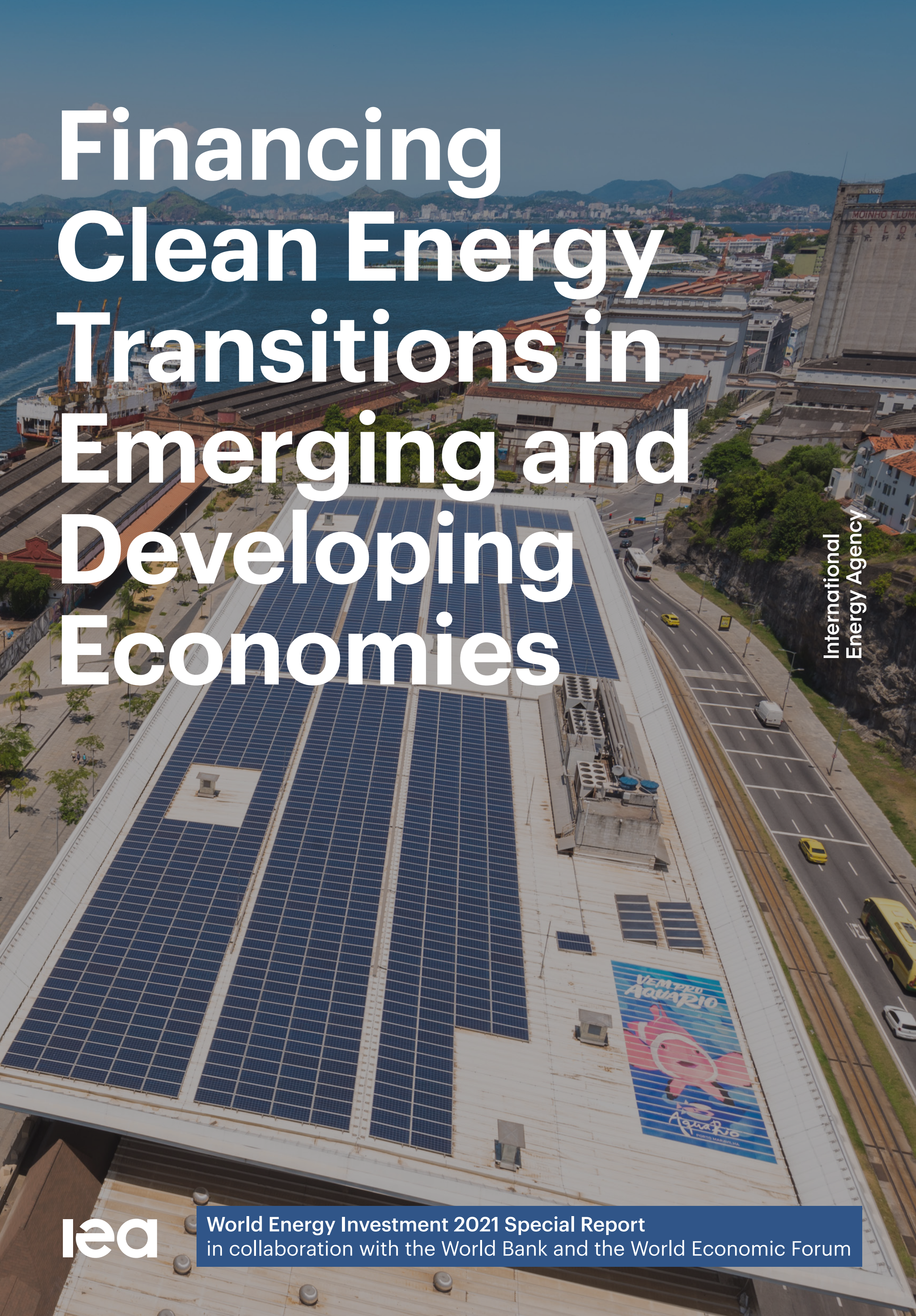

Financing Clean Energy Transitions in Emerging and Developing Economies

International Energy Agency

iea

World Energy Investment 2021 Special Report
in collaboration with the World Bank and the World Economic Forum

INTERNATIONAL ENERGY AGENCY

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The work of the International Energy Agency (IEA) has made it crystal clear that countries around the world must urgently accelerate their transitions to clean energy. This is critical to stave off the worst effects of climate change – and to build a more healthy, prosperous and secure future where everyone has access to clean and affordable energy supplies. Our recent landmark report, Net-Zero by 2050: A Roadmap for the Global Energy Sector, set out a narrow but achievable pathway towards such a future.

However, countries are not starting on the journey from the same place – and the damaging effects of the Covid-19 crisis are lasting longer in many parts of the developing world: the economic slump is deeper, and the capacity to drive a sustainable recovery is limited. If energy transitions and clean energy investment do not quickly pick up speed in emerging and developing economies, the world will face a major fault line in efforts to address climate change and reach other sustainable development goals. This is because the bulk of the growth in global emissions in the coming decades is set to come from emerging and developing economies as they grow, industrialise and urbanise.

There is a huge opportunity to take advantage of lower-cost clean energy technologies, led by solar and wind, to forge a new low-emissions development model for the developing world. There is also no shortage of capital globally to realise such a vision. However, this capital is not finding its way to the countries and sectors where it is most needed. Many institutions are supporting energy transitions in developing countries, with good intentions and often impressive results. But private capital does not yet see the right balance of risk and reward in clean energy projects. Fostering the financial conditions for a rapid deployment of clean energy technologies in emerging and developing economies is one of the defining challenges of our times.

Every country must choose its own energy path based on its specific needs and resources, and there is a lot that countries themselves can do to create and improve the conditions for clean energy investment. But the global challenge of climate change demands global solutions: the international community has to ensure that all countries have the support that they need to move forward in this critical endeavour.

This why the IEA joined forces with the World Bank and the World Economic Forum to produce this special report, which draws on nearly 50 on-the-ground case studies – across clean power, efficiency and electrification, as well as transitions for fuels and emissions-intensive sectors – in countries ranging from Brazil to Indonesia, and from Senegal to Bangladesh. This enables us to offer recommendations for priority actions to get the investment tap flowing to vast under-served areas of the world.

These recommendations include measures to enhance financial markets, improve the visibility of public policies, remove distortions from energy markets, enable grids to better integrate renewable power, empower local entrepreneurs to develop smaller-scale clean energy solutions, as in energy efficiency, and build models for universal access to modern energy.

These are tasks that the energy sector cannot tackle alone. The massive scale of the challenge requires rethinking how we approach it – and major efforts from international financial institutions, their donors, multilateral development banks and many other actors. Many institutions are already seeking to do more, which I welcome. But when we look at the numbers globally today, it is clear that we are nowhere near mobilising the level of funds that will be needed. This is why one of the most urgent recommendations is that governments give international public finance institutions a strong strategic mandate to finance clean energy transitions in the developing world.

Accelerating clean energy transitions in emerging and developing economies can no longer be just one investment option among many. It has to become a major priority for governments and investors worldwide.

Our planet's future depends on meeting this challenge and avoiding deep fractures in global efforts to tackle climate change. The IEA is ready to play a leading role in bringing countries together to share resources and expertise in tackling key sources of emissions. Our Clean Energy Transitions Programme – which leverages the IEA's unique energy expertise across all fuels and technologies to accelerate global clean energy transitions, particularly in major emerging economies – and other key initiatives across Asia, Africa and the Americas demonstrate our commitment and capacity to help build a sustainable future for all.

I hope this special report will move the conversation forward and lead to concrete actions to enable a far greater number of clean energy projects to flourish worldwide. This work will also be a guiding light for the IEA's own work on investment and finance, where we will continue to provide the data, insights and advice for policy makers and practitioners.

I would like to address special thanks to the entire team that produced this crucial report under the outstanding leadership of my colleagues Tim Gould and Michael Waldron.

Dr Fatih Birol
Executive Director
International Energy Agency

This report was prepared by the Energy Investment Unit in the Energy Supply and Investment Outlook (ESIO) Division of the Directorate of Sustainability, Technology and Outlooks (STO). Michael Waldron co-ordinated the project and was the lead author; he designed and directed the report with Tim Gould, Head of Division for Energy Supply and Investment Outlooks.

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The world's energy and climate future increasingly hinges on decisions made in emerging and developing economies

This very diverse grouping – spanning countries in Africa, Asia, Europe, Latin America and the Middle East[1] – includes the world's least developed countries as well as many middle-income economies, emerging giants of global demand such as India and Indonesia, and some of the world's major energy producers. On a per capita basis, energy consumption in these countries is generally low, but expanding economies and rising incomes create vast potential for future growth. The challenge is to find development models that meet the aspirations of their citizens while avoiding the high-carbon choices that other economies have pursued in the past. The falling cost of key clean energy technologies offer a tremendous opportunity to chart a new, lower-emissions pathway for growth and prosperity. If this opportunity is not taken, and clean energy transitions falter in these countries, this will become *the* major fault line in global efforts to address climate change and to reach sustainable development goals.

Covid-19 has widened the huge gap between investment needs and today's flows

Developing and emerging economies account for two-thirds of the world's population but only one-fifth of investment in clean energy – and just one-tenth of global financial wealth. Annual investments across all parts of the energy sector in developing and emerging markets have fallen by around 20% since 2016, in part because of some persistent challenges in mobilising finance for clean energy projects. The Covid-19 pandemic has weakened corporate balance sheets and consumers' ability to pay, and put additional strains on public finances. The effects have been felt most severely in emerging and developing economies, and the impacts on public health and on economic activity are far from over, undercutting the prospects for a swift recovery and the means for a sustainable one.

Today's development pathway for emerging and developing economies points to higher emissions

Emerging and developing economies are set to account for the bulk of emissions growth in the coming decades unless much stronger action is taken to transform their energy systems. With the exception of parts of the Middle East and Eastern Europe, their per capita emissions are among the lowest in the world – one-quarter of the level in advanced economies. In a scenario reflecting today's announced and existing policies, emissions from emerging and developing economies are projected to grow by 5 gigatonnes (Gt) over the next two decades. In contrast, they are projected to fall by 2 Gt in advanced economies and to plateau in China.

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[1] The emerging market and developing economies grouping in this report does not include the People's Republic of China (hereafter, "China"), as the dynamics of energy investment in China are quite distinctive.

But a massive surge in clean energy investment in the developing world can put emissions on a different course

An unprecedented increase in clean energy spending is required to put countries on a pathway towards net-zero emissions. Clean energy investment in emerging and developing economies declined by 8% to less than USD 150 billion in 2020, with only a slight rebound expected in 2021. By the end of the 2020s, annual capital spending on clean energy in these economies needs to expand by more than seven times, to above USD 1 trillion, in order to put the world on track to reach net-zero emissions by 2050. Such a surge can bring major economic and societal benefits, but it will require far-reaching efforts to improve the domestic environment for clean energy investment within these countries – in combination with international efforts to accelerate inflows of capital.

The transformation begins with reliable clean power, grids and efficiency …

Transforming the power sector and boosting investment in the efficient use of clean electricity are key pillars of sustainable development. Electricity consumption in emerging and developing economies is set to grow around three times the rate of advanced economies, and the low costs of wind and solar power, in particular, should make them the technologies of choice to meet rising demand if the infrastructure and regulatory frameworks are in place. Societies can reap multiple benefits from investment in clean power and modern digitalised electricity networks, as well as spending on energy efficiency and electrification via greener buildings, appliances and electric vehicles. These investments drive the largest share of the emissions reductions required over the next decade to meet international climate goals. Innovative mechanisms with international backing to refit, repurpose or retire existing coal plants are an essential component of power sector transformations.

… but has to encompass all parts of fast-growing and urbanising economies

Clean power is central to development and transition strategies but cannot provide all the answers in economies undergoing rapid urbanisation and industrialisation. Transitions in fuels and energy-intensive sectors such as construction materials, chemicals and shipping are essential to achieve deep emissions reductions. This requires improvements in the efficiency of industrial equipment and heavy transport – as well as fuel switching, mainly to electricity and bioenergy but also to natural gas in areas where cleaner energy cannot yet be deployed on the scale needed. In parallel, it will be essential to lay the groundwork for a rapid scaling-up of low-carbon liquids and gases, including hydrogen, as well as carbon capture technologies, although many of these areas lack viable business models for the moment. Major fuel-importing countries, notably in Asia, stand to benefit from downward pressure on import bills. But among the world's largest oil and gas producers and exporters, clean energy transitions create huge pressures on economic models that rely on hydrocarbon revenue, raising questions about the finance available for energy and non-energy investments alike.

Action on emissions in emerging and developing economies is very cost-effective

The average cost of reducing emissions in these economies is estimated to be around half the level in advanced economies. All countries need to bring down emissions, but clean energy investment in emerging and developing economies is a particularly cost-effective way to tackle climate change. The opportunity is underscored by the amount of new equipment and infrastructure that is being purchased or built. Where clean technologies are available and affordable – and financing options available – integrating sustainable, smart choices into new buildings, factories and vehicles from the outset is much easier than adapting or retrofitting at a later stage.

Transitions in the developing world must be built on access and affordability

Affordability is a key concern for consumers, while governments have to pursue multiple energy-related development goals, starting with universal energy access. There are almost 800 million people who do not have access to electricity today and 2.6 billion people who do not have access to clean cooking options. The vast majority of these people are in emerging and developing economies, and the pandemic has set back financing of projects to expand access. Efficiency is key to least-cost and sustainable outcomes. For example, meeting rising demand for cooling with highly efficient air conditioners will keep energy bills down for households – and minimise costs for the system as a whole. Action to provide clean cooking solutions and tackle other emissions will have major benefits for air quality: 15 of the 25 most polluted cities in the world are in emerging and developing economies, and air pollution is a major cause of premature death.

Smart use of public finance will need to come with much more private capital

Mobilising capital on a much larger scale will require a dramatic increase in the role of the private sector, and an enhanced role for international and development finance institutions will be critical to catalyse this investment. Energy investments today in emerging and developing economies rely heavily on public sources of finance, but in our climate-driven scenarios, over 70% of clean energy investments are privately financed, especially in renewable power and efficiency. Public sources of finance, including state-owned enterprises, will continue to play vital roles, especially in grid infrastructure and in transitions for emissions-intensive sectors. Provision of blended capital from development finance institutions is critical to attract private investment to markets and sectors at early stages of readiness – or in situations where the risks are hard to mitigate, such as energy access projects for vulnerable communities or in remote areas. Boosting finance to the required scale demands a wide range of instruments and approaches, including long-term local-currency debt for renewable power, corporate and consumer finance for efficiency, and risk capital to support new technologies, companies and project development.

Energy transitions will need more debt financing by companies and consumers

While clean energy transitions rely on much higher levels of both equity and debt, the capital structure of investments is likely to move towards more debt. This arises mainly from a shift in investment flows towards sectors such as electricity where debt finance is more common, as well as a greater emphasis on funding models that support household purchases of electric vehicles and improvements in buildings and factories. Mobilising investment across all sectors will depend on enhancing financial flows from local sources as well as from international providers. Renewable power offers the most likely route for increased participation by international project developers, commercial banks and other relevant investors. Consumer-based investments or those coming from state-owned enterprises – in fuel supply and grids, for example – rely more heavily on domestic sources of capital, but they also need access to a wider set of fundraising options.

In a more capital-intensive energy system, the cost of capital is key

The affordability of clean energy transitions will depend on reducing the cost and improving the availability of capital. Many clean energy technologies such as wind, solar PV and electric vehicles, have relatively high upfront investment requirements that are offset over time by lower operating and fuel expenditures. The shift towards a more capital-intensive energy system means that keeping financing costs low will be critical to accelerating energy transitions while keeping them affordable. However, for the moment, capital is significantly more expensive in emerging and developing economies than in advanced economies. Nominal financing costs are up to seven times higher than in the United States and Europe, with higher levels in riskier segments. This points to a relatively high bar for projects to raise debt finance and offer sufficient returns on equity.

Global investment capital is available but needs projects and incentives to match

There is no shortage of global capital, but there is a shortfall of clean energy investment opportunities around the world that offer adequate returns to balance the risks. Coming into 2020, global financial wealth held by investors stood at over USD 200 trillion. There is strong appetite among investors to fund clean energy projects, with global issuance of sustainable debt soaring to record levels in 2020. Most of this is concentrated in advanced economies. If energy transitions are to be successful, then developers and financiers need to increase the amount of capital they allocate to two underserved asset classes – to clean energy in particular, and to emerging and developing economies more broadly. Sustainable finance frameworks should encourage both of these shifts. As things stand, the alignment of investment portfolios with net-zero emissions goals risks excluding countries with higher-carbon footprints or sectors with more challenging transition pathways.

Clean energy projects struggle to grow in many parts of the developing world …

Many emerging and developing economies do not yet have a clear vision or the supportive policy and regulatory environment that can drive rapid energy transitions. Project-specific factors are compounded in many cases by broader cross-cutting issues, which undermine risk-adjusted returns for investors and the availability of bankable projects. For projects, these include the availability of commercial arrangements that support predictable revenues for capital-intensive investments, the creditworthiness of counterparties and the availability of enabling infrastructure, among other challenges. Broader issues include subsidies that tilt the playing field against sustainable investments, lengthy procedures for licensing and land acquisition, restrictions on foreign direct investment, currency risks, and weaknesses in local banking and capital markets. The financial performance of utilities can also be a major constraint, as they underpin investment in networks and serve in many instances as the buyer of renewable output. Debt burdens are on the rise in many economies and few governments in emerging and developing economies have the fiscal space to mobilise resources for a sustainable recovery.

… but unleashing clean energy investments brings multiple benefits

Energy transitions bring major new economic opportunities, notably through the creation of new jobs associated with clean energy investments and activities. Spending on more efficient appliances, electric and fuel cell vehicles, building retrofits and energy-efficient construction provide further employment opportunities. Development in these areas can especially support the role of women and female entrepreneurs in driving change and improving gender equality. Governments need to ensure that clean energy transitions are people-centred and inclusive, helping communities navigate the new opportunities as well as the economic burdens arising from the transition away from fossil fuels and the potential closure of emissions-intensive assets. Addressing transition challenges requires a focus on transparent public dialogue, developing programmes to boost skills in all aspects of clean energy transitions and supporting the growth of new job opportunities in more sustainable economic activities.

An international catalyst is needed to boost clean energy investment in emerging and developing economies

Transitions in these economies will falter without more international engagement and support. Actions by policy makers within their countries to address the challenges and seize the opportunities will not, on their own, generate sufficient momentum. Supportive international actions will be essential to catalyse the necessary investments in critical areas and to support longer-term reform processes, starting with the commitment by developed economies to mobilise USD 100 billion per year in climate finance. The current international financial architecture offers some support for sustainable development around the world. However, today's strategies, capabilities and funding levels do not yet answer the call for a fundamental transformation of the energy sector in emerging and developing economies. The international financial system lacks a clear and unified focus on financing emissions reductions and clean energy – particularly in the developing world. This needs to be done across multiple aspects of energy transitions, with co-ordinated finance from donors and the provision of technical assistance on the ground. Increasing the effectiveness of the delivery channels for investments is critical.

A clear set of priority actions must guide strategies and accelerate transitions

This special report proposes a clear set of priority actions to mobilise the necessary capital to finance clean energy transitions. This is based on detailed analysis of successful projects and initiatives, including almost 50 real-world case studies – across clean power, efficiency and electrification, as well as transitions for fuels and emissions-intensive sectors – in countries ranging from Brazil to Indonesia and from Senegal to Bangladesh. The priorities focus on financing sectors that are market-ready, based on technologies at mature and early adoption stages, such as renewables and efficiency. They also examine options for financing transitions in fuels and emissions-intensive sectors where decisions taken over the next decade can lay the groundwork for the integration of new technologies – or could potentially lock in emissions for decades to come. We focus on actions that need to be taken between now and 2030 – a pivotal decade for economic recovery, for the realisation of the UN Sustainable Development Goals and for climate action.

Priority actions for financing clean energy transitions in emerging and developing economies

Redouble international support

- **Give international public finance institutions a strong strategic mandate to finance clean energy transitions.**
- **Boost and improve the delivery of international climate finance.**
- **Enhance the deployment of blended finance to mobilise additional private capital.**
- **Incentivise international capital markets to fund a broader range of clean energy investment opportunities in emerging and developing economies**

Tackle cross-cutting issues that affect investment risks and returns

- **Make it easier and cheaper to develop viable new clean energy projects.**
- **Improve domestic access to capital through more robust banking and capital markets.**
- **Remove distortions in markets and prices that work against sustainable investments.**
- **Put state-owned enterprises, especially utilities, on a firmer financial footing with sustainable strategies.**
- **Empower local entrepreneurs and small/medium-sized enterprises to drive change.**
- **Harmonise sustainable finance frameworks and improve reporting on climate risks.**

Scale up private capital rapidly for clean power, efficiency and electrification

- **Build equitable and sustainable models for universal access to modern energy.**
- **Harness the readiness of investors to back renewable power.**
- **Ease the delivery of reliable and clean power by expanding and modernising grids.**
- **Embed high efficiency and connectivity into all new buildings and appliances.**
- **Leap ahead to invest in more efficient and electrified mobility solutions.**

Focus already on the hardest aspects of transitions

- **Recast the development model for major producer economies.**
- **Lay the groundwork for scaling up low-carbon fuels and industrial infrastructure.**
- **Develop innovative strategies to transform emissions-intensive sectors.**
- **Accelerate the shift away from unabated coal while ensuring a people-centred transition.**

Summary of case studies referenced in the report

Priority	Case studies and examples
Harness the readiness of investors to back renewable power	▪ Reducing revenue-related risks with creditworthy intermediaries in **India** and **southern Africa** (utility-scale solar PV, wind) ▪ Boosting development with competitive procurement and public finance in **Argentina** and **Brazil** (utility-scale solar PV, wind) ▪ Addressing exploration and project development risks in **Indonesia**, **Turkey** and **East Africa** (geothermal, hydropower) ▪ Lowering financing costs with blended finance in **Indonesia**, **Senegal** and **South Africa** (utility-scale solar PV, wind) ▪ Rolling out infrastructure in **Burkina Faso** (utility-scale solar PV, wind) ▪ Planning for regional integration and large-scale deployment in the **Sahel** (all renewables) ▪ Setting supportive policies, reducing costs in **Brazil** (distributed solar) ▪ Improving domestic lending and developers in **India** (distributed solar) ▪ Promoting uptake through industrial business models in **Bangladesh** (distributed solar)
Ease the delivery of reliable and clean power by expanding and modernising grids	▪ Developing new business models to attract private investment in transmission in **Brazil** and **India** ▪ Encouraging third-party distribution investment in **Latin America** ▪ Setting tenders for bulk procurement of smart grids in **India** ▪ Providing early-stage capital for smart-grid development in the **Philippines** ▪ Promoting public-private partnerships for electrification in **Sierra Leone**
Enhancing the financial performance of utilities	▪ Boosting competition through unbundling reforms in **Colombia** ▪ Restructuring debt to fund access investments in **Kenya** ▪ Improving financial management, reducing losses in Bengaluru, **India**
Build equitable and sustainable models for universal access to modern energy	▪ Integrating services and solar products through pay-as-you-go in **West Africa** ▪ Leveraging public concessional finance and impact capital to fund mini-grids in **Democratic Republic of Congo**, **Kenya** and **Nigeria** ▪ Promoting pay-as-you-go to finance clean cooking in **Bangladesh**
Embed high-efficiency and connectivity into all new buildings and appliances	▪ Strengthening building codes, domestic certifications and performance standards in **India** ▪ Using international certification programmes and green bonds to fund sustainable buildings in **Colombia** ▪ Promoting a diversity of finance from local and green banks in **Mexico** ▪ Addressing multiple barriers for efficiency with international assistance in **sub-Saharan Africa** ▪ Government bulk procurement of appliances in **India** and establishment of a Global Cooling Prize ▪ Developing cooling-as-a-service business models in **South Africa**

Priority	Case studies and examples
Leap ahead to invest in more efficient and electrified mobility solutions	▪ Setting incentives to improve affordability of EV purchases in **Mexico** ▪ Expanding financial offerings and service models for consumers in **India**, **Singapore** and the **United Arab Emirates** ▪ Supporting EV manufacturing and industrial development in **Thailand** ▪ Issuing green bonds to fund electric trains and railways in **India** ▪ Creating international partnerships to procure electric buses in Bogota, **Colombia** ▪ Developing a local electric bus business in **Uganda**
Recast the development model of producer economies	▪ Reducing the emissions intensity of oil and gas production in **Mexico, Nigeria** and the **Middle East** ▪ Reforming fossil fuel subsidies and promoting energy efficiency in **Egypt** ▪ Promoting cost-effective deployment of renewables in the **Middle East** ▪ Expanding into downstream products in the **Russian Federation** and the **Middle East**
Lay the groundwork for scaling up low-carbon fuels and industrial infrastructure	▪ Greater measurement, reporting and verification of supply chain emissions in **Qatar** and **Singapore** ▪ Attracting private, international investment into liquefied natural gas infrastructure in producers (**Mozambique**) and gas distribution in importers (**India, Brazil**) ▪ Exploring new contractual models for delivering gas in **Bangladesh, Indonesia** and **Pakistan** ▪ Including low-carbon gas projects in priority lending sectors in **India**
Boosting innovative strategies to transform emissions-intensive sectors	▪ Improving financing options for industrial efficiency with concessional finance and energy service companies in **Thailand** and **Singapore** ▪ Procuring renewables, funding emissions reductions with performance- based instruments by cement companies in **India**, **Mexico** and **Thailand** ▪ Investing in industrial clusters to support efficiency, gas infrastructure and the development of low-carbon hydrogen in **Oman** ▪ Integrating carbon capture, utilisation and storage (CCUS) into national energy and climate strategies and building capacity in **Indonesia** with funds from development finance institutions ▪ Tapping into sustainable debt and transition finance markets to fundraise for CCUS projects in **China**
Accelerate the shift away from coal while ensuring a people-centred transition	▪ Using **international mechanisms**, including voluntary carbon markets and emissions trading mechanisms to improve bankability and raise finance for carbon capture ▪ Using sustainable finance markets to fund renewables, reduce emissions from coal power and support retraining of coal-based workers in **Poland** ▪ Setting a retirement schedule for coal power plants and monetising avoided carbon emissions through concessional finance in **Chile**

Introducing the Special Report

Our energy and climate future increasingly hinges on the decisions made in emerging market and developing economies. These countries currently account for around two-thirds of global carbon emissions – with one-third of this occurring in the People's Republic of China (hereafter, "China") and another third arising from other markets – and would represent the largest source of future emissions growth if insufficient action were taken to transform their energy systems.

This special report focuses on clean energy transitions in the universe of emerging market and developing economies in **Africa, Europe, Latin America, the Middle East, and Asia** (referred to in this report as the emerging market and developing economies, or EMDEs). Please note that:

- For the purposes of this report, the EMDE grouping includes four member countries of the Organisation for Economic Co-operation and Development (OECD): Chile, Colombia, Costa Rica and Mexico.
- This group excludes China, as the dynamics of investment in China, which are quite distinctive, is also a major outward investor in EMDEs.

This EMDE grouping is a very heterogeneous group of countries, with a wide range of national circumstances, average income levels and starting points. However, a common element is that countries in this grouping account for only a relatively small share of historical emissions, and – with some exceptions – per capita emissions remain low today.

This special report aims to address the challenge of mobilising investment and finance to support clean energy transitions in the emerging and developing world. It analyses the outlooks for investment and financing across sectors that are key for clean energy transitions, assesses the key issues related to attracting finance and provides advice on how policy reforms and financial mechanisms can work together to mobilise and align private finance, at scale, highlighted by over 45 real-world case studies and examples.

The forward-looking scenarios referred to in this report are:

- The **Net Zero Emissions by 2050 Scenario (NZE)**: this is an IEA Scenario that shows what is needed for the global energy sector to achieve net-zero CO_2 emissions by 2050, with advanced economies reaching net zero emissions in advance of others. It also contains concrete action to reach energy-related United Nations Sustainable Development Goals (SDGs). The NZE does not rely on action in areas other than the energy sector to achieve net-zero emissions, but with corresponding reductions in emissions from outside the energy sector, it is consistent with limiting the global temperature rise to 1.5 °C without a temperature overshoot (with a 50% probability).
- The **Sustainable Development Scenario (SDS)**: the SDS is likewise based on a surge in clean energy policies and investment that puts the energy system on track to achieve key SDGs, including universal energy access by 2030, air quality goals, and reductions in emissions. In this scenario, advanced economies reach net-zero emissions by 2050,

China around 2060, and all EMDEs by 2070 at the latest. This scenario is consistent with limiting the global temperature rise to 1.65 °C (with a 50% probability).

- The **Stated Policies Scenario (STEPS)**: the two scenarios mentioned above, the NZE and SDS, work backwards from defined outcomes to establish how they can be achieved. By contrast, the Stated Policies Scenario is based on a set of initial conditions and then explores where they lead the energy system. The STEPS is based on a detailed assessment of today's policy settings and constraints, including the effects of the Covid-19 pandemic, and provides a balanced assessment of the direction in which EMDE and global energy systems are heading.

The focus for the analysis in this report is the next decade, a pivotal decade for economic recovery, for the realisation of the SDGs and for climate action. Given the scope to 2030, the analysis focuses on financing sectors that are market-ready, based on technologies at mature and early adoption stages, such as in renewables and efficiency. It also examines options for financing transitions in fuels and emissions-intensive sectors, where decisions taken over the next decade can lay the groundwork for the integration of new technologies, but also have the potential to lock in emissions for decades.

The report is structured as follows:

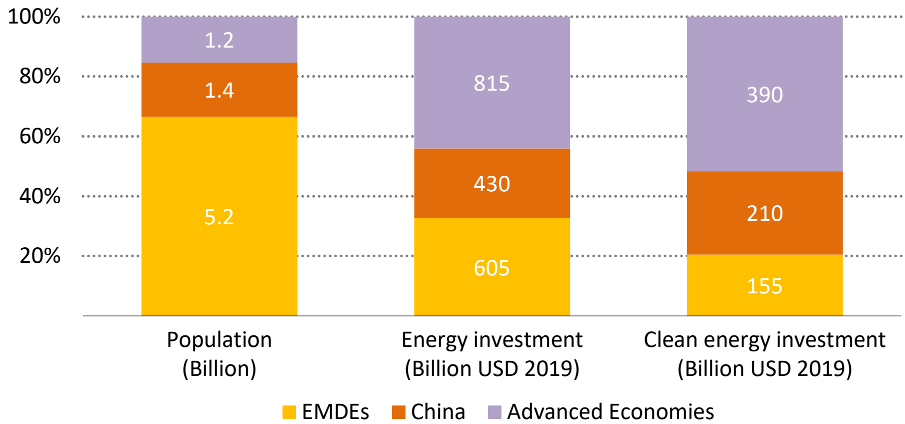
- **Chapter 1** sets the scene for financing clean energy transitions in EMDEs. It presents a broad update of today's investment trends in EMDEs and assesses their implications for energy security and sustainability goals. It outlines the investments that would be required to align with IEA climate scenarios.
- **Chapter 2** assesses the sources and types of capital required to fund these investments. It presents the cross-cutting factors, including the investment frameworks, industrial landscape and macro-financial factors that influence capital allocation across the energy sector and in the wider economy, and proposes ways in which major economies and EMDEs can step up efforts to catalyse capital flows.
- **Chapter 3** examines how to scale up and finance investments for clean electricity, including in utility-scale renewable power, as well enabling grid and flexibility infrastructure. It assesses how to finance smaller-scale investments, in distributed power and in improving the efficiency and electrification options for end-use sectors in buildings and transport. It also focuses on cross-cutting investment issues related to the financial performance of utilities and how to finance energy access.
- **Chapter 4** looks at financing transitions in fuel supply and in emissions-intensive sectors. It considers the choices facing major hydrocarbon-resource holders during energy transitions, as well as the role of gas in EMDE transitions. It explores financing options for emissions-intensive sectors, such as heavy industry, where commercial options are currently more limited as well as considerations for newer technologies, such as carbon capture and low-carbon gases.

Setting the scene

SUMMARY

- Our energy and climate future increasingly hinges on decisions made in emerging market and developing economies (EMDEs), [1] which face the challenge of developing in a way that meets the aspirations of their citizens while avoiding the high-carbon pathway that other economies have pursued in the past. The falling cost of key clean energy technologies offers a tremendous opportunity to chart a new, lower-emissions pathway for growth and prosperity.

Figure 1.1 ▷ Key indicators for EMDEs in 2021



In 2021, EMDEs account for two-thirds of the world's population, but only one-third of total energy investment and 20% of global investment in clean energy technologies.

- EMDEs include a wide range of countries, national circumstances and income levels. Overall, they are home to two-thirds of the world's population and will see almost all of the world's expected population growth over the coming decades. However, they currently account for only one-third of global energy investment and an even smaller 20% share of clean energy investment.
- Annual energy investments in EMDEs have fallen by around one-fifth since 2016. While around 70% of this reduction has come from lower spending on oil and gas supply, predominantly in the major hydrocarbon-rich countries, investment has fallen across all regions. This reflects persistent challenges in mobilising finance towards more capital-intensive and lower-carbon assets, even before the economic shock caused by the Covid-19 pandemic.

[1] As described in the introduction, for the purposes of this report this grouping excludes China

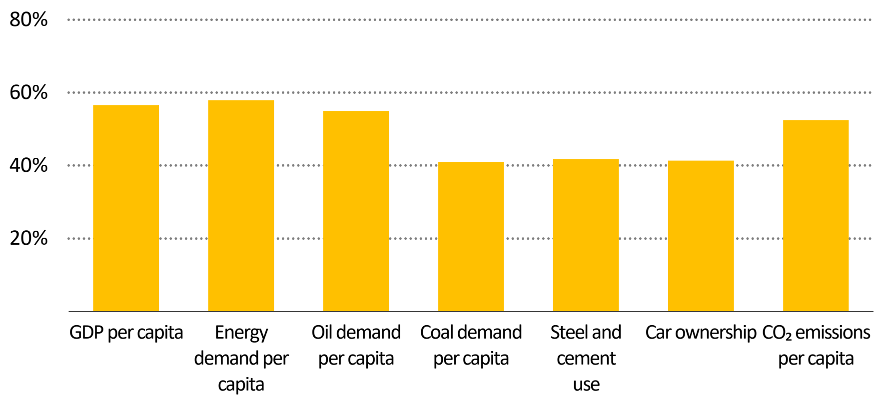
- There are around 785 million people who do not have access to electricity today and 2.6 billion people who do not have access to clean cooking options. The vast majority of these are in EMDEs (with around 15% of those without clean cooking in China), and the pandemic has set back financing of access projects.
- With the exception of parts of the Middle East and Eurasia, per capita emissions in EMDEs are among the lowest in the world, one-quarter of the level in advanced economies. However, EMDEs are set to account for the largest source of emissions growth in the coming decades unless sufficient action is taken to transform their energy systems. Action on emissions will have major co-benefits for air quality: 15 of the 25 most polluted cities in the world are in EMDEs (and a further 9 in China), and air pollution is a major cause of premature death.
- Clean energy investment in EMDEs is typically a very cost-effective way to reduce emissions on a global basis. All economies need to act on emissions, but we estimate that the average cost of emissions avoidance in EMDEs in IEA climate-driven scenarios to 2030 is around half the level in advanced economies. The opportunity to avoid future emissions is underscored by the fast-growing nature of EMDE economies and the amount of new equipment and infrastructure that is being purchased or built – whether buildings, factories, vehicles or networks.
- However, building a low-emissions future for EMDEs will require a massive increase in spending on clean energy technologies and energy efficiency. Clean energy spending in EMDEs declined by 8% to less than USD 150 billion in 2020, with only a partial rebound in 2021. This figure would need to reach around USD 600 billion in annual capital spending by 2030 in the Sustainable Development Scenario, and more than USD 1 trillion in the Net Zero by 2050 Scenario.
- If energy transitions are to be successful, then developers and financiers need to increase the allocation of capital towards two underserved asset classes – to clean energy in particular, and to emerging markets and developing economies more broadly. Over the next 10 years, these capital flows have to be enabled by a determined policy push in EMDEs, backed by strong international support.
- Energy transitions involve a shift in the allocation of EMDE spending from dollarized, globally traded commodities, such as oil, with fuel price volatility but established risk management, towards capital-intensive clean technologies, where the stability of lifetime revenues depends much more on the quality and predictability of domestic EMDE policy and regulation. The capital intensity of clean energy investment means that keeping financing costs low will be critical to the speed and affordability of this transformation – this shift towards a more capital-intensive energy system is particularly challenging in geographies where capital has traditionally been constrained.

1.1 EMDEs in global energy, investment and emissions

Emerging market and developing economies (EMDEs), excluding the People's Republic of China ("China"), are the focus of this report. Whichever way you look at the future of the global energy economy, the role of energy in human development, or the role of energy in the fight against climate change, you quickly come back to the importance of these economies and their choices in the years ahead. There is no single lens through which to view these choices. Energy has a crucial part to play in the drive to end poverty and improve economic outcomes, to achieve better health and education, to reduce inequalities, to build new cities and industries, ensure clean water and sanitation, as well as tackling environmental degradation. Finding ways to meet all of these objectives in EMDEs, while avoiding the high-carbon pathway that other economies have pursued in the past, is one of the defining challenges of our time. Solving it will require a determined effort to understand the varied circumstances and concerns of EMDEs, which are quite distinct from those that prevail in most advanced economies.

Under any future pathway, EMDEs will represent the largest sources of global energy demand growth. These countries collectively make up almost two-thirds of the global population today and will see almost all of the world's expected population growth over the next two decades. They are home to almost all of the global population without access to electricity or clean cooking facilities. Ensuring the universal provision of clean, affordable, reliable energy services in these economies is a crucial step towards offering a more durable and sustainable development path.

Figure 1.2 ▷ Indicators in EMDEs as a percentage of global averages, 2019



On a range of economic and energy-related indicators, EMDEs remain well below global averages; The potential for growth is enormous.

EMDEs include some world-leading countries in the deployment of clean energy technologies, and many countries have set a firm policy course in favour of increasing the share of clean energy in their energy mix. However, at a time when accelerated action is required, the pace of energy investment in many EMDEs has faltered, including for clean energy. The Covid-19 pandemic has stemmed the flow of new investments and is exacerbating pre-crisis imbalances in access to capital. Various factors also make lower-income populations more vulnerable to the immediate impact of the crisis, including limited access to health care, protective equipment and education. As countries emerge from the crisis, they have an opportunity to create more inclusive, resilient and sustainable societies, but this will not happen unless the flow of climate finance and new clean energy projects increases dramatically.

Box 1.1 ▷ EMDEs in global energy investment

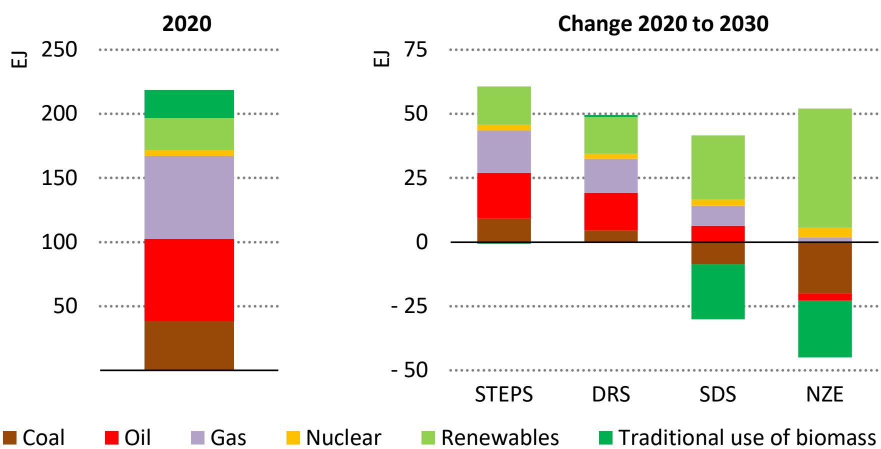
Global energy investment is set to bounce back quite strongly in 2021 after the shock of the pandemic: a rise of around 10% in energy investment worldwide would reverse most of the declines seen in 2020 (IEA, 2021). However, the strength of the investment recovery is weaker in EMDEs – unlike in advanced economies, investment does not return to pre-crisis levels. In large part, this is because the twin public health and economic crises are more prolonged. Compared with elsewhere in the world, there is generally much less fiscal space to support economic recovery. The pandemic has exacerbated financial pressures on utilities and other major investment players, and also reversed several years of progress in expanding access to electricity, notably in parts of Africa.

Annual energy investments in EMDE have fallen by around one-fifth since 2016. While around 70% of this reduction has come from lower spending on oil and gas supply, predominantly in the major hydrocarbon-rich countries, investment has fallen across all regions. This reflects persistent challenges in mobilising finance towards more capital-intensive and lower-carbon assets, even before the economic shock caused by the Covid-19 pandemic. Overall, despite accounting for two-thirds of the global population, EMDEs account for only one-third of global energy investment and an even smaller 20% share of clean energy investment. While there are many individual success stories in EMDEs, highlighted in case studies throughout this report, the broad investment picture is well out of step with the massive scale-up in capital flows that is required to meet sustainable development goals.

Today's energy mix in EMDEs varies widely by country, depending on the level of development in different economies and their resource endowments. Overall, the share of fossil fuels in total energy supply in EMDEs is around the same as elsewhere, i.e. at around 80%. However, at 18%, coal plays a bigger role in EMDEs than it does in advanced economies, even as its share is much lower on average than it is in China. Compared with the rest of the world, EMDEs account for a slightly higher share of natural gas, largely due to the inclusion of major gas-consuming countries across Eurasia and the Middle East. EMDEs account for almost all of the world's traditional use of solid biomass, which is widely used as a cooking fuel[2].

How this energy mix evolves over the coming decades will depend strongly on the trajectory of economic recovery from the crisis, prevailing policy and market signals, the financial attractiveness of different investments, and the ability of different actors to mobilise capital towards these options. In the Stated Policies Scenario (STEPS), which reflects today's policy settings, energy demand in EMDEs rises by nearly 30% over the next decade, with nearly three-quarters of this increase met by fossil fuels (IEA, 2020a). However, this outlook could well be affected by prolonged public health and economic impacts from the Covid-19 pandemic – in the case of a much slower recovery, as modelled in the Delayed Recovery Scenario (DRS), demand would rise by around 20%. A delayed recovery would not only represent a major setback to hard-won gains in the fight against energy poverty, but also deprive the energy sector of much needed funds to renew and expand the capital stock.

Figure 1.3 ▻ Total energy supply by fuel and scenario in EMDEs



The energy mix in EMDEs over the next ten years will be shaped by the speed of the recovery from the pandemic, but also by national and international policy responses.

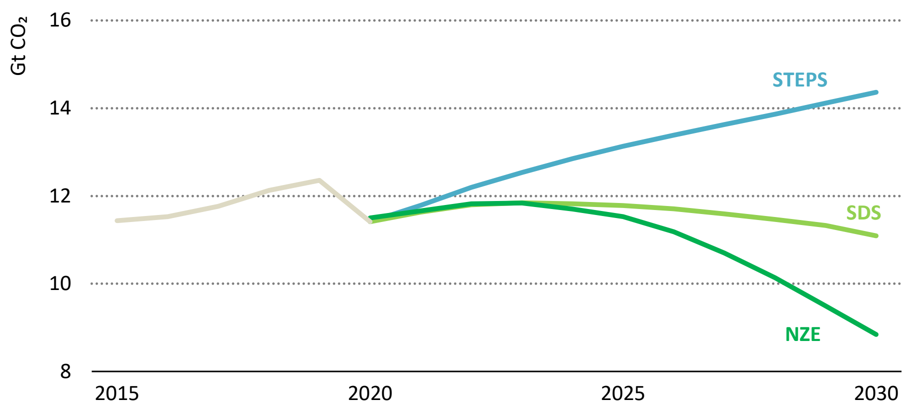
Note: EJ = exajoule.

Meeting the goals of IEA climate-driven scenarios points to a fundamental transformation of the energy sector, one in which recovery plans and policies are oriented towards a near-term surge in clean energy investment, measures to use energy more efficiently, fuel switching to lower-carbon sources of energy, while efforts to ensure universal energy access regain momentum quickly. In the Sustainable Development Scenario (SDS), these efforts support a

[2] Traditional biomass use is unsustainable and burning it in inefficient cook stoves produces high levels of indoor air pollution

near-term plateau in emissions, followed by a steady reduction to 2020 levels by 2030. The Net Zero Emissions by 2050 (NZE) Scenario, calls for even higher levels of ambition and a massive ramp-up in clean energy deployment to secure a one-fifth decline in emissions over the coming decade.

Figure 1.4 ▷ CO_2 emissions reductions in IEA climate-driven scenarios relative to the STEPS in EMDEs



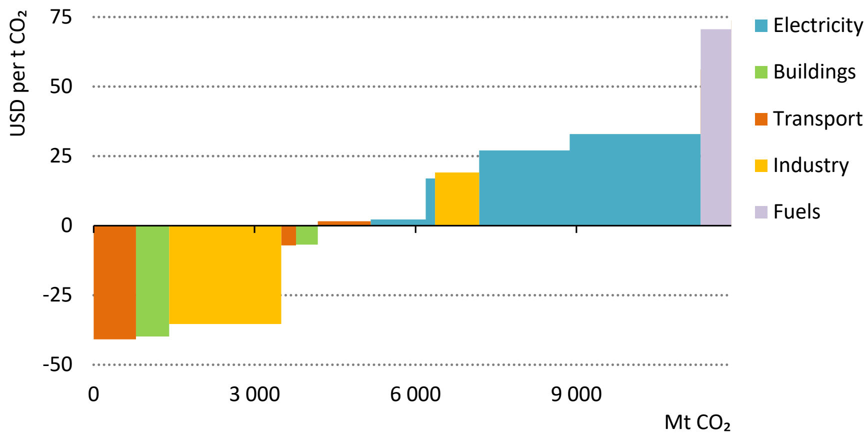
The prevailing policy direction in EMDEs points to rising emissions as economies recover: a huge policy-driven increase in clean energy investment will be required to change course.

On a per capita basis, carbon dioxide (CO_2) emissions in these regions are typically among the lowest in the world, at just over 2 tonnes (t) of CO_2 per capita (with the main exception of parts of the Middle East and Eastern Europe), compared with advanced economies where they have averaged around 8 t CO_2 per capita in recent years; as such, rising incomes and increasing demand for energy services could easily create upward pressure on emissions in the future. In the STEPS, emissions from EMDEs are projected to grow by 5 gigatonnes (Gt) over the next two decades, while plateauing in China and falling by 2 Gt in the rest of the world.

All countries have to step up their efforts to shift energy systems onto a more sustainable pathway, but our climate-driven scenarios highlight the crucial importance of EMDEs. These countries account for around 40% of the global emissions reductions required to move from the STEPS trajectory to the SDS, compared with one-third from China and one-quarter from advanced economies. There are also major environmental co-benefits beyond greenhouse gas emissions, notably in improved air quality: as things stand, 15 of the 25 most polluted cities in the world are in EMDEs (and a further 9 in China), and air pollution is a major cause of premature death across the developing world.

Clean energy investment in EMDEs is typically a very cost-effective way to reduce emissions on a global basis. In these markets, the average cost of emissions avoidance in the SDS is around USD 5 per t CO_2, half the level of average emissions avoidance cost in advanced economies. We estimate that around 35% of the emissions reductions that occur in EMDEs over the next decade would have negative abatement costs, meaning they would save emissions while also saving money. These negative-cost emissions would come from efficiency improvements and electrification measures in the end-use sectors: buildings, industry and transport.

Figure 1.5 ▷ Abatement cost curve of EMDE emissions avoided in the SDS, 2020-2030



More than one-third of EMDE emissions reductions over the next decade, mainly from efficiency improvements and electrification, would have negative abatement costs.

This potential is not being exploited today (for reasons discussed in Chapters 2, 3 and 4), but this analysis highlights the significant, cost-effective potential for EMDEs to shift across to a lower emissions pathway. In general, there are many more emissions-saving opportunities compared with those available in more mature markets. This is related in some cases to the carbon-intensity of the existing energy mix, especially in countries with higher shares of coal. More broadly, it is linked to the fast-growing nature of these economies and the amount of new equipment and infrastructure that is being purchased or built – whether buildings, factories, vehicles or networks. Where technologies are readily available and affordable, it is generally easier to build efficiency or low-carbon energy into the design of these new investments, rather than retrofit or retire existing assets.

A more sustainable pathway relies on a systematic preference for investment in new, low-emissions or highly-efficient assets wherever possible, such as renewable power and efficient new buildings and vehicles. This preference naturally results in fewer polluting technologies being deployed. In the STEPS, around 160 gigawatts (GW) of coal-fired power plants are built by 2030 in EMDEs, but only a fraction of these, those already under construction, start operation in our climate-driven scenarios because their place is taken by cleaner alternatives.

In addition, a wide range of technologies and measures are also deployed to reduce emissions from existing assets and infrastructure, in order to avoid some of the "locked-in" emissions that would arise from their continued operation. For instance, in economies such as India that have a significant stock of existing coal-fired power plants, reducing emissions from coal is not only a question of early retirement of assets (see Chapter 4). Some plants can be repurposed to provide flexibility in support of the rise of solar and wind, others can be retrofitted either with carbon capture or for co-firing with biomass or hydrogen-based fuels (or full conversion to these low-emissions fuels).

Getting pricing signals right by allowing revenues to fully cover costs and removing fossil fuel subsidies is essential. Among EMDEs, the median subsidisation rate for consumers is around one-fifth, and energy consumption subsidies account for around 1.5% of gross domestic product (GDP) (IEA, 2020b). Phasing out inefficient fossil fuel subsidies in nearly all regions would reduce CO_2 emissions by around 700 million tonnes by 2030. These reforms can be politically challenging, given the priority to avoid further near-term strains on household and corporate budgets. But well-signposted reform measures, combined with targeted support to the most vulnerable segments of the population and measures to increase the availability and defray the upfront costs of purchasing more efficient equipment and appliances, can bring multiple fiscal and environmental gains.

The countries examined in this report are heterogeneous, with a wide variety of starting positions and country-by-country circumstances. They range from major energy suppliers to international markets, including Saudi Arabia and the Russian Federation (hereafter, "Russia"), to giants of global consumption such as India and Indonesia, as well as a host of other countries with distinctive energy backgrounds and resources. If energy transitions are to be rapid and secure, and avoid severe impacts from climate, each of the EMDEs has to mobilise investments, at scale in clean energy. The remainder of this chapter examines the level and types of investments that would be required.

Table 1.1 ▷ Demographic, energy and financial indicators for selected EMDEs

	Population (2019) (million)	GDP (2019) (USD/capita)	CO2 emissions (2018) (million t)	Energy demand (2018) (EJ)	Energy Investment (2019) (% of GDP)	Share of renewables in power mix (2018) %	Global fixed capital formation (2019) (% of GDP)	Sovereign debt rating classification (2021) Grade
Argentina	45	9 912	171	2	2%	24%	14%	Non-investment
Bangladesh	163	1 856	82	1	5%	2%	32%	Non-investment
Brazil	211	8 717	406	9	2%	82%	15%	Non-investment
Chile	19	14 896	86	1	3%	46%	22%	Investment
Colombia	50	6 429	73	1	2%	77%	22%	Investment
Egypt	100	3 019	224	3	4%	8%	17%	Non-investment
India	1 366	2 100	2 308	25	3%	19%	27%	Investment
Indonesia	271	4 136	543	7	2%	17%	32%	Investment
Kazakhstan	19	9 813	214	2	8%	10%	24%	Investment
Kenya	53	1 817	16	1	4%	82%	17%	Non-investment
Mexico	128	9 946	448	5	1%	16%	21%	Investment
Morocco	36	3 204	59	1	4%	18%	28%	Investment
Mozambique	30	504	6	0	4%	84%	24%	Non-investment
Nigeria	201	2 230	104	6	4%	18%	25%	Non-investment
Russian Federation	144	11 585	1 587	22	6%	17%	21%	Investment
Saudi Arabia	34	23 140	492	6	4%	0%	22%	Investment
Senegal	16	1 447	8	0	4%	11%	29%	Non-investment
South Africa	59	6 001	428	3	1%	5%	18%	Non-investment
Thailand	70	7 807	241	4	3%	16%	23%	Investment
Viet Nam	96	2 715	227	3	3%	35%	24%	Non-investment

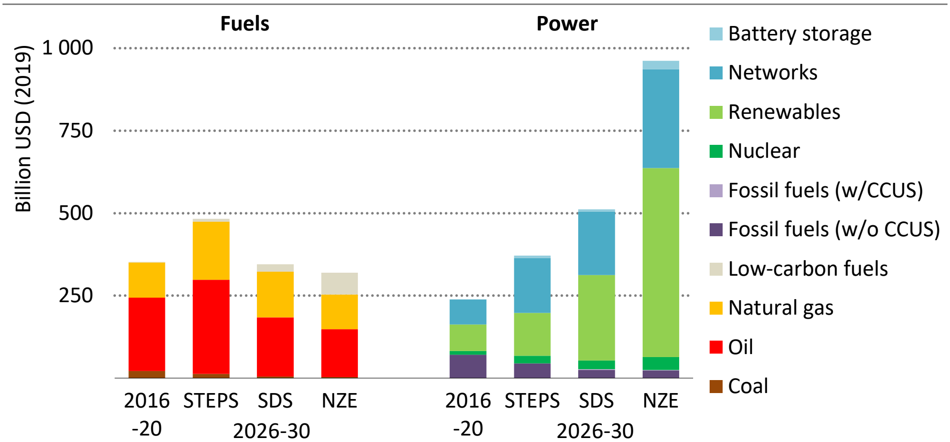
Note: Securities with a rating of Baa3 or better by Moody's are investment grade. Sources: IEA calculations; World Bank (2021); IMF (2021), Moody's (2021).

1.2 Clean energy investments and financing costs

1.2.1 The scale of the investment challenge in EMDEs

Whichever way the energy system evolves, energy investments need to rise sharply in EMDEs over the coming decade in order to support rising demand for energy services in growing economies. All EMDEs see higher spending needs, with the largest expansions occurring in India, sub-Saharan Africa, Southeast Asia, followed by Latin America and the Middle East and North Africa (MENA). The faster the pace of energy transitions, the more that EMDEs become a focal point for worldwide spending on cleaner technologies. While the share of EMDEs in total energy investment remains at around one-third in the STEPS, by 2030 EMDEs account for more than 35% of global investment in the SDS, and over 40% in the NZE.

Figure 1.6 ▷ Energy supply investment in EMDEs, compared with annual average projections under STEPS, SDS and NZE, 2026-2030



Energy investment in EMDEs has fallen by one-fifth since 2016, but this needs to be turned around quickly with a massive expansion in spending on clean power.

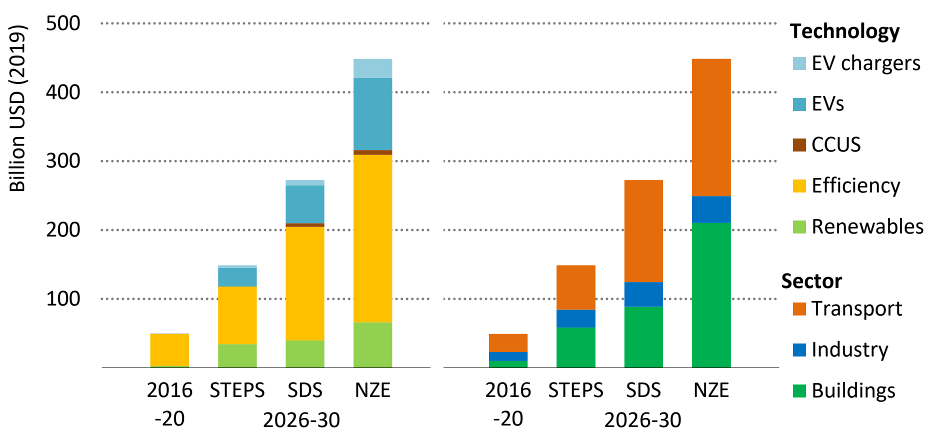
Note: The 2026-2030 period is used throughout this report as an indicative post-recovery benchmark for investment spending in the different scenarios.

The acceleration in investment in all regions to support clean energy transitions is accompanied by major reallocation of capital across sectors. Over the past five years, fuel supply has accounted for well over half of EMDE energy investment, with higher shares in the Middle East, North Africa and sub-Saharan Africa, where fuels account for over two-thirds of capital spend. Overall spending on fuel supply over the next decade is relatively stable in rapid transitions, although with an increasing share going to low-emissions fuels (especially in the NZE). However, this spending would account for a much smaller share of the total, as investment in clean power expands rapidly. In the NZE, the focus for oil and gas producers switches entirely to output – and emissions reductions – from the operation of existing assets.

In some regions, such as India and Southeast Asia, power investments already make up the largest part of capital spend, in order to meet fast-growing electricity demand. The shift in capital allocation towards power in IEA climate-driven scenarios is most prominent in sub-Saharan Africa, where it rises from just one-quarter of supply investment over the past five years to more than half by 2030.

In all scenarios, renewables are the first choice for new generation capacity, but rising electricity needs and rising shares of solar and wind also dictate a huge uptick in spending on networks and sources of flexibility, including battery storage. By contrast, investment in fossil fuel-based power declines almost everywhere. There were some 5 GW of approvals of new coal-fired capacity in EMDEs in 2020, in Cambodia, Indonesia and Pakistan, but these are expected to become increasingly scarce as financing dries up for new coal plants and their role in power system planning is further scaled back. Investment in gas-fired generation remains part of the picture in most regions in our scenarios, although the amount of new capacity – and its utilisation – varies widely depending on the stringency of emissions reduction targets. Investments in nuclear power are concentrated in a handful of countries, led by India.

Figure 1.7 ⊳ Energy end-use investment in EMDEs, compared with annual average projections under STEPS, SDS and NZE, 2026-2030



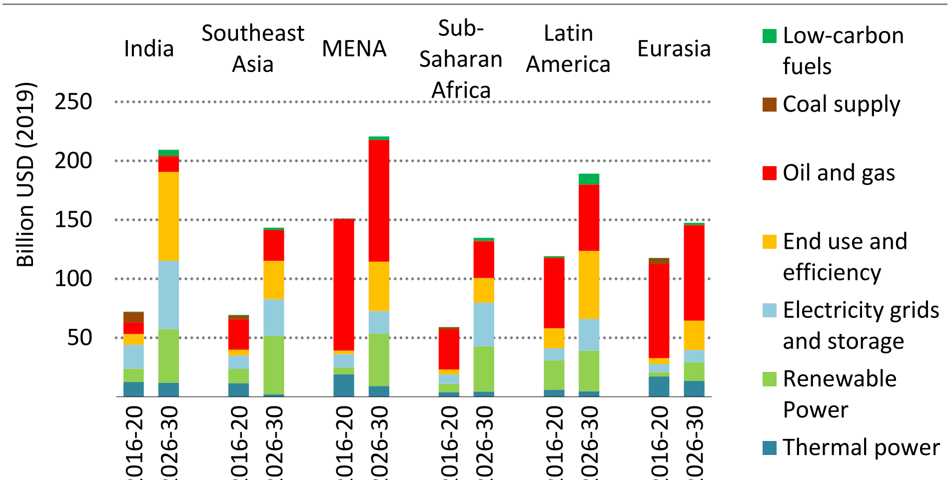
In clean energy transitions, EMDE investment in energy efficiency, electrification and clean energy for end use accelerates from less than 10% to over one-quarter of the total.

Notes: EV = electric vehicle. EV chargers include those owned by private consumers; publicly accessible chargers are included under electricity networks.

Investments in energy access also step up in our climate-driven scenarios in order to meet the SDG 2030 targets. There are around 785 million people who do not have access to electricity today and 2.6 billion people who do not have access to clean cooking options; the vast majority of these are in EMDEs (although around 15% of those without clean cooking are in China). A lack of access to energy not only impedes economic development, but also causes serious harm to health and is a barrier to progress on gender equality and education. In scenarios that achieve universal access by 2030, around USD 35 billion is spent each year improving access to electricity and almost USD 6 billion each year on clean cooking solutions for people in low-income countries. This is a major step up compared with the amounts spent in recent years on access, but only a small fraction of total investment.

Investments in energy end use and efficiency in EMDEs accelerate from less than 10% of the total today to over one-quarter of investment by 2030 in clean energy transitions. The end-use spending reflects an acceleration of EV sales, the roll-out of enabling charging points, and greater direct use of renewables in buildings and industry for heating and cooling. Increased efficiency investments for buildings, transport and industry reflect more stringent regulatory measures, spending on energy management systems; fuel-efficient vehicles; more efficient appliances, especially air conditioners, and new industrial equipment. The overall energy intensity of EMDE economies improves by around 4% each year in the NZE led by improvements in commercial buildings and in key industrial sectors such as cement and steel. While all regions see a ramp-up in end-use investments, the strongest growth comes in India, where they account for 40% of the total, Southeast Asia and Latin America.

Figure 1.8 ⊳ EMDE energy investment by region and sector in the SDS



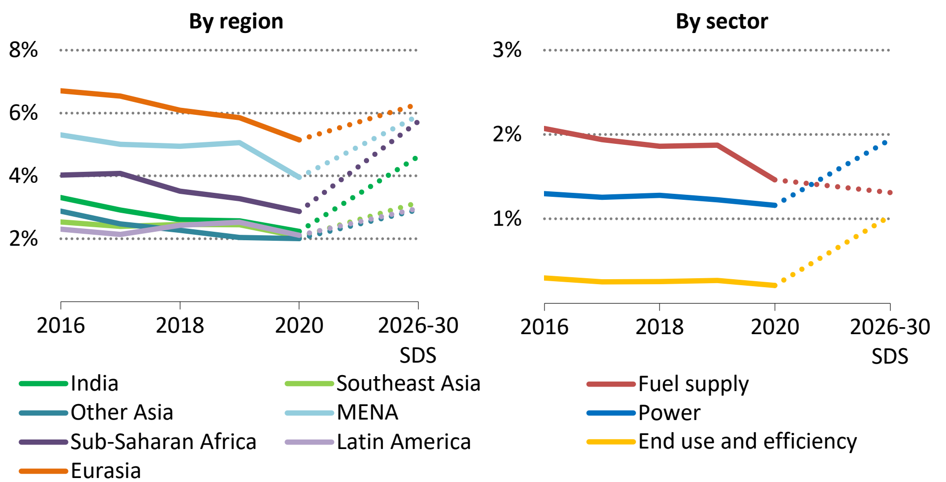
Higher levels of investment in the SDS are accompanied by a reallocation of capital towards power, end use and efficiency, and low-emissions fuels across all EMDE regions.

Note: MENA = Middle East and North Africa.

In recent years the combined share of EMDE energy investment in the region's GDP has declined and fell to under 3% in 2020 – down from around 5% in 2014. Economy-wide investment also declined as a share of GDP over this period, but the declines in energy have been particularly steep. In part, this reflects a retreat from the boom years of oil and gas spending in the earlier part of this decade. However, the trend is visible too in the power sector and elsewhere, reflecting a lack of progress in boosting investment in key clean energy technologies and infrastructure.

This trend would need to reverse in any pathway. Taking the SDS as an example, the share of energy investment in economic output reaches nearly 4.5% by 2030 and it would need to be even higher in the NZE. This represents a larger call on economic resources than projected in advanced economies, although it does not represent a dramatic break from the past for EMDEs overall. It does, however, point to important shifts across sectors and regions, in particular a shift in aggregate towards meeting domestic needs through power and efficiency investments, rather than providing fuels for export, and a notable pick-up in spending in the least-developed economies to ensure reliable supply and meet sustainable development needs.

Figure 1.9 ▷ Energy investment in EMDEs as a share of GDP in the SDS



In the SDS, the share of energy investment in GDP rises to nearly 4.5% by 2030, although some countries and regions see an even higher call on economic resources.

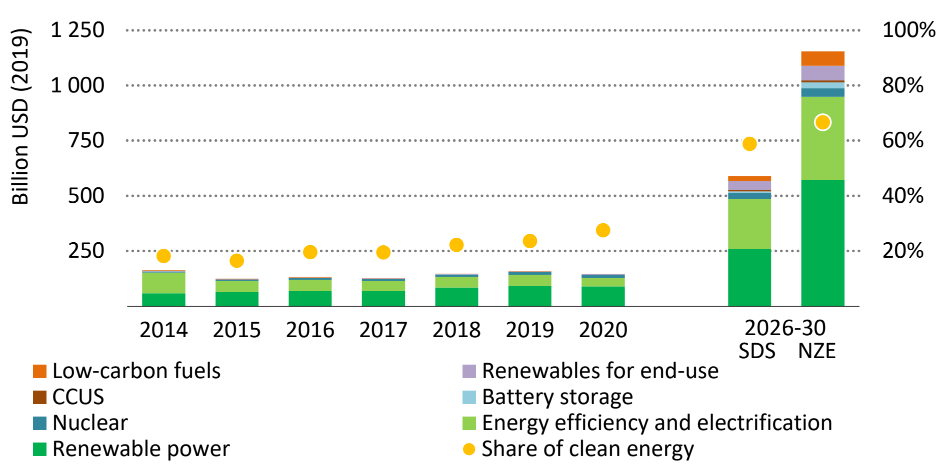
Compared with recent years, energy investment as a share of GDP would need to accelerate particularly in sub-Saharan Africa, to nearly 6%, and in India, to over 4.5%, by 2030. Relative to historical spending, higher commitments of economic output to investing in energy are required also in Southeast Asia and Latin America. Other regions face less of an historical break in terms of the level of investment in GDP; instead, their challenge revolves around the reallocation of capital from fossil fuels to clean energy sectors.

EMDEs are undertaking clean energy transitions from very different starting points. Revenues from fossil fuel sales have underpinned economic growth in a number of markets, primarily those in the Middle East, North Africa and some countries in Latin America and sub-Saharan Africa. Oil and gas form a sizeable part of the import bills of many Asian developing economies, where there has also been a strong link in many cases between industrial development and domestic coal consumption.

Capital spending on fuel supply declines as a share of GDP in the SDS, down to around 1% from the over 3% of economic output it represented in the early part of last decade. This points to some strong implications for hydrocarbon revenues and economic diversification for producer economies. Nonetheless, investment in fuels remain critical to simultaneously address energy security as well as support clean energy transitions in EMDEs – these issues are explored in Chapter 4.

A challenge that all EMDEs face is how to finance the huge ramp-up in more capital-intensive investments in power, energy efficiency and end-use applications for electrification. Such investments typically have lower operating costs over their lifetime compared with fuels, but the cost of finance figures more prominently in the overall economic burden – these issues are explored below and in Chapter 3.

