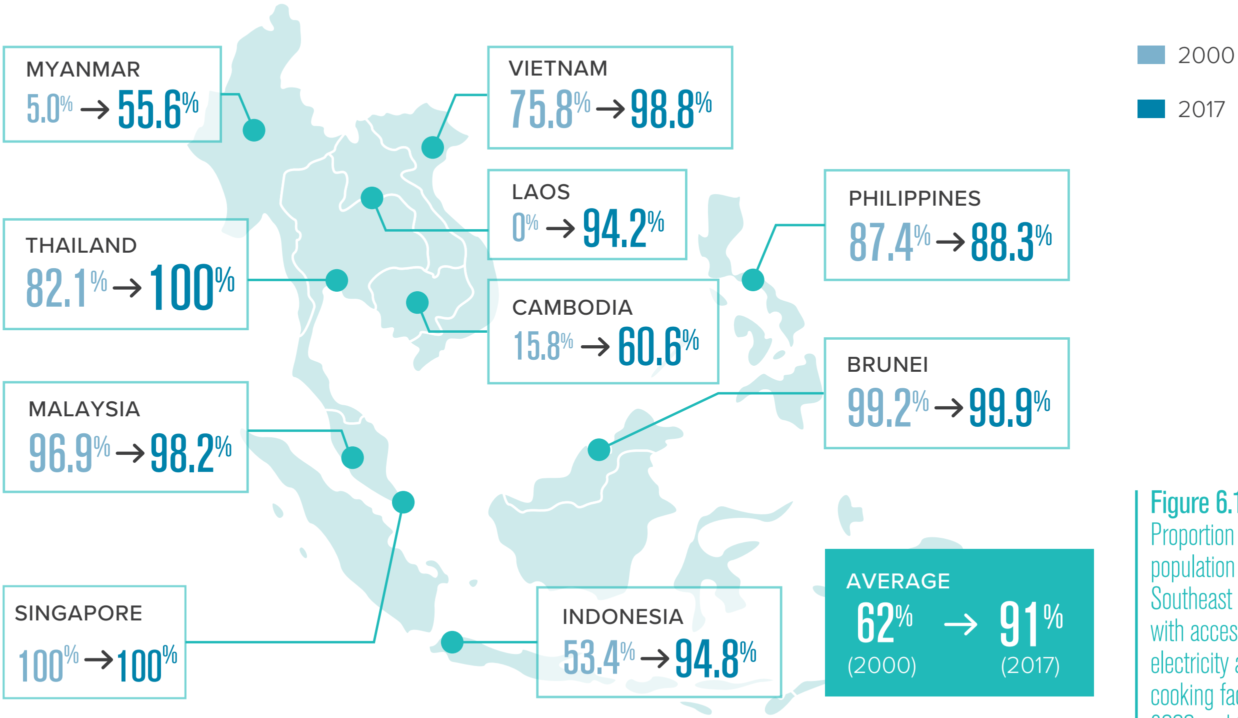


Figure 6.1
Proportion of population in Southeast Asia with access to electricity and clean cooking facilities, 2000 and 2017

Decoupling Southeast Asia's energy demand growth from carbon emissions is critical to its long-term prosperity

Tackling climate change (SDG13) by means of reducing the CO_2 and other GHG emissions is also a central priority for Southeast Asia. The region has a high concentration of settlements and economic activity along its long coastlines, and a strong reliance on natural resources, agriculture and forestry. This makes Southeast Asia vulnerable to the effects of climate change, such as rising sea levels and extreme weather events. According to a World Bank study, a one-meter rise in sea levels would inundate more than 13,800 square kilometres of land in Indonesia and displace 2.8 million people. Similarly, 11% of Vietnam's communities living in low-lying areas around the Mekong and Red River Deltas face similar risks of inundation. Should sea levels rise to three metres, inundation risks will affect 5.1 million people in Indonesia and 26% of Vietnam's population.

Energy-related CO_2 emissions in Southeast Asia has risen in lockstep with the rise in energy demand, reaching 1,323 Mt CO_2 in 2017, up from 692 Mt CO_2 in 2000. Southeast Asia needs to intensify efforts to reduce the carbon intensity of its energy demand, with the aim to decouple its economic development from carbon emissions if it hopes to achieve a sustainable growth that considers its impact on the environment, and vice versa.

Southeast Asia is faced with increased risks to energy security, environment and health as fossil fuels continue to retain a powerful position in the NPS

Fossil fuels continue to be Southeast Asia's main energy source under today's policies and policy ambitions

In the NPS, Southeast Asia continues to experience robust growth in primary energy demand, which increases by two-thirds by 2040. A growing manufacturing base means that industrial energy consumption almost doubles by 2040. In the residential sector, rising household incomes and higher ownership of appliances results in a near-tripling of electricity use.

To meet rising electricity demand, installed generation capacity is estimated to more than double to around 620 GW in 2040. Renewable generation capacity makes the largest contribution to growth, but coal- and gas-fired plants remain the largest sources of power. Coal is the largest source of demand growth, with its use more than doubling by 2040, mainly due to increased use in power generation. Consumption in power plants accounts for three-quarters of the additional coal use by 2040. Coal maintains a strong foothold in the region not only because it is markedly cheaper than natural gas, but also readily available domestically in some countries.

Natural gas demand also rises, by more than 53% by 2040. Industry is the main growth engine for gas in the region, accounting for 60% of the incremental gas demand in the period to 2040. Meanwhile further demand growth in the power sector is constrained primarily because of the relatively high cost of gas compared with coal.

Oil remains the largest fuel in the region's energy mix, propelled by an increase in the region's vehicle stock. Transport alone accounts for more than half of oil demand in 2040.

The use of renewables, including hydropower, wind and solar PV, triples over the period to 2040. In terms of solar generation, Thailand currently accounts for most of the region's installed capacity, and this is expected to increase in coming years. In terms of wind energy resources, the Philippines is thought to have the greatest potential in term of wind energy resources, with an estimated potential of around 70 GW.

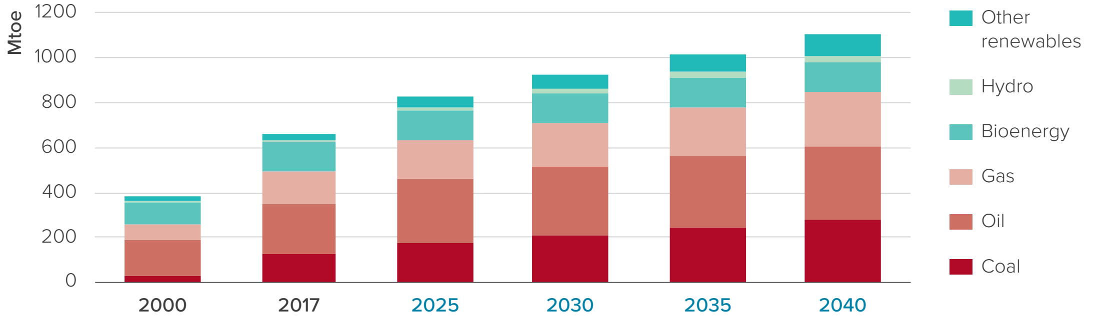


Figure 7.1
Primary energy demand in Southeast Asia in the NPS

Growing fossil fuel consumption gives rise to energy security, health and environmental concerns

In the NPS, growing demand for fossil fuels, a fall in regional oil production, and a levelling of gas production are increasing Southeast Asia's fuel import dependency. The region's energy import bill is expected to exceed $300 billion by 2040, and oil import dependency (the amount of oil imported as a proportion of total demand) increases by 10 percentage points, reaching around 80% in 2040.

Despite reduction in carbon intensities, the projected rise in energy demand continues to drive up energy-related CO_2 emissions: they are expected to increase by more than three quarters by 2040, growing five times as fast as the global average. Overall, Southeast Asia is projected to be responsible for 6.5% of global CO_2 emissions by 2040, from 4.1% today.

Similarly, emissions of dangerous air pollutants also increase. Sulphur dioxide and nitrous oxides emissions grow by 40% and 50% respectively by 2040, driven by rising coal use in power generation and oil use in transport. Pollutant emissions take a tremendous toll on health: ambient air pollution is expected to result in over 400,000 premature deaths annually by 2040, a 70% increase from current levels. An equal number of premature deaths are likely to be associated with high levels of household air pollution.

