CLIMATE ANALYTICS

Long term strategies: low carbon growth, resilience and prosperity for Least Developed Countries

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Summary

Least Developed Countries (LDCs) – 46 countries highly vulnerable to economic and environmental shocks -- contribute little to global emissions. In 2019 they were responsible for just over 1% of emissions from fossil fuel and industrial processes.

And yet LDCs are taking action. At the UN Secretary General's Climate Action Summit in 2019, LDCs launched the **LDC Group Vision toward a climate-resilient future** – which calls for all LDCs to be on climate-resilient development pathways by 2030 and to deliver net zero emissions by 2050.

Guided by this overarching Group vision, individual long-term low greenhouse gas emission development strategies (LT-LEDS or LTS) provide a beneficial space for each LDC government to set out a **visionary blueprint for a resilient, decarbonised future, compatible with limiting warming to 1.5°C**.

An LTS is **essential for guiding near-term ambition and actions**, aligning investment with Paris Agreement goals, and taking advantage of **synergies between mitigation, development and adaptation needs**.

At COP21 in 2015, all governments were invited to submit LTSs by 2020, but few developing countries were able to meet this timeframe. In 2021 at COP26, the Glasgow Climate Pact again urged countries that had not yet done so to bring forward an LTS by COP27. Since the Glasgow session, the UNFCCC Executive Secretary has also communicated directly with governments, urging the communication of new or updated LTSs by November 2022 (COP27).

Progress is being made. As of June 1, 2022, 51 countries have officially submitted an LTS to the UNFCCC Secretariat. This number includes three LDCs: Cambodia, Nepal and Benin. The Gambia also has prepared a 2050 Climate Vision, available on its Government website, and other LDC LTSs are in the preparation phase. The first-ever LTS synthesis report will be prepared by the UNFCCC Secretariat and published by October 2022.

While for many countries, an LTS has as its goal the decarbonisation of carbon-intensive economies, **for LDCs the challenge is to develop sustainably along a low-carbon growth path**: avoiding the installation and use of carbon-intensive infrastructure, while also protecting valuable ecosystems and planning for increased resilience against climate impacts across all sectors.

An LTS offers significant opportunities for cost savings and development gains for LDCs. The process of developing an LTS can generate a series of **co-benefits and opportunities**. These include:

- policy coherence and support for short-and medium-term planning
- the avoidance of stranded assets, caused by short-term planning

- planning for climate-resilient infrastructure
- upskilling and expanding local employment opportunities in renewable energy technologies and in extractive industries
- new sources of funding support for development
- greater energy independence and cost savings
- reduced trade vulnerabilities
- expanded access to affordable energy
- enhanced food security
- enhanced resilience to climate impacts
- prosperity through new growth models, and
- improved health outcomes, among many others.

This paper addresses some of the **challenges LDCs face in preparing and implementing LTSs**, including limited data availability to support economic and socio-economic modelling, human and financial resource constraints and limited institutional capacities. It considers **key building blocks of an LTS** and identifies the key sectors to be addressed through an LTS, which for most LDCs include the **energy sector, the agricultural sector and the land sector**. It then highlights some of the **important co-benefits that can be derived from LDC preparation and implementation**, and outlines some of the **resources and support available for preparation and implementation of LTS.**

Financial and technical support for LTS development is growing across donor funds, multilateral funds, development banks and intergovernmental initiatives and a number of organisations are now providing their expertise and resources to support the LTS development process.

LTSs are now an essential component of national climate policy architecture. They are also a **ticket to greater prosperity for LDCs**, due to the many co-benefits that arise from long-term low-emission development planning.

Contents

1. Introduction

Parties to the Paris Agreement have agreed to "strive to formulate and communicate long-term low greenhouse gas emission development strategies" consistent with the long-term goals of the Paris Agreement, including the long-term temperature goal (LTTG) of holding global temperature rise to well below 2°C and pursuing efforts to limit warming to 1.5°C (see Paris Agreement Articles 4.19 and 2.1(a)).

Parties were invited to submit these strategies by 2020 (decision 1/CP.21, para. 35); few developing countries were able to meet this timeframe. Subsequently, in November 2021, at COP 26, by decision 1/CMA.3, Parties adopted **the Glasgow Climate Pact** (UNFCCC, 2021a). This decision **contains a renewed, expanded, and strengthened call for Parties to communicate long term strategies**, urging Parties that have not yet done so to communicate their LTS by November 2022, "towards just transitions to net zero emissions by or around mid-century, taking into account different national circumstances" (decision 1/CMA.3, para. 32). All Parties are invited to update these strategies regularly in line with the best available science (para. 33), and to note the importance of aligning these with Nationally Determined Contributions (NDCs) (para. 35).

In particular, the Glasgow Climate Pact calls upon Parties to rapidly scale up the deployment of clean power generation and energy efficiency measures, phase-down unabated coal power and phase out inefficient fossil fuel subsidies (decision 1/CMA.3, para. 36). The Pact also invites Parties to consider further actions to reduce non-carbon dioxide greenhouse gas emissions, including methane, and emphasises the importance of protecting, conserving and restoring nature and ecosystems, including forests and other terrestrial and marine ecosystems acting as sinks and reservoirs of greenhouse gases (paras. 37-38).

As of June 1, 2022, 51 Parties (50 countries plus the EU), had submitted an LTS to the UNFCCC Secretariat (UNFCCC, 2022). This number includes **three LDCs** - Benin, Cambodia and Nepal. The Gambia has also published its own 2050 Climate Vision document, with its full LTS to follow (Government of the Gambia, 2021). Those LDCs that have not yet communicated an LTS will now be considering how best to respond to the Glasgow Climate Pact's renewed call for LTS submission.

LTSs are expected to set out a visionary blueprint for a resilient, decarbonised future, compatible with limiting warming to 1.5°C, that steers near-term ambition and action, and secures domestic political buy-in for a low emissions development pathway aligned with Paris Agreement goals.

In 2018, the IPCC Special Report on Global Warming of 1.5°C (SR1.5°C) found that global emissions would have to drop to a level of 25-30 GtCO2eq/year by 2030 – to **roughly half** the level of emissions implied by full implementation of then-pledged Nationally Determined Contributions (NDCs) (52-58 GtCO2eq/year) -- to be on a pathway consistent with achievement of the LTTG.

Despite improved emission reduction pledges from Parties since the IPCC SR1.5°C was released, projected emission levels remain inconsistent with a 1.5°C pathway. The UNFCCC'S 2021 NDC synthesis report finds that full implementation of pledged NDCs is estimated to deliver an emission level in 2030 that is ***13.7 per cent above*** the 2010 level (UNFCCC, 2021a, para. 25; UNFCCC, 2021b). The IPCC's recent AR6 WGI and WGIII reports confirm that 1.5°C is still within reach, but that staying within this threshold will require immediate, rapid, and large-scale reductions of emissions. This includes a reduction of global carbon dioxide emissions by 45 per cent by 2030 relative to the 2010 level and to net zero around mid-century, as well as deep reductions in other greenhouse gases.

The Glasgow Climate Pact acknowledges this challenge (UNFCCC, 2021a, para. 22) and recognises the importance of aligning NDCs with LTSs (UNFCCC, 2021a, para. 35). Massive economic transformations will be needed in many countries to decarbonise what are now carbon-intensive economies, to reach 1.5°C-consistent pathways. **For LDCs, the challenge is a different one – to develop along on a low emission development pathway.**

The IPCC SR1.5°C sets out the transformations needed at global and sectoral levels to achieve the Paris Agreement's LTTG (IPCC, 2018; Schaeffer et al., 2019). A summary of some of the key messages from this report is given in Table 1. **Of these sectoral transformations, the most significant for LDCs will be those related to the decarbonisation of energy generation and use, the reduction of land sector emissions and reductions in non-CO_2 greenhouse gases – for example, methane and nitrous oxide from agriculture.**

Table 1. Key messages from the IPCC Special Report on 1.5°C

(adapted from Schaeffer et al. 2019)

Achieving the Paris Agreement's Long-term Temperature Goal requires transformative systemic change across the whole economy and society that is integrated with sustainable development. The key characteristics of 1.5°C consistent sectoral transformations are:

Large reductions of fossil fuel use, in particular:

- Reduce fossil-fuel consumption towards zero by mid-century
- Fully decarbonised primary energy supply by mid-century

Large demand reductions across all end use sectors by 2030:

- Increase building energy efficiency such as air conditioning systems and lighting
- Improve public transportation to reduce individual demand

Full decarbonisation of electricity generation by 2050, mainly through:

- Over 50% of electricity from RE by 2030
- Fossil fuel phase out in power sector by 2050

Coal use for electricity reduced dramatically

- Reduce coal use by around 70% by 2030
- Complete global phase out by 2050
- Due to high carbon intensity, no role for coal even with CCS by 2050

Electrification of end use sectors (transport, buildings, and some industry processes)

- Ramp up penetration of EVs in public and private transportation to reach full decarbonisation by 2050
- Deployment of charging infrastructure

Decarbonisation of final energy other than electricity, for example through the use of biofuels, hydrogen or other energy carriers (aviation, shipping, and some industry processes

- Plan replacement of marine fleet by low-carbon vessels
- Deploy port infrastructure for charging facilities

Net-zero land-use emissions between 2025 and 2040

- Steep reduction in deforestation
- Adoption of policies to conserve and restore land carbon stocks and protect natural ecosystems
- By 2050, negative emissions need to be on a multi-Gigatonne scale

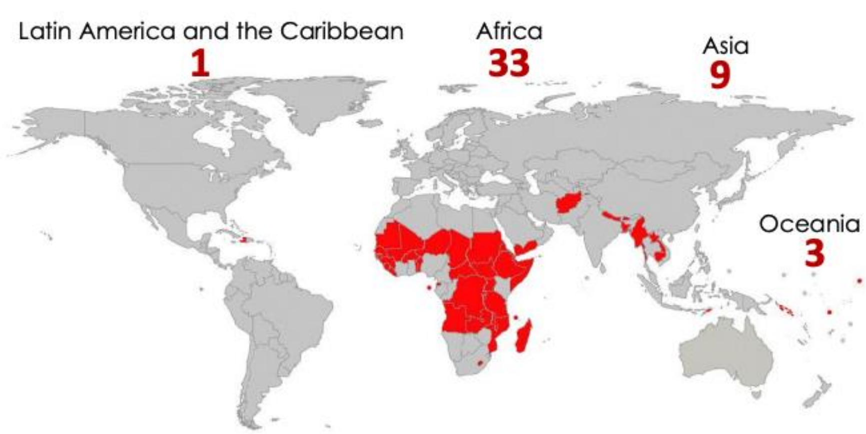
Substantial reductions of emissions of non-CO2 greenhouse gases

- Reductions in methane and nitrous oxide from agriculture, industry and other sectors needed
- Phase out of Hydrofluorocarbons

2. The LDC context

2.1 Development challenges

About 1.1 billion people live in the 46 countries collectively described as Least Developed Countries – a grouping of countries characterised and defined by their low level of income and capacity, highly vulnerability to external shocks, and multiple long-standing structural impediments for sustainable development (UNCTAD, 2021a). This vulnerability to external shocks has been worsened most recently by the COVID-19 pandemic, which significantly affected international trade, disrupted regional and global value chains for manufacturing, and brought international tourism to a virtual standstill for a time, leading to a sharp reduction in GDP growth and rise in poverty, food and nutrition insecurity and inequality (UNCTAD, 2021a; UN-OHRLLS, 2021).



Source: *[CDP Datasheet: The LDC category after the 2021 triennial review]*

LDCs account for 14 percent of the global population, but only 1 percent of global GDP. While some social and economic progress has been achieved, individual LDCs continue to struggle with a set of challenges similar to those that led to the establishment of the LDC category in 1971 (UNCTAD, 2021a; UN-OHRLLS, 2021). Only 6 countries have graduated from LDC status over the last 50 years, though another seven are scheduled to graduate by 2026 (Angola, Bangladesh, Bhutan, Lao PDR, Nepal, São Tomé and Príncipe, Solomon Islands) (CDP datasheet, 2021).

The 46 LDCs collectively are responsible for just over 1% percent of global emissions from fossil fuels and industrial processes (UNCTAD, 2021b). While significant economic transformations will be needed in many countries to decarbonize what are now carbon-intensive economies, to reach 1.5°C-consistent pathways**, for LDCs, the challenge will be to develop sustainably along a low-carbon growth path, avoiding the installation and use of carbon-intensive infrastructure while planning for increased resilience against climate impacts across all sectors. From this perspective, the development of an LTS generates many opportunities and co-benefits.**

2.2 Challenges facing LDCs in LTS development

LDCs face challenges for both the preparation and implementation of long-term low emission development strategies. The most significant of these are:

- human capacity and resource constraints;
- a lack of robust data collection systems and datasets; and
- limited institutional capacities.

These elements impact emission projections, socio-economic projections, long-term priority setting, vision, policy coherence and ultimately implementation

LTS development requires a broad, cross-sectoral effort, requiring coordination between different ministries and the agencies under them. However, **LDCs often lack institutional frameworks that allow for coordination and allocation of responsibilities across different levels of government** and across government agencies, including for monitoring and reporting on progress made for transparency purposes. Dedicated government institutions with responsibility to spearhead work related to climate change in LDCs can be understaffed and in-country technical capacity can be limited.

A lack of robust and sustainable data collection systems and datasets can make emission projections and socio-economic projections difficult, creating challenges for informed LTS target setting.

As a result of limited human and financial resources, LDCs will require significant international support for both LTS development and implementation. However, and perversely, this financing can be hard to access for LDCs, due to their limited technical and institutional capacity. For example, it can be difficult for LDCs to fulfil the requirements and criteria of climate funds, such as quantification of the financial, technical and capacity-building support required for the development and implementation of long-term plans. The challenges LDCs face in this context were particularly evident in the first round of NDC submissions, in which few LDCs quantified the financial support they would need to meet their mitigation and adaptation targets. This data gap for quantified need was even more evident for adaptation. Because LTS requires longer-term planning than NDCs, these strategies will require extensive data and information, which LDCs may be hard-pressed to find. Section 5 below identifies the growing resources now being made available to support LDCs in LTS preparation and implementation.

2.3 LTS building blocks for LDCs

An LTS communicated under the Paris Agreement should aim to provide both a **vision and a pathway** to guide countries' transitions to a decarbonised, 1.5°C compatible economy, consistent with the achievement of net zero emissions by mid-century, and taking into account national circumstances (2050 Pathways Platform). This vision can help formulate a country's aspirations for the future, by identifying critical questions at the intersection of development and climate.

An LTS will ideally be **holistic in nature**: it will address all key sectors of the economy and be supported by sectoral pathways, with short-, medium-and long-term milestones. It will include strategies for achieving these pathways, even though it may not necessarily contain detailed policies and actions. Short- and medium-term sectoral targets and milestones will be helpful in supporting scaled investment planning. As a living document, an LTS can and should be **updated and refined over time** to reflect best available science, technology development, and evolving national and international circumstances, as well as to reflect progress toward milestones.

