01

Introduction

1.1 Clean energy adoption is a development opportunity

The energy sector underpins economic activity. Ensuring universal access to clean, affordable and reliable energy is a critical sustainable development goal.

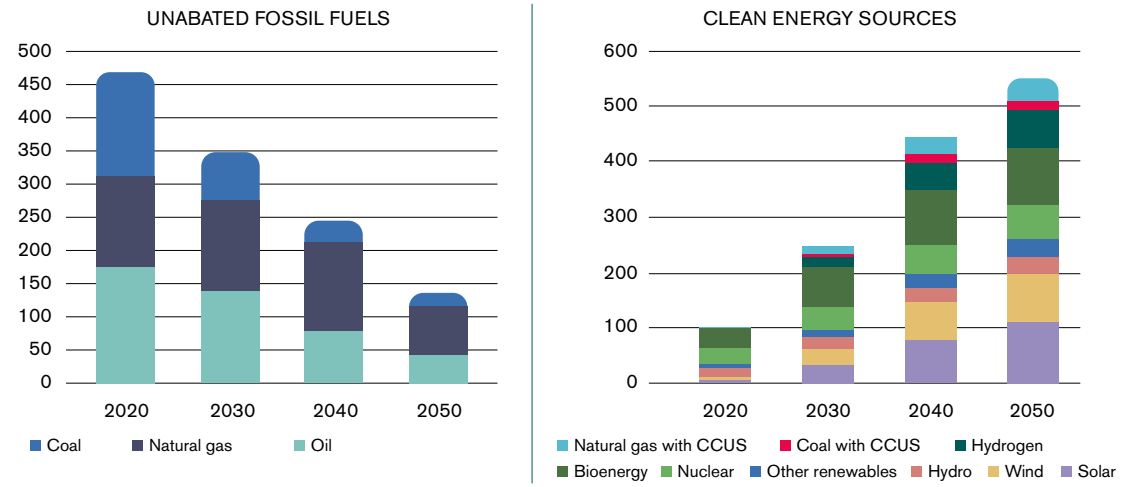
Clean energy accounted for 28 per cent of the 28,334 terawatt-hours (TWh) of electricity produced globally in 2021 (IEA, 2022a). International Energy Agency (IEA) projections indicate that clean energy could account for 90 per cent of total electricity generation by 2050 (IEA, 2023a).[1] Clean energy adoption is driven by net zero greenhouse gas (GHG) emission pledges and increasing rates of household and industrial adoption.

Enabling the clean energy transition is a significant global investment opportunity. In 2022, global investments worth US$ 600 billion were channelled into renewable electricity generation, a 70 per cent increase on 2017 levels. This growth is being driven by expansion of solar and wind generation capacity, which doubled over the five-year period 2018-22 (IEA, 2023h). The IEA also estimates that investments into renewable power generation accounted for 78 per cent of all new energy generation capacity in 2022. Clean hydrogen has emerged as an area of focus over recent years, with investments into electrolysers for power generation increasing sixfold over the 2018-22 period (IEA, 2023a).

This expansion in investment is expected to result in a tangible acceleration in clean energy adoption rates. Renewable electricity adoption is expected to increase by more than 60 per cent between 2020 and 2026 (IEA, 2022e), and expected to generate 80 per cent of the global electricity supply by 2050, if net zero pledges are realized (IEA, 2023e).

Figure 1.1 provides a breakdown of supply estimates per energy source, based on the IEA's "Net Zero Emissions by 2050 Scenario".[2] It indicates that the clean energy mix is made up of diverse energy forms that include both renewable and non-renewable sources (IEA, 2021c). This scenario projects that a gradual decline in unabated fossil fuel use could be complemented by more than proportional growth in clean energy usage.

FIGURE 1.1 IEA total energy supply projections to 2050[3]



Source: IEA (2023e).