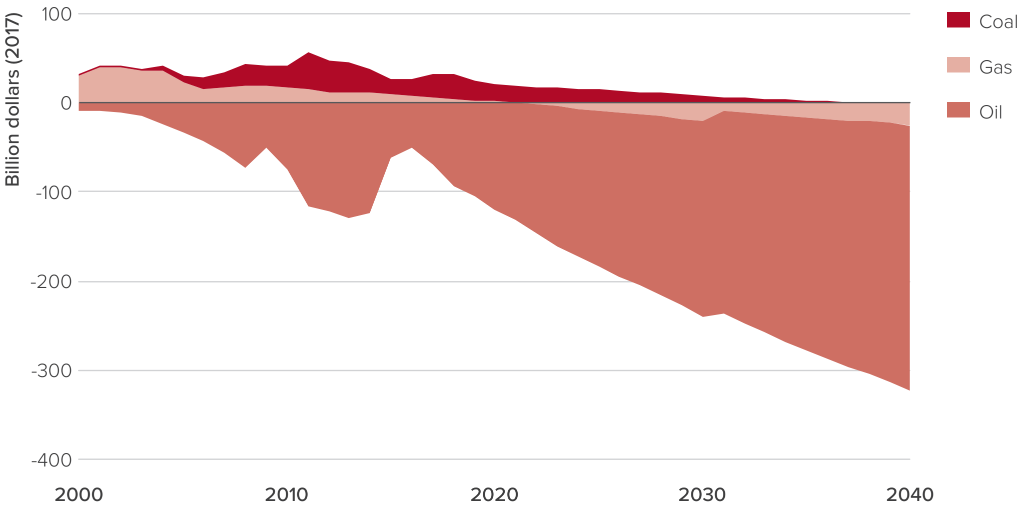


Figure 7.2
Fossil fuel trade balance in Southeast Asia in the NPS

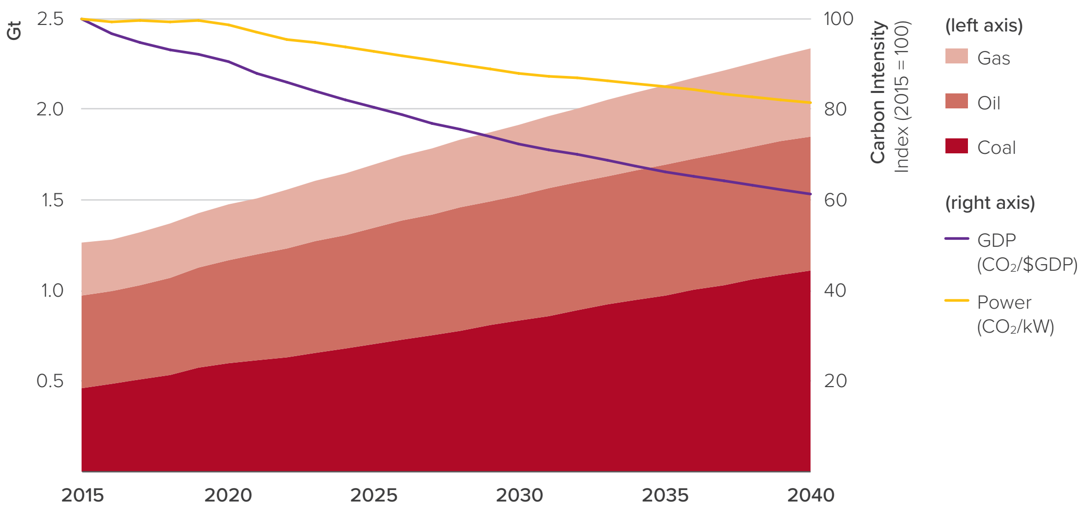


Figure 7.3
Energy-related CO_2 emissions and carbon intensities in Southeast Asia in the NPS

CHAPTER 3

Transitioning Towards a Sustainable Energy Future for Southeast Asia


Rice fields with wind turbines,
Tan Hai, Phan Rang, Ninh Thuan, Vietnam

Recognising the risks that Southeast Asia will be exposed to if the bloc does not decouple its energy demand growth from carbon emissions, this chapter discusses the key levers that can be taken to achieve the transition towards a more sustainable energy future.

A country's energy system is largely influenced by its energy policies and power market structure. To this end, this chapter draws upon the projections and analyses of IEA's SDS for this discussion. The SDS models the various energy policy scenarios in Southeast Asia to arrive at the least-cost pathway that fulfils our sustainability ambitions as defined by the energy-related SDGs and the Paris Agreement.

The falling cost of key energy technologies represents a major opportunity for the region. If policies and investment strategies are supportive, the transition is estimated to yield savings of about $150B from reduction of fossil fuel imports, halving of emission levels and prevention of up to 70% of premature deaths. However, this will require a sizeable shift of investments from fossil fuel supply and power generation towards renewable energy spending and efficiency.

Achieving a sustainable energy future requires a fundamental shift towards energy efficiency and low-carbon sources

Charting a sustainable energy pathway towards the SDGs and Paris Agreement

In establishing an action plan to decouple energy demand growth from carbon emissions, it is important to be guided by internationally recognised and science-based frameworks.

The IEA's SDS sets out an ambitious but pragmatic vision of how the global energy sector can evolve in order to achieve the objectives of the Paris Agreement and the UN's energy-related SDGs.

Starting with the SDG outcomes, the SDS then works backwards to determine the actions needed to deliver these goals in the most cost-effective way. The SDS is fully aligned with the goal of the Paris Agreement to limit the temperature increase above pre-industrial levels to "well below 2°C". From now until 2040 (the period covered by the model), the emissions trajectory of the SDS is at the lower end of other decarbonisation scenarios projecting a median temperature rise in 2100 of around 1.7°C to 1.8°C. It is also within the envelope of scenarios projecting a temperature rise below 1.5°C, as assessed by the recent IPCC Special Report on 1.5°C.

Putting the region's energy system on a sustainable path, as outlined by the SDS, would bring about substantial benefits in terms of prosperity, health, environmental and energy security, but would require a profound transformation in the way we produce and consume energy.

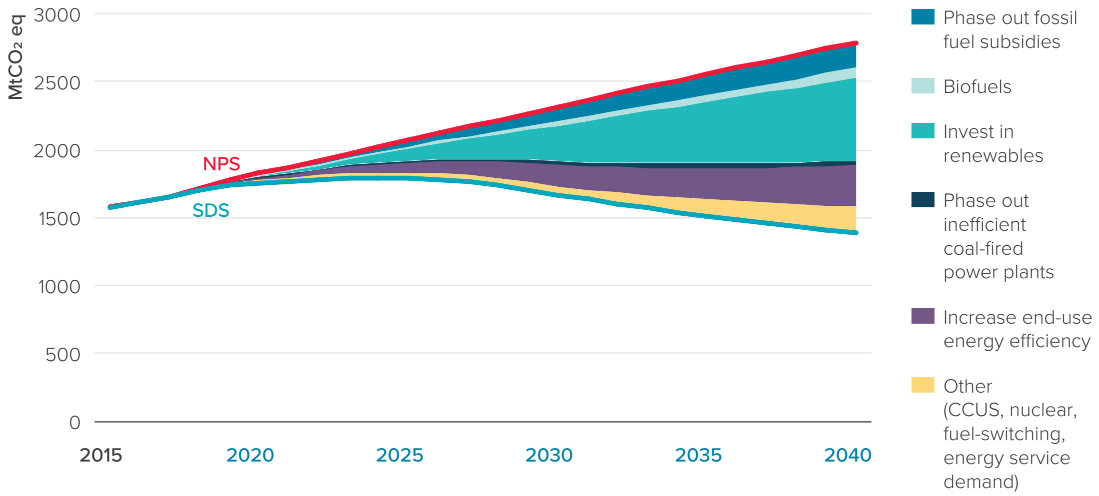


Figure 8.1
CO_2 and methane emissions reduction measures in Southeast Asia in the SDS relative to the NPS

In the SDS, CO_2 emissions are half the level of the NPS in 2040

Ambitious scale-up of clean energy and adoption of energy efficiency measures underpin Southeast Asia's pathway towards a sustainable energy future

As illustrated in IEA's SDS, emission levels in 2040 have to be lower than today's — even as energy demand is forecasted to be two-thirds higher. This is not possible unless we achieve significant decarbonisation of our energy demand.