An LTS can play an important role in driving the alignment of NDCs and near-term actions with longer-term Paris Agreement goals. Each successive NDC, and the policies and measures used for its implementation, should be aligned with the LTS, and not be inconsistent with, or undermine, the long-term vision or goals of the Paris Agreement. To ensure continuity of an LTS through short-term political changes, the long-term target and sectoral targets set out in an LTS may be embedded in a country's legally-binding national frameworks, with mechanisms for monitoring, reporting, verifying and reviewing progress (e.g. UK's Climate Change Act 2008) (Government of the United Kingdom 2008).

Importantly, the longer-term perspective of an LTS allows for discussions that go beyond incremental technological substitutions and innovations (for example, solar panels for diesel generators, hydrogen) and enable thinking about larger-scale **transformational changes** (interconnected distribution and production of electricity). Early thinking about long-term stragies can reveal the potential drawbacks of technology choices that may appear promising in the short-term, but that can make achieving long-term goals more difficult. For example, a short-term focus can lead to stranded assets. A near-term effort to shift to lower-emitting fuels could lead to the build-up of natural gas import infrastructure at high cost and which would secure only marginal GHG emissions reductions gains, when with a longer-term perspective it is already evident that natural gas infrastructure will become a stranded asset in the medium to longer-term as the shift to renewable energy takes place.

The long-term planning horizon of an LTS provides an opportunity to consider interactions, synergies and trade-offs between different sectoral goals and national development priorities, to ensure that any transformational changes slated for implementation will promote sustainable development. Coordination among ministries, agencies and departments will be needed to support policy harmonisation and consider interactions, synergies and opportunities. A fully participatory, cross-sectoral process that engages a broad range of stakeholders at different levels will assist in considering the most prudent pathways forward for each sector, creating greater understanding between governments and impacted stakeholders and fostering the political buy-in needed for implementation.

Table 2 highlights **key building blocks for the process of developing a robust LTS for LDCs**. (Note also that WRI/UNDP has developed a quality assurance check-list with guiding questions to be considered in the context of LTS preparation (WRI/UNDP, 2021).

Table 2. Key LTS building blocks for LDCs

(adapted from Schaeffer et al. 2019)

Secure mandate for LTS development process

- Identify responsible ministries
- Design cross-sectoral participatory process: engage government departments across sectors and levels and enhance institutional strength; engage all public and private actors/stakeholders, including donors, to enable societal transformation and strengthen all contributions
- Agree timeframe for process
- Agree overarching long-term vision (e.g., LDC Group Vision)

Identify key economic sectors and sectoral transformations needed

- Address all key sectors, beginning with largest-emitting sectors (e.g., e-nergy, agriculture, land, transport, industrial processes, waste)
- Consider both supply side and demand side transformation scenarios
- Identify gaps in knowledge and data

Develop strategies for sectoral transformations across key sectors and benchmarks for necessary progress

- Develop strategies and policies for reducing and avoiding future emissions, e.g.,
  - Alternative renewable energy portfolios and their co-benefits, trade-offs and impacts on sustainable development goals and national priorities e.g., on energy independence, cost savings, access to clean and affordable energy, climate impacts, avoiding stranded assets, while planning for the future
  - Land sector management options, emission removal potential, and trade-offs and co-benefits (e.g., sustainable development goals, impacts on food security, biodiversity, human settlements)
  - Climate smart agriculture options – decreasing emissions while enhancing food production and food security
  - Urban infrastructure, transport infrastructure and other opportunities for low-emission development and end use electrification
- Define short- and midterm benchmarks consistent with the scale and pace of the required transformation across all sectors, with the SR1.5^{o}C helping to guide priorities and coupling between sectors, to reduce costs and avoid locking in carbon-intensive infrastructure and practices

Address and enhance synergies with adaptation and with other objectives and goals

- Build climate-resiliency into investment decision-making (e.g., siting of RE infrastructure, climate-smart agriculture, land use planning)
- Consider the impact of mitigation options and policies on sustainable development goals (such as food security, public health, energy security, access to clean energy, alleviation of poverty, impacts on biodiversity etc.)

Consider domestic economic opportunities arising from the move to global net zero emissions

- Potential resource-based supply opportunities, e.g. mining opportunities (cobalt, lithium, nickel and copper used for electric vehicles, solar PV cells, wind turbines and electrical grids); biomass export in connection with bioenergy and carbon capture and storage (BECCS); in view of opportunities, impacts and trade-offs

- Potential renewable energy export opportunities (e.g., West African Power Pool (WAPP); East African Power Pool (EAPP) and end use electrification opportunities
- Potential for hosting various biological and technological carbon dioxide removal (CDR) options (e.g., afforestation, reforestation, bioenergy and carbon capture and storage (BECCS), soil carbon management, enhanced weathering, etc.) in view of opportunities, impacts and trade-offs in national context
- Potential role of markets / cooperative approaches in delivering net zero emissions, (e.g., whether Article 6 and the voluntary carbon market can support national low-emission development goals)
- Potential new employment opportunities and skills enhancement
- Economic diversification for fossil-fuel producing economies, and cost savings from a reduction in fuel imports

Consider regional opportunities consistent with Paris Agreement goals, domestic and regional development interests

- Consider potential cross-boundary efficiencies and long-term demand scenarios and seasonal variability in infrastructure investment planning, to support win-win investments and outcomes (e.g., in connection with Grand Ethiopian Renaissance Dam (GERD), WAPP, EAPP and the extension and establishment of reliable RE portfolios)

Robust and inclusive policies to support systemic transformations

- Develop policies in line with robust strategies with multiple benefits:
  - Consider opportunities and challenges in each sector
  - Reduce demand and improve efficiency across all sectors, while addressing the need for access to modern services
  - Accelerate the uptake of renewable energy and storage technologies
  - Electrification of end-use sectors – transport, building, industry
- Implement well-established robust policies (including removing fossil fuel subsidies and implementing effective carbon pricing)
- Mobilise resources and capacities to ensure timely shifting of investments at scale
- Consider need for supporting legislation to secure continuity
- Develop and implement policy packages to address trade-offs and equity and distributional impacts

Monitoring and evaluation processes

- Engage scientific institutions, to strengthen learning from and improvement of LTS policy processes
- Inform and implement a ratcheting up process as provided by the Paris Agreement

Implementation Plan

- Identify financial, technological and other forms of support needed for implementation, to support the mobilisation of resources
- Consider reallocation of existing finance and impacts of fiscal policy levers (e.g., taxes, subsidies)
- Consider financial plan for implementation
- Identify implementation partners and potential partners

2.4 LDC progress with LTS submissions

The LDC Group launched its LDC Group Vision toward a climate-resilient future at the UN Secretary General's Climate Action Summit in 2019. This vision calls for all LDCs "*to be on climate-resilient pathways by 2030 and to deliver net zero emissions by 2050*."

As of June 1, 2022, three LDCs (Benin, Cambodia and Nepal) had formally communicated an LTS to the UNFCCC Secretariat. The Gambia has adopted its own 2050 Climate Vision document while it finalises its LTS (Government of the Gambia, 2021). See Box 1 below, setting out the LDC Group Vision and Boxes 2-5, setting out the framing visions for referenced LDC LTSs. Other LDCs are in the process of developing their long-term strategies for submission.

Box. 1. LDC Group on climate change long-term initiatives

At the UN Secretary General's Climate Action Summit in September 2019, the LDC Group launched its LDC Group Vision towards a climate-resilient future, which is for all LDCs to be on climate-resilient development pathways by 2030 and to deliver net zero emissions by 2050, to ensure that their societies and ecosystems thrive. This vision draws on the resources and work of three initiatives: (LDC Group, 2022)

1. **LDC Initiative for Effective Adaptation and Resilience (LIFE-AR)** - an LDC-led, LDC-owned initiative which aims to inform the development of adaptation plans; identify immediate priorities that will further build national institutions, domestic systems, and capabilities; and further define National Adaptation Plans (NAPs), NDCs and wider national efforts to build resilience and address poverty. (LDC Group, 2022). The LIFE-AR has delivered a robust review of evidence on effective adaptation and resilience interventions which has helped inform the LDC Group 2050 Vision. (LDC Group, 2022)

2. **LDC Renewable Energy and Energy Efficiency Initiative for Sustainable Development (LDC REEEI)** - outlines a vision of energy for people-centred development and aims to capitalise on the availability of affordable and sustainable renewable energy solutions and promote models of sharing energy that empower communities to take charge of their own futures. The focus of the LDC REEEI is to help countries develop the most ambitious and comprehensive long-term plans and transformative policy packages for people-centred renewable energy deployment across 8 work areas. (LDC REEEI, 2022)

3. **Least Developed Countries Universities Consortium on Climate Change (LUCCC)** - a South-South consortium of 10 Universities from across LDCs to enhance knowledge on climate change through climate capacity building, with a focus on adaptation measures, such as education and research. The LUCCC will develop common research projects and implement teaching and training programs in different climate change aspects across all LDCs, in a two-way collaborative capacity building program in which countries offer help to others and seek support from others to build capacity within LDCs. (LDC Group, 2022)

Box 2. Benin's LTS

Vision: Benin is, by 2025, a country whose development is resilient to climate change and low carbon.

Pillars of the 2025 vision

- **Pillar 1: Strengthening the resilience of local communities and agricultural production systems.** Five (5) sub-programs will be implemented under this pillar.
- **Pillar 2: Reduction of anthropogenic GHG emissions and enhancement of the carbon sequestration potential.** This pillar includes three (3) sub-programs.
  Pillar 3: Climate risk reduction. Four (4) sub-programs will be implemented.

  Source: MCVDD (2016, pp. 53-58)

Box 3. Nepal's LTS

Vision: Nepal aspires to minimise emissions and sustainably achieve net zero emissions by the year 2045.

Key elements of the 2045 vision

- Increase the use of clean/renewable power in all sectors, including fuel switching to clean and modern energy in all economic sectors.
- Improve energy efficiency and maximise benefits by utilising clean energy efficiently in the residential, industrial, and transportation sectors.
- Adopt clean, secure, and connected mobility. This includes decarbonising the transportation sector through the use of alternative modes of transportation, shifting to electric mass transportation, and increasing the use of clean fuels.
- Increase carbon sinks by managing forests and natural resources in a sustainable manner.
- Encourage sustainable agriculture and land use management to maximise co-benefits.
- Expand the circular economy to improve industrial sustainability, promote industrial sector modernisation through installations, and invest in new carbon-neutral and circular-economy compatible technologies and systems.
- Maximise the benefits of the mitigation of clean energy trade.
- Enhance international cooperation and support (technical and financial) for climate actions.

Source: Government of Nepal (2021, p. 8)

Box 4. Cambodia's Long-Term Strategy for Carbon Neutrality

Vision: The LTS4CN outlines a vision of a carbon neutral economy and provides long-term policy direction on how to reduce emissions in the next few decades. The overall goal of the strategy is to describe a pathway towards a country-wide carbon neutral economy by 2050.

- Cambodia's vision for carbon neutrality is largely founded on the continued implementation of existing commitments in the FOLU sector. Execution of the REDD+ Investment Plan2 will drive reduced rates of deforestation as well as an expansion of afforestation and reforestation activities. The FOLU sector is expected to provide a significant carbon sink leaving room for other sectors to incrementally transition towards carbon neutrality.
- Policies are set out in Agriculture, Forestry and Other Land Uses, Energy, Transportation, Industrial Process and Product Use, and Waste.

Box 5. The Gambia 2050 Climate Vision

Vision: By 2050, The Gambia aspires to be a climate-resilient, middle-income country through green economic growth supporting sustainable, low emissions development, contributing its fair share to global efforts to address climate change.

Strategic priorities:
Policy commitments and actions prioritised into four strategic and integrated focus areas:
- Climate-resilient food and landscapes: Agriculture, food security, forestry and natural resources (including water, biodiversity and wildlife).
- Low emissions and resilient economy: Energy, transport, infrastructure and the key economic sectors of tourism and financial services.
- Climate-resilient people: Health, education, equitable social development and human settlements.
- Managing our coasts in a changing environment: Climate-aware Integrated Coastal Zone Management.

3. Long-term strategies for decarbonisation in key sectors in LDCs

An LTS should address all key sectors of a country's economy. For the majority of LDCs, the agricultural and land sectors represent the largest contributions to emissions. The energy sector is also significant for some, and will grow considerably with economic development in LDCs. See Figure 1 (sectoral shares of emissions) and Figure 2 (sectoral shares of non-LULUCF emissions) below. As the one sector's share of emissions decreases, other sectors will take on a greater proportion of total emissions. As a result, an LTS needs to consider decarbonisation options for all sectors, including those that currently have a relatively lower share of emissions.

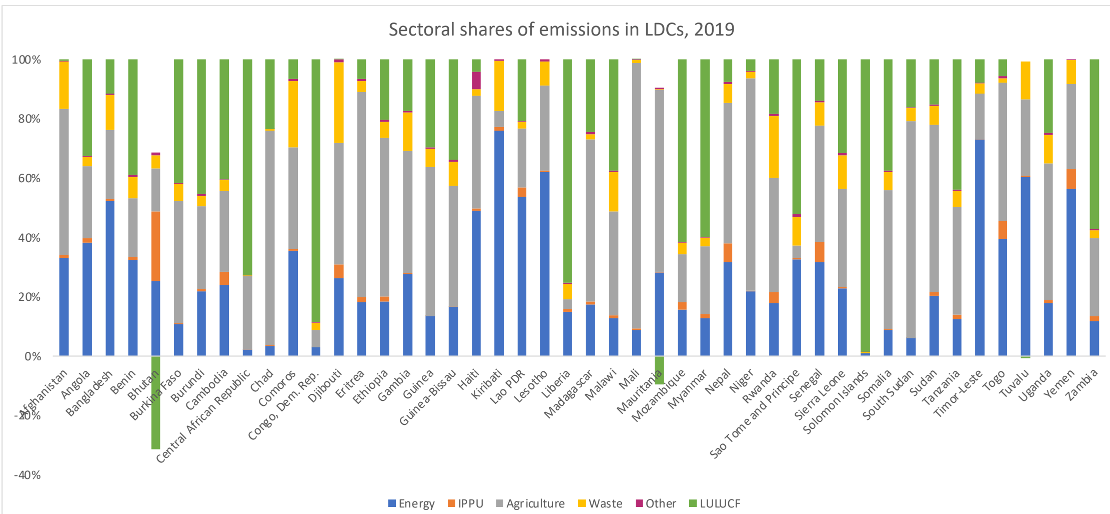


Figure 1 Sectoral shares of total GHG emissions in LDCs, 2019 (MtCO2e in AR4 GWP). (Gütschow, J.; Günther, A.; Jeffery, L.; Gieseke, R., 2021) used for all sectors (FAOSTAT, 2022).

