The least developed countries report 2024

Chapter II

Carbon market participation: Opportunities, challenges and pitfalls

United Nations

A. Where do the least developed countries fit in carbon markets?

Development finance and climate finance delivered through bilateral and multilateral channels have proved insufficient to fund the investment needs of least developed countries (LDCs) for meeting their goals in key areas of sustainable development. Consequently, it is believed that carbon markets could be a possible source of additional finance for this purpose. This chapter provides an analysis of the current state of carbon markets and their future potential to mobilize finance for greenhouse gas (GHG) mitigation efforts in LDCs. Specific risks and opportunities associated with LDCs' participation in carbon trading under Article 6 of the Paris Agreement and through the voluntary carbon market are also discussed.

1. The performance and future potential of carbon markets in the least developed countries

(a) The current landscape and recent trends

Chapter 1 highlights in detail the global carbon market landscape including its structure and recent trends. To assess the performance and potential of carbon markets in LDCs, a two-step analysis is undertaken. First, the patterns and outcomes of baseline and credit schemes in LDCs are analysed, followed by an assessment of the potential for scaling up their carbon market activities.

LDCs were early participants in the voluntary carbon market. The Gold Standard and Verra, the two main standards on the voluntary carbon market and the dominant standards in LDCs, started issuing carbon credits in 2008 and 2009, respectively. The first carbon credits from LDC-hosted mitigation projects in the voluntary carbon market were issued in 2009 from a cookstoves project in Cambodia.[1] In 2010, carbon credits were issued from mitigation projects in 8 LDCs with the number rising to 16 by 2014. And by April 2024, 38 out of 45 LDCs were hosting mitigation projects that had issued carbon credits. The LDC share of credits issued from mitigation projects in the total credits from such project hosted by developing countries as a whole has been on the rise, from 5 per cent of cumulative issued credits in 2013 to 23 per cent in 2023. Moreover, 6 LDCs, namely Bangladesh, Cambodia, the Democratic Republic of the Congo, Malawi, Uganda and Zambia, were among the top 20 developing countries with the highest volume of issued credits.

Although there is some evidence that participation in the Clean Development

[1] Cookstove projects focus on replacing traditional stoves with cleaner, more efficient ones in order to reduce GHGs from wood fuel consumption, which is a major driver of deforestation. It is estimated that half of all wood harvested worldwide is used as fuel including for cooking (Bailis et al., 2015).

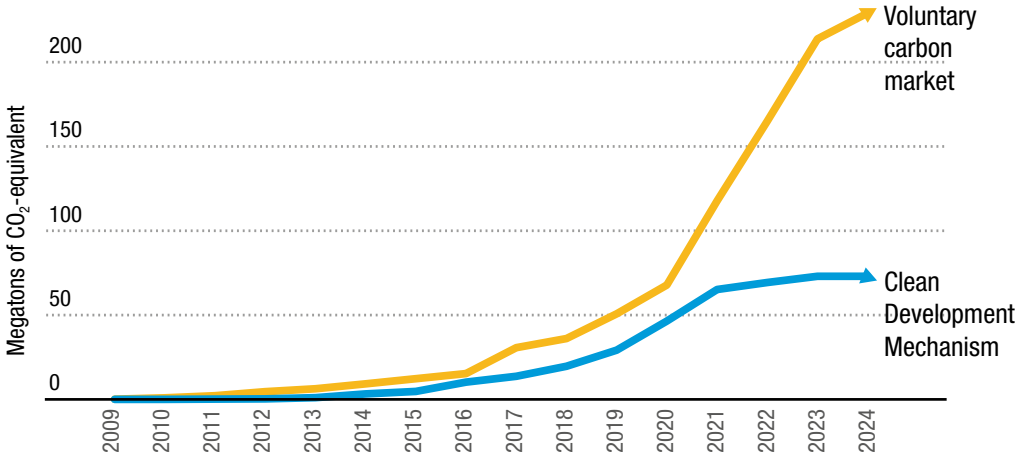
Mechanism can contribute to building domestic capacity for voluntary carbon market participation in developing countries, including LDCs (Andonova and Sun, 2019), LDC uptake of the Clean Development Mechanism was slower than for the voluntary carbon market, and participation remains less widespread. While the Clean Development Mechanism started to issue certified emission reduction credits in 2005, the first LDC-sourced certified emission reduction credits were not issued until 2010, when one project in the Lao People's Democratic Republic and another in the United Republic of Tanzania came online. By 2014, certified emission reduction credits had been issued from only seven LDCs, and, over the course of the lifespan of the Clean Development Mechanism, certified emission reduction credits were issued from 21 of the current 45 LDCs. The introduction of the operational mode of programme of activities under the Clean Development Mechanism, together with financial support for underrepresented host countries – including LDCs – played a key role in lowering transaction costs and facilitating access (UNFCCC, 2009). Overall, by May 2024, 37 per cent of all certified emission reduction credits issued from LDCs were sourced from programmes of activities, compared with only 2 per cent from other developing economies (ODEs).[2] In retrospect, LDCs played only a marginal role in the Clean Development Mechanism, collectively accounting for just 3 per cent of all certified emission reduction credits issued through the mechanism. This is due to the high concentration of certified emission reduction credit issuances in the three main certified emission reduction credit source countries: Brazil, China and India. Despite this, three LDCs, namely Bangladesh, Cambodia and Uganda, are among the top 20 developing countries with the highest volume of issued certified emission reduction credits.