Energy efficiency adoption in all sectors is lower than global averages. The low adoption of energy efficiency measures across all sectors presents a low-hanging opportunity in the bloc's decarbonisation journey. Doing so will curb the rise in energy demand required to fuel the forecasted economic growth and the associated emissions. IEA's SDS estimates that improvement in energy efficiency adoption is enough to meet a quarter of the emissions abatement needed.

After accounting for energy efficiency gains, it is important to meet new energy demand by addressing the relatively low renewables penetration rate in Southeast Asia's energy mix. The IEA's SDS projects that about $500B of additional investment is needed above the NPS to increase the share of renewables in power generation from the current 20% to about 70% by 2040 in order to meet sustainability goals. Such substantial investments in renewable energy will require the right market structures and incentives. Southeast Asia's traditional reliance on fossil fuel subsidies for economic growth has to be re-evaluated against the accompanying environmental and health risks.

Existing and committed coal-fired generation capacities also pose further challenges. Replacing existing coal plants with renewables alone will be difficult, and will require additional solutions like retrofitting existing plants with carbon capture methods and ensuring that future capacities come online with the most efficient technologies possible.

Given its large agriculture sector, in particular concerning palm oil, Southeast Asia should also consider actively supporting research to unlock more pathways for advanced biofuel to play a bigger role in its energy mix. Doing so will also indirectly contribute to emissions abatement by preventing the loss of valuable carbon sinks.

Multiple clean energy technologies and integrated policy approaches will be essential for Southeast Asia's energy transition. The following sections will provide more details on the decarbonisation levers mentioned above.

Increasing renewable energy to meet Southeast Asia's rapidly growing electricity demand is a significant driver of GHG emission reductions for the region

Share of renewable power generation needs to more than triple in order to meet sustainability goals

The IEA estimates that increasing the share of renewables in the energy mix could fill more than 40% of the gap between the NPS and SDS.

Since 2000, renewables-based generation capacity has tripled in Southeast Asia, reflecting policy efforts to deploy renewables, including tariffs, tax breaks and soft loans. However these are not sufficient. Today, renewables account for less than 20% of total power generation in the region, of which only a small fraction is solar and wind. To deliver emission reductions targets and put the power sector on a sustainable path according to SDS, the share of renewables in generation needs to more than triple to almost 70% by 2040.

Hydropower already plays an important role in power supply, having generated 13% of the region's electricity in 2017. Despite this, considerable untapped potential remains to expand hydropower facilities, particularly in the Lower Mekong Basin, namely in Cambodia, Laos, Myanmar and Thailand. These four countries have significant hydropower potential of more than 110 GW, but the development of large-scale projects raises a plethora of social and environmental questions that could stymie expansion.

Existing upstream dams have taken a toll on the Mekong River Basin, with water levels at their lowest levels since records began 100 years ago. In recent year, droughts have hit a number of countries, including Cambodia and Vietnam. This stress, coupled with the high number of people directly reliant on the river for their livelihoods, make large-scale projects controversial. In an effort to ensure responsible development, Thailand, Cambodia, Laos and Vietnam signed the "Mekong Agreement" in 1995.

Today, wind and solar remain a small part of the overall generation. However, many countries in the region plan to increase the use of renewables to capitalise on their geographical advantages and have already introduced various support measures. Five ASEAN members (Indonesia, Malaysia, Thailand, Philippines and Vietnam) have introduced feed-in tariffs to incentivise investment in renewables.

The IEA suggests that wind and solar together could potentially account for almost 30% of total power generation in Southeast Asia by 2040. This would require careful attention from policy-makers and regulators to ensure that the power system operates with sufficient flexibility. Continued efforts to improve regional cooperation and interconnection – through plans for an ASEAN Power Grid – can play a very strong supporting role for the integration of increasing shares of solar PV and wind power.

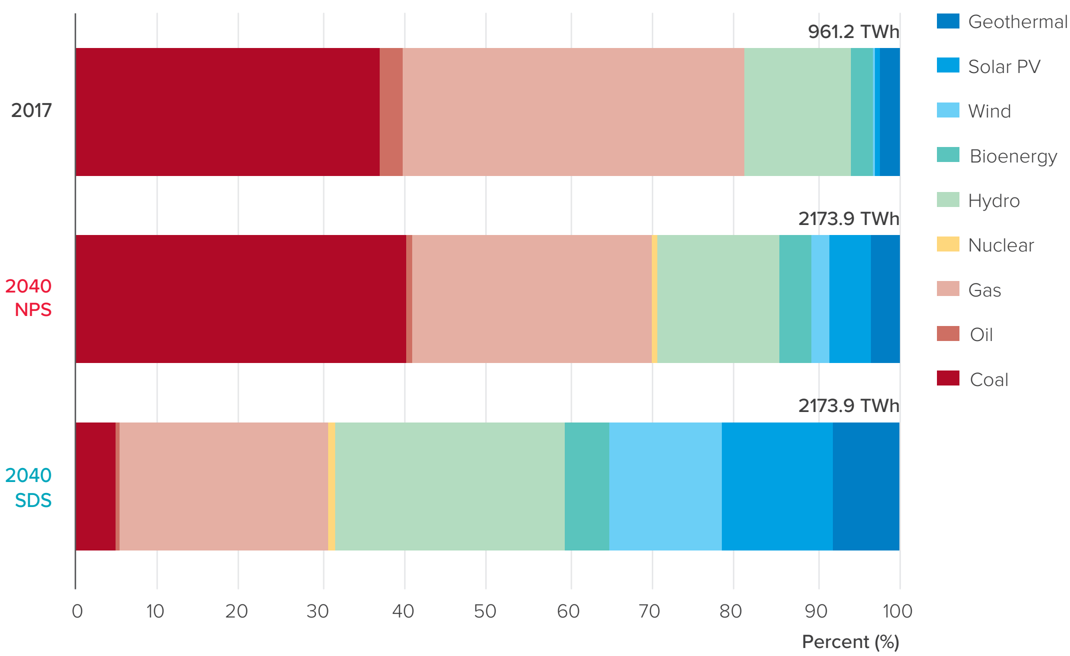


Figure 9.1
Share of electricity generation from power technologies in Southeast Asia today and in 2040 by scenario (NPS and SDS)

Renewables need to contribute the majority of overall power generation in the SDS compared to the status quo

Conducive reliable market structures and incentives are crucial to attracting the additional investments needed to realise the added growth in renewable generation capacity

In the SDS, the cumulative investment needed for renewables-based power generation to 2040 is more than $850B ($500B more than what is needed in the NPS). This corresponds to an annual average of around $40 billion, around 10% of total government revenue in Southeast Asia, illustrating the potentially large burden on government budgets if there is a lack of meaningful participation from the private sector and international financial institutions.

While energy market policies such as feed-in tariffs, tax breaks and soft loans can help to encourage renewable energy investments, they need to be developed in tandem with a sustainable power market structure to ensure lasting growth in the sector.

Investors' participation can also be dampened by the presence of unfavourable policies such as electricity price controls and fossil fuel consumption subsidies. Subsidised prices in energy market do not reflect the true cost of energy to consumers for them to make the right choice and when coupled with the burden of renewables subsidy, the governments' energy liability can become untenable.

Southeast Asia is improving energy efficiency in all end-use sectors, but huge untapped opportunities remain

Limiting the increase of energy demand by improving energy efficiency of end-use sectors will reduce environmental and energy security risks

As energy demand in Southeast Asia is projected to increase at a rapid pace, the extent to which countries in the region improve energy efficiency will have huge environmental implications. Indeed, improvements in end-use energy efficiency are key to achieving the transition associated with the SDS, contributing a quarter of emissions reductions in the SDS compared to the NPS, as illustrated in Figure 8.1.

Improved energy efficiency also has the potential to relieve energy security concerns. This becomes increasingly important as declining oil production and rising demand heightens policy-makers' concerns over the challenges associated with increasing import dependency, increased energy import bills, and increased capital requirements to invest in energy supply.