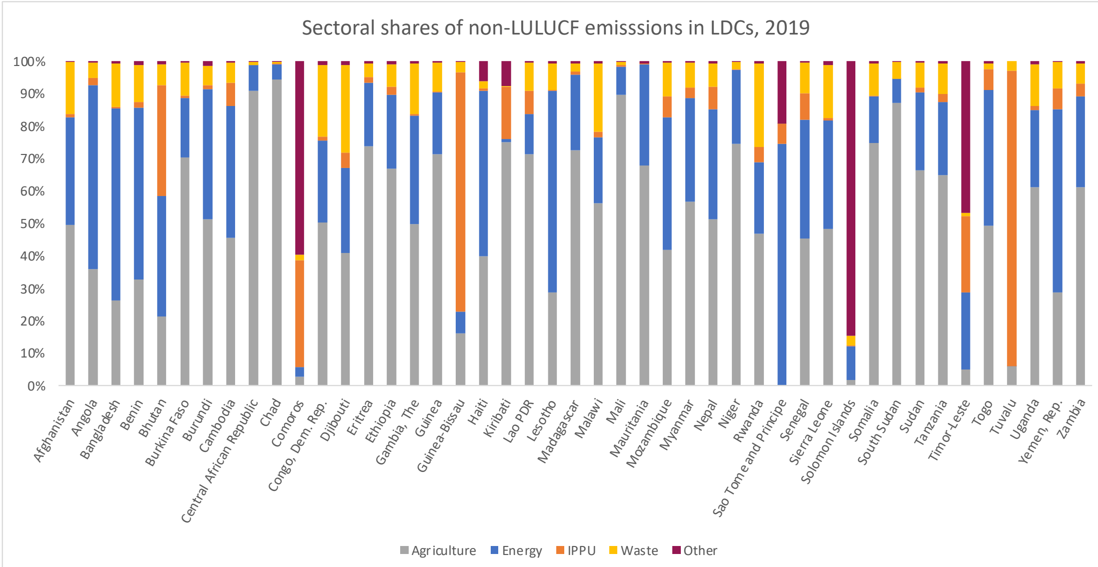


Figure 2 Sectoral shares of non-LULUCF GHG emissions in LDCs, 2019 (MtCO2e in AR4 GWP). Source: (Gütschow, J.; Günther, A.; Jeffery, L.; Gieseke, R., 2021) used for non-LULUCF sectors (FAOSTAT, 2022).

A crucial feature of long-term strategies is that they should allow for interactions between sectors to be considered so that a comprehensive and integrated decarbonisation strategy can be put into place.

In addition, there is now universal recognition that climate change impacts are already occurring and that adaptation measures will be increasingly necessary, in particular in countries that are highly vulnerable to the impacts of climate change (UNFCCC, 2022). For this reason, **LDC long term strategies should consider energy system resilience, ecosystem resilience and food security, and take advantage of potential synergies between low GHG emissions planning and adaptation needs wherever possible**. LDCs can benefit by realising synergies between LTSs and other sustainable development and resilience goals, and between LTS and NDCs and NAPs.

3.1 Energy sector low-emission strategies

The energy sector is a priority sector for emissions reductions in the short term because it offers the greatest opportunity for rapid reductions, cost savings and developmental co-benefits. It is also likely to require the greatest lead time for transformation.

Biofuels and waste dominate the primary energy supply of the majority of the LDCs (Figure 3). Nearly all LDCs are highly dependent on imported fossil fuels, with energy imports constituting 33% of total energy use (World Bank, 2022a).

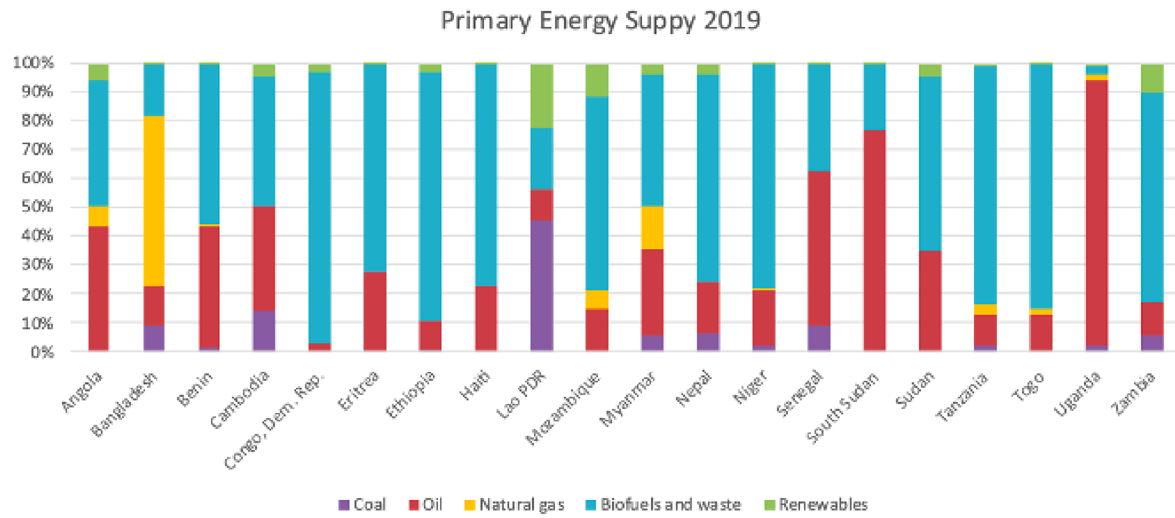


Figure 3 Share of energy sources in primary energy mix as a percentage of total energy supply, 2019 (IEA, 2022a)

Electricity generation in LDCs is dominated by fossil fuels, particularly oil and natural gas, though some LDCs generate a significant share of electricity from hydro capacity (Angola, Democratic Republic of Congo, Ethiopia, Mozambique, Nepal, Zambia). See Figure 4, showing the electricity generation mix in a selection of LDCs in 2019.

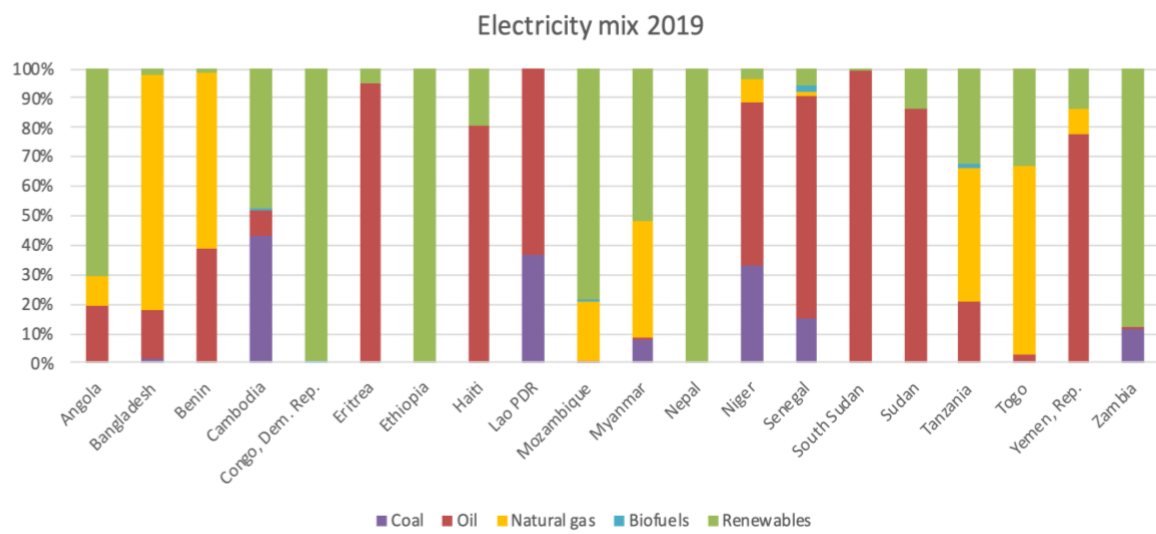


Figure 4 Electricity generation shares in selected LDCs in 2019 (IEA, 2022a)

The share of electricity generated from solar and wind is very low in almost all LDCs. Solar energy currently plays almost a negligible role in electricity generation, though most LDCs are in lower latitudes with abundant sunshine. **The African continent has some of the world's greatest potential for solar energy generation** (IRENA, 2022). **Wind potential is also underexploited in North Africa and the Sahel** (IRENA, 2022).

The past decade has seen a sharp decrease in costs of renewable energy sources, especially solar PV and wind energy. The levelised cost of electricity from utility-scale solar PV dropped 82% between 2010 and 2019, while the cost of onshore wind fell by 40 per cent (IRENA, 2020a). As seen in Figure 5, **the costs of most renewable energy technologies are competitive with fossil fuel costs on a global level, making the advantages of renewables clear in most LDCs given the negative externalities associated with fossil fuels.** The cost of utility scale battery storage has also dropped by two-thirds from 2015 to 2019, enabling dispensable electricity at a price that is now clearly competitive with fossil fuels, even in Africa where there can be higher capital costs and logistics costs (IRENA, 2020a). In some LDCs in Sub-Saharan Africa, the levelised cost of electricity is lower than the global average - see Figure 6.

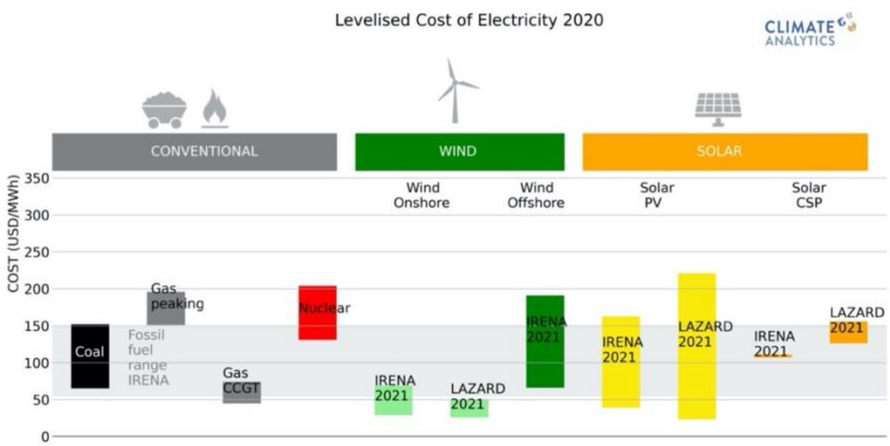


Figure 5 Global levelised cost of electricity of different generation technologies in 2020. Source: Own elaboration based on Lazard analysis (Lazard, 2021) and IRENA (IRENA, 2021b)

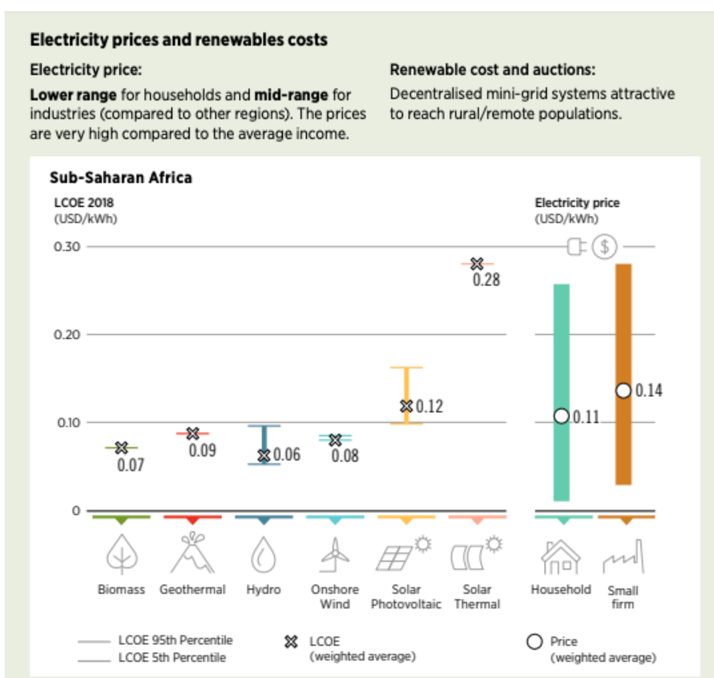


Figure 6 Sub-Saharan levelised cost of electricity in 2018 (IRENA, 2020b)

The lowered cost of decentralised renewable energy systems can be an important lever to extend electricity to populations that have been without access and in locations where extensions of a centralised grid are cost prohibitive. Thirty-two LDCs have now signed and ratified the **International Solar Alliance (ISA)** framework (ISA, 2019), which provides a platform for increased deployment of solar energy technologies as a means for bringing energy access, ensuring energy security, and driving energy transition in its member countries. (ISA, 2022).

The ISA strives to develop and deploy cost-effective and transformational energy solutions powered by the sun to help member countries develop low-carbon growth trajectories, with a particular focus on LDCs and SIDS. To foster mutual collaboration, the West African Power Pool (WAPP) Secretariat and the International Solar Alliance signed a Memorandum of Understanding in March 2022 (WAPP, 2022).

3.2 Land sector

The land sector represents a large source of emissions for many LDCs. As shown in Figure 7, for a third of LDC countries, combined emissions from agriculture and LULUCF account for more than 75% of total emissions.

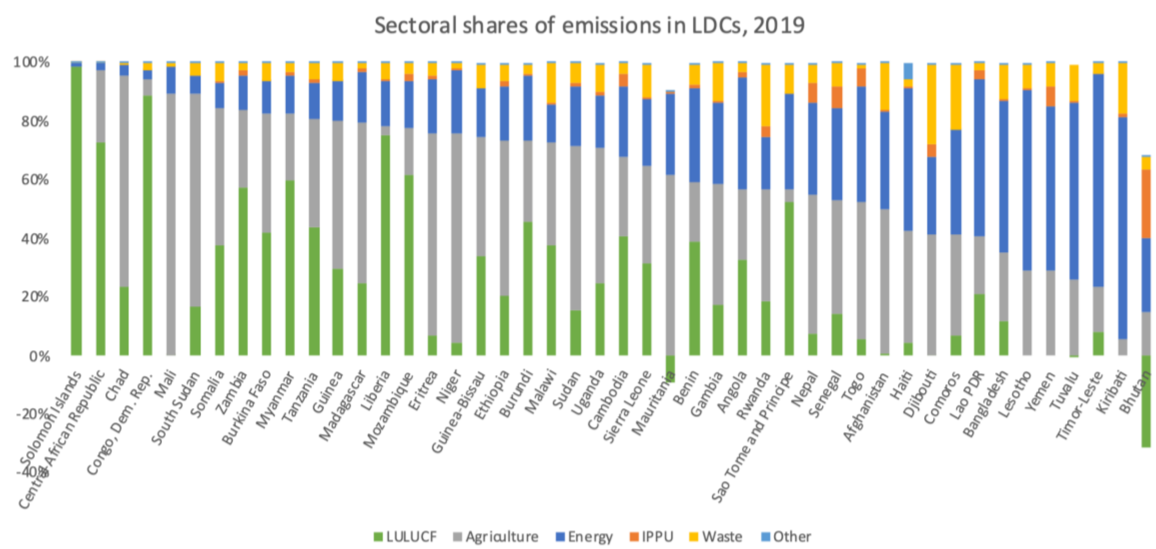


Figure 7 Agricultural and LULUCF sectoral emissions combined as a share of total GHG emissions in LDCs, 2019 (MtCO2e in AR4 GWP). (Gütschow, J.; Günther, A.; Jeffery, L.; Gieseke, R., 2021) used for non-LULUCF sectors. (FAOSTAT, 2022) for LULUCF.[1]

Mitigation options in the land sector include reduced conversion of forests and other ecosystems; ecosystem restoration, afforestation, reforestation; and improved sustainable forest management (IPCC 2022a, Figure SPM.7).