BOX 1.1 SDG 7 – Access to affordable and clean energy

A clean energy transition is among the objectives set out in the United Nations (UN) Sustainable Development Goals (SDGs). It is framed in SDG 7,[4] which aims to ensure "affordable and clean energy" for all. Five targets have been defined for SDG 7, with each having important linkages to a clean energy transition:

7.1

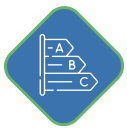
by 2030

ensure universal access to affordable, reliable and modern **energy services**

7.2

by 2030

increase substantially the share of renewable energy in the global energy mix



7.3

by 2030

double the global rate of **improvement in energy efficiency**

7.3a

by 2030

enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology

7.3b

by 2030

expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing economies, in particular least-developed economies, small-island developing states and landlocked developing economies, in accordance with their respective programmes of support

Approximately 20 per cent of all Aid for Trade disbursed over the period 2012-20 targeted SDG 7 objectives. This is indicative of a sustained interest in fulfilling SDG 7 goals among Aid for Trade stakeholders. Rising interest in fulfilling clean energy objectives should further increase the prioritization of SDG 7 in Aid for Trade flows over the coming years.

The energy sector accounts for approximately 60 per cent of annual global GHG (IEA, 2021b). Unsurprisingly, it has been the focus of successive United Nations Framework Convention on Climate Change (UNFCCC) Conferences of the Parties (COP) since the Paris Agreement, which was adopted in 2015. Clean energy goals have been prioritized under SDG 7, which provides five targets with important linkages to the clean energy transition (see Box 1.1).

The centrality of clean energy adoption for a net zero transition was recognized during COP28, held in 2023 in Dubai. The COP28 outcome document[5] underlines the importance of "transitioning away from fossil fuels in energy systems in a just, orderly and equitable manner so as to achieve net zero by 2050". Parties recognized the need to triple the rate of adoption of renewable energy and to double energy efficiency by 2030, while building

momentum towards a new architecture for climate financing to achieve this goal. Additional references to the importance of a clean energy transition in this decision text can be found in Box 1.2.

Fossil fuels are expected to remain as transitional fuels in the global energy mix with limited contributions in an abated form by means of carbon capture utilization and storage (CCUS) technologies.[6] Such technologies are necessary to achieve net zero objectives, as they capture and subsequently store or utilize CO_2 emitted by fossil fuel combustion.[7] If adoption costs decline, this technology could provide breathing space for LDCs and developing economies reliant on the production and exports of fossil fuels. An appropriate technology transfer and diffusion regime is an important consideration.

Growing populations, rapid urbanization and rising living standards are driving up the demand for electricity. IEA estimates suggest that the growth in the demand for electricity among developing economies, based on the IEA's "Net Zero Emissions by 2050 Scenario", could increase by 50 per cent by 2030, and by 300 per cent by 2050 (IEA, 2021c). Many developing economies are on the cusp of a historically energy-intensive time window as their manufacturing and infrastructure expands. Taken together, these factors could stimulate the demand for energy.

BOX 1.2 Clean energy references in the 2023 COP28 decision text[8]

Article II.A.28 of the 2023 COP28 decision text recognizes the need for deep, rapid and sustained reductions in GHG emissions in line with 1.5°C pathways and calls on parties to contribute to the following global efforts, in a nationally determined manner, taking into account the Paris Agreement and their different national circumstances, pathways and approaches:

a. "Tripling renewable energy capacity globally and doubling the global average annual rate of energy efficiency improvements by 2030;
b. Accelerating efforts towards the phase-down of unabated coal power;
c. Accelerating efforts globally towards net zero emission energy systems, utilizing zero- and low-carbon fuels well before or by around mid-century;
d. Transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner, accelerating action in this critical decade, so as to achieve net zero by 2050 in keeping with the science;
e. Accelerating zero- and low-emission technologies, including, *inter alia*, renewables, nuclear, abatement and removal technologies such as carbon capture and utilization and storage, particularly in hard-to-abate sectors, and low-carbon hydrogen production;
f. Accelerating and substantially reducing non-carbon-dioxide emissions globally, including in particular methane emissions by 2030;
g. Accelerating the reduction of emissions from road transport on a range of pathways, including through development of infrastructure and rapid deployment of zero- and low-emission vehicles;
h. Phasing out inefficient fossil fuels that do not address energy poverty or just transitions, as soon as possible".