To address fast-rising energy demand, Southeast Asian countries are increasingly pursuing energy efficiency policies and have agreed on a collective efficiency target of reducing energy intensity by 30% by 2025 compared with 2005, including national targets. A few countries, such as the Philippines and Thailand, have gone further, adopting extensive energy efficiency polices under comprehensive national energy efficiency plans. However, across the region, the degree of implementation of efficiency policies varies significantly.

For example, many appliances such as air conditioners, refrigerators, and television sets are covered by energy-efficient labelling schemes in Thailand, Vietnam and Singapore, while other countries like Cambodia, Laos and Myanmar have not yet introduced efficiency labelling schemes. These countries often lack the institutional resources and capabilities necessary to implement efficiency policies, including data collection as a basis to measure consumption and save energy, as their resources are often directed towards other policy priorities, such as extending electricity access.

Energy efficiency gains must be realised in every end-use sector, with the transport sector having the largest potential for improvements

There is significant untapped potential to improve energy efficiency measures in all end-use sectors. More than $600 billion is needed to improve end-use energy efficiency in the SDS to 2040, a 13% increase compared to the NPS.

The transport sector is projected to have the largest potential for efficiency improvements. It is forecasted to attract almost half of the investment, mostly for road transport. Growing demand for mobility and limited public transport network in some countries are set to increase the passenger vehicle stock by 70% by 2040 in the NPS. This makes improvement of vehicle fuel efficiency a key action to realise energy savings.

In the buildings sector, only half of the countries in Southeast Asia have introduced mandatory minimum energy performance standards for appliances, including equipment and lighting. Moreover, although most countries have adopted building energy codes, their rigour and enforcement vary significantly and often are not mandatory. The harmonisation of standards would provide equipment and appliance manufacturers with larger market opportunities and reduce the cost of meeting standards, while also lowering consumer costs. Close collaboration in policy planning and implementation could also deliver significant benefits, particularly as the region is going through rapid and large-scale urbanisation, meaning that early implementation of best practices could lead to immediate gains.

The industrial sector is another area where Southeast Asia would benefit from close collaboration in policy planning. Currently only half of Southeast Asian countries have introduced management systems in industry. The infrastructure necessary for such an initiative is considerable, and as such sharing resources across the ASEAN members could be useful.

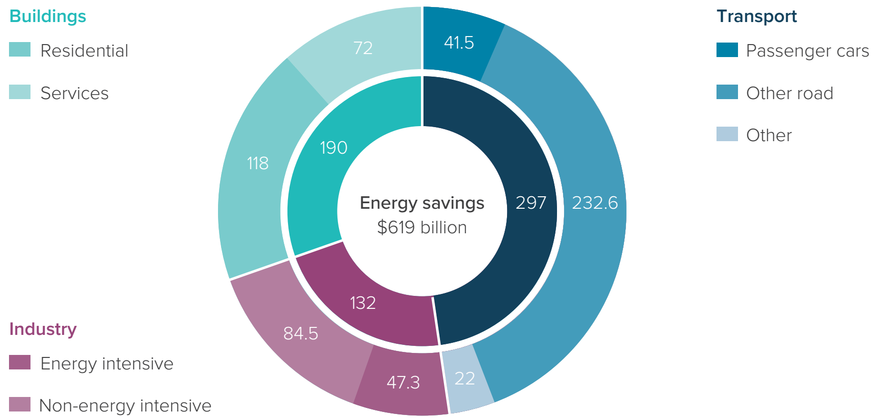


Figure 10.1
Energy savings by end-use sector in the SDS (outer circle) relative to the NPS (inner circle), 2040

As demand for mobility and vehicle ownership continues to grow rapidly, the transport sector potentially presents the largest potential for energy savings

Widespread adoption of mandatory fuel-economy standards is needed to realise the efficiency gains in the transport sector

Many governments in Southeast Asia have introduced measures to improve efficiency in the transport sector, such as by introducing tax incentives to purchase vehicles with higher efficiency, but currently only Vietnam has established a fuel-economy standard. Singapore has a labelling and an emissions scheme, including CO_2 emissions limits to provide rebates or impose surcharges on vehicles purchases. Thailand also introduced a CO_2 tax-based incentive scheme and a labelling programme that rates the fuel economy of passenger cars. Brunei Darussalam, Indonesia, the Philippines and Thailand are currently discussing plans to introduce fuel-economy standards.

In the NPS estimates, the limited adoption of fuel-economy standards largely explains why this indicator in Southeast Asian countries lags behind the global trend, with average fuel economy of passenger vehicles in the region 20% lower than the global average in 2040. Fuel-economy standards in Southeast Asia in 2040 would also be 30% lower than what is required to meet the targets of the SDS.

More widespread adoption of mandatory fuel-economy standards can help Southeast Asian countries mitigate environmental concerns. Countries can take advantage of ongoing international co-operation to share best practices and information in shaping and implementing the policy, such as the GFEI.

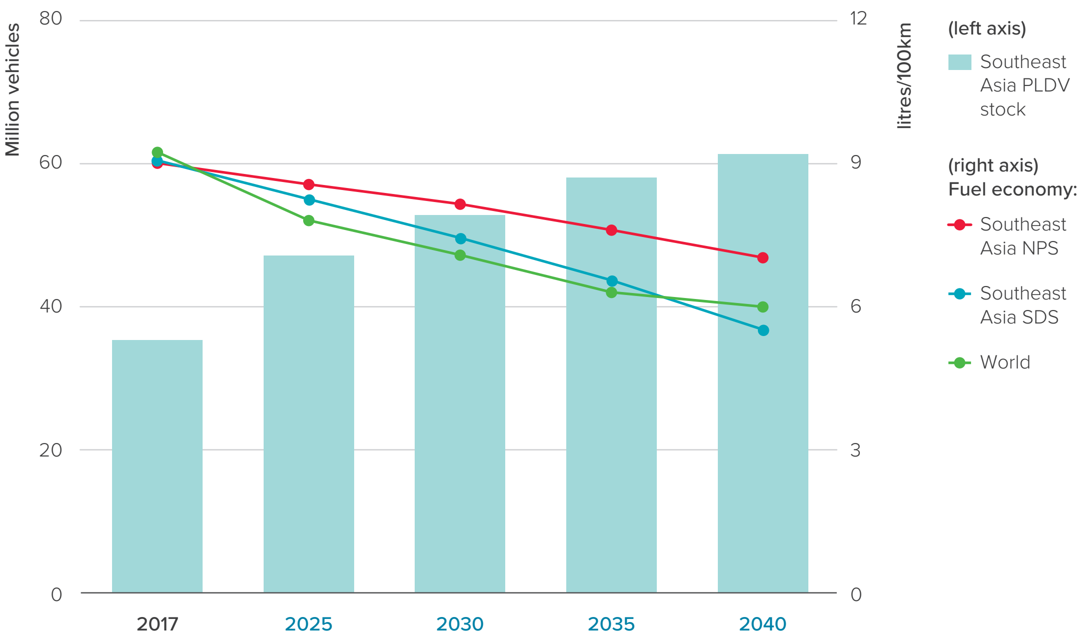


Figure 10.2
As demand for mobility and vehicle ownership continues to grow rapidly, the transport sector could present the largest potential for energy savings

Deeper reforms to phase out fossil fuel consumption subsidies in Southeast Asia can reduce government spending pressures and facilitate decarbonisation

Fossil fuel consumption subsidies artificially lower end-user prices to below international market levels by subsidising the prices of fossil fuels used to generate power. The rationale for providing fossil fuel subsidies has typically been linked to various social and economic objectives, for example, to reduce poverty, ensure energy access and redistribute national wealth stemming from the exploitation of natural resources.

In practice however, subsidies, if not efficiently targeted, often disproportionately benefit wealthier segments of society which consume more of the subsidised products. They also deprive states from valuable revenue that is often needed for infrastructure investment. Fossil fuel subsidies often encourage wasteful use of energy and discourage investment in energy efficiency and low-carbon technologies, thereby increasing energy-related CO_2 emissions. Artificially lower electricity prices can also discourage private investment in the power sector, as they hamper the ability of private investors to recoup their investment cost and make necessary returns.