[1] Note that Figure 7 excludes LULUCF emissions from the following three countries: Lesotho, Kiribati, and Yemen. This is due to the lack of data available from the FAO on LULUCF emissions from these countries. While LULUCF emissions for these countries are available (for example in Biennial Update Reports submitted to the UNFCCC), for the purpose of this analysis we only considered countries with data available from both the FAO and PRIMAP. Note that Figure 7 above does show the non-LULUCF emissions for these three countries. Note also that this figure reflects negative emissions for Mauritania and Bhutan.

Most assessed global mitigation pathways rely heavily on the land sector to serve as a sink through afforestation and reforestation, and to provide a high amount of biomass for bioenergy with CCS (BECCS) to achieve negative emissions. When these mitigation options are considered at scale, as they will need to be globally to meet climate goals, many trade-offs will need to be considered. For example, ecosystem restoration and reforestation sequester carbon, and can enhance biodiversity and provide additional biomass, but can also displace food production and livelihoods (IPCCa, 2022, D.1.6). Setting aside land for afforestation has opportunity costs, if this land could be used for other economic or development purposes. Enhancing biomass supply for bioenergy can pose a threat to biodiversity. At the same time, protecting biodiversity and ecosystems can also limit biomass potential for bioenergy, which impacts climate goals. As a result of these kinds of interactions, integrated approaches to land use planning are needed to meet multiple objectives including food security (IPCCa, 2022, D.1.6).

Results will also be context-specific, which necessitates detailed planning. For example, BECCS deployment requires biomass to be harvested and combusted, with the resulting CO_2 captured and stored underground. To reduce emissions or achieve negative emissions, the harvested biomass must be replanted so that it is fully replaced in an ongoing cycle. But if the expansion of land use for biomass production displaces a more productive carbon sink, or if increased extraction leads to reduction of the carbon sink, or if the land generating biomass is not replanted, then the demand for biomass can lead to an increase in CO_2 emissions (see IPCCb, Ch. 7).

Maximising synergies and managing trade-offs depend among other things on the specific location and practices involved, the scale of implementation, governance tools in place, capacity building, integration with existing land uses, and the involvement of a wide range of stakeholders, including local communities and Indigenous Peoples (see IPCC 2022a, D.1.4).

An LTS provides the opportunity to engage a wide grouping of stakeholders in weighing and managing trade-offs between competing priorities, and in identifying and exploiting synergies, to obtain buy-in where choices are sensitive.

3.3 Agriculture

For many LDCs, the agricultural sector is a key and growing contributor to emissions (Figure 8). In 2019 total emissions from agricultural activities across all LDCs were around 1 GtCO2e (Gütschow, J.; Günther, A.; Jeffery, L.; Gieseke, R., 2021).

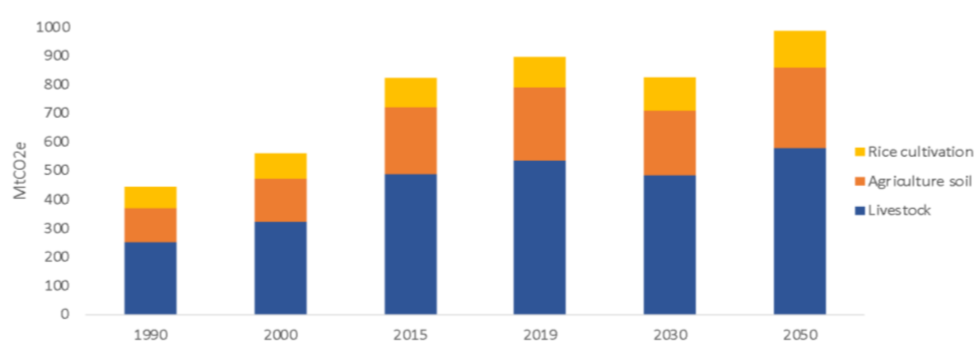


Figure 8 Historical and projected emissions from agriculture sector in LDCs. Source: (FAOSTAT, 2022)

On average, the agricultural sector employs around 50% of the total working population for all LDCs (World Bank, 2022a) (Figure 9). The aggregate share of agricultural value added, as a percentage of total GDP, ranged up to 58% with an average share of 22% in 2019 (Figure 9).

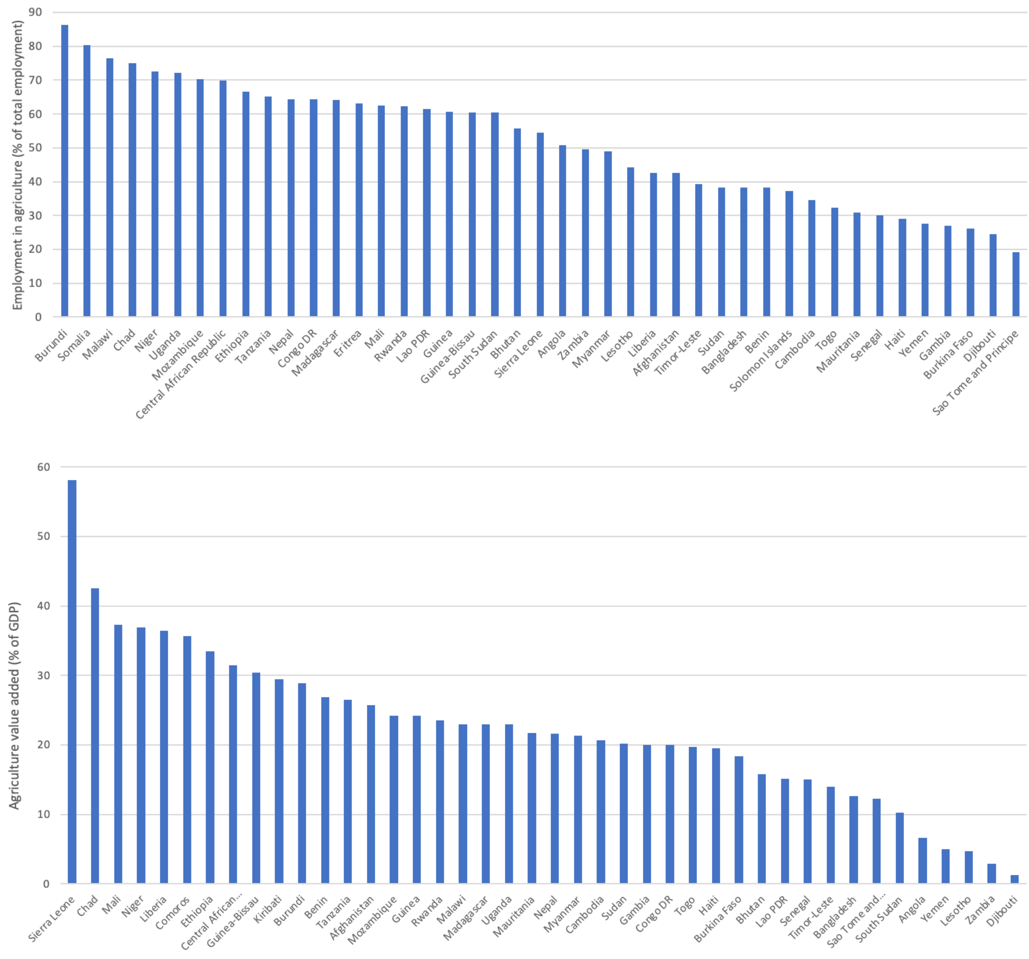


Figure 9 Employment in agriculture as percent of total employment and agricultural value-added as a share of GDP in the selected LDCs in 2019. Source: (World Bank, 2022a)

In LDC countries in eastern and central Africa, including Ethiopia, Chad, Niger, Mali, Uganda and Somalia, **where dependency on livestock significantly contributes to agricultural emissions, enteric fermentation and manure left on pastures are two main sources of emissions**. Methane is the main emitted gas (Figure 10).

In Asian LDCs, such as Bangladesh, Myanmar, and Cambodia, rice is one of the main crops and **emissions of methane from water use during paddy cultivation and nitrous oxide from use of synthetic fertiliser contribute significantly to emissions from agricultural practices**. For example, in Bangladesh in 2019, rice cultivation accounted for 33% of agricultural emissions (24.8 $MtCO_2e$), with emissions from digestive processes in animals (33%), livestock manure (19%) and use of synthetic fertiliser (11%) (Climate Transparency Report, 2020).

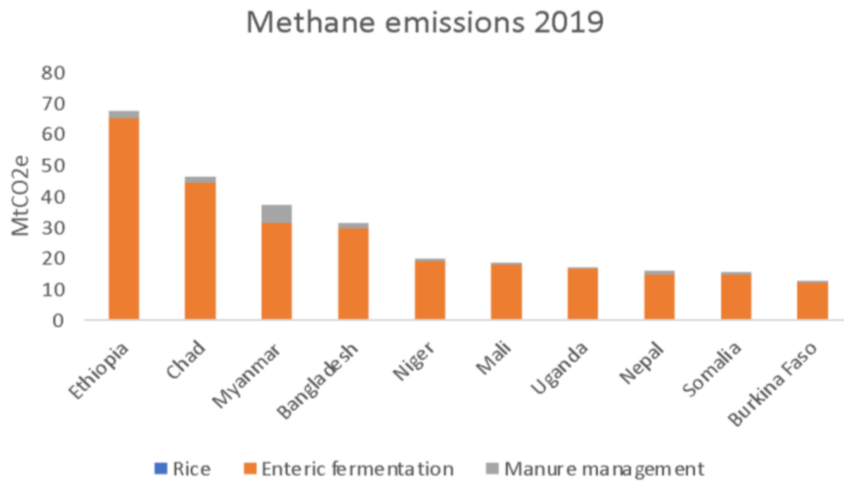


Figure 10 Methane emissions from various sources in 2019 in selected LDCs. Source: (FAOSTAT, 2022), Methane emissions by source

Mitigation options in the agricultural sector include the reduction of methane emissions through fertiliser management and water management and mitigation of nitrous oxide emissions from agricultural soils through organic farming practices. For example, Cambodia plans to decrease emissions in crop cultivation by using less methane-intensive rice cultivars, direct seeding practices, alternate wetting and drying practices, and organic fertiliser and deep fertiliser technology (Kingdom of Cambodia, 2021).

In **livestock management, options for reducing methane emissions include decreasing the number of ruminant animals, improving manure handling, dietary composition and livestock feed additives** (Ouatahar et al., 2021). LDC countries may need to give consideration to any food security implications in this context.

Opportunities for securing negative emissions in the agricultural sector, or opportunities for offsetting emissions, include soil carbon sequestration and biochar, which can improve soil quality and food production capacity (IPCC 2022a, D.1.6). Agroforestry, soil carbon management, and options that reduce CH4 and N2O emissions in agriculture from livestock and soil can have multiple synergies with the SDGs, including enhancing sustainable agricultural productivity and resilience, and food security (IPCC 2022a, D.1.6).

Climate-smart agriculture

Efforts to mitigate emissions in the agricultural sector need to reflect the pressing concern of food security, while also building in consideration of the projected impacts of climate change.

"With nearly 690 million people around the world facing hunger today (FAO et al., 2020), agri-food systems emitting one third of global anthropogenic GHG emissions (Crippa et al., 2021) and a growing public demand for climate action, it is pressing to achieve food security while adapting to - and mitigating - climate change."
FAO, 2021

The concept of Climate-smart agriculture (CSA) aims to support the transformation of agri-food systems to sustainably increase agricultural productivity and incomes, while supporting climate adaptation, resilience and emissions reduction outcomes (FAO, 2019). CSA has three pillars:

- sustainably increasing agricultural productivity and incomes,
- adapting and building resilience of people and agri-food systems to climate change, and
- reducing and/or removing greenhouse gas emissions where possible.

Five actions points have evolved for CSA implementation: 1) expanding the evidence base for CSA, 2) supporting enabling policy frameworks, 3) strengthening national and local institutions, 4) enhancing funding and financing options, and 5) implementing CSA practices at field level. The FAO has produced a set of case studies that are instructive in considering the practical application of CSA approaches. A selection of successful CSA approaches from different LDC regions is presented in Box 6 below, drawn from the 2021 FAO Report.

Both Nepal and Benin have adopted CSA as a central pillar of their LTSs. For Nepal see all actions planned under Agriculture, Forestry, and Other Land Use (AFOLU); for Benin (Pillar 1: Strengthening the resilience of local communities and agricultural production systems). Gambia's LTS 2050 vision has as a focus area climate-resilient food and landscapes.

The development of an LTS allows for long-term planning to incorporate mitigation options in the agriculture sector that also support resilience, e.g., CSA practices such as establishing agroforestry systems, planting climate-resilient crops, developing reserve capacity to build resilience to climate disruption and other initiatives that aim to increase the availability, affordability, and accessibility of locally grown food for food security.

LTS also offer opportunities to consider how best to strengthen value-chains and market linkages that will support climate resilience in the event of disruption, e.g., by developing new markets for local agricultural products; enhancing food storage and preservation; increasing consumption of local food; and planting climate resilience crops.

Box 6: Climate-smart agriculture – LDC case studies (drawn from *Climate-smart agriculture case studies 2021 – Projects from around the world* (FAO, 2021)

Lao People's Democratic Republic

Between 2016 and 2017 in a joint effort by the Laotian Government, smallholder farmers and FAO, 18 Farmer Field Schools were organised under the project Regional Rice Initiative. In the Farmer Field Schools, smallholder farmers explored and field-tested labor-saving practices and technologies, including a drum seeder. The result shows that, farmers who use a drum seeder can plant rice faster, which enables them to better cope with erratic weather. Furthermore, the drum seeder is suitable for agro-ecological approaches such as alternate wetting and drying and rice-fish systems that helps to mitigate climate change by reducing the amount of water needed to produce rice and limiting GHG emissions. Rice diversification methods, such as rice-fish systems, also increase the resilience of smallholder farmers against climate change (SDG13).