Figure 1.10 ▷ Clean energy investment in EMDEs compared with projections in the SDS and NZE



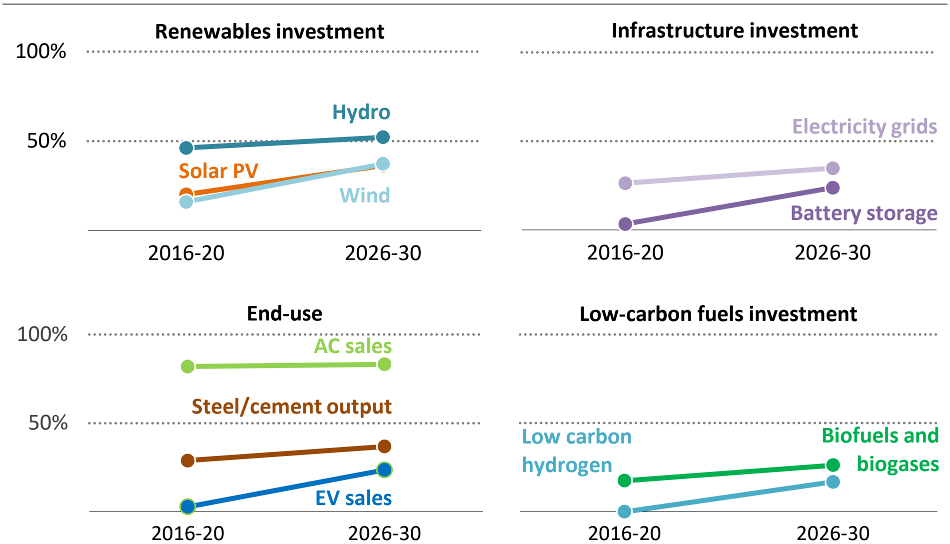
Clean energy investment in EMDEs has averaged under USD 150 billion in recent years; this would need to rise by a factor of 4 by 2030 in the SDS, and by more than 7 times in the NZE.

For the moment, the volume of energy investments devoted to a range of clean energy technologies and energy efficiency falls far short of the nearly USD 600 billion in annual capital spending required by 2030 in the SDS, and even further from the more than

USD 1 trillion required in the NZE. In practice, our tracking of these investments showed a decline of some 8% to less than USD 150 billion in 2020, with only a partial rebound in 2021. In EMDEs, clean energy accounted for less than a quarter of overall energy investment in the past five years, a share that has remained lower than in advanced economies and China.

In IEA climate-driven scenarios, around 30% of clean energy investment by 2030 occurs in Brazil, Mexico and India, which is similar to the combined share of these countries over the past five years. The role of sub-Saharan Africa and Southeast Asia would need to rise from around one-fifth of spending to over one-quarter by 2030. All clean energy sectors would need to see a dramatic scale-up in capital spend. In the period to 2030, most of these investments flow into technologies that are already market-ready. Renewable power makes up around half and energy efficiency and electrification of transport through EVs accounts for one-third of projected clean energy investment. Though levels remain much lower in absolute terms, a dramatic scale-up in spending is also required in biofuels and biogases and across less mature sectors, including in battery storage to support system flexibility, as well as in technologies, such as low-carbon hydrogen and carbon capture, that are critical for addressing hard-to-abate sources of emissions. Further details on the investment projections by sector, technology and region are provided in Chapters 3 and 4.

Figure 1.11 ⊳ EMDE share of the global market in select key investments and activities for clean energy transitions in the SDS



In a successful global energy transition, financiers and developers need to increasingly allocate clean energy investment activities towards EMDEs.

Notes: PV = photovoltaic; AC = air conditioners in residential buildings.

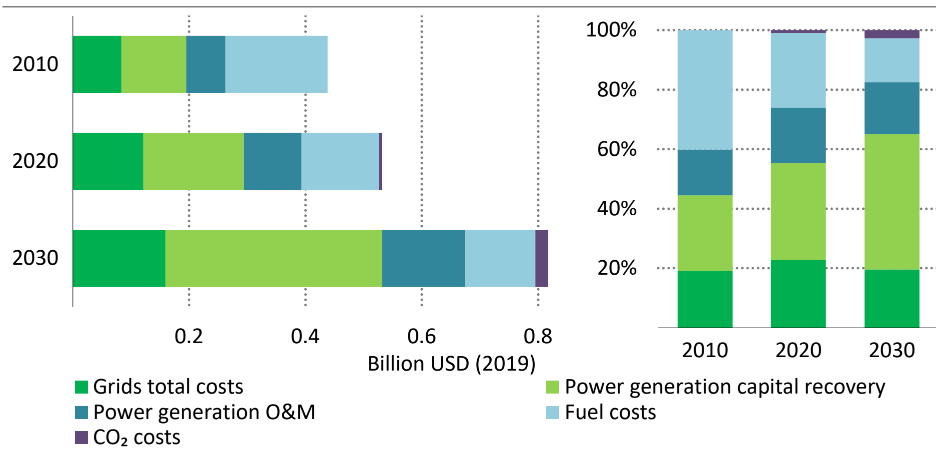
EMDEs are industrialising and urbanising at a rapid pace, underpinning a rising share of global demand for steel and cement. Residential energy use is poised to surge, underpinned by greater demand for cooling, with EMDEs accounting for over 80% of air conditioner sales. In our climate-driven scenarios, the need for cleaner, more efficient mobility solutions means that EMDEs account for nearly a quarter of global EV sales by 2030, from minimal levels today. Reflecting their growing role in the deployment of key clean energy supply technologies, EMDEs account for nearly 40% of global spending on solar PV and wind by the end of this decade, a quarter of new battery storage, and around a fifth of the world's investment in low-carbon fuels.

In order for clean energy investment levels to keep pace with burgeoning demand, as well as help to reduce emissions in the existing capital stock, developers and financiers need to increase the allocation of capital towards two underserved asset classes – to clean energy in particular, and to emerging markets and developing economies more broadly. This naturally depends on adequate signals for investment being put in place.

1.2.2 Outlook for capital and operating costs in the transition

During transitions, key parts of the energy system, notably the power and end-use sectors, become more reliant on technologies that have higher upfront capital costs, but save on fuel costs. Keeping these upfront costs low will be critical to the speed and affordability of this transformation – this shift towards a more capital-intensive energy system is particularly challenging in geographies where capital has traditionally been constrained.

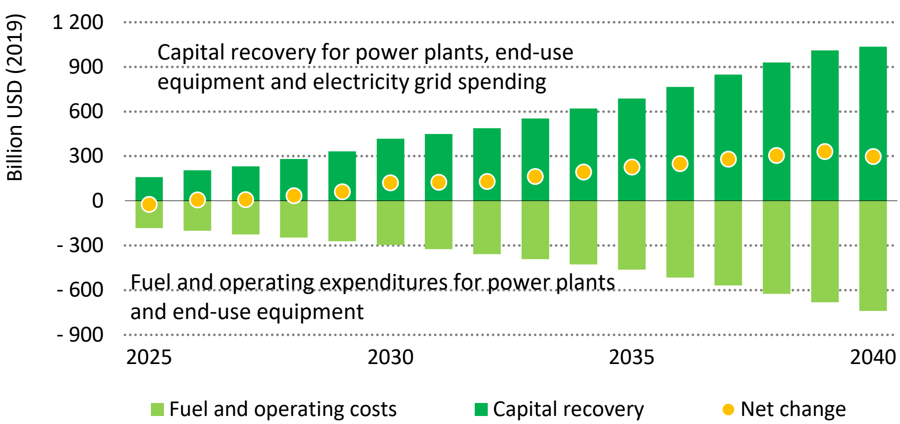
Figure 1.12 ▻ EMDE electricity supply costs, historical and in the SDS



Clean energy transitions involve a shift towards a more capital-intensive system; as power supply costs rise by half to 2030, a greater share goes towards capital.

As a result, spending devoted to servicing financing costs – capitalised interest on debt and returns to equity – also rises in clean energy transitions. This is offset in part by reduced operating expenditures, helping to keep the additional costs of transition in check. In the power and end-use sectors, the expenditures on the recovery of capital in EMDEs – including financing – are around 60% higher than under the STEPS over the next two decades. However, this is partly offset by reduced expenditures on fuel and other operating costs, which are around 15% lower. When taking the full cost of transition into account for these sectors, the total spend is only 5% higher in our climate-driven scenarios.

Figure 1.13 ▷ Additional capital recovery expenditures and operating costs in the power and end-use sectors, SDS compared with STEPS



In climate-driven scenarios, spending on recovery of capital, including financing, rises in power and end-use sectors, but lower operating costs helps keep overall costs in check.

Energy transitions involve a broad shift in the nature of spending in the energy system, from dollarized, globally traded commodities, such as oil, with fuel price volatility but established risk management, to capital-intensive clean electricity and efficiency, with more stable lifetime costs, but new risks coming from pricing in local currency, reliance on domestic demand and counterparties as well as less developed risk management approaches.

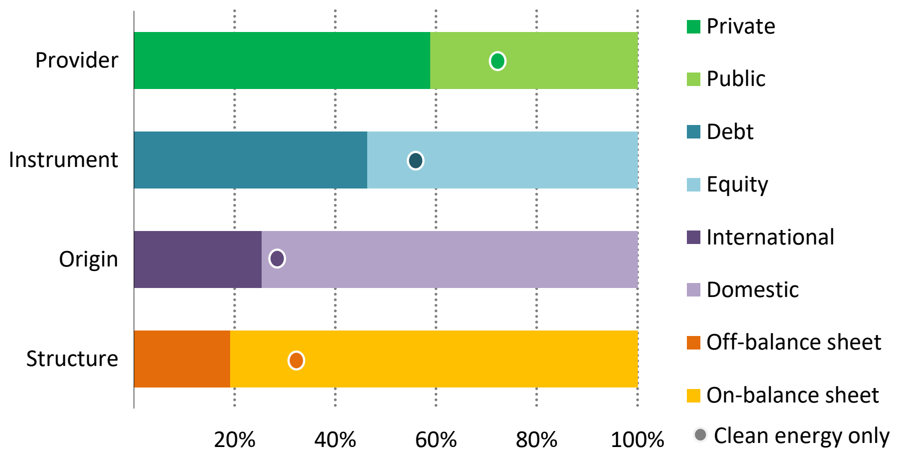
In clean energy transitions, capital matters more than ever. The ability to borrow and service a larger share of debt (see Chapter 2), as well as ensure adequate risk-adjusted returns on investment for equity holders are critical for attracting investment and shifting capital allocations to clean energy. Managing financing costs and diversifying the sources of finance become increasingly important to make these transitions affordable. While the debt component is set out, often in a fixed manner, in the terms of loans and bonds based on prevailing interest rates, equity returns depend far more on the profitability of assets after debt service, as well as risks related to project development and construction.

The landscape for clean energy finance in EMDEs

SUMMARY

- The cost and availability of capital for investing in clean energy transitions is a crucial aspect of the ability of EMDEs to meet sustainable development goals. Although EMDEs account for around 40% of energy investments and emissions reductions under IEA climate-driven scenarios, they currently hold only 10% of global financial wealth. Improving the domestic ecosystem for investing in clean energy, while addressing risks and barriers that shape access to foreign capital, will be critical.

Figure 2.1 ▷ Indicative sources of primary finance for EMDE energy investments in IEA climate-driven scenarios, 2026-2030



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Clean energy transitions involve growing reliance on private sources of finance, as well as greater use of lower-cost debt, off-balance sheet structures and international capital.

- Energy investments in EMDEs today rely heavily on public sources of finance. However, in IEA climate scenarios over 70% of clean-energy investments - mostly renewables and efficiency - are privately financed. Public actors, including SOEs, are key for grids and transitions for emissions-intensive sectors. The catalytic role of development finance institutions, through blended finance, will be critical to attract capital to markets and sectors at early stages of readiness, or with hard-to-mitigate risks.
- While clean energy transitions rely on much higher levels of both equity and debt, the capital structure of investments is likely to move towards more debt. This stems from the shift from investment in fuels to the electricity and end-use sectors, as well as the higher fixed element in the cost and revenue structure of the underlying assets. While

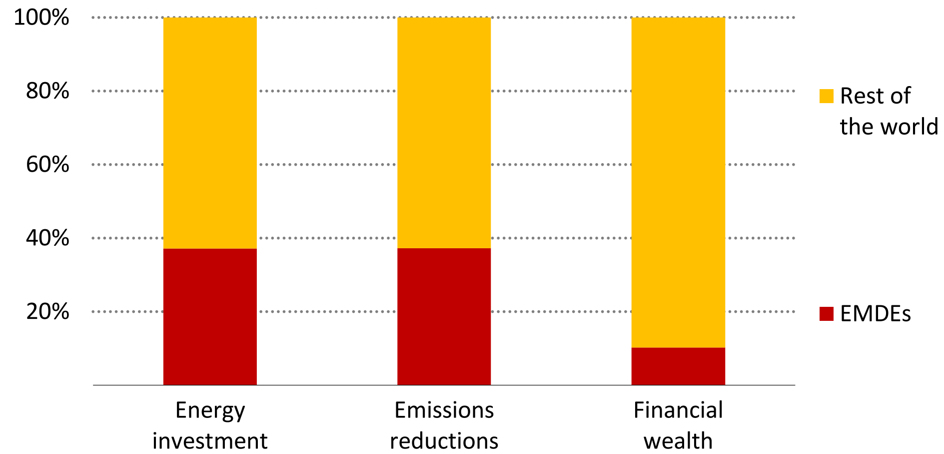
most energy investments are funded from company and consumer balance sheets, off-balance sheet financing structures, which typically involve higher degrees of leverage, play an increasingly important role in extending the capacity of developers to fund clean energy projects under IEA climate-driven scenarios.

- Mobilising clean energy investment will depend on enhancing finance from local sources as well as international providers. Foreign capital is likely to increase the most in directly financing renewable power. While consumer-based investments, as in end-use and efficiency, and those more reliant on SOEs, as in fuel supply and electricity grids, rely heavily on domestic capital, the importance of foreign sources of capital in funding projects, companies and financial intermediaries rises in these areas as well.
- While global capital is abundant, attracting finance hinges on addressing cross-cutting factors that hinder investments in EMDEs. The economy-wide cost of capital is higher in EMDEs than advanced economies. Economy-wide nominal financing costs in EMDEs range some 700 to 1 500 basis points - up to seven times - above values for the United States and Europe, with higher levels in riskier segments. This points to relatively high bar for investments in accessing debt finance and meeting equity return hurdle rates.
- EMDEs face heightened macroeconomic risks and domestic capital constraints. Over 90% of EMDE investment needs are in countries with underdeveloped banking and capital markets. Debt burdens are on the rise in a number of economies, and EMDEs have not sufficiently mobilised resources for sustainable recovery. Domestic savings are unevenly distributed across regions, while currency risks and restrictions on direct investment can dissuade foreign investors, especially in developing economies.
- Today's policy settings in EMDEs do not provide a trajectory for emissions reductions or access to energy that achieves sustainable development goals. Actions to unlock higher levels of long-term local currency debt, and equity for riskier projects, develop and enhance learning for financial intermediaries, channel institutional capital – including through public funds – and develop international partnerships are critical.
- Cross-cutting investment issues can be better addressed through policy predictability, setting clear and ambitious clean energy strategies and good governance. Getting price signals right and addressing contractual, licencing and land acquisition issues are key for jump-starting projects. Enhancing the financial performance of SOEs, empowering new businesses and SMEs, and aligning strategies with transition pathways is critical. EMDEs have an opportunity to integrate sustainability in financial systems with clear taxonomies and rules for disclosure and risk assessment.
- Stronger international efforts are also needed. Realising the commitment by advanced economies to mobilise $100 billion per year in climate finance is a critical starting point. The COP26 is an opportunity to boost the catalytic role of public finance with stronger mandates and boosting and improved delivery of international climate finance. Aligning capital markets with net zero goals risks excluding EMDEs with higher-carbon footprints or sectors with more challenging transition pathways. Initiatives could better target EMDEs and sustainable development more widely.

2.1 Introduction

The cost and availability of capital for investing in clean energy transitions will determine the ability of EMDEs to meet sustainable development goals. Although EMDEs account for around 40% of global energy investments and emissions reductions under IEA climate-driven scenarios, they currently hold only around 10% of the world's financial wealth. Improving the domestic ecosystem for investing in clean energy projects and enabling infrastructure, enhancing financial system development and shifting the strategic orientation of companies as well as addressing risks and barriers that shape access to foreign capital are critical to meeting the accelerated investment requirements under climate-driven energy pathways.

Figure 2.2 ▹ Share of EMDEs in global energy investment and emissions reductions under IEA climate-driven scenarios compared with their share of financial wealth in 2019



While EMDEs account for around 40% of energy investment and emissions reductions in climate-driven scenarios, they currently comprise only 10% of global financial assets.

Notes: Share of emissions reductions in IEA climate-driven pathways relative to the Stated Policies Scenario. Global wealth is defined as cumulated financial asset value, including investable (equity, bonds, deposits etc.) and non-investable (unlisted debt and equity, life insurance and pensions) assets.

Sources: Calculations for financial wealth based on BCG (2020).

There is no shortage of global capital. Coming into 2020, global financial wealth held by the world's investors had topped $200 trillion. Financial conditions changed rapidly during the Covid-19 pandemic, and global debt levels are on the rise. Although conditions have eased somewhat recently, the supply of negative-yielding bonds had reached a record of $18 trillion at the end of 2020, reflecting a preference by the world's investors to allocate capital towards less risky markets in advanced economies and representing a large potential source of financing that could be shifted towards more attractive investment opportunities. There is also strong appetite from the capital markets to fund sustainability, with global issuance of sustainable debt soaring to record levels in 2020.

Nevertheless, there is a shortage of clean energy investment opportunities with adequate risk and return characteristics, both globally and especially in EMDEs, as well as appropriate channels for allocating finance to companies and projects. The economy-wide cost of capital is generally higher in EMDEs than advanced economies, which reflects a number of factors, including heightened macroeconomic risks, underdeveloped financial systems and challenges associated with investing in projects. Economy-wide nominal financing costs in EMDEs range some 700 to 1 500 basis points above values for the United States and Europe, with higher levels for riskier markets and segments. This suggests a relatively high bar for energy investments in raising debt finance and meeting equity return hurdle rates. At the same time, EMDEs have contributed only around 10% to the global rise in sustainable debt issuance.

Understanding how finance needs to evolve in clean energy transitions is critical to setting policies that encourage the flow of capital with appropriate characteristics towards companies and projects, at the right time and in the right places.

This chapter highlights the areas in which major economies and EMDEs can step up efforts to catalyse these flows, before entering into the sector-specific conditions of Chapters 3 and 4. It starts by assessing the sources and types of capital required to fund the investments across the energy sector that are needed under clean energy transitions, quantifying them across four parameters of financing. It presents the cross-cutting factors, including the investment frameworks, industrial landscape and macro-financial issues that influence capital allocation across the energy sector and in the wider economy. Finally, it analyses the strategies being taken in EMDEs, from the financial system perspective, to address the potential risks associated with climate change and clean energy transitions, as well as to guide the growing appetite for sustainable finance from capital markets.

2.2 Sources of finance for EMDE investments

How companies across the energy sector fund their overall operations and growth varies significantly, with much depending on the type of developer and investor, and the risk and return profile of the asset. On a primary basis, most energy assets are financed directly from the balance sheets of developers and consumers, but these funds are not nearly enough to fund investments and may not represent the most optimal use of a company's own capital. Primary financing structures that pool a diversity of capital providers, including banks and institutional investors, are often used in large transactions or those with high upfront capital requirements.

Secondary sources of finance from banks and the capital markets also take on increased importance in the face of pressures on retained earnings for companies. A number of consumers with limited balance sheets depend on access to loans from financial intermediaries. This is, however, likely to pose its own challenges: banks have to contend with lending limits, and equity and debt capital markets remain underdeveloped in a number of key markets. Improving the availability of financing options hinges on creating and linking appropriate sources of capital with the areas of greatest need, and aligning them with the requirements of companies and assets.

Box 2.1 ▷ Modelling the primary sources of finance for energy investment

This report projects how the primary sources of finance[1] - i.e. direct investment in energy assets - evolve across four parameters and under different energy scenarios:

- **Type of financing structure** – whether the investment involves the financing of assets on a company's or consumer's balance sheet using retained earnings from income as well as corporate debt and equity, or financing is made off-balance sheet, such as in project finance or in third-party ownership and leasing arrangements.
- **Type of provider** – whether the finance comes from private sources – companies, commercial banks, private investors and consumers – or public ones, such as state-owned enterprises (SOEs) and public finance institutions and funds.
- **Type of instrument** – this parameter reflects the capital structure of energy investments, analysing the mix of debt and equity that developers, households and project companies use in the primary financing of projects and assets. While grants are accounted for within equity, the use of guarantees is not modelled.
- **Origin of provider** – whether the capital comes from domestic or international sources from the standpoint of the country in which the investment takes place.

Sources of finance for investments under an energy pathway based on today's policy settings, as in the STEPS, largely reflect the continuation of recent financing trends across sectors and geographies. With the enhanced policies and measures that deliver the ambitions needed to deliver investments under IEA climate-driven scenarios the outlook for finance shifts, and reflects a better availability of clean energy projects with risk-adjusted returns that attract a wider range of structures and investors; more efficient capital allocation, especially from public sources; and the development of local capacity to invest in clean energy.

Given the difficulties in synthesising complex financial transaction data, which are not always complete or transparent, modelling results should be seen as providing a broad indication of trends. Further details on definitions and methodology can be found in the *World Energy Investment* methodology documentation.

[1] Estimates for the sources of finance do not include secondary flows to financial intermediaries, which are particularly important in extending loans to consumers and small businesses.

2.2.1 *Type of financing structure*

The majority of primary financing of energy investments in EMDEs has come from capital incorporated into a company's balance sheet or from consumers' own assets. The remainder comes from project finance structures, where risks are shared among funding providers in non-recourse vehicles held off the balance sheet of the project owners, as well as off-balance sheet structures, such as third-party ownership and leasing arrangements, which are used in smaller-scale assets for end users.[2]

Final investment decisions (FIDs) for off-balance sheet financing structures have declined globally in recent years, reflecting reduced transactions as a result of the pandemic, but also growing market uncertainties in some energy sectors. The share of these type of FIDs in EMDEs has grown, reflecting their elevated role in project finance transactions for liquefied natural gas and fossil fuel-based power investments. However, there is increased uncertainty over the availability of such structures for fossil fuel-related investments going forward. Large-scale natural gas infrastructure projects in EMDEs have relied on long-term offtake agreements to secure project debt finance, with about 90% of this raised internationally. However, the availability of these agreements may lessen in the future (see Chapter 4).

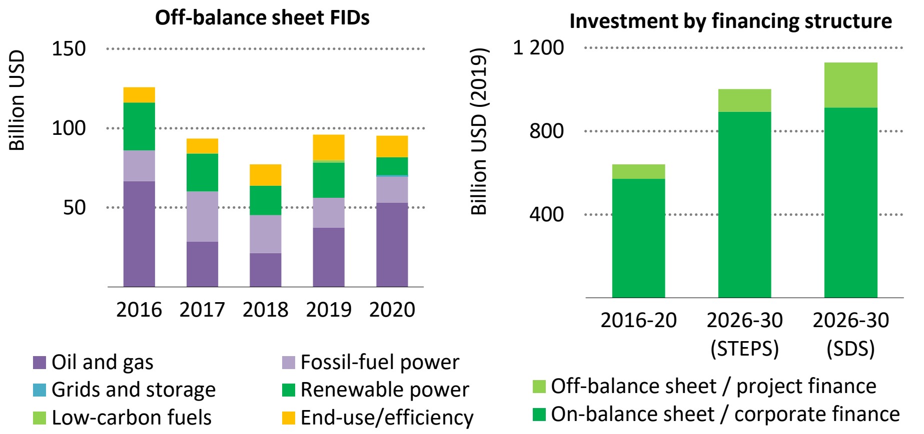
Project financings for renewable power and off-balance sheet arrangements supporting efficiency and distributed resources have grown in markets with policy frameworks that support the allocation of risks within bankable financing arrangements. Such frameworks for renewable power include the presence of auctions for awarding long-term power purchase agreements (PPAs) with creditworthy counterparties and energy service contracting for efficiency improvements. Off-balance sheet structures for renewables have generally occurred in the Middle East, India and Latin American countries such as Mexico and Brazil. However, they account for a relatively low share of energy investment in economies with the presence of higher risks and less developed investment frameworks and financial ecosystems. In efficiency and distributed power, such arrangements have occurred in markets that support energy performance contracting with an energy service company (ESCO) or a PPA with a third-party project developer.

Meeting the investment requirements of IEA climate-driven scenarios points to off-balance sheet financing structures playing an increasingly important role in extending the capacity of developers to fund clean energy projects, accounting for nearly a third of such investments. Improved policy frameworks and availability of risk management mechanisms under this scenario would enhance the bankability of large-scale clean energy assets, such as utility-scale renewable power, and help companies to develop new ownership, service and leasing models for small-scale assets, such as in distributed clean power, efficiency and EVs (see Chapter 3). Aggregation of small-scale assets into portfolios by financial intermediaries is also likely to support a greater degree of refinancing using off-balance sheet structures, such as securitisation. The potential for more private participation in regulated networks is also likely

[2] The share of off-balance sheet structures is based on disclosed project finance transactions and estimates for third-party ownership and contracting models used in small-scale clean energy investments.

to open up some opportunities for project finance in electricity grids, where it currently remains modest.

Figure 2.3 ⊳ EMDE energy investment by financing structure (right) and FID trend for off-balance sheet investments (left)



While off-balance sheet and project finance structures have played a larger role in fossil fuels, enhancing their use for clean energy increasingly underpins investment in the SDS.

Note: End-use/efficiency in left chart includes distributed solar PV.

Source: Calculations for FIDs are based on IJ Global, 2021.

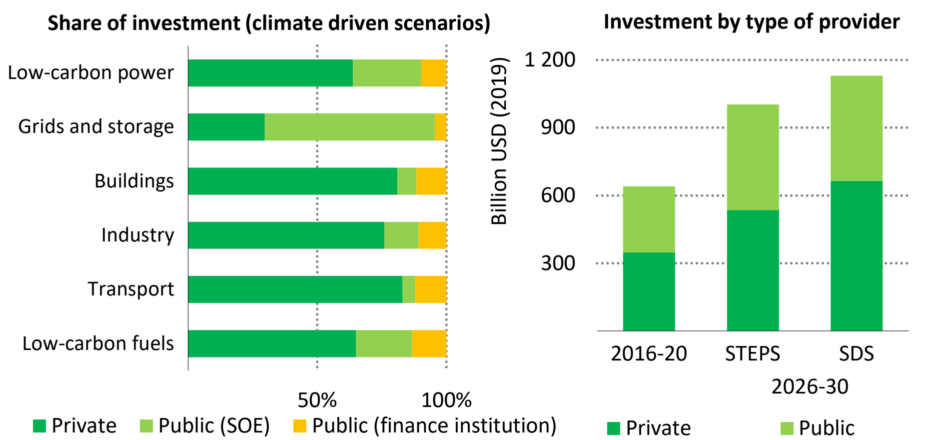
While the share of project finance rises somewhat in IEA climate-driven scenarios for newer technologies – such as battery storage, carbon capture and low-carbon hydrogen – uncertainties over the evolution of business models, and cash flows, point to a dominant role for financing made directly on-balance sheet with equity from companies with good financial resources and risk capital from public actors over the next decade. In clean energy transitions, pressure from capital markets reduces direct participation of external financial providers for fossil fuel-related investments, which would likely constrain their use of project finance structures. However, there are uncertainties over how the financing for natural gas infrastructure might evolve, given that in IEA climate-driven scenarios gas contributes to certain development goals and emissions reductions in the near term (alongside a massive ramp-up in renewables), before facing declining use under pressure from longer-term net-zero ambitions.

Funding options would also need to improve in IEA climate-driven scenarios for companies and governments that are self-financing assets and emissions reduction measures that support clean energy transitions. This would require the continued development of more robust capital market frameworks and investor appetite for sustainable finance, underpinning the issuance of labelled green and sustainability-linked debt instruments (see below). Development of a market for transition finance would also support more complex transitions by fuel supply and emissions-intensive sectors (also covered in Chapter 4).

2.2.2 Type of provider

In recent years, public sources of finance have accounted for nearly half of energy investments in EMDEs. SOEs, often financing projects on their own balance sheet, account for the majority of this public contribution. They are particularly important in driving investment in regulated networks – SOEs account for over three-quarters of electricity grid spending, and their creditworthiness affects nearly all electricity-related transactions. They remain important in the development and utilisation of fossil fuel assets: around half of coal power finance comes from SOEs and around 40% of oil and gas spending is underpinned by national oil companies (NOCs). Some SOEs are making efforts to diversify, although financial strains – exacerbated by the pandemic – make this more challenging.

Figure 2.4 ▷ EMDE energy investment by type of provider



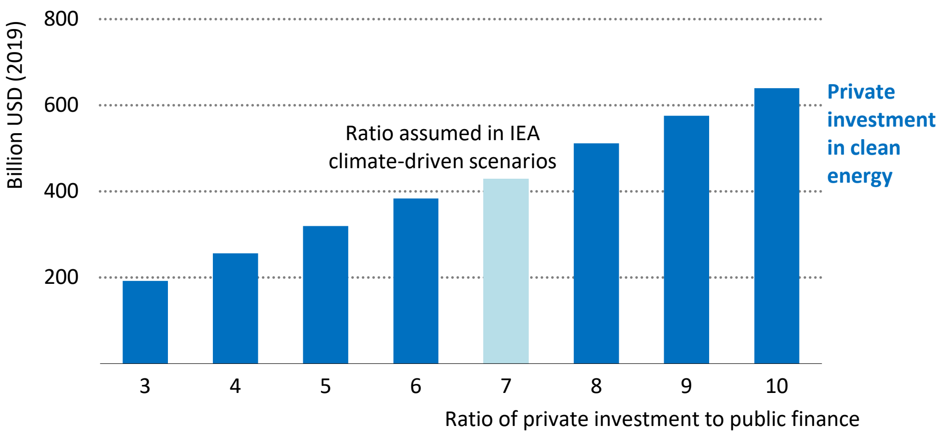
Energy investments in EMDEs today rely heavily on public sources of finance, but over 70% of clean energy spend in IEA climate-driven scenarios comes from private capital.

Notes: Estimates include primary finance for assets; in the case of end-use sectors, estimates do not include flows to financial intermediaries.

Clean energy sectors in EMDEs (as elsewhere) have been financed mostly by private sources. While some segments, such as hydropower, nuclear or industry, have relatively high participation of SOEs, most other clean projects are owned by private developers. Public finance institutions remain instrumental in a number of markets to catalyse private sources and help improve the bankability of clean energy projects. In some areas, such as in the sub-Saharan Africa power sector, an absence of financially resilient SOEs combined with persistent risks has translated into a high reliance on international public finance. Public finance also underpins a large part of investment made in improving energy access for areas that lack reliable electricity or clean cooking facilities (see Chapter 3).

Meeting the investment requirements of IEA climate-driven scenarios involves a dramatic shift in the types of capital provider in EMDEs to private sources, who finance around 60% of total energy investment and over 70% of clean energy investments, and these sources play an especially important part in the scaling up of renewable power, efficiency and new technologies. Governments play a critical role in mobilising and enabling this uptick in private investment in IEA climate-driven scenarios. Attracting private investment in clean energy fuels and technologies in particular will depend to a large extent on the existence of appropriate regulatory frameworks, infrastructure planning, standardised and scalable contractual frameworks, appropriate market design, and fiscal incentives. These issues – and actions to address them – are treated in more detail in the cross-cutting and sectoral discussions throughout this report.

Figure 2.5 ▷ Implications for private investment for clean energy in EMDEs from changes in the ratio of private to public finance



A crucial variable in financing clean energy transitions in EMDEs is how effectively money from public finance institutions is used to mobilise additional private capital.

Notes: Public finance includes primary finance for projects (debt and equity) from public finance institutions. Values shows are for 2026-30 in the SDS.

In IEA climate-driven scenarios, SOEs would continue to account for most direct investment in enabling infrastructure (e.g. networks), even as private financing models provide an important complement in some markets (Chapter 3). Government ownership and guarantees could also serve as powerful tools to push transitions in emissions-intensive sectors as well as to provide risk capital to fund first-of-a-kind projects in new markets or sectors. But budgetary constraints and debt overhang among governments and SOEs is likely to limit their capacity to take on large levels of direct spending. Some SOEs may also be reluctant to invest in clean energy sources that affect their revenues from fossil fuel sales (e.g. for NOCs) or entail a higher cost of energy consumption (e.g. heavy industry currently reliant on cheap coal).

Public finance institutions, including development and green banks as well as infrastructure and clean energy funds, are expected to play important complementary roles in the structuring of bankable projects, providing financial de-risking mechanisms, in co-financing alongside private-sector capital providers and as vehicles for capital disbursement from recovery packages. They play important roles in extending credit lines to financial intermediaries and companies, especially for energy efficiency, and providing guarantees for projects and loans. Meeting the goals of IEA climate-driven scenarios depends in part on enhanced provision of debt, equity and a range of blended finance instruments and structures that would help to catalyse project development and attract higher levels of private capital in markets and sectors with persistent risks and barriers.

The ratio of private investment mobilised by a given amount of public funds – often described as investment multipliers – can vary widely by sector, market and type of instrument. The International Finance Corporation's (IFC's) portfolio of blended climate finance investments highlights multipliers in the range of 3 to 15 times for project debt and even higher levels (10 to 30) for debt finance provided on concessional terms (IFC, 2021). The investment multipliers associated with different green banks and strategic investment funds range from 2-12 times (OECD, 2021a).

Recognising some of the uncertainties in estimating multipliers, and accounting for the specific private capital mobilised by public finance at the project level, this report presents a simple comparison of the ratio of these two elements at an aggregate level. In IEA climate-driven scenarios, private clean energy investment totals are around seven times higher than the debt and equity provided directly to projects by public finance institutions. This ratio is higher than in the STEPS, where it is between five and six. The higher ratio in climate-driven scenarios reflects the implementation of policies and financial measures – as described in the sectoral discussions of Chapters 3 and 4 – that help to more effectively mobilise private investment in clean energy transitions. That said, the outlook does not account for all specialised instruments and credit enhancements, including guarantees, the impacts of providing finance on concessional terms and indirect means of public participation, such as through technical assistance and the financing of local intermediaries, which also play critical roles in catalysing investment.

Improving the effectiveness of public finance through such means – or through corresponding policy reforms – could further increase the amount of private investment associated with a given level of public funds. For example, enhanced policy reforms and targeted risk capital that would boost this ratio to ten is associated with a level of private investment in clean energy that is around 50% higher. In the longer term this evolution becomes increasingly important for meeting more ambitious net-zero emissions goals.

S P O T L I G H T

Bridging investment gaps through international public finance

While financing clean energy transitions depends on improving the domestic enabling environment for investment, efforts by EMDE governments alone are not enough to bridge investment gaps. A number of EMDEs, especially those with lower incomes, as well as hard-to-finance clean energy sectors require a catalyst to boost investment and to support governments in longer-term reform processes. Notably, advanced economies have an opportunity through the upcoming 26th Conference of the Parties (COP26) agenda on finance to step up efforts.

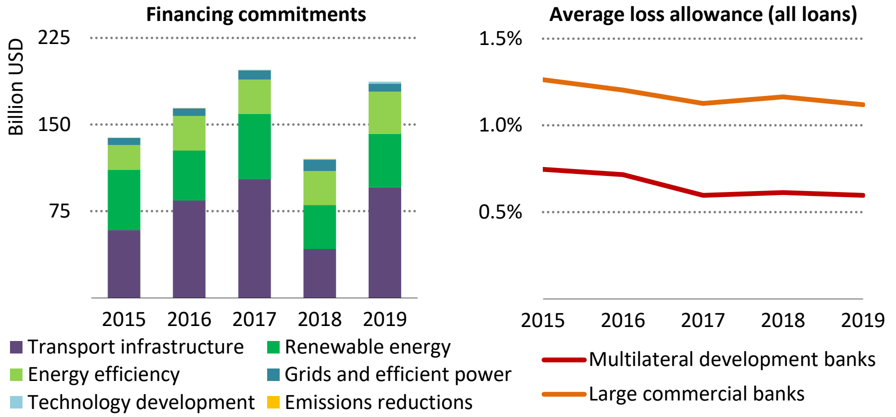
Realising the commitment by advanced economies to mobilise funds to address the requirements of developing economies is a critical element of the response. Climate finance provided and mobilised for developing economies grew to nearly USD 80 billion in 2018, with public sources making up 80% of this, though it remains short of a goal of USD 100 billion by 2020 (OECD, 2020a). Energy supply accounted for nearly one-third of these funds, with further amounts provided to key demand sectors (transport and industry). But even with the overall goal met by 2020, and all funds directed towards clean energy, the sum represents less than one-fifth of EMDE clean energy investment requirements in the SDS by 2030, and less than 10% of those in the NZE scenario.

Clean energy-related commitments by development finance institutions (DFIs) more broadly (including those funding advanced economies) have stepped up in recent years, rising to nearly USD 190 billion in 2019, up by one-third since 2015. Nearly half has come in transport, in infrastructure for electrification and in modal shifts for sustainable urban development.[3] Renewables and energy efficiency accounted for over 45%. National and bilateral development banks have accounted for 85% of the total, but the strongest growth has come from multilateral development banks (MDBs), whose commitments more than doubled. Over 85% of this finance has come from loans; among national/bilateral banks, one-third of it was committed on concessional terms.

More recently, there is evidence that DFIs expanded overall commitments during the pandemic, but it is less clear that funding decisions for new clean energy projects rose. One reason is that during the height of the crisis, social measures, in health and safety, and near-term economic relief were likely prioritised. DFIs may have also focused more on servicing existing projects to ensure financial viability rather than originating new ones, as well as disbursing already-committed capital more quickly. Preliminary data point to official development assistance from advanced economies rising to a new high in 2020, but the increase was not uniform across donor countries (OECD, 2021b).

[3] Transport investments reported by DFIs include urban mass transit and inter-urban rail and waterway projects, which are not included as part of energy investment in this report.

Figure 2.6 ▷ **Clean energy-related financing commitments by DFIs (left) and comparison of average loan loss allowances (right)**



Nearly half of DFI clean energy finance commitments have gone to transport; loan loss allowances for MDBs declined in recent years, to half that of major commercial banks.

Notes: DFIs include the MDBs and national development bank members of the International Development Finance Club. Large commercial banks include Bank of America, Barclays, Citigroup, Credit Suisse, Deutsche Bank, HSBC, J.P. Morgan and UBS.

Sources: Calculations for commitments based on MDBs (2020), IDFC (2020), CPI (2019), and annual reports; loan loss allowances based on Thomson Reuters Eikon (2020) and annual reports.

Successfully financing clean energy transitions will depend on stepping up efforts to channel lower-cost capital from international sources and capacity building to facilitate better local management of risks, all underpinned by partnerships and collaboration. While the existing international financial system plays an important role in supporting economic development goals worldwide, the investment strategies, capabilities and funding levels of its actors may not be adequately tailored to supporting a more fundamental transformation of the energy sector in EMDEs.

For one, DFIs can face a tension in their mission between the objectives of providing risk capital to areas most in need, promoting private-sector development and fulfilling their roles as banks with sound risk management and public accountability. Their lending approaches differ from those of private actors. While they tend to provide lower-cost and longer-term financing, as a group the MDBs have maintained lower loan loss allowances on portfolios, an indication of overall lower risk-taking capacity. Some commercial financial institutions have raised concerns of crowding out by DFIs, pointing to transactions carried out as club deals that limit external participation.

Bridging financing gaps will require boosting blended finance solutions as well as better collaboration between public and private financiers. While some DFIs have revamped lending strategies, there are questions over how well current approaches across all the DFIs can support the dramatic scale-up and range of solutions needed to finance clean energy transitions. Key considerations that DFIs face include:

- Integrating climate impacts into decision-making and portfolio management, which can be challenging for investments with less clear emissions profiles (e.g. grids).
- Boosting project pipelines and transaction sizes, such as with project preparation and development funds, while fostering capacity among local financial institutions.
- Developing approaches to finance small-scale projects for energy efficiency, small and medium-sized enterprises (SMEs), distributed energy, and access.
- Targeting new sectors and markets with risk capital – e.g. from dedicated entities such as ADB Ventures, IDB Invest, IFC Disruptive Technologies and Venture Capital.
- Financing transitions and economic development for regions dependent on coal.

These considerations raise challenges given the scale and pace of investment required to meet climate goals. Moreover, today's strategies, capabilities and funding levels do not yet answer the call for a fundamental transformation of the energy sector. The international system lacks a clear and unified focus on financing emissions reductions and clean energy – particularly in the developing world. There are limits on the availability of public funds to finance transitions. Boosting the catalytic role of public finance institutions, improving delivery channels, and promoting local institutional capacity to disburse capital, are critical.

One way to address this gap may be through a process that supports dedicated clean energy transition finance institutions or funds – carved from existing actors or new entities – that synthesise these functions. Their features could include ability to channel long-term, low-cost capital, including blended finance mechanisms, from public and private investors and a clear investment strategy based on sustainable development pathways. Pairing funding with policy advice and technical assistance from other international institutions would further help build capacity among public and private actors in EMDEs and facilitate project development.

Any stepped-up international effort may function best by collaborating with a corresponding clean energy transitions institution, such as a green bank, in EMDEs. Only a few such banks exist in EMDEs (e.g. in India, Malaysia, South Africa, United Arab Emirates), though a number are under development or consideration. Supporting the roll-out of such dedicated local institutions could help to more efficiently allocate capital and provide investment facilitation for projects. Benefiting from an infusion of international funds and collaboration, the strategy of such institutions could include all types of capital and the ability to fund sectors at varying degrees of maturity.

2.2.3 Type of instrument

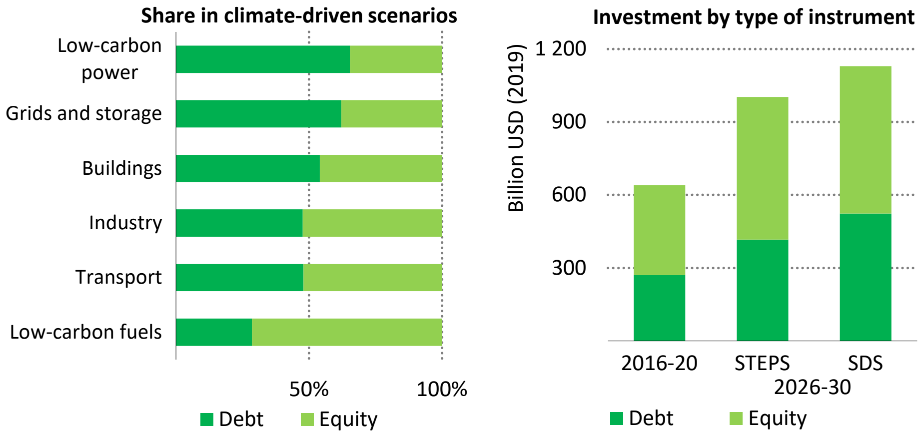
In clean energy transitions, the capital structure of investments is likely to rely on a greater share of debt finance. This stems both from the relative shift from investment in fuels to investment in the electricity and end-use sectors, but also the higher fixed element in the cost and revenue structure of the underlying assets. Electricity sector investments, which in EMDEs are often underpinned by long-term PPAs or regulated remuneration, typically rely on debt more than those in fuel supply, and some end-use sectors also rely to a considerable degree on debt financing, such as efficiency improvements in housing and commercial buildings. However, the provision of privately sourced debt, in particular, is often constrained in EMDEs, due to relatively high risks (such as those related to reliable power purchase) and a lack of projects that meet the lending criteria of banks, as well as underdeveloped local banking systems and corporate and consumer credit markets.

Scaling up private investment means mobilising financing instruments – debt and equity – to match the capital structure of energy companies and assets. Globally, half of investment needs under IEA climate-driven scenarios would be financed by debt at a time when global debt-to-GDP levels are on the rise, which is likely to put major pressure on the ability of governments and companies to service this debt. In EMDEs, the share is expected to be slightly lower under climate-driven scenarios, but still over 45%. While major economies are set for an extended period of very low borrowing costs as accommodative monetary policy has pushed interest rates down, economic risks and concerns over the impacts of debt management have also increased in many EMDEs.

The availability of debt to finance low-carbon power and flexible infrastructure represents a critical uncertainty for clean energy transitions. Under IEA climate-driven scenarios, nearly two-thirds of clean power investment would depend on debt, with electricity grids requiring debt levels above 60% of investment. Yet in today's circumstances, the availability of fixed-rate debt with long-term tenures to match the duration of contracted revenue streams (e.g. from PPAs) can hardly be taken for granted. Countries that have improved debt financing terms over time, in markets such as Brazil and India, have typically featured competitive procurement programmes with clear and transparent risk allocation, which are major factors in the bankability of utility-scale solar PV and wind (see Chapter 3). In Brazil, co-financing by the national public finance institution was also instrumental to attract private lenders and developers.

While its overall share declines somewhat, the provision of equity from developers and investors underpins the majority of investment, especially in fuel supply. As it does today, equity plays a dominant role in financing all types of energy investments at certain points of the project life cycle, for example in funding development and construction phases, where upfront risks are higher. It is likely to remain particularly important in financing renewable projects with specific risks, such as geothermal during exploration phases, and large-scale projects, such as hydropower, requiring long periods of due diligence and feasibility studies.

Figure 2.7 ▷ EMDE energy investment by type of instrument



Energy investments require a diversity of financing instruments under any scenario, but actions to unlock higher shares of debt become more critical in clean energy transitions.

Notes: Estimates include primary finance for assets; equity includes grants.

For some sectors, equity shares can rise as policy incentives are reduced and as projects take on higher degrees of market risk to support system integration goals or more complex project designs emerge, such as hybridisation with battery storage. Such developments, however, are more prevalent in advanced economies than in EMDEs, where the majority of utility-scale renewable projects are likely to depend on long-term fixed price contracts.

Improving the availability of equity is likely to underpin investments in energy efficiency, distributed power and end-use sectors, where transaction sizes are smaller and SMEs face higher lending rates, compared with larger companies and assets (see below). That said, meeting the accelerated investment requirements under IEA climate-driven scenarios also means increasing the share of debt in these sectors as better implementation of efficiency standards, labelling, and monitoring and verification protocols help banks to better assess the financial case associated with energy savings. In addition, efficiency investments under this pathway are likely to involve increased participation by third-party developers, such as ESCOs, which start to tap more into sustainable debt markets to fund investments.

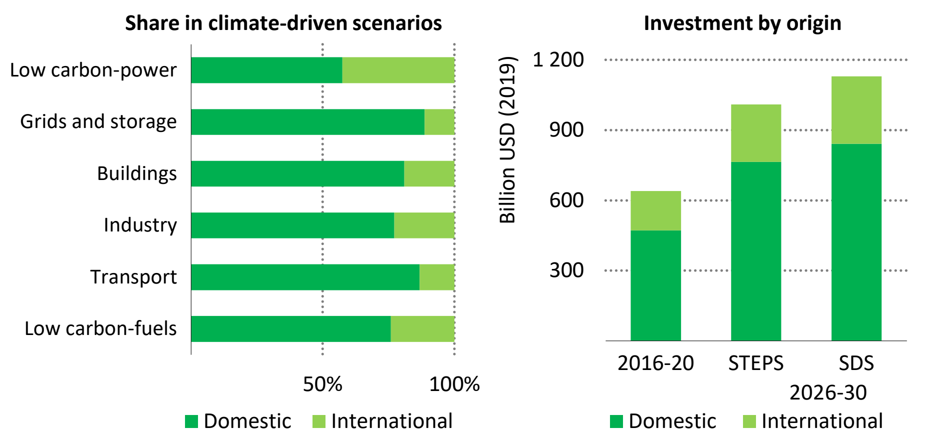
While energy-intensive industrial sectors tend to be financed with more equity, the cultivation of stronger corporate bond markets and development of instruments, such as transition bonds (see Chapter 4), helps increase the role of debt under climate-driven scenarios, subject to the debt service limits of the borrowing companies. The same is true in transport, where greater availability of auto loans helps to support EV purchases.

For newer technologies, such as battery storage, carbon capture and low-carbon hydrogen, capital needs are expected to be initially based more on balance sheet and equity finance, but with potential for project finance and debt shares to rise as technologies develop a track record with banks and as policies are set that help support business models with reliable cash flows. In early stages of development, public finance institutions are seen playing a critical role in credit enhancement, such as guarantees, which help to reassure private lenders. Meanwhile, tightened lending criteria by financial institutions seeking to align portfolios with sustainability pathways is likely to reduce the availability of debt for fossil fuel projects. This is already the case for coal, where over 100 institutions have announced such restrictions.

2.2.4 Origin of financial provider

Mobilising higher levels of debt and equity finance from private sources will depend on enhancing the availability of capital from local sources as well as the ability of markets to attract much higher levels of investment from international providers. The origin of finance remains one of the most challenging financing parameters to assess. This report estimates the role of international sources in directly financing projects, but does not fully account for the range of financial flows, such as those provided to domestic financial intermediaries for onlending, that also underpin investment, especially in sectors such as energy efficiency.

Figure 2.8 ▷ EMDE energy investment by origin of provider



Mobilising finance from private sources depends on enhancing availability of capital from local sources as well as attracting higher levels of investment from international providers.

Note: Estimates include primary finance for assets.

We estimate that around one-quarter of the primary finance for energy investments in EMDEs has come from international sources over the past five years. These sources mostly include foreign project developers, international commercial banks and public finance institutions. While foreign direct investment (FDI) and cross-border lending have grown in some markets and sectors, e.g. for renewable power in regions with robust competitive procurement frameworks, the level of private participation by international sources in energy investment remains well below its potential.

In clean energy transitions, there are two main dynamics that influence the role of international sources of investment. For markets already reliant on relatively high levels of international finance, such as in sub-Saharan Africa, improved policy efforts in IEA climate-driven scenarios are likely to result in improved investment capabilities and opportunities for local companies and financial institutions, as well as greater attraction of international private developers and banks towards clean energy. In markets where the role of international sources in energy investment is relatively muted, such as India, improving investment conditions for clean energy would likely have the effect of attracting higher levels of international capital.

Under the improved policy and investment environment of climate-driven scenarios, the role of international capital in clean energy transitions is likely to increase the most for renewable power, with greater participation by private developers, banks and institutional investors. It is also seen playing an important role in kick-starting investment for newer technologies, such as low-carbon hydrogen, where technology and equipment providers are concentrated in advanced economies and China, and joint ventures play a role in helping to develop complex first-of-a kind projects in new markets.

Most direct finance for efficiency projects is likely to come from domestic consumers and companies, in part due to the more local nature of purchases of efficient goods, such as automobiles and air conditioners. Cross-border investment is likely to occur among relatively few internationally oriented ESCOs, as well as direct investment by international developers (as in real estate and industrial facilities) and the secondary financing of companies and domestic intermediaries who carry out and fund projects. That said, foreign capital is likely to play an important role in the provision of technology and equipment that underpin these investments – for example, nearly all of the existing and under development battery manufacturing capacity for EVs is concentrated in advanced economies and China (see Chapter 3).

For electricity networks, nearly all investment is expected to be carried out domestically, but is also likely to benefit from participation by international technology providers, for example, in the development of smart grids and large-scale, cross-border transmission. While around 90% of project debt for large-scale natural gas infrastructure projects in EMDEs over the last decade has been raised internationally, there are questions over how this will evolve under IEA climate-driven scenarios, with 70% of the total coming from entities domiciled in countries that now have net-zero targets (see Chapter 4).

The role of cross-border sources of finance is also shaped by wider economic trends in investment promotion for FDI as well as international efforts by advanced economies and countries such as China to invest abroad. These dynamics are discussed more below.

2.3 Cross-cutting factors affecting investment and finance

Mobilising capital to support clean energy transitions depends on addressing cross-cutting factors that affect the risks and returns faced by companies and financiers as they make investment decisions. While some factors, such as the energy pricing, influence how investors allocate capital across different parts of the energy sector, others – such as the level of macroeconomic stability, private ownership and financial system development – affect the formation of capital more broadly. Conditions vary widely across EMDEs, but in general these types of issues pose a greater challenge than in advanced economies, where investment frameworks have evolved in a way to attract more private capital. In addition to persistent structural issues, the Covid-19 pandemic has exacerbated near-term fiscal and economic pressures in many EMDEs.

2.3.1 Cross-cutting investment framework issues

Cross-cutting policy and regulatory frameworks have a big impact on investment decisions, opportunities and risks in EMDEs. The overall investment climate for energy, as for other sectors, is determined by many factors, including the strength and predictability of prevailing policy and regulatory frameworks, the rule of law, and the operation of markets. While treatment of all these issues lies beyond this report's scope, we focus here on key areas that influence the finance available for clean energy transitions.

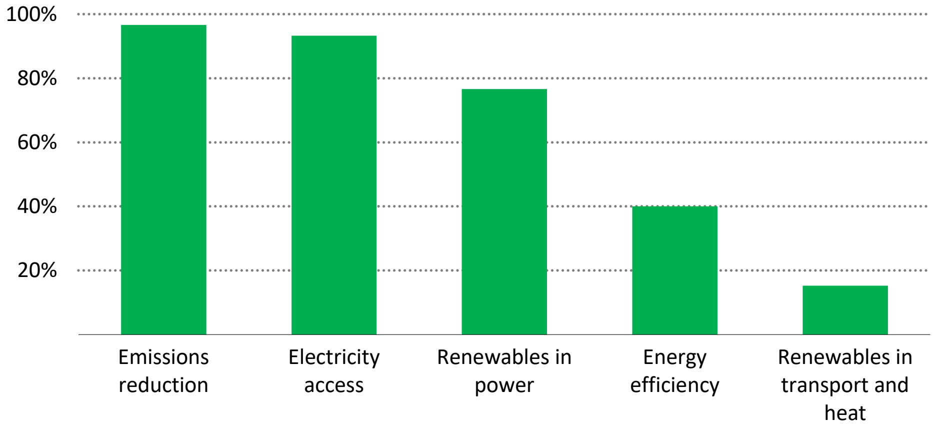
Energy strategies and energy systems planning

Clear energy goals, targets and strategies provide guidance of a government's long-term commitment to clean energy transitions and serve as critical signals to attract investment. In most EMDEs, nationally determined contributions (NDCs) and other emissions goals (notably relating to air quality) provide a foundation for emissions reductions. Globally, NDCs have been put forth by around 190 countries, although these vary considerably in scope and level of ambition. Overall, existing and announced government policies around the world, as reflected in the STEPS, do not provide a trajectory for emissions reductions or access to energy that achieves climate goals or the energy-related UN Sustainable Development Goals (SDGs).

While nearly all the EMDE focus countries[4] of this report have set targets for emissions reductions and energy access, these are not always backed up by clear policies and measure for their realisation. A few (Argentina, Chile, Colombia, Ethiopia, Kenya) have strengthened efforts as part of a 2020 NDC update. An increasing number of countries around the world have announced targets or goals to achieve net-zero emissions by 2050; among EMDEs, Chile, Costa Rica, Mexico, South Africa and Uruguay have signalled an intent or announced such intentions.

[4] Our focus countries are: Angola, Argentina, Bangladesh, Brazil Chile, Colombia, Costa Rica, Egypt, Ethiopia India, Indonesia, Iraq, Jordan, Kazakhstan, Kenya, Malaysia, Mexico, Morocco, Mozambique, Nigeria, Pakistan, Peru, the Philippines, Russia, Saudi Arabia, Senegal, Singapore, South Africa, Thailand, Uruguay and Viet Nam.

Figure 2.9 ▻ Share of EMDE focus countries with sustainable energy targets



Targets in most EMDE focus countries cover renewables in power, emissions and electricity access, although less so for renewables in end-use sectors and efficiency.

Note: Renewable targets correspond to those quantified and included in countries' respective NDCs.

These broad emissions goals are backed by varying degrees of sectoral ambition. Renewable power targets are much more common than those pertaining to harder-to-abate sectors in heat and transport. At a regional level, 85% of the countries in sub-Saharan Africa have set renewable power targets (quantified and included in their NDCs), 45% in Asia and nearly 70% in the Middle East and North Africa. Only 40% of EMDE focus counties have put in place targets to improve energy efficiency, and around 15% have renewable energy targets for heat and transport.

Strong leadership and buy-in for sustainable energy goals is crucial, but the capacity to implement these targets is equally important. This requires an integrated energy strategy that includes supply- and demand-side elements, accompanied by a clear and well-resourced plan on how it is to be put into action. Energy or environment ministries alone cannot deliver the policy actions required: effective energy transitions strategies require buy-in and cooperation from across government, integrated into policies on finance, labour, taxation, transport and industry. So a coherent approach to energy and environmental issues needs to be embedded in broader national frameworks (e.g. national development plans) as well as more detailed policy and planning documents (e.g. renewable energy action plans, transport strategies, infrastructure or electrification planning, building codes).

These efforts need to be accompanied by stakeholder engagement, at all stages, and a strong focus on enforcement and compliance as well as the possibility to review and refine the approach over time. Implementation efforts are most effectively designed and carried out when regulators are empowered to develop and enforce regulations free of political influence, and the designated authorities have the capacity and independence to undertake integrated energy planning, as well as to address other factors that affect clean energy transitions. A commitment to dialogue on the changes that are required during energy transitions, and a broad and inclusive view of the contributions that different parts of society can make, is also essential.

Box 2.2 ▹ Gender-lens investing and sustainable finance

Orienting financial systems and energy investments around sustainable development involves criteria that go beyond alignment with climate and emissions reductions goals. Gender-related impacts have historically been neglected, but achieving the goals associated with SDG 5 (gender equality) means that investors and decision makers increasingly look to consider the role of women in financing clean energy transitions. These roles include bringing in women during the investment decision-making process, as well as in project design, staffing and the potential impacts that clean energy investments can have on improving the livelihood of local female populations.

Gender-lens investing integrates impacts on women's equality and empowerment with financial criteria. It can focus on supporting women-owned or women-led companies, or investing in companies that promote gender equity in the workforce or in companies that offer products or services designed to improve the lives of women and girls (GIIN, 2021). Financing can come from private and public debt, innovative funds, or venture capital, in some cases with donor support and concessional financing.

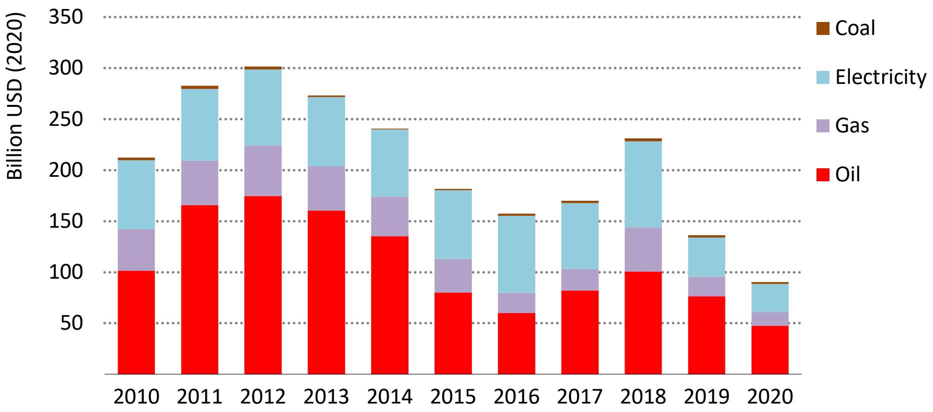
In Latin America, IDB Invest (the private arm of the Inter-American Development Bank) offered a performance-based financial instrument based on gender outcomes, with funds from the Canadian Climate Fund. If a project meets a pre-defined gender-related target, it could obtain a reduction in the interest rate on the loan of up to 25 basis points. For example, a loan provided to a firm in Uruguay, Tecnogroup, to build six solar PV plants, included targets that at least 15% of the workers had to be women, and at least 15% of the working hours in each plant had to be assigned to women, with two-thirds of the working hours related to construction (Oueda et al., 2018).

Gender-lens financing is likely to continue growing as investors increase demand for investments that meet social criteria and donors enhance financial support, especially with concessional financing. Still, achieving SDG 5 requires greater attention to fundamental factors, such as boosting the share of women choosing careers related to science, technology, engineering and mathematics; addressing gender biases and gender gaps; enhancing mentoring; and improving work-life balance.

Fossil fuel and electricity consumption subsidies

Price signals are crucial for investors, but it remains the case in a number of EMDEs that the playing field is tilted against sustainable investments by fossil fuel consumption subsidies (including subsidies to fossil fuel use for electricity). IEA tracking of the value of these subsidies shows a substantial decline since the mid-2010s. This is due in part to policy and pricing reforms – Egypt, India and Tunisia are good recent examples. However, the major reason has been lower fossil fuel prices, especially for oil, which reduce the gap between international market-based prices and the subsidised prices paid by some consumers. The protection afforded to consumers, especially from untargeted or poorly-targeted subsidy measures, comes at significant fiscal and environmental cost.

Figure 2.10 ▷ Energy consumption subsidies in EMDE focus countries



Energy consumption subsidies fell by more than 40% over the past five years, but remain sizeable at nearly USD 100 billion per year, reflecting the political challenge of reforms.

Note: Chart includes data on Angola, Argentina, Bangladesh, Colombia, Egypt, India, Indonesia, Iraq, Kazakhstan, Malaysia, Mexico, Nigeria, Pakistan, the Philippines, the Russian Federation (hereafter, "Russia"), Saudi Arabia, South Africa, Thailand and Viet Nam.

The plunge in fuel prices in 2020 provided another opportunity to phase out fossil fuel consumption subsidies, as lower prices meant that the required adjustment to end-user prices (and impact on inflation) was smaller. However, in practice, this was not a path pursued by many at a time when the overriding priority was to limit the damage to households and companies from the economic crisis, particularly with regards to the affordability of electricity (IEA, 2020).

Energy subsidy reform remains a tough political challenge. To be effective and durable, pricing reforms need to be combined with a broader suite of policy measures aiming at more robust, secure and sustainable energy sectors, as well as the protection of vulnerable groups in society[5]. But the prospects for building clean energy systems are inextricably linked with getting these price signals right, allowing prices to cover full costs.

[5] In early 2021, the IEA established the Global Commission on People-Centred Clean Energy Transitions to explore the social and economic impacts of energy transitions on individuals and communities, as well as issues of affordability and fairness.

Carbon pricing

Getting pricing signals right in energy transitions also requires ways of reflecting the negative externality generated by carbon-related emissions. Carbon pricing achieves this by taxing or setting a cap on the greenhouse gasses (GHGs) that can be emitted, for the whole economy or certain sectors. Analysis of mechanisms in advanced economies has shown that carbon pricing has overall improved productivity and innovation rather than having a detrimental effect on economic outcomes (World Bank, 2021). However, implementation remains relatively rare in EMDEs. In some countries – such as Indonesia, Senegal and Viet Nam – governments are considering carbon pricing for certain sectors, such as power or industry. South Africa is implementing a phased carbon tax for large emitters. Chile set a carbon tax in 2017 at USD 5/tonne of CO_2 for power plants of at least 50 megawatts, and is considering an emissions trading scheme.

Pricing carbon can open a new source of finance for EMDEs. The Kyoto Protocol, which allowed the sale of emission reductions in the form of carbon credits to advanced economies, ended in 2020. The Paris Agreement now provides a framework to trade Internationally Transferred Mitigation Outcomes (ITMOs), where a country which is achieving climate objectives faster than it pledged to in its NDC can transfer ITMOs to countries with slower progress. Countries with a broad spectrum of mitigation options available, will focus on implementing the lowest cost abatement measures at home to meet their climate pledges, and sell the more expensive emission reductions to international buyers, thereby financing part or all of their climate action. As this transfer should not lead to higher global emissions, the Paris Agreement provides for bookkeeping rules called corresponding adjustments, where the buyer country subtracts the purchased reductions from its emission levels and, conversely, the seller makes an addition to its GHG inventory (although the negotiations on rules for these carbon markets have yet to be concluded). Advanced economies will also be able to sell ITMOs, which could open up a wider market for trade, and potentially increase competition for emissions reductions generated in EMDEs.

Pricing carbon is necessary but may not be sufficient to address investment barriers in EMDEs. Long lead times and payback periods associated with clean energy investments require additional incentives and regulations. Implementing carbon pricing alone can raise energy bills for households, if clean and inexpensive alternatives are not readily available.

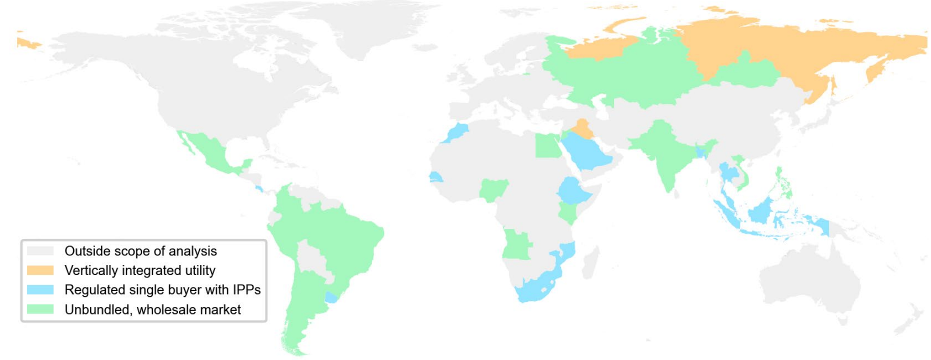
Finance from companies or countries with net-zero pledges, who aim to contribute to carbon reductions outside of their direct value chain by financing nature-based solutions or other mitigation activities, can also constitute a new funding source for EMDEs. Other initiatives implicitly putting a price on carbon, such as those in the European Taxonomy or the proposed carbon border adjustment mechanism, can also influence the availability of finance, through guiding international capital to markets and sectors with more robust clean energy transition efforts. Successful implementation requires political support and effective design, which also means including all important emitting assets and companies as part of pricing measures.

Market structures for energy investment

The market structure of energy systems determines who can invest in the sector as well as issues around ownership, market access and pricing. For example, in the electricity sector there are essentially three types of market structure, summarised below, with each framework having different implications for investment planning and opportunities. Moving from a vertically integrated utility to a more competitive system, with greater private participation and investment, involves reform to the role and influence of the incumbent utility, which is typically a politically challenging process:

- Vertically integrated utility: a single utility – generally state-owned in EMDEs – owns and operates generation, transmission and distribution assets, and sells power to all customers. Only a few of our focus countries, like Iraq, have this market structure.
- Regulated single buyer with IPPs: IPPs may own and operate generation, but they generally transact with a single utility on the basis of regulated pricing. This utility (generally state-owned) sells power to all the customers. Most countries in sub-Saharan Africa and Southeast Asia, such as Indonesia and South Africa, have this market structure, though some are also starting to transition towards more unbundling.
- Unbundled, or wholesale market with IPPs and retail competition: IPPs own and operate generation, with options to sell to the market or contract with utilities or other customers. Grid assets are separate from generation and retail. Markets or negotiation set prices, but some regulators maintain oversight of retail tariffs. Many countries in South America provide examples of this approach.

Figure 2.11 ▷ Market structure of selected EMDE power systems



While some countries have undertaken full or partial reforms towards unbundling the power sector, a number of EMDEs have market structures based on a single-buyer model with IPPs.

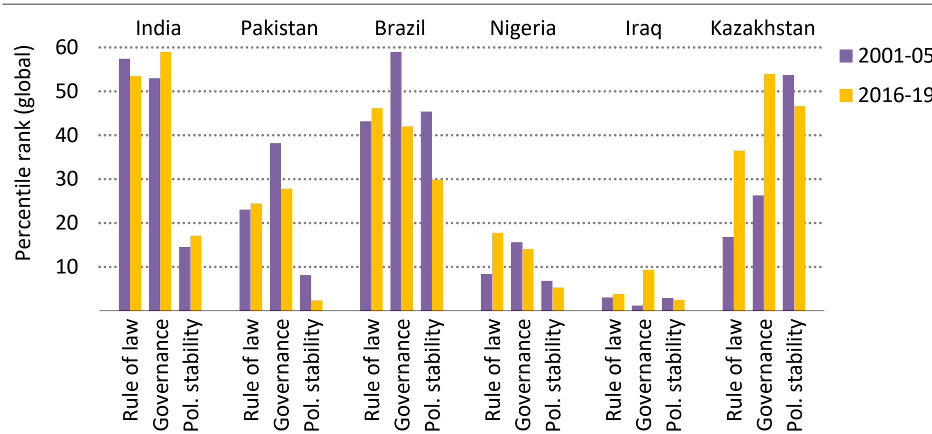
Notes: IPPs = independent power producers. The classification of country market structures takes into account ongoing reform efforts.