Southeast Asian governments are gradually reforming their country's fossil fuel subsidies

Rising energy demand in Southeast Asia means that reform of fossil fuel consumption subsidies, which are prevalent in some countries in the region, becomes imperative in order to prevent wasteful consumption, incentivise investments in efficiency and avoid a drain on fiscal resources. Phasing out fossil fuel consumption subsidies is a particularly important driver of CO_2 emissions reductions in Southeast Asia, making up 15% of the gap between the NPS and SDS (figure 8.1).

Six countries – Brunei Darussalam, Indonesia, Malaysia, Myanmar, Thailand and Vietnam – subsidise the use of fossil fuels and electricity prices, but the region has had several subsidy reforms in recent years. For instance, Malaysia had abolished gasoline and diesel subsidies, and raised electricity tariffs in 2014, and then increased domestic gas prices for the power and industrial sectors in late 2016.

In Indonesia, the government abolished subsidies for gasoline in 2015 and fixed subsidies for diesel at about $0.04/litre in 2016. LPG subsidies constitute the bulk of remaining oil subsidies in the country. LPG is particularly important for the poorer segments of society, especially those without access to clean cooking facilities. The current LPG scheme does not subsidise consumers directly, but instead targets 3 kilogramme LPG cylinders sold in the market and has led to the gas being diverted to commercial use.

Relatively low international oil prices since mid-2014 have facilitated recent reform measures, but in 2017 higher oil prices led to a small rebound in total subsidy value. In 2017, the level of subsidies in Southeast Asia stood at $20 billion, although its proportion of global energy-related CO_2 emissions covered by fossil fuel subsidies has decreased to around 22% from 34% in 2015. Two-thirds of total fossil fuel subsidies stem from oil ($15 billion) and almost all the rest from electricity ($5 billion).

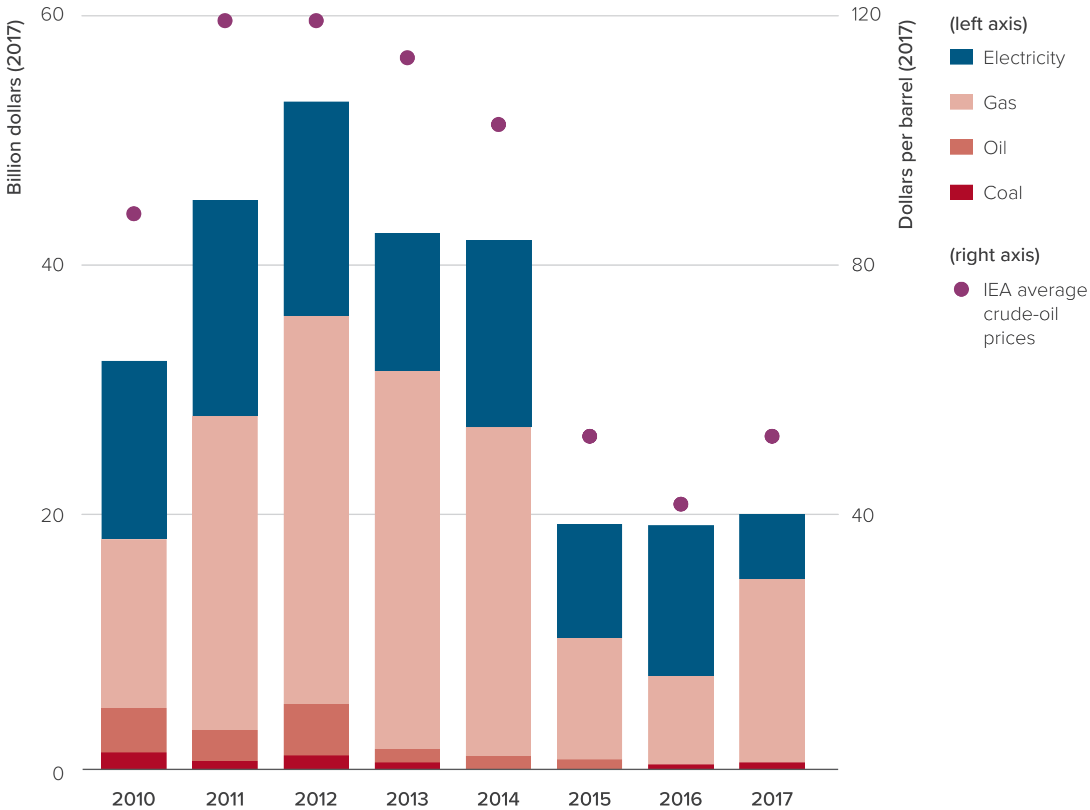


Figure 11.1 Economic value of fossil fuel consumption subsidies in Southeast Asia by fuel, 2000-2017

Strategies to reforming of fossil fuel subsidies will depend on domestic energy market situation

A number of challenges remain in reforming fossil fuel subsidies in Southeast Asia. In the transport sector for instance, although price of oil products in Indonesia and Malaysia now fluctuate based on prices in international markets, they remain regulated and are not completely liberalised. This leaves the door open for subsidies to be re-introduced if international prices rise, particularly if there is political and public pressure to alleviate the impact of price hikes.

Another challenge lies in the residential sector, in which subsidies to electricity and LPG are significant. These energy carriers are crucial to providing access to energy, especially for the poor. As seen in Indonesia, subsidised LPG is often diverted to commercial purposes, leaving room to consider more targeted provision of subsidies.

National circumstances and changing market conditions mean that there is no single path to follow when reforming fossil fuel subsidies. However, experience has shown that the prospects for success can be enhanced by adherence to some guidelines. These can be summarised as follows: (I) Ensure that prices reflect the full economic cost of the energy that is being supplied; (II) Introduce reforms in small steps; (III) Implement social reforms in parallel to protect vulnerable groups; (IV) Develop a comprehensive communication strategy to convince citizens of the need for reform and the justice of its implementation.

Meeting the targets of the SDS requires decreased utilisation and retirement of inefficient coal plants

Coal-fired power generation capacity growth is out of step with the trajectory required to achieve the SDS

In the NPS, coal's share in Southeast Asia's power mix increases to 40% in 2040, becoming the most important source of power generation in the region. Reflecting today's plans and policy intentions, around 115 GW of new coal-fired capacity is built in Southeast Asia to 2040, bringing installed coal capacity to 175 GW in 2040.

Some countries, notably Indonesia, the Philippines and Thailand, are prioritising the deployment of more efficient coal-fired power generation. As a result, while around 25% of the new plants added to 2040 are projected to use subcritical technology, the bulk of the capacity additions rely on more efficient supercritical or ultra-supercritical technology. More efficient coal-fired power generation helps to bring the fleet's average efficiency up from 33% today to 38% in 2040, requiring less fuel and therefore emissions per unit of electricity generated is reduced.

An average reduction of 0.5% per year in capacity from today's levels until 2040 is required to fulfil the SDS.

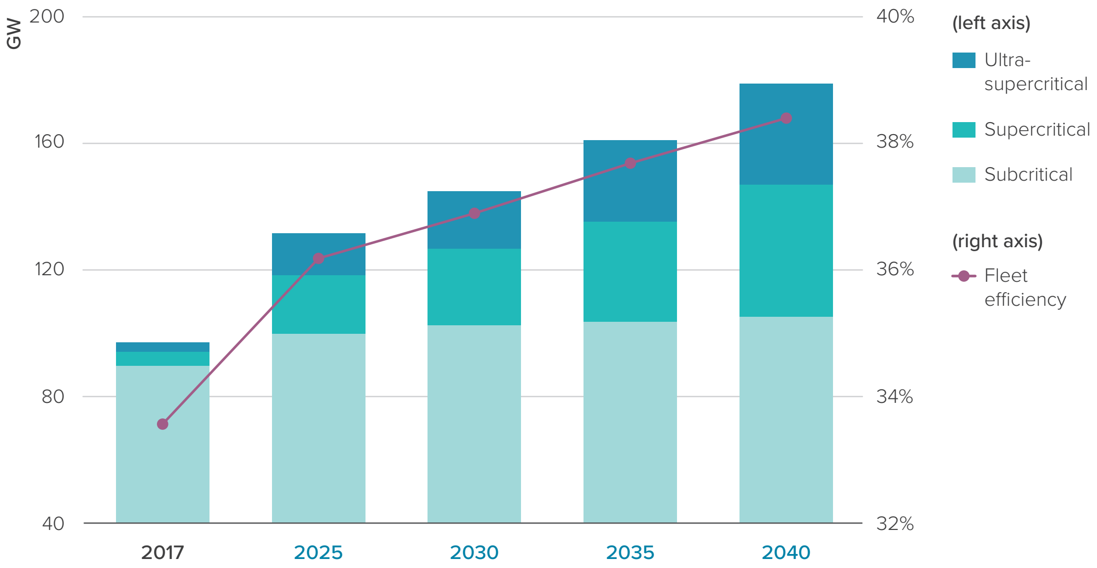


Figure 12.1 Installed coal-fired capacity by technology, and average fleet efficiency in Southeast Asia in the NPS

Subcritical (conventional) coal-fired power plants, which generates steam to activate a turbine, have an efficiency of about 32%. Supercritical and ultra-supercritical power plants operate at higher temperatures and pressures, above the critical point of water. This results in higher efficiencies of above 45%. Supercritical and ultra-supercritical power plants require less coal per megawatt-hour, leading to lower CO_2 emissions.