Mali

In 2019, the government of Mali adopted the Climate-Smart Agriculture Investment Plan (CSAIP) which aims to invest in agriculture based on four components of CSA. Mali's CSAIP enabled its authors to prioritise investments and identify potential barriers and opportunities related to those investments. The plan targets an investment of USD 300 to 500 million in four investments at the national level, six commodity-specific investments and two restoration projects. It is estimated that 1.8 million Malians will benefit from these investments. Focusing on promoting resilience for some commodities and growth for others, the Mali's CSAIP will reduce poverty (SGD1) and hunger (SDG 2) by increasing farm productivity and mitigating climate-related risks and contribute to decent work and economic growth (SDG 8). It will also ensure the sustainable use of terrestrial ecosystems (SDG 15) and targets women producers (SDG 5) and youth (SDG 10) as beneficiaries.

Senegal

Between November 2015 and December 2021, FAO used community-based learning-by-doing approach to identify a need to better integrate indigenous knowledge and perceptions of climate change into the learning process. Funding by the Global Environment Facility, the project cost USD 6,228,995 and directly benefit to 25,000 members of farmer organisations in Senegal. By building the evidence base for CSA and providing crucial information on local priorities and challenges, communities' needs and the ecosystem values, the project contributes to the SDGs' overarching goal of "leaving no one behind".

Somalia

In 2019, the Somali Disaster Resilience Institute conducted a study to build the evidence base for CSA. This study funded by International Fund for Agricultural Development (IFAD) identified over 80 CSA practices and provides short descriptions of over 60 practices. By doing so, the findings of this study are relevant for achieving SDG 1 (No poverty) and SDG 2 (Zero hunger). The implementation of the recommendations of the study will also help to achieve SDG 13 (Climate action) and SDG 5 (Gender equality).

Source: (FAO, 2021, pp. 8-10 (Mali), 14-19 (Senegal, Somalia) & 64-66 (Lao PDR)

4. Co-benefits for LDCs from LTS development

A number of benefits and opportunities arise from the process of developing an LTS. Some of these are set out below.

4.1. Policy coherence and short and medium-term planning efficiencies

The process of developing an LTS can help Parties realise efficiencies in their short and medium-term planning. For example, the Paris Agreement establishes a five-year cycle for the communication of successively more ambitious NDCs by each Party. Each country's NDC is to reflect highest possible ambition, reflecting its common but differentiated responsibilities and respective capacities, in the light of different national circumstances (see Paris Agreement, Article 4.3). The existence of an LTS can help countries respond to this five-yearly requirement; once long-term pathways have been identified, each successive NDC can rely on strategies, modelling, projections and milestones that have already been established.

An LTS can also assist in avoiding a misallocation of resources that can happen if only shorter-term planning horizons are used. For example, take an illustrative scenario of a small island LDC country that aims to reach a 100% renewable energy (RE) share by 2050. To reach this 100% RE target, the country will need to have implemented by 2030 a share of dispatchable renewables that would not have been necessary in a scenario that aimed only to reach a 50% to 60% share of renewable energy by 2050. This becomes clear with longer-term modelling, which shows that if this country does not implement incentives and policy measures sufficient to enable the early deployment of dispatchable renewables, it might lock itself into a position in which the deployment of variable renewables is no longer possible without endangering the stability of the distribution network. A delay in the deployment of dispatchable renewables would impede the country's ability to move to 100% RE, and create a risk of saddling the country with high-emitting stranded assets that cannot be safely replaced. Forward planning can avoid this situation, by informing shorter- and mid-term planning that can support the achievement of the 100% RE goal.

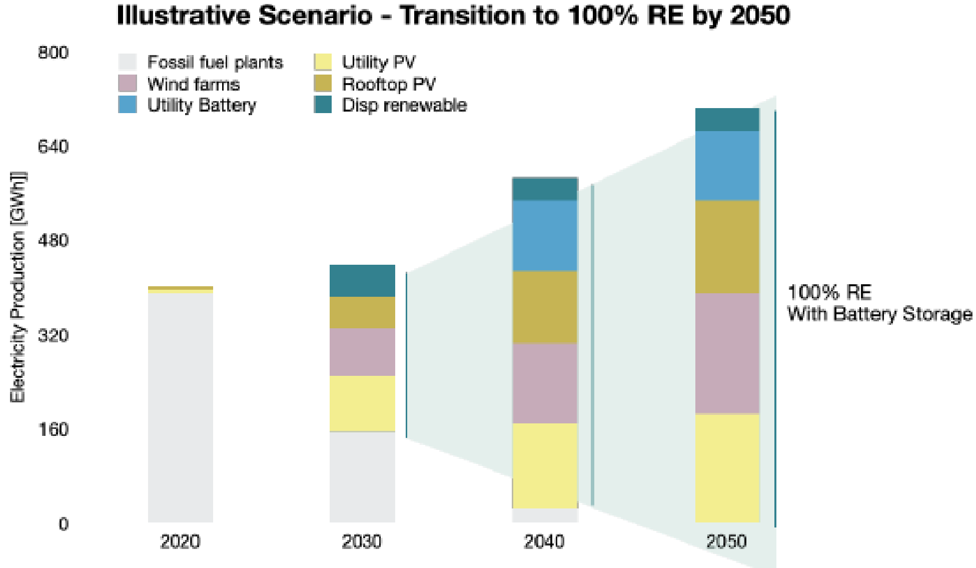


Figure 11 Illustrative scenario based on a fossil fuel phase out in 2050. The model assumes that the transport sector is electrified over time, leading to higher demand for electricity, but a phase out in gasoline and diesel fuel for transportation as well as in the power sector.

Integrating domestic processes for the development of NDCs and LTSs can reduce costs and increase efficiencies in planning processes. As mentioned above, duplication of efforts can be reduced by modelling a country's long-term vision and pathway to 2050, and then setting interim targets for the successive NDCs to 2050 that are derived from this pathway. This can avoid modelling emissions and energy systems to 2025 or 2030, and then undertaking the same exercise again every five years thereafter for successive NDCs. This also addresses the need for consistency between NDCs and long-term strategies, reducing the burden on ministries, government agencies rand personnel responsible for engaging in both processes. Ideally, an LTS should be developed before or jointly with the communication of an updated or new NDC (WRI, 2019 at p.5) to support consistency. The Republic of the Marshall Islands followed this path by releasing both its LTS and its second NDC in 2018, with the latter informed by the former.

Stakeholder consultations that consider the LTS and NDC in tandem can also increase efficiency, while providing stakeholders with a better understanding of the context in which NDCs are being developed and the role each successive NDC will play in the delivery of the LTS. The five-yearly NDC revision cycles are likely to be more efficient if stakeholders are already on board with the country's long-term vision and ambition, reflected in the LTS.

4.2. Avoiding stranded assets caused by short-term planning

The need to decarbonise economies rapidly creates a risk of stranded assets – investments that lose economic value before the anticipated end of their life. In the energy sector, examples of possible stranded assets include fossil fuel power generation infrastructure, given that policies to reduce emissions to achieve Paris Agreement goals will require the phasing out of fossil fuel use. Further examples are internal combustion engine vehicles and their associated infrastructure (e.g. refuelling stations), as achieving Paris Agreement goals will require the electrification of light and heavy-duty vehicles over time.

Long-term planning can reduce the risk of stranded assets, by identifying which types of investments should be avoided in the near-term, because they will have no role in a future system. Natural gas for example is often incorrectly considered as a "bridge" toward decarbonisation. GHG emissions from natural gas are significant, both during combustion for power generation and also along the production and supply chain. Accordingly, any future investment in natural gas infrastructure is likely to become a stranded asset.

An LTS can also help avoid stranded assets by considering different pathways to achieving the same long-term emission reduction goal and the implications of those choices for the lifetime of near-term investments. Bangladesh, for example, is currently considering expanding fossil gas generation to replace coal or to provide greater access to energy to its population. Climate Analytics' 1.5 °C National Pathway Explorer uses IPCC 1.5°C compatible pathways in combination with more recent lines of scientific evidence to show how a selection of 64 countries across all regions and the development spectrum can align their decarbonisation trajectories with the Paris Agreement. Data from this tool indicates that 1.5°C pathways for Bangladesh achieve zero carbon power systems by 2050.[2] This indicates that any near-term investment in fossil fuel infrastructure will need to be closed early.

Figure 12 below sets out two alternative 1.5°C pathways for Bangladesh that contrast in their reliance on renewable energy (grey) and gas (blue). Scaling up renewable energy sooner and faster will result in a smaller quantum of stranded gas infrastructure, which, after installation, would need to be abandoned within two decades. The longer-term perspective of an LTS can inform these nearer term decisions to avoid stranded assets.

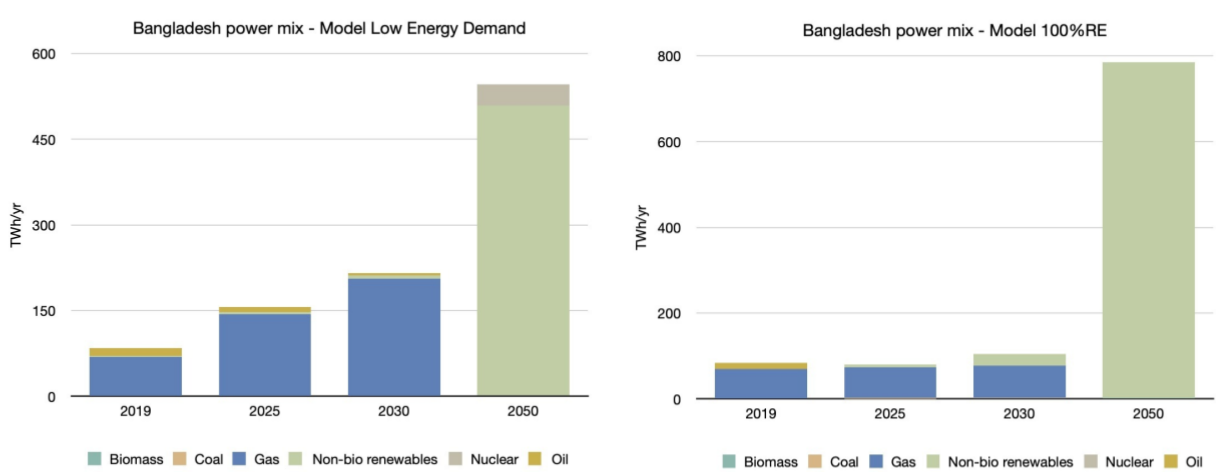


Figure 12 Bangladesh's power mix terawatt-hour per year. Source: (1.5C National Pathways Explorer)

[2] http://1p5ndc-pathways.climateanalytics.org/countries/bangladesh/sectors/. The Explorer contains data for four LDC countries: Bangladesh, Senegal, Ethiopia, Nepal.

4.3. Planning for climate-resilient infrastructure

The low-carbon long-term planning required to decarbonise an economy is intrinsically linked with resilience; **long-term planning enables climate impacts to be built in to all major investment decisions.** The LTS process offers opportunities to consider synergies between mitigation and adaptation needs and plan for climate-resiliency.

For example, in the energy sector the time horizons relevant for planning a power system transformation can range from 5 to 20 years or more (see Table 3), a timeframe over which further significant climate change impacts are to be expected, and which corresponds to the timeframe usually considered in long-term resilience strategies.

Power system transition planning phases	Typical time horizon for planning
Long-term generation expansion planning	20-40 years
Geospatial planning for transmission	5-20 years
Dispatch simulation	Weeks to several years
Technical network studies	Up to five years ahead

Table 3 Key phases in planning power system transition and their time horizons. Time horizons refer to the period of time over that is subject to techno-economic analysis during planning. Note that these time horizons do not consider the need for additional measures related to resilience in the face of natural disasters. Sources: (IRENA 2017; IRENA 2018).

A higher share of renewables can make a country's economy more resilient to variations in market prices for fuel imports, if there is access to up-front capital, as renewable-based electricity costs are mostly driven by capital costs, in contrast to the fuel costs associated with fossil fuel power generation.

Diversification of energy supplies offers opportunities for more climate-resilient services (Hallegatte, Rentschler, & Rozenberg, 2019). Extreme weather events and other events that impact energy infrastructure result in both direct monetary damages (for example, costs to firms and households from power outages) and indirect costs, such as reductions in productivity and health impacts. Planning for the use of power generation with differentiated vulnerabilities (for example, hydropower, which is vulnerable to drought, versus solar and wind, which are vulnerable to strong winds) makes it more likely that a system will be able to maintain a minimum level of service. (Hallegatte, Rentschler, & Rozenberg, 2019; Sterl et al., 2020; Sterl et al., 2021).

Decentralised supply can also support climate-resiliency. Distributed power systems using solar and batteries can make a grid more resilient; mini-grids and microgrids can provide useful backup generation in case of grid failure, because they do not rely on long-distance transmission wires. (Hallegatte, Rentschler & Rozenberg, 2019). Increasing energy efficiency and reducing or shifting demand can also make power systems more flexible and resilient.

The development of an LTS offers an opportunity to model and plan for a renewable energy portfolio that will be flexible, cost-effective and climate-resilient, and that will function in the context of an LDC's own particular conditions. This planning process can also consider regional vulnerabilities and opportunities. See Sterl et al., (2020) and Sterl et al. (2021), finding that there are strong climate-related, environmental and economic incentives to better streamline hydro, solar and wind power planning across both West African and East Africa – see Box 7.

There is a disproportionate impact on lower-income countries of disruptions to infrastructure of various types, yet the additional investment needed to make infrastructure more resilient is estimated to be relatively small for low- and middle-income countries, with a benefit-to-cost ratio significantly greater than one for undertaking resilience planning and investments. (Hallegatte, Rentschler, and Rozenberg 2019).

Box 7. Integration of Hydro/Wind/Solar – Eastern African power pool and West African power pool - portfolio approaches

<u>The West African Power Pool</u> (WAPP) covers 14 of the 15 countries of the ECOWAS (Benin, Côte d'Ivoire, Burkina Faso, Ghana, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo). 12 of these 15 countries are LDCs. The WAPP currently has 38 utility members.

The **<u>Eastern African Power Pool</u>** (EAPP) has 11 member countries - Burundi, Djibouti, Democratic Republic of Congo (DRC), Rwanda, Egypt, Ethiopia, Kenya, Sudan, Tanzania, Uganda, and Libya. Eight of these 11 are LDCs. There is a possibility that other countries such as Eritrea, South Sudan, and Somalia may join EAPP. The EAPP has 14 utility members.

To achieve the long-term objectives of the Paris Agreement, the electricity supply worldwide will have to decarbonise by mid-century. In this context, it is imperative that the shares of low-carbon resources in power systems increase. (Sterl et al. 2022).