In fuel supply sectors, the market structure is often determined by the presence of one or more state-owned oil and gas companies, which often own the refineries and pipelines and control distribution infrastructure, as well as have preferable access to upstream developments. Many of these state-owned companies benefit from production subsidies and preferential access to national hydrocarbon resources.

Market structures that improve the participation of private actors and increase the role of competition and transparent price formation have tended to better support investment over time. By contrast, those that are purely vertically integrated are often influenced by political factors and inadequate governance that undermine efficient allocation of resources. There are exceptions to this picture, which depend on wider institutional factors. While unbundling reforms can better support investment, many EMDEs over the next decade would need to attract investment within existing market structures.

Rule of law, contract sanctity and other governance issues

Figure 2.12 ▷ Evolution of governance indicators for select EMDEs



EMDE focus countries generally rank in the lower half of worldwide governance indicators, though there is some variation across time and between countries.

Note: A higher percentile means the governance indicator is better ranked.

Sources: World Bank (2021) based on methodology by Kaufmann (2010).

Broader governance factors, including political stability, rule of law and the effectiveness of governing bodies, have a big impact on risk perceptions and investment protection. Low political stability can raise expropriation risks, while lack of rule of law in contract enforcement and property rights can also raise the spectre of financial losses in disputes. Government effectiveness (e.g. quality of public services and policy formulation) determines how well regulations are designed and implemented, as well as the administration of SOEs, which affects the case for both public and private investment. While countries such as Singapore, Chile, Uruguay, Colombia and Malaysia score highly on a range of governance indicators, our focus countries generally rank in the lower half of worldwide rankings, with varied progress over the past two decades.

Licensing and permitting

Processes for obtaining licences, permits, rights and other approvals to build, own or operate an energy asset are critical variables in investment planning. When not well designed or implemented, these can add economic burdens and uncertainties to project development, contributing to cost overruns and delays. These procedures can relate to a range of activities, including the titling of property, establishing interconnections, environmental impact assessments and land acquisition (see below) and can sometimes add months or years to project timelines. Streamlining permitting and licensing procedures, in a way that still addresses system requirements and broader public policy objectives, can reassure developers as well as reduce the costs and increase the speed of project development.

Programmes to streamline permitting and licensing depend on the country context, though general principles can help reduce transaction costs and ease the process. A World Bank study highlights seven principles of well-functioning licensing or permitting processes to authorise renewable energy projects, as well as an evaluation checklist. These principles include legal consistency, transparency, institutional capacity, a clear time frame, public consultation, monitoring and evaluation, and enforcement and recourse (World Bank, 2015). Several countries have also implemented programmes to centralise permits and approvals, such as in "one-stop shops" for energy project development.

Box 2.3 ▷ One-stop shops and financing early-stage project development

Early-stage energy project development involves contract negotiations, acquisition of land and permits and navigation of legal frameworks, all of which can raise barriers in EMDEs. Many projects – in all parts of the world – fall at this stage, some because they do not clear legitimate hurdles, but others because of complex or opaque procedures.

The creation of "one-stop shops" for services related to project development has helped accelerate investment and deployment of renewables in several markets. For example, the Infrastructure Development Company of Bangladesh played a critical role as a centralised agency leading a solar home systems (SHS) programme, which mobilised finance for over 4 million SHS (Cabraal, 2021). Morocco's success in attracting capital to renewable power was enabled by the creation of the Moroccan Agency for Sustainable Development – which acts as tendering agency, an intermediary offer-taker and a hub for most project-related inquiries. More broadly, the Tanger Med Zones in Morocco act as one-stop shops for investors looking to locate in the North African country, helping companies to obtain the permits, authorisations and licences required to start operations as fast and smoothly as possible. Economic zones and port authorities, such as SOHAR in Oman, are also facilitating clean energy planning around industrial hubs, supporting investments in efficiency and potentially low-emissions fuels.

Combining efforts with public funds and programmes for pre-feasibility and feasibility studies can help the gap between early development and construction phases. This includes legal advice, such as the African Development Bank's African Legal Support Facility, project preparation and development funds (such as InfraCo), and co-ordinating platforms. The World Bank's Sustainable Renewables Risk Mitigation Initiative (SRMI) packages multiple services and climate finance for development of renewables, helping to boost institutional capacity, reduce transaction costs, clarify permitting processes, introduce competition and scale, and mobilise private capital to complement limited public funding in sub-Saharan Africa and Asia Pacific. The Scaling Solar programme, launched by the World Bank Group and led by the IFC, has provided important insights and experiences for SRMI.

Land acquisition

Land acquisition for projects depends on various factors, such as local usage regulations and registration and ownership factors. In countries or cities where population density is high, as in many parts of Asia, land availability is a challenge. It may also be expensive, depending on its other uses. In India, utility-scale solar PV and wind projects with better access to land and timely grid connections are associated with lower risk perceptions by investors (IEA and CEEW, 2020).

Land-related risks can be particularly important for renewables, although this varies by technology. The land-use intensity (the area needed to produce a given amount of electricity) is generally higher for solar PV than hydropower, while wind power is generally lower than hydro. At the same time, the modular nature of solar PV means it can be installed in urban areas more easily than other renewables. Other considerations, such as presence of local population or endangered species, can also affect investment decisions, especially in the case of hydropower development.

Some governments have introduced programmes to address land constraints. The designation of Renewable Energy Zones can facilitate planning and the bundling of land and grid infrastructure with power plant development. The Solar Energy Corporation of India has been developing solar parks with state governments, and takes on the risk of acquiring and bundling land, with developers paying a user fee. Single-window clearances have also been set up in a few Indian states to expedite approvals. Still, land approvals remain slow, and development of solar parks lags government targets. In the United Arab Emirates, land acquisition has been addressed directly in PPAs, and very-low-cost solar projects in Dubai have benefited from land provided as part of the contract.

2.3.2 Common risks and barriers to mobilising capital

Table 2.1 ⊳ Common risks and barriers for investment in energy projects

Category	Risk/Barrier	Examples
Policy and regulations	Regulatory uncertainty	Unexpected, retroactive or frequent changes in law/regulation. Unclear laws/regulations.
	Contractual	Risk allocation between parties is not optimal or unclear. Enforcement of contracts, dispute resolution.
Local administrative capacity	Licensing and permitting	Delays, long lead times or unclear processes to obtain project licences and permits.
	Land acquisition	Availability and/or high land cost. Complications arising from issues around overlapping permits, fragmented ownership and unregistered land.
	Strict local content requirements	Very high local content requirements for project approvals, sometimes also combined with minimum shares of local ownership, especially in countries without a manufacturing capacity that could meet such requirements.
Revenue	Energy purchase	Delays in the payment for power,fuels or energy services by counterparty, which is often related to the overall financial performance of the counterparty.
	Volume	Curtailment, low demand, underperformance of technology, faulty operation and maintenance, meteorological variations.
	Measurement, reporting and verification	In energy efficiency, establishment of a reliable baseline and processes for measuring, reporting and verifying energy savings.
	Contract renegotiation	Renegotiation of energy purchase contracts due to price dispute or after observing lower prices elsewhere.
	Price	Exposure to variable wholesale market pricing with limited ability to manage price fluctuations with hedging instruments.
Enabling infrastructure	Evacuation infrastructure	Availability of local grid or pipeline connection and wider network is uncertain; no secondary market for connectivity rights.
	Grid flexibility	Insufficient ability to accommodate variability in supply and fluctuations of demand, as well as bilateral flows, which can lead to unreliable dispatch or affect provision of electricity services.
Technology	Technology maturity	Uncertainty over the performance of new technologies without a track record and wide demonstration at a global level. Lack of familiarity by technicians or providers of finance with a new technology.
	Performance	Output or performance at less than rated specifications; unforeseen maintenance or outages.
Market	Interest rate	Unexpected changes in the (variable) interest rate of a loan.
	Currency	Unexpected inflation, exchange rate fluctuations; underdeveloped local capital markets; currency convertibility restrictions and restrictions to repatriate capital.
Financing	Availability of appropriate finance	Limited availability of long-term, fixed-rate finance. High cost of financing; limited capacity of local banks to conduct due diligence and value projects.

Energy projects can face a number of common risks and barriers, shaped by the cross-cutting factors described above, as well as those relating to energy policies and market developments. Table 2.1 provides a framework for standardising language around risks and barriers, which are elaborated upon in the sectoral discussions in Chapters 3 and 4.

2.3.3 The energy industry landscape

The investment outlook also depends on the type of companies developing projects and the way they manage risks and capital budgets. Within EMDEs, the industry landscape is marked by two major trends in rapid energy transitions – a larger role for private companies and the increasing orientation of corporate strategies for all types of actors around meeting sustainability goals.

Role of private companies and SOEs

Over the past five years, SOEs have accounted for over 40% of energy investment in EMDEs. They also feature prominently among the top-listed EMDE companies in energy-related sectors by revenues. SOEs tend to be more prevalent in energy supply sectors, especially in markets where electricity and fuel transport networks remain bundled with production activities. In end-use sectors, state ownership is lower, but SOEs play important roles in strategic heavy industry sectors (e.g. steel and chemicals) in some countries.

Table 2.2 ▷ Top ten listed EMDE energy companies, by revenues

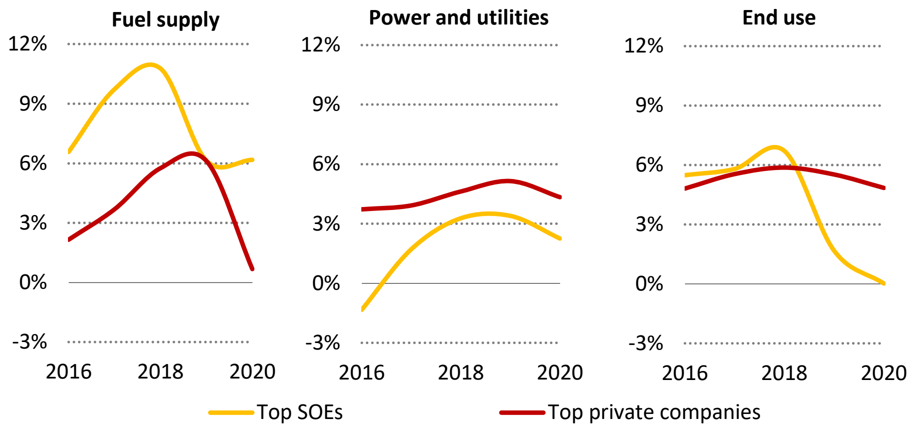
Fuel supply	Power and utilities	End use
Saudi Aramco (SOE) - *Saudi Arabia*	Saudi Electricity Company (SOE) - *Saudi Arabia*	Tata Motors - *India*
Rosneft - *Russia*	NTPC (SOE) - *India*	Vale - *Brazil*
Gazprom (SOE) - *Russia*	PAO Rosseti (SOE) - *Russia*	Manufacture de Panneaux Bois du Sud - *Tunisia*
Reliance Industries - *India*	Enel Americas - *Chile*	Sabic (SOE) - *Saudi Arabia*
Lukoil - *Russia*	Tenaga Nasional - *Malaysia*	Tata Steel - *India*
Indian Oil Corporation (SOE) - *India*	Eletrobras (SOE) - *Brazil*	Hindalco Industries - *India*
Oil and Natural Gas Corporation (SOE) - *India*	CPFL Energia - *Brazil*	Alfa Group - *Mexico*
Petrobras - *Brazil*	Abu Dhabi National Energy Company (SOE) - *United Arab Emirates*	Norilsk Nickel - *Russia*
PTT Public Company (SOE) - *Thailand*	Neoenergia - *Brazil*	Siam Cement - *Thailand*
Bharat Petrol (SOE) - *India*	Manila Electric Company - *Philippines*	Cemex - *Mexico*

Note: End use = automotive, chemicals, construction materials, diversified, home construction, metals and mining, pulp and paper, real estate, and steel.

In IEA climate-driven scenarios, private companies play an increasingly important role in the ownership of energy investment, especially in clean energy sectors, where they account for over 70% of investment by 2030. While the role of SOEs declines, these actors remain systemically important for investment in network infrastructure, as the primary investors in fuel supply, and as potential vehicles for recovery programmes and in demonstrating new technologies. The financial performance of all types of actors shapes their ability to make investments and serve as creditworthy counterparties. Our analysis of recent profitability trends (return on assets) across different sectors shows some wide variations across different types of company active in fuel supply, power and utilities.

Following several years of improvement, investment challenges in EMDEs are particularly visible for the largest SOEs in power, utilities and end use, which have experienced large profitability declines and rising debt burdens, making them more vulnerable to economic shocks. For utilities, a key question is whether underlying regulatory frameworks support cost recovery (see Chapter 3). At a time when higher levels of investment are required to put the energy system on a more sustainable pathway, companies may also face a potential need to focus on deleveraging. For their part, the profitability of fuel supply companies has trended downwards over the past five years. However, in contrast to power and end-use sectors, where private companies have offered higher returns on assets, during the crisis the financial performance of the largest SOEs in fuel supply was relatively resilient.

Figure 2.13 ▹ Return on assets for top listed energy-related companies



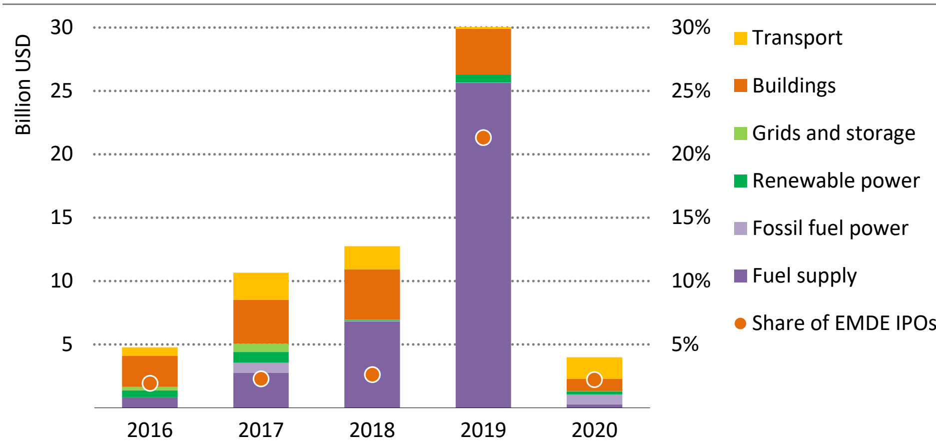
In 2020, SOEs in power, utilities and end use experienced weaker profitability compared with private actors, while those in fuel supply were more resilient.

Notes: Listed companies with over USD 1 billion annual revenues; end use = automotive, chemicals, construction materials, diversified, home construction, metals and mining, pulp and paper, real estate, steel .

Sources: Calculations based on Bloomberg (2021).

The evolution of the industrial landscape within EMDEs also depends on the role of new companies and entrants into the energy sector. Initial public offerings (IPOs) by newly listed firms is one measure of this, although this route to fundraising at scale from the capital markets has also been followed by existing SOEs in recent years. Since 2015, new equity market listings in EMDEs across all sectors have totalled over USD 1 trillion, with significant year-on-year variations. Companies in energy supply and in key end-use sectors have typically accounted for less than 5% of all EMDE IPOs on an annual basis. This share shot up to over 20% with the Saudi Aramco IPO in 2019, which alone accounted for over a quarter of the energy-related transactions. New company fundraising also stalled during the pandemic. Outside of fuel supply, most new listings have been among developers and manufacturers serving the buildings and transport sectors.

Figure 2.14 ▹ Initial public offerings of energy-related companies in EMDEs



Outside of one large transaction in 2019, energy-related sectors have accounted for less than 5% of newly listed companies in EMDEs over the past five years.

Notes: End-use = automotive, chemicals, construction materials, diversified, home construction, metals and mining, pulp and paper, real estate and steel.

Sources: Calculations based on Bloomberg (2021).

More critical funding gaps are faced by SMEs, which account for 45% of employment and one-third of GDP in EMDEs (World Bank, 2021). Such companies are often in the services sector, and play a big influence in the economy, as in India, where the vast majority of value-added growth in GDP has come from low-energy-intensity sectors. SMEs overwhelmingly depend on bank loans and informal credit, and lack access to capital markets. Some solutions, such as microfinance, and funds like the African Enterprise Challenge Fund, are helping to channel risk capital to entrepreneurs, in addition to focus by impact investors and technology solutions, such as peer-to-peer lending.

Evolution of corporate sustainability strategies

Strategic shifts by energy companies are critical to meet sustainability goals and ultimately net-zero ambitions. In EMDEs, the most ambitious targets on emissions reduction announced so far have largely been from companies located in Latin America and Asia.

Table 2.3 ▹ Top listed EMDE companies, by sector and emissions target

Company	Country	Sector	Emissions scope	Intensity reduction (%)	Absolute reduction (%)	RE target
Petronas	Malaysia	fuel	1, 2	100% (2050)	100% (2050)	yes
Petrobras	Brazil	fuel	1, 2	32% (2025) in E&P	25% (2030)	-
PTT	Thailand	fuel	1, 2	-	27% (2030)	yes
Ultrapar	Brazil	fuel	1, 2	5% (2023)	6% (2025)	-
India Oil Corp	India	fuel	1, 2	18% (2020)	-	yes
Colbun	Chile	power	1	50% (2030)	-	yes
Cemig-Pref	Brazil	power	1, 2	-	14% (2022)	-
Energias Do Brasil	Brazil	power	1, 2, 3	85% (2032)	-	yes
Tata Power	India	power	1, 2, 3	100% (2050)	100% (2050)	yes
First Gen	Philippines	power	2	-	5% (2022)	-
Tata Steel	India	end use	1, 2	33% (2025)	-	-
City Developments Limited	Singapore	end use	1, 2	100% (2030)	100% (2030)	yes
PTT Global Chem	Thailand	end use	1, 2	52% (2050)	20% (2030)	yes
Braskem	Brazil	end use	1, 2	100% (2050)	100% (2050)	-
JK tyre & Ind LT	India	end use	1, 2	30% (2020)	-	yes

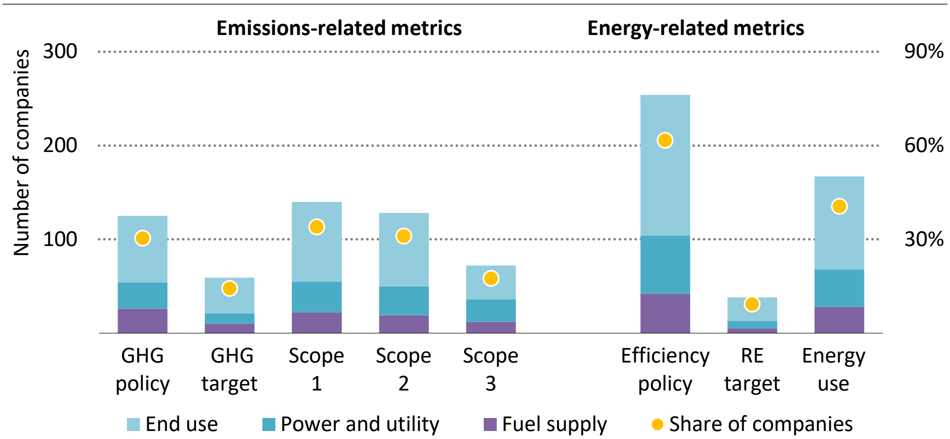
Notes: Companies with the highest CO_2 intensity/absolute reduction targets among listed companies with annual revenues of at least USD 1 billion. End use = automotive, chemicals, construction materials, diversified, home construction, metals and mining, pulp and paper, real estate, and steel.

Source: Bloomberg (2021), the companies' response to the CDP climate change information request (2020) and from the companies' websites.

These pledges typically cover scope 1 emissions, from operations, and scope 2, those arising from the purchased energy by companies. Some of the targets aim at emissions reductions well above 50% with few major EMDE energy players that have announced so far a net-zero emissions objective. Among the top listed companies in terms of emissions reduction goals, higher levels of ambition have been announced by fuel supply and end-use companies, compared with utilities. Only around half of the latter have set renewables targets.

There is a growing need for companies and investors to identify, disclose and evaluate financial risks posed by the energy transition. So far the quality and comparability of the disclosed data remain incomplete, with well below 50% of all major EMDE companies (those with revenues above USD 1 billion) disclosing energy- and emissions-related metrics. Such disclosures have been much more prevalent among companies in end-use sectors and focus mostly on direct emissions (scope 1) by companies and emissions associated with purchased energy (scope 2). Only around one-fifth of companies has started to disclose scope 3 emissions, which are associated with the use of a company's products and services.

Figure 2.15 ▷ Number of EMDE companies reporting sustainability metrics



There is a growing need to identify the financial risks posed by the energy transition, but well below 50% of major EMDE companies report energy and emissions metrics.

Notes: Includes listed companies with annual revenues of at least USD 1 billion (> 400). End use = automotive, chemicals, construction materials, diversified, home construction, metals and mining, pulp and paper, real estate, and steel. The information of the targets are directly from the company's response to the CDP climate change information request. Scope 1 emissions come directly from company operations; scope 2 emissions arise from the generation of energy that is purchased by companies; scope 3 emissions occur during the use of a company's products and services. RE = renewable energy consumption target.

Source: Adapted from Bloomberg (2021)

Over half of companies report the establishment of a target for energy efficiency, but only around 10% of them have established one for renewables consumption. Only around one-third have set a policy for GHG emissions, while less than 40% of companies report any type of emissions. Further efforts by financiers to include requirements for companies to develop decarbonisation plans as well as improved disclosure around sustainable finance frameworks are likely to prompt more widespread adoption of these kinds of initiatives.

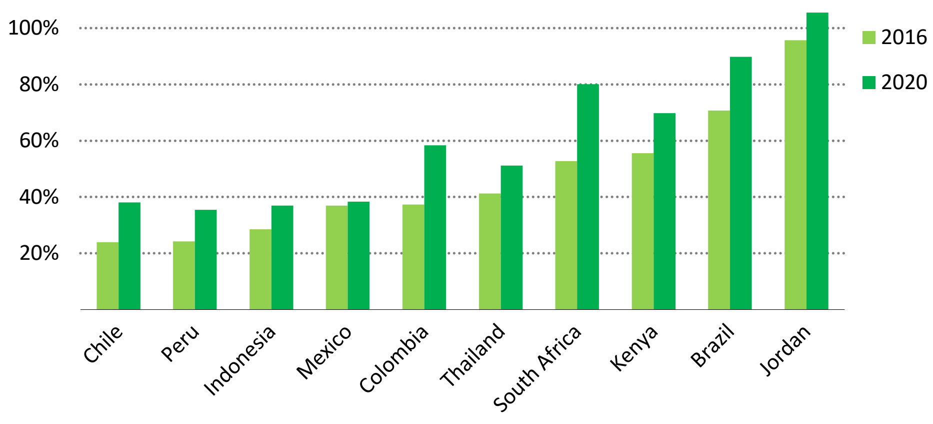
2.3.4 The economic and financial landscape

Today's clean energy investment opportunity comes at a time of economic uncertainty and new financial risks. While supportive clean energy policies play a key role in creating bankable projects, broad macroeconomic conditions, evolution in the economy-wide cost of capital, domestic financial system development, and the availability and flows of international capital provide the foundations for adequate supply of finance.

Macro-financial conditions in the wake of the pandemic

Over the past year, EMDEs have seen deterioration of government balance sheets and increasing financial pressures, even as conditions have eased somewhat from the height of the economic crisis. Coming into 2020, global debt levels were on the rise. While government debt burdens remain higher in advanced economies, jumping to over 120% in 2020, these markets enjoy better access, and lower cost, of debt finance to fund recoveries. In response to the pandemic, advanced economies have marshalled significantly more fiscal and credit support than EMDEs (Box 2.4).

Figure 2.16 ▷ Government debt-to-GDP ratios for select EMDEs



Government debt burdens have risen across many EMDEs; some highly indebted countries now face more difficult borrowing conditions, constraining responses to the pandemic.

Notes: Debt positions in 2020 represent the latest month of available data.

Sources: Calculations based on TheGlobalEconomy.com (2021).

The debt situation varies among EMDEs. Emerging market economies (i.e. middle and upper-middle income) have tended to experience rising levels of public debt, while the positions of developing economies (i.e. low income) have been driven more by rising private debt. The thresholds of debt sustainability are typically lower for EMDEs than advanced economies, due to higher interest rates, and some highly indebted EMDEs are starting to experience more difficult borrowing conditions, eroding their ability to respond to the pandemic. High and rising private debt may also cause economic headwinds and increase vulnerability of economies to large-scale bankruptcies (Han, 2021).

Debt management has become increasingly important for EMDEs, raising the issue of how governments will balance the policy support required to achieve sustainable development goals against fiscal credibility. Among the set of EMDE focus countries in this report, only around half have investment-grade credit ratings, and over one-third of these have negative outlooks from ratings agencies. While countries with stronger credit quality, such as those in Asia, can better navigate these conditions, external funding risks remain high among many EMDEs, especially among the least-developed countries. The G20 Debt Service Suspension Initiative is providing some temporary relief. At the same time, the World Bank and the International Monetary Fund (IMF) are also exploring a platform to potentially link debt relief, and advice, with EMDE plans for aligning investments with climate-driven pathways.

Box 2.4 ▻ A sustainable recovery?

The Covid-19 pandemic hit EMDEs very differently, but the induced economic crisis has generally translated into mounting public and private debt levels, diminishing remittances and domestic investments, and important capital outflows. Commodity exporters were especially hard hit in 2020.

Policy reaction accordingly varies across countries. Overall, recovery spending in EMDEs is relatively low, at only 2-4% of GDP, while advanced economy support is around 16% (IMF, 2021). Between January 2020 and April 2021, emerging economies within the G20, which have greater public spending capacity, have on average spent around USD 200 billion, almost seven times less than G20 advanced economies. Their spending measures also have shorter time horizons, with few beyond 2021, while part of advanced economy plans go beyond 2022. This difference in size and perspective is partly due to restricted fiscal leeway, and partly to wariness of replicating post-2008 crisis asset inflation induced by large public stimulus spending, as in India and China (Wong, 2021).

Compared with previous crises, many EMDEs have so far relied more heavily on monetary policy. Faced with the perspective of downgraded sovereign credit ratings, currency depreciation risks and increased borrowing costs (as in South Africa), many EMDE governments concentrated on asset purchase plans. Due to the difficulties experienced in 2008 with these plans, few of these countries have issued “recovery plans” as such, with the exception of Colombia, India and South Africa. In some cases, notably Middle East producer economies, where fiscal measures in 2020 were short-lived, the orientation has focused on maintaining spending on priority projects.

Most EMDE governments are still focusing on emergency relief for vulnerable households and priority sectors. The energy sector has not featured prominently among recovery measures so far, apart from initial emergency provisions deferring, subsidising or cancelling energy bills for vulnerable consumers channelled through utilities and other energy SOEs, and general liquidity support for energy companies. However, recovery-oriented infrastructure spending has been announced on a few occasions, notably in South Africa, where it is set to encompass upstream oil and gas, electricity and public transport sectors, and in Malaysia, Mexico and Thailand. In addition, strategic near-term industrial and labour issues have motivated support in Russia (for gas infrastructure) and India (coal mining, coal and gas infrastructure).

Sustainable recovery measures have favoured energy efficiency in a few EMDEs (Chile and Mexico), as they combine recovery-compatible benefits, including cost-effective, shovel-ready and labour-intensive projects. The inclusion of new renewable power, electricity network and mini-grid investments (as in Argentina, Chile, Colombia, India and Mexico), or energy efficiency and fuel switching (as in Chile's *Recambia to calor* [Change your heat] programme) are less common in EMDEs than in advanced economies. A few countries (Chile, Colombia, India and Russia) are looking to support green hydrogen development. Measures to develop sustainable finance are also present in Mexico's plans, and in South Africa's, where the government seeks to use green finance to support "a just transition". Colombia has announced a "ten milestones in 2021" platform, which aims at accelerating clean energy transitions through renewable energy, electric mobility and enhancing energy access.

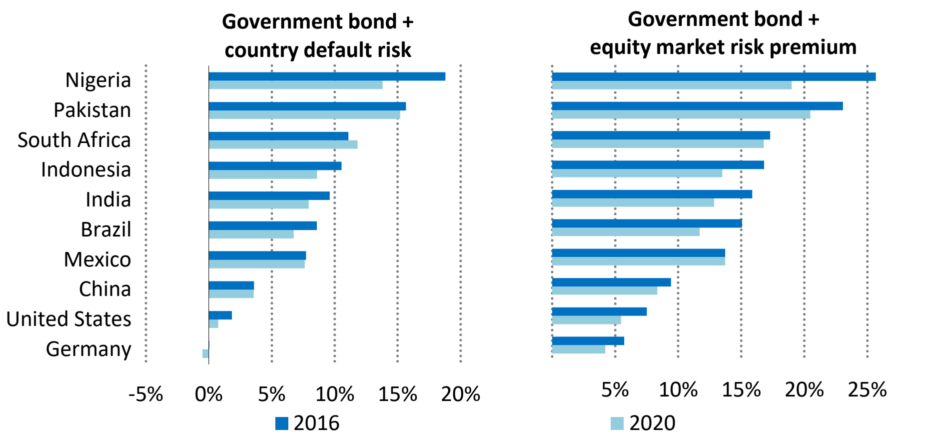
There is evidence that building back better by supporting clean energy transitions brings robust long-term economic benefits. Recent research suggests the GDP impact of clean energy investment plans may be higher than for fossil fuel spending programmes (Batini et al., 2021). This is due to generally higher labour intensity for clean energy projects, and more intense local economic effects. Such findings echo the message from the IEA Sustainable Recovery Plan for the energy sector, which found that spending of USD 1 trillion over three years would increase global GDP by 3.5%, and that for EMDEs by close to 4%. So far, countries are spending only around USD 400 billion in public money in line with the recommendations of the Sustainable Recovery Plan, with EMDE commitments four times less than in advanced economies.

Previous experience suggests that delays in rolling out recovery measures and focusing solely on short-term emergency response can undermine longer-term transitions. For example, the West Africa Ebola outbreak over 2014-16 caused delays to energy projects as well as domestic policy reforms. While prioritisation of near-term needs was important to address the crisis, international aid efforts lacked longer-term focus and energy-related development assistance declined abruptly following the health crisis, with adverse impacts on progress for energy access in rural areas (SE4ALL and CPI, 2020).

The economy-wide cost of capital

Over the past five years, government benchmark bond yields have fallen across a number of EMDE and advanced economies, a trend which continued in the second half 2020 following an uptick in bond yields during the height of the crisis. In general, this trend has broadly pushed down economy-wide debt financing costs. Lower bond yields have also supported lower borrowing rates for parts of the energy system, such as renewable power, in countries with supportive policy frameworks (see Chapter 3). Lower rates have been partly offset by rising country default risks in most EMDEs in 2020, and the impact varies by region, with countries in sub-Saharan Africa facing greater challenges than EMDEs in Asia. Moreover, in early 2021, bond yields in global benchmark economies, such as the United States, crept upwards in response to inflation pressures. On the equity side, apart from increased volatility during the height of the crisis, market risk premiums for most countries have fallen as well in 2020.

Figure 2.17 ▻ Indicators of economy-wide cost of capital for debt (left) and equity (right)



While lower government bond yields have pushed down financing costs in many countries, EMDEs face costs of capital 700-1500 basis points higher than in advanced economies.

Note: Nominal government ten-year bond yield plus country default spread, based on sovereign rating and equity market risk premium.

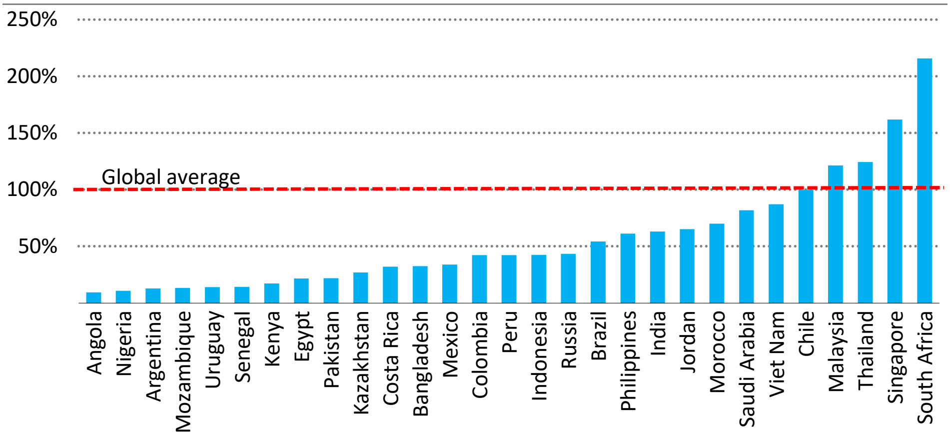
These broad macroeconomic indicators point to a potential opportunity for financing investments at lower cost of capital compared with five years ago, but much depends on the ability of financiers and developers to source such capital, as well as company- and project-specific factors that shape the cost of finance. In EMDEs, the economy-wide cost of capital remains much higher than in advanced economies, due to country risk factors and the level of domestic financial system development. Economy-wide nominal financing costs in EMDEs generally range some 700 to 1 500 basis points higher, on a nominal basis, compared with average values for the United States and Europe, with higher levels in risky markets and segments. This suggests a relatively high bar for energy investments in accessing debt finance and meeting equity return hurdle rates.

Financial system development and the availability of domestic capital

The ability of EMDEs to fund clean energy transitions with low-cost domestic sources of capital strongly depends on the underlying level of financial system development. Deep availability of debt and equity from private institutions, liquid capital markets, and access to diverse financial sources are hallmarks of a supportive enabling environment.

There are a number of ways to assess the depth, efficiency and accessibility of financial institutions and markets. This report assesses financial sector development by creating a composite of two widely available indicators of financial depth in debt and equity capital – the share of private bank credit to GDP and the share of stock market capitalisation to GDP.

Figure 2.18 ▷ Financial system development indicator for select EMDEs, as share of GDP



While financial conditions vary, over 90% of EMDE energy investment is in geographies with underdeveloped banking sectors and capital markets, relative to the global average.

Notes: Financial system development indicator shows the average of share of private credit to GDP and share of stock market capitalisation to GDP over the most recent five years; the global average is weighted by GDP.

Source: Calculations based on World Bank (2021).

Among EMDEs the level of financial system development varies starkly. In some middle-income countries, such as Chile, Malaysia and Thailand, this indicator points to better access to finance than the global average. That said, there can be big differences in the robustness of local banking systems compared with that for equity markets. In South Africa, for example, stock market capitalisation far exceeds the level of private credit to GDP. Other economies in Asia, Latin America and the Middle East fall into the middle third of financial sector development among EMDEs, while countries in sub-Saharan Africa usually face the most challenging availability of domestic capital.

Investment gaps are largest in areas currently with mid- to lower levels of financial sector development, with many of these examples concentrated in Africa and South Asia. In IEA climate-driven scenarios, over 90% of EMDE energy investment is projected in such regions, meaning that the need to boost investment in clean energy transitions is concentrated in the countries and regions with the least-developed financial systems.

Broad indicators provide only part of the story, and EMDEs face more granular challenges in raising finance for both large-scale and small-scale clean energy projects. While there is no shortage of equity, investors typically require higher returns compared with advanced economies. Access to debt, which increasingly funds energy investment under IEA climate-driven scenarios, is more constrained. Local banking sectors often lack the capacity and expertise to evaluate clean energy projects, which have less of a track record compared with other types of assets. Public finance institutions and strategic funds, especially those oriented around infrastructure investments, would need to play an important role in co-financing and managing risks.

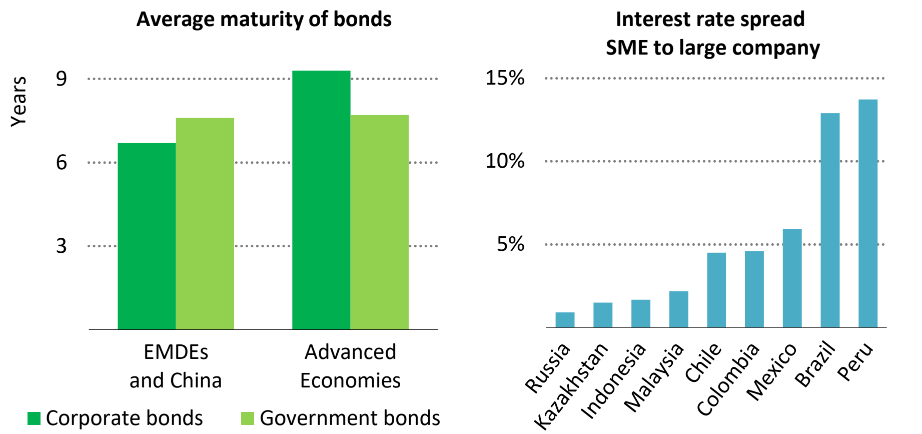
Though the picture can evolve depending on prevailing market conditions, the loans that local commercial banks make available may not provide the terms and tenures that match well with those required for long-term infrastructure. For example, the average duration of a loan in Southeast Asia is just over six years, while 60% of loans in West Africa are short term, making it difficult to finance assets that have longer operating lifetimes. While in some markets, such as India, long-tenure debt is available for renewable power projects with power purchase contracts, financial rules limit bank exposure. In India, renewables compete for the same pool of bank capital as coal power, and an increase in stressed thermal power assets has put pressure on bank lending.

Debt in EMDEs is even more constrained for consumers, and formal credit markets are available for only a fraction of SMEs. The smaller size of transactions and lack of credit ratings makes lending to small-scale borrowers more challenging. The cost of finance for SMEs can far exceed that for larger companies – in Brazil and Peru the interest rate spread tops 12%, while in a number of EMDEs, small-scale finance involves a premium that is higher than that in advanced economies (around 1.2%). New financing innovations, particularly service models and digital payments, can help address such constraints, especially in energy efficiency and electrification (see Chapter 3).

In many EMDEs, corporate fundraising faces challenges due to underdeveloped bond markets. While EMDE governments, on average, are able to issue government bonds with similar duration to those from advanced economies, companies typically issue bonds with maturities that are 30% shorter in than in advanced economies. Among EMDEs, Brazil, Malaysia, South Africa and Thailand tend to have the most developed corporate bond markets, with Argentina, Colombia, Nigeria and Pakistan among the least developed.

These issues contribute to the undersized role that new instruments play in EMDE clean energy transitions. Sustainable debt issuance has surged globally, but EMDEs have accounted for just over 10% of these flows in the past five years, mostly in Southeast Asia, Latin America and India (see below). While securitisation – which aggregates loans, receivables or projects and issues them as listed securities to refinance at lower cost of capital – has accelerated in some advanced economies with green asset and mortgage-backed securities, this practice has yet to take off in EMDEs.

Figure 2.19 ▷ Average bond maturity (left) and SME interest rate spreads (right)



EMDE companies and projects generally have reduced access to longer-term debt, while SMEs, in particular, can face relatively high financing costs in some markets.

Sources: Calculations based on Chen et. al (2018) and OECD (2020b).

International availability of capital

The uneven availability of capital raises tricky allocation questions over meeting the additional investment requirements of climate-driven scenarios. Estimates provided by the World Bank for this report highlight that, coming into the pandemic, a number of regions were net suppliers of capital to global markets. Among these countries domestic savings exceeded domestic investments, including those for energy. However, such surpluses have developed unevenly across countries.[6]

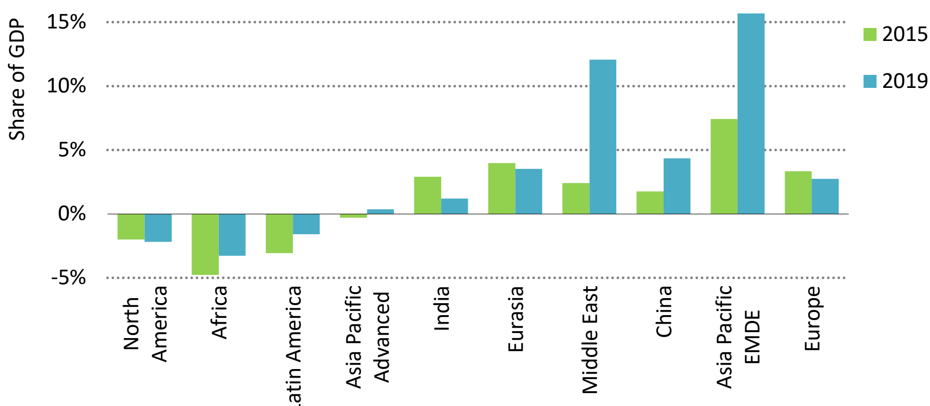
Net savings currently tends to be largest in Asia (including China and advanced and emerging economies), Europe, the Middle East and Eurasia. By contrast, economies in Africa and

[6] The question of the economic and financial adequacy of capital account deficits is outside the scope of the present report.

Latin America, lower-income countries in Asia, and North America must import savings to meet their current investment needs. While impacts from the pandemic remain too early to judge, preliminary indications point to slightly narrowing but persisting imbalances (IMF, 2020).

Savings and investment patterns are determined by underlying policy and institutional environments; the size, maturity and level of integration in financial markets; and domestic socio-demographic trends. Persistent capital deficits in some EMDEs reflect low levels of domestic savings, a lack of identified investment opportunities and limited capacity of domestic financial markets to attract and absorb foreign capital efficiently (Bernanke, 2005). Capital surpluses can reflect precautionary savings by households and foreign exchange reserves accumulated as buffers against potential capital outflows and currency devaluation, a risk among some EMDEs facing persistent macroeconomic management challenges (in Asia and the Middle East). Commodity exporter surpluses additionally mirror revenue accumulation.

Figure 2.20 ▹ Available domestic savings by region (share to GDP)



Some EMDE regions have sufficient domestic savings to support domestic investments, but clean energy transitions will require even more capital to flow to deficit areas.

Note: Surpluses and deficits reflect the annual differences between domestic savings and investment, including those in the energy sector.

Source: Data based on modelling from World Bank Macroeconomics and Fiscal Management Global Practice.

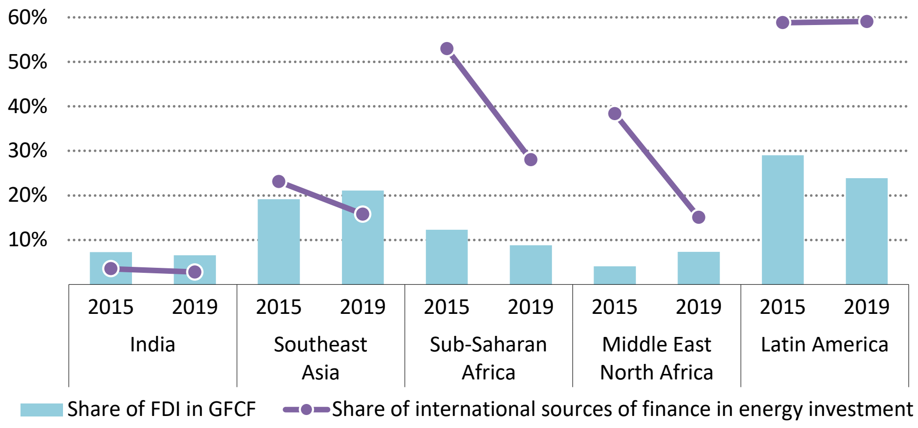
There is the potential for the landscape of global capital to evolve under a climate-driven energy scenario. The future picture would likely reflect the accumulated economic benefits, especially in today's underserved regions, from higher levels of sustainable development, which would tend to support domestic capital accumulation. Pressures on traditional parts of the energy system are also likely to reduce the surpluses available to producer economies.

Overall, a broad-based shift towards clean energy transitions requires structural policies supporting domestic financial market developments and regulation, as well as policy and price signals that foster the buildout of a corresponding pipeline of projects, thus incentivising the attraction of international capital within deficit countries. As described above, such capital would need to become available in a way that meets the needs of corporations, consumers and governments investing in energy assets, with the appropriate type of finance available at the right time, place and stage of project development.

Attracting long-term international investment and managing currency risks

The pandemic has sapped global flows of FDI, which dropped by almost 50% in the first half of 2020 (UNCTAD, 2020). The largest retrenchment is in EMDEs, particularly in extractive industries and complex global value chains. Coming into the crisis, some EMDEs, especially in Southeast Asia, had seen improvements in foreign investment, as reflected by a rising share of FDI in gross fixed capital formation (GFCF). But many continue to have restrictions related to foreign participation and ownership. Steps towards market liberalisation were under way in 40 countries, mostly in Asia, but the current environment threatens to slow progress in reforms to improve foreign investment. In some areas, such as India, Latin America and sub-Saharan Africa, the role of FDI remains low or has declined.

Figure 2.21 ▷ Role of FDI in GFCF and international sources of finance in energy investment for select EMDE regions



Foreign sources of energy investment have declined faster than economy-wide FDI and remain relatively low in Asian EMDEs; frameworks in Latin America support higher levels.

Note: Regional values are based on the sum of individual countries.

Sources: Calculations for FDI in GFCF based on UNCTAD (2021) and World Bank (2021).

The role of foreign sources in energy investment (including debt and equity) has declined faster than economy-wide FDI. This is evident in producer economies in sub-Saharan Africa and the Middle East after the fall-off in oil prices from the middle of the decade, as well as in Southeast Asia. International sources in energy remains below that of FDI in Asian EMDEs, while in Latin America, where clean energy policy frameworks and regulations supporting foreign participation are more developed, energy is underpinned by international investment far more than other regions.

International factors also shape long-term energy investment into EMDEs. As noted above, climate finance provided by advanced economies for developing economies grew to nearly USD 80 billion in 2018. Outbound investment from China totalled more than USD 2 trillion since 2013, with 40% in energy. Such investments varied by provider, with lending by policy banks (China Development, Export-Import) going more to coal power plants, especially in Southeast Asia, whereas FDI from Chinese SOEs has gone more towards renewables, especially hydropower. In 2020, renewables, at nearly 60%, topped China's outbound energy investment for the first time (IIGF, 2021). .

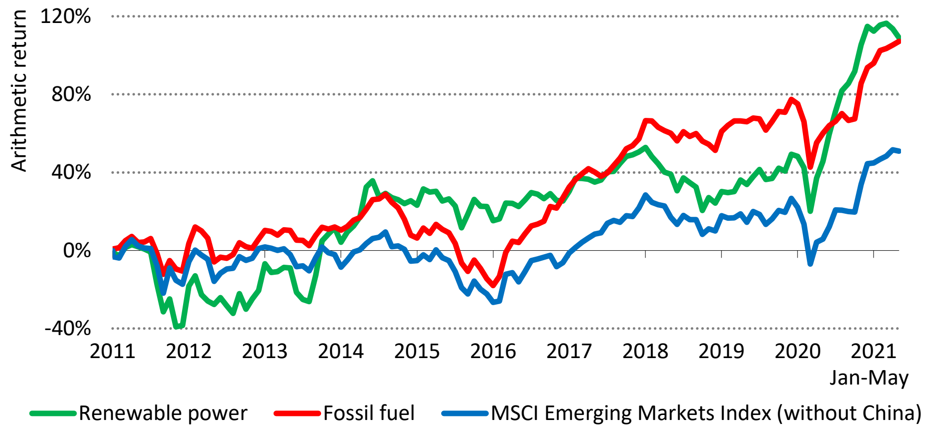
Risk perceptions over exchange rate volatility remain an impediment to attracting foreign capital. Currency markets are underdeveloped in a number of EMDEs, and foreign exchange movements can create mismatches between obligations priced in dollars and revenues denominated in local currency, as with PPAs in some markets (see Chapter 3). Global efforts are aiming to better support local currency finance. For example, DFI guarantee programmes, such as GuarantCo, provide local currency credit solutions for infrastructure projects and support the development of capital markets in EMDEs. At the same time, specialised hedging entities, such as The Currency Exchange Fund, provide financial instruments – swaps and forward contracts – that enable investors to provide local currency financing. Still, such programmes require greater scale in terms of resources and coverage.

Role of institutional investors

Globally, institutional investors – including asset managers, infrastructure funds, insurance companies, pension funds, private equity and sovereign wealth funds – directly finance a small share of energy projects, with relatively less participation in clean energy sectors. In EMDEs, institutional investors have funded less than 1% of energy investments on average, via direct project financing on a primary basis, over the last five years. They have been much more active in secondary transactions – project acquisitions and refinancing of energy assets – accounting for nearly a quarter of this market. In recent years, over 80% of acquisitions and refinancing by investors has come in geographies with relatively liquid and deep capital markets (i.e. North America and Europe); an increasing share has gone to assets with reliable cash flows, especially renewable power and networks.

Market signals point to a strengthened appetite over time for investing in clean energy companies. From 2014 onwards, the returns associated with listed EMDEs renewable power companies have trended above the MSCI Emerging Markets ex-China Index, a benchmark for overall equity market performance in these regions. This performance reflects the improving risk-return profile for renewable power in these markets supported by falling technology costs for renewables and an improved investment environment (e.g. especially in India and Brazil). That said, returns have been comparable overall to those for fossil fuels companies and have trailed that of advanced economies, reflecting slower progress in improving investment conditions in some markets (e.g. in Southeast Asia).

Figure 2.22 ▷ Financial performance of EMDE equity portfolios, 10-year monthly returns



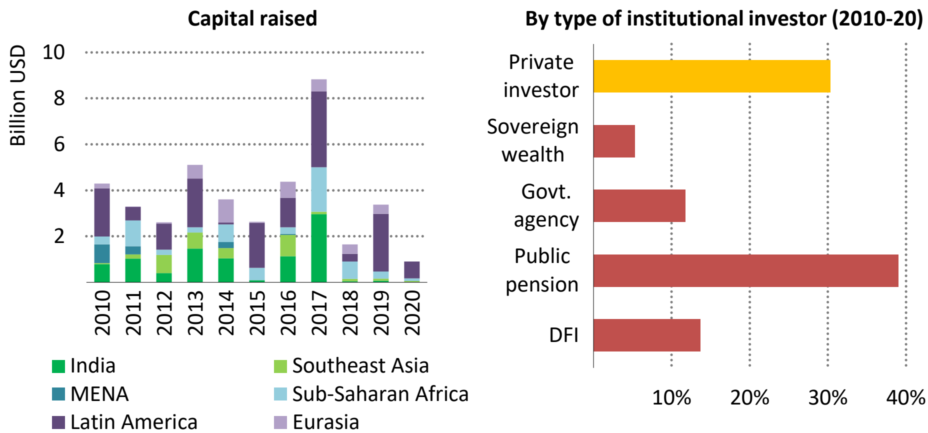
While returns for EMDE renewable power companies have been strong compared with the broader market, they are on par with fossil fuels and trailed those in advanced economies.

Source: Calculations based on IEA and Imperial College (2021).

Compared with direct project investments, capital flows into clean energy-oriented funds, including those with asset allocation strategies focused on companies and projects in renewables, energy efficiency, electrification, low-emissions fuels and storage, account for a larger part of investor participation in clean energy transitions. Globally, annual fundraising by such entities stood at nearly USD 120 billion in 2019, double the level of that five years prior. However, capital raised by clean energy funds fell by nearly 60% in 2020 and has remained muted thus far in 2021.

Due to inadequate capital markets, higher perceived risks and rules governing the activities of domestic funds, most EMDEs still have relatively low participation of institutional investors in financing clean energy transitions. That said, the involvement of investors in the refinancing of renewable power projects in some markets, such as India and Brazil, where the government has promoted tax-exempt local infrastructure bonds, has picked up in recent years. Institutional investors have also been instrumental in purchasing the issuance of sustainable debt coming from EMDE companies and governments (see below).

Figure 2.23 ▷ Fundraising by clean energy investment funds targeting EMDEs



Capital flows into investment funds targeting clean energy in EMDEs has declined in recent years; over the past decade around 70% of inflows have gone to publicly-backed funds.

Note: Includes infrastructure, private equity and venture capital funds with strategies oriented around renewables, efficiency, electrification, low-emissions fuels and storage, and geographic focus on EMDEs.

Source: Calculations based on Preqin (2021).

Investment funds – including those focused on infrastructure, private equity and venture capital asset classes – with objectives of targeting clean energy and EMDEs in their strategies have raised capital of around USD 4 billion over the past five years. Still, this accounted for less than 5% of capital raised by clean energy funds globally. Over 40% of the EMDE activity has come in funds oriented towards Latin America with one-fifth directed towards India. The fundraising fell to decade lows in 2020. But several large investors, including the USD 1.5 billion B2 Infra fund – a public fund targeting Brazil – and USD 1 billion Blackrock Climate Infrastructure Fund – which aims to invest at least 25% in Africa – have started raising capital in 2021.

The majority of clean energy fund activity in EMDEs has come from public sources of capital. Among institutional investors, funds owned or managed by public finance institutions, publicly-owned pension funds and strategic investment funds, such as sovereign wealth funds, accounted for 70% of the capital raised over the past decade. Finding ways to unlock higher levels of low-cost capital from private institutional sources will be important to funding transitions, but depends on evolving financial system rules and the risks around projects and companies. In that light, partnerships between public and private funds, such as the Decarbonisation Partners fund being set up by BlackRock and Singapore sovereign wealth fund Temasek, may become more prevalent.

Box 2.5 ▷ "Bold proposals" for accelerating clean energy finance in EMDEs

Over 20 companies, financiers and institutions are participating in a task force on Mobilizing Investment for Clean Energy in Emerging Economies organised by the World Economic Forum (WEF), with whom the IEA is collaborating on evaluating barriers, developing case studies and real-world ideas, and implementing solutions for addressing financing challenges in clean energy in EMDEs. From the discussion, participants have brought forth several "bold proposals" to support an acceleration of clean energy investment, described below. These proposals and opportunities for implementation are being further explored within the task force and by other relevant stakeholders:

- Energy Transition Mechanism: a blended finance mechanism based on national government transition plan and tied to the nation's NDC commitment to allow countries to retire portions of their carbon-intensive power assets over a defined period of time. The mechanism is composed of two complementary financial facilities: a carbon reduction facility and a clean energy facility.
- Net Zero Equity: a new investment product that channels money from investors not expecting immediate returns (e.g. foundations, citizens, governments and other sources) but looking for a greater contribution to society. This layer of capital can de-risk and enable projects which would not otherwise be funded.
- Decommissioning coal mapping: a purpose-built methodology that maps plants at national fleet level and prioritises retirements. The model helps frame and sequence decommissioning pathways and gives visibility to the investments needed while providing a standard approach to deal with debt/equity payouts. Participants are investigating potential application in geographies beyond the current effort in India.
- Cost of Capital Observatory: this effort would collect data on estimated and actual cost of capital for projects, as well as investigate reasons for differences. A related study, Clean Energy Investing: Global Comparison of Investment Returns, by Imperial College and the IEA (IEA and Imperial College, 2021), shows that publicly traded renewable companies have outperformed fossil fuel companies with higher returns and lower volatility, with the renewable portfolio less correlated to the broader market.
- Accelerating Corporate PPAs: a proposal to promote direct procurement as corporations target high levels of renewables consumption. Most emerging markets do not enable direct power purchase, which could provide another contracting option for renewable power projects beyond utility counterparties. Efforts are needed to improve enabling regulation, system integration and addressing the implications for utilities at risk of losing profitable customers.

2.4 Financial systems and clean energy transitions

Worldwide, there are growing efforts by governments and financial regulators, as well as pressures by investors, to incorporate sustainability measures into the decision-making of corporations. This section analyses the strategies being taken in EMDEs, from the financial system perspective, to address the potential risks associated with climate change and clean energy transitions, as well as to guide the growing appetite for sustainable finance from capital markets. Such strategies include:

- Identifying and evaluating financial risks – including transition and physical risks – through disclosure frameworks.
- Promoting more sustainable capital allocation through the elaboration of taxonomies on sustainable finance and creation of new labelled instruments.
- Setting financial regulations and standards to promote risk management, and in some cases, reward investment in clean energy transitions.

The absence of a globally harmonised reference for accounting and reporting on sustainability complicates any broad assessment of financial sector risk exposure, especially given that disclosure frameworks in EMDEs are at an early stage of development. Demand for sustainable finance has been constrained by a relatively weak flow of suitable projects. The influence of international investor initiatives is also less clear-cut with regard to SOEs and unlisted private companies, which are prevalent in EMDEs. Financial regulations with respect to climate change are, however, evolving quickly, with new approaches being advanced to boost the supply of sustainable finance.

Table 2.4 ▷ Main actors and roles in sustainable finance frameworks

	Classification and assessment	Reporting and disclosure	Risk and performance management
Corporate investors and insurance companies	Contribute to sectoral disclosure frameworks	Implement disclosure	Align portfolios with sustainable pathways Issue sustainable debt Integrate risks in audits insurance
Banks and investors	Assess risk exposure of portfolios	Implement disclosure	Align portfolios with sustainable pathways
Researchers	Improve risk modelling	Analyse disclosures	Assess impact of regulations
Governments	Set clean energy transition pathways and enabling taxonomy and disclosure rules	Implement disclosure (public sector)	Define central bank role in risk management Promote project pipelines Issue sustainable debt
Financial regulators and supervisors	Encourage and support use of disclosure standards and risk management recommendations	Assess state of domestic disclosure Implement disclosure (own portfolio)	Consider green prudential regulations, investment incentives Issue sustainable debt

	Classification and assessment	Reporting and disclosure	Risk and performance management
International investors	Support disclosure (toolkits, guidelines)	Implement disclosure	Channel investments
Development and international financial institutions	Support framework implementation Integrate risks in system assessments	Implement disclosure	Align lending with climate goals and provide risk management tools Issue sustainable debt
International standard setters : FSB, BCBS, IAIS	Set up international disclosure standards and risk management recommendations	Publish state of investor compliance with international disclosure standards	Foster lesson sharing on green financial regulations

Notes: FSB = Financial Stability Board; BCBS = the Basel Committee on Banking Supervision; IAIS = International Association of Insurance Supervisors. Unless stated otherwise, risks referred to here are financial risks related to climate change and to clean energy transitions. Disclosure refers to transparency schemes related to both exposure to climate change-related risks and carbon emissions associated with investments and business activities.

2.4.1 Identifying and evaluating financial risks posed in energy transitions

Harmonisation of disclosure practices around sustainability

Making climate and clean energy transition risks more transparent is a first step to helping investors better identify potential impacts on existing assets and companies, as well as future investment requirements. There is so far no internationally agreed set of rules on disclosure or definition of "green" investment, although the G7 recently agreed to the principle of a future mandatory climate-related financial disclosure framework. A number of global frameworks (e.g. Equator Principles, Principles for Responsible Investment, Principles for Sustainable Insurance, Principles for Responsible Banking) co-exist with national rules, as well as international partnerships, standard-setters and initiatives[7].

In response to a survey by the Network for Greening the Financial System, banks pointed to no less than seven frameworks as disclosure references, including national[8] and international[9] guidelines (NGFS, 2020). The multiplicity of initiatives has not so far translated into widespread and consistent disclosure. Accounting and disclosure frameworks are also

[7] Examples include CDP's Climate Disclosure Standards Board (CDSB) Framework, Common Principles for Climate Mitigation Finance Tracking from the International Development Finance Club (IDFC) and MDBs, the International Organization of Securities Commissions (IOSCO} Statement on Disclosure of ESG (environmental, social and governance) Matters by Issuers. Company rules and accounting standards are also widely used, as well as labels (France's GreenFin, the Luxembourg Finance Labelling Agency [LuxFLAG])

8 Examples include Brazil's banking association's classification framework, Morocco's Capital Market Authority's guidelines on green, social and sustainability bonds

9 Examples include the UN Environment Programme Finance Initiative's (UNEP FI) Principles for Responsible Banking, Equator Principles, the Task Force on Climate-Related Financial Disclosure (TCFD), Green Bond Principles, Green Loan Principles. The coverage of international frameworks has grown – almost 3 500institutions, representing over USD 100 trillion in assets, have signed the Principles for Responsible Investment, and the Net Zero Asset Managers initiative totals 87 members with USD 37 trillion in assets.

complex to implement. Emissions reporting is by far the most commonly quoted minimum transparency effort in existing frameworks. Reporting on financial risk exposure remains less advanced, due to the limitations of tools and methodologies to assess the consistency of investment decisions with climate objectives, and to a lack of adequate resources and expertise at company level, especially in EMDEs.

Well below half of all major EMDE companies report energy- and emissions-related metrics. Scope 1 and 2 emissions are published by almost 40% of major Asian and Latin American companies; scope 3 emissions are disclosed by around 40% of Asian companies and half of Latin American actors. Conversely, well below 10% of Middle East and African companies report on any of these categories. There are also important differences in orientations and ranges. Some frameworks look only at CO_2 or GHG emissions, while others rate sustainability or risk exposure in line with other metrics. While there is a certain degree of convergence within the TCFD on reporting of scope 1 and 2 emissions, approaches to scope 3 vary (Corporate Reporting Dialogue, 2019).

Asset class coverage varies widely; most frameworks tend to encompass equities, and more occasionally fixed income, infrastructure, real estate and mortgages. They often leave aside sovereign bonds and derivatives due to accounting methodology challenges. Frameworks also take different approaches at the portfolio and company levels, where rules related to carbon pricing and investments are even more disparate. The absence of a single reference for accounting and reporting on sustainability issues weakens the utility of the disclosed information. Adoption of internationally harmonised and up-to-date standards and guidelines, capacity building, and establishment of verification systems would be particularly valuable to improve disclosures in EMDEs.[10]

Disclosure has improved in EMDEs, but the picture remains incomplete

Climate risk assessment and disclosure for financial actors are now in principle mandatory in nine of the focus countries of this report, and voluntary in six others.[11] Listed companies are the main focus of national disclosure requirement in EMDEs, and are often required to incorporate environmental impacts and/or risk exposure to annual reports (as in Argentina, Brazil, Chile and Southeast Asia). Stock markets are reinforcing such efforts: 26 EMDE-based exchanges have published ESG reporting guidelines (out of a global total of 60), and 25 indicate ESG reporting as a listing rule (SSEI, 2021). Sustainable debt issuance has also induced a number of financial regulators in EMDEs to set up ad hoc disclosure guidelines.

[10] Recent initiatives such as the WEF 2020 report *Toward Common Metrics and Consistent Reporting of Sustainable Value Creation* delineate possible ways to generate reliable, comparable and comprehensive disclosures through an international framework. There are also benefits attached to having global references for sector-specific tools, for instance along the TCFD proposals.

[11] Mandatory frameworks exist in Colombia, India, Indonesia, Mongolia, Nepal, Nigeria, Pakistan, the Philippines and Vietnam. Voluntary schemes are in Ecuador, Kenya, Mexico, Morocco, Peru and South Africa. Securities Commissions in Thailand and Malaysia have also confirmed that they are working to improve disclosure requirements in line with TCFD recommendations. The Chinese authorities are also considering compulsory disclosure for financial actors.

Their scope is often domestic, but some align with international standards (notably in Argentina, Mexico and Chile). Southeast Asia introduced voluntary green and sustainability bond standards in 2017/18.

Current disclosure does not yet provide a precise picture of financial sector exposure, with data and coverage gaps. Although domestic guidelines on sustainable banking have recently been strengthened in Indonesia, Malaysia, Thailand and Viet Nam, information published by the 35 main Southeast Asia banks leaves out energy sector details, and only two banks have analysed the climate risk exposure of their portfolios (ADB, 2020). In India, green bond guidelines include disclosure requirements and reporting obligations, and the top 1 000 listed companies are required to publish annual business responsibility reports. But in 2019 only around 50 companies report via CDP disclosed scope 1 and 2 emissions, with only half of these verified by a third party. While almost all companies identified "substantial exposure" to transition and climate risks, much remains to be done on quantifying potential financial impacts (CDP, 2020).

The role and limitations of sustainable finance taxonomies

Countries or supranational authorities are increasingly elaborating sustainable finance taxonomies for classifying activities and assets contributing to clean energy transitions, or financial risks associated with climate change. Originally set up as international voluntary initiatives, taxonomies have been further developed and tailored to private-sector assessments by credit rating agencies and company research consultancies (S&P, Moody's, CICERO), including a broader selection of sectors and asset classes. Governments have more recently developed official classifications, starting with China's Green Bond Endorsed Projects Catalogue in 2015 and including, more recently, the European Union (EU) Sustainable Finance Taxonomy. There is no one-size-fits-all approach and differences reflect the multitude of local pathways that align with clean energy transitions:

- "Green" taxonomies identify activities fully aligned with clean energy transitions or are least exposed to climate-related risks.
- "Carbon-intensive" taxonomies focus on activities exposed to climate or transition-induced risks (such as stranded assets).
- "Transition" taxonomies identify diversification or emissions improvements within carbon-intensive sectors, in supporting their transition to a low-carbon economy.

Many EMDEs, and a few advanced economies (the European Union, Bangladesh, Brazil, China, Colombia, Indonesia, Kenya, Malaysia, Mexico, Mongolia, Peru, Singapore, South Africa, New Zealand and the United Kingdom) have developed green or carbon-intensive taxonomies, while a few advanced economies (Canada, Japan) have or are currently establishing complementary transition classifications. Similar recommendations have been provided to the European Commission by its Sustainable Finance Platform, for future taxonomy orientations.

Although they cannot per se fully depict the full range and importance of climate-related risks, taxonomies are used in practice by financial actors to assess the risks of different investments and/or to allocate capital. Their usefulness has so far been limited by their heterogeneity, which can require internationally focused companies and investors to comply with multiple systems. Approaches to certain energy sectors, such as nuclear and gas, can vary according to local pathways and preferences. While the definition of a sustainable investment is likely to differ depending on national preferences, efforts to harmonise EU and Chinese accounting definitions and explore taxonomy commonalities may help to offer a more standardised analytical framework.

There are further questions over the robustness of certain taxonomies for meeting long-term sustainability goals and their impacts on financial markets. On the one hand, incomplete or unclear risk appraisals from taxonomies could lead to an exclusive focus on classes of clean energy investments in the near term, at the expensive of financing more complex transitions in emissions-intensive sectors. On the other hand, transition taxonomies may not create the momentum required to generate emissions reductions at the speed required. The elaboration and use of taxonomies is limited by data gaps, which cannot be appraised on the basis of historical metrics (NGFS, 2020); actuarial and credit risk models are not fully adapted. However, even though taxonomies may not be a "silver bullet" for greening financial regulation, they can fulfil a useful co-ordinating function for many green financial regulations and policies.