Figure II.1 shows that, particularly since 2020, the voluntary carbon market was the main source of carbon credits from LDC-based baseline and credit schemes. From 2020 to 2021 the issuance of LDC-sourced carbon credits saw a growth spurt, increasing from 18 $MtCO_2e$ to

Figure II.1

The bulk of carbon credits sourced in least developed countries comes from the voluntary carbon market

Cumulative issued carbon credits from the Clean Development Mechanism and voluntary carbon market



Source: UNCTAD, based on data from the UNEP CDM pipeline and the registries of the Gold Standard, Verra, Plan Vivo and Climate Forward.

Note: Data for 2024 cover the period 1 January to 30 April 2024.

[2] UNCTAD calculation based on data in the UNEP Clean Development Mechanism pipeline as of 30 April 2024.

51 $MtCO_2e$. During the same period, the Clean Development Mechanism was starting to wind down as it stopped accepting new project registrations on 31 December 2020 and preparations for a successor scheme under Article 6.4 of the Paris Agreement commenced. Overall, as on May 2024, 310 $MtCO_2e$ worth of credits were issued by baseline and credit schemes for mitigation projects hosted by LDCs. Of these, 237 $MtCO_2e$ (76 per cent) were issued in the voluntary carbon market and 73 $MtCO_2e$ (24 per cent) under the Clean Development Mechanism.

Both voluntary carbon market and Clean Development Mechanism participation is highly concentrated within the LDC group.[3] As on May 2024, the six largest LDC host countries – Bangladesh, Cambodia, the Democratic Republic of the Congo, Malawi, Uganda and Zambia – jointly accounted for 75 per cent of all carbon credits issued from LDC-hosted projects in the voluntary carbon market (table II.1). Concentration is even higher for the Clean Development Mechanism, with the 6 largest host countries – Bangladesh, Cambodia, Malawi, Myanmar, Nepal and Uganda – accounting for 80 per cent of all issued certified emission reduction credits. A major factor driving concentration across countries is the presence of particularly large individual projects or groups of projects, which in turn also implies high concentration at the country level. For instance, the Mai Ndombe REDD+ Project in the Democratic Republic of the Congo (see chapter III for a case study) accounts for

Table II.1

Baseline and credit schemes are highly concentrated within the least developed country group

Total issued credits in least developed countries as of May 2024

	Country	Share in LDC total (Percentage)	Cumulative share (Percentage)
Voluntary carbon market Total volume in LDCs as of May 2024: 237 $MtCO_2e$	Cambodia	22	22
	Democratic Republic of the Congo	14	36
	Bangladesh	12	49
	Uganda	11	60
	Malawi	8	68
	Zambia	7	75
Clean Development Mechanism Total volume in LDCs as of May 2024: 73 $MtCO_2e$	Bangladesh	26	26
	Uganda	17	44
	Cambodia	13	57
	Myanmar	10	66
	Nepal	7	74
	Malawi	6	80

Source: UNCTAD, based on data from the UNEP CDM pipeline and the registries of the Gold Standard, Verra, Plan Vivo and Climate Forward.