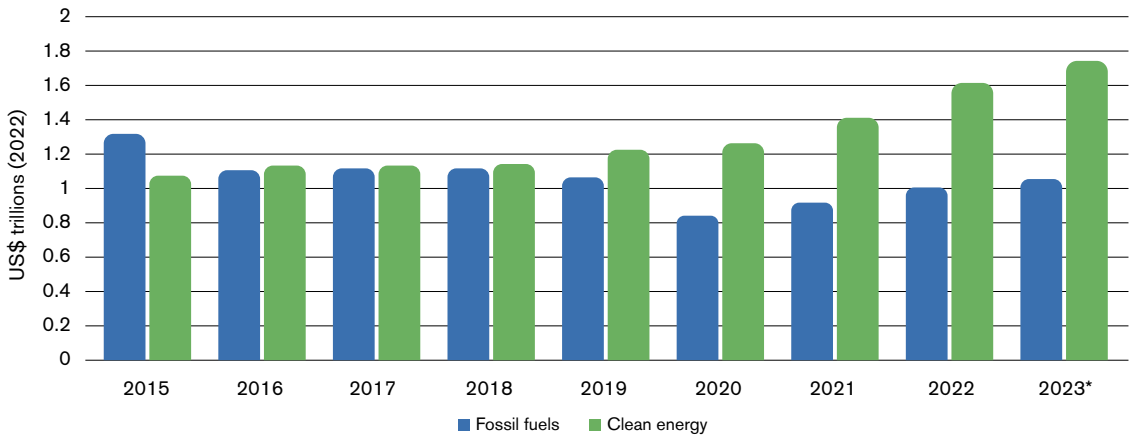
1.2 Clean energy technologies are increasingly cost-competitive

In 2021, the global installation costs of solar photovoltaic (PV) and hydropower were 11 per cent lower than those of the cheapest new fossil-fuel-fired power generation option, while the global installation costs of onshore wind power were 39 per cent lower for the same amount of energy generated (IRENA, 2022a). Renewables and other clean energy sources are positioning themselves as the cheapest sources of electricity generation for greenfield investments, (i.e., when a parent company builds a new venture in another country from the ground up).

The falling costs of clean energy relative to fossil fuels are indicative of an imminent inflection point for the energy transition. This refers to when clean energy adoption reaches a critical mass, so that clean energy deployment is driven by market decisions rather than the regulatory investments of the transition to clean energy. Annual investments into global fossil fuel production have witnessed a gradual decline over the past decade as clean energy, especially renewables, has become more cost-competitive. Figure 1.2, prepared using data compiled by the IEA, illustrates the gradual shift towards clean energy investments. In 2015, each dollar spent on clean energy investment was offset by a US$ 1.2 investment into brown energy (i.e., energy from polluting sources) generation. This trend had reversed by 2022, with each dollar spent on brown investment matched by a US$ 1.6 investment in clean energy capacity. In other words, clean energy investment is outpacing the pace of brown energy investment.

Accelerating investments into clean energy presents an opportunity for developing economies and LDCs, for instance, by helping these economies reduce their reliance on fossil fuel imports. Four out of five people live in economies that import fossil fuels (UN, 2020). Nearly 90 per cent of the energy requirements in the Pacific islands are currently satisfied through oil and coal imports. A clean energy transition – particularly in the context of renewables such as wind and solar energy – could have long-term cost benefits, as the installation

FIGURE 1.2 Investments into clean energy and fossil fuels 2015-23



Source: IEA (2023a).

BOX 1.3 The Fossil Fuel Subsidy Reform Initiative (FFSR)

Forty-eight WTO members are co-sponsoring joint action at the WTO with the aim of achieving effective WTO disciplines on fossil fuel subsidies.

The co-sponsors are of the view that inefficient fossil fuel subsidies encourage wasteful consumption, are disadvantageous to the generation of renewable energy, and depress investment in energy efficiency. They argue that addressing fossil fuel subsidies effectively will deliver trade, economic, social and environmental benefits, as well as releasing government funds to support a green and climate-resilient recovery from the COVID-19 pandemic.