In West Africa, hydropower now provides 20% of electricity, with the remainder mostly generated from natural gas and oil (Sterl et al., 2020). If renewable energy targets for 2030 are achieved, hydropower will remain the dominant renewable resource in most countries, providing 69% of RE with solar PV at 21% and wind at 5% (Sterl et al., 2020). Sterl et al. (2020) find that **there are strong climate-related environmental and economic incentives to better streamline hydro, solar and wind power planning across West Africa.** A renewables-oriented power pool could be based on which resources are most strongly present nationally. Certain countries would be net exporters of hydropower, such as Ghana, and others of solar and wind, such as Senegal. Smart management of present and future hydropower plants in West Africa can support substantial grid integration of solar and wind power, limiting natural gas consumption while avoiding ecologically harmful hydropower overexploitation. Pooling regional resources and planning transmission grid expansion according to spatiotemporal hydro–solar–wind synergies are crucial for optimally exploiting West Africa's renewable potential. **By 2030, renewable electricity in such a regional power pool, with solar and wind contributing about 50%, could be at least 10% cheaper than electricity from natural gas**.

In **Eastern Africa**, the construction of the Grand Ethiopian Renaissance Dam (GERD) has raised concerns in Egypt and Sudan as a result of impacts on water availability (Basheer et al., 2021). With the construction of the GERD, Ethiopia's power sector is now entirely renewable (97% hydro, 3% wind), though its national CO_2 emissions are still increasing, driven by expansions in agriculture and LULUCF practices. Sterl et al. (2021) find that **an explicit integration of complementary hydro, solar and wind power strategies in GERD operation and Eastern Africa Power Pool expansion planning could mitigate multiple political and environmental challenges**, delivering benefits across Ethiopia, Egypt and Sudan, by: decarbonising power generation in the Eastern Africa Power Pool; allowing compliance with Sudan's environmental flow needs; optimising GERD's infrastructure use; harmonising the yearly refilling schedules of GERD and Egypt's High Aswan Dam; and supporting a strong diversification of Ethiopian power generation for domestic use and for Eastern Africa Power Pool exports.

A new spatio-temporal hydropower database of existing and future hydropower resources on the African continent is available to assist energy modellers in Africa consider these portfolio approaches. See Sterl et al., 2022. This can help move the region toward appropriate 100% renewable power systems.

Source: Sterl, et al. (2020, 2021, 2022); WAPP (2022); EAPP (2022)

4.4. Upskilling and expanding local employment opportunities in renewable energy technologies and extractive industries

The energy transition offers significant employment opportunities, with new technologies and infrastructure systems requiring new job skills and training. The skill sets needed for geothermal energy, wind energy, PV and solar water heaters are distributed across marketing and administrative personnel, engineers and those with higher degrees, experts and workers and technicians. According to IRENA's Renewable Energy and Jobs – Annual Review 2021, globally, renewable energy will employ 43 million people by 2050 under a 1.5°C Scenario (IRENA, 2021a).

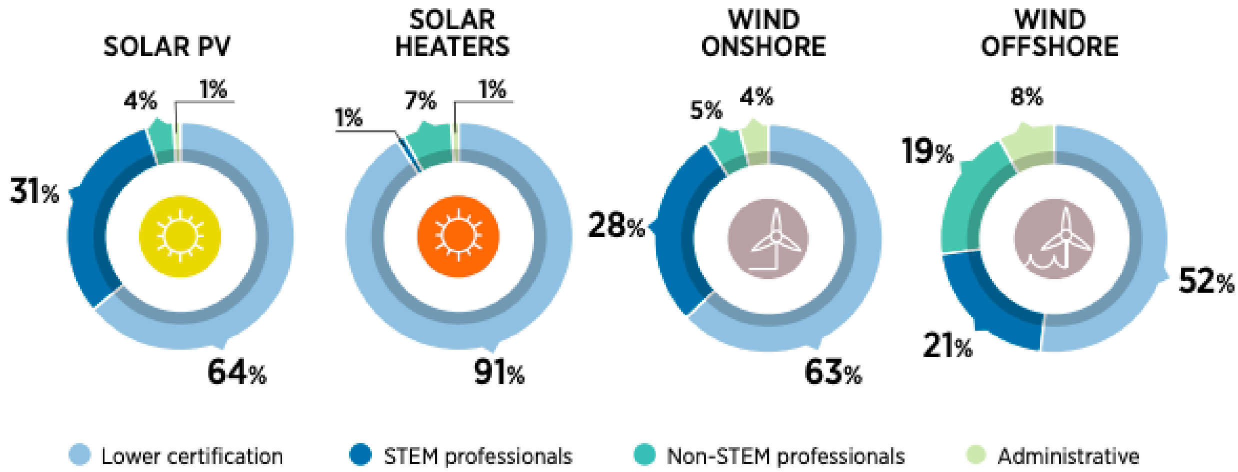


Figure 13 Human resource requirements for workers in solar PV, wind energy (onshore and offshore), and solar water heaters. Source: (IRENA, 2021a)

Training the future workforce requires time (IRENA, 2021a). **Putting in place an LTS that sets a long-term vision for the future energy mix, and benchmarks along that path, can provide important guidance to education and training institutions on the future skills that will be needed**. A broadly consulted LTS can also facilitate coordination between the energy sector and education sectors, to help prepare the necessary workforce and facilitate a just transition.

Job opportunities in solar and wind

To provide an idea of the scale of job potential in an LDC context, we calculated the employment potential for Bangladesh, Myanmar, Ethiopia, Mozambique, Congo DR and Senegal if these countries were to deploy renewables in line with a 1.5ºC emissions pathway. Renewable capacity data for two illustrative scenarios was used from scenario data underlying 1.5°C compatible pathways in the IPCC 1.5ºC Special Report from the 1.5°C national pathway explorer. Two categories of jobs with high potential for job creation were the primary focus of this assessment: (1) jobs in construction and installation (C&I) and (2) jobs in operations and maintenance.

Our calculation shows that, for the 1.5ºC scenario, **the estimated total job potential in construction and installation alone for Bangladesh, Myanmar, Ethiopia, Mozambique, Congo DR and Senegal taken together could range from 2.5 million job years (low energy demand) to 6.6 million job years (high energy demand),** when considering solar PV and onshore wind capacity.

Estimates of created jobs in operations and maintenance for these LDCs taken together could range from over 1.1 million (low energy demand) to over 2.5 million (high energy demand) for solar and wind together over the lifetime of the installed renewable energy facilities.

Figure 14 shows the range of the estimated job potential (in job years) for selected LDCs in construction and installation for low and high energy demand scenarios compatible with 1.5ºC pathways. For Bangladesh, the number of jobs years that could be newly created in the illustrative scenario could range from close to 0.6 to almost 2 million job years. For Mozambique, the job potential for construction and installation could range between 0.7 to 1.7 million job years.

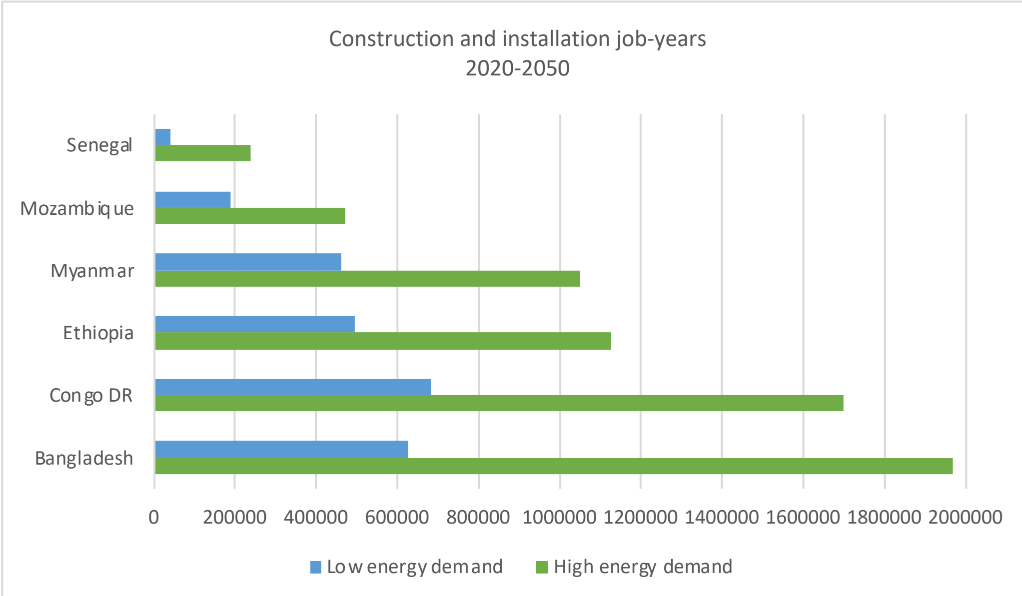


Figure 14 Job potential for illustrative scenario: Job years in Construction and Installation jobs (solar and wind combined)

Figure 15 shows the range of the estimated job potential for operations and maintenance over the entire lifetime of new RE facilities for selected LDCs for low and high energy demand scenarios. Bangladesh has the highest job potential. The operations and maintenance jobs that could be newly created over the whole lifetime of the facilities could range from close to 0.9 million jobs to over 0.75 million created jobs in Bangladesh.

Figure 15 Job potential for illustrative scenario: Jobs in operations and maintenance (solar and wind combined)

These estimates are conservative, as indirect and induced jobs created in related industries further down the supply chain were not included.

Job opportunities in mineral extraction

In addition to new job opportunities in the construction, installation, maintenance and operation of solar, wind and other renewable energy technologies, **mineral extraction for use in clean energy technologies are set to become a fast-growing segment of demand for most minerals** (IEA, 2022). Demand will depend on levels of climate ambition and on technology development pathways (IEA, 2022). But regardless, green technologies require a substantially larger amount of minerals than the current energy mix.

The expansion of electricity grids requires a large amount of copper and aluminium for wires and cables, as well as for transformers (IEA, 2022b). A typical electric vehicle battery pack (single car lithium-ion NMC532) needs around 8 kilograms of lithium, 35 kilograms of nickel, 20 kilograms of manganese and 14 kilograms of cobalt (Valckx et al., 2021). Charging stations require substantial amounts of copper. Solar panels use large quantities of copper, silicon, silver and zinc; wind turbines require iron ore, copper, and aluminium (Valckx et al., 2021).

The World Bank's 2020 Climate-Smart Mining report states that demand for graphite, cobalt and lithium may increase by 500 per cent by 2050 (World Bank, 2020b). **A large proportion of these and other minerals are found in many African countries** such as the Democratic Republic of Congo (cobalt, copper), Gabon (manganese), Madagascar (graphite, cobalt), Zambia (copper, cobalt) and Zimbabwe (lithium). (World Bank, 2020a; World Bank, 2017). The World Bank estimates that over 3 billion tons of minerals and metals will be needed to deploy wind, solar and geothermal power, as well as energy storage, for a below 2°C future (World Bank, 2020b). A corporate desire to shorten global supply chains may also provide some impetus for industrialisation in Africa (Toledano et al., 2021).

This increased demand brings with it both risks and opportunities. The mining industry and resource-rich economies could see a contribution to economic growth and sustainable development; at the same time, demand for water resources can conflict between mining companies and the communities around which they operate (World Bank, 2020a). Understanding future demand patterns for these minerals is crucial to long-term planning for producing countries.

4.5. Facilitate access to new sources of funding support for development

In addition to helping allocate domestic resources efficiently, an LTS can also facilitate access to international climate finance resources, by demonstrating country ownership and commitment towards achieving Paris Agreement goals and sustainable development. See Section 5 below.

A country's NDC and LTS are likely to have overlapping investment and financial goals and gaps. As a result, projects that contribute to NDC target achievement could also contribute to the fulfilment of an LTS, and vice versa, given the alignment needed between NDCs and LTSs.

There is an increasing interest by international bilateral and multilateral agencies in supporting LTS development and there are several organisations that support LTS development, from which LDCs could benefit. These are addressed in **Section 5**, below.

4.6. Greater energy independence and cost savings

Nearly all LDCs are characterised by a high dependency on imported fossil fuels with energy imports constituting roughly one-third of total energy use across the group of LDCs. In 2017, LDCs spent more than USD 30 billion importing fossil fuels, including oil products, coal and gas, to meet energy demand. Prices are set by the international market, which can be highly volatile. Accordingly, import-dependent LDCs can experience cost increases due to external shocks, as has been seen with the increase in fuel prices resulting from the war in Ukraine. Most African LDCs spend over 5% of their total GDP on fossil fuel imports; on a per capita basis, a number of LDCs spend more on fuel imports than on health and education (Zimmer et al., 2019).

Renewable energy that is generated domestically, and consumed domestically, can contribute to energy independence and result in cost savings, freeing up valuable resources for investments in health, education or other domestic priorities. Renewable energy development requires: (a) national energy planning, policy analysis, and formulation of strategies; (b) identification, evaluation, exploitation, and marketing of specific energy resources; and (c) the capability of energy sector institutions to manage and operate RE projects. The planning and stakeholder consultation that goes into LTS development can help avoid the mis-allocation of resources in this process. See sections 4.1 (policy coherence and planning) and 4.2 (stranded assets) above. The LTS itself can help mobilize domestic and foreign resources to support expanded RE generation capacity. See section 5 below.

Improved energy efficiency, achieved through long term efficiency targets, can also lower reliance on fossil fuel imports and result in significant cost savings. Bangladesh, for example, has developed a master plan on energy efficiency (see Box 8 below). The country faces peak domestic production of natural gas, which will require it to look abroad to supplement its own energy mix. In response to this challenge, Bangladesh has resolved to achieve a reduction in primary energy consumption per GDP for all sectors by 20% in 2030 from the 2013 level, through its Energy Efficiency and Conservation Master Plan up to 2030 (Government of Bangladesh, 2015) conserving domestic gas resources and saving money.

For those LDCs for whom fossil fuel exports constitute a significant share of GDP (including, Angola, Mozambique, Niger and Senegal), a LTS will help put in place a plan for the economic diversification and cross-sectoral transformation needed to align with Paris Agreement goals, and help support a just transition of workers.

Cambodia's LTS is instructive in its consideration of trade-offs, opportunity costs, interlinkages between policies and quantification of adaptation benefits. Full net benefits start from the first year of the LTS for carbon neutrality, and grow to more than $11 billion in 2050, which is 7.5 percent of projected GDP that year. This is detailed in Box 10 below.

Box 8. Excerpt - Bangladesh's Energy Efficiency and Conservation Master Plan

"It is expected that by taking the EE&C scenario (i.e., 20% energy efficiency improvement by 2030 compared with the 2013 level), the electricity demand in 2030 will be reduced by 8GW compared with the BAU case. This will lead to the decrease in the amount of fuel imports for power generation, resulting in a cumulative savings of DBT 2.3trillion between 2015 and 2030 or an average annual savings of 135 billion taka, which is equivalent of 6% of national budget and 1% of GDP (2013)."