Use and creation of new sustainable asset classes

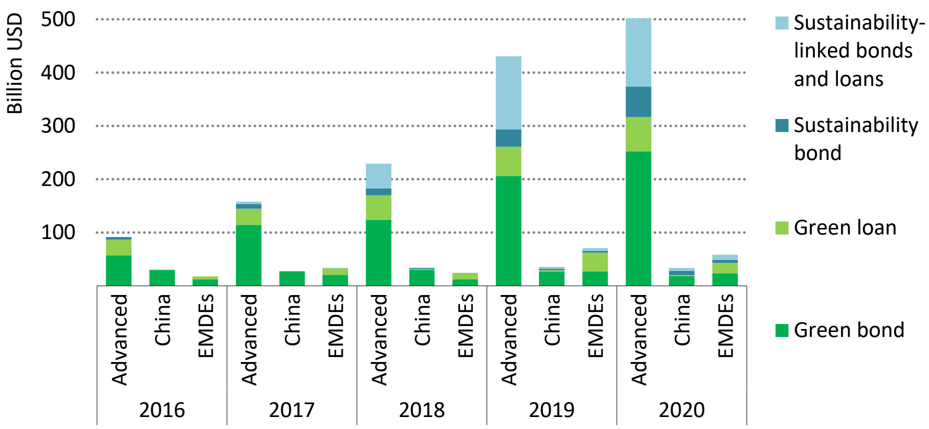
EMDEs have so far contributed only around 10% of the global issuance of clean energy related sustainable debt, a comparable share to that from China. Most issuance in the last 20 years within these countries has come from Latin America and Southeast Asia, each of these regions contributing to around 3% of the global total, and from India, which represents over 1% of global amounts issued. Issuance in EMDEs has been mostly green bonds (defined by use of proceeds) and sustainability-linked bonds (with returns connected to firm-level key performance indicators). Unlike in advanced economies, there has been little issuance of green asset-based securities, green debt by local authorities and very few project-based products. Financial actors, which account for two-thirds of issuance in China, represent around 30% in EMDEs. Corporations are the other leading issuers of sustainable debt, around half, especially utilities and energy companies.

EMDEs have issued relatively few sovereign green bonds, despite governments' potential interest. There are examples in Chile, Indonesia and Nigeria, and the issuance by Egypt of a USD 750 million sovereign green bond in 2020 was the first in the Middle East and North Africa region, and the first from the African continent to be denominated in US dollars (Nigeria's issuance was in local currency). South Africa, whose financial markets is one of the most developed among EMDEs, saw initial green bonds issued as early as 2012.

These instruments seek to attract new sources of finance for clean energy projects. So far, however, their impact remains hard to monitor, as limited financial market development in

EMDEs as well as lack of capacity by companies and banks hinders the development of green debt markets and corporate bond markets in general. The pipeline of eligible projects has been quite weak (e.g. projects satisfying both key "green" criteria and investor liquidity requirements). Moreover, institutional and legal capacity issues, and related costs of issuance of these specific instruments further explain why green debt development has lagged; financial regulators are increasingly seeking to design financial rules explicitly favouring green investments in EMDEs (see Section 1.5.2).

Figure 2.24 ▹ Annual sustainable debt issuance by economy



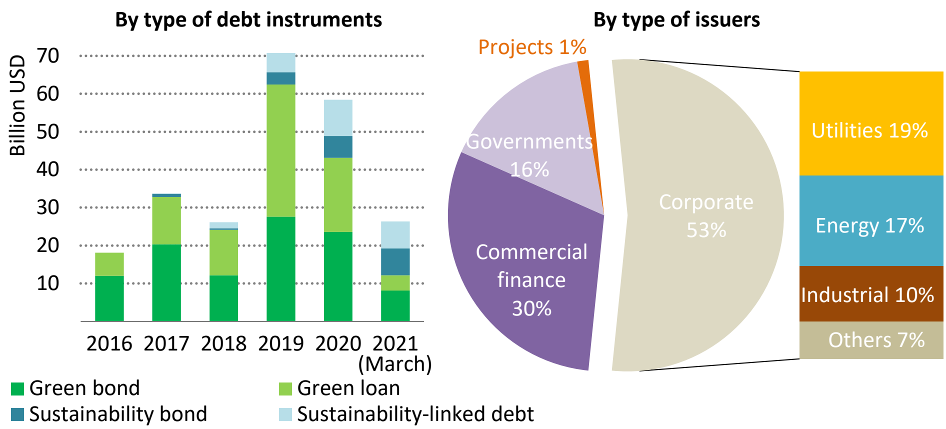
Sustainable debt issuance has been heavily concentrated in advanced economies and – with a few exceptions in Latin America and Asia – has not taken off in EMDEs.

Source: IEA calculations based on BNEF (2021).

Most EMDE green bonds have been issued in hard currency, but international investor appetite has been limited by the generally high volatility, illiquidity and risk levels of EMDE bonds. Institutional investors dedicate only a small portion of their investment portfolio to EMDE debt and tend to favour larger issuances. They also may be more sceptical of environmental credentials for sustainability-linked products in EMDEs due to less precise frameworks around use of proceeds). Asset managers often prefer to use general ESG frameworks instead of existing international ones or even those elaborated by countries themselves, which may lack transparency and granularity on environmental issues. Absence of a dedicated EMDE green bond index also raises challenges in benchmarking financial performance.

There is increased scrutiny of the credibility and additionality of some green labelled investments. EMDE green debt issuers mostly use proceeds to finance renewables projects (in India, 80% of proceeds are channelled to this sector), but also to refinance existing projects. Sustainability-linked bonds have potential to more flexibly fund clean energy transitions in EMDEs. But they can raise questions, as witnessed in the issuance of a sustainable transition bond Brazil in 2019.[12]

Figure 2.25 ▷ Sustainable debt issuance in EMDEs, by category and issuer type



Annual sustainable debt issuance in EMDEs dropped by almost a fifth in 2020. Before the Covid-19 crisis, growth had mostly been driven by corporate issuers.

Source: IEA calculations based on BNEF (2021) and Bloomberg (2021).

DFIs and sovereign wealth fund participation may help mitigate some concerns, as well as support local capacity building. The World Bank supported Egypt's sovereign green debt issuance last year, helped with the elaboration of a Green Bond Framework and supported independent verification. The IFC Technical Assistance Facility helps underserved regions tap into the potential of green bond markets, with a current focus on the Middle East, Africa and Central Asia. The Asian Development Bank's Catalytic Green Finance Facility similarly supported Thailand's government in setting up, monitoring and reporting arrangements in line with global standards before it issued its first sovereign green bond.

The role of institutional investor initiatives

Most sustainable finance-related investor initiatives do not have a strong focus on EMDEs. For instance, only 10% of the almost 3 500 signatories to the Principles for Responsible Investment are active in EMDEs; and the Net Zero Asset Managers Initiative has mostly advanced economy members. EMDE key challenges or particularities are therefore not tackled, with most of these initiatives concentrating on advanced or global market

[12] Marfrig Global Foods SA , Brazil's second-largest meatpacking company, attracted criticism when floating the idea of issuing a green bond, which was afterwards relabelled "sustainable transition bond" amid concerns on the impact of the company's activity on deforestation. The bond was eventually oversubscribed, but the case sparked a debate over what qualified as sustainable debt and how its impact should be monitored.

opportunities and/or specificities, or on elaborating global frameworks. As a consequence, few EMDE companies are involved and few EMDE governments are currently encouraging the adoption of the guidelines some of these groups issue. It is notably quite visible for the TCFD, which has very few representatives from EMDEs and whose disclosure guidelines are followed by very few EMDE actors.

Outside these voluntary initiatives, the lower adoption of net-zero emissions targets and related plans by EMDEs can also pose limits to investor capacity to allocate capital to these markets. To date, among the almost 50 countries that have set themselves such targets, only a third are EMDEs. This can translate into a disincentive for greater incorporation of EMDE-related equity or sovereign debt in the portfolios of investors seeking to fulfil clean energy transition goals, mostly based solely on carbon emissions measurement and not clean energy transition performance. These constraints also limit institutional investors' support to utilities, oil and gas companies, or emissions-intensive consuming sectors currently requiring capital to fund decarbonisation or diversification of their activities.

2.4.2 Climate-related risk management and financial regulation

Consideration by financial regulators and supervisors of climate challenges has evolved in recent years. In EMDEs, regulators have been most active in setting "green" financial rules in Bangladesh, Brazil, Colombia, India, Indonesia, Lebanon, Mongolia, Nepal, Nigeria, Pakistan and Viet Nam, although these countries have taken a wide variety of approaches.

The rationale behind more active involvement of financial regulators reflects the potential interaction of climate-related risks, clean energy transitions and broad financial system stability, including via changes in revenue and asset valuation due to shifting economic patterns (transition risks), financial losses induced by extreme or chronic natural events (physical risks), and litigation actions against companies or public actors (liability risks). Some central banks report concerns over potential "green swans" or "climate black swans" – wide-ranging disruptive events not entirely predictable with existing models – that may force them to intervene to preserve financial system stability.

In practice, financial regulators are pursuing two broad types of approaches. The first is aimed at building or reinforcing financial sector resilience against climate-induced risks. This approach is accepted within the mandates of a number of advanced economy central banks-those from the G7 recently committed to assess the financial stability risks related to climate change. It has so far led financial regulators to provide information on climate risks, disclosure incentives for financial actors, efforts to integrate climate considerations into asset managers' fiduciary responsibilities, and, mainly in EMDEs, the incorporation of climate-related risks in prudential regulations.

The second approach goes a step further in seeking to correct market distortions, including the inadequate accounting of environmental externalities, lack of market transparency leading to improper risk valuation of "brown" investments and a general investor focus on near-term impacts. This approach, widely followed in EMDEs but less so in advanced economies, has prompted financial regulators to incorporate incentives in prudential or monetary policies that shift financial flows towards clean energy.

Incorporating climate risks in macro- and micro-prudential regulations

Micro-prudential regulations, aimed at ensuring the solvency of individual financial actors, were reinforced in the aftermath of the 2008 financial crisis, while macro-prudential regulations, with the objective rather to safeguard the systemic stability of the financial sector, were added then to the scope of financial regulators and supervisors' activity.

There is disagreement among observers on whether international standard-setters, notably the BCBS, the European Solvency II insurance regulation and the International Accounting Standards Board, have favoured "brown" investments to the detriment of "green" ones in response to the post-2008 crisis. International regulations only marginally address or mention climate-related risks, and have established higher capital requirements and liquidity coverage ratios for long-term loans, deemed riskier. However, current international standards allow national and financial supervisors to integrate climate-related risks to the scope of their appraisal, and not all clean energy transition investments require long-term lending.

Adapting micro-prudential rules to incorporate climate-related risks has so far mainly concerned credit limits, meant to induce lenders to diversify their portfolios. Seven EMDEs within the scope of the present report have integrated climate concerns in the calculation of exposure limits for individual loans or credit ceilings/floors. These instruments have been implemented on a mandatory basis in Bangladesh, Brazil, India, Indonesia, Nigeria and Viet Nam, and voluntarily in Cambodia. Few countries have adopted other types of micro-prudential rules: Nigeria has integrated climate risks into liquidity requirements (aligning loan durations with those of assets), and Lebanon's central bank lowered commercial banks' reserve requirements for green loans financing projects with energy savings.

Fewer actors have integrated climate-related risks in macro-prudential regulations, by organising "climate stress tests" or sensitivity analysis. Apart from China and the European Union, which implemented them, such tools are under discussion in France, the Netherlands and the United Kingdom.

Shifting investment allocation to scale up "green finance"

A number of EMDEs have chosen to use financial regulations to support strategic sectors and projects for accelerating domestic clean energy transitions. The most common approach has involved mobilising the credit limits mentioned above and using them as an economic policy instrument rather than a micro-prudential tool. To channel investments towards specific sectors, financial regulators have established lending programmes and sectoral priority lists and set up credit floors (encouraging investment in priority sectors) and/or ceilings (discouraging investment in non-priority sectors) for investors, most often commercial banks. The Reserve Bank of India has classified renewable energy as a priority sector, alongside eight others, and Indian banks have a requirement to dedicate at least 40% of net credit to priority sectors, but these are also subject to loan ceilings.

Some EMDEs have designed more direct incentives. The Bank of Bangladesh introduced a refinancing scheme for renewable energy and green sectors in 2009, and, with support from the World Bank, has implemented and refined a set of Guidelines on Environmental and Social Risk Management since 2011. Together with an Environmental and Social Due Diligence tool, these regulations support the mandatory screening of environmental and social risk (ESRs) by banks and financial institutions, whose exposure is monitored by the central bank. Favourable general conditions, interest rates, legal authorisations and risk appraisal (loan-to-value and debt-to-equity ratios) are offered to loans with high ESRs, or a positive progression in ESRs post-disbursal. Investments with lower ESRs can see degradation of lending terms.

Governments engaged in these policy strategies usually issue frameworks on risk evaluation as well as guidelines on green finance/banking to further guide investment. Some have built upon existing private actors' initiatives, or upon international standards such as the Equator Principles. The IFC has also played a key role, recommending the integration of ESRs in performance standards and establishing a Sustainable Banking Network, of which over 30 EMDEs are members.

Recent years have also seen growing debates around the role of central banks in addressing the potential impacts of climate-related risks induced by their own financing activities. Redefining asset purchase programmes has emerged as an idea, as analysis of corporate bond purchase programmes by the European Central Bank and the Bank of England (BoE) indicated that these had the effect of directing capital towards emissions-intensive sectors. The BoE has announced it would assess the climate impact of the issuers of the bonds it holds and accordingly adjust its purchase scheme by the end of 2021.

In advanced economies, the development of targeted financial regulations aimed at scaling up green finance has not been widely embraced, due to concerns over the potential exercise of economic policy-making roles. By contrast, in EMDEs, some financial authorities are implementing such approaches based on government requests.

Nevertheless, green financial regulations remain limited by a lack of data on climate-related financial risks and effectiveness is difficult to evaluate. For instance, the integration of climate-related risks into capital requirements (the rules setting minimum amounts of capital banks need to hold against their assets) is particularly challenging to design in practice, due to knowledge gaps on sectoral performance against clean energy transition goals. Its effect on mobilising investment also remains uncertain and may be limited if project-specific risks are not simultaneously addressed (I4CE, 2020). Without adequate calibration, the integration of climate risk evaluation in bank prudential regulations such as liquidity ratio, lending limits or large exposure rules may also run counter to the original financial stability motives of these regulations. Eventually, if incentives aimed at directly supporting clean energy transition investments are too strong, they could also lead investors to over-value projects or assets displaying minimal climate-related aspects. Refinement of underlying data and regulation design in the coming years is likely to be essential to ensure green financial regulations meet their aspirations.

Box 2.6 ▹ International approaches to sustainable financial regulation

Beyond EMDEs, the institutional and political factors that underpin financial systems guide different approaches to sustainable financial regulation.

China's approach is unique in scale and degree of intervention. It is enabled by a regulated banking system, less independence of the central bank, and a historical orientation of financial regulator mandates towards policy implementation. The Guidelines for Establishing a Green Financial System issued in 2016 led to the establishment of lending limits. In 2017, under the People's Bank of China (PBoC) re-lending facility, green projects were offered low-cost funding, with subsidies for interest payments and guarantees.

The government is now testing additional incentives to mobilise private capital. China has one of the world's largest reserve of green loans, at around USD 14 billion according to publicly disclosed information. Its Green Bond Endorsed Project Catalogue was recently updated, removing coal production and the utilisation of fossil energy, and it is working with the European Union to harmonise taxonomies. In December 2020, the PBoC announced that climate risk disclosure may soon be mandatory (but classified) for public and private financial actors.

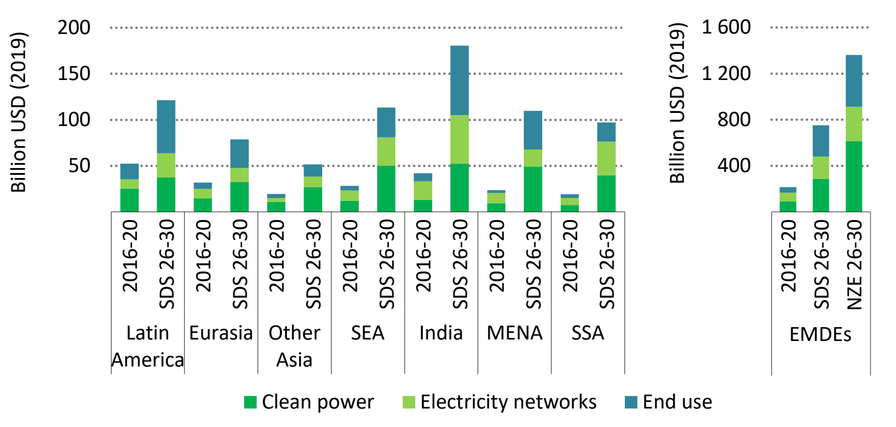
In advanced economies, monetary and prudential regulations are both decided upon by an independent and influential central bank and favour voluntary regulations focusing on a financial stability approach. Canada, the United Kingdom and the European Union are concentrating on climate stress test demonstrations and efforts to adjust fiduciary responsibility scopes. To date, only South Korea has implemented mandatory lending limits and disclosure requirements. The European Union and the United Kingdom announced mandatory disclosure rules by 2025, and Banque de France is considering a strategic review of its monetary policy, which may indicate a shift in focus towards a more "'policy-orientated'" approach.

Financing clean power, efficiency and electrification

SUMMARY

- Investment in capital-intensive clean power and electricity networks, as well as spending on energy efficiency and electrification via greener buildings, appliances and EVs, would need to more than triple in EMDEs in the 2020s to be consistent with a well-below-2 °C temperature outcome (from about USD 45 per person in EMDEs today to around USD 130) and increase more than six times in order to keep the door open for a 1.5 °C stabilisation (to around USD 240 per person).

Figure 3.1 ▷ Current versus future average annual investment in clean power, grids and energy end use in climate-driven scenarios



Moving to an IEA climate-driven scenario in EMDEs requires at least a tripling of annual investments in clean power, networks, efficiency, and other consumer applications.

Note: MENA = Middle East and North Africa, SEA = Southeast Asia, SSA = sub-Saharan Africa.

- The power sector accounts for a rising share of total investment, as clean electricity and electrification need to play central roles in EMDE strategies for sustainable development. At least 1 600 GW of renewable capacity is added over the next decade in rapid transitions, increasing the share of renewables in total power installed capacity to well above half by 2030, from 30% today. This shift demands an increase of private capital with greater reliance on debt and project finance. Policies supportive of private-sector participation and competition, and targeted public finance have helped lower the cost of capital and attract private investment in renewable power, but stronger efforts are needed. In more mature EMDE markets, efforts focus on addressing persistent risks, such as access to long-term, locally denominated debt,

while markets at earlier stages of development still require clear targets supported by regulation and a greater role of blended finance to help crowd in private capital.

- Investment in electricity networks and battery storage has to grow rapidly to accommodate rising electricity demand and the surge in renewables deployment; in the SDS it nearly triples to USD 200 billion by the late 2020s, and rises even faster to USD 325 billion in the NZE. Financing – provided mainly by state-owned utility balance sheets – depends on good system planning and regulation. Development finance institutions can help to bolster funding options along with supporting investment in smarter, digitalised systems. In some markets, with enabling reforms, new business models to attract private financing for grids could help bridge the investment gap.
- Generation and networks businesses are unbundled in most EMDEs, but states often own the utility companies that shape decision-making across electricity investments. While many utilities in EMDEs have improved cost recovery over time, the pandemic has exacerbated vulnerabilities and financial stresses, including their ability to invest in grids and act as creditworthy power purchasers. Better financial performance comes through reforms that boost competition, enhance planning and operations, promote cost-reflective tariffs, sound financial management and good governance.
- Rapid urbanisation and strong construction activity in EMDEs puts a premium on investment in energy-efficient, digitally-connected buildings in climate driven-scenarios, alongside a step-change in spending on clean solutions to manage the huge rise in demand for cooling. Constrained access to affordable consumer finance, lack of building codes, split incentives, and energy subsidies all inhibit investment in green construction at the scale needed to meet climate-aligned scenarios. Stronger performance standards, building certification schemes and increased deployment of a range of financing solutions – including credit lines from development finance institutions and ESCOs – can help to overcome spending barriers.
- Fast-growing mobility demands in EMDEs call for a roll-out of cleaner transport solutions, including public transit and new vehicle options. Passenger EV sales reach over 5 million in 2030 in the SDS from a very low base today, with capital increasingly reliant on better access to debt finance. High borrowing costs, underdeveloped manufacturing capacity and limited charging stations pose challenges to deployment. These can be bridged with tax incentives, purchase subsidies, expansion of green auto loans and leasing models. Efforts to roll out mass transit benefit from tapping into sustainable debt markets and partnerships with global technology providers.
- Enabling universal access to electricity by 2030 requires investment of USD 35 billion per year, with half of that for decentralised solutions including USD 13.5 billion in sub-Saharan Africa. While debt fundraising has improved as some markets have become more attractive to lenders, public concessional funds continue to underpin investment, especially in countries with high risks or weak underlying economics. A similar story holds for clean cooking, where business models are still being explored.

3.1 Introduction

Transforming the power sector and boosting the efficient use of clean electricity are key pillars of sustainable development and account for the largest part of emissions reductions necessary to meet global climate change goals. The homes, offices, factories and mobility solutions that support rising living standards and economic growth in emerging market and developing economies (EMDEs) are increasingly powered by electricity. Electricity consumption grows by around 3-4% annually in EMDEs in all scenarios, more than twice the rate in advanced economies. Starting positions of EMDEs – with 785 million people lacking reliable access, financial strains on incumbent utilities, high reliance on coal-fired power in some countries and the prospect of a rapid uptake of space cooling – create additional investment challenges.

This chapter focuses on financing an acceleration of investment in the suite of technologies and measures that would support clean energy transitions in electricity supply and demand. High and continuous growth in these areas align with the ambitious decarbonisation and universal access aims of the Sustainable Development Scenario (SDS) and the even stronger efforts required under the Net Zero Emissions (NZE) by 2050. By 2030, power sector investments rise from an average of USD 240 billion in 2016-20 to USD 560 billion in 2030 in the SDS, and to USD 1.1 trillion in the NZE. This expansion is accompanied by a major shift in generation investment towards low-carbon sources, which represent around 40% of total power investment today, and includes a huge increase in spending on networks to meet growing electricity demand, integrate renewables and modernise power systems.

On the end-use side, investments target more efficient buildings and appliances that would support an improvement in energy intensity of at least 4% per year amid a boom in construction activity over the next decade. By 2030, one out of seven new passenger light-duty vehicles (PLDVs) sold in EMDEs is electric in the SDS, due to fiscal incentives and declining electric vehicle (EV) costs. Compared with today's transport scene, this requires a step-change in financing arrangements to cover upfront costs and the roll-out of associated charging infrastructure. However, such changes can bring important economic and environmental benefits in terms of lower import bills, for countries like India, as well as improved local air quality.

As spending shifts towards these more capital-intensive technologies, the role of financing becomes more critical for the feasibility and affordability of the transition. Mobilising much higher levels of investment will depend on policy and market conditions, as well as the sustainability goals increasingly set out by developers and investors, all which influence the profitability of investments.

Still, investment characteristics, including returns, financing and risks associated with these projects, can vary widely, according to the level of market readiness. For example, while international private developers play more of a role in utility-scale solar PV and wind in markets with long-term contracts and well-allocated risks, transmission and distribution grids have monopolistic characteristics and depend more on state-owned enterprise (SOE) balance sheets and regulatory planning. In the case of end use and energy efficiency, investments depend considerably on the balance sheets of consumers and companies for whom access to finance is more limited and energy spending falls outside their core business.

Table 3.1 ▷ Selected indicators of investment spending in power and end-use sectors in EMDEs by scenario (USD billion)

		2026-30		
	2016-20	STEPS	SDS	NZE
Power	**238**	**371**	**512**	**962**
Electricity generation	**163**	**198**	**313**	**637**
Of which clean power	*56%*	*77%*	*92%*	*96%*
Of which utility-scale	*91%*	*91%*	*87%*	*90%*
Renewable power	81	130	259	573
Solar PV	32	42	78	157
Wind	19	34	85	243
Hydropower	24	35	55	92
Nuclear	11	23	27	39
Fossil fuel power	71	45	27	25
Coal	32	19	3	2
Gas	27	24	22	23
Electricity networks	**75**	**167**	**192**	**299**
Transmission	22	41	44	85
Distribution	53	126	148	214
Battery storage	**0**	**7**	**7**	**26**
End use	**49**	**149**	**273**	**449**
Energy efficiency	47	84	165	243
Buildings	8	37	53	151
Transport	26	34	86	67
Renewables and other end use	3	65	108	205
EVs and chargers	0	31	63	133

Notes: STEPS = Stated Policies Scenario; PV = photovoltaic. Fossil fuel power includes plants with and without carbon capture, utilisation and storage (CCUS). Energy efficiency includes the incremental spending on more fuel-efficient transport modes. Other end use includes CCUS in industries and spending in EV and privately financed EV chargers. Publicly financed EV chargers are included under Distribution. The scope and methodology for tracking energy investment and finance is available in the methodology document.

Simultaneously addressing the risk and return proposition for investing in clean energy will be critical to attracting capital. Today's lower-interest-rate environment – especially in advanced economies – creates an opportunity to crowd in wider pools of capital. However, this depends on efforts to improve investment conditions that would help to support predictable pipelines of bankable projects and better access to new sources of finance for low-carbon power and end use. Given the size of the investment gap and the limits of public balance sheets in EMDEs, clean energy transitions hinge on the ability of these economies to attract much higher levels of private capital and build local capacity for project development.

Rapid energy transitions require power and end-use annual investment to rise to at least 3% of expected gross domestic product in EMDEs by the second half of 2020s, doubling the historical rate which has been relatively flat at around 1.5% in recent years. In the NZE, an even more precipitous rise in renewables is motivated by the imperative to displace existing carbon-intensive sources of power – mainly coal – as quickly as possible from the system.

The case studies in this chapter provide examples of policies and financing mechanisms working together to address the risk perceptions and barriers that hold back clean energy projects, as well as to enhance the attractiveness of investments in order to support the continuous growth required for clean energy transitions.

3.2 Financing clean power and electricity infrastructure

Expanding clean power and electricity grids is central to national development strategies in many EMDEs, and these are also critical vectors for energy transitions. Over the next decade, these economies are set to account for a third of the growth in global electricity demand, which needs to be supplied reliably, affordably and with as light an environmental footprint as possible. Compared with today, the largest annual investment increases occur in the Middle East and North Africa, India and Southeast Asia (from highest to lowest).

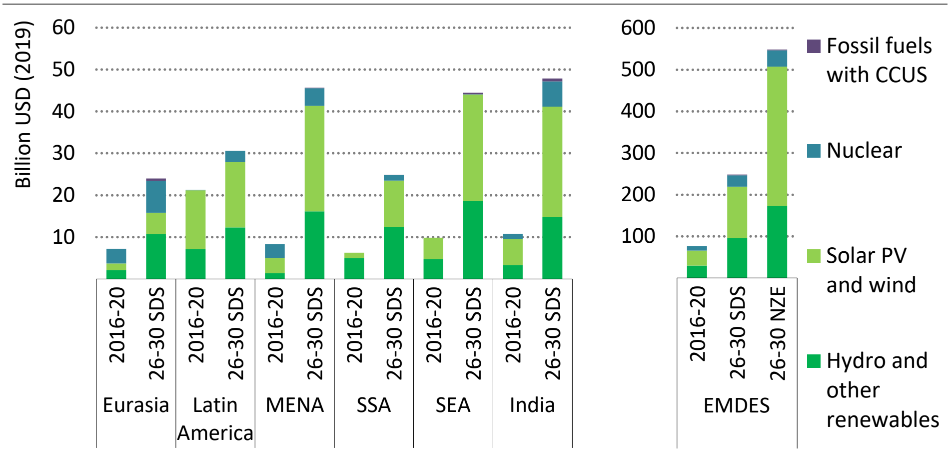
3.2.1 Utility-scale clean power

Investment outlook and sources of finance

In IEA climate-driven scenarios, renewable power needs to account for more than 90% of the generation capacity added over the next decade in EMDEs. Average annual investment in renewable power increases by at least three times, with the vast majority going to utility-scale projects and solar PV and wind leading the way. Though much smaller in terms of capacity added, the services provided by hydropower plants and other dispatchable renewables are critical to integrate the vast amount of wind and solar PV. Nuclear power also increases rapidly, notably in India, the Russian Federation (hereafter, "Russia") and the Middle East, though accounting for a much smaller role in overall investment. While investment in carbon capture remains small, by 2030 it starts to play a role in addressing emissions from existing coal-fired power (see Chapter 4).

Mobilising this investment requires significant shifts in the financing of power generation in EMDEs, which have traditionally relied on SOE balance sheets and international debt – both public and private – to develop fossil fuel and hydropower plants. As variable renewables scale up, the power sector depends increasingly on private sources of capital, which account for over 80% of annual capital expenditures in IEA climate-driven scenarios. This investment is underpinned by independent power producers (IPPs) and long-term power purchase agreements (PPAs) supplemented by funds from public finance institutions (PFIs). The effectiveness of such arrangements depends on good project structuring and system planning, private participation in investment, and the underlying financial health of the counterparties – issues that are explored throughout this chapter.

Figure 3.2 ▷ Annual average investment in clean sources of power in IEA climate-driven scenarios



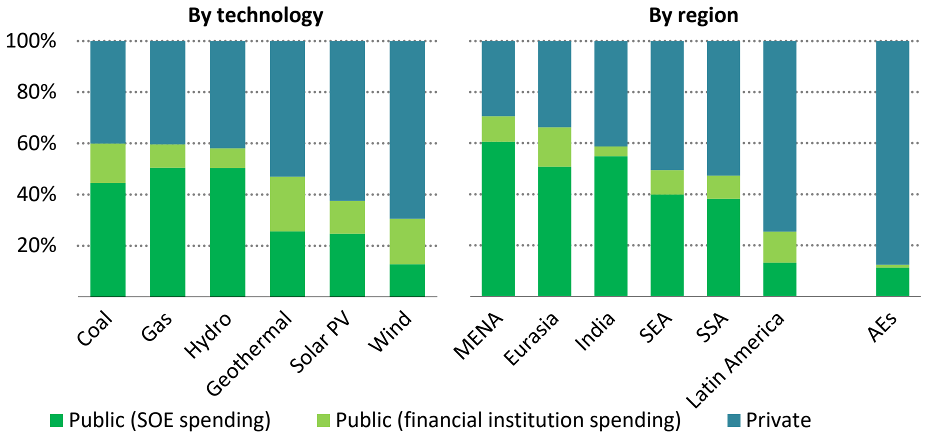
Within ten years, investments in clean sources of generation would need to increase dramatically to put EMDEs on a Paris-compliant trajectory.

Notes: MENA = Middle East and North Africa; SSA = sub-Saharan Africa; SEA = Southeast Asia. Data show investment to all new utility-scale clean power projects.

State-backed financing and ownership play a greater role in large-scale dispatchable renewables, such as hydropower and geothermal, and more than 50% of hydropower investment depends on public sources. Hydropower and geothermal projects also entail the ownership and management of sensitive natural resources and land, which can entail risks for investors, given the very long lifetimes (up to 100 years) and long construction periods (five to ten years) of the assets. PFI support remains important. Sole reliance on commercial capital is rarely viable, even in advanced economies, for geothermal projects.

Among regions, Latin America has historically attracted the highest share of financing from private actors, followed by sub-Saharan Africa and Southeast Asia. Countries in Latin America have led the way in opening up to the establishment of long-term auctions for IPPs, which were predominantly taken up by private companies, and the privatisation of distribution. Countries in Eurasia, such as Russia, and the Middle East and North Africa have a much higher reliance on SOEs. PFIs, particularly international development finance institutions (DFIs), remain important to reduce risks for private investors, especially in countries where cross-cutting risks are high and when a country is newly introducing a specific technology.

Figure 3.3 ▷ Sources of finance for generation by type of provider, 2016-2020



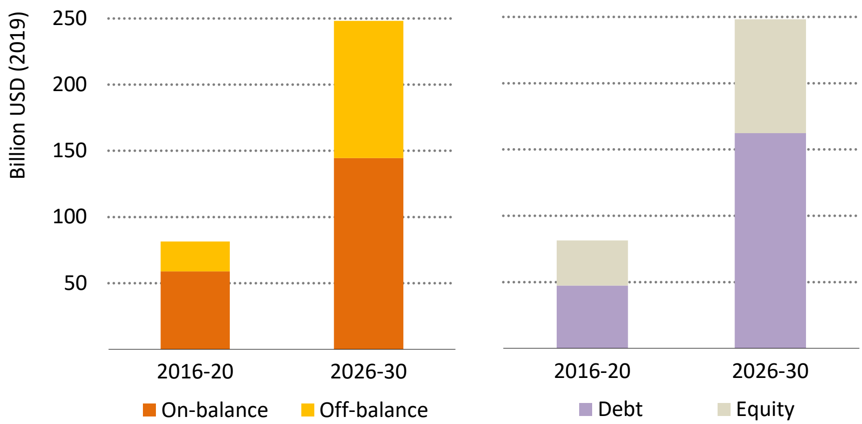
The establishment of long-term auctions for IPPs was key to attract private capital to variable renewables. Private investment in grids was also a driver in Latin America.

Notes: AEs = advanced economies. Public (financial institution spending) refers to concessional financing provided by DFIs, export/credit agencies and other similar entities.

In the 2016-20 period, mature technologies such as coal, solar PV and wind power in EMDEs were financed with around 60% of debt, on average, and more than 30% on a project finance basis. PFIs were important players in this picture, allowing for higher levels of debt and project finance. Other technologies with higher development risks, such as hydro, needed generally more than 40% of equity and were financed based on SOE balance sheets. Financing the rise of clean power, which will likely come through IPPs and project finance structures, requires a significant increase in debt finance.

Compared with today, private investment rises fourfold in the SDS, with greater reliance on debt (which triples) and project finance (which jumps over fourfold). Such an increase in the requirements for long-term debt rely upon a major reduction in perceived risks, enhanced capacity of banks (given the uptake in project finance structures) and changes in financial sector rules in some cases. As an example, while long-tenure debt is generally available for renewable power in India, regulatory rules on sector lending mean that renewables compete for the same pool of bank capital as thermal power, where an increase in stressed assets has put pressure on bank lending (IEA, 2021b).

Figure 3.4 ▷ Sources of finance for clean power in the SDS



With supportive policies to address risks, off-balance sheet financing structures and the use of debt in clean power investments need a three to fourfold increase over the next decade.

Key factors influencing investment decisions for variable renewables

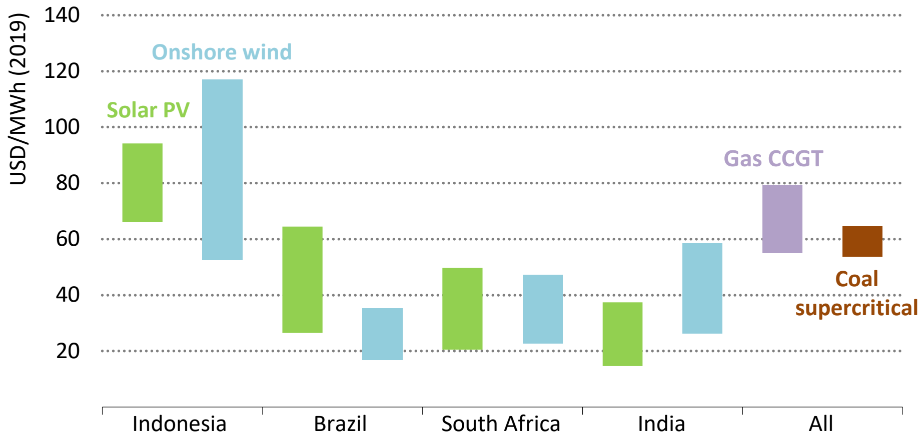
Mobilising much higher levels of investment in utility-scale solar PV and wind will depend on robust policy and market conditions, as well as the sustainability goals increasingly set out by developers and investors, all of which influence the profitability of investments. Investment decisions are likely to be influenced by:

- The costs of solar PV and wind, which depend on the quality of local resources, global industry trends and the maturity of supply chains in a given country or region.
- Government clean energy strategies and policies, including clear visibility over procurement plans and project pipelines to create signals for investment.
- Expectations of obtaining the required rate of return and successfully servicing the debt.
- Well-designed contracts to provide clarity over revenues and ensure project bankability.
- The cost and availability of capital, which depends on the factors above, as well as financial mechanisms that address specific issues such as currency or payment risks.
- The availability and cost of land and level of enabling transmission infrastructure to ensure an effective integration of variable renewables.

Costs of solar PV installations in Brazil, India, Mexico and South Africa fell by around 40-55% over the 2015-19 period, and wind installations by 15-30%. Still, relatively high costs remain a key impediment for renewables development in several EMDEs, particularly in sub-Saharan Africa, or Indonesia for example, where the average cost per megawatt of solar PV capacity is 65% higher than in India and 10% higher than in Thailand (IRENA, 2020; IEA 2019b).

A comparison of the levelised costs of energy (LCOEs) among different sources of new power generation points to variable renewables as the most affordable option in an increasing number of EMDEs; in some cases the LCOEs of renewables are lower than the variable costs of existing coal plants. However, as LCOEs do not account for the value that different sources of generation bring to power systems (e.g. flexibility and capacity services), a comparison between variable renewables and dispatchable technologies can be misleading. In the case of India, for instance, factoring these in moves the calculation back towards thermal generation, as coal-fired power plants capture an additional USD 10 per megawatt-hour (MWh) to USD 30/MWh of market value compared with solar PV. However, with more and more renewables in the system, thermal assets often run for lower than their theoretical baseload capacity factors, which plays in favour of renewables. All in all, solar PV and onshore wind remain the most competitive option for investment decisions taken today, with a value proposition that can often be enhanced by adding storage.

Figure 3.5 ▷ LCOEs of utility-scale solar PV and onshore wind, based on FIDs in 2020 in selected markets



Falling technology costs and improved financing have helped new utility-scale solar PV and onshore wind to become cheaper than new gas- or coal-fired power in many EMDEs.

Notes: FID = final investment decision; CCGT = combined-cycle gas turbine. LCOEs are based on projects with FIDs in 2020.

Despite lower costs, the absence of a clear and credible strategy to increase clean energy deployment is a big barrier for investments in many EMDEs. Elevated demand expectations and a lack of economic-based planning result in ambitious expansion plans which are then hard to achieve or, on the contrary, can result in oversupply in some cases. Where targets are defined, they sometimes lack a clear deadline or an implementation plan. Out of our

31 focus countries, almost all countries have defined renewable energy targets, for example, but only a handful have clear implementation plans.[1]

The attractiveness of investments is heavily affected by the level and predictability of revenue streams. Globally, most utility-scale solar PV and wind projects are deployed under models where tariffs are defined up front in long-term contracts: feed-in tariffs (FiTs), PPAs, contracts for differences and other mechanisms that provide a degree of price certainty over the asset lifetime. Such contracts are increasingly awarded by competitive auctions and multi-stage procurement programmes that facilitate transparent price formation and learning that helps reduce the cost of capital. They also deliver standardised, streamlined approaches with long-term visibility on the flow of new projects, to promote competition and achieve economies of scale.

Out of our 31 focus countries, the majority of investments have been made through unsolicited proposals. The examples of competitive procurement include the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) in South Africa, and other similar facilities in Brazil, India, Mexico and Morocco, which have been important mechanisms to attract investment. Designing and implementing such programmes require expertise and costs, but they also enhance transparency and predictability and market confidence, and facilitate price discovery.

Such programmes have evolved with time, and have not always worked smoothly. Over the past decade South Africa's REIPPPP – based on the 2010 Integrated Resource Plan, which targeted over 15 GW of renewables by 2030 – has mobilised over USD 12 billion of investment in solar PV and wind over four rounds. This has spurred the development of more than 100 new renewable IPPs in the country, with an installed capacity of almost 6.5 GW, half onshore wind and close to 40% solar PV (Redis, 2021). Despite its ability to mobilise capital, including from the domestic financial market, the REIPPPP faced a few challenges. For example, projects under round 4 were held up in 2016 and 2017 due to political uncertainty and delays in PPAs being signed by the state-owned utility Eskom. Round 5 was launched in early 2021 (bidding submission expected for August 2021), after a long paused. Still, load shedding (860 hours in 2020, despite reduced demand (Calitz and Wright, 2021)) and major financial strains on Eskom remain a worry for investors and financiers.

In Brazil, auctions for variable renewables started in mid 2000s, focusing on wind. At the beginning, auction and contract design protected generators against unforeseeable wind fluctuations (generators received mild penalties) and the government was responsible for the grid expansions and reinforcements needed to integrate the new generation. These and other factors were important to attract investment, but they also caused challenges. More than half of the wind plants procured in the first three wind auctions over 2009-10 suffered delays greater than a year as a result of problems with the construction of the enabling grid

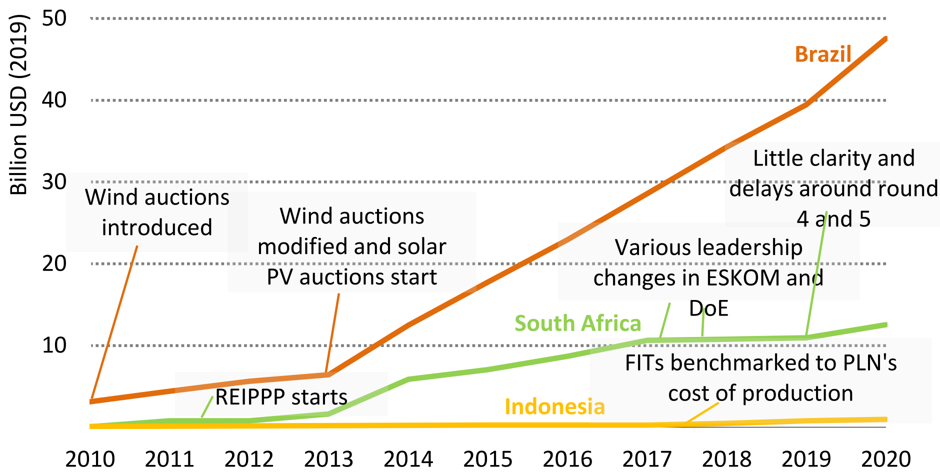
[1] Our focus countries are: Angola, Argentina, Bangladesh, Brazil Chile, Colombia, Costa Rica, Egypt, Ethiopia India, Indonesia, Iraq, Jordan, Kazakhstan, Kenya, Malaysia, Mexico, Morocco, Mozambique, Nigeria, Pakistan, Peru, the Philippines, Russia, Saudi Arabia, Senegal, Singapore, South Africa, Thailand, Uruguay and Viet Nam.

infrastructure (World Bank, 2014). In 2013, the responsibility of grid connection was passed to the investor, generally the private sector, and solar PV auctions were introduced, leading to higher investment in variable renewables over the following years.

Indonesia, on the other hand, is a case where renewable policy and regulation have been relatively unclear and where competitive auctions are still far from the norm. These technologies account for less than 5% of the country's installed capacity in 2019. Despite some progress, critical issues remain, such as the remuneration mechanism and tariff level for renewables. These factors are expected to be included in an awaited presidential regulation, though so far no large procurement programme has been announced.

3

Figure 3.6 ▷ Cumulative investment in utility-scale solar PV and wind in Brazil, Indonesia and South Africa

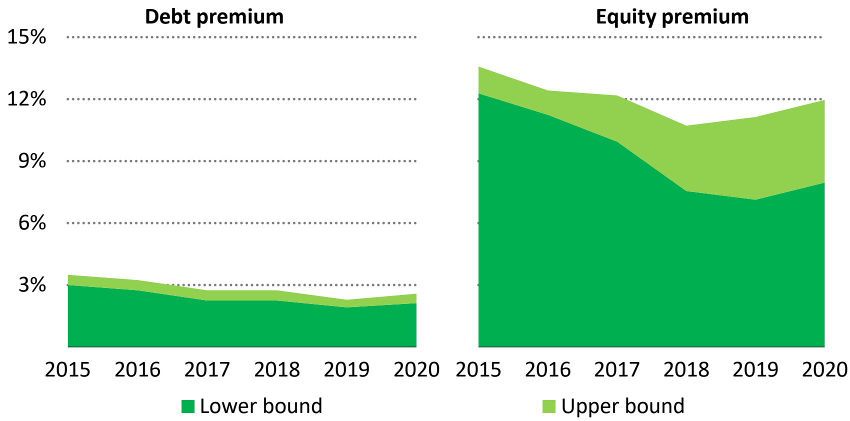


Clear and well-designed competitive procurement programmes, as well as strong institutions, have been successful in driving and sustaining renewable power investment.

Note: DoE = Department of Energy. FiTs = Feed-in tariffs.

In countries that implemented competitive procurement, offered visibility over the project pipeline and bankable long-term contracts, the cost of capital for utility-scale solar PV and wind has come down strongly. Indicative financing costs for solar PV projects fell by around 20-40% in these countries between 2015 and 2020. Lower base lending rates, driven by accommodative monetary policy and lending competition, were also an important driver of this reduction. Yet, factoring out this effect, an analysis of the evolution of the debt and equity premia in India shows that lower overall risk perceptions have contributed to improved pricing of debt and equity for utility-scale solar PV. This was not uniform for all projects, however, as financiers and investors still face challenges like currency risk, ability to obtain land, access to transmission infrastructure or low creditworthiness of off-takers.

Figure 3.7 ▻ Debt and equity risk premia for new utility-scale solar PV in India



Lower risk perceptions have helped improve the pricing of debt and equity for utility-scale solar PV in India. Wide ranges highlight that risks and challenges remain, however.

Note: Premia reflect the portion of the cost of debt and equity excluding base financing rates, which are often determined by government bond yields. Debt premium is shown in a real pre-tax basis.

Revenue-related risks – those associated with the low operational and financial performance of utilities, the main off-takers of the power purchase – can be a key barrier (see below). Exposure to foreign exchange risk, or currency convertibility, is also a worry for investors. Where contracts are set in local currency, PPA prices are sometimes adjusted for local inflation, but occasionally not in full. In countries where it is very hard to raise finance in local currency or which have a history of high inflation, PPAs are generally set in foreign currency, where the counterparty or government takes on the exchange risk. How these and other risks are defined and allocated in the PPA have a big effect on whether developers can reach financial close (i.e. bankability) and at what cost of capital.

Challenges related to land acquisition and access to enabling infrastructure – which can be required by financiers and investors – are also an important risk in some countries. In India, better access to land and timely grid connections lowered returns expectations for investors, with EIRRs for projects in solar parks 20-260 basis points lower than for those on developer-acquired land (IEA and CEEW, 2020). Changes in land policies in Gujarat also brought new wind tendering to a standstill in 2019 and 2020. In Indonesia, where project developers are responsible for securing the land and connecting to the electricity network, an unclear land registry and spatial planning system have created uncertainty over land tenure and caused various local land disputes. Foreigners are not allowed to own land, and in some cases land rights over the same piece of land have been provided to different developers.

Table 3.2 ▷ Currency treatment of renewable PPAs in select EMDEs

Country	PPA currency	Indexation/adjustment to inflation	Cumulative change in exchange rate (2015-20)
Brazil	Domestic	Yes, adjusted by annual inflation	-42%
Chile	Foreign (USD)	No	-21%
India	Domestic	No, though depends on auctions	-15%
Indonesia	Foreign (USD)*	No	-9%
Kenya	Foreign (USD)	No	-8%
Morocco	Domestic	Yes	2%
Pakistan	Domestic	Yes, partially	-57%
South Africa	Domestic	Yes, adjusted by annual inflation	-27%

*Indonesia may be moving towards PPAs that are only partially pegged to the USD.

Note: A negative cumulative change implies a currency depreciation against the US dollar.

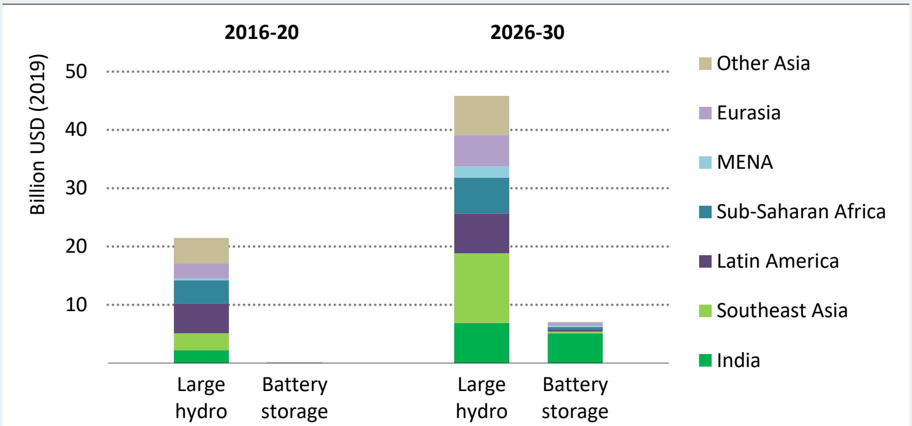
Among the multiple sources of volume risk (curtailment, low electricity demand, underperformance of technology, faulty operation and maintenance, meteorological variations), curtailment risk is often an important concern for investors. Weak transmission systems, or transmission links, mean generators face output uncertainty outside their control. How curtailment is treated in the PPA (e.g. whether the IPP is compensated when curtailment is outside its responsibility) is critical to reach financial close. Incidences of curtailment arise more frequently in countries where the solar PV and wind sectors are more mature, or in cases where deployment has picked up quickly (given that transmission lines are generally slower to design, build and commission than solar PV and wind plants), or where transmission capacity is very low and even small projects can cause problems.

Box 3.1 ▷ Financing low-carbon options for electricity storage

As power systems decarbonise and shares of variable renewables rise, so the importance of electricity storage rises as a way to underpin reliable supply. Electricity storage assets are required to provide both short-term flexibility, to cope with frequency or voltage control, and long-term reserves, to give firm capacity to cover seasonal variations in demand, lulls in wind and solar availability and an ability to absorb periods of excess variable renewable power. Robust and well-functioning electricity grids are an indispensable ally of storage, and hydropower reservoirs, including pumped hydro, and batteries are the main low-carbon options for energy storage today. Batteries are a good solution in remote areas, where they can be hybridised with solar PV in mini-grid systems, or in systems characterised by daily rather than seasonal fluctuations in demand. Cost improvements have been a key driver of the pickup in battery storage deployment. Lithium-ion battery costs have fallen more than 85% since 2010 (BNEF, 2020), and costs are expected to continue falling, with foreseen reductions in capital costs of 50% through 2040 (IEA, 2020e).

One of the main risks for storage investments is low cash flows during the first years of operation, as fossil fuel-based systems can cope with small shares of decentralised loads and variable renewables, and economic incentives for flexibility can take time to appear. If solar PV or onshore wind plants penetrate fast into the system, flexibility and firm-capacity gaps can arise more quickly as pumping storage needs several years of planning, permitting and construction. Alongside opportunities for energy arbitrage, much depends on market design, how the services provided by storage are remunerated – including payments for capacity – and the evolution of existing fossil fuel power plants, to the extent that these are refurbished to run more flexibly. Tariff design is also an important aspect to incentivise the participation of distributed batteries from the residential, commercial and industrial segments.

Figure 3.8 ▷ Annual average EMDE investments in large hydro (including pumped hydro) and battery storage in the SDS:



Investments in hydro more than double over the next decade in a climate-driven scenario, while battery storage requires average annual spending of over USD 5 billion.

An approach to incentivise investments in storage is to set specific targets based on optimised cost-effective power plans. In Viet Nam, specific pumping and battery storage sites were identified in the National Electricity Development plan for 2021-30, and around 2.7 GW of hydro power stations (with 900 MW of pumped hydro) and 1.2 GW of lithium-ion batteries are expected to come online by 2030. Specific long-term auctions can be another alternative, such as those organised in Brazil, which have awarded nearly 6 GW of hydro power projects since 2005. Another option is to offer hybrid renewables-plus-storage auctions. In 2020 the Solar Energy Corporation of India (SECI) held such a tender, awarding contracts for 3 gigawatt-hours (GWh) of pumped hydro and battery storage.

Some EMDEs are developing options for diversifying the sources of power purchase, outside of traditional utility counterparties. Corporate PPAs for solar PV and wind have experienced impressive growth, with more than 25 GW signed in 2020 globally, up from around 5 GW in 2015. EMDEs accounted for a small, but growing share, with 3.5 GW awarded in 2020 up from less than 100 megawatts (MW) in 2015. Regulations for direct procurement have been put in place in India and some countries in Latin America and Southeast Asia, but a number of barriers remain for widespread adoption. In Brazil, large consumers can negotiate PPAs with developers is an unregulated market known as the "mercado livre de energia". In India, corporate PPAs can be attractive in light of high commercial and industrial tariffs, especially for energy intensive users such as cement companies (see Chapter 4), but growth depends on reforms to facilitate contracting while ensuring system adequacy and cost recovery.

Key factors influencing investment decisions for dispatchable renewables

Dispatchable clean power provides firm, flexible and, in most cases, very economic power that can help to integrate variable renewables. The main sources of low-carbon dispatchable power are nuclear, hydropower, bioenergy and geothermal, supplemented in far-reaching energy transitions by fossil fuels equipped with CCUS and by hydrogen and hydrogen-rich fuels. In this section, we focus on investment in hydropower and geothermal.

The LCOEs for new hydropower and geothermal projects in EMDEs range from USD 40/MWh to USD 100/MWh, depending on project-specific factors. Hydropower projects, for example, vary from very large plants such as the 1.4 GW Inga II dam in the Democratic Republic of Congo or the recently completed 11 GW Belo Monte dam in Brazil, to a few megawatts (notably, mini and pico hydro can play a very important role for energy access and powering remote communities). Large-scale projects benefit from economies of scale, and have low generation costs. Prices discovered in a 2019 Brazilian auction were less than USD 40/MWh for large hydro (almost 450 MW), while recent-year auctions for smaller-scale projects resulted in prices of USD 55/MWH to USD 60/MWh in Brazil, and around USD 100/MWh in Argentina. Awards have benefitted from lower long-term interest rates over time.

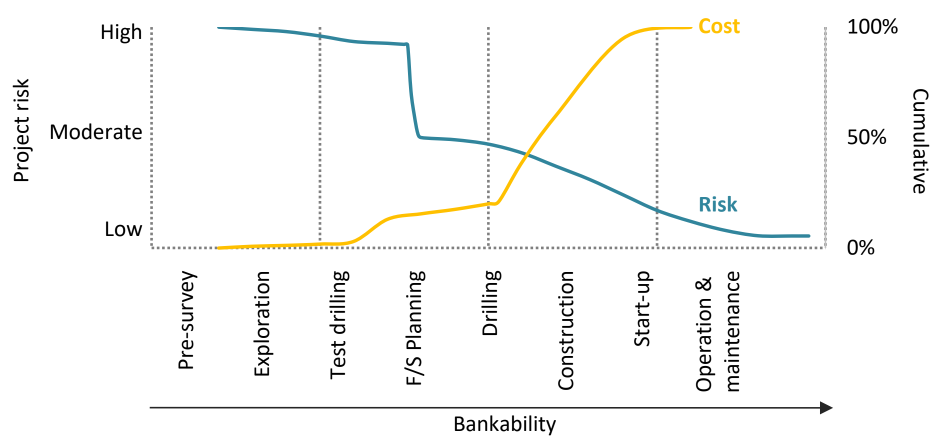
Hydropower and geothermal projects are generally financed under long-term PPAs, as with solar PV and wind. However, they face additional, specific risks. As resources are sometimes located in sensitive areas, the challenges associated with permitting and environmental licensing procedures can also be high and lead to cost overruns due to delays in project development. This is why procurement programmes generally incorporate targets and project development support for geothermal, in the countries where this resource is concentrated (El Salvador, Ethiopia, Indonesia, Kenya, and the Philippines), and sometimes small-scale hydropower.

While hydropower can bring multiple benefits, three important barriers can hold back development. First, projects are site-specific, with the availability of good economic and technical resources limited to certain countries and regions. Second, projects need to meet high environmental, social and governance standards to make them bankable. Careful assessments need to be made on the potential impacts to biodiversity and ecosystems (e.g. river basin management plans), as well as social consequences (e.g. displacements). Third, despite being substantially more reliable than wind and solar PV in the operational phase, hydropower involves much more uncertainty during the development and construction phases, which can take up to ten years and are often subject to local opposition.

Hydropower projects can also face climate-related physical risks – floods and droughts – affecting generation output and project returns. Some of EMDE countries more vulnerable to extreme weather events (Latin America and sub-Saharan Africa) are the regions with the greatest resource potential (IEA, 2020b). For example, a shorter rainy season and more frequent droughts has undermined power supply in Zambia, where more than 80% of electricity comes from hydro, typified by declining water availability in the Kariba dam.

As potential damages are generally very large, private insurance options might not be able to cover the full cost. For example, damage to the Ituango dam in Colombia caused by heavy rainfall and landslides resulted in the largest claims in the history of engineering (over USD 2.5 billion for infrastructure recovery), and a loss of over USD 600 million (IEA, 2021a). Plus, impacts can affect the surrounding population and ecosystems. Tens of thousands had to evacuate the Ituango dam in 2018. Civil society and environmental movements have increasingly raised concerns in light of such experiences. In Chile, the HydroAysén project (approved in 2012) – a 2.7 GW dam with a 3 000 MW high-voltage, direct-current (HVDC) line – was later cancelled following an environmental hold and large-scale protests.

Figure 3.9 ▹ Project cost and risk profile for geothermal projects



Geothermal projects face additional risks during early stages of development which require public support to mitigation such risks, especially in countries with little experience.

Note: F/S = Feasibility study.

Source: IEA analysis based on ESMAP (2012).

Geothermal power is enjoying a resurgence of interest because of the huge size of the resource, the importance of dispatchable low-carbon power, the overlap with the skills of an oil services industry looking to diversify, and rapid technological innovation. However, it is a very knowledge-intensive industry, with few experts around the globe and where working with experienced teams is paramount to project success. It also faces high exploration and drilling risk. The output and returns of a geothermal project can be determined only after substantial capital expenditure in exploration drilling. Price-based instruments such as FiTs may not be enough to encourage investment, and public support during the exploration phase is generally needed, especially in countries with a low track record of investment.

Given high early-stage risks, equity investors can require annual returns of 20-30% and commercial lending is not generally available during this phase. As the sector matures, though, governments can move towards transferring more of the early-stage risk to the private sector, as in the Philippines. In many instances, the economics of geothermal projects can be improved by offering direct heat to communities and industries, as well as electricity.

Actions and case studies for mobilising finance

Addressing issues raised above and mobilising much higher levels of renewables investment in EMDEs points to stronger policy and financial efforts around the following areas:

- Reducing revenue risks through creditworthy intermediaries, or alternate buyers.
- Boosting market development with procurement and concessional funds.
- Addressing specific project risks (e.g. exploration) with risk-sharing mechanisms.
- Lowering financing costs and increasing the role of private capital with blended finance.
- Rolling out infrastructure to overcome land and grid bottlenecks for generation projects.
- Regional project co-ordination to reach scale and attract international funding.

Reducing revenue-related risks can involve incorporating liquidity mechanisms in the contract (e.g. an escrow account), using intermediary tendering entities or hedging risk by selling to different parties. In **India,** the government set up a creditworthy intermediary (SECI), responsible for designing and establishing competitive renewables auctions for long-term PPAs. Since 2013, SECI has awarded capacities of 20 GW of solar PV and 9 GW of wind (MNRE India, 2020). Given SECI is a quasi-sovereign off-taker, investors can make investment decisions with lower cost of capital assumptions, leading to very competitive tariffs.

In **southern Africa,** Africa GreenCo acts as an intermediary to provide hedging mechanisms that address revenue risks. It is piloting a scheme to buy electricity from renewable IPPs and re-sell to utilities and private consumers as well as trade power in the Southern Africa Power Pool. While GreenCo's business model is set to fill a crucial risk management gap to enable investment, scaling this model may depend on the development of more extensive wholesale markets as well as rules permitting greater private participation in power trading.

Boosting market development. In **Brazil,** renewables investment accelerated through a combination of competitive auctions, with long-term PPAs denominated in local currency, and concessional loans from the Brazilian Development Bank (BNDES). The loans included tenors of up to 20 years for projects meeting local content requirements. The availability of concessional, long-term debt unlocked funding when market-based interest rates were high at around 15%, and domestic capital was constrained. Notably, BNDES was responsible for 70-80% of infrastructure financing in Brazil over 2007-17 (S&P Global Ratings, 2017). In **South Africa**, the Development Bank of Southern Africa played a similar role under the REIPPPP.

As markets mature, the role of national development banks (NDBs) is set to shift from direct finance to catalysing projects. In Brazil, bonds have become increasingly popular to finance renewable power and BNDES adopted a new financing strategy in 2017 to gradually bring its concessional rate towards a market-based long-term rate, and encourage more capital coming from commercial sources, as well as the capital market Veirano Advogados (2020).

In **Argentina**, the government launched the RenovAR auction programme to increase renewables in the electricity mix to 8% in 2017 and 20% in 2025, from 2% in 2015. A complementary Fund for the Development of Renewable Energy (FODER) provided financing and a guarantee that covered risks of delayed or non-payment by the utility, and termination risk (World Bank, 2018). This fund assuaged investor concerns over Argentina's track record of high political risk and lack of experience developing renewables. A guarantee provided by the World Bank backstopped the fund in case of shortfalls. Of the nearly 60 projects awarded in the first two rounds of RenovAR, nearly half (1 GW) were covered by the World Bank guarantee. This programmatic approach to guarantees, a first for the World Bank, mobilised around USD 3.2 billion in investment with almost 80% from commercial sources.

Addressing specific project risks. Much of **Indonesia**'s renewables investment over the past five years has been in geothermal, for which there is excellent potential. However, exploration risk still hinders development. Given high upfront drilling costs, private actors are reluctant to develop projects. In response, the government, with support from the World Bank, launched the Geothermal Fund in 2017, which offers concessional loans to developers for early-stage exploration. The USD 275 million fund is administered by PT SMI, a state-owned entity under the Ministry of Finance created in 2009 to catalyse infrastructure investments. With the PT SMI portfolio still limited in 2020 (due to stringent criteria required to tap into the fund and relatively low tariffs for geothermal projects), the government and the World Bank, together with the Clean Technology Fund, launched the Geothermal Resource Risk Mitigation Facility. The facility aims to provide financing and risk mitigation for exploration activities, available for both SOEs and private companies. This model could help unlock more geothermal investment in Indonesia and provide a template for other countries.

In Turkey**,** the government took a different approach in tendering out geothermal sites (and rights) to developers for a FiT. Turkey now implements a risk-sharing mechanism similar to that from PT SMI, where developers obtain partial coverage of drilling costs (40-60%, up to USD 4 million, depending on location) in the case of unsuccessful wells. Unlike in Indonesia, this mechanism is available only for privately financed projects. The Geothermal Risk Mitigation Facility – funded by both African and European donors – is another mechanism that co-finances surface studies (up to 80% of the cost) and drilling programmes (up to 40%) in **Eastern African countries**, such as Ethiopia and Kenya.

Lowering financing costs. Blended finance has helped mitigate some perceived risks in new markets and attract lower-cost private capital. In **Indonesia,** concessional debt enabled the country's first utility-scale wind farm in South Sulawesi – the 75 MW Sidrap Wind Farm – which started operations in 2018. The USD 150 million project was financed with 80% debt. Half of the USD 120 million 16-year loan was provided by the Overseas Private Investment Corporation (now the US International Development Finance Corporation) and half by a Japanese commercial bank. The project was developed as a joint venture between a US and an Indonesian company. The second project in Indonesia, the 72 MW Tolo 1 Wind Farm, was financed with a USD 120 million loan from the Asian Development Bank (ADB), with a Singapore-based fund (Equis Asia Fund II) providing a 25% equity share of USD 40 million..

Local financial system development, and the availability of long-term finance, is an important enabler of investment. In **South Africa**, where the financial sector is better developed than in most EMDEs, IPPs were able to mobilise higher levels of debt, with less reliance on public funds, compared with other sub-Saharan African countries. In some cases, domestic pension and sovereign wealth funds play key funding roles. For example, **Senegal**'s Sovereign Fund for Strategic Investments (FONSIS) has provided equity for solar PV in Senegal.

Rolling out infrastructure. Generation investment can often be hampered by a lack of transmission infrastructure to integrate the project output. DFIs have been working with governments to unlock grid bottlenecks and to ensure system stability. For example, the World Bank is developing a project with the utility and the Ministry of Energy in **Burkina Faso** to double the capacity to integrate solar generation by 2025. The project combines concessional financing from the Clean Technology Fund and World Bank to create a hybrid solar park with storage and reinforce the dispatch and network of SONABEL (state-owned vertically integrated utility). The project also includes financing for the shared infrastructure for a 300 MW solar park and a 300 MWh battery. The World Bank expects to mobilise over USD 350 million of private investments for the solar park power plant.

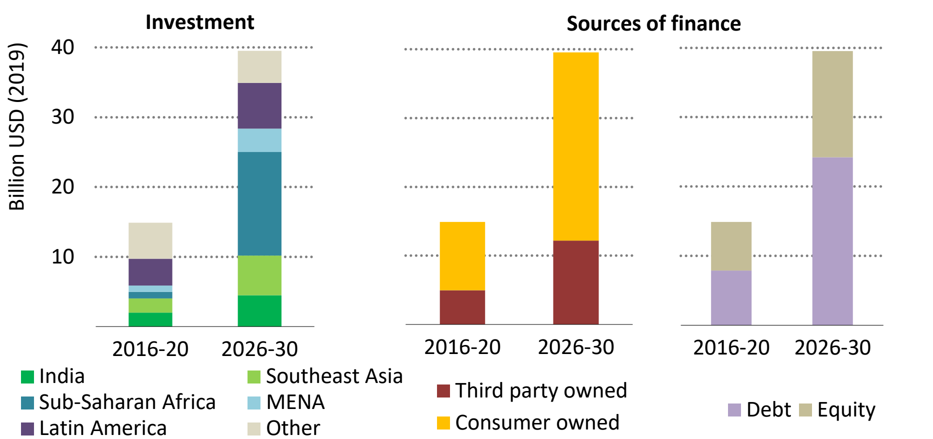
Regional system planning and coordination for project development at scale. The **G5 Sahel** countries (Burkina Faso, Chad, Mali, Mauritania and Niger) endorsed the Desert to Power initiative to harness the solar potential of the region alongside five key priorities: increasing on-grid solar generation capacity, strengthening transmission and distribution, rolling out decentralised solutions at scale, reforming national utilities, and strengthening the policy, legal and regulatory framework. All five countries adopted in 2020 national Desert to Power roadmaps collectively envisaging 10 GW of additional capacity. Some 85 priority projects were identified, including over 2 GW of solar PV, with associated investment of USD 3 billion. A few projects have also been approved for financing by the African Development Bank (AfDB), though realizing the scope of the initiative will require much more resources mobilised and a high degree of coordination between public and private entities.

3.2.2 Distributed clean power[2]

Investment outlook and sources of finance

Distributed solar PV is playing an increasing important role in EMDEs. Over the past five years, capital spend in EMDEs has grown from under USD 5 billion annually to over USD 20 billion in 2020, supported by steady cost reductions of solar PV modules. This investment has so far been concentrated in relatively few markets with supportive policies, but it would need to double (at least) by 2030 and become much more broad-based to match the needs of IEA climate-driven scenarios. Given its modular nature and rapid development times, deployment can react quickly to changing policy and market signals, as in Viet Nam, where deployment topped 9 GW in 2020. Some 40% of projected growth in the 2020s in the SDS comes in sub-Saharan Africa, with Southeast Asia, India and Latin America accounting for more than one third.

Figure 3.10 ▷ Annual average EMDE investment and financing for distributed solar PV in the SDS



EMDE investment in distributed solar PV more than doubles in a climate-driven scenario, which depends on options for third-party ownership and debt financing structures.