The co-sponsors aim to seek the rationalization and phase-out of inefficient fossil fuel subsidies that encourage wasteful consumption along a clear timeline and plan to bring forward concrete options to advance this issue.

Reducing fossil fuel dependency negates the need for extensive fossil fuel subsidy programmes, leading to budgetary savings. For instance:

- **Fuel price adjustments in Indonesia** led to savings of US$ 15.6 billion in fiscal revenue. This amounted to a nearly 10 per cent gain in government revenue, which was used to finance social welfare programmes and infrastructural upgrades.
- **Fossil fuel subsidy reforms in Egypt** in 2013-16 led to a 30 per cent decline in energy-related expenditure. Much of the savings from this policy were then redirected towards health and education expenditure (Pradiptyo et al., 2016).

of capital equipment is an infrequent expense requiring less recurrent expenditure. In this context, a clean energy transition could help to lessen current account pressures and improve fiscal sustainability by reducing the need for fuel subsidies.

The war in Ukraine has sharpened policy attention to the role of clean energy technologies in addressing energy security issues. Installed clean energy capacity has absorbed some of the shock from the turbulence in fossil fuel energy markets. As reported by the International Renewable Energy Agency (IRENA), renewable capacity added in 2021 helped economies to save US$ 55 billion in 2022 by reducing the need for fossil fuel imports. In Europe between January and May 2022, as a result of solar PV and wind generation, it was possible to forego US$ 50 billion in fossil fuel imports, predominantly gas. IRENA estimates that in the long term, investment in brown energy technology could be four to six times more expensive than any new additions to solar and onshore wind capacity (IRENA, 2022a). These figures highlight a broader issue related to volatility linked to energy imports and the fiscal impact of price variability.

Annual investments into global fossil fuel production have witnessed a gradual decline over the past decade as clean energy, especially renewables, has become more cost-competitive.

1.3 Developing economies and LDCs are key stakeholders in a clean energy transition

Many developing economies and LDCs have a potential "latecomer" energy advantage in the adoption of clean energy infrastructure. For instance, Africa's grid infrastructure remains insufficient to sustain reliable and affordable power supply. In 2017, the length of transmission lines in the entire continent was 247 km per million people (Lerner et al., 2017). This collective figure was well below that of other developing regions. Extending this infrastructure now offers significant potential to integrate transmission systems that can align with clean energy needs, and that can stimulate backward industrial and services linkages.

Several economies have rapidly expanded their domestic renewable capacity over recent decades. China stands as a prominent example. Over the past 10 years, Chinese renewable energy capacity has increased by around 90 times, and by 2025, China expects its renewable energy generation capacity, driven by wind and solar power output, to account for more than 50 per cent of total generation capacity (Zheng, 2022).

Morocco is an example of an economy with accelerated renewable energy adoption. Renewables contribute to almost 40 per cent of Morocco's installed energy capacity, and they are targeted to exceed 50 per cent by 2030. Morocco's Noor Ouarzazate Solar Complex is the largest concentrated solar power plant in the world, spread over 3,000 hectares of desert and with an overall capacity of 580 megawatts (MW) of power. The economy has also developed more than a dozen large-scale windfarms, as well as providing incentives for businesses and residences to invest in their own solar panels to save on energy costs (Papathanasiou, 2022).

Latin America and the Caribbean have made remarkable progress in renewable energy adoption. According to data from the Latin American Energy Organization (Organización Latinoamericana de Energía – OLADE), more than a half (59 per cent) of electricity generation now comes from renewable sources. The ambition is to reach 70 per cent by 2030 (OLADE, 2023).

BOX 1.4 The Noor Ouarzazate Solar Complex Project[9]

The NOOR Ouarzazate Solar Complex Project, with a capacity of approximately 580 MW, represents a pivotal milestone in Morocco's National Energy Strategy (2010-2030). This initiative is part of the broader NOOR Program and aims to develop integrated solar energy projects with a cumulative capacity of at least 2,000 MW by 2030. The Ouarzazate solar power station (OSPS) stands as the flagship endeavour within Morocco's new energy strategy, striving to elevate the proportion of renewable energy sources to 52 per cent by 2030.