CCUS is an emissions reduction technology that can be applied to the industrial sector and in power generation. These technologies involve the capture of carbon dioxide (CO_2) from fuel combustion or industrial process, the transport of CO_2 via ship or pipeline, its use as a resource to create valuable products or services, or its permanent storage deep underground in geological formations.

Increased efficiency, a changing power mix, and integration of CCUS is required to reduce up to 60% of coal-fired power generation from the NPS by 2040

By 2040, coal-fired power generation capacity is 60% smaller in the SDS than in the NPS. Between 2017 and 2040, installed power generation from coal power plants using subcritical technologies decreases by almost 30 GW, while power generation from more efficient supercritical or ultra-supercritical coal power plants increases by almost 15 GW. Supercritical and ultra-supercritical technologies to mitigate air pollutant emissions from large coal combustion plants are readily available but use of this technology needs to be incentivised by regulation. Although the level of pollutant emissions of SO_2 is somewhat helped by the generally low sulphur content of Indonesian coal, disconnecting air pollutant emissions growth from coal demand growth is primarily a policy challenge.

Carbon capture, utilisation and storage (CCUS) plays an important role in making coal-fired generation in Southeast Asia more compatible with climate goals. The existing and committed capacities contribute significantly to the baseline levels of emissions as estimated in the NPS. The only way to meaningfully address this is to capture these emissions and prevent them from being released to the environment.

All major coal-consuming countries in the region have emissions regulation standards for coal-fired plant in place but these vary in stringency. If new coal capacity is to be built over the coming years, it is crucial that policy-makers in Southeast Asia continue to raise the stringency of emission standards for new plants.

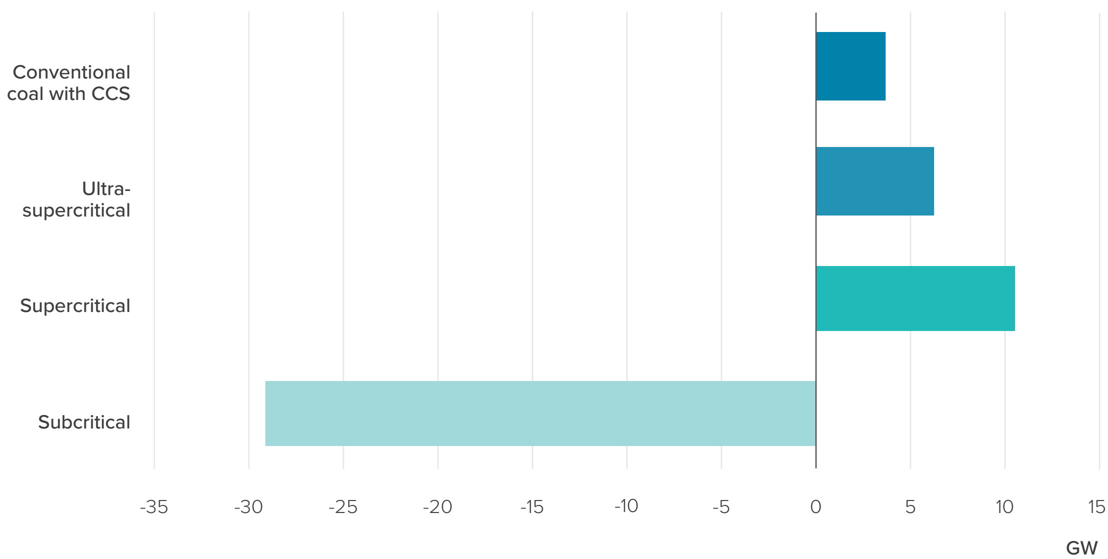


Figure 12.2
Change in installed coal capacity by type in Southeast Asia in the SDS, 2017-2040

If managed sustainably, biofuels can bring substantial environmental benefits

The life cycle of a biofuel determines its suitability to be considered as an emissions abatement lever

Biofuels can provide transport fuel with substantially lower CO_2 emissions than conventional gasoline or diesel when comparing the entire “life cycle” of production – that is, from the field to the vehicle. But there are caveats. It is important to reduce the use of fossil energy during cultivation, transport and conversion of biomass to biofuel. It is also important to avoid direct or indirect land-use changes, such as converting forests to grow biofuel feedstocks, which release large amounts of CO_2 and could offset the CO_2 reduction potential of biofuels.

Concerns around the sustainability of biofuels produced with “conventional” methods have led to a large interest in advanced biofuels that can be produced from waste oils, animal fats, lignocellulosic material such as agricultural and forestry residues, and municipal. If successful, this could lead to huge potential increases in biofuels production, but costs have slowed their development. Conventional biofuels can be harvested close to production centres, have higher energy content and lower levels of contaminants, making treatment relatively inexpensive. In contrast, advanced biofuel feedstock tend to be spread over larger geographical areas and are of variable quality. The future of advanced biofuels will depend on continued technological innovation and policy support to reduce costs.

The transportation sector is forecasted to grow considerably in Southeast Asia with demand for transport fuels rising. Given the large agricultural presence in the region, the IEA assesses sustainable biofuels as one of the key technologies that can meaningfully reduce CO_2 emissions in the region.

Managing land use sustainably is particularly important for Southeast Asia’s main biofuels producers, notably Indonesia and Malaysia, who are responsible for over 80% of the world’s palm oil production, prominently used as a biofuel. In 2015, Indonesia introduced a nationwide certification process for smallholder farms, responsible for around 40% of the country’s palm oil production, helping to establish more environment-friendly methods that can also increase productivity. Malaysia announced a similar certification scheme in 2015, which is to be mandatory by 2019.

Biofuels can complement electrification and fuel efficiency plays in decarbonising the transport sector

Today, 80% of biomass is utilised in the residential sector. By contrast, bioenergy's use in transport, in the form of biofuels, accounted for less than 5% of total final bioenergy consumption in Southeast Asia in 2017, or 1% of total final energy consumption. This reflects the continued dominance of oil in the transport sector, which in 2017 met 94% of transport-related demand. Bioenergy only accounted for 4% of transport energy demand and natural gas for the remaining 2%.

Biofuel consumption in Southeast Asia has the potential to increase in a sustainable way, one in which production of biofuels brings significant life cycle environmental benefits and does not compromise food security or bring about adverse land use changes. In the SDS, the use of biofuels as an alternative to oil in the transport sector grows from 4.8 million tonnes of oil equivalent (Mtoe) in 2017 to 15.1 Mtoe in 2040, bringing the share of biofuels in total transport fuels to 10% in 2040.