Distributed solar plays a distinct role in enhancing electricity service, particularly in markets where land is constrained and for consumers facing daytime peak demand and high power prices. It can also have implications on the value and performance of investments elsewhere in the system, depending on factors such as the strength of the grid and the degree of self-consumption. Our projections cover all market segments, but the opportunity in many EMDEs is particularly strong for commercial and industrial consumers, who account for the

[2] This section focuses on grid-connected installations, which present distinct policy and investment issues compared with the off-grid and mini-grid applications analysed in Section 3.4 on energy access.

majority of electricity demand growth in many countries to 2030. The residential segment is a more difficult area to tackle as households generally enjoy greater degrees of electricity price subsidies and face higher constraints in terms of access to finance.

In addition to broader power system considerations, the outlook for distributed solar PV also depends on the availability of certain sources and types of finance. While most investments are made on the balance sheets of consumers, the role of off-balance sheet arrangements, such as third-party ownership, grows as a way of helping to defray the upfront capital requirements for cash-constrained companies. Over half of investments are financed with debt, pointing to the importance of domestic credit for small and medium-sized enterprises (SMEs) and energy service companies (ESCOs). Direct finance by public finance institutions remains low, but indirect funding of local banks for on-lending purposes serve as an important source.

Key factors influencing investment decisions

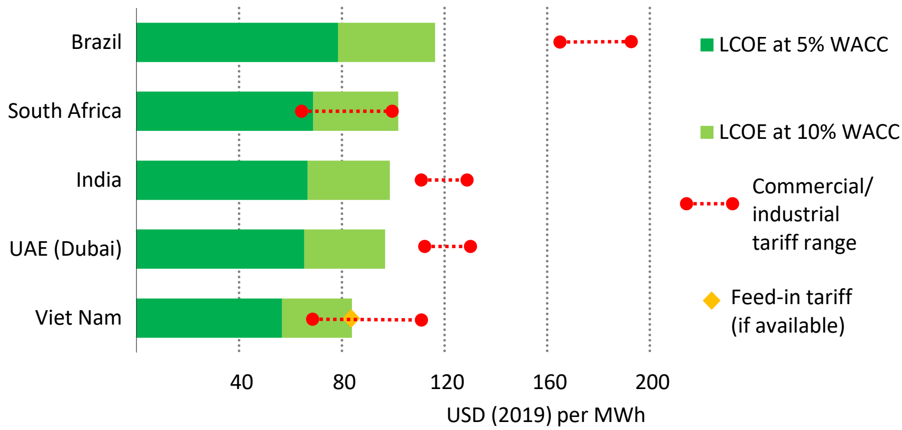
The availability of suitable roof space, or land, in the case of ground-mounted systems is a key challenge for investment in distributed solar PV. Since such installations are often located close to demand centres, and in dense cities, the built environment may not offer adequate physical space. There is also the question of ownership. In multi-tenant or leased buildings, opportunities and incentives to invest may be split between the owner and the occupants, a common challenge also for energy efficiency investments (Section 3.5). The length of building leasing arrangements may not align with the lifetime of the solar PV system. Moreover, the volatility of the economic cycle, in which new businesses come and go, may leave banks without suitable collateral in the case of default or relocation.

Distributed solar PV can have very good potential in countries with wide buildings with consistent daytime demand loads, such as shopping malls, warehouses, ports and factories. But the investment case depends on clear underlying titling regulations as well as ways to monetise solar PV systems in the case of ownership transfers. This also highlights the role of good resource assessment tools, such as the Global Solar Atlas, and the World Bank's effort to conduct more detailed rooftop mapping for 14 client country cities (World Bank, 2020a).

The investment case also depends on the underlying capital costs, revenues and available financing, which can vary widely by market. On the cost side, commercial-scale solar PV installations currently range between USD 700 per kilowatt (kW) and USD 2 100/kW. While equipment costs have fallen in recent years, benefiting from global module price reductions, balance of system costs and soft costs related to legal, permitting and customer acquisition can remain elevated. These factors can contribute to a high LCOE even in markets with very good resources.

The revenue profile depends strongly on the level of self-consumption, as well as policies for retail tariff design and remuneration of excess power. Almost half of the distributed solar PV installations expected over the next five years in EMDEs are based on net metering schemes, where generation is credited to a consumer's bill at retail rates based on annual or monthly accounting (IEA, 2020d). More than 35% is expected to be based on self-consumption, where consumer cash flows are based on savings from reduced grid consumption and the remuneration of any excess power at a value-based price. The remainder stems from buy-all, sell-all schemes (e.g. FiTs), where there is no self-consumption, or self-consumption where excess power is remunerated at wholesale prices.

Figure 3.11 ▷ Distributed solar PV LCOE and retail power tariffs in select areas



Distributed solar PV investment has increased more in markets with relatively high power prices and lower costs; better financing options would help improve the investment case.

Note: Only industrial tariffs are available for Argentina and Mexico.

Source: Electricity tariffs from IEA (2020c).

Designing schemes that balance deployment goals and equity issues poses a challenge. While policy makers seek to keep power prices affordable for consumers, subsidised electricity tariffs can undermine the attractiveness of net metering or self-consumption, which is the situation in a many markets. Unclear remuneration rules (e.g. in Egypt) and limits on grid exports (e.g. in Malaysia) can affect the investment case. At the same time, there is the potential for boom-and-bust cycles when incentives are set at generous levels, as in the case of FiTs in Viet Nam. If not designed properly, net metering schemes that result in the crediting of bills during periods of relatively low solar system value or allow the avoidance of fixed network and other system charges by solar PV owners can shift cost burdens onto other customers. Unlike in utility-scale solar PV, price discovery via auctions is rare, with challenges in aggregating many small installations into larger tendering blocks.

Utilities in EMDEs, many of which struggle with cost recovery (Section 3.4), are often wary of the revenue implications of expanding distributed solar PV, including grid defection and loss of high-paying customers, who often cross-subsidise less well-off consumers. Exporting power can require grid investments to accommodate bidirectional flows. Planning based on the recovery of fixed costs; integration of flexibility, such as battery storage, to promote self-consumption; and utility ownership (see below) can help address such issues. Still, this requires rigorous cost-benefit analysis. Balancing deployment goals with retail tariff design to allow for cost recovery is critical, but unpredictable changes to fixed charges can raise investment risks.

A persistent challenge relates to financing upfront expenditures by companies for whom energy is not part of core business. In general, SMEs often have limited access to debt because of underdeveloped financial markets, as well as lack of credit rating and project scale. Three financing structures predominate, but their attractiveness depends on the regulatory framework, underlying project cash flows and financial health of the participants.

Table 3.3 ▷ Financing structures for distributed clean power

Ownership structure	Consumer payment options	Financing options
Consumer	Direct purchase by consumer	Balance sheet Solar loans from banks
Third-party developer	Rooftop rental Equipment leasing PPA/shared savings contract	Developer equity/debt Solar loans from banks Refinancing (securitisation)
Utility/community	PPA with utility Solar or green tariff	Regulated rate of return Green bonds

To date, most investment has come via consumer-owned systems. While third-party ownership has grown in some markets (e.g. India, Brazil), local developers are often undercapitalised and rely on high degrees of costly equity. A few large international players have emerged (e.g. Cleantech Solar, Sunseap), but third-party ownership is often hampered by local regulations regarding ownership and market access.

Increasing third-party ownership could help unlock investment, and the potential to aggregate projects into larger transaction sizes, through securitisation, could also help improve off-balance sheet and debt financing options, as well as the ability to refinance portfolios to free up capital for reinvestment. The attractiveness of such arrangements may also shift over time. For example, as installation costs have fallen in the United States, and banks have offered more solar loans, consumer ownership has risen in recent years.

Actions and case studies for mobilising finance

While national policies and financing schemes play an important role in distributed solar PV, the small-scale nature of investment and interaction with utility distribution and billing systems mean that regulations and programmes at the subnational (e.g. municipal, state) level have a big impact on financing projects. Several cases illustrate policies and financial approaches to address these issues, including:

- Setting appropriate remuneration, implementing procurement and reducing costs.

- Improving domestic lending and developer capabilities with public finance.
- Promoting new business models targeting commercial and industrial customers.

Setting supportive policies and reducing costs. In **Brazil**, most investment is driven by net metering, which was introduced in 2012, but did not take off until 2016, when regulations changed to accommodate projects up to 5 MW, and exempt sales tax for smaller installations. Based on the sales profile of the country's largest developer, around 50% of investments are financed with third-party ownership. The government's elimination of import taxes on solar PV modules combined with improved financing conditions also supported development. With the Selic rate (Brazil's base rate) at around 2%, the cost of financing for commercial consumers has come down over time. State-backed investment, through the São Paolo Metro's procurement plans, further support the market, but currency depreciation in recent years has also raised uncertainties over imported equipment costs.

Improving domestic lending and developer capabilities. India's nearly USD 2 billion annual investment is supported by self-consumption, state-level net metering and third-party ownership. State-backed procurement, e.g. by Indian Railways, and utility-run auctions in Delhi, Telangana and Uttar Pradesh provide a new route for investment. Public finance plays a key role. Domestic lending capacity has been reinforced by development banks, with preferential lines of credit by the World Bank and ADB. UK Climate Investments provided equity to fund expansion plans of CleanMax, the largest developer, and KfW partnered with local banks to facilitate project refinancing. Still, investment is falling short of India's ambitious targets – tariffs in many states do not sufficiently incentivise utilities to promote distributed PV, and large potential among SMEs remains untapped due to credit constraints.

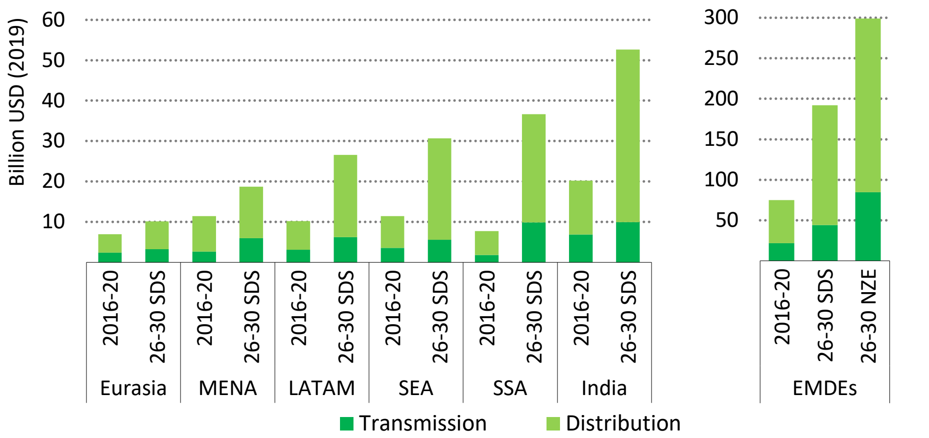
Promoting new business models. Bangladesh is a market with low financial system development, high population density and rapidly growing electricity demand. Investment is supported by the recent adoption of net metering, which has become attractive for textile and garment factories that have high and consistent daytime loads and pay high industrial power tariffs. New third-party developers, such as Joules Power, are now offering 20-year rooftop leasing arrangements. At the same time, the government is working with the World Bank on feasibility studies to bring rooftop solar PV to factories within the country's largest economic zone under development, helping to reduce transaction costs and facilitate aggregation. Still, Bangladesh's distributed solar PV development remains at early stages, and factory owners are calling on the government to simplify processes to obtain bank loans.

3.2.3 Electricity networks

Electricity grids are the backbone of power systems and investment in their expansion and modernisation becomes even more important in rapid transitions. They not only need to accommodate growing demand, but also the integration of renewables. However, as things stand, the poor state of electricity grids in some EMDEs (accompanied, in some cases, with poor operational practices) acts as a major constraint on clean power investment, making it more difficult to accommodate new wind and solar PV projects and increasing economic hurdles because a higher share of the produced electricity is lost before it gets to consumers.

From today's levels, annual investment in electricity grids needs to more than double by the end of the decade in the SDS, and it quadruples in the NZE. India is a major focus for investment, followed by Southeast Asia and sub-Saharan Africa. Distribution accounts for most of the total investment, though there is some variation by region. For example, distribution lines account for 80% of the capital spend in Southeast Asia, a region with dispersed geography and local integration challenges. Around 15% of the increase in EMDEs is attributable to renewables integration, while 20% goes to the replacement and modernisation of existing infrastructure.

Figure 3.12 ⊳ Annual average EMDE investment in power grids in IEA climate-driven scenarios



To support growing demand and modernisation and integration goals, EMDE investment in power grids more than doubles in the SDS, with three-quarters of this in distribution.

Note: LATAM = Latin America.

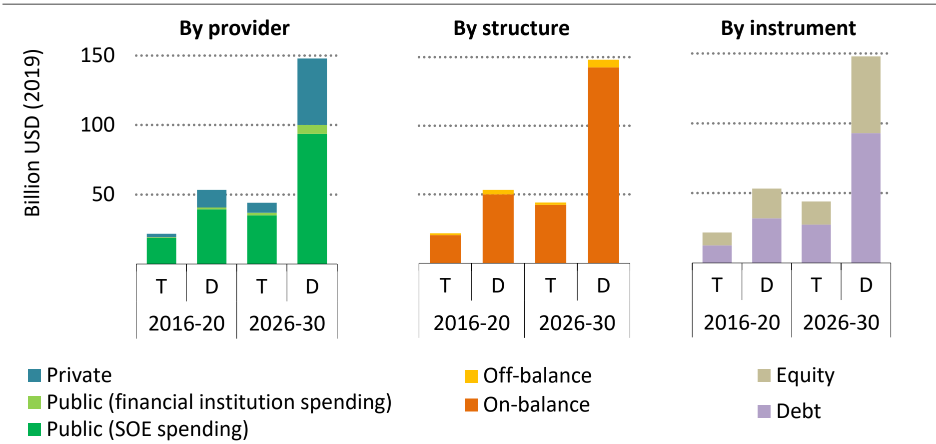
The majority of transmission and distribution assets in EMDEs are owned by state-owned utilities and financed by governments, supplemented by public finance institutions. Some of these utilities operate as vertically integrated monopolies. Unlike in transmission, where regulators and system operators often seek to centralise planning and operations, distribution grids are more compartmentalised, with greater allowance for private participation in the fully regulated business, though it varies country by country. For example, while transmission and distribution in South Africa is dominated by vertically integrated and state-owned utility Eskom, there are a dozen private and public transmission and distribution companies in Brazil.

Private participation in distribution has mainly come through liberalisation efforts where regulators sought to improve capital efficiency, encourage higher standards in O&M and quality of service, and drive innovation. Such efforts have led to increased private distribution investment in many Latin American countries over the past three decades.

However, there are other business models to attract private investment. Some examples include long-term concessions, such as the one granted by the Uganda Electricity Distribution Company Limited to the private entity Umeme – to invest, operate and maintain the distribution network for 20 years – or the "distribution franchises model" in India, with public-private partnerships like the Tata Power Delhi Distribution Limited, which has a concession to invest, operate and maintain distribution in one of Delhi's four zones.

In IEA climate-driven scenarios, public sources of finance remain dominant, but a higher level of private sources is needed to achieve the boost in necessary investments. PFIs, including domestic infrastructure banks and international finance institutions, have a small but growing role in financing grid infrastructure. They provide mainly loans to SOEs, but their involvement becomes more vital also to crowd in private capital to distribution, off-grid and mini-grid investments, and transmission projects built on a project-financed basis.

Figure 3.13 ▷ Sources of finance for EMDE investment in power grids in the SDS



In climate-driven scenarios, public sources of finance remain dominant for grid investments but private capital can play an important role to reach the necessary boost in spending.

Notes: T = transmission, D = distribution.

Due to their planned and regulated nature, with largely stable revenues defined up front, and dependence on government entities for funding, electricity networks are often treated by investors as bond-like investments. This situation has allowed for relatively high leverage, with debt accounting for around 60% of grid investment. The pandemic has raised near-term vulnerabilities for debt finance for some governments and SOEs. In IEA climate-driven scenarios, the share of debt rises over time with an improved economic and regulatory framework for grid investments. Off-balance sheet project finance structures gain in importance, but at around 5% of investment, are limited to specific cases, such as HVDC lines or interconnectors in transmission or mini-grids in remote areas.

Expanding and upgrading transmission

Key factors influencing investment decisions

A combination of state ownership and regulatory oversight shapes most investment in grids in EMDEs. In the majority of this report's 31 focus countries, private-sector participation is not allowed. Even where private actors participate, investor interest has been generally low, except, for example, in some Latin American countries and India's interstate transmission.

A number of factors contribute to underinvestment. High system losses undermine the attractiveness of financing, even though the situation varies by geography, with countries in sub-Saharan Africa having higher system losses on average than those in Southeast Asia. Many proposed projects do not have a firm economic justification, resulting in overinvestment in some parts of the system and transmission constraints in other parts. Lack of mandatory planning is also an issue. Only around one-fifth of EMDEs require least-cost system planning (Foster and Rana, 2020). Furthermore, plans are often not developed with a long-term view on the specific requirements of rapid energy transitions.

Another barrier, especially in large transmission projects that involve multiple jurisdictions and actors, is the difficulty to allocate project costs. This is particularly important in the context of multilateral power trading, for example, where transmission interconnectors are built between two or more countries. Higher power integration can bring multiple benefits, including: creating savings in generation and transmission assets by optimising at a regional level, better management of hydrological and seasonal imbalances, and the ability to respond quickly to changes in demand. Yet cross-border trading is still generally quite low in EMDEs and transmission interconnectors can face a drawn-out process to obtain financing.[3]

Under a sound regulatory and institutional environment, revenues to the transmission company (whether public or private) should be enough to finance its own assets; i.e. provide a reasonable return for new investments and cost recovery for existing projects, with or without subsidies. But this is often not the case in EMDE countries, where retail electricity prices are set too low for reliable cost recovery and only around half of EMDE utilities can be considered financially viable (Section 3.3). While reforms over the past three decades have broadly improved prospects for cost recovery, progress has been uneven.

Financing of transmission projects to meet rapidly growing investment requirements remains a crucial challenge for energy transitions. Cost recovery issues and a lack of private-sector involvement means that development finance needs to play a big role in helping to unlock capital. DFIs are also well placed to take more regulatory and political risk and may have influence in system modernisation efforts. When reforms are put in place to improve cost recovery, private-sector financing can play a larger role, particularly for new lines.

[3] Cross-border transmission lines, which have specific characteristics and associated risks, are not the focus of this report.

A few models have been applied across the world to mobilise private capital to the transmission sector. These vary in terms of coverage, contract duration, revenue setting and risk allocation. The choice of business model also depends on the country's regulatory capacity, as some models require much stronger implementation efforts.

In EMDEs, various business models have been used, though the BOOT model (build, own, operate and transfer) is one that has been implemented more successfully in various South American countries (largely in Brazil, Chile, Colombia and Peru) and in India for interstate transmission lines.

Table 3.4 ▹ Main business models for privately financed transmission

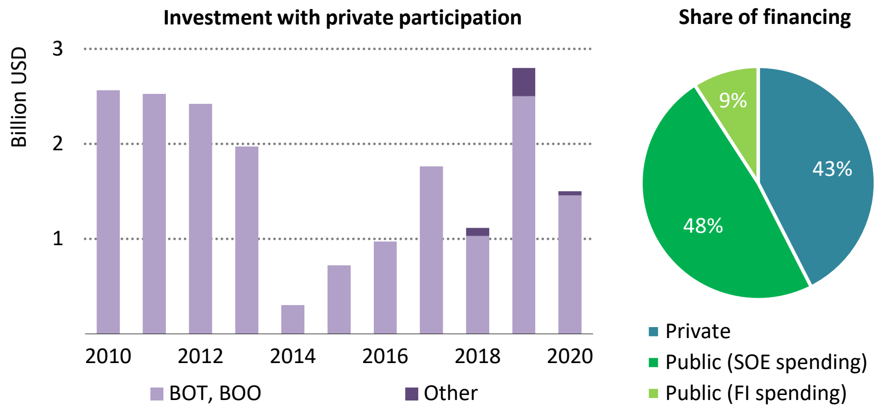
Business model	Description	Contract duration	Contract coverage	Revenue/ tariff setting	Examples
Long-term concession	Private company manages and operates existing assets and expands in its area of operation	Long term (30-50 years) or indefinite	All existing and new lines in a country/region	Regulated revenues, subject to periodic review	Philippines, United Kingdom (UK)
BOOT	Private company finances, builds and operates line under long-term contract; transfers later to government	Long term (often 25+ years)	New line (or package of lines)	Majority of revenues defined by winning bid, for entire duration	Australia, Brazil, Chile, India, UK, US
Financial ownership	Private company partially finances new line; built and operated by system operator	Indefinite; optional system operator buy-back	New line	Congestion rents or regulated revenue to operator	Denmark and Germany
Merchant line	Private company finances, builds and operates line; revenues from short-term wholesale market	Indefinite	New line, often HVDC	Wholesale market; price mechanisms (e.g. cap-and-floor)	US and Australia
Dedicated line (for IPP)	New line evacuates power from IPP to existing grid	Same as IPP, unless transferred up front	New line	If line not transferred, revenues part of IPP contract	Globally applied

Source: Adapted from Arboleya, L. and Kristiansen, R. (2021).

Under the BOOT model, a private company finances and builds a transmission line, operates it for around 20 to 25 years and then transfers it to the government. The private company typically receives a tariff and does not take price risk on the investment, an arrangement similar to the IPP model in generation (Arboleya, L. and Kristiansen, R., 2021). Investors get paid as long as they meet a certain line availability criteria (generally around 95%) and have other performance indicators and penalties during construction and commissioning.

The BOOT model can also help reduce system costs and mobilise new sources of finance. Investors generally compete by bidding an annual transmission price, subject to a price cap defined by the regulator's expected cost. Evidence from Brazil and Peru shows that winning bids were generally below the estimated cost, with average discounts on the cost estimate of almost 30% in Brazil over the last 20 years and 36% in Peru in 15 tenders between 1998 and 2013 (World Bank, 2017). In India, BOOT developers have also issued non-recourse bonds receiving an AAA credit score and have successfully refinanced their debt.

Figure 3.14 ▷ Investment in power transmission in Brazil, 2010-2020



Brazil has mobilised considerable private capital for transmission, especially under contracts on a build, own, operate and transfer basis.

Notes: BOT = build, own, transfer; BOO = build, own, operate; FI = Financial institutions.

The concession model has also been applied in a few EMDE countries, with varying degrees of success. In the Philippines, a private consortium formed by international and local players has a concession to operate, maintain and expand the transmission sector from 2009 until 2034, while the government retained ownership of the country's transmission assets. Cameroon, Mali and Senegal implemented long-term concessions in sub-Saharan Africa over the last two decades, but these were either terminated earlier than expected or the government regained a majority ownership of the concession (World Bank, 2017).

Actions and case studies for mobilising finance

A few examples illustrate EMDE efforts to boost investment in transmission, involving DFI support, new business models to attract private capital and better revenue setting.

New business models to attract private capital. As discussed above, the BOOT model has helped raise debt and equity on a project finance basis in **South America** and **India**. Expanding this model to other geographies, tailoring it to local needs and characteristics, could boost investment. An advantage of this model is that it supports learning through tendering small parts of transmission and then evaluating progress before expanding. It also requires less institutional capacity compared with a long-term concession, which can also be politically more sensitive in its wider coverage of the grid.

In **Brazil,** the Tropicália project, a 245 kilometre (km) transmission line in the state of Bahia is an example of how a trustworthy and dynamic regulatory environment can attract private capital from new players, even during a crisis. Costing around 370 million reals, the project aims to transmit excess wind power from the Northeast to cover power deficits in the South. The bidding process took place at the end of 2016, a time of political and economic uncertainty, which dissuaded many traditional investors. The regulator subsequently increased the maximum tariffs in auctions to attract new players. This resulted in financial investors, such as the Brazilian BTG Pactual, stepping in. Given higher perceived risks under the prevailing macro environment, the fund managed by BTG Pactual opted to finance construction with full equity, and third-party financing would be raised only post-completion (ultimately, the project managed to raise long-term finance from an NDB and the local capital markets and banks prior to completion). Apart from the tariff level, the pre-defined inflation-indexed revenues, an objective cost of capital formula, and the possibility for a tenor extension in the event of delays due to licensing and land acquisition helped secure finance.

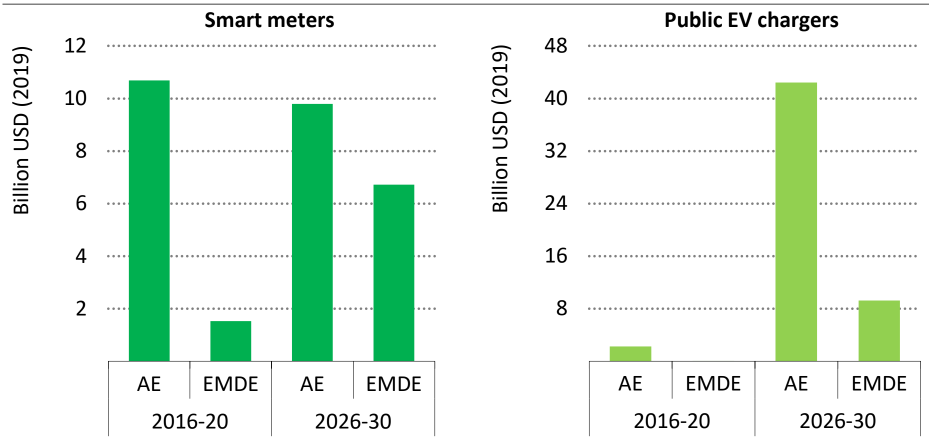
Modernising distribution grids (smart grids)

Investment outlook for smart grids

As the electrification of transport, industry and buildings ramps up and distributed renewables become more prevalent, electricity systems are marked by an increasingly dynamic and digitalised distribution sector. While advanced economies have led developments, investing in modernising distribution will be critical in rapid energy transitions not only to meet higher demand in a reliable way but also to integrate investments in distributed solar PV and accommodate the rise in EVs. In this way, smarter grid infrastructure underpins electricity security as well as decarbonisation aims, as digital infrastructure unlocks flexibility on the demand side, through market-responsive industrial demand and EV charging. But digital devices without correct tariff designs are inadequate, as prices need to reflect hourly granularity in consumption patterns. In rapid energy transitions, at least one-third of investments in distribution worldwide are projected to be devoted to digital assets.

To date, most EMDEs have concentrated more on the traditional distribution business issues, including building lines, connecting new customers, and accommodating higher loads as living standards rise and urbanisation increases. Although countries such as Colombia, India and Thailand have well-established plans for the deployment of smart grid infrastructure, overall EMDE investments in smart meters totalled less than annual USD 2 billion over the past five years, while advanced economies spent over USD 10 billion annually. Smart meters provide an important way to reduce non-system losses, as remote reading helps to reduce fraudulent connections and enhances efficiency by improving customer demand forecast and awareness of consumers. Therefore, meeting the accelerated decarbonisation and electrification aims of IEA climate-driven scenarios amid continued expansion of demand requires at least a quadrupling of investments in smart meters by 2030.

Figure 3.15 ▷ Annual average investment spending in digital distribution assets: smart meters and public EV charging, SDS



Investment in smart meters in EMDEs needs to rise very rapidly in rapid energy transitions, while spending on EV charging has to accelerate fast from a standing start.

Note: EVs include plug-in hybrids and battery-electric vehicles.

EMDE investment in public EV charging infrastructure has also been limited over the past five years, and sales of EVs have not yet taken off in most markets. However, investments in public EV chargers in EMDEs need to grow rapidly to accommodate growing electric mobility needs. India is a good example of strong momentum, where the Bureau of Energy Efficiency has laid out targets for the installation of at least one publicly accessible charger within every 3km-by-3km area in cities, one charging station every 25 km on both sides of highways and roads, and one fast-charging station to be installed at every 100 kms for inter-city travel.

Key factors influencing investment

Investment in digital grid infrastructure is capital-intensive and often involves the financing of smaller pieces of equipment that need to be installed in a distributed manner, whether or not these are recognised as capital expenditures by regulation. While designing programmes and transactions to support investment can require complex efforts from regulators, utilities and investors, digital grids allow for a more efficient and economic operation of the distribution system. The weak financial situation of some distribution companies in EMDEs, and lack of purchasing power, can be a first barrier for making such investments. In addition, poor or non-existent network planning can lead to misallocations of resources that exacerbate the financial situation. Investment depends on inclusion of digital infrastructure in regular cost-effective network planning, with clear targets and pathways.

Markets can face multiple challenges related to the variable financial situation of distribution companies, high operational and commercial losses, and the complexity of interventions. Distribution grid and associated system management include a wide variety of measures and issues including the availability of advanced metering infrastructure, substation modernisation with deployment of gas-insulated switchgear, development of medium-sized mini-grids, real-time monitoring and control of distribution transformers, creation of EV charging infrastructure, reductions in system losses, and the implementation of dynamic tariffs for demand response and distributed solar PV. Better planning and regulatory incentives are essential for tackling these measures in a co-ordinated manner. For example, the Indian government's National Smart Grid Mission, put forth in 2015, brought forward smart grid deployment and mobilised investments of around USD 300 million.

Technology has advanced faster than regulation for some digital and smart devices. For example, there is uncertainty about the regulatory treatment of public EV charging assets in some markets, whether they belong to the distribution segment, or if a company needs a distribution operating licence to install and operate them. Business models in this area range widely from regulated asset schemes, with regulated tariffs, to pay-as-you go services, with implications for the degree of price competition.

In Indonesia, electricity tariffs at the charging stations are determined by the energy ministry, and companies selling power through charging stations are required to hold an electricity supply business licence and own an electricity service area. Though some business models are envisaged for private-sector participation, these rules effectively make state-owned utility PLN the principal actor for investment. By contrast, in India, public charging stations are a delicensed activity and any entity is free to develop as long as it meets technical, safety and performance standards. Developers may establish connections via the local distribution company, and also obtain electricity from any generation company through open access.

Another common barrier is the lack of skills and capacities to deploy and operate digital infrastructure. Technical assistance from DFIs and other international institutions can be vital in this respect, offering lessons learned, sharing knowledge, setting up training and establishing regulatory frameworks. Assistance is often folded into broader transactions, such as investments of USD 350 million from the World Bank and USD 200 million from the African Development Bank in the Nigeria Electrification Project. This project leverages private-sector investments in solar mini-grids and stand-alone solar systems to provide electricity to 2.5 million people. Such efforts can support the development of a sustainable framework for expanding electricity access. The design of the mini-grid component, for example, including advice on regulations to enable private-sector participation, market intelligence for 250 sites through geospatial planning tools, an electronic platform to accommodate minimum subsidy tenders, and incorporation of productive uses through integration with agriculture and business development programmes.

Finally, performance-based regulation (PBR) can be an important driver for the deployment of smart grid infrastructure. PBR is a regulatory framework that connects achievement of specified objectives to utility financial performance, incentives for investment and implementation of operational upgrades. Its main objective is to improve distribution system reliability while keeping electricity affordable for customers. Many countries in Latin America, such as Chile or Peru, have included performance indicators in their regulation.

If PBR is inexistent, an alternative is to increase operating efficiency through project-based finance with DFI participation. This is the case of the Eletrobras Distribution Rehabilitation Project in Brazil, with disbursements of USD 272 million from the World Bank and USD 148 million from Eletrobras, focused on six distribution companies. The project helped to reduce outages, improve voltage levels and increment collection rates by deploying smart grid network equipment, advance metering technology and network extensions.

Actions and case studies for mobilising finance

Several examples illustrate the strategies and approaches that EMDEs are using to boost investment in distribution, including through:

- Encouraging third-party participation through contracts to provide smart grid services.
- Bulk procurement of smart grid infrastructure via tenders to enable lower prices.
- Early-stage capital for initial smart grid development to encourage investment at scale.
- Policies for partnerships to build, own and operate smart grids by third parties.

Successful programmes are often underpinned by targeting upgrades among companies with relatively good financial resources as well as involving the financial capabilities of DFIs.

Encouraging third-party investment through contracts. In **Latin America**, Interconexion Electrica S.A. (ISA) – a transmission company operating in Argentina, Brazil, Chile, Colombia, Ecuador, Peru and Central America – signed a five-year framework contract with the third-party vendor ABB to enhance the reliability and efficiency of the transmission and distribution network. The contract is estimated to be for around USD 100 million, with ABB supplying shunt reactors to the ISA grid, ensuring that the voltage stays within safe limits and helping to avoid blackouts. In addition, the contract includes the supply of gas-insulated switchgear, air-insulated switchgear equipment such as circuit breakers, instrument transformers and hybrid modules.

Tenders for bulk procurement of smart grid infrastructure. In **India**, Energy Efficiency Services Limited (EESL), which is a Super Energy Service Company focusing on energy-efficient technologies, has held several tenders for bulk procurement of millions of smart meters. The large-scale purchases brought down the cost of equipment – similar to its efforts in procuring LED light bulbs and efficient ACs – and allowed EESL to succeed in the procurement of 15 million smart meters, through its Smart Meter National Programme.

Early-stage capital for initial smart-grid development. The **Philippines** Smart Solar Network project is a 35 MW mini-grid developed through the installation of digital controls in combination with solar PV and battery storage. It will allow for 200 000 households to receive clean electricity via a pre-paid mobile-based metering system, mitigating some of the revenue collection risk. The project is being rolled out in partnership with the local community to install, operate and maintain the systems. InfraCo Asia's business model consists of providing early-stage development capital and expertise, de-risking the overall project and ensuring the project becomes a bankable investment opportunity. InfraCo bridges the initial critical gap between project conceptualisation and financial close by funding high-risk development costs to catalyse private-sector investment. As such, the electrification of the first 4 000 households will be funded via equity from InfraCo Asia for USD 8 million, before handing over the remaining pipeline of 196 000 households to another investor who would bring in their equity and potentially raise debt to build out the portfolio.

Policies for public-private partnerships. In **Sierra Leone**, less than 10% of the rural population has access to electricity and depends on diesel-powered mini-grids or individual home systems. Solar-powered mini-grids have the potential to provide cheap, reliable clean power. But performance relies on digital infrastructure (smart metering and remote monitoring of assets). The Rural Renewable Electrification Project, which benefits from international public funds, is electrifying 94 communities over four regions as part of a 20-year partnership with the government. Private-sector equity finance was provided by InfraCo Africa and PowerGen, a renewable energy developer based in Kenya. Rural communities are the off-takers, purchasing power on a pay-as-you-go basis. The government's methodology for setting cost-reflective tariffs, approval of tariffs for five years with inflation indexation and tax duty exemptions for equipment help to support investment.

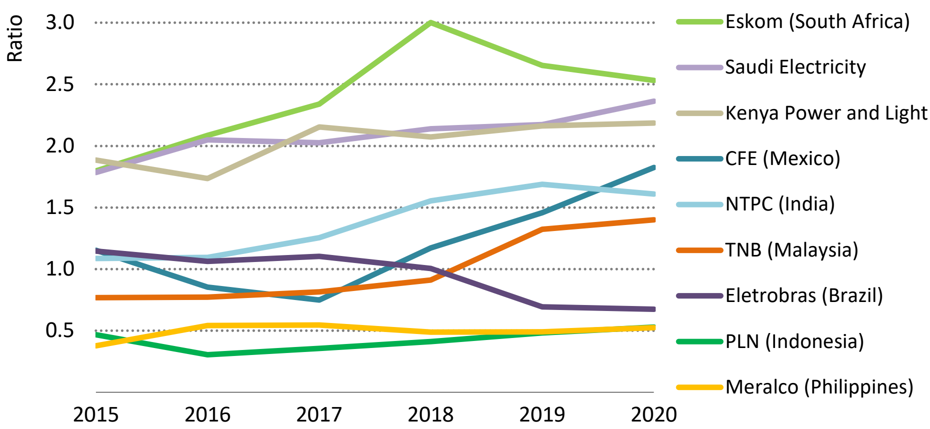
3.3 Enhancing the financial sustainability of utilities

Investments in power generation, networks and the electrification of end-use all depend on the financial sustainability of utilities, i.e. their ability to cope with short-term stress, invest in grids, act as creditworthy power purchasers and provide electricity services. Sustainability is linked to cost recovery, where revenues from electricity sales and services cover operating capital expenditures and debt service, including a profit margin. Cost recovery is strongly linked to the underlying market structure and tariff design, where state-ownership and price regulation typically play important roles in EMDEs. While improvements in cost recovery support more robust investment conditions and the ability of electricity systems to better provide clean, reliable and affordable power, challenges can lead to high debt and subsidies, service quality issues, and payment and contractual risks, affecting financing for all actors.

3.3.1 Financial performance and cost recovery in key markets

While many utilities have improved cost recovery in recent years, the pandemic has worsened stresses on this sector and exacerbated some pre-existing vulnerabilities. Some utilities, particularly state-owned ones, have taken on greater debt in recent years. State-owned utility financing is often tied to the sovereign entity guaranteeing the debt, and changes in emerging market bond prices can affect financing costs. While government bond yields in some countries have moderated compared with levels seen during the height of the crisis, weakened exchange rates, which affect dollar-denominated debts, and high leverage continue to weigh on utility balance sheets. Combined with more tenuous revenues, this situation puts a near-term strain on governments that are stepping in to shore up utility finances at a time of reduced fiscal capacity.

Figure 3.16 ▷ Debt-to-equity ratio for select EMDE utilities



Leverage ratios have risen over time for a number of EMDE utilities, increasing vulnerability to market shocks, while pressures from the pandemic are keeping debt burdens high.

Note: 2020 values are based on most recent financial statement (June or September depending on utility).

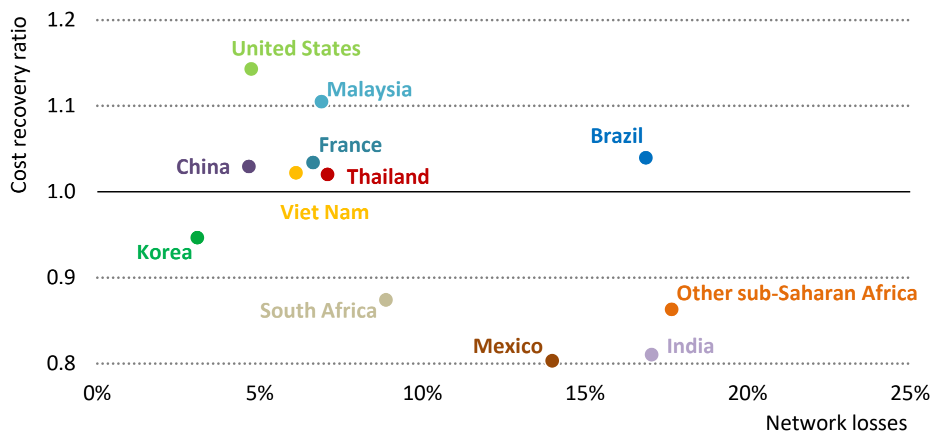
Source: Calculations based on company reporting and Eikon (2021).

Such trends reinforce the importance of continuing to address longer-term structural issues – including reforms that support financially viable business models, increase private participation and enhance service to customers – that have a strong relationship with cost recovery. Notably, utilities in EMDEs with high network losses struggle to make a profit, as seen in many parts of sub-Saharan Africa, as well as in India and Mexico. Tariff setting and good governance matter a lot, with poorly performing utilities often subject to shortfalls from subsidised retail pricing and inability to undertake effective system planning.

The cost recovery situation often depends on whether the electricity system is unbundled, based on a single buyer with private generators, or is vertically integrated. Market structures can vary considerably around the world (see Chapter 2). Systems with restrictions on private participation often have the greatest challenge in making a profit (Foster and Rana, 2020).

In the past two decades, some economies have moved towards unbundled systems and private ownership in generation as well as competition in wholesale markets. Systems that currently fall under this category of market account for a minority but increasing share of the EMDE investment in clean power, grids and efficiency in the SDS by 2030. In Brazil, for example, these changes boosted the profitability of distribution companies over time. While slower economic growth and contractual power purchase obligations sapped cost recovery during the middle part of the past decade, increased revenues have better supported financial performance in recent years.

Figure 3.17 ⊳ Utility cost recovery and network losses in selected markets



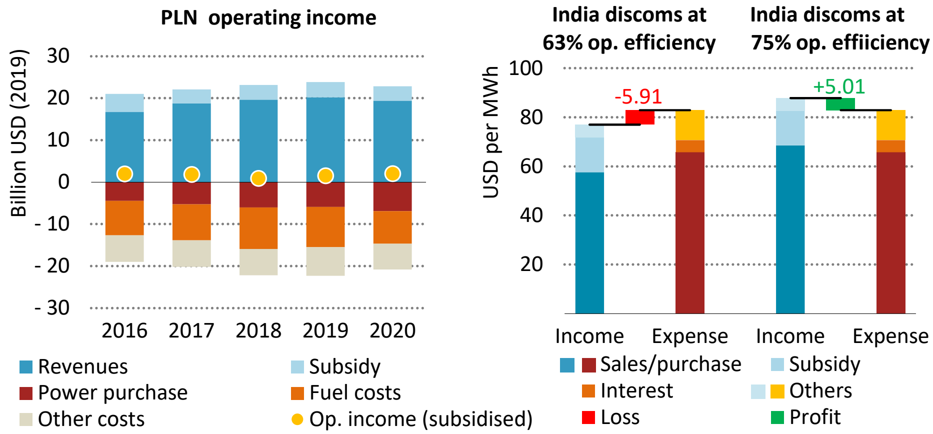
Utility cost recovery depends on improving operational efficiency, cost-reflective tariffs and financial management, but some EMDE markets underperform in these areas.

Notes: Cost recovery = the ratio of revenues to costs, including operating costs, depreciation and financing. A number of factors influence this ratio, including system costs; sales revenues; operational efficiency; connecting, metering, billing and collecting from customers; and debt levels and financing costs. Losses include technical and non-technical losses in electricity transmission and distribution.

In the second category, generation and network businesses have been unbundled, but the state has retained ownership of a single-buyer utility. Taking into account systems that have not yet fully adopted competitive markets, this case accounts for the majority of investment. In Malaysia, reforms have increased cost pass-through into electricity tariffs. However, a lack of competition in the distribution sector and persistent underpricing of electricity have weighed on performance in some markets. In Mexico, where unbundling reforms are currently taking place, the financial performance of Comisión Federal de Electricidad (CFE), the national utility, has been harmed by network losses (at near 15%), high generation costs and regulated tariffs that do not cover costs, as well as pension obligations.

In Indonesia, PLN, has improved financial performance over the past decade by increasing revenues faster than costs, thanks to government efforts to make electricity tariffs more cost-reflective, connect new customers and reduce operational losses. However, operational inefficiencies, obligations from legacy take-or-pay contracts, and persistent under-pricing of electricity still contribute to big financial losses. Since 2017, automatic tariff adjustments have ceased. Losses are covered by a government subsidy, which was anticipated to grow by 13% in 2020, compared with a planned 4% increase (IEA, 2020a).

Figure 3.18 ▷ Income for Indonesia's PLN (left) and India's state distribution companies by level of operating efficiency (right)



In Indonesia and India, improved operational efficiency, better financial management and more cost-reflective pricing are key to the financial sustainability of utilities.

Notes: Discoms = distribution companies; op. = operating; PLN 2020 income is annualised based on reporting from the first half of the year.

In India, revenue shortfalls for state distribution companies led to outstanding dues to generators climbing from nearly USD 4 billion in 2017 to over USD 18 billion in September 2020. While the government's UDAY initiative has helped to reduce debt burdens, enhancing cost recovery hinges on improving key performance indicators and action to improve the cost-reflectiveness of tariffs, increase the share of low-cost renewables, and address the financial implications of existing thermal power assets. Utilities are able to monetise less than two-thirds of distributed electricity; raising this to three-quarters through better billing efficiency, collection efficiency and reducing losses could restore profitability (IEA, 2021).

In South Africa, the profitability of Eskom has declined in recent years with a slowing of annual energy revenue growth, rising operating expenses and a large increase of debt, which have quadrupled net financing costs over fiscal years 2016 to 2020. Coal plant outages and delays in bringing new capacity online, which have led to periodic power cuts, now exacerbate the operational situation, while South Africa's loss of its sovereign investment grade rating has increased pressure on Eskom's fundraising ability.

In the third set of economies, state-owned vertically integrated utilities predominate, and their financial state is often precarious. For example, the national utilities in many parts of sub-Saharan Africa remain far from cost recovery. A World Bank study on utilities in sub-Saharan African countries found that most suffered from persistent "quasi-fiscal deficits". In countries outside South Africa, 40% of these deficits were attributable to under-pricing of electricity, 30% to high network losses and 20% to inadequate bill collection (Kojima, 2016). In South Africa, under-pricing accounted for around 80% of deficits.

Actions and case studies for mobilising finance

Power systems face the challenge of addressing near-term financial pressures, investing in technologies to support clean energy transitions and managing more comprehensive reform efforts. State-owned utilities may also function as key vehicles for governments to carry out recovery plans. The World Bank identifies three pillars to enhance system performance:

- Systematic optimised (least-cost) planning and investing in all parts of the supply chain, including in smart grids and demand-side measures.
- Efficient operational performance of service providers (utilities) in all business areas, including through reduced losses.
- Financial sustainability: revenues (tariff + subsidies) allowing recovery of costs.

Several cases illustrate how utilities are addressing these pillars through reforms to boost competition and measures to restructure debt and improve financial management.

Boosting competition. In **Colombia**, unbundling reforms made several decades ago introduced competition, enabled third-party grid access and brought more transparency to distribution pricing. Such reforms improved private-sector participation and profitability and efficiency for utilities. Although the system now includes some 250 companies, generation, distribution and retail are dominated by only four main actors, accounting for 60% of these activities (IMF, 2019). Joint ventures with international players support investment in new technologies, as in Codensa's initiative to roll out electric bus charging in Bogota, and cheap, flexible hydropower helped power companies to weather the storm in 2020. While auctions for solar PV and wind have picked up, investment lags that of other Latin America markets and retail price subsidies and high market concentration raise fiscal risks for the government.

Restructuring debt. In **Kenya**, the country's main distribution utility faced the challenge of meeting electrification goals through a USD 1 billion capital expenditure programme, while also servicing heavy near-term debt. Enabled by the provision of a guarantee from the World Bank in 2016 that covered 40% of the loan, the utility was able to refinance its obligations with USD 500 million of longer-tenure commercial debt and realise savings equivalent to nearly 20% of its planned investments. This support continued improvements in electricity access (at 75% in 2018). Still, the debt restructuring – novel in the sub-Saharan Africa context – provided a catalyst but did not address more fundamental issues, such as lack of cost-reflective tariffs. Notably, the utility's obligations to generators grew to record levels in 2020 and was discussing with regulators a potential 20% retail price hike to improve cost recovery.

<u>Improving financial management.</u> In the **city of Bengaluru**, the distribution company has become the fourth-best in India through a balanced mix of residential, commercial/ industrial and rural sales. But network losses of 13%, high by international standards, and other vulnerabilities threatened to undercut the city's role as a technology hub. The utility sought USD 845 million to upgrade and strengthen the distribution grid, but its financing depended on sovereign loans from Karnataka state and domestic public sources. In support, the ADB is providing a non-sovereign rupee loan (USD 90 million) to the utility and a sovereign loan (USD 100 million) to Karnataka. The project looks to help the utility develop financial management capacity to eventually transition towards commercial bank financing; it may also serve as a model for large-scale lending to sub-sovereign entities, especially in distribution (ADB, 2019).

3.4 Investing in energy access

Although there are signs of progress, the world remains severely off track to achieve universal access to affordable, modern, reliable and sustainable energy for all by 2030. This is a huge impediment to improving livelihoods and well-being for large parts of the world's population, especially in many parts of Africa.

There are multiple aspects to this problem, covered in different ways throughout this chapter. The availability of grid-based electricity and the quality of electricity services that they provide are key elements (Section 3.2), a consideration that puts the spotlight on the strained financial condition of utilities (Section 3.3). Energy efficiency is likewise a key component of energy access, as the reduced costs of energy-efficient appliances is one of the key factors that has enabled increased use of off-grid solutions such as solar home systems and off-grid fans for cooling. The focus for this section is on financing off-grid power solutions – mini-grids and standalone systems – as well as access to clean cooking fuels.

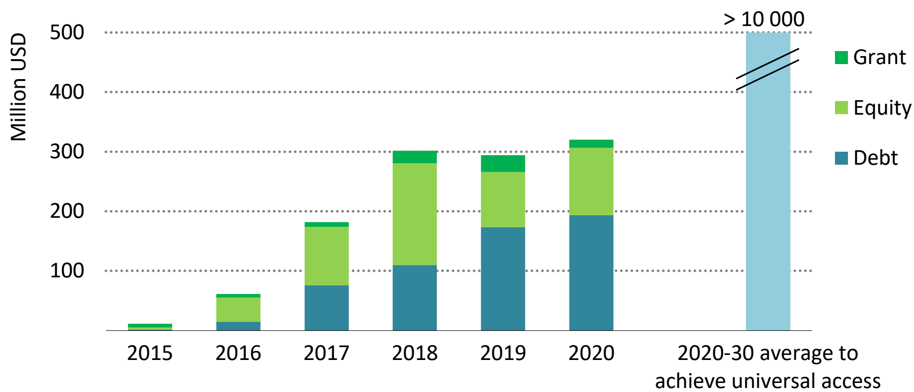
3.4.1 Financing off-grid electricity

In 2019, 785 million people across the world still lacked access to electricity, with 75% of them living in sub-Saharan Africa. Despite improvements in expanding electrification in recent years – since 2013 the number of people without access to electricity has been on a declining trend – the Covid-19 pandemic reversed progress, notably in Africa. In addition, as many as 100 million people who already had access were at risk of not being able to afford basic services due to the economic fallout from the crisis (IEA, 2020e). Improving financing options and boosting investments are key to achieving universal access by 2030.

Investment outlook and sources of finance

Achieving universal access to electricity by 2030 requires investments of more than USD 35 billion per year, in new on-grid generation, electricity grids and decentralised solutions. [4] More than half of the cumulative investment to 2030 is expected to support mini-grids and stand-alone systems. In sub-Saharan Africa, these solutions can be the least-cost electricity option for two-thirds of the population without access (IEA, 2019a) and require USD 135 billion cumulatively invested by 2030.

Figure 3.19 ▹ Investment in SHS and mini-grids in sub-Saharan Africa by sources of finance



As the sector matures, debt has increasingly displaced equity finance; meeting access goals points to more than a fortyfold rise in investment over the next decade.

Note: SHS include stand-alone solar systems with lighting and other appliances such as household and productive use of efficient appliances. This figure includes publicly disclosed commitments tracked by the Global Off-Grid Lighting Association's (GOGLA) Deal Investment Database and numbers from the Africa Mini-grid Developers Association (AMDA) for grant and debt investments up to June 2019 and then estimated by the International Energy Agency (IEA). Therefore it represents a conservative view of the overall finance flowing into the sector.

Source: IEA analysis based on GOGLA (2021).

The example of solar home systems (SHS) illustrates the evolving nature of financing models in a maturing industry. Equity commitments fell globally in 2020 due to tighter markets and an increase in perceived risks, while debt financing has risen. Debt providers are mostly DFIs and impact investors, with crowdfunding accounting for 10%. Grants have been critical to fund early-stage ventures, market entry by new players, and new business models and products. These usually come from governments, DFIs and family offices. Recently, such actors are boosting efforts to support energy access companies under financial pressure from the pandemic. For instance, the AfDB launched the COVID-19 Off-Grid Recovery Platform, a

[4] For comparison, between 2013 and 2018, around USD 9 billion was spent annually to improve electricity access in 20 countries representing around 70% of the world's population without such access (SEforall, 2020a).

USD 50 million blended facility with 20 concessional resources. A group of public and private investors created the Energy Access Relief Fund to provide concessional loans to smaller companies facing liquidity challenges in Africa and Asia. There are also new programmes to provide electrification support to rural health facilities.

Funding via private debt may grow in EMDEs where private-sector participation in decentralised solutions has been relatively successful and where regulations are clear. However, concessional financing will continue to be critical, especially in countries where perceived risks remain too high or where the underlying economics are too weak. The cost of service of populations without access – mainly rural and geographically dispersed – is higher than the average cost of service, so viability gap financing will be required, especially given that affordability and ability to pay have been hit by the pandemic. Aggregating projects can help reduce transaction costs and unlock larger levels of capital. Platforms such as the AfDB Facility for Energy Inclusion on- and off-grid funds are providing blended finance in the form of junior equity that anchors more commercially oriented investors. Rolling out targeted financial solutions, such as instruments to address working capital needs, will also be vital to achieve universal access by 2030.

Key factors influencing investment decisions

Investment criteria for SHS and mini-grids are shaped by a variety of policy and financing considerations. However, they also face a number of common challenges that hamper development, including end-user credit risk, payment methods for electricity and a scarcity of domestic investor capital for mini-grid projects, as well as broader issues such as currency risk. A lack of economies of scale pushes up costs and slows down project execution.

Annual sales of SHS have been strong in recent years at around USD 1.75 billion, serving around 420 million consumers in developing countries. In 2020, fundraising by SHS companies proved resilient in several markets, attracting over USD 315 million, comparable to the 2019 level. The SHS space is composed of a limited number of large private players, with relatively good access to international finance. While the landscape has diversified, the top ten deals in 2020 still accounted for two thirds of funding, down from 95% in 2015 (GOGLA, 2021). Most investment is concentrated in sub-Saharan Africa, historically in Kenya and East African markets and now moving to West Africa. While several local companies have emerged, they struggle to attract international finance and develop business at scale.

Innovative business models for electricity access include pay-as-you-go (PAYG) schemes where private companies lease the solar products to customers who make periodic payments and can take ownership of the system once the loan is repaid (also known as lease-to-own models). Company revenues depend mainly on loan repayment rates.

Mini-grid companies now connect almost 50 million people annually across around 20 000 projects. Most of these are based on hydropower and diesel generator sets (ESMAP, 2019). Consumers most commonly fund systems through PAYG models, but these are more sophisticated than for SHS, and revenues depend on broader customer demand and tariffs levels. These features can create more risk compared with SHS, as a bankable anchor customer and measures to defray capital costs are often required to economically serve residential demand. Policies and cost reductions have driven the mini-grid expansion, with average price per connection halving from more than USD 1 500 in 2014 to less than USD 750 in 2018, and market entry costs decreasing by one-third (AMDA, 2020).

Table 3.5 ▷ Risks faced by SHS distributors and mini-grid operators

	Mini-grids	SHS	Mitigation measures
Revenue risk			
Demand	Lower-than-expected electricity demand or defection by grid-connected customers	Low sales or low repayment rate, concentration among less well-off customers	Improved credit and demand assessment; integrated offerings including appliances and end-use equipment
Affordability	High price per connection	Burdensome value-added tax and import tariffs	Reduced upfront costs with longer repayment periods
	Customers with low and unpredictable income		
Tariff level and subsidies	Uncertainty over subsidies, lack of local adjustments; too-high tariffs affect collection	Uncertainty over project enablers – e.g. mobile services – and financial/ subsidy regulations	Viability gap financing from public sources; integrated service contracts
Financial risk			
Working capital	Delays between equipment purchases (mostly from China) and customer payment (often in rural Africa).		Debt and other instruments to address working capital needs
Financing needs	Mismatch between expectations and returns	Lack of aggregation to attract finance at scale	Enhanced support from an ecosystem of investors to offer adequate financial sources
Currency risk	Difficulties raising capital in local currency		
Regulatory risk			
Registration and licensing	Unclear licensing rules; barriers to developers offering other services; permitting delays	Generally none	Improved dialogue among government entities; legal and regulatory protections and visibility over grid encroachment by utilities, learning from successful models
Tariff setting	Inadequate tariff-setting methodology	N/A	
Interaction with grid	Unclear regulations for grid encroachment	N/A	

Despite these improved economics, the sector remains underfunded. Out of USD 2 billion approved since 2007 under the Mini-grid Funders Group (MGF) – which includes DFIs and donors – only 15% or USD 300 million has been disbursed, due to mismatches in market readiness, bankability expectations, and delays in procurement and tariff negotiations. Countries in sub-Saharan Africa, led by Nigeria and Kenya, have received four-fifths of all investments under the MGF, and Pakistan also ranks high (SEforAll, 2020b). In 2018, a record USD 100 million was disbursed by the AfDB, but there was no disbursement in 2019.

To date, most mini-grid projects have relied on equity or grants from public sources, such as DFIs, donor agencies, foundations and governments. Results-based financing schemes have helped mini-grid developers get per-connection grants once reliable power is provided.

Among investors, international oil and gas majors as well as power utilities have increased interest in off-grid start-ups, largely through their venture capital arms. Philanthropies and companies in telecommunications and diversified conglomerates are also among the investors. Corporate players accounted for 60% of equity investment in 2019, but their role moderated in 2020. They participate in different ways, ranging from direct investments to taking minority shares through funds. These funds may seek social impact via energy access while investing in new businesses or technologies which could be acquired in the future.

3

Table 3.6 ▷ Select energy company investments in electricity access

Company	Investment approach features	Investment examples
ENGIE	Impact fund provides equity, incubation services; corporate acquisitions	Acquisition of SHS manufacturers and distributors (Fenix, Mobisol), mini-grid operators (PowerCorner)
Total	Venture fund provides equity and incubation services	Companies in SHS, PAYG software, smart meters, micro-grids and cold-chain solutions
Shell	Venture fund provides equity, research and development support	SHS distributor and mini-grid operators, and also investment in funds
EDF	Joint ventures, co-founding companies or direct investment	Joint ventures in Côte d'Ivoire, Ghana, Morocco, Senegal, South Africa; solar pump and SHS firms.

Actions and case studies for mobilising finance

Several examples illustrate approaches that governments and private companies in EMDEs are using to boost investment in electricity access, including:

- Innovative business models for bundling services and shift towards consumer financing.
- Concessional public finance or impact capital to mobilise private capital.
- Financing through a dedicated domestic fund.

Innovative business to integrated services and shifts to consumer financing. SHS companies have been evolving fast, specialising their business models and adapting their value propositions. While the initial actors were mostly vertically integrated – dealing with everything from solar product manufacturing, retail field distribution, developing the customer-support software and technical after-sales services – there has been a trend for specialisation across the value chain. Increasingly, distributors focus on the products and services offered to customers, and have taken a major shift towards consumer financing.

Solar products offered through PAYG tend to create a platform that enables the distribution of a large portfolio of products and services for customers who could not access credit before. Energy companies such as PEG Africa are successfully leveraging their relations with rural households in **West Africa** to provide solar water pumps, for example, on top of SHS with lighting, a fan, radio and TV. Companies dealing with an increasing amount of account receivables are adapting their structure and taking on some features of microfinance institutions. Others such as Zola in **Côte d'Ivoire** are splitting financial vehicles regrouping customer receivables from vehicles financing company operations. Such tools help raise the adequate funds for each activity, with debt – potentially in local currency – matching well the working capital needs related to customer receivables, while equity is a better match for overheads and expenditures needed for opening new markets.

Using concessional public funds or impact capital to mobilise private capital to access. In **Kenya**, the government is using a USD 150 million loan from the World Bank to close the access gap in remote, low-density areas of the country as part of the Kenya Off-Grid Solar Access Project. With this, 120 mini-grids are due to be built under public-private partnerships with Kenya Power and Lighting Company. The SHS component will provide incentives for local providers to expand services in traditionally underserved regions, and there is also support for stand-alone solar systems and water pumps for community facilities.

One of the largest hybrid solar PV mini-grids in sub-Saharan Africa was commissioned in the **Democratic Republic of Congo**, where the private operator Nuru builds, operates and maintains a 1.3 MW plant for hundreds of customers in the urban but poorly connected city of Goma. Nuru has raised equity and debt from various sources, including the Energy Access Ventures and the Electrification Financing Initiative (an investment fund owned by the European Union). Gaia Impact Fund, a French investment fund focused on financing renewable energy, acquired a shareholding in Nuru in 2020.

Financing through a dedicated domestic fund. On the mini-grid side, the **Nigeria** Infrastructure Debt Fund (NIDF) enabled in 2021 the financial closing for the construction of 22 mini-grids by a local company, providing 70 000 people, businesses and community centres with electricity. The NIDF is denominated in local currency and has raised capital from different actors, including Nigerian pension funds.

Box 3.2 ▹ Financing clean cooking

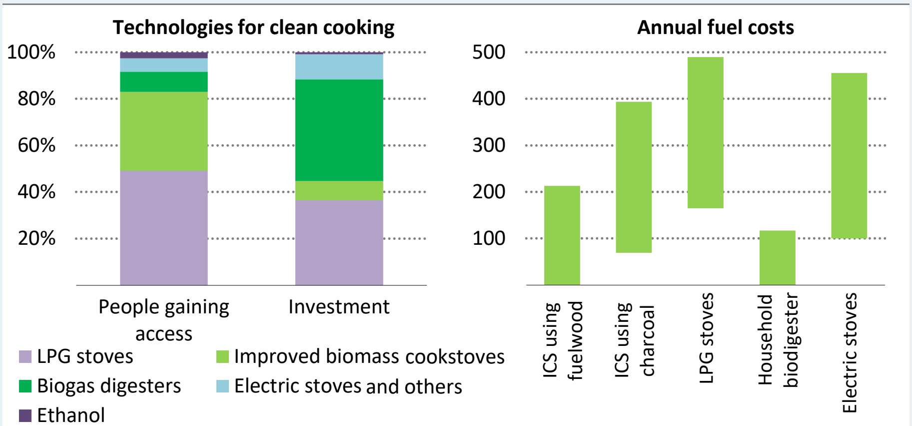
More than 2.5 billion people without access to clean cooking fuels and equipment relied on traditional use of biomass, coal and kerosene in 2019. Cooking with modern and clean solutions often means investing in liquefied petroleum gas (LPG), improved biomass cook stoves and electric cookers. But solutions can be complex, especially in areas where firewood does not have a monetary cost; in India, for example, government support has rapidly broadened the availability of subsidised LPG, but nearly half of all households in 2019 continued to rely on traditional biomass as their primary cooking fuel (IEA, 2021).

The LPG value chain includes a mix of private distributors and publicly funded infrastructure, and is influenced by consumption subsidies. LPG has attracted the most investment, predominantly in Asian countries such as Bangladesh, India and Indonesia, and sometimes under PAYG models. Biomass involves a range of private manufacturers and distributors of cooking devices alongside local fuel suppliers. Companies are also advancing solutions such as improved or clean biomass cook stoves, bioethanol, biodigesters, and electric cookers.

Investments in companies deploying clean cooking solutions (excluding LPG) reached USD 70 million in 2019, 50% more than in 2018 (CCA, 2021). To achieve universal access by 2030, USD 6 billion would be required in such biomass cooking devices and LPG stoves. Private investors, such as angel investors and venture capital, made the most commitments – more than USD 40 million raised in 2019 – with DFIs, governments and foundations accounting for 25%. Investments also suffer some funding concentration as capital flow is concentrated among a limited number of players. The top ten companies account for 80% of all funds raised between 2017 and 2019.

Key challenges are limited knowledge among households about the benefits of improved cook stoves, affordability and low ability among the population to pay the upfront costs, weak supply chains, and limited incentive for service providers to expand into areas with lower population density and lower perceived returns. Government, donor-backed programmes and commercial funds will be essential to overcome these barriers and expand the reach and opportunities for commercial operators providing clean cooking solutions, thereby reducing the costs and impacts of the clean cooking deficit.

Figure 3.20 ▹ Technologies providing clean cooking globally by 2030, capital investment costs and fuel costs



Meeting clean cooking targets requires a number of solutions. High upfront investment costs can be a barrier to realising savings for technologies with lower fuel costs.

Note: ICS = Improved cook stoves. Based on (IEA, 2019c).

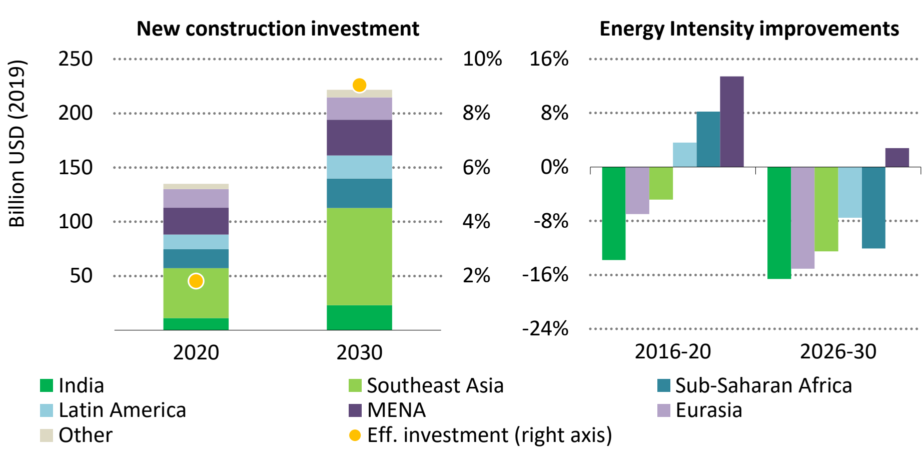
3.5 Financing end-use electrification and efficiency

Dramatic improvements in energy efficiency and applications that support electrification are required in clean energy transitions to support rising living standards and increasing demand for energy services in EMDEs, reduce reliance on emissions-intensive sources of energy, and manage the amount of investments required in clean power. Measures to improve efficiency are often the most cost-effective way of reducing emissions, but due to their small-scale nature, can be the most difficult to finance. Investments across end-use would support an improvement in energy intensity of at least 4% per year amid a boom in economic activity over the next decade. The following sections analyse investments and financing for the buildings and transport sectors, while the industrial sector is covered in Chapter 4.

3.5.1 Green buildings

EMDEs are set to see rapid increases in their urban population over the coming decades, adding close to 2 billion inhabitants in urban areas by 2050 in our projections. The focus countries of this report accounting for over 80% of this new urban population, with particularly large growth in the urban population in countries across sub-Saharan Africa and in India. There are already two megacities with more than 10 million inhabitants in sub-Saharan Africa (Kinshasa and Lagos) and another in North Africa (Cairo). There are another five large cities on the continent with a population of between five and ten million each: Alexandria, Dar es Salaam, Johannesburg, Khartoum and Luanda. Of these, Dar es Salaam and Luanda are likely to become sub-Saharan Africa's next megacities. The anticipated increase in the urban population in India is the equivalent of adding 13 cities the size of Mumbai by 2040.

Figure 3.21 ▷ New construction floor space and energy intensity gains in the services sector in IEA climate-driven scenarios



Investment in new construction in the services sector is the largest in Southeast Asia, where recent intensity gains have been realised.

Note: Energy intensity in the service sector is calculated as the unit of energy (in tonnes of oil equivalent) consumed per dollar unit of value added (Market Exchange Rates (MER) adjusted). A negative percentage indicates an improvement or a lower amount of energy necessary to generate the same value added.

The implications of an increasingly urban population for the energy sector are profound. In general, urban residents tend to consume more energy than those in rural areas, in large part because of differences in income levels. Smart urban planning and sustainable development offer a huge opportunity to shape patterns of future energy use. However, there are also likely to be major challenges arising from further strains on air quality, housing, transport, public utilities and sanitation. While the size and scope of buildings can range from small houses to large commercial towers, they typically involve long lifetimes, with the potential to lock in emissions and energy consumption levels for decades. The efficiency and emissions profile of the buildings stock represents an increasingly important lever for sustainable development.