Note: Figures have been rounded to full percentages.

[3] High concentration is also a feature of FDI and ODA flows to LDCs. For instance, in 2023, the six largest FDI destinations among LDCs accounted for 58 per cent of total FDI inflows to the LDCs (calculation based on data provided with UNCTAD (2024)) and, in 2022, the six largest ODA recipients among LDCs accounted for 41 per cent of total ODA flows to LDCs (calculation based on data from the OECD Creditor Reporting System).

92 per cent of all voluntary carbon market credits issued in that country as on May 2024. And the Dapein Hydropower Project in Myanmar accounts for 69 per cent of all certified emission reduction credits issued in that country. Five projects designed to reduce leakages in local gas distribution networks account for 80 per of voluntary carbon market credits and for 63 per cent of certified emission reduction credits for Bangladesh. And in Malawi, five cookstove projects registered under Verra by the same project developer, account for 53 per cent of all voluntary carbon market credits in that country. Incidentally, this is the same company that developed four of the five gas leakage projects in Bangladesh and numerous carbon projects in other LDCs and ODEs suggesting that there is also concentration at project developer level.

There is also concentration at the sectoral level with 52 per cent of credits issued in the voluntary carbon market originating from nature-based solutions and another 35 per cent from household-level interventions (figure II.2).

Nature-based solution credits sourced in LDCs come almost exclusively from the forestry sector, and primarily from REDD+ activities. Within the household category, cookstove projects account for 84 per cent of issued credits and 15 per cent from interventions aimed at improving access to clean water through boreholes and household water purifiers.[4] Cookstoves projects are widely deployed in LDCs, as they are relatively low-cost compared to other mitigation options. And they seem to address an area of Sustainable Development Goal 7 (Affordable and clean energy) that is particularly relevant for LDCs, where, as on 2021, there were 891 million people (40 per cent of the global total) who relied mainly on polluting fuels and technologies for cooking.[5] It is not surprising, therefore, that 41 LDCs have included clean cooking or related goals in their nationally determined contributions (NDCs) (Clean Cooking Alliance, 2024).

The share of renewable energy-based carbon credits in LDCs is negligible, at 2 per cent of issued credits, whereas in ODEs, this is the largest sectoral category, accounting for 45 per cent, compared with only 8 per cent for household projects.

The sectoral distribution of issued credits is different for LDCs under the Clean Development Mechanism (figure II.3). Here, renewable energy accounts for the largest share (41 per cent), followed by household projects (39 per cent). Within the renewable energy category, the share of hydropower projects is 96 per cent of issued credits, while that of solar is only 1 per cent and no credits were issued for wind power projects. This is in stark contrast to ODEs, where wind power projects account for 47 per cent of all credits issued in the renewable energy category. In this context, high upfront investment costs of technology, infrastructure and grid integration, as well as technical capacity limitations, are likely the major barriers to implementing wind power projects in LDCs (Diógenes et al., 2020). More than two thirds of household-based credits come from cookstoves. The significant share of credits issued in the non-renewable energy sector does not reflect a general pattern; rather, it is due to large-scale projects that aim at reducing leakages from natural gas networks in Bangladesh[6] and a new gas-fired power plant in Mozambique.[7]

[4] Figures are rounded percentages; based on data from the Voluntary Carbon Market Dashboard by Climate Focus (updated 7 May 2024). Lighting and solar home systems account for less than 0.5 per cent of credits from the household category.

[5] UNCTAD calculation based on WHO Global Health Observatory, available at https://www.who.int/data/gho (accessed 5 June 2024).