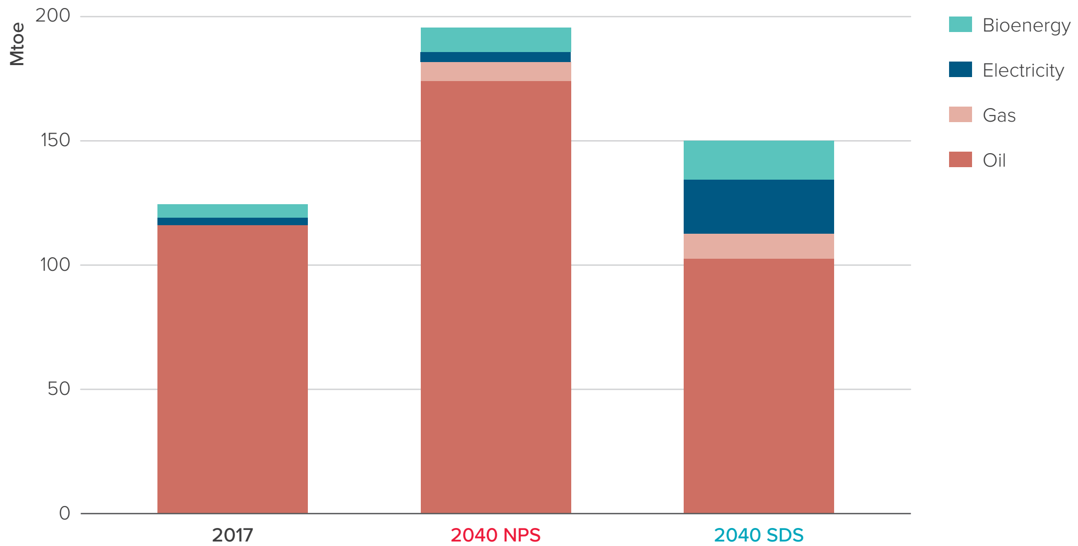
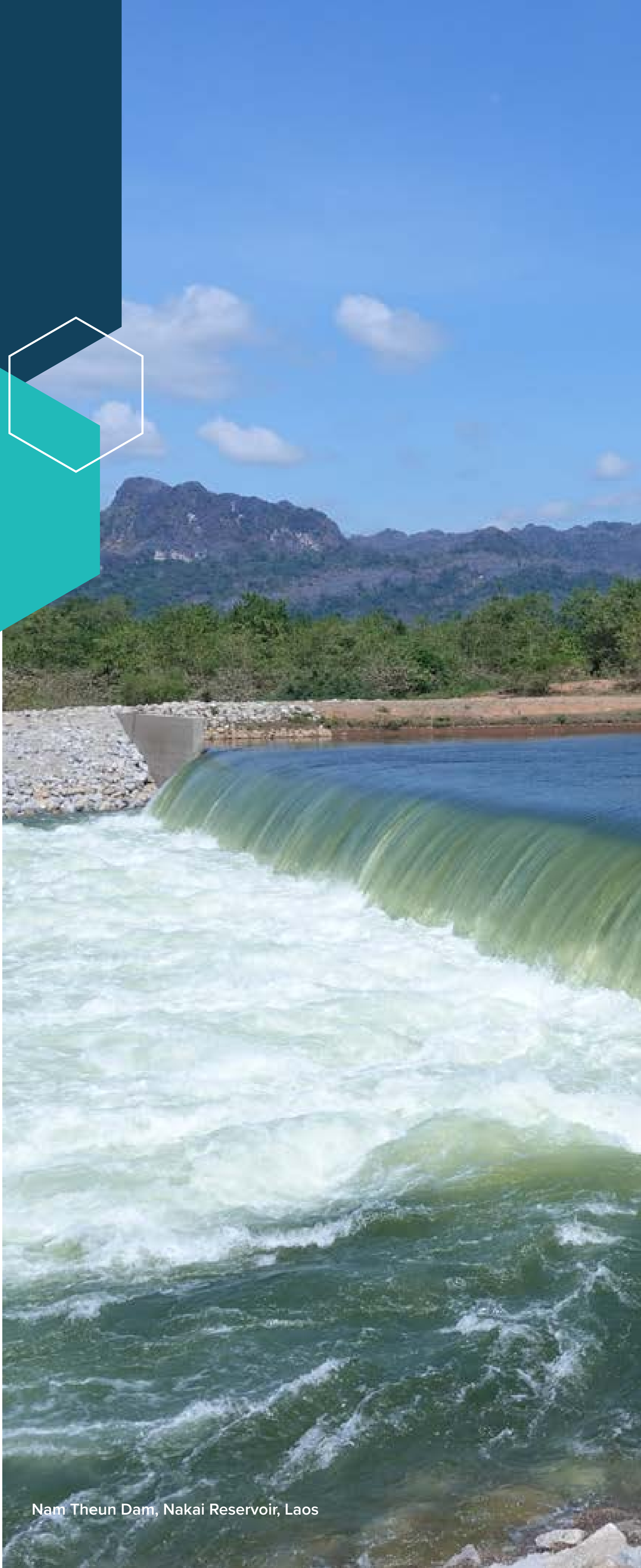


Figure 13.1
Energy demand in the transport sector by fuel and by scenario 2017, 2040

> The use of biofuels as an alternative to oil in the transport sector more than triples by 2040 in the SDS

CHAPTER 4

A Sustainable Energy Mix for Southeast Asia



Nam Theun Dam, Nakai Reservoir, Laos

Achieving a sustainable energy system requires a significant reallocation of capital and capability development effort towards energy efficiency, renewables and other low-carbon technologies.

The IEA estimates that nearly $3 trillion worth of investments, focused on renewable generation and energy efficiency, is needed in the period between 2017 to 2040 in Southeast Asia to establish a sustainable energy future for the region. In such a scenario, the overall energy demand is reduced by about 15% from the NPS with energy-related GHG emissions being reduced by half. This would represent a strong response from Southeast Asia to the calls of the Paris Agreement, the United Nations SDGs and the IPCC reports.

Underpinned by a majority share of renewable energy generation and energy efficiency gains, the SDS results in significant environmental and health benefits compared to the NPS

Reliance on fossil fuels is significantly reduced as clean energy technologies define the SDS energy landscape

In the power sector, renewable generation, including hydropower and bioenergy, reaches almost 70% by 2040 in the SDS. This is in contrast to 30% in the NPS.

Coal plays a significantly diminished role in the power sector, with a share of 5% in power generation in 2040. Natural gas becomes the largest source of power after renewables, providing a flexible option to accommodate a larger share of renewables-based power generation.

In the transport sector, oil continues to play a dominant role, but the sector's energy use is more diversified, aided by tighter CO_2 emissions and fuel-economy standards. Biofuels, gas and electricity reach shares of 10%, 8% and 14% respectively in transport.

In the buildings and industry sectors, increased use of electricity and more stringent efficiency policies, such as the use of energy management systems and energy audits, help to lower CO_2 emissions.

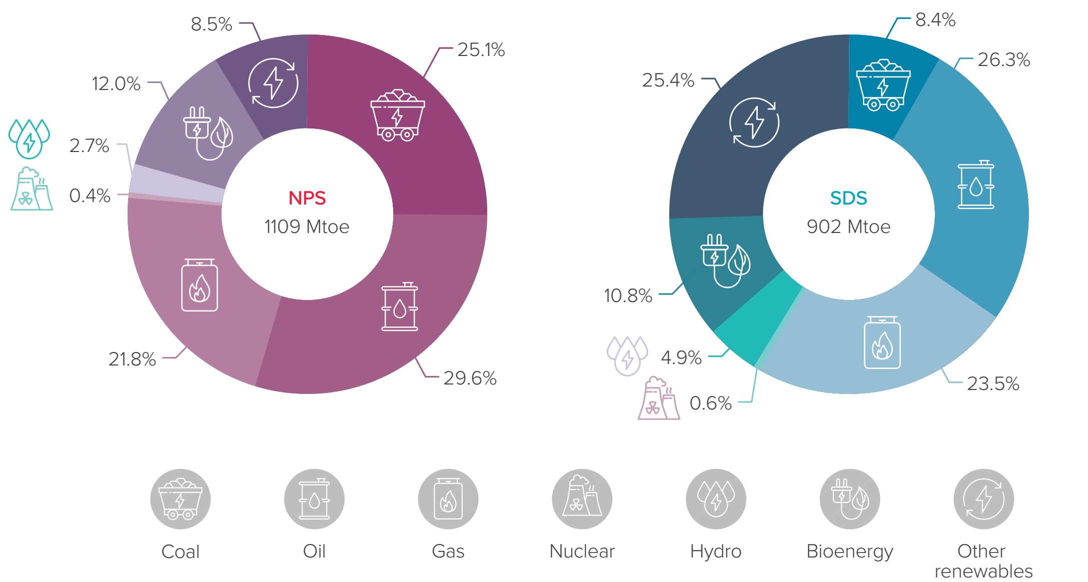
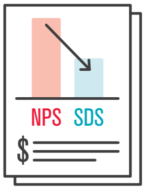


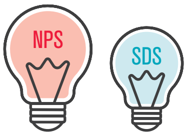
Figure 14.1
Primary energy mix in Southeast Asia, by scenario

The SDS reduces the risk of energy security, health and environmental impacts in Southeast Asia



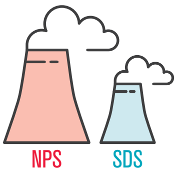
Reduction of energy import bill by
$150B

The increasing penetration of renewables, coupled with more efficient use of energy, reduces dependence on imported oil and gas, leading to an import bill that is around $150 billion less than the NPS in 2040.