Over the coming decade, we estimate that EMDEs will need to add over 3.6 billion square metres (m^2) of residential space, or a 4% increase, each year. Floor space per capita is also set to increase alongside rising incomes and a reduced number of dwellers per household. A particular challenge is to address the floor space built by the informal sector,[5] which is particularly difficult to reach with regulations and financing. In the services sector, EMDEs add 660 million m^2 annually, with building retrofits covering around 20% of commercial stock. A large part of this expansion comes from Southeast Asia, with significant additions in remaining EMDE regions. In IEA climate-driven scenarios, nearly all EMDE regions have to make dramatic improvements in energy intensity (i.e. the amount of energy required for a given unit of floor space) over the next decade, underpinned by supportive policies. However, in some areas, notably the Middle East and Eastern Europe, cheap and sometimes subsidised fuel supply and weak building codes have been major barriers to improvements in efficiency.

Investment outlook and sources of finance

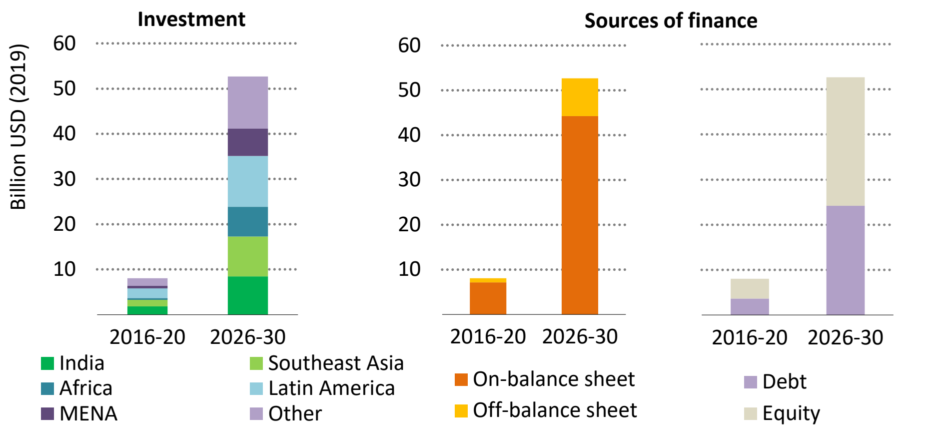
An early and large-scale ramp-up of investment in more efficient and cleaner buildings is a key pillar of rapid energy transitions, and is especially important in EMDEs because they see the largest amount of new construction activity. Investments include a variety of interventions and equipment, including the careful early-stage design of the building envelope as well as passive measures (reflective paint, external window shades and air sealing), which yield the most energy savings. Investment in retrofits of the existing building stock accounts for only a small fraction of overall spending in buildings in EMDEs. By 2030, renewables meet over 17% of energy demand in buildings in the SDS, with a significant uptake for space and water heating – especially solar thermal, which nearly triples from 2020.

Investments in buildings – including new construction, retrofits and appliances – is typically made on the balance sheet of the developer or the tenant, mostly using equity. In IEA climate-driven scenarios, around one-fifth of investment in buildings, appliances or retrofits is made off balance sheet by 2030 either through energy service contracts or leasing

[5] The informal sector refers to construction by unregistered companies or contractors and where government regulations are not necessarily observed.

agreements, while more than half is still financed through equity, as the development of green consumer finance (green loans/mortgages) does not yet allow households or companies to use more debt to fund investments in energy efficiency. Commercial banks in EMDEs are experiencing difficulties in aggregating loans in portfolios and in accessing refinancing, for instance through green bonds.

Figure 3.22 ▷ Investment and sources of finance in energy-efficient buildings in EMDEs in IEA climate-driven scenarios



IEA climate-driven scenarios require a large and immediate increase in spending on energy-efficient buildings over the next decade.

Note: Average annual investment is measured as the incremental spending necessary to achieve higher energy efficiency than the current baseline.

Public investment represents just over 15% of energy efficiency spending in buildings and is set to increase somewhat in the decade, in part due to large public housing programmes, notably in India and Indonesia. The structuring of public finance vehicles (e.g. green banks) to direct stimulus funds for energy efficiency is slowly picking up pace in advanced economies. While a few green banks have emerged in EMDEs (e.g. in India, Malaysia, South Africa, and United Arab Emirates) progress has been slow in developing them on a widespread basis and in directing funds to the buildings sector (RMI, 2020). The issuance of new sustainable debt (e.g. green bonds) by the public or quasi-public sector can bring new funding for buildings, but challenges related to the maturity of financial markets and currency risks remain. DFIs are expected to play an increased role in financing green buildings, for instance by mandating that all new construction funded by concessional finance achieves a certain level of energy savings.

Key factors influencing investment

The main issues and barriers for investment in energy efficient buildings include:

- Lack of stringent, clear and enforced building codes and performance standards.
- Split economic incentives between developers and tenants; consumption subsidies.
- Perception of higher costs, lack of experience and development of supply chains.
- Lack of access to affordable financing for developers and consumers.
- Challenging financial model for valuing and verifying energy savings.

The design and implementation of policies that tighten building codes and set minimum energy performance standards (MEPS) represents a key channel for investment in efficient buildings and appliances around the world. A review of building codes in 195 countries showed that 80% of countries considered in advanced economies had mandatory (66%) or voluntary building codes that cover energy efficiency. In contrast, only 15% of the countries in EMDEs mention energy efficiency in their building codes. While countries with supportive policies have seen improvements in buildings energy intensity, those where building codes do not exist or where implementation is suboptimal are not seeing the same growth, and in many cases have seen reduced efficiency levels over the past five years.

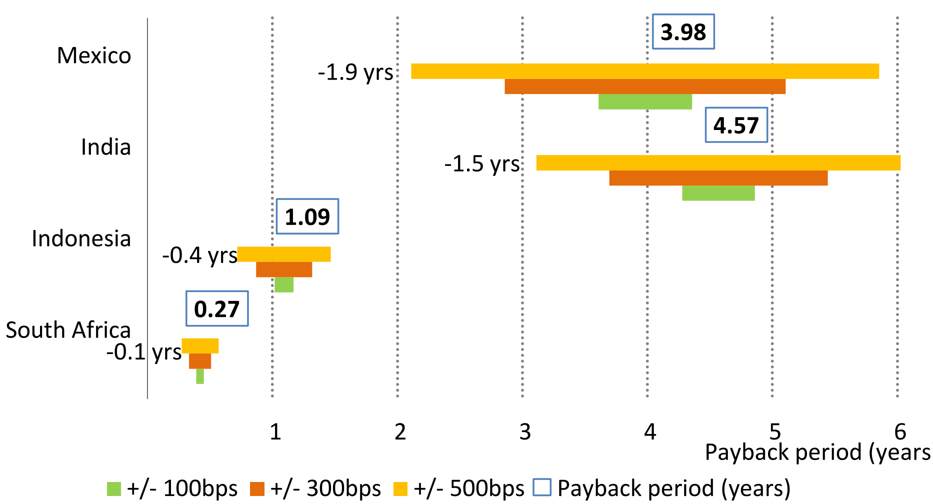
The presence of split incentives between the developer who makes the investment and the tenants who benefit from energy efficiency savings has long been a barrier to wider adoption of green building designs. This situation is especially apparent in the affordable housing segment, where the selling price of the building might be capped and margins are lower. Moreover, while studies have shown that buildings up to certain efficiency standards can be less expensive than conventional designs (due to savings on material), developer perceptions about the high incremental costs (due to the different skills and material supply chains required) can inhibit investment.

In EMDEs the construction industry is often composed of SMEs for whom access to finance remains costly and restricted, in part due to the challenges banks face in evaluating underlying credit quality for small companies and assets. For tenants, the upfront cost of new and more efficient equipment can often be a significant barrier, despite savings over the lifetime of the product. In EMDEs, the payment options available for consumers, such as on-bill financing schemes with utilities, are also less prevalent than in advanced economies.

Monetising energy savings into cash flows to secure lower-cost financing from commercial banks can help to reduce payback periods by months, or even years. Such savings can often be best valued through project structuring that aggregates efficiency measures into project sizes that facilitate due diligence and reduce transaction costs. Yet financial institutions often do not recognise electricity bill savings as a credible collateral towards new loans. Unless stringent MEPS are established by regulation, and if consumers are unaware of energy performance because labelling requirements are weak, capital tends to go towards buying cheaper, less efficient appliances.

A number of cost-effective efficiency options already exist in EMDEs, but their uptake is inhibited by some of the factors described above. Switching to efficient light bulbs can quickly lower electricity consumption emissions, but the cost of purchasing more efficient light bulbs remains significant in some parts of the world where the on-bill payback period can exceed three years, partly because of low energy tariffs and consumption subsidies. Policy support can make a huge difference to outcomes. In India, with the exception of three states, LEDs are now used in over 80% of households thanks to a major effort to move away from more inefficient bulbs. The government's flagship Unnat Jyoti by Affordable LEDs for All (UJALA) scheme, launched in 2015, has led to the deployment of 366 million LEDs by leveraging the power of large-scale public procurement to bring down costs. The government estimates that energy savings of about 54 terawatt-hours (TWh) per year have been achieved through these measures (PIB, 2020). Green or energy efficiency certification schemes have shown that on-bill savings from investing in buildings' retrofit to achieve at least 20% energy savings can have payback periods of less than a year for tenants.

Figure 3.23 ▻ Payback period for resource-efficiency investments and sensitivity to the cost of capital



High borrowing costs and low electricity tariffs can have a significant impact on the payback periods for resource efficiency in different economies.

Notes: bps = basis points. Estimates assume at least 20% savings in energy, water and materials in the lower-middle-income segment, using the IFC's Excellence in Design for Greater Efficiencies (EDGE) tool's default assumptions for each country. WACC: Mexico = 11%, India: 16%, Indonesia: 15% and South Africa: 14%.

Source: Calculations based on the EDGE online tool (2021).

Building certification schemes remain underdeveloped in many markets. In 2020, an area equivalent to 3.5 billion m^2 has been certified by a green building scheme (WGBC, 2020). International or domestic green buildings certifications are a set of rating systems and tools that are used to assess the performance of a building or a construction project from a sustainability and environmental perspective. Certifications will usually be awarded to a building that achieves energy, water consumption and raw material savings beyond what is required in the country's building code. Certifications usually have multi-layered levels of achievements (e.g. bronze, silver, gold), from basic energy savings all the way to net-zero or carbon-neutral buildings.

Such labels bring international recognition, standardisation and confidence for unfamiliar investors to engage in the market. They can also address the perception of higher construction costs and administrative hurdles faced by developers through the standardised features and tools commonly included within documentation. Developers can for instance use them to estimate the incremental cost of building green, plan for the reconfiguration of their supply chain, or find ready-to-use standardised agreements and procedures.

Table 3.7 ▷ Selected green buildings certifications

Certification	Developer	Geographical focus
Leadership in Energy and Environmental Design (LEED)	US Green Building Council	Global
Excellence in Design for Greater Efficiencies (EDGE)	International Finance Corporation (IFC)	Global
Building Research Establishment Environmental Assessment Method (BREEAM)	Building Research Establishment (UK)	Global
Greenship	Green Building Council of Indonesia	Indonesia
Green Rating for Integrated Habitat Assessment (GRIHA)	The Energy and Resources Institute (TERI)	India
Indian Green Building Council	Indian Green Building Council	India

In many cases achieving resource-efficient construction will be cost-effective, and studies point to improved financial returns stemming from investment in green buildings and better performance on indicators such as occupancy rate, time to sell and selling price overall. Securitising investment in certified green buildings for refinancing in international capital markets is also easier via, for instance, the emission of green bonds denominated in euros or dollars. For developers, green certification can provide access to a wider pool of investors worldwide, though this also depends on availability of suitable financial vehicles, such as real estate investment trusts and mortgage-backed securities, which enable such aggregation.

Improving the availability of cheaper and longer-duration financing will be vital to better enable investment opportunities. Access to international finance for green buildings developers in EMDEs remains low (around 15%) as the fragmentation of small-scale deals, the high perceived barriers to entry in local markets, currency risks, and patchy or poorly enforced regulatory building codes prevent international investors from seeking to invest in that space. International or medium-size local investors point to the difficulty in conducting the required due diligence process for such small deals.

Mobilising investment depends a lot on matching the right financing mechanism with the degree of market maturity. Reliance on public, highly concessional financing will be high in nascent, risky markets, where no return is expected. Transactions will be conducted by highly specialised companies. With a bigger market and appropriate enabling mechanisms in utility regulation, public companies are able to start using on-bill financing mechanisms with the support of credit lines from DFIs. Enabling mechanisms include revenue cap regulation (to remove the fiscal disincentive to invest in demand-side measures) and introduce specific incentives or performance metrics for utilities. Once the market matures, commercial finance becomes available and private-sector companies start structuring sophisticated funding mechanisms, including debt issuance (bonds) or project finance. Some of these mechanisms involve commercial and payment arrangements, such as the provision of energy efficiency as a service, to address the upfront investment barriers. This trend is discussed in greater detail in the spotlight section below.

Table 3.8 ▷ Financing energy efficiency: A ladder of options

Higher market maturity Access to commercial financing	Advanced commercial or project financing (ESCOs)
	Vendor credit, leasing
	Commercial financing, bonds
	Partial risk guarantees
	Credit lines with commercial banks
	Credit lines with development banks
	Public or super ESCOs
	Energy efficiency revolving funds
	Utility (on-bill) financing
	Budget financing, grants with co-financing
Lower market maturity Public financing	Grants

Source: Adapted from World Bank (2013).

Local banks play an important role in mobilising finance through products that bring developers and tenants to engage in green construction or home improvement, but in many EMDEs they lack capacity and experience in evaluating projects. Local banks can leverage their knowledge of the local market and conduct the due diligence process to allocate green financing and aggregate it into portfolios, which then can attract a wider pool of institutional or international investors and potentially lower their cost of capital.

Some banks have been established with the specific purpose of investing in assets that accelerate the transition to a low-carbon economy. Green banks play a particularly important role in financing energy efficiency and small-scale clean energy projects, with green construction loans, first loss guarantees, or mortgages with a longer tenor or a lower interest rate than what would be available on the market. Two-thirds of existing green banks are located in high-income countries, and their further development in EMDEs is hindered by obstacles such as availability of and access to finance, political and regulatory environment, and human capacity and availability of staff with the right skill sets (RMI, 2020).

Actions and case studies for mobilising finance

Addressing the issues raised above and mobilising much higher levels of investment in buildings would require stronger efforts in EMDEs around the following areas:

- Strengthening regulatory frameworks for buildings efficiency, including through building codes, performance standards.
- Putting in place green building certification schemes that facilitate bankable projects and refinancing.
- Promoting a diversity of financing options to build capacity and lower the cost of capital.
- Addressing multiple barriers around the economic case for investment.

A few examples illustrate how EMDE governments are approaching these issues in practice.

Strengthening investment frameworks. In **India**, where the Energy Conservation Building Code roll-out is progressively becoming mandatory in states across the country, investment in energy efficiency in buildings has more than doubled since 2017, when the building code was last revised. Energy intensity of commercial buildings has seen a 7% reduction while residential construction saw an 8% improvement during the same period. A total of 52 million m^2 of housing was certified under GRIHA and the Voluntary Star Ratings for services, which was launched is 2006, and has now been extended as a labelling programme for some appliances.

The **MEPS,** which have been used successfully as an effective policy tool to overcome information and split-incentive barriers, are key to raising the energy efficiency of new appliances. This approach means investment in higher efficiency is mandated, though over time the expected increase in purchase prices rarely occurs due to learning and economies of scale. Consumers also benefit from lower energy bills. Ratcheting up the performance requirements over time is an effective way to raise efficiency, especially when they are signalled in advance and requirements are aligned with regional and international markets.

Certification schemes that facilitate bankable projects. In **Colombia**, the adoption of a new building code in 2015 and the endorsement of the IFC EDGE certification by the chamber of commerce enabled two local banks to design new products to raise funds for green buildings. In 2017, Bancolombia and Davivienda, two of the largest banks in the country, issued USD 260 million in green bonds to fund the construction of EDGE-certified green housing developments and two green office buildings. The issuances also demonstrate how investment in green buildings can be securitised and marketed to international investors. The building code paired with a widely recognised certification provided investors with a higher level of confidence in the bankability and the sustainability impacts of the project, and brought commercial banks to the table. The green bond issuance provided an easy, cheap and liquid investment vehicle to channel funds into the projects. Similar financing structures are quite simple to implement and can channel investment into green buildings at scale.

Promoting a wider diversity of finance from local and green banks. In **Mexico,** the Infonavit Green Mortgage Programme provides enhanced financing conditions for the purchase of a home with a lowered environmental footprint. The programme, which was initially designed for lower-middle-income households to have access to ownership while saving on energy bills, has proven successful in funding more efficient housing purchases. Households are given a credit on top of existing mortgages to help cover the cost of such purchases, with the aim of reducing utility bills by more than the amount of the increase in mortgage costs. The programme has been extended to all loans offered by the Mexican federal institute for workers' housing.

Addressing multiple barriers around the investment case. Some barriers in EMDEs can be best addressed by interventions by international development finance, through catalytic instruments, such as grants, and technical assistance. For instance, the **Agence Française de Développement** has established a technical assistance and financing facility for commercial banks and companies across the African continent. The facility, called SUNREF, promotes the use of green and blended finance instruments tailored to the needs of economic actors in Africa, by reinforcing capacities of local banks in the areas of renewable energy and energy efficiency, and helping them develop innovative green banking products. Local knowledgeable intermediaries will be crucial in financing the transition towards greener construction, and developing financing tools and the capacity that are adapted to the new requirements of clean energy finance is of paramount importance.

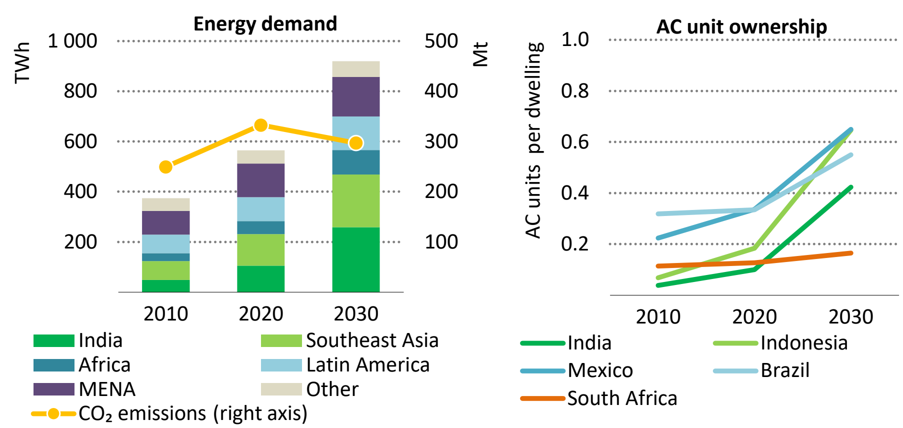
3.5.2 Focus on cooling

Space cooling is the fastest-growing use of electricity in the buildings sector worldwide, and has tremendous potential to rise in the coming years in EMDEs, with potentially very stark implications for the electricity sector and for peak electricity demand in particular. Today only 14% of households in EMDEs have an air conditioner (AC), compared with more than 80% of households in some wealthier countries with less challenging climates. There are also large differences in ownership – in some economies ownership rates approach 80%, such as in Singapore and Malaysia, while in other markets, such as Cambodia, Indonesia, the Philippines and Viet Nam, penetration is at around or less than 10%. In EMDEs it adds over 350 terawatt-hours (TWh) or 5% per year between 2020 and 2030 in the SDS, an amount greater than the annual electricity consumption of Indonesia today.

This disparity highlights the significant potential for increased adoption of air conditioning in many EMDEs. As incomes rise, access to electricity improves and prosperity becomes more widespread, air conditioning is becoming affordable for more people, particularly in the fast-growing markets of Asia and the Middle East. Increasing urbanisation accentuates the increase in demand for space cooling, as incomes (and temperatures) tend to be higher in urban areas.

This poses a series of challenges for electricity systems, including expansion of grids, higher investment requirements in electricity supply and rising evening peak demand. The share of cooling in electricity system peak load could ultimately reach 40% and above in Indonesia and India. While cooling loads are powered by cleaner electricity sources, and as more renewable power is brought online, the mismatch between the time of the day when solar and wind power can generate electricity and the time when power for cooling is needed creates system integration challenges. Running efficient AC units is therefore of paramount importance for all EMDEs to ensure access to cooling while balancing the environmental and electricity system impacts. Many households projected to own ACs by 2030 have yet to purchase their first unit, and in some countries households that purchase ACs are expected to own more than one unit in the same timeframe (IEA, 2020f).

Figure 3.24 ▻ Energy demand and CO_2 emissions from cooling in EMDEs and AC units per household in IEA climate-driven scenarios



Electricity demand from space cooling is set for very rapid growth in EMDEs – action to improve efficiency is critical to mitigate the impacts of rising ownership of AC units.

Note: Mt = million tonnes. AC = air conditioners.

Low-tech alternatives to air conditioning can be prioritised for cooling in certain parts of the world. The most cost-effective way is to integrate cooling consideration into a new building design phase. The passive cooling measures can bring down the temperature inside a building and reduce the need to purchase AC units. These measures can include external shades, reflective wall and roof paints, cool roofs, and off-grid solar home systems to power highly energy efficient devices.

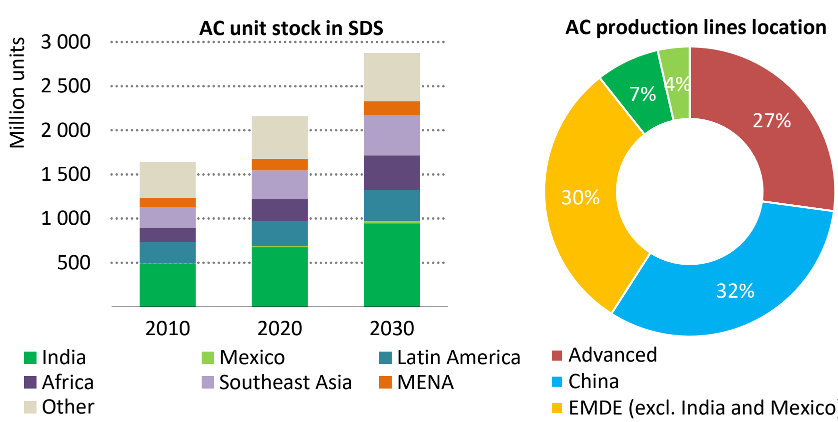
Investment outlook and sources of finance

Spending on energy-efficient cooling equipment in EMDEs more than doubles in our climate-driven scenarios over the next ten years, as the stock of AC units reaches almost 3 billion in 2030. Two-third of new ACs are purchased in India, Southeast Asia or Africa. In the residential sector in EMDEs, there is a direct correlation between income levels and AC ownership, suggesting that the purchase of residential cooling units is almost exclusively realised on households' balance sheets as the general income rises and access to electricity improves. By 2030, leasing or cooling-as-a-service arrangements are available, but the vast majority of ACs are expected to be purchased directly by households. Green loans for retrofits expand the role of debt financing, but cooling is still limited to those who can afford it and most generally financed through readily available equity. In the services sector, the higher upfront cost of industrial-scale chillers requires greater levels of debt financing by 2030. By the end of the decade, twenty percent of the investment in energy-efficient cooling in India is made by the public sector through the development of public housing programmes and bulk AC purchasing.

Key factors influencing investment

Most cooling appliances sold today are manufactured by one of the ten leading firms in the world, typically multinational, multiproduct appliance companies, with the broader share of their manufacturing capacity traditionally located close to their core but mature and saturated markets (Europe, Japan, the People's Republic of China [hereafter, "China"] and the United States). These companies typically enjoy broad access to cheap international financing and are very responsive to customer demand in terms of energy-efficient products.

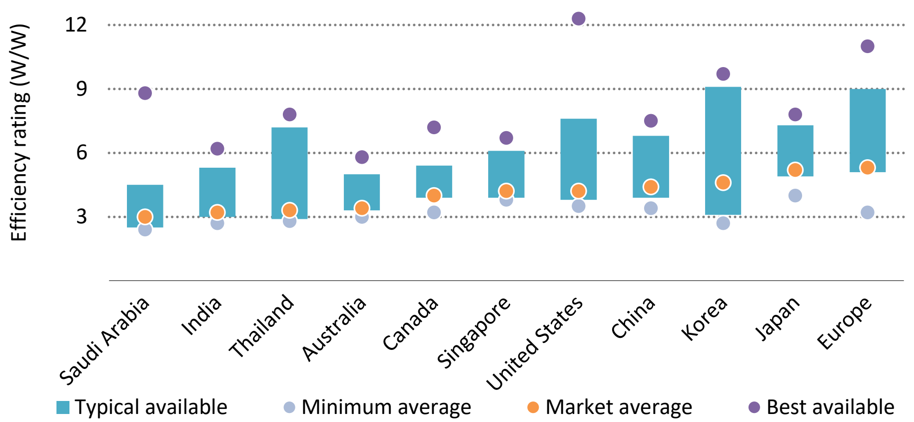
Figure 3.25 ▷ AC unit stock in the SDS and current location of manufacturing



EMDEs account for 50% of global AC sales in IEA climate-driven scenarios, and the efficiency of these models is a crucial variable for electricity security and emissions.

Some EMDEs are trying to develop their domestic capacity. In the last decade, in response to restrictions on the import of finished cooling products in India, 18 AC production lines have opened in the country and several others operate or are in development in Southeast Asia, where the majority of growth of sales is expected. As import taxes are levied on suppliers of parts and components, manufacturers have also relocated their supply chain to those countries. Although Africa will be another growth market for the industry, no major AC manufacturing plants are located on the continent and most units are imported.

Figure 3.26 ▷ Efficiency ratings of available AC units and market average



Despite wide availability and affordability of efficient ACs, perception of higher upfront costs and ineffective labelling drive investment towards the minimum average efficiency.

Source: IEA (2020).

Note: W/W is the efficiency rating of an appliance. However the standards, test procedures, temperatures bins and metrics used to evaluate efficiency ratings differ among countries, so ranges should not be compared across countries. SEER = Seasonal Energy Efficiency Ratio. CSPF = Cooling Seasonal Performance Factor. APF = Annual Performance Factor. COP = Coefficient of Performance. ISEER = Indian Seasonal Energy Efficiency Ratio. IPVL = Integrated Part Load Value.

ACs have high upfront costs relative to income in EMDEs and investment tends to be directed towards the cheapest available unit, regardless of efficiency level. Most EMDEs have mandatory MEPS, although the required efficiency levels are typically far below those of the most efficient products available. In most markets the typical efficiency rating of the average cooling unit is only slightly better than the minimum standard, and affordable options exist with efficiencies that are 50-70% better.

However, even a slight increase in upfront costs can send customers towards cheaper and less efficient units, despite the disadvantages in terms of full life-cycle costs. Studies have shown that in India, for instance, the additional payback period of purchasing a unit with an energy efficiency ratio of 5 instead of a market average was around two years (Lawrence

Berkeley National Laboratory, 2017), well within the lifetime of the typical room air conditioner. By contrast, services and businesses are more capable of integrating the full life-cycle cost of cooling and will generally purchase slightly more efficient units than the minimum available. Coupled with MEPS, mandatory comparative energy labelling is important to provide reliable information to consumers about the efficiency of AC units. These should be upgraded as product efficiency improves, and such information can also be the basis for other programmes (such as rebate or aggregated procurement programmes).

Actions and case studies for mobilising finance

Some EMDEs are developing approaches to promote widespread uptake of more efficient and affordable ACs, including through introduction of MEPS and labelling. Other examples include bulk procurement programmes, innovation competition and service models.

Government bulk procurement. In an effort to bring energy-efficient AC to the market at an affordable price, **India**'s super ESCO, EESL, replicated its approach for purchasing light-emitting diode (LED) bulbs to launch a bulk procurement tender for 50 000 energy-efficient residential AC units. The Indian company Voltas won the tender and provided the units to EESL, which then sold them to its customers at a discount on a first come, first served basis. By purchasing in bulk, EESL was able to achieve economies of scale and provide customers with a 30% discount on the price of even less efficient units, replicating the success of the early scheme with LEDs. The bulk procurement programme was conducted with support from international financial institutions, and proved that efficient cooling can be achieved at a price similar to or lower than the baseline.

The Global Cooling Prize demonstrated that leapfrog improvements were possible in cooling efficiency. In 2018 the programme, initiated by the Government of India, Mission Innovation and RMI, launched a two-year-long competition for AC manufacturers and engineers to develop a super-efficient residential cooling solution with at least five times less climate impact than standard AC units present on the market. To win the prize, newly developed AC units had to meet a range of criteria beyond pure efficiency such as affordability, scalability, limited power draw and water usage. Two consortia received the first prize in 2021 for achieving all criteria. While the successful technologies were deemed to have an initial upfront cost that would be two or three times more expensive than that embedded in standard units, their life-cycle cost of ownership was expected to be reduced by half.

Cooling as a Service (CaaS) business models or the Coolease financial mechanism can help solve the barrier of the cost of purchasing energy-efficient ACs by smoothing the high upfront investment into the whole life cycle of the unit, or more simply by leasing efficient AC units to households or companies, who will not have to make the on-balance sheet upfront investment. Both models use a pay-per-use financial mechanism. In **South Africa**, fruit grower Afrupro outsourced and was able to upgrade its cooling operations, which lowered energy consumption by 20%, without spending any upfront capital (CaaS, 2020).

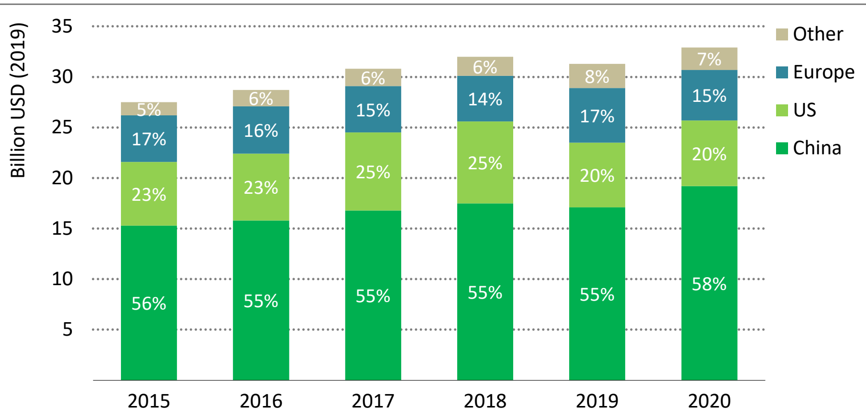
SPOTLIGHT

Boosting investment in energy efficiency through ESCOs

The world is a long way from unlocking the full potential of energy efficiency. Despite ample evidence of their cost-effectiveness, investments in efficiency have not grown significantly since 2017. While this stems in large part from slow progress in strengthening efficiency policies, the challenges associated with access to finance by consumers remains a constraint. ESCOs are businesses that provide energy solutions which can include generation and supply, energy efficiency, or retrofitting projects. They deliver efficiency based on contracts tied to energy performance and are key enablers of investments. They help consumers identify, finance and implement projects, thereby lowering the threshold to invest. In particular, ESCOs can reduce the burden of making upfront capital expenditures and facilitate access to commercial financing.

The impacts of the Covid-19 pandemic on ESCO investment spending varied by geography. The size of the global ESCO market increased by 6% to USD 33 billion, continuing steady growth since 2015. Most of this stemmed from China, where estimated revenues rose 12% despite the pandemic. The United Arab Emirates and United States also saw growth, while European markets and those in emerging Asia contracted.

Figure 3.27 ▷ Global ESCO market growth 2015-2020



The ESCO market has been growing steadily since 2015, but the full potential of the industry remains hindered by multiple barriers.

Notes: Totals can be more than 100% due to rounding.

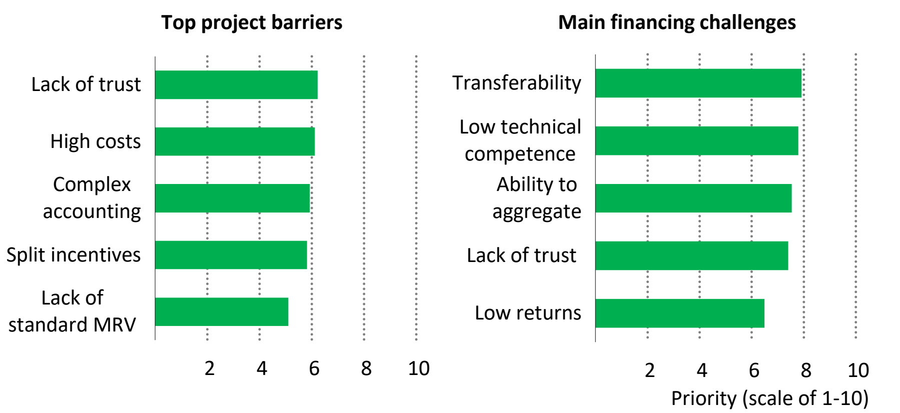
Source: IEA annual ESCO market surveys.

In advanced economies, commercial arrangements have shifted over time, from a focus on energy performance contracting (EPC) with shared savings for publicly owned buildings, to those offering guaranteed savings and targeting a more diverse set of counterparties. Energy supply contracts, often referred to as "chauffage", are increasingly popular for both private- and public-sector clients, mainly in Europe.

In EMDEs, shared savings, where ESCOs assume both the technical and financial risks, remain the dominant EPC model and help reassure companies and banks with less familiarity with efficiency. Where state-backed super ESCOs are active, as in India and Saudi Arabia, the shared savings model is also preferred. Policies have underpinned the expansion of ESCOs into the industrial sector in Asia. In such markets, as well as Mexico, most revenues have come from the private sector. Still, this approach can constrain small and medium-sized ESCOs that lack access to finance, despite average rates of return above 15% and payback periods shorter than five years for most interventions. Debt finance costs range over 6-12%, with required returns on equity at 12-25%.

Lack of consumer awareness and confidence in the services that ESCOs provide is a cross-cutting barrier to project development and access to finance. Issues related to ownership and commercial arrangements (e.g. lack of transferability, split incentives and ability to aggregate projects) as well as technical aspects (e.g. costs, competence and accounting) figure prominently among challenges.

Figure 3.28 ▷ Barriers and challenges to ESCO projects and financing



Boosting ESCO investments requires improving consumer trust in the industry, as well as challenges related to ownership, commercial arrangements and technical aspects.

Notes: MRV = measurement, reporting and verification.

Source: Company responses based on IEA annual ESCO market surveys.

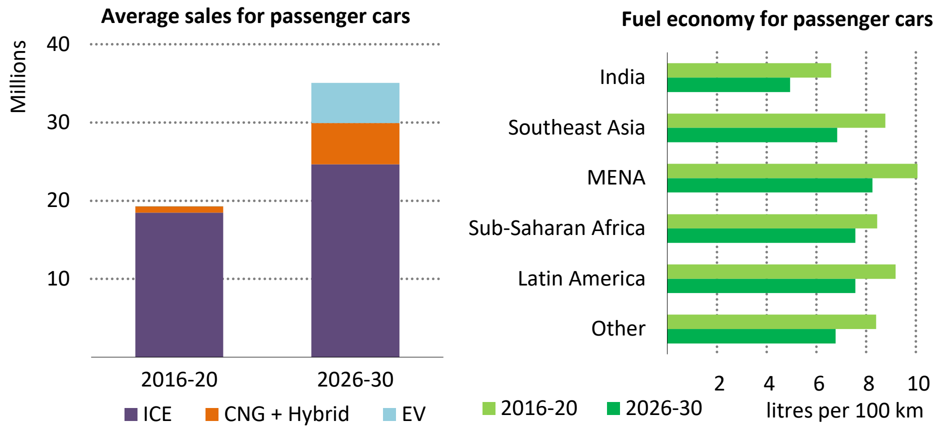
Governments and financiers play a critical role in addressing these issues. DFI engagement has helped support development in China and other EMDEs, as well as dedicated funds and risk-sharing facilities. For example, Thailand's Energy Efficiency Revolving Fund has improved access to finance and stimulated commercial bank lending.

Adoption of digital tools could also stimulate investment. Smart sensors and big data enable more transparent and systematic MRV of energy savings, building trust among counterparties, creating energy system benefits and enabling project finance. They also support business models such as CaaS, as in Argentina and India. Smarter ESCOs can also tap into wider efforts, such as those pertaining to connected cities.

3.5.3 Efficient and electrified vehicles and charging infrastructure

Meeting fast-growing mobility demands in EMDEs represents a crucial pillar for sustainable development and energy security. Among different modes of transport, this section focuses on the electrification of PLDVs, which account for the largest CO_2 emissions (38%) and energy consumption (39%) in EMDEs' road transport. Two-/three-wheelers and buses serve as a major means of transport in some EMDEs, especially in the case of India and Indonesia, with a rapid growth in the shared mobility business, but still represent a minor proportion of total CO_2 emissions and fuel consumption in EMDE road transport.

Figure 3.29 ▷ EMDE passenger car sales in the SDS



Sales of more efficient ICEs, as well as EVs, hybrids and CNG-based vehicles in EMDEs need to rise very rapidly in IEA climate-driven scenarios.

Notes: ICE = gasoline- and diesel-based internal combustion engine vehicles; CNG = compressed natural gas vehicles; hybrid = hybrid gasoline and diesel vehicles. EVs include plug-in hybrid electric, battery electric and fuel cell electric vehicles. All vehicles include passenger cars only.

By 2030, one out of two passenger cars sold globally is electric under the NZE by 2050 and one-third is electric in the SDS. In the SDS, EMDEs purchase around 40% of new PLDVs globally, while their per capita ownership levels increase by around one-third from today. Oil for transport has accounted for almost 30% of the growth in final energy consumption in

EMDEs over the past decade and almost 50% of the growth in CO_2 emissions. Without greater efforts to find a low-carbon pathway for transport, such trends would create multiple hazards for EMDEs, including dramatically rising fuel import bills for some regions, such as Southeast Asia and India, as well as deteriorating local air quality.

A number of EMDEs have included vehicle efficiency and the electrification of transport as key elements of economic development plans and nationally determined contributions. For example, among the focus countries in this report, almost 70% have set a target for EV deployment. However, these ambitions confront challenges related to mobilising upfront capital from a class of purchasers for whom finance is typically most constrained – consumers and SMEs – as well as the development of a robust ecosystem of technology and service providers, and enabling infrastructure, that facilitate investment.

Over the next decade, EMDEs have the highest growth rates in new electric PLDV sales in IEA climate-driven scenarios, albeit from a low base in many countries. The shift away from old diesel and gasoline vehicles is initially spurred by strong policy measures such as mandatory emissions reduction targets for new cars and mandatory EV quotas, but over time the economic case for EVs will drive the transition towards efficient and electrified vehicles with lowered manufacturing costs and expansion of debt-financing and auto-leasing services in EMDEs. India and Southeast Asia become the largest EV markets in EMDEs to 2030, from a low base, but a broad-based upswing in deployment is critical for realising a longer-term shift where EVs account for the majority of growth in transport by the mid-2040s.

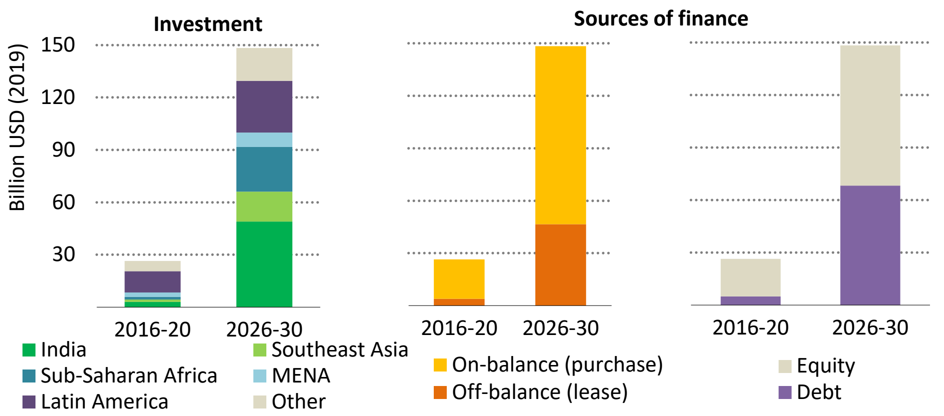
Investment outlook and sources of finance

IEA climate-driven scenarios see a very rapid increase in investment in more efficient and electrified vehicles and charging infrastructure; in the SDS this means a rise of almost six times to over USD 140 billion annually by 2030. Around 30% of this takes place in India, followed by a strong role for Latin America and the Middle East and North Africa. While EVs account for around one-third of this investment, other forms of transport improvements, such as transport energy efficiency (60%) and EV chargers (5%), play an important role. Unlike the high concentration of EV sales in a few EMDE regions, transport investment grows more evenly across all EMDEs.

Most of this investment comes from private sources, but government policies play important roles in mobilising capital. Households and companies finance around 75% of future investments in EVs and EV-related energy efficiency spending by 2030. SOEs and public finance institutions finance the remainder - mostly through procurement for government vehicle fleets and the direct provision of grants to consumers and enabling infrastructure, such as the construction of public EV charging stations. Some eligible customers benefit from the growing role of off-balance-sheet leasing arrangements, but the majority of purchase costs are met by balance sheet finance. With expansion of auto loans and auto-leasing arrangements, debt financing ramps up from nearly USD 5 billion to over USD 45 billion in the next decade, but over 50% of investments are still financed by equity.

The affordability and feasibility of new vehicle purchasing depends increasingly on the availability of debt financing options to help fund upfront expenses. More than 30-40% of future investment needs is met by auto-leasing services and auto loans. However, these types of financial products remain less accessible in EMDEs, where credit quality for consumers and SMEs is difficult to assess and borrowing costs remain elevated.

Figure 3.30 ▷ Investment and sources of finance for the transport sector in the SDS



In IEA climate-driven scenarios, EMDE EV investments increase at least six times in the coming decade with the need for 30-40% of this to be financed through leasing and debt.

Notes: Transport investment is calculated based on investment spending in EVs, EV charging stations and transport efficiency, which is defined as the incremental spending on new energy-efficient vehicles compared with the average efficiency of new vehicles for light-duty vehicles and the average fuel intensity for freight vehicles and other transport. Under conventional accounting, part of this is categorised as consumption rather than investment.

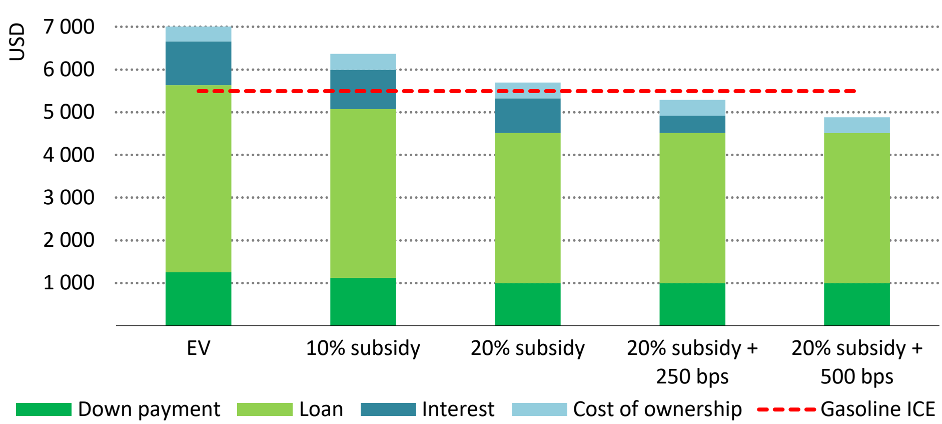
Key factors influencing investment in EVs

Over time, continued technology progress and falling costs for batteries contribute to improving economics of EVs. However, in the absence of government supports, EV purchases remain a high hurdle for most consumers in EMDEs due to relatively high financing costs compared with advanced economies and high initial purchase costs compared with ICEs, which is often influenced by the presence of subsidies for gasoline and diesel. Creating domestic capabilities in delivering these solutions also has an impact on wider economic benefits and willingness to set policies that support EVs at scale. Notably, investment decisions in rapid energy transitions will depend on addressing three crucial factors:

- Lack of access to debt financing and high cost of borrowing in EMDEs.
- Deployment of EV charging infrastructures with proven business service models.
- Availability of manufacturing capacity to boost the role of EMDEs in the EV value chain.

In advanced economies, the average EV purchase price is around 1.5 times higher than for comparable passenger vehicles. For the same price of EVs, the consumers in EMDEs bear higher financing costs than those in advanced economies due to higher interest rates and lower availability of debt. They also have less access to service models, such as leasing. While financing terms vary considerably by geography, the cost of consumer debt can range from 4% to 18% (in real terms). By contrast, consumers in other markets can often finance over 90% of the purchase cost with auto loans or pay less upfront with a lease contract though local service agencies. In recent years, lower interest rates have decreased the cost of auto loans to around 4-5% in the United States and China. Local banks also provide concessional rates for EV auto loans with discounts ranging from 25 to 100 basis points, as in the United States and Australia.

Figure 3.31 ▷ Annualised total cost of ownership for EVs in EMDEs, by incentive level and financing cost reduction



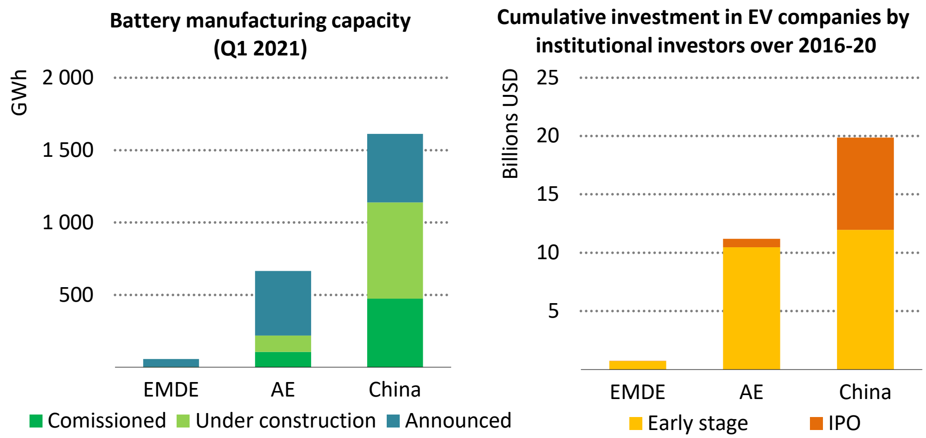
A combination of direct incentives and reduced financing costs for auto loans can help defray upfront investment and the cost of ownership and speed up EV deployment.

Notes: The annualised total cost is calculated based on 20% down payment, 5% fixed interest rates, 3% discount rate, eight years of loan payment and annualised cost of ownership which reflects fuel costs.

The combination of relatively high technology and financing costs contributes to a more challenging investment case, in the absence of government support. Moreover, the total cost of ownership can be reduced by the public grant programme or concessional loan schemes for EV purchasers. For instance, a subsidy rate of 20% would lead EVs to reach a break-even point with gasoline vehicles by 2030 in the SDS. Lowering the cost of borrowing by 100 basis points would move up the break-even point by 2022. Low-cost policy incentives can also increase the demand for EVs. In the case of Delhi, the EV incentive schemes were financed through revenue raised by congestion charging and a road tax. In other markets, free charging and free parking for EVs were adopted to incentivise EV deployments.

Investment in EV charging stations has not yet taken off due to the lack of proven service business models and high upfront cost for installation especially for fast-chargers (see distribution grids discussion above). Such business models face uncertainty over future demand and associated revenues. Battery-swapping services reduce refuelling times and upfront EV purchase costs for consumers but their commercial viability still needs to be tested in the broader markets outside China and the United States. With limited access to public and private charging stations, the financial burden is cascaded to consumers. With the already high cost of EVs, consumers may find the additional investment for home or office EV charging stations unfavourable to switch to EVs. Without strong policy and public investment support, the economic case for EV charging investment remains low to meet the growing demand in EVs in EMDEs.

Figure 3.32 ▹ EMDE battery manufacturing capacity and early-stage/IPO fund-raising by EV companies



In EMDEs, development of capacity to support battery manufacturing and institutional investment by new EV companies remains low compared with the rest of the world.

Notes: IPO = initial public offering. Early stage includes disclosed venture capital and private equity fund transactions in EV and EV manufacturing companies. It excludes investments in autonomous vehicles and artificial intelligence related to EV. Commercial stage includes new capital raised through IPOs.

Sources: IEA calculations based on Bloomberg (2021), BNEF (2021) and Preqin (2021).

With respect to the EV value chain, original equipment manufacturers (OEMs) and suppliers may often face high barriers to accessing finance and scaling up local manufacturing capacity. Global battery manufacturing capacity is currently concentrated in advanced economies and China, pointing to a potential high reliance on imports to support vehicle manufacturing. With advances in battery technology, incumbent automobile OEMs around the world are looking for opportunities to vertically integrate along the EV value chain, but EMDEs face the risk of missing out on this development.

Most EMDEs lack domestic manufacturing capacity for EV-exclusive components (e.g. battery pack), which account for 35-50% of the vehicle cost. Incumbent OEMs in EMDEs face higher upfront manufacturing costs for EVs than ICEs as the majority of EV-exclusive components need to be imported overseas with import tariffs and transactional costs. Without further development, EMDEs may lose out on investment opportunities in the fast-changing auto industry, especially for SMEs, and struggle to accelerate EV deployment.

In electrified transport, development of new companies is also proceeding slowly in EMDEs. Over the past five years, nearly all the funding by institutional investors directed at EV companies occurred in advanced economies and China. Globally, while the EV space continues to gather a lot of traction from investors, the emphasis on unlisted investments, with IPOs on listed markets making up a minor portion outside of China, indicates the still-nascent state of new company formation in the sector. That said, new transport companies oriented around mobility as a service, such as ride-hailing operators like Gojek (Indonesia) and Grab (Southeast Asia), have scaled up rapidly with investor support and may offer a platform for further adoption of electrified transport at scale.

Actions and case studies for mobilising finance

Addressing the issues raised above and mobilising much higher levels of investment in passenger EVs would require stronger efforts in EMDEs around the following areas:

- Setting incentives to help offset initial purchase costs and reduce the cost of ownership.
- Expanding consumer access to low-cost auto loans and leasing models.
- Supporting manufacturing and industrial development, such as through joint ventures.

A few examples illustrate how EMDE governments are approaching these issues in practice.

Setting incentives to improve affordability of EV purchases. In Mexico, the government provides tax incentives for EV purchases as well as investments in charging stations. It continues to exempt all tariffs on imported EVs over the 2020-24 period and provides a tax credit of 30% of the investment made in public EV charging infrastructure. These incentives are combined with regulatory benefits in some cases – e.g. Mexico City waives EV owners from vehicle verification proceedings and complying with no-driving-day rules. The new building code also requires exclusive parking spots for EVs in both publicly and privately owned parking lots. State-owned utility CFE is supporting deployment with investments of over USD 3 million for 100 free charging stations in Mexico City. With tax benefits and financial incentives in place, EV sales in Mexico increased around 250% from 2019 to 2020.

Expanding financial offerings and service models for consumers. Financial institutions in **India**, **Singapore and the United Arab Emirates** have launched dedicated green auto loan programmes, which provide discounted lending terms for qualifying vehicles. The Emirates NBD – the Dubai government-owned bank – offers a 25-50 basis point discount on loans for qualified hybrid and electric cars as a part of UAE Vision 2021. The State Bank of India (SBI) offers a discount of 20 basis points with maximum loan tenure of eight years for EVs. The SBI also plans to replace its auto loan programmes with 100% EV auto loan programmes by 2030.

DBS Bank and OCBC Bank in Singapore provide EV loans at a fixed rate of 1.68% for the entire tenure, more than 30 basis points lower than conventional auto loans. As a part of EV loan programmes, DBS and OCBC will install 10 000 EV charging stations by 2030 and expand sustainable finance portfolios, which include clean auto products, more than double by 2025.

Supporting manufacturing and industrial development. In 2020, **Thailand's** Board of Investment (BOI) introduced an USD 1.1 billion incentive scheme for the EV manufacturing industry, which provides a corporate income tax exemption to plug-in hybrid electric vehicle manufacturers, of up to three years, and up to eight years to battery-electric vehicle manufacturers. The BOI will extend the tax exemption periods if the company spends more on research and development for EVs or meets the EV production requirement of 10 000 units within three years. In addition, the BOI will exempt 90% of import duties on non-locally-available materials for EV battery production.

S P O T L I G H T

Financing low-emission public transit projects in EMDE cities

More than half of the global population lives in urban areas, with the fastest-growing cities located in EMDEs. But their development is challenged by congestion and air quality issues, pointing to the important role of investing in sustainable transport modes beyond passenger vehicles.

Successful public transit projects can enable economic growth with high potential to reduce emissions. However, they require large upfront capital expenditures, most often by public authorities, and long construction times. This puts pressure on the budgets of governments or municipalities, who are more restricted in fundraising. Finding ways to attract external capital from private sources, including project finance and institutional investors, is critical to supporting investment. Such projects can generate fixed-income like returns in local currency, but may face currency, permitting and counterparty risks.

Some EDME public transit projects have successfully attracted capital through policy incentives and risk-management solutions, including from public finance institutions. They have also used a range of financial instruments and structures, including green and project bonds, joint ventures with technology companies, early-stage equity and grants.

In India, the Indian Railway Finance Corporation (IRFC) provides an example of an SOE raising capital through sustainable debt markets to fund public transport. It raised USD 500 million through a dollar-denominated green bond with a ten-year maturity paying a 3.835% semi-annual coupon rate. The bond was subscribed three times more than its initial target, reflecting a high interest among global investors in hard currency denominated sovereign green bond products in emerging markets. IRFC used the raised capital to finance the acquisition of clean electric trains and railway infrastructure.

Table 3.9 ▷ Features of select electric mass-transit projects in EMDEs

Project type	Country	Investor type	Policy and financial instrument
Electric rail	India	SOE, private investors	Green bond issued in USD by the state-owned rail company
	Costa Rica	SOE, government, DFI	Concessional loan extended by CABEI with sponsor equity from state-owned rail company
Electric buses	Thailand	SOE, DFI, private sector	Joint venture between ADB (concessional loan) and private-sector company (early-stage equity investment) with financial supports from government initiative
	Colombia	SOE, private investors	Competitive bidding won by a joint venture between international bus technology company and local manufacturing partner
	Uruguay	DFI, SOE	Concessional loan from DFI and sovereign guarantee from government
	Uganda	SOE, government	Grant and equity investment by government
Electric taxis	Chile	Government	Government loan facility for private taxi companies

Note: CABEI = Central American Bank for Economic Integration.

In Colombia, the Bogota City Public Transport Authority (TransMilenio) is shifting its bus fleet from diesel to electricity using international partnerships and competitive procurement. In January 2021, the company signed a USD 1 billion contract with a French mobility company, Transdev, and its local partner, Fanalca, to procure more than 400 electric buses in Bogota through competitive bidding open to all fuel types. The e-buses are set to be operational by the end of November 2021, when the diesel buses will also be phased out.

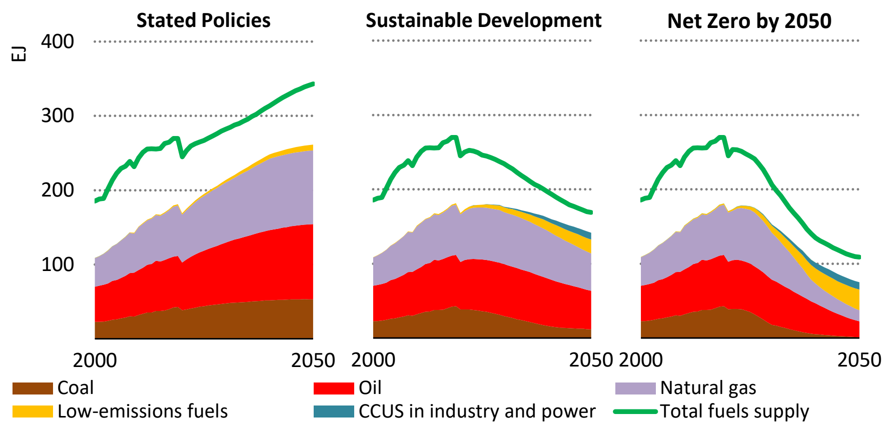
In Uganda, Kiira Motors Corporation is a stated-owned EV automaker, established under the Uganda Vision 2040 to create jobs and diversify the economy. The company designed the first EV in Africa, the Kiira EV, in 2011 and started an electric bus business with two pilot projects to replace diesel-based school buses and airport shuttles. In April 2018, the government of Uganda supported the roll-out of this model through the provision of land to help the company to build an auto manufacturing factory.

Financing transitions in fuels and emissions-intensive sectors

SUMMARY

- Very rapid increases in renewable power, efficiency and electrification are central to climate-driven scenarios, but on their own will not secure the emissions reductions required without complementary transitions in fuels and emissions-intensive sectors. The latter issues are particularly challenging in EMDEs because they are undergoing rapid industrialisation and urbanisation and, in many cases, the abatement options are less mature and affordable.

Figure 4.1 ▷ Demand for unabated coal, oil and natural gas and low-emissions fuels and CCUS in EMDEs by scenario



Clean energy transitions require a massive shift away from unabated fossil fuels and a concurrent rise in low-emissions fuels and CCUS.

- Changes in fuel use and in emissions-intensive sectors in IEA climate-driven scenarios in the 2020s focus on improvements in efficiency and fuel switching, mainly to electricity but also, in some sectors for a limited timeframe, to natural gas. In parallel, it will be essential to lay the groundwork for a rapid scale-up of low-emissions liquids and gases. Established bioenergy supply chains can be developed further with well-designed incentives, while hydrogen and carbon capture are some of the fastest-growing areas for investment in rapid transitions, although for the moment they lack viable business models in many EMDEs.
- EMDEs include major fuel-importing countries, such as India, that stand to benefit during transitions from reduced import bills. However, this grouping also includes some of the world's largest hydrocarbon resource-owners and exporters, and net

income from these sources (domestic sales and exports) has averaged around USD 1 trillion each year. We estimate that the pandemic has already reduced the present value of future income from oil and gas in EMDEs by around 20%, and an acceleration of energy transitions would bring it down still further. This creates huge pressure for changes to development models in hydrocarbon-reliant economies, and raises questions about the finance available in these countries for energy and non-energy investments alike.

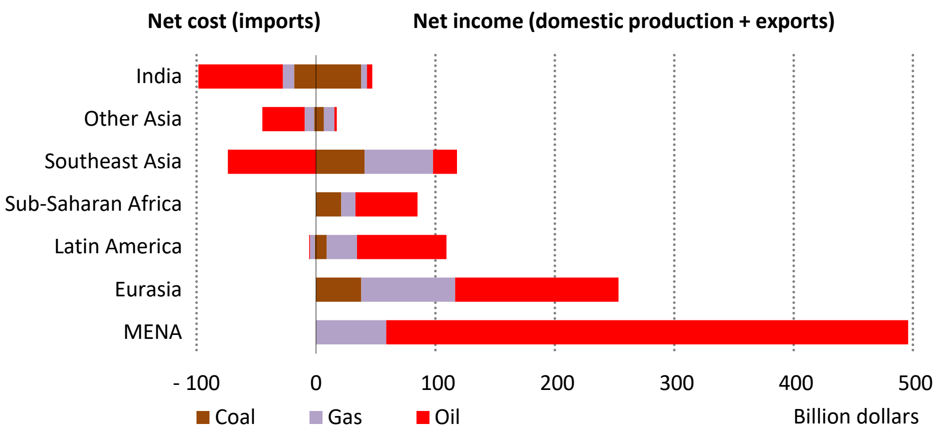
- Strategies to mitigate these risks involve the diversification of energy mixes and broader economic structures. Despite an outstanding resource, as of 2020 only around 10 GW of solar PV has been installed across the whole of Middle East and Africa, less than in Viet Nam. Getting price signals right is essential to encourage more sustainable investment; 90% of the global fossil fuel consumption subsidies tracked by the IEA are in EMDEs, distorting investment incentives.
- State-owned enterprises play central roles in fuel markets and heavy industrial sectors in many EMDEs. Ensuring transparent governance and disclosure can help to avoid risky bets on polluting or inefficient technologies. Strategic shifts by these companies are a necessary condition to meet sustainability goals. National Oil Companies have options to make their fuel production compatible with energy transitions, including the production of low-carbon hydrogen.
- Natural gas occupies a difficult space in EMDE clean energy transitions. It is seen in many cases by these countries as an ally in the push for national development and lower-emissions growth, but projects will need to demonstrate a strong alignment with transition objectives; financing criteria for gas projects are tightening. Around 90% of project debt for large-scale natural gas infrastructure projects in EMDEs over the last decade has been raised internationally, and 70% of the total came from entities domiciled in countries that now have net zero targets.
- For many EMDEs, fuels such as biofuels and biogases can foster domestic industries with major benefits for emissions, if sustainability criteria are met. Latin America accounts for almost half of total EMDE investment in bioenergy over the next decade, but markets in Africa and Asia also have major potential.
- Deployment of low-carbon hydrogen and CCUS are at a very early stage, although 4 out of 22 large-scale CCUS facilities capturing more than 40 $MtCO_2$ are located in EMDEs. Resources and technical abilities are strong for these technologies; growth will rely on international joint ventures and partnerships, commercial arrangements to secure debt and demand for clean products and fuels in advanced economies.
- Coal continues to play a significant role in the energy economies of many EMDEs, especially among developing countries in South and Southeast Asia. In these economies the age of the existing coal fleet is relatively young, with most of the capital invested yet to be recovered. Innovative financial mechanisms and international support are required to help to refit, repurpose or retire such assets.

4.1 Introduction

EMDEs are urbanising and industrialising. Cities, factories and transportation networks are being built at a rapid pace, in lockstep with economic growth and socioeconomic development. The development of national infrastructure means scaling up heavy industries such as cement, steel and chemicals, as well as growth in other sectors such as heavy-duty transportation and shipping. In other countries, this process has been deeply intertwined with the use of fossil fuels, but achieving deep reductions in global emissions require that EMDEs now chart a low-emissions pathway.

Avoiding the "carbonisation" of EMDE economies as they grow, while still catering to the development needs of an expanding population, is no easy task. The challenge is fundamentally different from that facing most advanced economies and China, who have already built up this capital stock and can continue to use it even as it is decarbonised. As discussed in Chapter 3, cost-effective clean technologies are available for electricity generation, offering a powerful tool for EMDEs to avoid emissions growth in this sector as well as in end-uses that are easy to electrify. But affordable solutions are less obvious elsewhere in the energy system, as not all the technologies required for low-carbon industrial growth are yet mature.

Figure 4.2 ▹ Average annual net income and import costs of oil, natural gas and coal in EMDEs, 2016-2020



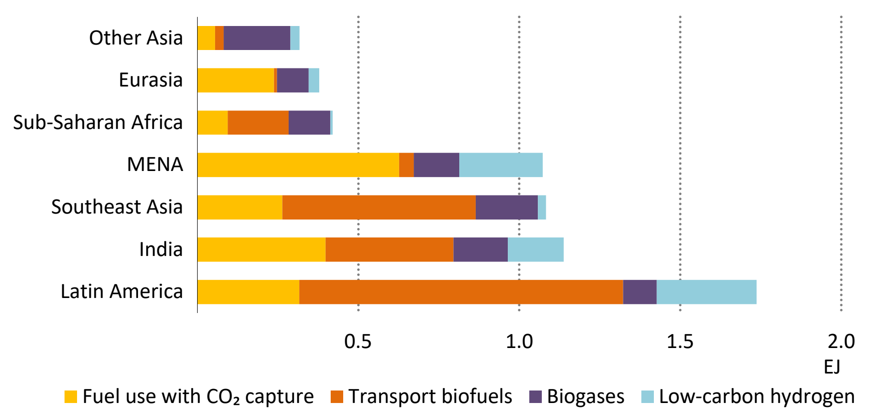
EMDEs face clean energy transitions from very different starting points, with oil especially important to resource-rich economies in MENA and Eurasia.

The possible pathways towards sustainable fuels and the outlook for emissions-intensive sectors vary widely across EMDEs. This grouping includes some of the world's largest hydrocarbon resource-holders, for whom revenue from oil and gas is a key source of fiscal income, as well as some economies, notably in Asia, where oil forms a sizeable part of the overall import bill. It includes the world's largest producer of biofuels in Brazil, and numerous economies with potential for biogases and low-carbon hydrogen. Natural gas is a major – and growing – part of the resource economy, with several discoveries in Africa and other producing regions attracting investments in upstream projects and export infrastructure. Last but not least, coal continues to play an outsized role in the energy economies of many EMDEs, especially among developing countries in South and Southeast Asia.

In aggregate, net income to EMDE regions from exports and domestic sales of fossil fuels has averaged around USD 1 trillion each year, significantly higher than net costs from imports. The Middle East, North Africa and Eurasia account for nearly three-quarters of this total. Energy transitions will curtail this income considerably, raising questions in many countries about the finance available for energy and non-energy investments alike. This shift away from investment based on dollarized, globally traded commodities, as in oil and gas, puts the spotlight on a different set of risks affecting energy projects, related to domestic conditions and revenues.

The scope for growth in energy demand in EMDE is huge and a very rapid increase in renewables, efficiency and electrification is required just to slow the overall growth in fuel demand. The ways in which fuel switching can support energy transitions vary by scenario, but the drive to reduce coal use as quickly as possible creates an opening for natural gas in some sectors and timeframes. This raises complex questions about investment in new infrastructure alongside the risk of locking in new sources of emissions.

Figure 4.3 ▷ Change in low-emissions fuel supply, and fuel use equipped with carbon capture, in EMDEs in the SDS, 2020-2030



There are a variety of pathways to clean energy transitions in EMDEs, each capitalising on the unique set of policy ambitions, resources and opportunities in each region.

Note: low-emissions fuels refer to liquid biofuels, biogases (biogas and biomethane), and hydrogen-based fuels (hydrogen, ammonia and synthetic hydrocarbon fuels) that do not emit CO_2 from fossil fuels directly when used and also emit very little when being produced. Fuel use with carbon capture is also included here; however, steam methane reforming with CCUS is accounted for in low-carbon hydrogen.

The topics addressed in this chapter – transitions in fuels and fuel-producers, the hard-to-abate sectors, tackling emissions from existing (and often recently-built) coal-fired plants in EMDEs: these are the hard yards of the transformation of global energy. We examine the options and strategies open to existing actors in this arena, and the opportunities that open up for new entrants. Many of the key energy actors in EMDEs today are state-owned enterprises (SOEs), for which investing in low-carbon technologies is new territory. But as incomes from fossil fuels start to dwindle more rapidly after 2030, their financial performance increasingly depends on strategies to transition to cleaner energy sources. Alongside renewables and the prospects for electrification, cleaner liquids and gases play crucial roles, aided in some cases by carbon capture technologies. Transitions also depend on commercial options for producing low-carbon steel or cement, or sustainably transporting heavy goods over long distances.

4

Table 4.1 ▷ Selected indicators of investment spending in fuel supply and emissions-intensive sectors in EMDEs by scenario (USD billion)

	2016-20	2026-30		
		STEPS	SDS	NZE
Fuel production and transformation				
Oil	195	260	168	143
Gas	63	121	94	63
Coal	12	10	5	3
Hydrogen and hydrogen-based fuels	0	0	8	44
Biogases	0	2	4	4
Liquid biofuels	1	6	12	17
Fuel infrastructure and transport				
Oil	27	25	6	2
Gas	44	56	51	42
Coal	10	3	1	1
Fossil-based power generation				
Unabated coal	32	19	3	2
Unabated gas	27	24	22	23
CCUS-equipped capacity	0	0	2	2
End-use efficiency				
Industry	12	13	31	33
Of which CCUS	0	0	5	7
Long-distance transport	1	2	18	17

Notes: Oil production and transformation includes refining. Hydrogen and hydrogen-based fuels includes SMR CCUS, ammonia, synthetic liquids and gases. Long-distance transport includes freight trucks, aviation and shipping. The scope and methodology for tracking energy investment and finance is available in the methodology document.