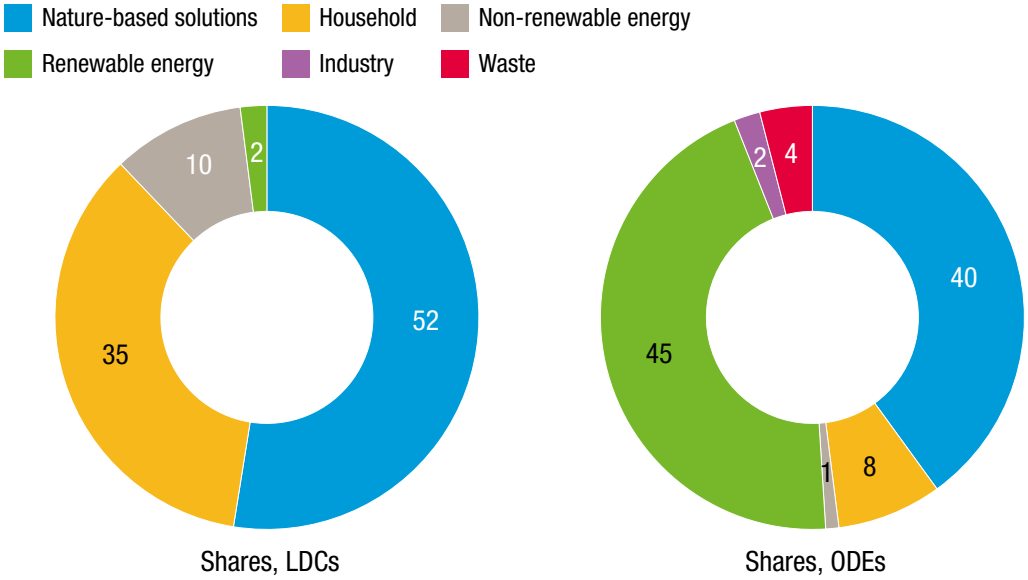
[6] See https://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1418008670.0/history, https://cdm.unfccc.int/Projects/DB/RINA1583155371.9/history, https://cdm.unfccc.int/Projects/DB/RINA1583158638.05/history, https://cdm.unfccc.int/Projects/DB/RINA1583318622.49/history and https://cdm.unfccc.int/Projects/DB/RINA1583328291.33/history.

[7] See https://cdm.unfccc.int/Projects/DB/CarbonCheck_Cert1479296630.72/view.

Figure II.2

Nature-based and household projects account for the bulk of credits issued in the voluntary carbon market in least developed countries

Shares of issued credits in the voluntary carbon market, by sector and country group* (Percentage)



* Cumulative until May 2024

Source: UNCTAD calculations, based on data from the registries of the American Carbon Registry, Architecture for REDD+ Transactions, Biocarbon, Cercarbono, Climate Action Reserve, Climate Forward, Global Carbon Council, Gold Standard, Plan Vivo, Puro.earth and Verra, and the Voluntary Carbon Market Dashboard of Climate Focus (updated 7 May 2024).

Notes: Percentages may not total 100 due to rounding. "Non-renewable energy" comprises all project types along the value chains of fossil fuel industries, including reducing fugitive emissions from natural gas networks, fuel switching to natural gas in power generation, coal mine methane, and gas recovery and utilization from oilfields. Fuel switching to natural gas in industrial plants is included under industry. Shares for LDCs do not show industry and waste, which account for less than 0.1 per cent of issued credits; likewise, a category "other", comprising the sum of carbon capture and storage and transport, is not shown.