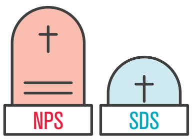
Reduction of energy consumption by
15%

Increased energy efficiency offsets growing energy demand, leading to approximately a 15% decrease in overall energy consumption. All end-use sectors contribute, with industry accounting for about half of the efficiency gains.



½ the levels of CO_2

The transformation of the energy system reduces energy-related GHG emissions, which peak around the mid-2020s, then begin to fall, and are almost half the level of the NPS in 2040.



70%
decrease in premature deaths

Reducing air pollution brings significant benefits to human health, leading to almost 70% decrease in premature deaths linked to air pollution.

Achieving a sustainable energy system requires a significant reallocation of capital towards energy efficiency, renewables and other low-carbon technologies

Meeting Southeast Asia's energy imperatives require a major commitment of investment. In the NPS, cumulative investment in energy supply infrastructure and energy efficiency is $2.3 trillion in the period to 2040.

On the supply-side, investment in fossil fuel production and related infrastructure totals around $880 billion, making up almost 40% of total supply-side investment. Most of this is needed to compensate for declines in output from existing fields. The large requirement for new resources development is reflected in an upward drift in the oil price in the NPS, which exceeds $100 per barrel by the 2030s.

To meet projected electricity demand, the cumulative investment needed in the power sector is $1.4 trillion by 2040. Investment for transmission and distribution (T&D) accounts for over half of the total power sector investment, reflecting the need to strengthen and extend the current network. Investment in new power plants accounts for the remaining share, of which 60% is for renewables-based generation.

On the demand side, investment in efficiency makes up more than 85% of demand-side energy sector investment to 2040. Among end-use sectors, road transport (around $300 billion) and buildings (around $200 billion) capture the lion's share of demand-side investment.

As presented in the SDS, achieving a more sustainable energy system requires an increase in total investment to nearly $3 trillion. A major shift in capital flows is also needed — from the production of fossil fuels and their use in power generation (where investment falls by around 30% and 50% respectively, compared to the NPS) and towards efficiency (+13%) and investment in renewables-based power generation which more than doubles.

As a consequence, the fuel mix for power generation shifts with renewables accounting for almost 70% of total generation by 2040, compared with 30% in the NPS, as increased deployment of wind, solar PV, geothermal and hydropower displace the share of coal, which falls to 5% compared to 40% in the NPS.

The oil price trajectory varies significantly in the SDS, compared to the NPS, reflecting their different supply, demand and policy elements. Market dynamics and price trends in the SDS limit the call on higher cost oil to balance the market, meaning that the oil market balances at a much lower price. In the SDS, the equilibrium oil price will be around $60-$70 per barrel by the 2030s. In practice (as in all scenarios), significant volatility is likely around the projected equilibrium levels.

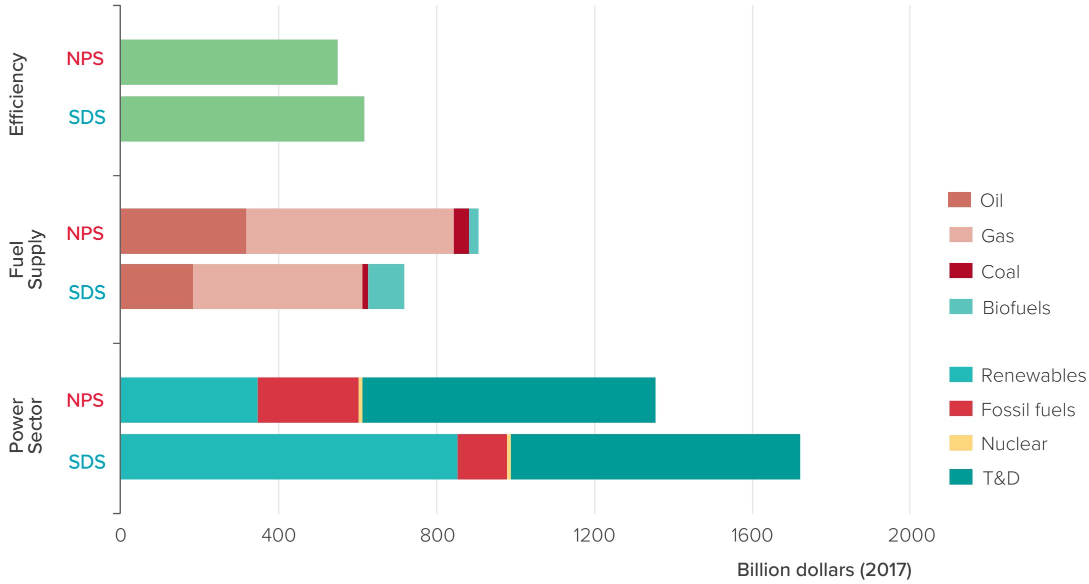


Figure 15.1
Cumulative energy investment in the NPS and SDS in Southeast Asia, 2018 - 2040

Fossil fuel investments in power sector accounts for investment in fossil fuel-based power generation; while that in fuel supply accounts for investment in the supply of fuels and related infrastructure (i.e. oil upstream, refining and downstream; gas upstream and downstream; coal mining and infrastructure).

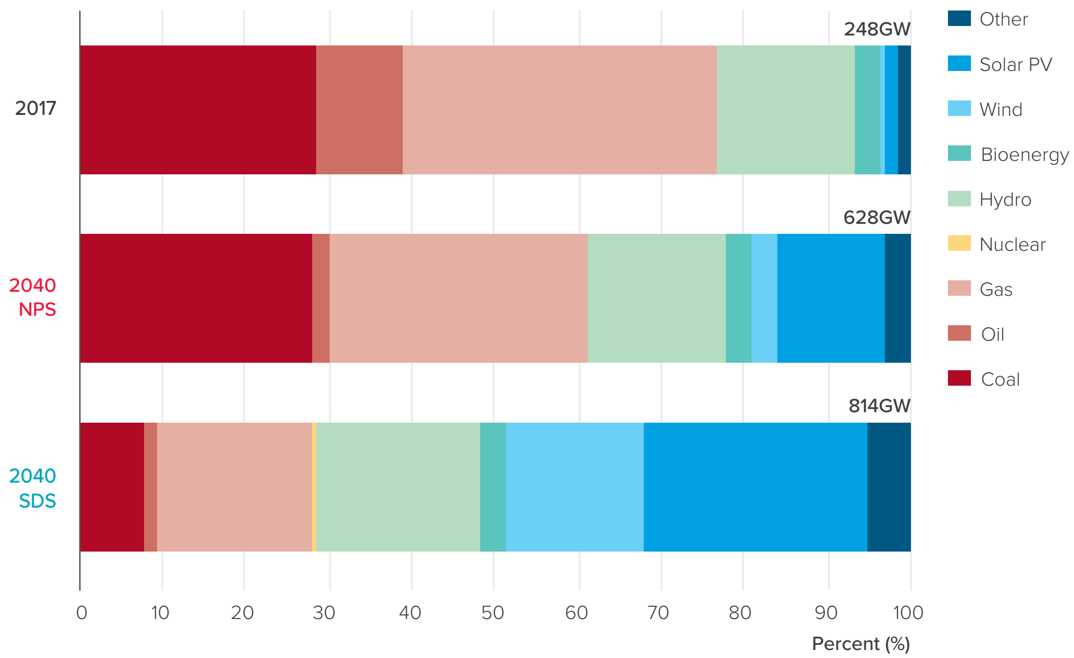


Figure 15.2
Power generation capacity mix in the NPS and SDS, 2017 and 2040