Supported by international partners, Morocco is progressing toward energy independence and sustainable development, reversing its previous reliance on imported fossil fuels for up to 95 per cent of its electricity. The objectives of constructing the Ouarzazate solar power station include diminishing Morocco's energy dependence, mitigating the adverse fiscal and trade balance effects of imported fossil fuels, increasing electricity production through harnessing sunlight efficiently, fostering the growth of a national solar energy industry, and reducing long-term GHG emissions.

The project's beneficiaries encompass Moroccan communities, businesses and various sectors such as industry, transportation and agriculture. These stakeholders stand to gain not only from an improved electricity supply but also from the cleaner and more sustainable nature of power generation. At the local level, the Ouarzazate province, with an estimated population of 583,000 and a poverty rate of around 23 per cent, anticipates socio-economic advantages from the project.

Clean energy deployment over the past decade has also contributed to some reduction in energy poverty.[10] Research by IRENA estimates that the number of connections to renewable grids doubled between 2010 and 2019, and that approximately one-third of this increase involved so-called "Tier 1" entrants, that is, entrants from the lowest level of energy access (IEA et al, 2021). Nearly 105 million people have received energy access through decentralized solar grids in sub-Saharan Africa alone.

Less well-known is that clean energy adoption can generate positive spillovers on digital connectivity, as access to electricity affects the availability, uptake and usage of mobile connectivity (Houngbonon, Le Quentrec and Rubrichi, 2021). This in turn has the potential to boost growth, expand economic opportunities and improve service delivery (Lerner, Fukui and Gallegos, 2017).

The expansion in clean energy investment has also been accompanied by a decline in funding for fossil fuel-based power generation. Since 2014, global investments in oil production have declined steadily, with a drop of 65 per cent in 2020 alone. The drop in funding for fossil fuels has been accompanied by sharp reductions in regulatory permits for new coal-fired power plants, with an 80 per cent reduction in permits compared to five years ago (IEA, 2021e). This is notwithstanding the uptick in fossil fuel energy generation driven by energy security concerns emanating from the war in Ukraine. IEA estimates reveal that for every US$ 1 spent on fossil fuels, US$ 1.7 is now spent on clean energy. In comparison, this ratio was 1:1 in 2017 (Sustainable Energy for All et al., 2023). And this ratio is expected to grow further in favour of clean energy.

Clean energy investment features prominently in the nationally determined contributions (NDCs) of developing economies, including those of LDCs. The NDCs, a key component of the Paris Agreement on climate change, outline economy-level commitments to reducing GHG emissions and adapting to the impacts of climate change.[11]

The UNDP notes than more than 110 economies have included clean energy targets in their NDCs.[12] Many economies have included targets for increasing the use of clean energy sources (such as wind, solar and hydropower) in their NDCs. For example, various economies have set targets for increasing the share of renewable energy in their electricity mix or for increasing the number of electrical vehicles on their roads (IRENA, 2022c). In addition to setting targets for clean energy, many economies have also included policies and measures to promote the deployment of clean energy technologies. Such measures include incentives for renewable energy investments, support for research and development (R&D) of new clean energy technologies, and regulatory reforms to remove barriers to the deployment of clean energy.

NDCs were a key topic of discussion during COP28 in 2023. The COP28 decision text calls upon economies to submit revised NDCs well ahead of COP30 in 2025, and highlights the need for these new NDCs to be more ambitious, to ensure that the goal to limit global warming to 1.5° Celsius is reached by 2050.

The inclusion of strengthened clean energy targets in NDCs will operate as a market signal for more investment inflows into clean energy generation. According to estimates by the IEA, the implementation of current NDCs could drive an additional US$ 13.5 trillion in clean energy investment by 2030 (IEA, 2016). Box 1.5 provides some examples of clean energy commitments found in the NDCs of developing economies and LDCs.

Clean energy expansion was recognized as a development priority by WTO members responding to the monitoring and evaluation (M&E) exercise carried out in 2022 by the WTO and the OECD. Of the developing-economy respondents, 78 per cent highlighted that their national development strategies identified SDG 7 ("Affordable and Clean Energy") as a key goal. SDG 12 ("Responsible Production and Consumption") and SDG 13 ("Climate Action"), which bear a collective clean energy emphasis, were also highlighted as priority Aid for Trade needs by members.