Some of the financial architecture needed for a transition to cleaner fuels and less emissions-intensive infrastructure is well established, other parts are still under scaffolding, particularly those related to funding complex transitions and channelling low-cost and blended finance to the areas where it is needed most. Robust disclosure and reporting mechanisms are progressing in many advanced economies but are only starting to gain traction in many EMDEs. Development finance remains scarce for carbon-intensive industrial activities. The bankability and risk profile of low-emissions fuel projects remains uncertain, while approaches to develop industrial clusters and shared low-carbon infrastructure for energy-intensive industries involve more complex financial and commercial arrangements.

The companies best positioned for clean energy transitions are those with investment strategies centred on portfolio diversification, a focus on technology development, reduced environmental footprints, increased operational efficiencies and capturing additional value in complex energy supply chains. At the same time, clear policy and market signals are needed to avoid over- or under-investing in traditional fuels, thereby minimising the risk of asset stranding, price volatility or challenges to security of supply. As ever, the role of governments is crucial, both in the EMDEs themselves and in other countries seeking to promote and support new low-emissions pathways for development.

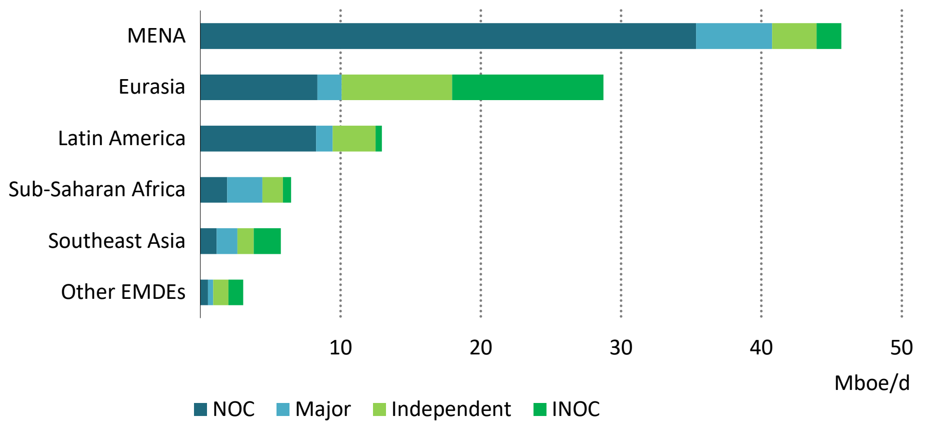
4.2 Financing transitions in oil and gas producing countries

Energy transitions pose existential challenges for development models that are dependent on hydrocarbon revenues, and these pressures have been amplified by the Covid-induced downturn. Even though the next few years could offer some limited relief as economies recover, longer-term structural changes in the global energy system are set to accelerate. Lower revenues from hydrocarbons – and ever-lower costs for clean energy technologies – create powerful momentum for change in the energy sector. But at the same time, for some EMDEs the revenues from oil and gas provide one of the main channels to finance a shift towards a more diversified economic structure and a more sustainable energy mix. The need for change among major oil and gas producers is unavoidable, and development prospects for any country or company pursuing "business as usual" will be bleak, but there are also downsides for those that move away from the hydrocarbons business without a clear strategy for what comes next.

One of the biggest uncertainties for oil and gas resource-holders is how to assess the gap between the world's ambition for rapid energy transitions and its actual delivery. If the world pursues a concerted pathway to net-zero emissions by 2050, then this would require continued investment in existing fields, but it would remove the need in aggregate for any new field developments, beyond those already approved (IEA, 2021). For the moment, the world is a long way from the policies consistent with such a dramatic change and, as a consequence, many producers are anticipating a rebound in oil and gas demand in the 2020s as economies recover from the pandemic, with another – perhaps final – price cycle if today's constraints on upstream investment lead to tighter markets ahead.

In this section, we explore some of the dilemmas that this creates for EMDE producers, and some of the opportunities to bring finance to emissions reduction initiatives and clean technologies. These EMDE producers are a very heterogeneous group, with a wide range of starting points and circumstances, but the common thread is that oil and gas revenue plays a major role in determining economic structure and prospects. Another common element in many regions is that national oil companies (NOCs) play the predominant role in the upstream.

Figure 4.4 ▻ EMDE oil and gas production by company type, 2016-2020



EMDEs account for more than half of global oil and gas production, with NOCs playing a major role.

Notes: Mboe/d = million barrels of oil equivalent per day; IOC = international oil company. For further discussion on the different types of oil and gas companies see IEA, 2020.

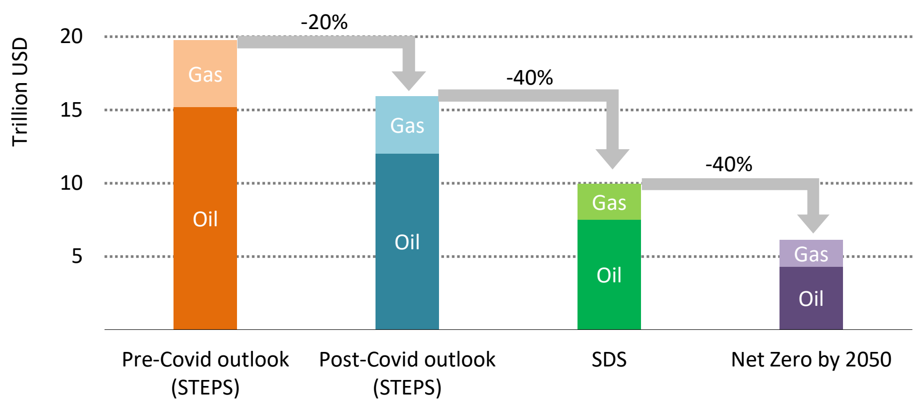
Source: Calculations based on Rystad (2021).

The pandemic has hit EMDE producer economies hard; an estimated two-thirds drop in net income from oil and gas in 2020 compared with 2019 has created the prospect of a new circle of low revenue and low investment in energy and prompted a renewed focus on capital discipline. With strained budgets and mounting levels of debt, only a handful of countries and companies are in a position to pursue countercyclical spending in oil and gas, or to step up investment in other areas, and there is less headroom than in the previous low-price environment for reducing capital costs further. The stresses are felt across the board: NOC budgets have been heavily affected, while the level of private-sector participation is as yet insufficient to pick up the slack. Prior to the crisis, Arab Petroleum Investments Corporation (APICORP) had projected that the private-sector share in energy project investments in the

Middle East over the period 2019-23 would be around 22%; one year later, this had shrunk to 19% of a reduced investment spend for 2020-24 (APICORP, 2020).

The big uncertainty concerns future hydrocarbon income: the scenarios modelled in the *World Energy Outlook* (*WEO*) series offer different perspectives. Our assessment of the present value of future income from oil and gas suggests that the pandemic has already resulted in a significant decrease compared with pre-crisis indicators, reducing this amount by around 20%. This is mainly due to a lower near-term outlook for prices (these estimates do not try to anticipate the possibility of another commodity price cycle in the 2020s). A strengthening of policies to reduce emissions would bring this down further because of a combination of volume and price effects.

Figure 4.5 ▷ Present value of future EMDE oil and gas production to 2050 by scenario



The pandemic and the prospect of an acceleration in clean energy transitions cut expectations of future income from hydrocarbons.

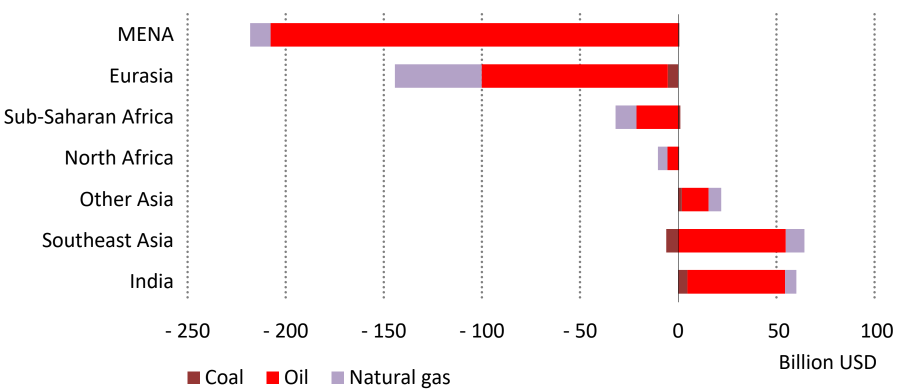
Notes: Average oil prices over the period 2019-40 in the pre-Covid outlook (*WEO 2019*) = USD 89 per barrel (bbl); post-Covid outlook (*WEO 2020*) = USD 72/bbl; SDS (*WEO 2020*) = USD 55/bbl. A 10% discount rate was used across all scenarios.

The implications of this picture vary for different EMDE producers; those that have large, low-cost resources might expect to receive a higher share of the income available; those that produce and export gas might expect this income to be more durable. But all are affected, with consequences for policy and financing that are discussed below. Countries face difficult choices in how to allocate scarce financial resources and how to broaden and diversify economic activity. At the same time, for those EMDEs that are net importers of fuels, well-managed energy transitions promise some relief from potential vulnerabilities.

Box 4.1 ▷ The other side of the transition coin: Reduced fuel import bills

Alongside countries with large hydrocarbon resources, EMDEs include many of the world's major fuel-importing nations; in fact, around half of the total population in the EMDE grouping – nearly 3 billion people – reside in countries that are net importers of fossil fuels. In the absence of a more rapid transformation of their energy systems, countries such as India and major nations in Southeast Asia are set to see a large increase in their fuel import bills. And net exporting regions also present a diverse picture. Africa, for example, is a major exporter of crude oil, but simultaneously an importer of refined products because of growing oil demand and an underperforming refining sector. Within the Middle East, the United Arab Emirates, Bahrain and Kuwait are all importers of liquefied natural gas (LNG) to meet rising demand.

Figure 4.6 ▷ Change in net economic position from oil, natural gas and coal trade in the SDS compared with the STEPS, 2026-30



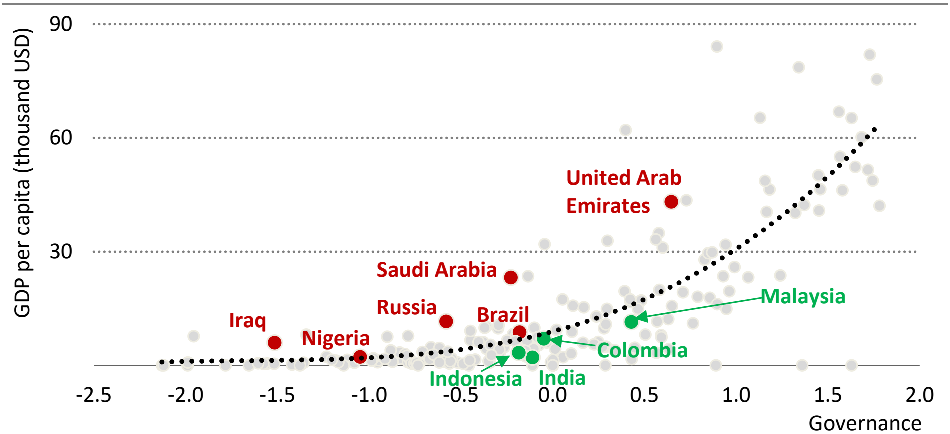
Energy-importing regions gain an additional benefit from a surge in clean energy investment via a significant reduction in fuel import bills.

In the STEPS, the fuel import bill for net importing regions in EMDEs balloons to USD 500 billion by 2030, more than tripling from 2020 levels. In the SDS, the total bill is 35% lower. India provides a good example of the effects of clean energy transitions on fuel import bills. In the STEPS, India's combined import bills for fossil fuels quadruple over the next two decades, with oil making up by far the largest component of the total. As of 2020, energy already accounts for almost one-third of India's total imports by value, with major implications for the balance of payments. The transition to a trajectory consistent with the Paris Agreement would reduce this oil import bill by a cumulative USD 1.4 trillion over the period 2019 to 2040 – the same amount that India would need to invest additionally in the deployment of clean energy technologies in this scenario.

4.2.1 Towards a new allocation of energy capital in producer economies

The ability to finance clean energy transitions in today's major oil- and gas-producing countries will depend on the broader economic health and resilience of these economies amid shifting market dynamics; their motivation and willingness to make such investments will also play an important role. A key dynamic, which we explore in this section, is the link between hydrocarbon revenues (and, in some cases, accumulated savings, e.g. in sovereign wealth funds) and broader programmes of energy and economic diversification. This raises questions about the roles, financial performance and strategies of today's NOCs.

Figure 4.7 ▷ EMDE governance indicators versus per capita GDP



The challenge for many producer economies is to strengthen the institutional foundations for growth in the non-oil economy.

Notes: The score for governance is an average of six indicators (government effectiveness, regulatory quality, rule of law, control of corruption, voice and accountability, political stability) prepared by the Worldwide Governance Indicators project, which combines the views of a large number of enterprise, citizen and expert survey respondents on country performance in government effectiveness, regulatory quality and the rule of law. Data are from 2019.

Source: Worldwide Governance Indicators (2021)

A starting point is the way that oil and gas revenue is used in many of today's producing countries. The oil and gas industry itself is a not a major direct source of employment – it is capital-intensive rather than labour-intensive. However, revenue from oil and gas has instead been used to support employment in other sectors, with the traditional route being via a growing public sector. In Iraq, for example, public-sector employment has grown from 1.2 million people in 2003 to more than 3 million people today, acting as a brake on private-sector investment and job creation. Demographic pressures and the prospect of lower hydrocarbon revenues mean that this development model is unsustainable.

Growth in non-hydrocarbon sectors is not simple to nurture, especially in countries where the macroeconomic and institutional foundations for this growth are weak, and where cheap (often subsidised) hydrocarbons are distorting investment incentives. The amount of energy used to generate a unit of gross domestic product (GDP) in EMDEs is well above the global average; this is, in part, a reflection of a comparative advantage in energy-intensive activities but it is also a signal that the efficiency of energy use is ripe for improvement. The value of subsidies for fossil fuel consumption in EMDEs in 2020 was estimated at USD 160 billion; this represents 90% of the global consumption subsidies tracked by the International Energy Agency (IEA).

Pricing reform is essential but far from simple; low-cost fuels are often part of the implicit social contract in EMDE producers. Subsidy removal, on its own, is a blunt tool, so efforts in this area need to be part of a broader strategy that includes efficiency policies (to improve the supply of more energy-efficient goods and services) as well as measures to protect vulnerable groups. Along with clear communication on the rationale and timing of reforms, these elements have been the key to successful subsidy reforms.

Analysis of the economic performance of oil and gas producers against a range of qualitative indicators of governance suggests that, by and large, they have higher levels of economic output than other countries with comparable levels of governance. This suggests that the growth of oil and gas industries is less dependent on good governance than other industries. It also suggests that producer economies wishing to stimulate growth in other sectors (including those related to cleaner energy technologies) can benefit greatly from actions to strengthen government effectiveness, regulatory quality and the rule of law.

The agenda for diversification in producer economies is much broader than energy, but it does not follow that energy should be considered "part of the problem". Many large hydrocarbon producers have very high-quality renewable resources as well, and a well-functioning energy sector, bringing a wider range of resources and technologies into play, can be a durable source of advantage for many of today's oil and gas producers. Capital and know-how from oil and gas activities can support more diversified growth. And, if the emissions can be disassociated from the use of the hydrocarbons – for example through the use of carbon capture – some traditional sources of energy can find a place in a low-emissions future.

The role of NOCs

NOCs include some of the world's largest companies, in terms of both production and reserve size. They are fully or majority-owned by governments, and typically have an explicit mandate to develop national hydrocarbon resources and a legally defined role in the upstream (although some countries with smaller reserves require their NOCs to focus on the downstream sector). The largest NOCs are in the Middle East, but there are examples from all parts of the world ranging from companies that operate mainly or exclusively on the domestic market to those with large investments overseas.

The income generated by their upstream assets is typically their main source of funding, although some are more reliant on debt financing, especially when they need to finance a rapid increase in production (e.g. Petrobras), or expand overseas (e.g. Russian or Chinese NOCs turning for funding, on favourable terms, from state banks). Operations in the midstream, such as pipelines, refineries or LNG plants, are often candidates for project finance. All NOCs are subject to a degree of political supervision, and this affects their strategic and financial autonomy.

Not all NOCs are cash generators for their host governments; there are many examples where they have run into financial problems and required costly bailouts, typically when they have been saddled with unprofitable obligations by their host governments: Petróleos de Venezuela, S.A. (PDVSA) has to sell a substantial share of its production on the domestic market at a price that barely generates any revenue, and the company's overall debts are estimated at a substantial portion of the country's GDP. This is an extreme example but it highlights a significant concern during energy transitions: NOCs could become significant drains on public finance in the event of poorly judged investment strategies, deteriorating creditworthiness or declining revenues.

Whether or not NOCs become forces for change in the energy sector, and the strategies that they might follow, are open questions. There is no single blueprint, and the constraints and opportunities that each company faces vary widely. Many NOCs are among the best-performing companies in their home markets, and so tend to be heavily involved with a variety of strategic initiatives inside and outside the energy sector. Saudi Aramco, for example, is key to the new Shareek (Partner) programme in Saudi Arabia, under which key incumbent companies will advance economic diversification by funding new investment projects across the economy. The United Arab Emirates' Operation 300 Billion industrial diversification strategy will be implemented by the recently created Ministry of Industry and Advanced Technology, under a minister who is also the chief executive officer of Abu Dhabi National Oil Company (ADNOC).

Despite these close associations with broader economic and industrial initiatives, it appears likely that most NOC operations will retain a specialisation on producing and handling liquids and gases. There are few signs that the largest NOCs are seeking to transform themselves into integrated energy companies in the manner of some European IOCs. While some are seeking to harness renewables to their own operations, there have been fewer direct moves into utility-scale renewable operations: in the case of Saudi Aramco, the main move has been via a new USD 500 million fund (Saudi Aramco Energy Ventures) that will seek investment opportunities in a range of new energy technologies, including renewables; grid energy storage; carbon capture, utilisation and storage (CCUS); methane abatement; and industrial and transport efficiency. There are, though, a few examples of more concerted shifts in strategy (Table 4.2). Malaysia's Petronas is investing directly in utility-scale renewables, aiming at 3 gigawatts (GW) of installed solar and wind capacity by 2024,[1] as have Thailand's PTT and Indian Oil.

[1] Petronas has also acquired Amplus, a leading distributed solar energy provider and developer in India. PTT has also reportedly been seeking acquisitions in renewables in India.

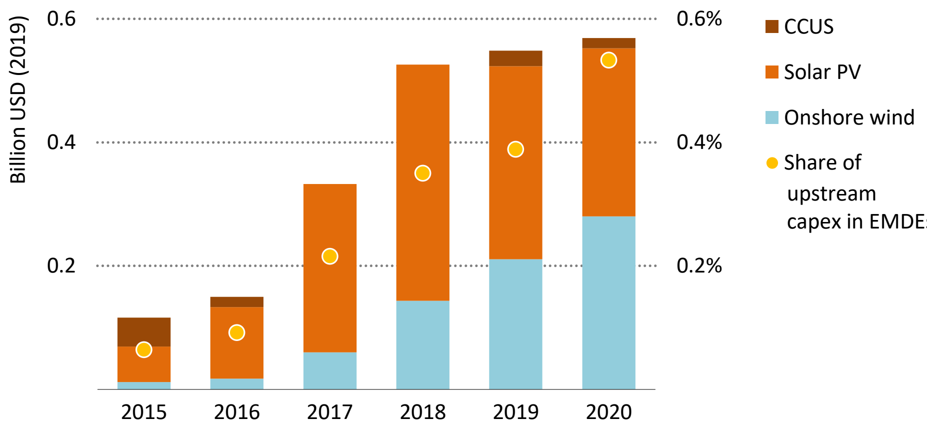
Table 4.2 ▷ Strategic choices of selected NOCs

	Revenues *Billion USD*	Emission reduction target	Renewable target	Low-carbon liquids or gases	CCUS
Indian Oil	60	○	● (260 MW by 2020)	●	○
NNPC	10	○	•	•	○
Pertamina	48	○	○	●	○
Petrobras	77	● (reducing operating emissions by 25% and zero routine flaring by 2030)	○	•	●
Petronas	52	● (net zero Scope 1 and 2 emissions by 2050)	● (3G W by 2024)	•	○
Rosneft	104	● (reducing GHG emissions by 20 Mt by 2035; zero routine flaring)	○	•	•
Saudi Aramco	235	● (zero routine flaring by 2030)	● (9.5G W by 2030)	•	•

Notes: Full circle = announced strategic target and/or investments; light blue circle = announced strategy without target/investment; empty circle= limited evidence of investment activity or target not achieved.
Source of revenue data: Bloomberg (2021) or company's annual report. Revenues are averages for 2016-2020.

Strategic shifts by European IOCs have been spurred in large measure by pressure from society and investors and by a desire to keep pace with stringent government targets to reduce emissions. While asset disposal and write-offs enable these companies to restore their balance sheets or fund clean energy projects, they may also end up transferring oil and gas assets to companies that are themselves less responsive to climate policy pressures. For example, BP, Shell and Total have all recently sold off oil and gas assets in places such as West and Central Africa, the Middle East and the Caspian to smaller independents and NOCs, where environment, social and corporate governance (ESG) pressures are generally weaker and national environmental goals less ambitious. Moreover, amid strong pressure on NOCs to support government income, institutional incentives within some NOCs to continue spending on large oil and gas projects could well increase the possibility of "risky bets" (NRGI, 2021). Nonetheless, there will be a commercial imperative to respond to changes in global markets and consumer preferences; NOCs currently rely on debt for around 40% of their total investment and NOCs seeking to refinance debt or secure project financing can expect close attention to their strategies and environmental performance.

Figure 4.8 ▷ Clean energy investment by oil and gas companies in EMDEs



Less than 1% of the annual investment by oil and gas companies in EMDEs has gone to funding capital expenditures in clean energy technologies.

Notes: PV = photovoltaic. Companies include the majors and selected others (ADNOC, China National Petroleum Corporation [CNPC], China National Offshore Oil Corporation [CNOOC], Equinor, Gazprom, Kuwait Petroleum Corporation, Lukoil, Petrobras, Repsol, Rosneft, Saudi Aramco, Sinopec, Sonatrach).

NOC efforts to move to a more sustainable revenue model need to focus on three main areas. First, making sure that traditional oil and gas operations are as low-cost and low-emissions as possible – Malaysia's Petronas was the first EMDE NOC to make an announcement targeting net-zero emissions from operations by 2050. Second, careful project selection with the aim to limit risks to new hydrocarbon investments. Third, efforts to develop and deploy sustainable fuels, including low-carbon hydrogen and biofuels. As yet, though, the evidence of a major switch in investment strategies is thin. We estimate that the share of total capital expenditure by the oil and gas industry in EMDEs that went to clean energy technologies in 2020 was less than 1%.

Actions and case studies for mobilising finance

Capital needs to flow towards a different set of energy priorities in producer economies, if they are to position themselves well for energy transitions. We examine five aspects of this, along with the policies and strategies that can facilitate these shifts.

Reducing the emissions intensity of oil and gas production. Reducing the emissions associated with the extraction, processing and transport of oil and gas, for many EMDE producers, may be the single most impactful short-term measure that they can take to reduce emissions. This is an area where many EMDE producers should in principle be well placed; emissions intensities in producers such as Saudi Arabia and the United Arab Emirates are low and these countries should have an active interest in greater global scrutiny of upstream emissions.

Elsewhere, there are many cost-effective opportunities to abate upstream and midstream emissions. Nigeria, for example, has reduced its flaring rate by 70% since 2000, through measures such as a bid-based flared gas commercialisation programme. Mexico in 2018 established a regulation for the comprehensive control of methane emissions, requiring oil and gas companies to establish and achieve six-year methane emissions reduction goals for each operated facility. Alongside action on methane leaks and flaring, other options include using renewables to power upstream operations (with good examples under way in Oman, Algeria and elsewhere), or attaching CCUS to liquefaction facilities (as Qatar is planning).

While many such investments should be low-cost, some innovative financing instruments have emerged to support action in these areas, through the use of special purpose vehicles (SPVs) that conduct due diligence, measurements and repairs and then monetise emissions reductions through direct gas sales, by generating carbon offsets, or through operator fees.

Improving energy pricing and efficiency. The way that energy is priced in many EMDEs is a huge barrier to a more sustainable allocation of capital. Subsidies to fossil fuels encourage wasteful consumption, but also distort investment incentives across the economy.

Egypt provides a good example of a reform process; in 2013, energy subsidies accounted for more than 20% of the government's budget (7% of GDP), greater than combined expenditures on health and education. Implementation of comprehensive reforms began in 2014 and, although the process of removal is not complete, most prices now move in tandem with global indices and the fiscal burden has been lightened considerably.

Pricing reform in resource-rich countries does not mean giving up a comparative advantage in energy – especially given the rich renewable potential in many EMDE countries. A low production cost base can provide a stable low domestic price, especially in electricity and natural gas, where a global commodity market is constrained by infrastructure bottlenecks and high transportation costs. Reform does, though, provide a platform upon which energy transitions can be built and financed.

Cost-effective deployment of renewables. Today's major oil and gas producers have a wealth of energy resources beyond hydrocarbons, but – with very few exceptions, Brazil being the main one – for the moment this potential is woefully underutilised. The Middle East and Africa, for example, have some of best solar irradiation rates in the world and where projects have gone ahead, e.g. in Saudi Arabia and the United Arab Emirates, they have received some of the lowest bids seen worldwide for solar projects. This opens up significant possibilities to produce not only clean electricity, but also low-carbon hydrogen via electrolysis. Yet the amount of solar PV that has been installed in these regions, in total, is around 10 GW. This is around a quarter of what the People's Republic of China (hereafter, "China") has typically been adding in a single year; Viet Nam, on its own, added 9 GW of solar capacity in 2020.

For the moment, the flow of energy-related projects in the Middle East is still dominated by fossil fuels. Of the top 20 planned energy projects by value tracked by APICORP for the Middle East, only four were in the power sector, of which two are nuclear projects and only one concerns renewables (APICORP, 2020). Recent announcements by Saudi Arabia (the Saudi Green Initiative) and others could change this outlook considerably but, as discussed in Chapter 3, a host of policy and regulatory changes will be required to step up renewable investments in today's major oil and gas producers.

Getting more value from hydrocarbons. Many producers, including those in the Gulf and in the Russian Federation (hereafter, "Russia"), are moving into downstream in order to capture additional value from hydrocarbons resources, often co-locating new petrochemical facilities with refineries to capture operational synergies. Expansion into more complex petrochemical products offers the potential to loosen price correlations with oil, although such diversification strategies are not without risk.

Expansion into downstream markets moves producers away from protected upstream markets into much more competitive market segments; often only established, well-capitalised players – backed by a holistic industrial strategy – are able to forge ahead with such large-scale projects. The attendant risks may be compensated by the relative resilience of demand for petrochemical products across different energy scenarios, even with growing attention to reducing single-use plastics and increasing recycling. Since they are not combusted, there are no direct emissions associated with the use of oil or gas as a petrochemical feedstock, offering something of a hedge against future falls in oil demand. In all our scenarios, an increasing share of Middle East oil output goes into these sectors.

Making liquids and gases compatible with energy transitions. Technologies that offer the possibility to monetise hydrocarbon resources without the associated emissions present an obvious attraction to today's producers. These include the production of low-carbon hydrogen via steam reforming with CCUS or pyrolysis, the manufacture of other synthetic fuels, the downstream application of carbon capture to stationary uses of hydrocarbons, research into new non-combustion uses of oil and gas, and innovative ways to convert emissions into industrial materials.

4.3 Financing natural gas infrastructure

Natural gas occupies a difficult space in clean energy transitions. In Europe and North America, and in countries where gas already plays a large role in the energy mix, gas demand becomes a target of decarbonisation policies. The perspective is often different in EMDEs, particularly those that do not use much natural gas today. This includes, for example, the coal-dominated energy systems in many developing countries in Asia, and in countries with rapidly growing energy and infrastructure needs, as in many parts of Africa.

Scenarios consistent with the Paris Agreement show an increase in demand for natural gas in some EMDEs, as investments in new gas infrastructure, alongside a massive ramp-up in low-carbon energy and efficiency, enable these countries to pursue development objectives while transitioning away from more polluting fuels. But the runway for unabated gas in these scenarios is typically shorter than the standard operational lifetime of new gas infrastructure, especially in scenarios pursuing a 1.5 °C stabilisation, raising questions about the required level of investment and the appropriate financing models, as well as the risk of locking in new sources of emissions. Affordability concerns also loom large, particularly for countries facing the prospects of increased imports of natural gas.

Demonstrating the value of specific gas projects to clean energy transitions is not easily done. This has become apparent in several advanced economies, such as the European Union (EU) and Canada, where the treatment of gas in sustainable finance frameworks remains hotly debated. Many would agree that where, and as long as, clean energy cannot yet be deployed on the scale needed, natural gas can play a role in the transition away from coal (in particular) and oil – as long as methane leaks are demonstrably minimised. However, defining the hurdles that new gas-related projects need to clear in EMDEs is no easy task. Policies and investment decisions made today necessarily involve a detailed assessment of the affordability of other options and whether projects are compatible with longer-term decarbonisation goals.

There is an equity aspect to the debate. Some of the developing countries with natural gas resources are among the poorest in the world, with huge energy access and development needs. Emissions on an absolute, historical and per capita basis are very small compared with advanced economies: to date, energy-related carbon dioxide (CO_2) emissions for the whole of Africa represent around 2% of cumulative global emissions. A blanket prohibition on gas-fired lending has to grapple with this starting point, as well as the fact that some of the services that gas provides, including in the power sector, are difficult to replicate cost-effectively with renewable sources of energy, especially in countries with very weak electricity networks.

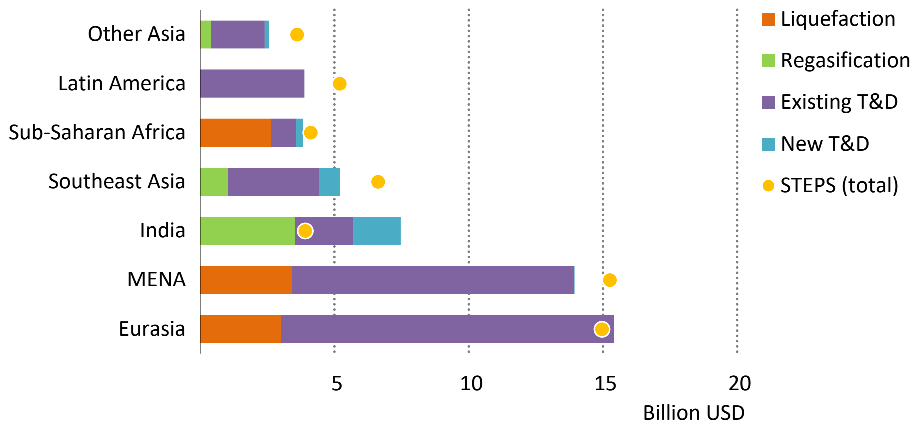
4.3.1 Investment outlook and sources of finance

The investment outlook for gas infrastructure in EMDEs varies by scenario and country, depending primarily on the policy context. Key variables are the size of the surge in clean energy investment (see Chapter 3), and the speed at which carbon-intensive energy economies act to reduce coal use. These affect the roles that natural gas is required to play within individual countries. The availability and price of low-carbon gases, as well as action to reduce methane leaks, are important elements in the broader picture. The broader international context for natural gas is also extremely important, notably for the way that this shapes investment in LNG assets.

In the SDS, EMDEs see a ramp-up in annual spending on new pipeline transmission and distribution grids (cross-border and domestic) as well as LNG assets (liquefaction, shipping and regasification) through the mid-2020s before gradually falling back to 2020 levels – around USD 10 billion – by the end of the decade. In the NZE, the near-term increase in investment in new infrastructure is smaller and the drop-off is faster.

The fall back in spending in EMDEs on new gas infrastructure in the SDS reflects a limited need for additional LNG and pipelines beyond what is already under construction or in an advanced stage of development (assuming project construction times in a range of three to seven years); in the NZE, many of these projects are not needed at all because of the more rapid decline in gas demand. By the end of the decade, most capital spending is instead directed towards maintaining existing infrastructure.

Figure 4.9 ⊳ Average annual spending on natural gas transport infrastructure in the SDS in EMDE regions, 2020-30



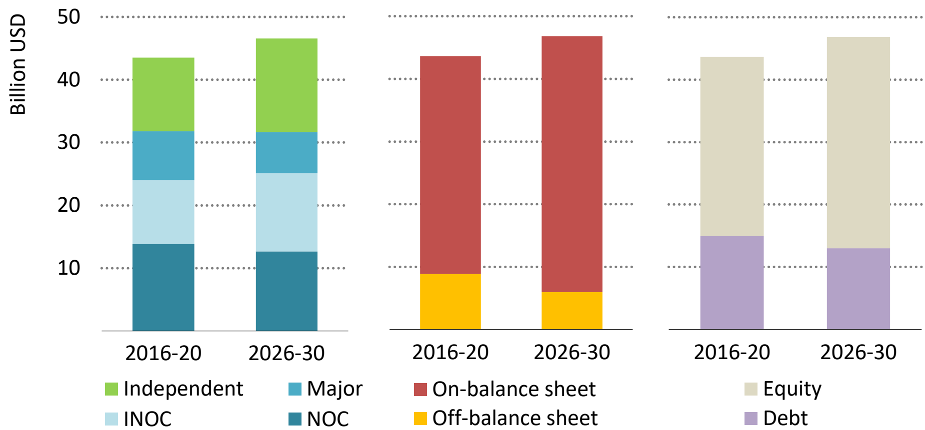
Investment spending in the SDS is 10% lower than in the STEPS, and would be even lower in the NZE. Capital is increasingly concentrated on maintaining existing infrastructure.

Some markets, such as India, see higher spending on gas in the SDS than in STEPS: the country has the highest investment in regasification among EMDEs in this scenario and also makes considerable investments in new T&D infrastructure. Alongside the huge rise in renewable sources of energy, especially in the power sector, this supports the transition away from coal. This bridge for natural gas is considerably shorter in the NZE, although the average annual spending on gas infrastructure in India in this scenario to 2050 is still higher than the amounts spent historically. In most EMDEs the need for large-scale investments in pipeline infrastructure is limited by the lack of a significant winter heating requirement by households and other small-scale customers connected to distribution networks.

Sources of finance

Investment horizons, payback periods and risk factors vary across different parts of the gas value chain, but the vast majority of projects involve the construction of long-lived, capital-intensive infrastructure. This means long-term offtake agreements with end users are usually required to justify the high upfront costs of infrastructure. Around 65% of the capital for several large-scale gas projects in EMDEs – worth around USD 120 billion over the last decade – has been debt-financed. Most of the spending has been on LNG: excluding Qatar's recent North Field expansion, there are currently 75 billion cubic metres (bcm) worth of LNG export projects that have taken final investment decisions (FIDs) and are being developed in EMDEs, adding to an existing LNG export capacity of over 280 bcm per year. This project pipeline is worth an estimated USD 100 billion.

Figure 4.10 ▷ Sources of finance for natural gas transport infrastructure in the SDS



Investment in gas infrastructure in the SDS sees a greater share of equity and on-balance financing from sponsors, with NOCs playing a leading role in new projects.

Note: NOC = 'national oil company'. INOC = 'international NOC'. INOCs are similar to NOCs in terms of governance and ownership but have large upstream investments outside the home country, usually in partnership with host NOCs or private companies.

Source of ownership: Rystad (2021).

The majority of gas projects have been sponsored by NOCs and INOCs, with an ownership share averaging around 55%; given the size and complexity of projects, these state-owned actors frequently partner with oil and gas majors, which typically hold a 25% stake in existing projects. Domestic pipeline and storage infrastructure and LNG regasification terminals are usually developed by vertically integrated, state-owned incumbent utilities. These entities draw on a mix of project finance and balance sheet investment, with capital recovered through regulated tariffs charged to a captive customer base. Efforts at market liberalisation and unbundling in places such as India and China may render such cost pass-through models more complex, as investment decisions become decentralised and merchant projects replace regulated asset expansion.

There is little certainty about which financing models become more commonplace for gas infrastructure in rapid energy transitions. As investments in low-carbon technologies intensify, there is likely to be more limited appetite among banks to finance traditional long-lived, capital-intensive LNG and gas pipeline infrastructure; sourcing debt therefore becomes more difficult. Project sponsors – less able to secure long-term offtake agreements – therefore become more reliant on equity financing solutions. However, such models involve higher financing costs and greater market risk, given fewer guarantees from long-term buyers and more exposure to global gas price volatility. In the SDS, NOCs and INOCs maintain their share of overall investment spending in gas infrastructure. Debt remains an important component of financing, as infrastructure operators continue to rely on corporate bonds to expand gas grids and begin to use other instruments, such as transition bonds, to finance carbon reduction strategies. However, most investments – particularly on existing gas assets – are financed on-balance sheets, with minimal levels of debt.

On the importer side, some EMDEs are looking to agree or renew existing natural gas supply contracts, particularly in countries where near-term gas demand is expected to grow. At the moment, there are contracts in place for around 260 bcm worth of gas deliveries each year to EMDEs, split roughly in equal parts between deliveries by pipeline and by LNG. Over the next decade around half of these contracts – mainly pipeline contracts – are set to expire. The amount of new contracting activity varies by scenario; in the SDS it is around 200 bcm by 2030, but lower in the NZE. LNG projects currently under construction are competing to meet this demand: for example, the majority of the output from Mozambique LNG is contracted on a long-term basis to buyers in China, Chinese Taipei, Indonesia, Japan and Thailand. A portion of the volumes are also destined for the portfolios of larger players. In rapid energy transitions, a greater share of the aggregate supply requirement is set to be filled through the secondary market, by portfolio players and already-existing LNG terminals, as buyers continue to shy away from contracts with high volumes or long tenures which are needed to sanction new projects; this accelerates further the growth of the spot market, particularly as buyers in mature markets such as Europe remain over-contracted as they move away from gas at an accelerated pace.

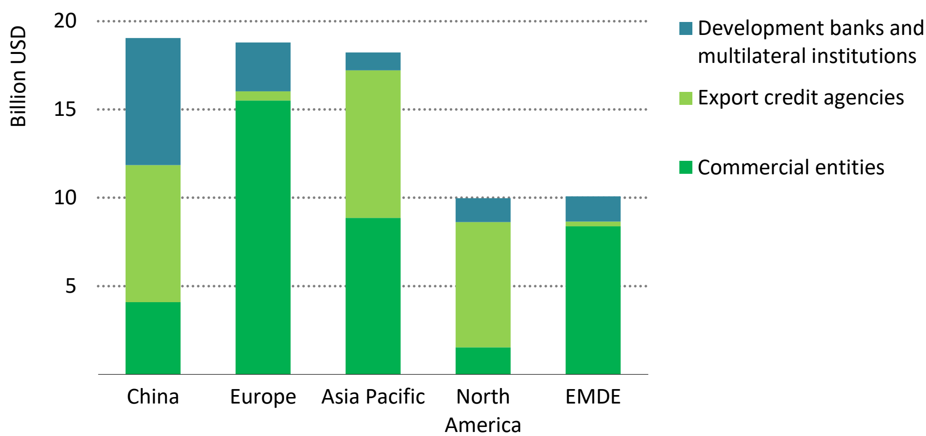
4.3.2 Key factors influencing investment decisions

Producers and exporters

LNG export projects have attracted the greatest attention from the international investor community in recent years: the ten largest LNG export projects account for 80% of the total natural gas project debt since 2010, with financing coming from multiple sources (more than 15 entities, on average, provide debt or equity funding for a single project). Most of the debt has been provided by financial entities domiciled in advanced economies, with around 70% coming from countries that have recently formulated net-zero targets.

Around half of LNG liquefaction terminal sponsors in EMDEs over the past decade have had a credit rating below investment grade, making it difficult to raise debt at attractive rates. This is a primary reason why LNG projects have traditionally been sanctioned through limited recourse project finance structures, which enable off-balance sheet debt to be raised to fund the upfront costs of a project, which is recoverable from subsequent cash flows. Commercial banks have been the main source of funding, with lenders attracted to the low risk profile of LNG projects, even in emerging markets, since assets are often located offshore or in remote locations, with output fully contracted on a long-term, dollar-denominated basis – with prices often linked to oil – to creditworthy off-takers. This also allowed a high share of debt in the financing. Export credit agencies have played a key role in project bankability, accounting for nearly a third of total debt financing over the last decade and also providing commercial and political risk cover for commercial bank loans.

Figure 4.11 ⊳ Debt finance for natural gas infrastructure projects in EMDEs by origin of provider, 2010-20



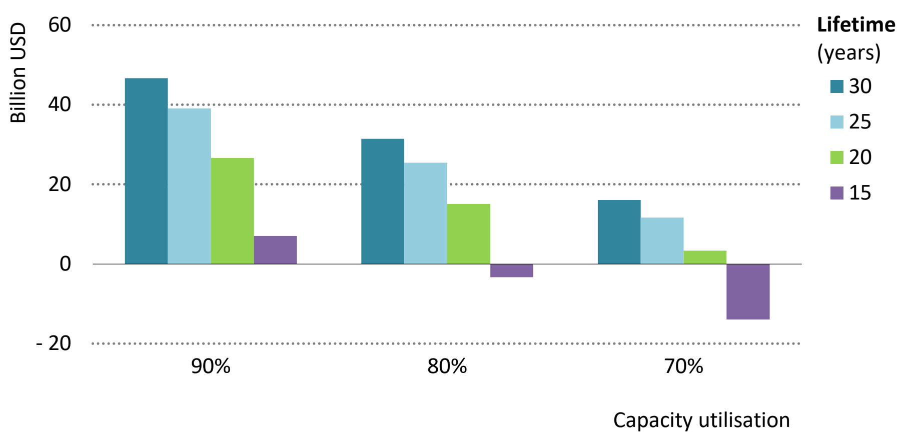
Around 90% of gas project debt in EMDEs over the last decade has been raised via international sources of capital, led by China, Europe and Asia Pacific.

In recent years, the commercial model for LNG projects has undergone a transformation, as market conditions have changed: fewer buyers have been willing to sign the long-term offtake agreements necessary to underpin financing for new projects, while the growing spot market for LNG has given larger, "portfolio" players greater confidence that LNG can be more easily bought and sold in a more liquid global gas market. As a result, equity lifting models have emerged as an alternative to project finance. This type of project structure involves on-balance sheet financing by project sponsors which sign up to LNG volumes proportionate to their equity stake. This route is essentially only open to NOCs and IOCs with significant financial resources. The Greater Tortue LNG project in Mauritania as well as Coral South in Mozambique have adopted this model.

The trajectory for gas demand in EMDEs in IEA climate scenarios creates a dilemma for aspiring producers that rely on equity participation. The Covid-19 pandemic already set back development plans to monetise gas resources in some areas, Mozambique and Mauritania and Senegal, as oil majors and NOCs alike have cut back spending (see Section 4.2).

For LNG terminals already under construction, there is a risk in rapid energy transitions that they are unable to recover their invested capital. Stress tests are typically undertaken to evaluate the economic resilience of LNG projects; circumstances vary by project, but a key variable is the degree of commodity price risk. Investors also assess project cash flows by assuming a 30-year asset lifetime and a high rate of utilisation (usually around 95%), both of which could be affected by accelerated climate ambition.

Figure 4.12 ▷ Net present value sensitivity of EMDE LNG export projects under development in the STEPS



Lower utilisation or a shorter lifetime as a result of clean energy transitions poses a major challenge to the majority of LNG projects being developed today.

Note: Includes projects in Indonesia, Mauritania and Senegal, Mexico, Mozambique, Nigeria, and Russia. Assumed discount rates are project-specific and lie in a range of 4-8%. Project economics are benchmarked against natural gas wholesale price assumptions in key importing regions in *WEO* scenarios over the period 2019-50. Average price in SDS = USD 5.9 per million British thermal units (MBtu); STEPS = USD 8.4/MBtu.

We undertook an assessment of the LNG projects currently under construction in EMDEs, exploring the effect of commodity price risk as well as reducing plant utilisation rates and technical lifetimes, while assuming projects are still commissioned as planned and on budget:

- **Commodity price risk**: In the SDS, gas prices over time fall toward the short-run marginal cost of delivering LNG, a consequence of a structurally oversupplied global gas market, which becomes more pronounced towards the end of the decade. The consequence is a 60% reduction, compared to the STEPS, in the anticipated rates of return for under-construction LNG projects, which on average fall below 5%.

- **Reducing average plant utilisation**: Holding gas prices at levels in the STEPS, but reducing average plant utilisation for all under-construction liquefaction terminals from 95% to 80%, would reduce the net present value (NPV) of projects by 40%, from USD 54 billion to just over USD 30 billion.
- **Reducing technical lifetime**: Cutting technical lifetimes short by ten years reduces the NPV of LNG terminals a further USD 20 billion. Combining this with reduced plant utilisation as above would render 6 out of 13 projects un-economic. The total stranded capital in this example would be around USD 30 billion, or around a third of total lifetime investment costs; this assumes that only around half of the total capital needed to develop the upstream resources to feed the LNG plants is initially committed before upstream developers and project sponsors adapt to changing market conditions and pare down their long-term investment plans.

Another risk to gas suppliers in rapid energy transitions involves the environmental performance of gas assets. Around 1 600 million tonnes of CO_2 equivalent is emitted across the gas supply chain in EMDE countries, which includes extraction and processing as well as transportation via cross-border pipelines or LNG. Methane emissions dominate the picture, making up around 60% of this total, but EMDEs are also responsible for 130 bcm worth of gas flaring, an 85% share of the global total. Flared gas is not only environmentally harmful but represents a wasted economic opportunity, and is often a reflection of poor infrastructure planning or inadequate regulatory intervention.

In rapid energy transitions, accessing capital markets for new gas projects in EMDEs becomes increasingly contingent on fulfilling environmental criteria, with projects assessed based on energy delivery with the lowest possible carbon footprint. There are already early signs that buyers are interested in sourcing carbon-neutral LNG, with suppliers offering to purchase carbon credits that offset either the supply chain or combustion emissions. Early reports are that these measures raise the delivered cost of LNG by USD 0.60/MBtu to USD 1.20/MBtu, or around 15-30% of today's market prices. To maximise the environmental benefits of moving to gas, a focus on offsets would be an initial stepping stone towards credible efforts to reduce the emissions intensity of the gas supply chain, by investing in methane leak detection and repair, powering operations using grid or renewable electricity, or investing in carbon capture and storage.

The willingness of consumers to pay for "cleaner" forms of gas has yet to be tested at scale, but can be viewed as an opportunity for suppliers to diversify and explore new business models and invest in fuels such as hydrogen, biomethane or CCUS, or new routes for gas to play a role in clean energy transitions, such as in shipping or through power-to-X. Lack of a clear business model and the bankability of projects remain key hurdles, though vertical integration may facilitate the financing of infrastructure necessary to accommodate low-carbon gases at scale. Ultimately, financing new gas production and export infrastructure in clean energy transitions would require an alignment with global climate ambitions. This might include the need to formulate business plans and engineering designs that include:

- A strategy to prevent or eliminate emissions associated with the supply of gas, e.g. through methane leak detection and repair or flaring avoidance.
- An assessment of the prospects for electrifying or using renewable energy for operational energy requirements.
- The cost and feasibility for carbon-capture technologies to be installed along the project's direct and indirect supply chain.
- The potential for the project to accommodate production of low-carbon hydrogen or the injection of hydrogen into gas grids.
- An assessment of the proximity of gas infrastructure to sources of sustainable feedstocks to support the uptake of biogas and biomethane.

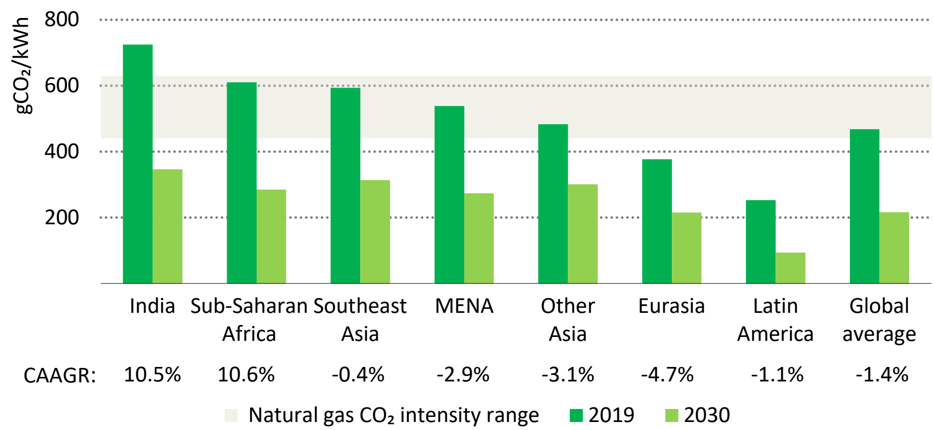
Consumers and importers

For gas-consuming and importing countries, the criteria for financing gas projects rests on their degree of alignment with long-term low-carbon demand pathways, and may include considerations such as whether natural gas infrastructure is being used to displace more polluting fuels, or aid the integration of renewables, or provide access to modern energy services or last-mile connectivity. Using best available technologies or ensuring compatibility with low-carbon gases such as hydrogen or biomethane are further possible screening criteria. There are already early signs that this is under development; the Asian Development Bank, for example, is considering a number of environmental criteria – including a social cost of carbon – for future lending to gas projects (ADB 2021).

The financing, contracting and construction of large-scale import infrastructure depends on investment further downstream, in end uses such as power generation, heavy industry or manufacturing. Gas is often a premium fuel compared with cheap domestic coal or other indigenous resources; the investment case therefore leans heavily on policy interventions made on the basis of the environmental benefits of gas against more polluting fuels – not just avoided emissions but improved air quality. But measuring the benefits of gas is complex as it relies on a credible counterfactual of which fuels it displaces, and gas is a fossil fuel with emissions in its own right and there may be a "carbon opportunity cost" in financing natural gas projects over other, lower-carbon sources of energy. Circumstances are bound to vary depending on the existing energy mix in each sector and country.

This is clearly demonstrated in the case of power, where the value of gas-fired power plants to energy transitions depends on a range of factors, including the carbon intensity of existing generation, the strength of network infrastructure, the availability of other flexibility options and the shape of electricity demand. Those regions that have relatively high shares of coal or oil in power generation have greater scope to invest in gas projects which help lower the emissions intensity and at the same time provide stable supplies to the grid. In India and sub-Saharan Africa, for example, the share of gas in the electricity generation mix is low, so investments in new capacity see a sharp uptick over the next decade in the SDS (even if the vast majority of investment goes towards renewables). In places where the average carbon footprint of electricity generation is already near the level of gas today, or where gas is already a well-established fuel (as in the Middle East or Eurasia), investment in new gas capacity tends to decline.

Figure 4.13 ▷ CO_2 intensity of power generation versus average annual growth in investment in gas-fired power plants in SDS, 2019-30



Investment trends in gas-fired power plants in the SDS are closely related to the starting level and rate of reduction in the overall emissions intensity of electricity generation.

Notes: gCO_2/kWh = grammes of CO_2 per kilowatt-hour; CAAGR = compound annual average growth rate.

In rapid energy transitions, the economics of new gas power projects also hinge on capturing value from ancillary services, such as backup and flexibility provision, and for power markets to adequately value the dispatchability of power generation assets during peak periods of demand. These mechanisms are still relatively underdeveloped in EMDEs (see Chapter 3). Gas-fired power plants initially financed on the basis of a baseload operating profile might adjust, over time, to provide peaking capacity or backup to renewables. As an illustration, a downward adjustment to the annual capacity factor of a combined-cycle gas turbine from 40% (the current average level for EMDEs as a whole) to 20% would increase its total levelised cost of electricity in the range of 20-30%. This would prolong the payback period, unless ancillary services or peak pricing provide compensating remuneration for a more limited operating profile. Mature gas markets with ambitious climate targets are exploring a range of financial options for easing the burden of stranded assets as more customers are switched to electricity or renewables. Novel financing mechanisms for early retirement of gas grids include issuing ratepayer-backed bonds as a form of securitisation, accelerated depreciation, or changes to the return on equity that reduce the remaining value of assets (EDF, 2020). Such models could serve as cautionary tales, or form the basis of stress tests, for EMDEs that might see a decline in gas consumption as lower-carbon sources of energy take hold in subsequent decades.

Actions and case studies for mobilising finance

Mobilising capital for new gas infrastructure projects in EMDEs in rapid energy transitions requires a careful balancing act with due weight accorded to environmental, energy security and economic criteria. There are several key aspects to this:

Attracting international investment into domestic markets. For exporters, there is an opportunity to channel finance into building up a local gas market through domestic market obligations on LNG export projects. This route has been pursued in sub-Saharan Africa in particular – where energy demand is growing but the share of natural gas in the energy mix remains negligible – albeit with mixed levels of success in established exporters such as Angola or Nigeria. A careful balance often needs to be struck between the risk perceptions of international investors versus the interests of host governments in providing affordable gas to nurture domestic industries. For example, the developers of the USD 20 billion Mozambique LNG, the largest project financing in African history so far, have an obligation to provide the domestic market with 0.7 million tonnes per annum (Mtpa) once the terminal is operational. Despite this guaranteed supply, initially proposed gas-to-liquids, fertiliser and power projects have all been shelved amid more challenging market conditions. The biggest hurdles for domestic gas consumption growth are lack of infrastructure and relatively low purchasing power of end users (IEA, 2021).

For importers, there are relatively few international players, although some have gained a foothold, for example in India's growing gas distribution sector: in 2020 Total acquired a stake in Adani Gas, India's largest listed city gas distribution company. A subsidiary of Singapore-based AG&P Group has also been awarded concessions to develop city gas grids, securing financing from the Asian Infrastructure Investment Bank as well as the Austrian Development Bank, both of which applied ESG criteria in their lending (ERM, 2020).

Liberalisation of gas markets. There have been long-running efforts to introduce competition in the gas sector in several EMDEs, which could attract private players and new sources of investment. A key component is the unbundling of vertically integrated gas supply chains, by way of creating an independent transmission system operator and ensuring third-party access to gas infrastructure. Efforts are progressing in India, while gas market reforms in Brazil, under development since 2013, have recently accelerated.

Exploring new contractual models for delivering gas. LNG-to-power projects have been gaining traction in recent years, appealing to buyers in EMDEs that lack the financial resources to sanction large-scale regasification infrastructure. Often such projects help plug an electricity generation deficit or serve as a stopgap in the face of declining indigenous production. The commercial and contractual structures for such projects are varied and complex, involving end-to-end financing models that integrate smaller-scale, modular infrastructure (primarily floating storage and regasification) with power generation assets. Several projects of this sort have recently been sanctioned in Bangladesh, Brazil, Ghana, Indonesia, Myanmar and Pakistan.

Greater measurement, reporting and verification of supply chain emissions. In rapid energy transitions, investments in unabated natural gas projects are more carefully vetted, with only the lowest-cost and least environmentally damaging projects able to attract financing from the international investor community. There are already signs of increased attention to the emissions associated with LNG. In a widely cited case, Singapore-based Pavilion LNG launched a tender in 2021 for a sale and purchase agreement carrying obligations to measure and report the emissions associated with the supplied LNG. Qatar's 33 Mtpa LNG expansion project includes a CCUS component, a sign that LNG suppliers are positioning themselves for a more environmentally discerning global gas market.

4.4 Financing low-carbon gases and liquids

In rapid clean energy transitions, renewable electricity and networks attract the largest levels of clean energy investment, but there also needs to be a considerable uptake of low-carbon liquids and gases. While investment in renewable sources of electricity often represents a least-cost option to expand supply, the same cannot be said in most cases for low-carbon gases and liquids; in this section we examine how more sustainable fuels can increase their market share in price-sensitive EMDEs.

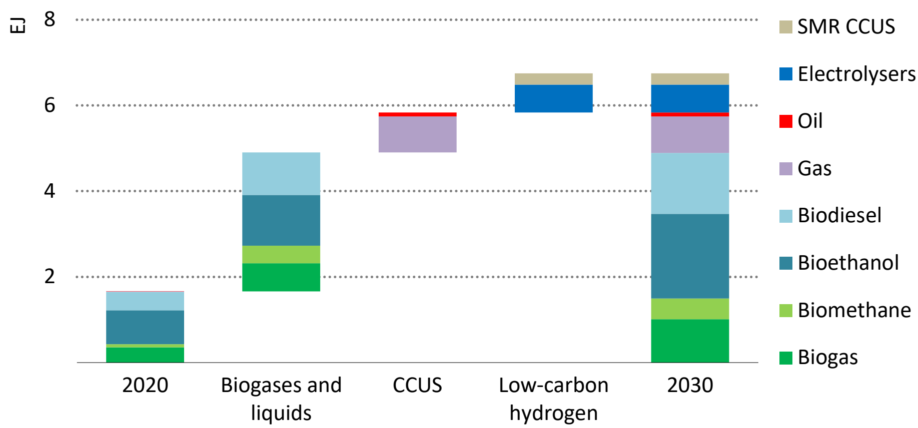
4.4.1 Investment outlook and sources of finance

In the SDS, the share of low-carbon in total liquids and gases supply in EMDEs climbs from around 1% today to over 5% by 2030, an increase that needs to be even steeper in a scenario that reaches net zero globally by 2050. Investment spending in EMDEs on transport biofuels, biogas and biomethane, and low-carbon hydrogen supply rises from around USD 2 billion today to over USD 35 billion by 2030 in the SDS, by which time it makes up around 10% of total investment spending on fuel supply.

Latin America accounts for 40% of the USD 20 billion invested in transport biofuels and biogases by 2030, underpinned by Brazil, the second-largest market for transport biofuels after the United States. Biogas projects continue to attract development finance to reach energy access goals, particularly in sub-Saharan Africa. Biomethane, which involves upgrading biogas to reach the quality specifications of natural gas, has seen growing support in several emerging markets, such as India and Brazil, given high levels of potential organic waste and other feedstocks that can be employed and the numerous co-benefits of biomethane deployment at scale, including rural and agricultural development, improved human health, domestic job creation, and avoided natural gas imports.

Low-carbon hydrogen is set to play a crucial role in the decarbonisation of hard-to-abate sectors. Early deployment has largely been concentrated in advanced economies that have the means to invest in scaling up these technologies and bringing down their costs (see Chapter 1). EMDEs have considerable potential as suppliers of hydrogen and hydrogen-rich fuels, whether produced via electrolysis or by adding carbon capture equipment to steam methane reformers (usually with natural gas as an input).

Figure 4.14 ▷ Growth in low-carbon gases and liquids supply in EMDEs in the SDS, 2020-30



A variety of low-carbon liquids and gases and technologies play a role in clean energy transitions.

Notes: Mtoe = million tonnes of oil equivalent; SMR = steam methane reforming.

Over the next decade, total investment in low-carbon hydrogen supply reaches USD 14 billion in the SDS. The largest shares of this investment are in the Middle East and Latin America. Electrolytic hydrogen is a promising option in many cases, especially in countries having some of the world's best solar resources. Chile is emerging as a promising site for investment in hydrogen, as it has abundant renewable resources, relatively expensive fuel imports and sectors amenable to hydrogen use cases, such as mining. The country is attracting international public finance into demonstration projects; for example, a 10 000-barrel-per-day green hydrogen pilot refinery is currently being built in Haru Oni drawing partly on German government funding. Hydrogen produced from CCUS also holds promise in resource-rich countries, and there is already significant conventional hydrogen production in refineries in places such as Kuwait, Russia and Saudi Arabia.

In addition, by 2030 there is around $12 billion invested in carbon capture and storage projects in power generation, oil and gas supply infrastructure and end-use industrial plants in the SDS (explored in more detail below).

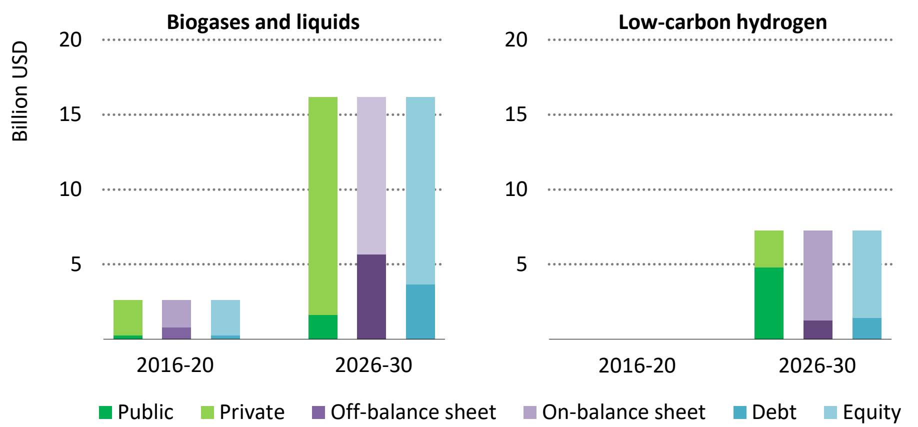
Sources of finance

The share of debt, on-balance sheet financing and public participation for low-carbon gases and liquids are project-specific, often hinging on the use case, as well as the degree of integration between the major parts of the value chain – production, transport and storage, and end use.

Scaling up low-carbon hydrogen will require an initial reliance on public funding and financial incentives, such as tax breaks or revenue guarantees, given the uncertainty about when hydrogen demand will be sufficient to support private investment. Blended finance from development finance institutions, including concessional funds and guarantees, play an important role in supporting first-of-a-kind projects in developing countries (World Bank, 2020). Regulatory differentiation of low-carbon gases – such as through blending mandates or tradeable certificates – provide an important regulatory underpinning for investment. As commercialisation models become clearer, export credit agencies and larger institutional investors may emerge as sources of finance for projects of larger sizes, underpinned by project finance structures and long-term offtake agreements.

International trade may provide an anchor to finance some EMDE low-carbon hydrogen production. In the same way that long-term contracts with utilities in Japan underpinned financing for the early development of LNG liquefaction and trade, so demand for low-carbon gases to meet decarbonisation goals in Northeast Asia could provide a foundation for the development of new international value chains. The key elements are the credit strength and influence of importers, backed by public co-financing and guarantees. The transport method for hydrogen remains unclear, and may not be hydrogen itself, with ammonia emerging as a particularly attractive option; a pilot cargo of low-carbon ammonia was shipped from Saudi Arabia to Japan in 2020.

Figure 4.15 ▷ Sources of finance for investments in biogases and liquids and low-carbon hydrogen in the SDS



The market for low-emissions fuels grows substantially over the next decade. Initial public support to early hydrogen projects gives way to large-scale private-sector investments.

Biogas projects have to date been largely based on national programmes and development finance, including overseas development assistance that co-funds the upfront costs of household and community-scale biogas systems. Biomethane projects also attract development finance, and are sponsored by utilities, gas suppliers, and in some cases medium-scale industrial and agricultural players, all via government incentives such as subsidies, tax breaks or low-carbon gas quotas. Both biogas and biomethane projects also benefit from inclusion in financial frameworks focused on renewable projects, such as green bonds and targeted institutional investor funds. This allows the share of debt finance to rise to a quarter of total investment spending by the end of the decade in the SDS. In parallel, the envisaged roll-out of tradeable certificates of origin for low-carbon gases, low-carbon fuel standards and biofuel blending mandates increase the bankability of low-carbon gas infrastructure projects, especially in markets where gas is currently less affordable, while at the same time tying the financing more explicitly to measurable environmental outcomes.

4.4.2 Key factors influencing investment decisions

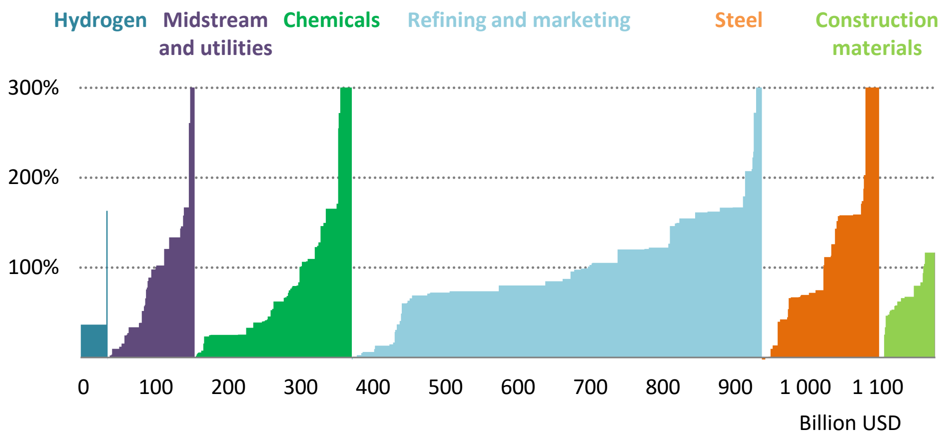
Hydrogen

The financing models underpinning low-carbon hydrogen projects differ depending on the use case, as the fuel can be used as a replacement for natural gas in power generation, as an energy storage solution, as heat supply for buildings and industries, or in the transport sector. Each use case carries different financing risks: e.g. a hydrogen transport project would require significant investment in refuelling infrastructure and a reliance on the uptake of hydrogen-based vehicles.

There are, however, some common elements: the low-carbon hydrogen value chain will rely on innovation and new technology to bring it towards cost-competitiveness with competing energy sources (such as natural gas). Moreover, a raft of legislative measures, targets and incentives are needed across the energy economy in order to attract the level of finance required to scale up hydrogen's long and complex supply chain. Projects that aim to substitute hydrogen supply currently sourced from fossil fuels with lower-carbon alternatives are likely to be first in line to attract debt financing, as they can leverage existing offtake infrastructure and commercial arrangements with end users.

The "gold standard" for creating bankable hydrogen projects hinges on having a long-term, fixed-price offtake contract with a creditworthy utility or public purchaser. Examples include publicly owned transportation companies (such as bus fleets) or large industrial players. Such a model bears similarities to other large-scale infrastructure projects such as LNG or mining, involving bilateral volume and price commitments between sellers and buyers – often along with government guarantees – to justify the high upfront capital costs. However, the availability of such contracts at scale for hydrogen beyond existing use cases will depend on the consumption patterns and creditworthiness of new buyers, where offtake risks may be higher. Although there are greater counterparty and technology risks, these may be managed by the modular nature of much of the technology, which means that banks can see demonstrations at small scale. Single buyer and industrial clustering models that aggregate demand could also serve to underpin larger-scale projects (see Section 4.5). Manufacturer warranties, potentially backed by insurance or partial credit guarantees, can also serve to reduce technology risks.

Figure 4.16 ▷ Debt-to-equity ratio and annual sales of listed companies with a potential stake in low-carbon hydrogen in EMDEs



The capacity to invest in hydrogen rests on the financial health of companies in different sectors; large-scale industrial companies may be well-placed as off-takers or investors.