Box 9. Costs and Benefits Analysis – Cambodia LTS excerpt

2.2 Economic costs and benefits

The sector analysis entailed consultations to identify 31 key actions contributing to carbon neutrality. Discussions of a long list of options led to the selection of five to eight key actions per sector that capture the main opportunities for achieving carbon neutrality. Some actions bundle sets of more detailed actions. An assessment of economic costs and benefits of the 31 key actions built on an Extended Cost Benefit Analysis (see more details in separate the Technical Annex). The LTS4CN scenario creates estimated net economic benefits for the public and private sectors of about $5 billion in 2050 (3 percent of projected GDP). Further benefits will include $1 billion in adaptation co-benefits from LTS4CN actions. Wider social and environmental benefits would reach $6 billion, mainly from FOLU actions. Full net benefits start from the first year of the LTS4CN and grow to more than $11 billion in 2050, which is 7.5 percent of projected GDP that year (see Section 3 for more details). This would compensate for about two thirds of the GDP lost due to climate change impacts, as estimated in the Climate Economic Growth Impact Model (CEGIM) for Cambodia.

Table 3: Total costs and benefits by public and private capital and operating expenditures

	Annual costs (orange) and benefits (green), millions of dollars		
	2030	**2040**	**2050**
Private capital expenditures	473	743	1,384
Private net annual costs	812	2,376	6,254
Public capital expenditures	159	294	476
Public net annual costs	59	69	176
Adaptation benefits	346	630	994
Wider benefits (social and environmental)	1,393	3,466	5,977
Total costs and benefits	**1,859**	**5,366**	**11,188**

By 2050, the private sector would be investing nearly $1.4 billion each year, mainly in energy, transportation and forestry, with some significant investment in the IPPU. Private-sector operating expenditure benefits are six times initial investment costs and come from a wide range of actions. Benefits are high from energy efficiency ($3.4 billion), vehicle electrification ($1.1 billion) and rail and freight haulage ($1.1 billion). These are reduced by nearly $800 million, however, due to the opportunity costs of protecting forest from conversion to agriculture. Public capital expenditure is relatively small, with some ongoing investment in renewable energy, buses, trains, and forestry, in line with the REDD+ Investment Plan. There are significant ongoing public operating expenditures, dominated by rail and haulage ($500 million) and the loss of a fuel tax from the electrification of vehicles ($200 million). These costs are offset by operating profits from renewable energy, however. The net contribution of the agriculture, waste, and IPPU sectors is small."

Source: UNFCCC, 2022, Communication of long-term strategies, Cambodia LTS at 15.

4.7. Expanded access to affordable energy

Electricity is crucial for poverty alleviation, economic growth, and improved living standards. However, energy access remains a substantial challenge for many LDCs. Despite gradual progress in the rate of electrification, **nearly half of the population of LDCs lacks access to electricity**. In some countries, including Burkina Faso, Burundi, Central African Republic, Chad, and Malawi, the share of the population with access to electricity is less than 20%, compared to world average of 90% in 2019 (Figure 16).

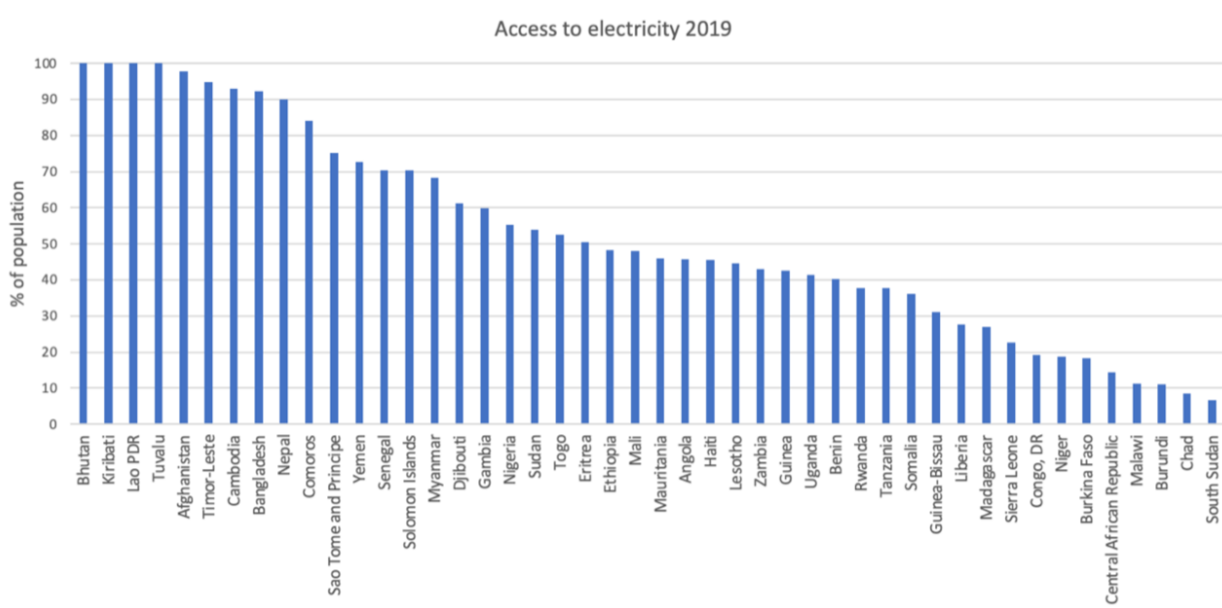


Figure 16 Access to electricity as percentage of population in all LDCs, 2019

Increasing the share of renewable energy in a country's total energy basket can be an important step forward in achieving affordable clean energy for all. Renewable energy costs have been declining much faster than expected over the last decade. In 2021, IRENA reported that costs for PV alone have decreased by more than 50% since 2014. Since 2010, globally, renewable power generation capacity has been added with estimated costs that have been lower than the cheapest fossil fuel-fired option (IRENA, 2021b).

The LTS development process can help policymakers consider medium and long-term synergies and trade-offs at the national and local levels in connection with renewable energy expansion. For example, in 20 LDCs, hydropower provides more than 50% of power generation. Within these 20 countries, six have used hydropower as a driving force to achieve more than a 90% electrification rate (Afghanistan, Bhutan, Cambodia, Nepal, Lao PDR, and Nepal). However, mega hydro projects contribute to increasing emissions through land use change and lead to complex displacement and resettlement issues. Thus, trade-offs need to be carefully considered.

Grid-based electrification has benefits but is more resource-intensive in terms of infrastructure and investment when compared to off-grid solutions. Distributed renewable power generation, including off-grid solar home systems and mini-grids, offer a fast and cost-effective way of providing people in rural areas with electricity, which can directly contribute to improving access to electricity and clean modern technologies in many LDCs (Baurzhan and Jenkins, 2016).
Bangladesh has the largest off-grid solar power program in the world, which enables 20 million homes (16% of rural population) to access electricity (Cabraal et al., 2021). So here again, synergies and trade-offs between investments in grid-based and off-grid approaches need to be considered. The LTS development process can help policymakers in working through these issues.

4.8. Enhanced resilience to climate impacts

With a long-term perspective, **the LTS development process creates an opportunity to consider how best to leverage synergies between mitigation needs and adaptation needs**.

For example, renewable energy expansion is a mitigation measure, but cost savings from decreased fuel imports can free up resources that can be spent on other domestic priorities, including adaptation needs. Increased fuel independence creates resilience to global supply chain disruptions and to international pricing swings for fuels in the international market, which can result from climate-related disasters or conflicts elsewhere in the world.

Diversifying and decentralising renewable energy generation will also increase resilience to drought, floods and other disruptions (see section 4.3, above). **Smart renewable energy portfolios can ensure that sufficient generation capacity is available when hydro is challenged due to drought, or when wind power is vulnerable to strong winds** (Sterl, et al., 2020; Sterl et al., 2021). Taking climate impacts into consideration when siting new facilities will further contribute to climate-resilience. Distributed power systems using solar and batteries can make a grid more resilient; and minigrids and microgrids can provide useful backup generation in case of grid failure (see section 4.3 above).

Climate-smart agriculture supports mitigation, but equally aims to increase agricultural productivity and incomes and adapt and build the resilience of people and agri-food systems to climate change impacts (see section 3.3, above).

Forests provide a critical carbon sink: halting the degradation of natural systems, and promoting carbon sequestration through afforestation and reforestation will support mitigation, but these approaches can also create buffer zones that halt erosion, offer communities protection in cases of heavy rainfall, protect coastal zones (e.g., mangrove forests), regulate local temperature creating cooler zones, and protect biodiversity.

4.9. Improved health outcomes

Rolling out renewable energy technologies will improve air quality in LDCs and reduce the burden of disease, including stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma. Other mitigation measures identified through the LTS process can also improve health outcomes. For example, the development of efficient, low carbon public transport networks and electrified transport options will also reduce exposure to outdoor air pollution.

It is well recognised that exposure to outdoor air pollution increases mortality and morbidity and shortens life expectancy (USEPA, 2009). Studies have shown that long-term exposure to air pollution is associated with increased mortality from cardiovascular and respiratory diseases (Brauer et al., 2012; Burnett *et al.*, 2014; Lelieveld et al., 2015).
In low-income countries, exposure to ambient pollution contributed to 4.9% of total deaths in 2015 (Cohen et al., 2017). Roughly 90% of premature deaths caused by outdoor air pollution in 2016 occurred in low- and middle-income countries (WHO, 2021). In addition to outdoor air pollution, household air pollution leads to significant mortality in low- and middle-income countries. Worldwide, over 3.8 million people a year die prematurely from illness attributable to the household air pollution caused by the inefficient use of solid fuels and kerosene for cooking (WHO, 2022).

Substantial health gains can be achieved from taking action to prevent climate change, independent of any future reductions in damages due to climate change (Markandya, et al., 2018).

The health co-benefits of low-carbon development can partially or even fully offset the overall cost of decarbonisation in some contexts. Vandyck et al. (2018) and Markandya et al., (2018) found that air quality co-benefits on morbidity and mortality substantially outweighed the costs of climate policy.

5. Resources for the preparation and implementation of LTS

As explained above in section 2, developing an LTS is a resource-intensive process that requires technical expertise to inform decision-making in the short and long-term and to plan future investments. The process requires extensive stakeholder engagement and building upon existing or new institutional capacities. LDCs often lack domestic resources for LTS development and implementation and also have human capacity and technical limitations in some of these areas.

However, a multitude of organisations have been scaling up support specifically for the development of LTS and the implementation of projects in line with the goals of the Paris Agreement. Some examples of these organisations and the kind of support they provide are described in the following sections.

5.1 Support for LTS development

There is increasing interest by international bilateral and multilateral agencies in supporting LTS development.

For example, at COP 25, a group of ten ***Multilateral Development Banks*** **(MDBs)** committed to develop a set of high-level principles to guide their support for a just transition and to ensure consistency, credibility, and transparency in their efforts. These principles, released before COP 26, aim to guide related MDB policies and activities, optimising development assistance and supporting consistency in country engagement, including in efforts to integrate just transition considerations into the LTS development and preparation (ADB, 2021). At COP 26, MDBs adopted a statement on collective climate ambition, highlighting their work to enhance support to countries for the formulation of robust and ambitious NDCs, LTSs, and National Adaptation Plans (NAPs) in line with the Paris Agreement goals, including by enhancing synergies between these instruments and by ensuring that LTSs are mainstreamed into national development plans (AIIB, 2021)..

These commitments are slowly coming together: the ***World Bank*** has already allocated USD 15 million through its Climate Support Facility for the development and enhancement of NDCs and LTSs (World Bank, 2022b). Other multilateral organisations active in LDCs may not have dedicated LTS support programmes, but nevertheless support activities under the scope of LTS development. For example, the *African Development Bank* **(AfDB)** is evaluating a project proposal to provide financial support for the preparation of LTSs for Liberia, Lesotho, Uganda, Gabon, and Botswana. Support opportunities for related LTS activities can be accessed through the Africa NDC Hub. Another example is the ***Asian Development Bank*** **(ADB)** which has a USD 2 million active regional project for its developing member countries aimed at preparing sectoral strategies and identifying investment opportunities to incorporate climate solutions into their long-term planning (ADB, 2022).

On the bilateral support front, France, Germany and the United Kingdom are actively supporting work on LTS. For example, the **French Development Agency** **(AFD)** is providing technical cooperation and capacity building to develop LTS through its 2050 Facility. It has provided support with energy scenario modelling and with formulation of long-term climate resilient development strategies in LDCs, including Burkina Faso, Cambodia, Ethiopia and Mozambique (AFD, 2022). **Germany's International Climate Initiative** **(*IKI*)** provides support through thematic calls, funding a range of activities, such as modelling and scenario development, stakeholder engagement, capacity development and enhancement of sectoral policies for implementing climate targets (IKI, 2021). The **UK's Foreign, Commonwealth and Development Office** **(*FCDO*)** is also providing support for LTS preparation as well as training on LTS in ASEAN countries.

Another example of support is the ***Green Climate Fund*** **(GCF)** with its Readiness Support Programme. This programme addresses capacity and technical gaps for the development of Country Programmes, Entity Work Programmes, long-term low-emission development strategies and action plans among other support areas (GCF, 2020).

United Nations (UN) Organisations also provide preparation support for LTSs. The ***United Nations Development Programme* (UNDP)**, for example, is currently assisting 118 countries in collaboration with 35 partners in aligning short and medium-term climate goals with long-term net zero development plans or strategies through its Climate Promise. Examples of LDCs supported through this window include Nepal and Cambodia (UNDP, 2021).

International initiatives are also supporting work on LTS. The ***2050 Pathways Platform*** **(2050PP)** is providing financial support and technical assistance for the formulation of country-tailored LTSs. It currently has 36 member-countries including two LDCs (Ethiopia and Gambia) (2050PP, 2022).

The ***NDC Partnership*** **(NDCP)** is another organisation mobilising financing for LTS preparation through its Climate Action Enhancement Package. There are 46 NDCP implementing partners including ***Climate Analytics*** **(CA)**, **IRENA**, the **ADB**, and the ***Global Green Growth Institute*** **(GGGI)** (NDCP, 2022). We understand that the NDCP is likely to release a call under the Climate Action Enhancement Package (CAEP) in near future that will include a focus on LTS.

The ***LEDS Global Partnership*** **(LEDS-GP)** provides countries with a platform for peer-to-peer knowledge sharing and technical assistance for enhancing sectoral policies and plans, supporting the design and implementation of national climate actions, including NDCs and LTS. LEDS-GP operates through five technical expert groups (Energy, AFOLU, Resource efficiency, Finance and Transport) and through three regional platforms in Africa, Asia and Latin America and the Caribbean (LAC). Its network is composed of 79 member-countries and engages with over 300 technical and research institutions (LEDS-GP, 2022).

The **German Agency for International Cooperation** (***GIZ*** for its acronym in German) has been supporting the implementation of the Paris Agreement since 2016 through its *Support Project for the Implementation of the Paris Agreement (SPA)*, by enabling partner countries to implement and enhance NDCs, LTS and NAP processes. The GIZ serves as the secretariat for the LEDS-GP by coordinating the technical assistance in regional and topical working groups. The GIZ also works in conjunction with the NDCP by coordinating efforts with government and institutional partners (GIZ, 2020).