According to IEA estimates, almost US$ 4-5 trillion (in real terms) is required as clean energy investment worldwide per annum by 2035. In 2023, total investments disbursed reached US$ 2.8 trillion (IEA, 2023a).

BOX 1.5 Examples of clean energy targets in developing-economy NDCs[13]

BANGLADESH
Increase the share of **renewable energy in power generation** to
10% by 2021 and to
15% by 2025

MEXICO
Achieve a
35%
clean energy share in its electricity generation by 2024

BRAZIL
Increase the share of **renewable sources in its energy mix** to
45% by 2030

MALAWI
Increase the share of **renewable energy in power generation** to
30% by 2030

ETHIOPIA
Achieve
100%
access to electricity from renewable energy sources by 2025

RWANDA
Increase the share of **off-grid renewable energy** in its electricity generation mix to
22% by 2030

INDIA
Achieve
40%
cumulative **electric power capacity** from **non-fossil-fuel-based energy** resources by 2030

SENEGAL
Increase the share of **renewable energies in installed capacity** to
40%
of its electricity mix by 2030

KENYA
Achieve
100%
renewable energy in its electricity generation mix by 2030

1.4 The clean energy transition is a trade integration opportunity

The demand for products and activities associated with clean energy is picking up pace. OECD research reveals that over the period 2017-19, the trade of critical raw materials used in clean energy products expanded more quickly – at an average growth rate of 38 per cent – than trade in all merchandise products, which had an average growth rate of 31 per cent (Przemyslaw and Legendre, 2023). IEA projections (under the Announced Pledges Scenario) indicates that the global market for manufactured clean energy technologies will be worth around US$ 650 billion a year by 2050, which is triple the value of current market estimates (IEA, 2023b).[14] Clean energy adoption would also boost the need for ancillary services, such as maintenance, operations and management, thus creating additional job and value generation possibilities.

Developing economies and LDCs can leverage the clean energy transition to achieve trade growth and export diversification. Key to meeting this target is integrating into value chains catering to the mineral, manufacturing and service inputs required for clean energy generation. Aid for Trade can play an important role in this process. Subsequent chapters of this report will further explore how Aid for Trade can help in achieving this integration.

Endnotes

1. Projections are based on the IEA's "Net Zero Emissions by 2050 Scenario" (https://www.iea.org/reports/global-energy-and-climate-model/net-zero-emissions-by-2050-scenario-nze). The scenario is designed to show what is needed across the main sectors by various actors for the world to achieve net zero energy-related CO_2 emissions.
2. See https://www.iea.org/reports/global-energy-and-climate-model/net-zero-emissions-by-2050-scenario-nze.
3. Projections are per the IEA's "Net Zero Emissions by 2050 Scenario".
4. See https://www.un.org/sustainabledevelopment/energy/.
5. See https://unfccc.int/sites/default/files/resource/cma2023_L17_adv.pdf.
6. According to the OECD, abatement refers to technology applied, or measures taken, to reduce pollution and/or its impacts on the environment.
7. https://www.iea.org/fuels-and-technologies/carbon-capture-utilisation-and-storage.
8. See https://unfccc.int/sites/default/files/resource/cma2023_L17_adv.pdf
9. See https://www.afdb.org/en/documents/morocco-noor-ouarzazate-solar-complex-project-phase-iii-noor-ouarzazate-iii-power-plant-project-completion-report.
10. The term "energy poverty" is defined by the G20 as occurring "when households or territorial units cannot fulfil all of their domestic energy needs as a result of lack of access to energy services, an inability to afford them, or their poor quality of unreliability in order to, at minimum, safeguard their health and provide for opportunities to enhance their well-being".
11. See https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs.
12. See the United Nations Environment Programme (UNEP) NDC Registry at https://unfccc.int/NDCREG.
13. See https://unfccc.int/NDCREG.
14. The Announced Pledges Scenario (APS) projections by the IEA illustrates the extent to which announce ambitions and targets can deliver the emissions reductions needed to achieve net zero emissions by 2050.