Notes: Debt ratio and sales are annual averages for 2016-20. Sample includes 230 EMDE companies. Hydrogen sector includes electrolyser and fuel cell manufacturers outside EMDEs, but excludes large-scale conglomerates. Midstream and utilities includes electrical equipment manufacturers and energy storage companies. Figure excludes upstream oil and gas and automotive sectors, which can also drive investment.

Which companies or sectors are best positioned to bring hydrogen to a commercial scale in EMDEs is a key uncertainty. The creditworthiness of project sponsors and technology providers – some of which may be smaller companies without large balance sheets – is an important consideration in this respect. We explored the debt-to-equity ratios for a selection of publicly listed EMDE companies in sectors that play a key role in scaling up low-carbon hydrogen supply in the SDS. These companies are responsible for annual sales of over USD 1 trillion, with sales per entity averaging around USD 5 billion.

The debt-to-equity ratio provides a proxy measure of the ability of companies to meet their financial obligations, with levels above 100% pointing towards greater credit risk, although circumstances vary by company and sector. At the technology provider end of the value chain, electrolyser manufacturers have tended to rely much more on higher-cost equity funds, rather than debt, an indication that lenders are not yet fully comfortable with the attendant technology risks.

At the sponsor and consumer side of the value chain, established sectors such as chemicals and refining may be well placed as hydrogen developers or as off-takers, given the size and strength of their balance sheets, and with sufficient incentives. Still, margins for refiners are currently low, which may deter investment in higher-cost low-carbon options. Some end-use industries, such as steel producers, have a combination of high debt levels and low margins and thus may face challenges raising the necessary capital to invest in high-cost hydrogen demonstration projects without significant state support or incentives.

In terms of the infrastructure part of the value chain, midstream and utilities have relatively high leverage, and this is often underpinned by regulated returns. Many state-owned entities can fold a hydrogen project into a broader portfolio of debt-financed projects that are ultimately backed by returns from a captive customer base.

Ultimately, there is no one-size-fits-all approach to financing hydrogen projects, just as there is unlikely to be one archetypal hydrogen project. Even the most straightforward cases of electrolysers feeding industrial plants will each face their own challenges in terms of matching hydrogen storage needs to renewable electricity variability and industrial operating schedules. Standardising engineering and financing approaches will be key to growing new hydrogen-based industries.

Biogas and biomethane

According to our bottom-up assessment of organic feedstock sources globally, there is around 400 bcm-equivalent of biomethane that can be developed in EMDEs – equivalent to nearly a quarter of natural gas demand today. India alone holds 20% of this potential, with its large agricultural sector providing ample energy-rich organic residues in the form of sugar cane, rice and wheat crops. Increased urbanisation and improvements in waste management and collection across a number of EMDEs also create significant potential for gas production from municipal solid waste. For import-dependent EMDEs, local sources of low-carbon domestic supply represent a potentially attractive option.

At the moment, the average cost of developing these biomethane resources is around USD 20/MBtu, far above the current level of gas prices. There are a number of options to narrow this cost gap, such as valuing the co-benefits to rural areas of developing biomethane supply chains, or crediting both the carbon and methane emissions savings. Some jurisdictions have provided tax exemptions in the final sale price, have granted biomethane projects preferential access to gas infrastructure, or have put forward measures to make financing more accessible. India, for example, as part of the government's Sustainable Alternative Towards Affordable Transportation (SATAT) scheme, has included bio-compressed natural gas projects in the priority sector lending programme of the Reserve Bank of India.

Despite higher average development costs, there is around 30 bcm of biomethane in EMDEs that can potentially be developed for prices under USD 10/MBtu. However, several financing barriers would need to be addressed first. From a banking perspective, there is often a lack of technical expertise in this area and relatively few benchmarks to assess adequately the risk and return profile for individual projects. There are also some risks that can be difficult to gauge, such as the ability of a project sponsor to secure reliable feedstock of consistent quality or, in the case of biomethane, to meet the rigorous gas quality specifications for injection into national distribution networks. These issues can increase risk perceptions and raise the cost of debt or reduce the loan tenure available to potential sponsors (IEA, 2020).

Biofuels

Spending on new production facilities for liquid biofuels has fallen sharply since the late 2000s, with shut-ins of biofuel production capacity in Brazil, the global market leader, in 2020, due to plummeting gasoline demand, dampening near-term appetite for new investments. However, growing interest in biodiesel production through hydrogen-treated vegetable oil (HVO), which unlike other variants does not have a blending limit, has put new momentum behind advanced biofuels. Most initiatives are being developed by oil majors and large refineries in advanced economies, as HVO plants are higher-cost and rely on economies of scale. However, EMDEs have also been able to attract investments by offering favourable tax terms: an USD 800 million advanced biofuel project in Paraguay, the largest single private investment in the country's history, relied on the creation of a free zone regime. Future developments in EMDEs are likely to be led by Asia and Latin America, especially in economies with ambitious blending targets, for example, India with a 20% share of ethanol in gasoline (E20) by 2025 and Indonesia with a 30% share of biodiesel in diesel (B30) in 2020.

4.5 Financing transitions in emissions-intensive sectors

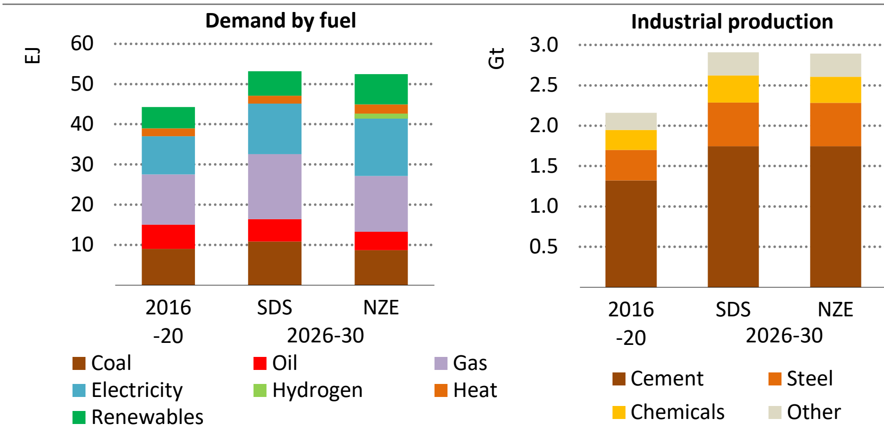
Clean energy transitions in EMDEs increasingly depend on finding pathways for financing emissions-intensive end-use sectors, such as steel, cement and chemicals, as well as heavy-duty transport. After coal power, these sectors account for the largest source of emissions today and a much larger source of potential emissions growth. The analysis here focuses on transitions in heavy industry and shipping, which together are responsible for 2.4 gigatonnes (Gt) of CO_2 – nearly a quarter of today's total energy-related CO_2 emissions in EMDEs. These sectors are not necessarily amenable to electrification, and many of the technologies needed to meet long-term net-zero energy goals remain at early stages of market readiness. As such, transitions over the next decade focus on improving efficiency, fuel switching, and investment in flexible infrastructure. Along the way, companies and whole industries need to decide whether they focus on incremental improvements to existing technologies, or how and when they adopt new ones.

4.5.1 Financing transitions in the industrial sector

Investment outlook and sources of finance

Industrial sectors increasingly drive the economic, energy and emissions profiles of EMDEs. Real industrial value added is set to rise by more than one-third over the next decade, driven by materials-intensive investments in infrastructure, urban housing, factories and productive equipment. All regions grow, but the most rapid expansion in industrial value added and production occurs in India and Southeast Asia. The energy and emissions intensity of this growth (i.e. the amount of energy required to produce an additional unit of industrial output) is a critical variable, affected by technology and fuel choices, and efficiency improvements.

Figure 4.17 ▷ EMDE industry energy demand by fuel and industrial production from key heavy industry sectors by scenario



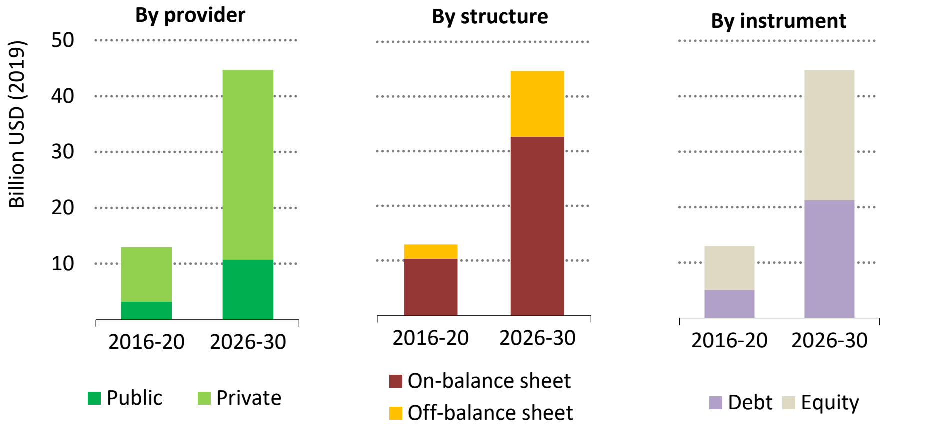
Output from cement, steel and other industrial plants outpaces energy demand due to efficiency gains and switching to electricity and gas, alongside a ramp up in renewables.

Note: Industry energy demand excludes blast furnaces, coke ovens and petrochemical feedstock.

Industry is a major consumer of coal, second only to the power sector. Avoiding a rapid, continued increase in coal use as developing countries industrialise is a multifaceted task. This requires improvements in energy and material efficiency, followed by fuel switching – including moving from coal to gas as well as to fuels with no direct emissions or to electricity for industrial processes requiring low temperature heat. New facilities offer the greatest potential to avoid emissions, but countries should not overlook possibilities to address existing assets. Investments in the next decade focus more on market-ready interventions and infrastructure, while funding for pilot and demonstration projects for newer near-zero emissions technologies contributes to longer-term transformation. In rapid energy transitions, gas, electricity and renewables satisfy a growing share of new demand, while low-carbon hydrogen starts to grow rapidly, albeit from a small base.

Investment in industrial transformation in EMDEs climbs to over USD 40 billion annually in the SDS, from around USD 10 billion during the previous five years. Financing relies heavily on company balance sheets and corporate fundraising through capital markets, with the sizes and risk profiles of transactions less attractive to banks. Still, off-balance sheet arrangements with energy service companies (ESCOs) and project finance to fund large-scale upgrades and industrial clusters become more prevalent.

Figure 4.18 ▷ Sources of finance for industry clean energy investments in SDS



Industry investments rely on corporate balance sheets and SOEs more than other end-use sectors, with potential in SDS to attract more debt from off-balance sheet structures.

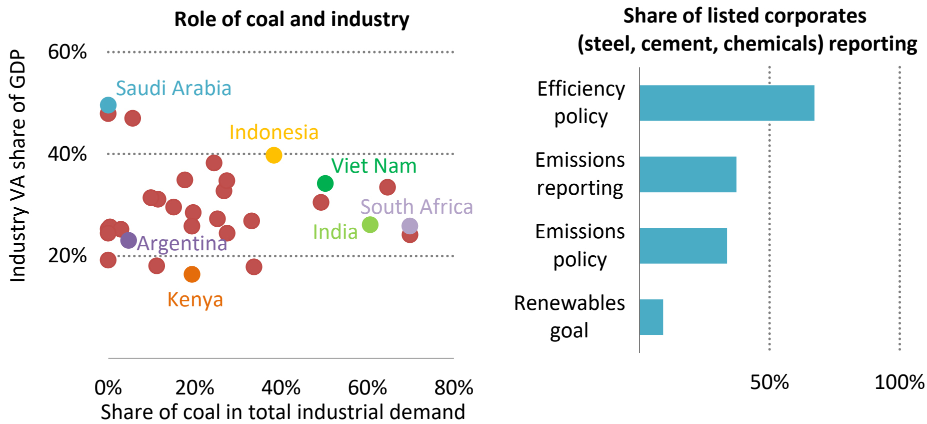
Notes: Estimates reflect sources of primary financing for projects, and do not include secondary flows. Includes investments in industrial efficiency, CCUS and the uptake of low-emissions fuels.

Public actors play an important role in financing industry-related clean energy investments, accounting for over one-quarter of investments today. While this share is lower than in regulated networks, it remains higher than in other end-use sectors, due to the prevalence of large SOEs. In some markets, such as India, the industrial space includes many small and medium-sized enterprises, as well as ESCOs, with more constrained access to finance. While we do not project privatisation of industrial companies, such reforms (e.g. as in Viet Nam) would contribute to a higher private share. The capital structure of major companies guides the outlook for financing instruments, which is based mostly on equity, although the role of debt rises over time and remains higher in iron and steel. Enhancing domestic banking and corporate bond markets would help to diversify financing.

Key factors influencing investment decisions

In many EMDEs in Asia, there is a strong relationship between industrial development and the use of coal to fuel industrial processes and demand for electricity and heat. This link is evident for economies such as India, Indonesia and Viet Nam, where coal has underpinned rapid economic growth and options for large-scale fuel switching have traditionally been relatively limited. Markets in the Middle East, North Africa and Latin America have tended to develop industries more based on access to natural gas supply. Coal plays an important role in the industrial development of South Africa and some sub-Saharan African countries, such as Senegal, but elsewhere, as in Ethiopia and Kenya, it is overshadowed by industrial use of oil.

Figure 4.19 ▷ **Economic role of coal and industry in key EMDEs (left); industrial companies with sustainability policies and reporting (right)**



Some EMDEs have relied on coal for their industrial development, while corporate sustainability actions and reporting remain at early stages.

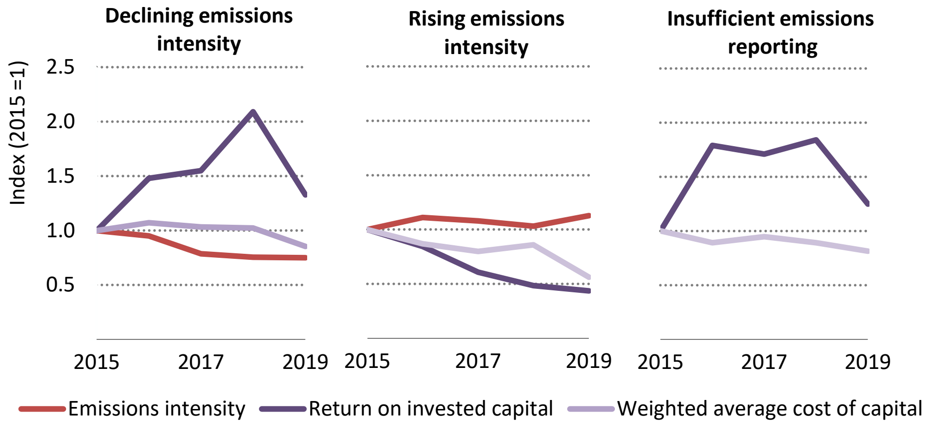
Notes: VA = value added. Left chart = countries making up over 70% of EMDE demand; right chart = listed companies in steel, cement and chemicals with annual sales of at least USD 1 billion.

Source: Calculations for GDP based on World Bank (2021); company reporting from Bloomberg (2021).

For industrial companies, policy signals – including energy performance standards and incentives to pursue energy savings and emissions reductions – play an important role in driving investments in climate-driven scenarios. Currently, efficiency policies set by governments cover less than 40% of industrial energy demand globally. In recent years, Brazil, India and Viet Nam have all adopted new industrial efficiency standards or incentives. Still, coverage in most EMDEs sits well below the global average, and there are relatively few policies for the uptake of low-emissions fuels.

Compared with the power sector, the investment story in industry is much more complex and encompasses technologies and measures with varying degrees of market readiness and emissions reduction potential. The multifaceted energy approaches to industrial transformation, and a dependence on corporate finance for funding improvements, mean that outcomes may depend more on company-level financial performance than is the case with large energy supply assets, where project cash flows can be more readily evaluated by investors. While it is straightforward for investors to fund corporate equity and bond issuance, directly investing in industry transformation remains difficult for capital markets, pointing to the importance of better data and availability of labelled instruments to guide more targeted allocations.

Figure 4.20 ⊳ Financial performance of listed EMDE steel, cement and chemicals companies, based on emissions intensity



For some industrial players, sustainability improvements have been associated with better financial performance, but only 30% of listed companies consistently report emissions.

Notes: Includes listed companies with annual sales of at least USD 1 billion with each portfolio weighted by revenues. Emissions intensity is the ratio of direct plus indirect emissions (scope 1 and 2) to revenues. Financial performance is reflected by the difference between return on capital and the cost of capital.

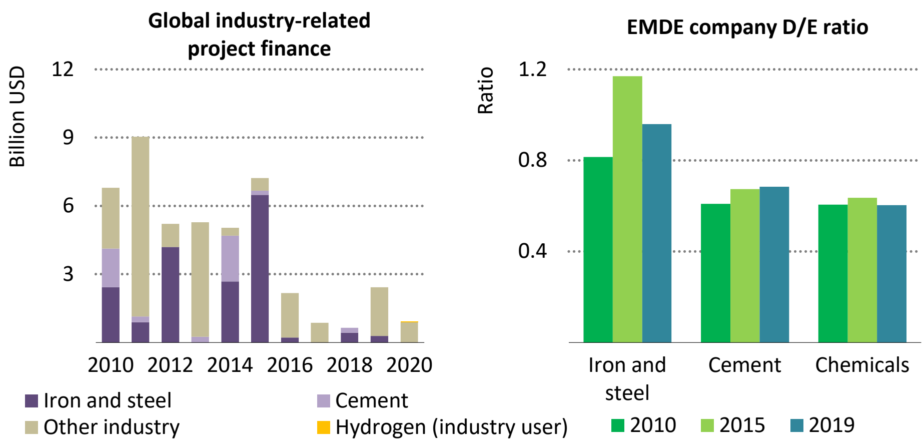
Source: Calculations based on company reporting from Bloomberg (2021).

We examined the performance of 110 listed companies with annual revenues of at least USD 1 billion in the steel, construction materials and chemicals sectors across EMDEs. Annual capital expenditures for these companies total nearly USD 40 billion. While two-thirds of them have set policies to improve energy efficiency, only one-third have emissions reductions policies and 10% have renewables consumption targets. Only 30% have consistently reported greenhouse gas or CO_2 emissions since 2015.

Among those companies disclosing emissions, there appears to be a positive relationship between valuation metrics and sustainability, which may stem from factors related to the cost-effectiveness of reducing emissions, but also the overall quality of firm management and governance. Over the past five years, companies with declining emissions intensity (i.e. reduction in the amount of emissions associated with a dollar of revenues) saw rising returns on their invested capital and experienced a somewhat lower cost of capital. By contrast, those with rising emissions intensity saw a steep decline in returns, and their cost of capital also fell, though at a slower pace than returns, resulting in an overall negative impact to company valuation metrics.

Of course, many factors influence profitability and financing costs beyond sustainability performance. Notably, the large sample of companies with insufficient reporting of emissions data experienced changes in financial performance comparable to those with declining intensity. This picture suggests that avoided emissions may have provided risk management benefits, e.g. in the face of energy price volatility, but it is less clear that investing in clean energy transitions has become a mainstream driver of industrial value.

Figure 4.21 ▹ Project finance FIDs for industry-related assets (left) and debt-to-equity ratios for listed EMDE companies (right)



Project finance has fallen over the past decade and rising credit risks for some EMDE companies may compound challenges in attracting external capital to industrial sectors

Notes: D/E = debt-to-equity; FIDs = final investment decisions for primary project financings based on disclosed transactions.

Source: Calculations based on IJ Global (2021) and Bloomberg (2021).

Further adoption of industrial energy schemes and new business models could influence the picture. For example, in India, the first cycle of the Perform Achieve Trade scheme – a market-based mechanism with efficiency targets and tradeable savings certificates – spurred investments of USD 4 billion, with targets met in all end-use sectors. Policies that facilitate greater use of energy performance contracting could help companies overcome upfront capital burdens for investing in upgrades. In India, Mexico and Thailand, over half the ESCO market serves industrial actors, though the pandemic has caused ESCO spend in EMDEs to moderate (see Chapter 3). Emissions performance may also become more closely linked to trade – especially if the debate over carbon border adjustment mechanisms gains momentum.

A key question concerns the ability of industrial investments to attract higher levels of external capital, and the types of commercial arrangements and project designs that would support this. The credit profiles, and counterparty risks, associated with EMDE companies can vary considerably, and those in the iron and steel and cement sectors have taken on higher degrees of leverage over time. The use of project finance for industrial facilities has fallen to low levels in recent years from mid-decade highs, reflecting shifting demand patterns and emergence of overcapacity in some sectors (e.g. steel). Globally, off-balance sheet structures aimed at funding the uptake of technologies remain rare due to the uncertainties associated with such projects, though a project finance FID was taken in 2020 for a low-carbon hydrogen demonstration plant in Australia serving an industrial company, with additional such projects under development in Europe and Latin America.

Table 4.3 ▷ Examples of industrial clusters based on clean energy

Country	Project	Technologies	Sources of finance	Commercial arrangement	Status
Spain	Puertollano Green Hydrogen	Solar PV, battery storage, hydrogen electrolysis	Utility balance sheet	Offtake by fertiliser company	Construction
China	Suzhou Industrial Park	Waste heat capture, renewable power, electric buses	Mostly on-balance sheet FDI	Offtake by technology manufacturers	Operating
United Kingdom	Humber Industrial Cluster	CCUS, hydrogen infrastructure and electrolysis, offshore wind	Private consortium; govt. grants	Use by heavy industry, refiners, power plants	Planned
Netherlands	Port of Rotterdam	CCUS, hydrogen	Private consortium; public funds	Companies supply CO_2; PPP manages transport/storage	Planned
Australia	Asian Renewable Energy Hub	Solar PV, onshore wind, hydrogen electrolysis	Private consortium; govt. grants	Offtake by miners; ammonia supply for export	Planned

Notes: FDI = foreign direct investment; PPP = public-private partnership.

Sources: Based on Accenture and World Economic Forum (2021) and IJ Global (2021).

Direct investments by institutional investors in new companies focused on clean technologies in the chemicals, materials and industrial machinery sectors have totalled nearly USD 10 billion over the past five years, but virtually all of these are located in advanced economies and China (Preqin, 2021).

Investment strategies for industrial companies are likely to depend on the role of different types of energy costs in the value added of different sectors, whether they primarily serve domestic markets or are export-oriented (where low-carbon products may have a different value), as well as their size. Smaller players may rely more on clean energy applications that require electrification and shared infrastructure, while larger actors may better serve as anchor investors in new, more complex solutions. The crucial uncertainty is the extent to which policymakers, consumers or investors assign value to cleaner production technologies.

Mobilising finance from wider pools of capital, including longer-tenure project debt, may also hinge on the aggregation of industrial demand to realise larger transaction sizes, as well as commercial arrangements that help spread costs and diversify risks among industrial consumers. Notably, the creation of industrial clusters, parks and hubs – including ports, storage facilities, railheads, distribution networks and industrial plants – has emerged as a potential solution to provide shared infrastructure and anchor investment in a combination of industrial solutions for decarbonisation, including electrification and the uptake of renewables-based heating; production and distribution of low-carbon hydrogen; integration of CCUS; and shared efficiency and waste management.

In Europe, some 3 000 industrial clusters are in existence, accounting for 20% of the region's emissions from stationary sources; they are prevalent in China as well. Around the world a number of industrial areas are developing plans around shared infrastructure in CCUS, low-carbon hydrogen and electricity grids in order to decarbonise local industries, while a few are looking to export products based on clean energy. These developments involve financial and commercial arrangements that are more complex than traditional energy projects – while a number are in advanced planning, few have reached financial close.

Industrial clusters are less prevalent in EMDEs, though some markets (e.g. India, Viet Nam) have long-standing industrial parks and integrated energy projects (e.g. desalination in Saudi Arabia). The upfront costs of land and associated development can act as a barrier to this type of aggregation, with such aspects making up some 30-60% of industrial park costs in sub-Saharan Africa (PwC and UK Aid, 2018). EMDEs with advantages in low-carbon hydrogen production or carbon sequestration, or those with more aggressive emissions reductions goals, can be expected to take the lead in these areas.

In EMDEs, shared infrastructure and anchor investments have yet to emerge at scale, and development of industrial clusters around clean energy faces several questions, which pertain to advanced economies as well. Proximity to transport infrastructure and resource mapping, including CO_2 storage potential, are critical for determining feasibility. Investment decisions depend on technological know-how as well as traditional policy, financial and contracting tools to support complex energy systems. Creating bankable projects is likely to hinge on availability of long-term contracts with a creditworthy utility or other public purchaser, which are features of investments across energy. Financing may also depend on industry collaborations that support technology transfer – e.g. nearly all electrolyser manufacturing is in advanced economies and China – as well as targeted use of blended finance, which is being explored by several international public finance institutions.

Actions and case studies for mobilising finance

Cases of financing clean energy transitions in industry can vary considerably, given the multifaceted approaches. Transformations depend on policy and financing priorities that direct new plant investments towards best available technology and the upgrade of existing capacity; building out flexible, shared infrastructure; and efforts to better link the provision of capital from banks and investors to purchase efficient equipment and uptake low-carbon energy. These examples are not exhaustive, but help illustrate a range of policy and financing approaches.

Improving financing options for industrial efficiency. Several Southeast Asian economies are engaged in ways to improve the availability and terms of off-balance sheet financing for industrial efficiency. In **Thailand**, the government combined its ESCO Fund, providing equity and equipment leasing, and Energy Efficiency Revolving Fund, providing low-interest loans for on-lending, with streamlined approval processes. The approach helped boost investments and deal flow for banks. Still, the size caps associated with the programme excluded larger projects. Banks also faced challenges of being exposed to full credit risk as part of the programme, which limited lending to smaller companies (ADBI, 2020).

In **Singapore,** the government seeks to improve industrial energy intensity by 1-2% annually. Alongside existing mandatory energy management practices, it set a SGD 5/tonne carbon tax for large emitters in 2019 and provides grants of up to 50% of equipment costs. It is also piloting a guarantee scheme for efficiency financing from a third party, which also provides a one-stop shop for project development, monitoring and verification, performance guarantees, and energy savings contracts. While the third-party scheme supported cooling system upgrades for some manufacturers, expansion has been slow. Financial institutions still associate the model with high risks and companies remain concerned over transaction costs.

Investment and financing strategies for cement companies. Cement companies around the world have taken steps to improve environmental performance. Over the past two years, companies in Mexico and Thailand (as well as Poland and the United States) have signed long-term contracts with renewable power projects. In many countries, governments are often the largest buyers of construction materials, and some US states are introducing rules for procurement of building materials based on environmental performance (Carbon180, 2020). Some companies are pioneering use of industrial CCUS (see below). Germany is considering awarding contracts-for-difference (fixed price contracts) via competitive procurement to help cement (as well as steel and ammonia) companies fund low-carbon products produced with renewables-based hydrogen.

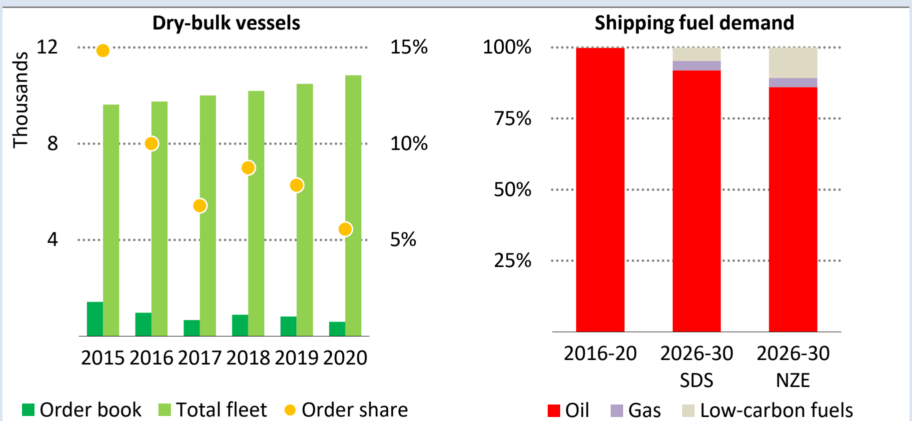
These efforts are supported by new financing strategies. One of the largest cement manufacturers, LafargeHolcim, issued the sector's first sustainability-linked bond in 2020, raising EUR 850 million based on an emissions intensity reduction of 17.5% by 2030, bringing its output to 475 kilogrammes of CO_2/tonne; failure to meet the goal would increase the coupon by 75 basis points. Ultra Tech Cement recently issued a sustainability-linked bond (the first such dollar-denominated bond in India), whose coupon is tied to a 22.2% emissions intensity reduction by 2030. Technology providers focused on low-carbon cement have also attracted institutional investor capital – in early 2021, Solidia raised nearly USD 80 million in venture funding from a consortium of investors including oil and gas companies and a public pension fund.

Investing in industrial clusters and flexible infrastructure. A potential emerging economy example of an industrial cluster around clean energy is provided by **Oman**, where the SOHAR Port and Freezone is looking to take advantage of excellent resources and its track record of attracting FDI to develop a hub around hydrogen electrolysis. The project is based on joint ownership with an international partner, the Port of Rotterdam – which is also collaborating with Chile on hydrogen projects – as well as technology from a German hydrogen developer and joint development of solar PV with an international oil major. The project would benefit from some of the sustainability measures that SOHAR has put in place in recent years, including efficiency standards for port buildings and the ongoing establishment of a new LNG liquefaction and bunkering facility, as well as offering discounted port tariffs to ships outperforming international emissions standards.

Box 4.2 ▷ Financing clean energy transitions in shipping

International shipping accounts for around 2% of global CO_2 emissions, and pressure is on the industry to reduce these emissions substantially in the coming years. Large vessels now rely on heavy fuel oil, with use of marine diesel in recent years to meet sulphur content standards. With electrification options limited to short-haul routes, actions focus on improving efficiency and operations, with some fuel switching to LNG. The International Maritime Organization (IMO) has set a goal for the shipping industry to cut emissions by at least half by 2050. Meeting this goal would require investment in new ships or upgrades in order to use low-emissions fuels – primarily biofuels, ammonia and hydrogen – though this depends on the commercial availability of such fuels.

Figure 4.22 ▷ Global dry-bulk fleet (left) and ship fuel demand (right)



Shipping fleet orders have slowed, with overcapacity, while meeting sustainability goals depends on scaling investment for efficiency and upgrades for low-emissions fuels.

Note: NZE = Net Zero Emissions Scenario.

Source: Calculations for dry-bulk fleet based on World Shipping Alliance (2020).

In recent years, total ship finance has fallen to around USD 50 billion annually amid overcapacity. Order book-to-fleet ratios reached their lowest levels in decades, with dry-bulk vessels at just 6% in 2020. In early 2021, container ship orders picked up, in part due to low-interest rates, competition among shipyards, and also fleet renewal decisions. Shipping investments are mostly made on-balance sheet and depend on debt. Leasing arrangements have risen, supported by long-term charters by Chinese companies, but remain below pre-2010 levels. The role of export credit – the largest public source of finance – has also fallen.

This backdrop points to a major investment challenge for a highly cyclical and competitive industry, requiring increased collaboration among companies, financiers and bodies, such as the IMO. Policy and financial mechanisms under consideration, such as creation of a global fund (paid from levies on bunker fuels) to develop new fuels and technologies as well as operational carbon standards and zero-emissions mandates could help guide the sector (IEA, 2020). In the Getting to Zero Coalition, a group of companies aims to commercialise deep-sea zero-emission vessels and associated infrastructure by 2030.

In 2019, banks representing USD 150 billion in shipping financing signed the Poseidon Principles, which integrate climate risk into financial assessments. In the first disclosure report, only 20% of lending portfolios were aligned with the IMO emissions intensity trajectory (13% annual reduction). The report also revealed that newer vessels do not always translate into better environmental performance; upgrades and measures that address the existing fleet remains important. For example, in 2014 the International Finance Corporation (IFC) provided loans to the Mediterranean Shipping Company to support retrofitting of 140 vessels, reducing fuel consumption by up to 12%, the largest emissions reduction by a single IFC investment to date (IFC, 2021).

4.6 Investing in CCUS

CCUS technologies are critical for putting energy systems around the world on a sustainable path. Deployment of CCUS in IEA scenarios is relatively limited compared with most scenarios that target similar temperature outcomes assessed by the Intergovernmental Panel on Climate Change (IPCC); CCUS in EMDEs accounts for 5% of the cumulative reduction in emissions required to reach the targets of the Paris Agreement. Nonetheless, CCUS can play a strategic role as a cost-effective pathway for low-carbon hydrogen production, as a solution for the most challenging emissions in sectors such as heavy industry and aviation, in removing carbon from the atmosphere, and in tackling emissions from existing energy assets.

The case for CCUS in EMDE energy transitions has multiple aspects, but three stand out:

- Many EMDEs are poised to experience remarkable growth in energy demand, and CCUS can be a key enabler for a low-emissions model of urbanisation and industrialisation, especially for some heavy industrial sectors.
- EMDEs include some of the world's major hydrocarbon resource holders, including economies highly reliant on income from oil and gas. CCUS offers an opportunity to

monetise some of these resources and create revenue streams that are compatible with climate goals, e.g. via production of low-carbon hydrogen or hydrogen-rich fuels.

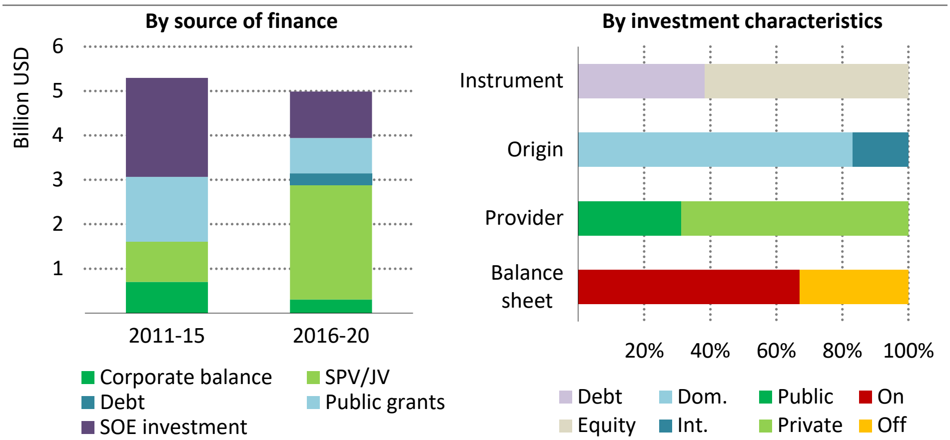
- Many EMDEs, such as India and countries in Southeast Asia, have relatively young industrial and power assets; cutting emissions from these assets while allowing for continued operation can provide economic, power system and employment benefits.

4.6.1 Financing CCUS projects in EMDEs

Investment outlook and sources of finance

The business case for CCUS today rests on supportive policy frameworks and investment incentives; these are gradually strengthening – albeit not yet at a pace consistent with reaching climate goals. Thus far, there are 22 large commercial CCUS facilities around the world with capacity to capture more than 40 Mt CO_2 each year. Four of these facilities are located in EMDEs, in Brazil, Qatar, Saudi Arabia and the United Arab Emirates. Globally, plans for at least 40 commercial facilities have been announced in recent years, and from the start of 2020 to May 2021, governments and industry committed at least USD 12 billion to CCUS projects and programmes. The pipeline of CCUS projects now nearing an FID represents an estimated potential investment of almost USD 30 billion.

Figure 4.23 ▷ Finance and investment characteristics of existing CCUS projects



Off-balance sheet arrangements, including SPVs, and joint ventures, have played an increasing role in financing CCUS, though debt finance remains limited.

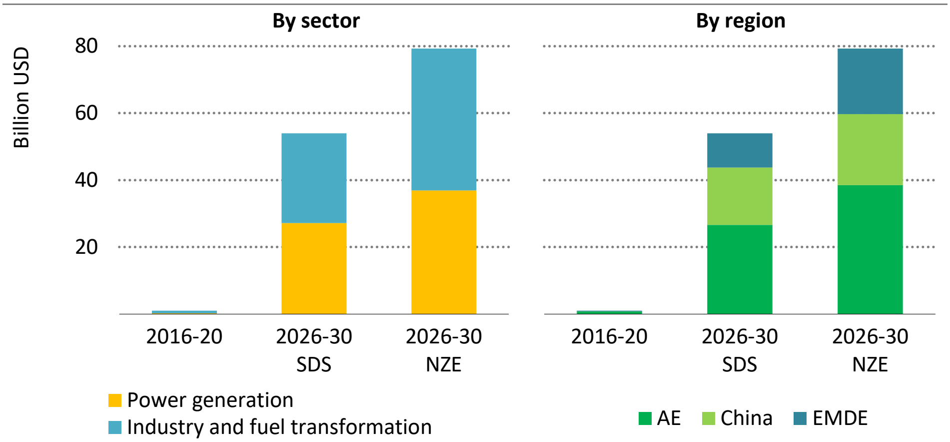
Notes: JV = joint venture; Dom. = domestic; Int. = international. Debt/equity ratios calculated based on both project finance and corporate balance sheet ratios. USD values are cumulative over the period shown.

Source: IEA analysis based on available financing information and technical characteristics of commercial/large-scale operational CCUS projects.

Most CCUS projects to date have been financed with a combination of grant funding, operational support such as tax credits and shareholder equity, and several have received direct investment through SOEs. Project finance debt has been considered for a number of projects, and provided around a quarter of the investment for the Petra Nova project (described below), but there are a number of specific challenges that CCUS projects face in securing debt financing.

Of the large commercial CCUS projects in operation, eight are owned and operated by an SOE. State-owned players, including in EMDEs, could play a leading role in widening the application of CCUS through direct investment and in some cases by creating a low-carbon market through procurement policies.

Figure 4.24 ▷ Average annual investment in CO_2 capture by sector and region by scenario



Meeting emissions reduction goals in climate-driven scenarios requires a ramp-up in CCUS investment in power, industry and hydrogen production, with a growing role for EMDEs.

Key factors influencing investment decisions

The environment for financing CCUS projects worldwide is evolving. Policy support has grown through tax incentives, government grant programmes and carbon pricing instruments. Experience is being gained across a wider range of countries and sectors; this has brought down costs for large projects, and demonstrated the potential of CCUS for steel, hydrogen and biofuels production as well as for power generation. There has been a shift in focus from large stand-alone facilities towards the development of integrated industrial hubs with shared CO_2 transport and storage infrastructure. This brings economies of scale and reduces some commercial risks and financing costs by separating out the capture, transport and storage components of the CCUS chain.

These developments are opening up new sources of finance from institutional investors and major banks. The Alberta Carbon Trunk Line, which came online in 2020, includes an investment of over CAD 300 million (USD 250 million) from Canada's largest pension fund. The developer of the Acorn Project in the United Kingdom (UK), Storegga, has attracted funding from Macquarie Group, Mitsui & Co. Ltd and GIC (Singapore's sovereign wealth fund). Additionally, the BlackRock Global Energy & Power Infrastructure Fund III has partnered to develop an industrial-scale CCUS pipeline system in the United States.

The challenges for CCUS investment in most EMDEs are greater than in advanced economies, with several of the risks for bankability amplified (Box 4.3). Countries are under pressure to meet multiple development goals, and policy support and public finance can be limited, as is the capacity to accommodate higher costs in power generation and industrial production. Many countries have yet to map out their potential for geological storage, and have yet to develop legal and regulatory frameworks that can ensure the effective stewardship of CO_2 storage sites over the long term. Many of the technical skills required for CCUS (and particularly CO_2 storage) are available in major oil and gas companies such as Saudi Aramco or ADNOC, but this expertise is not widely available across countries that might need to deploy CCUS technologies.

Box 4.3 ▷ Defining a bankable business model for CCUS

A key barrier to financing CCUS projects today is the limited case for investment in the absence of policies to support emissions reductions. Bankability of a project will be influenced by a number of factors including the application or sector (and associated costs of capture), availability of CO_2 transport and storage infrastructure, commercial structures, policy environment, and potential for revenue streams for the captured CO_2. Until now, the majority of CCUS projects have relied on revenue from the sale of CO_2 for enhanced oil recovery (EOR). However, there are other potential uses of the CO_2, including as a feedstock for the production of synthetic fuels, chemicals and building materials. The revenue stream from CO_2-EOR and other sales can help support investment in CCUS facilities and infrastructure and be a bridge towards more widespread deployment.

CCUS business models tailored to specific sectors are beginning to emerge, linked closely with policy measures. In heavy industry, public procurement measures can support new markets for low-carbon products alongside measures such as contracts for difference (which can support and protect producers from market variability by defining a minimum remuneration) and upfront capital support to make early CCUS projects financially viable. For transport and storage infrastructure, utility regulation and user pay models can provide useful templates for investment.

CCUS has unique risks that financiers will consider and assess in project financing decisions. While capital markets have an increasing appetite for low-carbon assets, several characteristics of CCUS present distinct risks for financiers and can challenge the ability of firms to obtain project financing.

Table 4.4 ▷ Investment and financing risks for CCUS projects

Risks	Description	Financing impact
Upfront capital needs	Large-scale industrial often requiring parallel investment in CO_2 transport and storage infrastructure.	High
Policy and market risk	Targeted policy support necessary to create a business case to advance early projects given early stage of commercialisation.	High
Counterparty risk	Varying "cross-chain" risks across the stages of CO_2 capture, transport, use and storage. Initially a "chicken and egg" challenge of matching capture with availability of transport and storage.	Medium
Political/social opposition	Perceived risks, varying by region, ranging from the generic (mistrust of new technologies, opposition to any project involving fossil fuels), to NIMBY effects and lack of confidence in the safety of storage.	Low / Medium
Legal and regulatory frameworks	Regulatory frameworks are important to facilitate safe and effective geologic storage of CO_2, and to manage long-term ownership and liability, with regionally varying confidence in regulatory systems.	Low
Development timelines	Development timelines vary across the CCUS value chain, with relatively long lead times for permitting and construction of CO_2 storage sites and pipeline or ship-based transportation networks.	Medium

Governments have a critical role to play to improve CCUS financing opportunities with policies that can establish revenue streams, reduce investment risks and ultimately create a sustainable and viable market for CCUS investment. Targeted measures in advanced economies that are providing a boost to CCUS include the Section 45Q tax credit in the United States, the SDE++ scheme in the Netherlands, and capital support measures such as the UK CCUS Infrastructure Fund and EU Innovation Fund. More broadly, CCUS is getting a boost from strengthened nationally determined contributions and net-zero targets, with corporate targets also creating demand for cleaner industrial materials and products. CCUS-based carbon removal is emerging as an important offset option for some companies that are expanding their involvement within voluntary carbon markets.

To a degree, these factors will create momentum also in EMDE economies. However, for the moment many EMDE governments have limited capacity to provide the public-sector support needed to address the high upfront capital costs faced by CCUS project developers. As such, the feasibility of developing CCUS in EMDEs will hinge on:

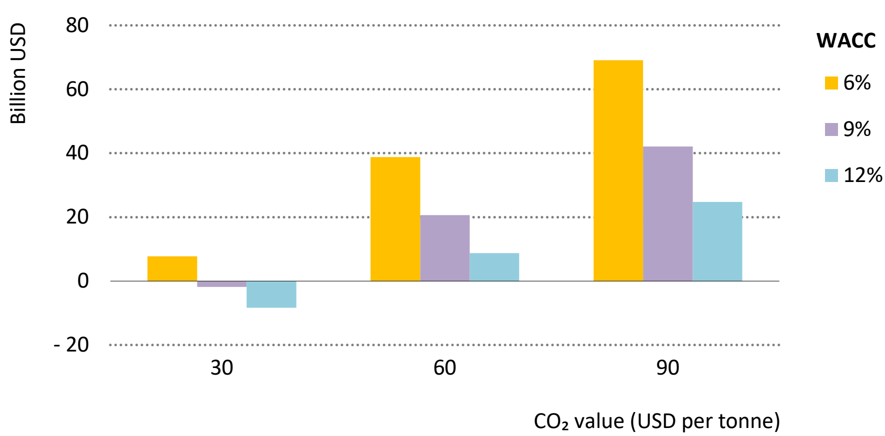
- International support for storage assessments, policy and regulatory development, capacity building, project identification, and pilot projects.
- Integration of CCUS into national energy and climate strategies, alongside a supportive policy framework that includes the ability to attribute value to emissions reductions or CO_2 sales as a result of capture. The recognition of CCUS in nationally determined

contributions is especially significant since multilateral climate finance can look to this when assessing funding requests (CEM CCUS, 2021).

- Enhanced availability of development and climate finance for commercial-scale projects (for example in the form of grants, loans or concessional debt). Blended finance and co-financing approaches are vital to de-risk longer-lived loans for potential investors, given long project timelines and large capex for CCUS developments.[2]

A key step is the identification of sites that are good candidates for CCUS hubs, with features such as nearby geological storage, potential for CO_2 transport networks and density of emissions-intensive facilities. For example, the Oil and Gas Climate Initiative KickStarter programme has identified a number of potential industrial CCUS hubs, while governments and industry are exploring CCUS opportunities in the Asia Pacific region, with potential to develop centralised offshore storage that could accept CO_2 from neighbouring countries. CO_2 transportation by ship to an offshore storage facility can offer greater flexibility in the CCUS value chain, particularly where there is more than one offshore storage facility available to accept CO_2. The flexibility of shipping can also facilitate the initial development of a CO_2 capture hubs, which could later be connected or converted into a more permanent pipeline network as CO_2 volumes grow.

Figure 4.25 ▷ NPV sensitivity of CO_2 capture projects in EMDEs in the SDS to capital costs and CO_2 prices



Reducing the cost of capital with grant funding and low-cost debt and enabling revenue streams for captured CO_2 can greatly improve the profitability of CO_2 capture projects.

Note: WACC = weighted average cost of capital.

[2] The IFC formed an internal Carbon Capture Interest Group in 2019 that is currently exploring potential investment opportunities, including in heavy industry, which could provide risk-sharing opportunities (IFC, 2021).

Financial modelling that reflects the technical characteristics and associated development challenges associated with CCUS highlights the impacts that capital support, operational revenue support and low-cost/concessional debt finance can have on the NPV of investments in CO_2 capture. This sensitivity analysis is based on a sample of CCUS projects required in the SDS, where an average of USD 7 billion in annual investment spending is projected over the next decade in EMDEs, to reach capture capacity of 150 Mt CO_2 per year by 2030. WACCs were varied in a range between 6% and 12% (representing regional variations, as well as capital grant provisions and favourable debt conditions that could reduce the WACC) as well as CO_2 values ranging from USD 30/tonne of CO_2 captured to USD 90/tonne (representing revenue from CO_2 sales, offset credits, tax/direct pay incentives or carbon pricing). Decreasing the WACC for a project from 12% to 6% has in many cases as great an impact on the NPV as varying CO_2-related revenue.

4

Actions and case studies for mobilising finance

International financing mechanisms will play a vital role in getting early CCUS projects off the ground in EMDEs. Grants and loans from development and climate finance institutions, emissions credit mechanisms and climate-related debt financing could all be applied to CCUS projects. Thus far, funds from multilateral development banks (MDBs) have helped establish pilot projects (e.g. via the World Bank in South Africa) and to support the development of legal and regulatory frameworks (e.g. via the Asian Development Bank [ADB] in Indonesia). However, for the moment, there are no examples of MDB financing for commercial-scale projects in EMDEs.

CCUS is eligible for climate finance from some multilateral climate funds, but has not yet been successfully accessed. An ethanol project with carbon capture in Brazil was approved for financing from the Global Environment Facility to cover 30% of projects costs, but the project was later cancelled due to a lack of supplementary domestic financial support (Moreira et al., 2016).

Voluntary carbon markets and emissions trading mechanisms of the United Nations Framework Convention on Climate Change (UNFCCC) that value emissions reductions could provide crucial revenue streams; these have likewise yet to be tested in practice. CCUS was approved to be eligible for the UN-led CDM scheme in 2011, but no projects appear in the CDM project list. A lack of resolution on the operation of international carbon markets (as per Article 6 of the Paris Agreement) also hinders the development of new approaches to CCUS financing and cost sharing (CEM CCUS, 2020). These approaches could include tradeable international mechanisms for CCUS such as storage certificates, which are likely to be a key option for financing projects – including in emerging economies – but will require assurance measures and verification (OGCI, 2021).

Sustainable debt could also help to fund CCUS investment. While green bonds based on use of proceeds may not be available to all projects (eligibility can be limited to specific clean energy technologies, and some explicitly exclude heavy industries or oil and gas companies, despite their CCUS experience[3]), performance-based instruments could facilitate CCUS investments, based on their emissions reduction potential. China updated its green bond standards to include CCUS in 2020. A new category of transition bonds could also assist companies in emissions-intensive industries fund improvements. Direct bank loans, including risk-tolerant financing and co-financing approaches, can provide substantial capital support and boost confidence of potential equity investors.

Table 4.5 ▷ CCUS eligibility for selected international financing mechanisms

		Pilot and demonstration projects	Capacity building*	Capital support	Operating or revenue support
Development finance institutions, MDBs	CCUS trust funds (ADB, World Bank)	●	●		
	Concessional loans from MDBs	●		●	○
	IFC leveraged investment	○		●	○
Climate finance / multilateral climate funds	Green Climate Fund	●		●	○
	Global Environment Facility	●		●	○
	Climate Technology Centre and Network	●	●		
Carbon markets	Joint Crediting Mechanism	○		○	●
	Clean Development Mechanism	○		○	●
	Voluntary carbon markets				●
Sustainable debt securities	Green/sustainability bonds	○		●	●
	Transition bonds	○	○	●	●
	Bank loans	○		●	●
Potential instruments	Storage certificates and credits	○		●	●
	Article 6 (Paris Agreement)	○		○	○

* Including legal and regulatory development and technology assistance.

Note: ● = eligible, ○ = may be eligible.

[3] Issuers of green bonds and other sustainable debt securities that restrict eligibility of CCUS could broaden their applicability so as to explicitly include companies with business models in transition, including oil and gas companies. This would reflect CCUS' role in low-carbon hydrogen production from natural gas, and the role that oil and gas companies can play in developing CO_2 storage and carbon removal projects given their existing skills base and subsurface expertise.

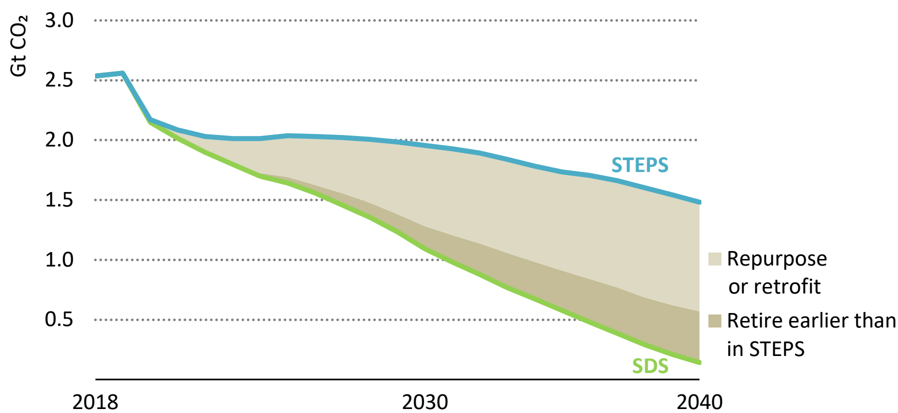
4.7 Financing considerations for sectors in transition

4.7.1 Financial considerations for retirement of carbon-intensive assets

In climate-driven scenarios, there is a systematic preference in favour of investing in low-emission assets in the future. In addition, existing carbon-intensive assets are operated in a very different way. There is a three-pronged approach to tackling emissions from existing coal-fired plants: these are either retrofitted, repurposed or retired. In the SDS, retrofitting some plants with CCUS or co-firing with low-emissions fuels, and repurposing others to focus on system adequacy and flexibility (remaining online but reducing output), are the main approaches.

4

Figure 4.26 ▷ Reducing CO_2 emissions from existing coal-fired power capacity in EMDEs by measure



Curbing CO_2 emissions from coal-fired power plants can be done cost-effectively by retrofitting, repurposing and retiring the existing fleet.

Choosing the optimal strategy of whether to refit, repurpose or retire an asset depends on country- and plant-specific factors that impact NPV and system performance (IEA, 2019). Increasing flexibility or enabling co-firing would require millions of dollars of investment per gigawatt of capacity, while equipping a typical plant with CCUS would cost USD 1 billion or more at current technology costs; the economics of such projects are challenging under current market conditions, and it would be difficult to clear project hurdle rates to invest in such measures in the absence of guaranteed income or a strong business case. Nonetheless, such investments could provide an asset protection strategy or fulfil wider strategic aims, such as supporting energy security or employment. Retirement requires little investment, but it may involve loss of revenues or unrecovered capital and has wider social implications. While plant closures can partly be offset by reinvesting capital in renewables or demand measures, they can raise issues for broader power system reliability, especially in areas with fast-growing demand. Good system planning and integration are essential to address the loss of dispatchable capacity.

EMDEs are also concerned with local air pollution, which can affect transition strategies. Investment in pollution control equipment to comply with more stringent environmental rules around sulphur dioxide, for example, could have the effect of prolonging asset lifetimes or raise risks of stranded capital associated with retirement or repurposing.

Applicability of financial options for early retirement

In cases where emissions and power system considerations point in the direction of early retirement, regulators are exploring financial strategies for how to pay for this. Recovering capital via an orderly market-driven or government-supported mechanism will be key. Three types of options have emerged: traditional utility regulatory tools, fundraising via the financial markets and direct measures. These all involve spreading costs and risks associated with closure. While such options may place additional burdens on governments, consumers and shareholders, the ability of these mechanisms to attract lower-cost debt finance or to offer a predicable step-down of income, often backed by public sources, can help smooth a pathway towards emissions reductions by offsetting some of the potential loss to asset owners.

Table 4.6 ▷ Financial options for early retirement of coal power plants

Mechanism	Typical applicability	Additional cost/risk typically allocated to
Change depreciation schedule for faster capital recovery	Regulated utility	Ratepayers
Reduce the allowed return on equity for an asset	Regulated utility	Utility, shareholders
Disallowance of capital recovery for stranded asset	Regulated utility	Utility, shareholders
Stranded cost recovery through electricity bill charges	Regulated utility	Ratepayers
Refinancing with rate reduction bonds or securitisation	Regulated utility	Ratepayers
Direct payment or acquisition by government	Utility, IPPs	Government
Public finance loan with sustainability-linked criteria	Utility, IPPs	PFIs
Instruments to monetise avoided carbon emissions	Utility, IPPs	PFIs, carbon market
Tenders for coal plant phase-out	IPPs	Government

Notes: IPPs = independent power producers; PFIs = public finance institutions.

Applying financial options for early retirements depends on local energy and financial frameworks. In the United States, regulated utilities have refinanced over USD 50 billion of assets over the past 25 years to recover various stranded costs. In 2016, securitisation funded early retirement of a nuclear plant. Some US utilities are now looking at securitising and then reinvesting proceeds from unprofitable coal power into renewables to create a new equity return and support transition goals. The Canadian province of Ontario phased out four coal plants over the course of 2003-14, through incentives for decommissioning and conversions to biomass as well as long-term planning that augmented the capacity of gas-fired, nuclear and renewable power generation. As Germany moves to close its coal power capacity by 2038, it has adopted phase-out tenders to compensate plant owners on a capacity basis.

In EMDEs, the average age of existing coal power plants today is relatively young compared with their typical lifetime. More than USD 1 trillion of capital invested in the existing fleet of coal plants has yet to be recovered, most of it in Asia. Retirement decisions are often linked to the strategies of state-owned utilities, as well as contracts with plant owners, which often provide incentives to keep plants open via capacity tariffs that cover capital recovery. Refinancing is less of an option in areas with underdeveloped financial markets.

Retirements also have potential employment and social implications, which increasingly factor into decision-making strategies. For example, civic leaders in South Africa recently signed a compact to assist Eskom, the state-owned utility, in shifting to renewables, reducing debt and ensuring a just transition for coal miners and plant workers. In India, the Council on Energy, Environment and Water is developing a methodology to map coal power fleets and assess potential incentives, including to workers, which could be used to ease the move away from coal. Given the multifaceted nature of retirement decisions, targeted use of public finance and design of new instruments would likely play a role in facilitating such transactions, illustrated by two recent cases.

Using sustainable finance to fund renewables and just transitions. In line with **Poland's** energy strategy, one of the country's largest energy utilities, state-owned Tauron Polska Energia, committed to reducing its emissions in half by 2030, by working to increase the role of renewable power to two-thirds of capacity and the decommissioning of ageing coal-fired power capacity. With a 24% bond participation by the European Bank for Reconstruction and Development, the company was able to raise capital through a local currency bond equivalent of USD 250 million – a sizeable issuance during the pandemic – to fund investment in construction and acquisition of renewables and distribution grid investments. The bond links the cost of capital to meeting emissions reduction and renewable power capacity targets. Tauron is also committed to offering relevant retraining opportunities for the employees affected by the transition.

New instruments to monetise avoided carbon emissions. In **Chile**, the government carried out a public dialogue in 2018 with coal plant owners, co-developed a closure schedule based on voluntary commitments by 2040, and set a carbon tax of USD 5/tonne for larger plants. In 2019, IDB Invest provided a USD 125 million loan, including USD 15 million of concessional finance from the Climate Investment Funds (CIF), to Engie to support early retirement of four units by 2024, with proceeds to be reinvested in a new wind farm. The concessional loan included a carbon floor price that monetised avoided emissions from the advanced decommission. Advisory services were provided to develop a GHG accounting methodology (aligned with the CDM and Paris Agreement Article 6). The transaction provided a template for emissions reductions with targeted concessional resources, along with structuring to accommodate the potential future development of carbon markets.

4.7.2 *Funding approaches to support company transitions*

As investors increasingly factor sustainability into their financing decisions, companies with high carbon footprints may face constraints in their access to finance. Labelling standards often exclude businesses based on their fossil fuel supply or consumption or disregard options that reduce emissions but do not fit neatly into the classification of a "green" company or activity. To alleviate this issue, a new market instrument called "transition bonds" is being marketed to help issuers, such as oil and gas companies or energy-intensive industries.

Transition bonds lack a clear definition, but interest is growing fast among potential issuers. The International Capital Market Association (ICMA) has provided recent guidance on the practices, actions and disclosures to be made available when raising funds with these instruments. Notably, ICMA includes both use of proceeds bonds (such as those aligned with Green and Social Bond Principles) and performance-based, general-purpose instruments (such as those aligned with the Sustainability-Linked Bond Principles) as part of the bond universe. While the guidance did not provide definitions or taxonomies of transition projects, on which efforts are under way by governments (e.g. European Union, Canada, Japan) and private actors (e.g. Climate Bonds Initiative), it recommended that transition bond labels and associated disclosure reflect:

- Corporate strategy to address climate-related risks and goals of the Paris Agreement.
- Application of this strategy within the issuer's "core" business activities.
- Basis of this strategy on science-based targets and transition pathways.
- Transparency around implementation and the internal allocation of capital.

The market remains small, but as actors reassess climate-related risks, transition bonds may help to fill financing gaps for developers and provide more nuanced capital allocation approaches for financiers. Interest is increasing among corporations and banks in the Middle East and other producer economies. To date, issuance has primarily concerned energy supply companies, for fuel switching and emissions reductions in oil and gas. A few bonds now pertain to hard-to-abate end-use sectors such as industry, shipping and aviation. And the London Stock Exchange has launched the first platform dedicated to trading transition bonds.

Transition bonds may not provide adequate transparency or levels of improvement for investors with strict sustainability criteria. And they may not fit within tightening standards for green bonds, such as under the proposed EU Taxonomy. Some stakeholders have suggested that transition bonds may increase risk of corporate greenwashing by focusing on incremental improvements rather than long-term climate solutions. There are also questions over additionality, insofar as companies use transition bonds to finance investments that would have been carried out anyway.

Given the range and complexity of solutions required to reach sustainable development goals, transition bonds are likely to remain a part of financing and policy discussions, but with increased focus on guidelines to improve standards and transparency. Such bonds can help to provide a new capital allocation signal and funding route for companies and projects in fuels and emissions-intensive sectors to invest in clean energy transitions, and serve as an important complement to already-established green finance instruments.

Table 4.7 ▻ Examples of energy-related transition bonds

Issuer	Amount	Intended use
Castle Peak Company (2017)	USD 0.5 billion	New combined-cycle gas power plant in China
Cadent (2020)	USD 0.535 billion	Retrofit gas distribution network to reduce methane leakages and trial hydrogen distribution
Crédit Agricole (2019)	USD 0.11 billion	Financing coal-to-gas switching in power and oil-to-gas switching in maritime shipping
European Bank for Reconstruction and Development (2019)	USD 0.55 billion	GreenTransition Portfolio: e.g. efficiency in cement, chemicals, steel manufacturing; electricity grids; buildings renovation
Etihad Airways (2020)	USD 0.6 billion	Meeting 2025 target on CO_2 emissions through purchase of more efficient aircraft and development of sustainable fuels
LafargeHolcim (2020)	USD 1 billion	Meeting 2030 target on CO_2 emissions intensity through use of low-carbon products, recycling, cleaner materials and processes
Shell (2019)	USD 10 billion	Emissions reductions
Snam (2019)	USD 0.5 billion	Biomethane, energy efficiency, methane emissions reduction

ANNEXES

Scope

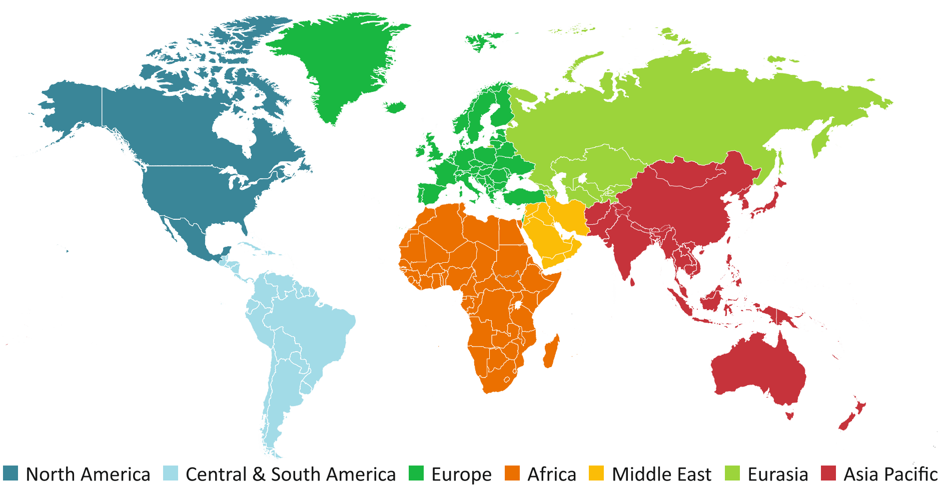
Regional and country groupings

Advanced economies: Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Cyprus[1,2],Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.

Emerging market and developing economies (EMDE): Africa, Developing Europe, Eurasia, Latin America, the Middle East and South and Southeast Asia.

For the purposes of this report, the EMDE grouping includes four member countries of the Organisation for Economic Co-operation and Development (OECD): Chile, Colombia, Costa Rica and Mexico. This group excludes China, as the dynamics of investment in China, which are quite distinctive, is also a major outward investor in EMDEs.

Figure C.1 ▷ Main country groupings



Note: This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Africa: North Africa and sub-Saharan Africa regional groupings.

Asia Pacific: Southeast Asia regional grouping and Australia, Bangladesh, China, India, Japan, Korea, Democratic People's Republic of Korea, Mongolia, Nepal, New Zealand, Pakistan, Sri Lanka, Chinese Taipei, and other Asia Pacific countries and territories.[3]

Caspian: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

Central and South America: Argentina, Plurinational State of Bolivia (Bolivia), Brazil, Chile, Colombia, Costa Rica, Cuba, Curaçao, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay, Bolivarian Republic of Venezuela (Venezuela), and other Central and South American countries and territories.[4]

China: Includes the (People's Republic of) China and Hong Kong, China.

Developing Asia: Asia Pacific regional grouping excluding Australia, Japan, Korea and New Zealand.

Developing Europe: Albania, Belarus, Bosnia and Herzegovina, Gibraltar, Republic of Kosovo, North Macedonia, Republic of Moldova, Montenegro, Serbia and Ukraine

Eurasia: Caspian regional grouping and the Russian Federation (Russia).

Europe: European Union regional grouping and Albania, Belarus, Bosnia and Herzegovina, North Macedonia, Gibraltar, Iceland, Israel[5], Kosovo, Montenegro, Norway, Serbia, Switzerland, Republic of Moldova, Turkey, Ukraine and United Kingdom.

European Union: Austria, Belgium, Bulgaria, Croatia, Cyprus[1,2], Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain and Sweden.

IEA (International Energy Agency)**:** OECD regional grouping excluding Chile, Colombia, Costa Rica, Iceland, Israel, Latvia, Lithuania and Slovenia.

Latin America: Central and South America regional grouping and Mexico.

Middle East: Bahrain, Islamic Republic of Iran (Iran), Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic (Syria), United Arab Emirates and Yemen.

Non-OECD: All other countries not included in the OECD regional grouping.

Non-OPEC: All other countries not included in the OPEC regional grouping.

North Africa: Algeria, Egypt, Libya, Morocco and Tunisia.

North America: Canada, Mexico and United States.

OECD (Organisation for Economic Co-operation and Development)**:** Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.

OPEC (Organisation of the Petroleum Exporting Countries)**:** Algeria, Angola, Republic of the Congo (Congo), Equatorial Guinea, Gabon, the Islamic Republic of Iran (Iran), Iraq, Kuwait, Libya, Nigeria, Saudi Arabia, United Arab Emirates and Bolivarian Republic of Venezuela (Venezuela).

Southeast Asia: Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam. These countries are all members of the Association of Southeast Asian Nations (ASEAN).

Sub-Saharan Africa: Angola, Benin, Botswana, Cameroon, Republic of the Congo (Congo), Côte d'Ivoire, Democratic Republic of the Congo, Eritrea, Ethiopia, Gabon, Ghana, Kenya, Mauritius, Mozambique, Namibia, Niger, Nigeria, Senegal, South Africa, South Sudan, Sudan, United Republic of Tanzania (Tanzania), Togo, Zambia, Zimbabwe and other African countries and territories.[6]

Country notes

[1] Note by Turkey: The information in this document with reference to "Cyprus" relates to the southern part of the island. There is no single authority representing both Turkish and Greek Cypriot people on the island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

[2] Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

[3] Individual data are not available and are estimated in aggregate for: Afghanistan, Bhutan, Cook Islands, Fiji, French Polynesia, Kiribati, Macau (China), Maldives, New Caledonia, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor-Leste and Tonga and Vanuatu.

[4] Individual data are not available and are estimated in aggregate for: Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bonaire, British Virgin Islands, Cayman Islands, Dominica, Falkland Islands (Malvinas), French Guiana, Grenada, Guadeloupe, Guyana, Martinique, Montserrat, Saba, Saint Eustatius, Saint Kitts and Nevis, Saint Lucia, Saint Pierre and Miquelon, Saint Vincent and Grenadines, Saint Maarten, Turks and Caicos Islands.

[5] The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD and/or the IEA is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

[6] Individual data are not available and are estimated in aggregate for: Burkina Faso, Burundi, Cabo Verde, Central African Republic, Chad, Comoros, Djibouti, Kingdom of Eswatini, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Réunion, Rwanda, Sao Tome and Principe, Seychelles, Sierra Leone, Somalia and Uganda.

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