5.2 Support for LTS implementation

Donor funds, multilateral banks and national funds are anticipated sources of support for LTS implementation in LDCs. It is an advantage that there is a climate finance architecture already in place to support the implementation of NDCs, which can be leveraged to also support the implementation of LTS.

The **Global Environmental Facility** **(*GEF*)**, as part of the GEF 8 replenishment package (pending approval), is expected to implement the *Net Zero Nature Positive (NZNP) Integrated Program* which seeks to accelerate the implementation of nature-positive, net zero pathways in developing countries, and raise ambition of climate national plans. The programme would: support the adoption of net zero strategies and policies taking an integrated whole-of-government approach; contribute to the effective integration of the climate and nature agendas at the national and global level; invest in Net Zero Nature Positive-aligned pipelines of projects generating multiple global environmental benefits; and support the development of robust data systems to monitor progress towards Net Zero Nature Positive targets (GEF, 2022).

At COP 26, the MDBs also committed towards working together to increase the level of funding and coordination of their support at national, sub-national and sector levels to facilitate the development and implementation of LTSs, including by exploring the potential establishment of ***a joint MDB LTS***

Facility. Further, they are working with clients to develop plans to integrate the transition to a net zero emissions and climate-resilient economy with development programs in key sectors such as energy, cities, food and land use, water, and industry (AIIB, 2021).

The ***Climate Investment Funds*** **(CIF)** initiative is another example of a multilateral climate fund, specialised in climate finance. The CIF looks to scale-up climate action, mobilising resources from the public and private sectors in its 72 member-countries, including over fifteen LDCs (CIF, 2021).

Global initiatives are forming to support mitigation efforts. The ***International Solar Alliance*** ***(ISA),*** for example, has to date 86 member-countries, including many LDCs and SIDS. This initiative aims to support and increase the deployment of solar energy technologies to enable energy access and security in its member countries. The ISA has different windows of support, including capacity building workstreams, and facilitates access to funding through seven implementing programmes, with a mission to unlock USD 1 trillion of investment by 2030. The ISA through its support could enhance the mobilisation of resources for the implementation of LTS in LDCs (ISA, 2021).

At a domestic level, **national climate funds** can facilitate the blending and leveraging of domestic public resources with private, multilateral and bilateral sources of finance to support LTS implementation. Examples include: Ethiopia's *Net Zero Nature Positive*, which leverages public investment in climate change mitigation and adaptation initiatives by mobilising grant and non-grant climate finance, including concessional loans, from bilateral, multilateral, private, and public sources; Rwanda's ***National Fund for Environment*** **(FONERWA)**, which gives technical and financial assistance to the best public and commercial projects that can support Rwanda's green economy commitment; and ***Beyond the Grid Fund for Zambia*** **(BGFZ)**, which provides clean off-grid energy access and services where it was not previously technically or economically feasible through results-based finance.

5.3 Planning for resource mobilisation

Each of the three LTSs formally communicated by LDCs (Benin, Nepal and Cambodia) has considered climate financing and resource mobilisation as part of its strategic planning process. All three LTSs present estimations of the overall costs or level of investment required for implementing key activities in their strategies, and each LTS contains a specific chapter covering resource mobilisation plan for addressing implementation needs. Plans are presented as high-level plans, mostly listing which financial mechanisms are being considered for implementing the range of climate actions. International and domestic sources are considered. A summary of the relevant chapters of these LTSs related to resource mobilisation are set out in Box 10 below.

Box 10. Resource mobilisation for LTS in LDCs

a) **Benin's "Strategy for a low emission and resilient development**" - communicated in 2016 as a short-to medium term plan, to be implemented from 2016 to 2025. Chapter seven describes the "Plan for resources mobilisation", which is composed by three main financing mechanisms: (a) public budget, (b) loans, grants and donations, and to a lesser extent, (c) private investment. Public resources are proposed to be leveraged through Public Private Partnerships (PPPs). International climate finance and development banks are expected to play a key role in supporting the implementation of the strategy through loans and grants. Private sector investment is planned to channel resources to the energy sector.

b) **Nepal's** "**Long-term strategy for net zero emissions**" – communicated in October 2021. Chapter four, "Investment and finance" provides information on expected costs to achieve GHG reduction targets under different modelling scenarios, and possible sources to finance the required investments. On international sources of support, Nepal is considering a diverse range of options including grants and concessional loans. The use of carbon markets is also highlighted as a feasible source of international funding. On domestic sources, Nepal mentions the importance to have in place a "sustainable funding mechanism". A set of fiscal instruments such as bonds, taxes, levies, and subsidies are considered as specific tools for raising revenues and creating incentives for green investment. It is expected that the implementation of these fiscal instruments will bolster mobilisation of resources from the private sector, which was identified as a major stakeholder to achieve the net zero emission target. Private Public Partnerships (PPPs) are also seen as an effective mechanism to attract private finance and complement public resources. Strengthening institutions and regulation to attract resources and provide certainty is also a main feature of the financial plan.

c) **Cambodia's** "**Long Term Strategy for Carbon neutrality**" – communicated in December 2021. Chapter two includes a section on "Public financing plan", while chapter three "Socioeconomic benefits" provides other information on investments needs and domestic costs. A gradual increase of public and private investment is expected to cover a major share of their financial needs, complemented by international climate finance. Sectoral pricing and tax policies are highlighted as specific sources of public revenue. The strategy relies on business opportunities from green policies to attract long term investment from the private sector, particularly in the energy and transport sectors. A critical consideration for Cambodia is not to reduce investment in other development areas and minimise loss of economic growth.

Source: UNFCCC, 2022: communication of long-term strategies

The Parties that have submitted LTSs to the UNFCCC to date have defined their LTS cost estimates, finance needs and finance sources in different ways. Nevertheless, there are some lessons LDCs could learn from these submitted LTSs to enhance their ability to mobilise climate finance resources (Pauw, König, Sadikhova, & Stutzmann, 2021):

- **Reallocation of resources:** The reallocation of public financial resources blended with private capital and complemented with support from international cooperation (such as the MDBs or the GCF, for instance) can help a country achieve its LTS objectives. An example of resource reallocation is the CrossBoundary Energy Access initiative which blends finance directly into mini-grid projects in African countries for rural households and businesses. The initiative has already implemented a project in Tanzania which enabled access to energy to over 34,000 people through 60 mini-grids (CrossBoundary Energy Access, 2022).

- **Use of fiscal policy levers:** Changes or additions to fiscal policies can contribute to reducing GHG emissions and create new sources of revenue for the countries that implement them. For example, Fiji and the Republic of the Marshall Islands LTSs mention tax reductions for electric vehicles and tax rises for fossil-fuel-based vehicles. Cambodia and Nepal also mention sectoral pricing and tax policies as specific tools to raise public revenue that could incentivise green investment and which need to be complemented by international climate finance.

- **Standardised reporting frameworks:** Countries have started introducing standardised frameworks to define and then report on long-term climate and sustainability factors. For example, the Task Force on Climate-Related Financial Disclosures, has issued a set of voluntary recommendations covering the ways in which business and financial institutions respond to climate factors in their strategy, risk, governance, and performance metrics. South Africa and the Republic of Korea are planning to implement the recommendations by the Task Force on Climate-Related Financial Disclosures as a mandate to drive a system-wide shift. The Republic of Korea also plans to build a taxonomy for green finance to inform investors whether the investment is environmentally friendly and to prevent greenwashing.

6. Conclusions

In light of the Paris Agreement's long-term goals, **long-term strategies are now a fundamental and vital component of national climate and development policy architecture**. The Glasgow Climate Pact urges countries that have not yet done so to bring forward their LTSs by November 2022 (COP27).

By providing an opportunity for governments to consider the sectoral transformations and milestones required to reach net zero emissions, **an LTS can inform short to medium-term planning, leverage synergies across government priorities, drive sectoral transformations, avoid the lock-in of high-emissions technologies, and support essential resilience planning**.

The **LDC Group Vision is for all LDCs to be on climate-resilient development pathways by 2030 and to deliver net zero emissions by 2050**. The sooner LTSs are in place, the sooner this vision can be realised, and the sooner cost savings and development gains can be secured.

For LDCs, the challenge will be to **develop sustainably along a low-carbon growth path**, avoiding the installation and use of carbon-intensive infrastructure while planning for increased resilience against climate impacts across all sectors.

The most significant **sectoral transformations for LDCs** will be those related to the decarbonisation of energy generation and use, the reduction of land sector emissions and reductions in non-CO_2 greenhouse gases – for example, methane and nitrous oxide from agriculture.

In addressing these areas, LDC long term strategies should consider energy system resilience, ecosystem resilience and food security, and take advantage of potential synergies between low GHG emissions planning and adaptation needs wherever possible. LDCs can also benefit by realising **synergies between LTSs and other sustainable development and resilience goals, and between LTS and NDCs and NAPs**.

The process of developing and implementing an LTS can generate a series of tangible **co-benefits and opportunities for LDCs**. These include:

- **Policy coherence and support for short-and medium-term planning:**
    - The process of developing an LTS can help Parties realise efficiencies in their short and medium-term planning. An LTS can also assist in avoiding a misallocation of resources that can happen if only shorter-term planning horizons are used.
    - Integrating domestic processes for the development of NDCs and LTSs can reduce costs and increase efficiencies in planning processes. Stakeholder consultations that consider an LTS and NDC in tandem can also increase efficiency.

- **The avoidance of stranded assets, caused by short-term planning**
    - Long-term planning can reduce the risk of stranded assets, by identifying which types of investments should be avoided in the near-term, because they will have no role in a future system.
    - An LTS can also help avoid stranded assets by considering different pathways to achieving the same long-term emission reduction goal and the implications of those choices for the lifetime of near-term investments.

- **Planning for climate-resilient infrastructure**
    - The long-term planning required to decarbonise an economy is intrinsically linked with resilience: long-term planning enables climate impacts to be built in to all major investment decisions. An LTS process offers opportunities to consider synergies between mitigation and adaptation needs and plan for climate-resilience.
    - The development of an LTS offers an opportunity to model and plan for a renewable energy portfolio that will be flexible, cost-effective and climate-resilient, and that will function in the context of an LDC's own particular conditions. This planning process can also consider regional vulnerabilities and opportunities.
    - Planning across boundaries can deliver even greater efficiencies, for example through the development of renewable energy portfolios in power pools that build on countries' natural resource strengths.

- **Upskilling and local employment opportunities in renewable energy technologies and in extractive industries**
    - Putting in place an LTS that sets a long-term vision for the future energy mix, and benchmarks along that path, can provide important guidance to education and training institutions on the future skills that will be needed.
    - A broadly consulted LTS can also facilitate coordination between the energy sector and education sectors, to help prepare the necessary workforce and facilitate a just transition.

- **Facilitate access to new sources of funding support for development**
    - An LTS can help allocate domestic resources efficiently and facilitate access to international climate finance resources, by demonstrating country ownership and commitment towards achieving Paris Agreement goals and sustainable development.
    - A country's NDC and LTS are likely to have overlapping investment and financial goals and gaps.

- **Greater energy independence and cost savings**
    - Nearly all LDCs are characterised by a high dependency on imported fossil fuels. Long-term planning through an LTS for renewable energy that is generated domestically, and

  - consumed domestically, can contribute to energy independence and result in cost savings, freeing up valuable resources for investments in health, education or other domestic priorities.
  - For those LDCs for whom fossil fuel exports constitute a significant share of GDP, a LTS will help put in place a plan for the economic diversification and cross-sectoral transformation needed to avoid trade vulnerability, align with Paris Agreement goals, and help support a just transition of workers. Improved energy efficiency, achieved through long term efficiency targets, can also lower reliance on fossil fuel imports and result in significant cost savings.
  - An economic cost-benefit analysis that looks at cross-sectoral linkages and includes adaptation co-benefits may expose significant overall cost savings from a move to carbon neutrality.

- **Expanded access to affordable energy**
  - Increasing the share of renewable energy in a country's total energy basket can be an important step forward in achieving affordable clean energy for all. The LTS development process can help policymakers in LDCs consider medium and long-term synergies and trade-offs at the national and local levels in connection with renewable energy expansion.

- **Enhanced resilience to climate impacts**
  - With a long-term perspective, the LTS development process creates an opportunity to consider how best to leverage synergies between mitigation needs and adaptation needs.
  - By way of example for LDCs, diversifying and decentralising renewable energy generation will also increase resilience to drought, floods and other disruptions. Climate-smart agriculture supports mitigation, but equally aims to increase agricultural productivity and incomes and adapt and build the resilience of people and agri-food systems to climate change impacts.

- **Improved health outcomes**
  - Measures identified and implemented through the LTS process can improve health outcomes in LDCs.
  - For example, rolling out renewable energy technologies will improve air quality in LDCs and reduce the burden of disease. The development of efficient, low carbon public transport networks and electrified transport options will also reduce exposure to outdoor air pollution.

While it is true that LDCs face substantial challenges in preparing and implementing LTSs, **financial and technical support** for LTS development is growing across donor funds, multilateral funds, development banks and intergovernmental initiatives. A number of organisations are now providing their expertise and resources to support the LTS development process. These initiatives will help LDCs realise the array of benefits and opportunities that the LTS ticket to prosperity offers.

List of acronyms

ADB	Asian Development Bank
AfDB	African Development Bank
AFOLU	Agriculture, forestry, and other land use
BECCS	Bioenergy Carbon Capture and Storage
CCS	Carbon Capture and Storage
CIF	Climate Investment Funds
COP	Conference of the Parties to the UN Framework Convention on Climate Change
CMA	Conference of the Parties to the UNFCCC serving as the Conference of the Parties to the Paris Agreement
CSA	Climate Smart Agriculture
CSAIP	Climate-Smart Agriculture Investment Plan
EAPP	East African Power Pool
ECOWAS	Economic Community of West African States
EE&C	Energy Efficiency and Conservation Master Plan
FAO	Food and Agriculture Organization
FCDO	The UK’s Foreign, Commonwealth & Development Office
FOLU	Forestry, and Other Land Use
GDP	Gross Domestic Product
GEF	Global Environment Facility
GERD	Grand Ethiopian Renaissance Dam
GHG	Greenhouse gas
GIZ	German Agency for International Cooperation
IKI	Germany’s International Climate Initiative
IPCC	International Panel on Climate Change
ISA	International Solar Alliance
LDC	Least Developed Countries
LDC REEEI	Least Developed Countries Renewable Energy and Energy Efficiency Initiative for Sustainable Development
LEDS	Long-term low emission development strategy
LIFE-AR	LDC Initiative for Effective Adaptation and Resilience
LTS	Long-term low greenhouse gas emission development strategy
LTS4CN	Long-term strategy for climate neutrality
LTTG	Long-term temperature goal
LUCCC	Least Developed Countries Universities Consortium on Climate Change
LULUCF	Land use, land-use change and forestry
MDB	Multinational Development Bank
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
RE	Renewable energy
SDG	Sustainable Development Goal
SIDS	Small Island Developing State
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WAPP	West African Power Pool

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