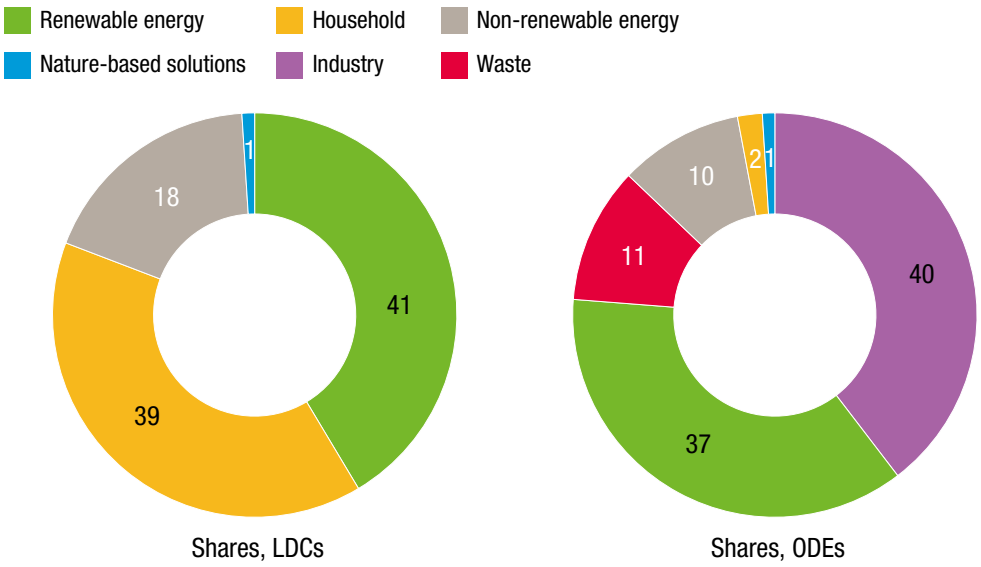
The bulk of carbon credits from baseline and credit schemes in LDCs originates from mitigation projects that aim at reducing emissions through forest protection, cleaner cookstoves and renewable energy. Overall, emissions reductions accounted for 96 per cent of all issued credits for the period January 2009 to May 2024, compared with only 4 per cent in the carbon removal category (comprising mainly reforestation and afforestation projects). The major reasons for this difference are the longer implementation periods and higher upfront costs of reforestation and afforestation projects, issues relating to monitoring and verification of sequestered carbon and risks, as well as uncertainties with regard to permanence. The distinction between emission reductions and removal is important in the context of carbon markets as the latter trades at a significant premium in the voluntary carbon market. For example, in 2023, removal-based credits traded at a premium of 245 per cent over the counter in the voluntary carbon market (Forest Trends' Ecosystem Marketplace, 2024).

Owing to the lack of transparency in carbon markets, in particular with regard to benefit-sharing, it is not possible to assess the volume of funds that were transferred to LDCs through those markets. However, it is possible to estimate the market value of LDC-sourced carbon credits in the voluntary carbon market by using average prices paid in market transactions and the volumes of issued credits. It must be noted that this market value does not represent

Figure II.3

Renewable energy and household projects account for 80 per cent of credits issued under the Clean Development Mechanism in least developed countries

Shares of issued credits in total credits under the Clean Development Mechanism, by sector and country group*
(Percentage)



* Cumulative to May 2024

Source: UNCTAD calculations, based on data from the UNEP CDM pipeline.

Note: Percentages may not total 100 due to rounding. In this chapter, certified emission are classified in the same categories as voluntary carbon market credits shown in figure II.2 to allow comparability of sectoral shares and volumes across all baseline and credit schemes. For «non-renewable energy», please see the note to figure II.2. Fuel switching to natural gas in industrial plants is included under industry. Shares for LDCs do not show industry and waste, which account for less than 0.5 per cent of issued credits; likewise, transport is not shown.

the size of financial transfers to the LDC host countries from underlying projects, since carbon markets are characterized by the presence of brokers, resellers and other intermediaries, all of which extract significant shares of the value created by mitigation activities (Carbon Market Watch, 2023). Calculating the market value of certified emission reduction credits sourced from LDCs faces similar constraints as for the voluntary carbon market. Although certified emission reduction credits are all certified by a centralized authority (the Clean Development Mechanism Executive Board), they are traded on various marketplaces, but with considerable price differentiation along underlying project characteristics. However, average prices paid on the United Nations online platform for voluntary cancellation of certified emission reduction credits are reported by the UNFCCC (2024), which are used to calculate the market values shown in table II.2.

The available data indicates that LDC-hosted mitigation projects in the voluntary carbon market and under the Clean Development Mechanism generated an estimated market value of $75.8 million in 2019, increasing to $305.1 million in 2021 due to a large rise in the value of nature-based credits (table II.2). In 2022, the market value increased to $403.5 million but dipped slightly to $403 million in 2023. Also in 2023, the household category – the bulk of which comprises cookstoves projects – became the largest category in the voluntary carbon market for the first time, in terms of both volume and value, accounting for 59 per cent of the

Table II.2

Baseline and credit schemes in least developed countries created a market value of $403 million in 2023

Volumes, average prices and market value of carbon credits sourced from least developed countries

Sector	2019			2020			2021			2022			2023		
	Volume ($MtCO_2e$)	Price ($/tCO_2e$)	Value (millions of $)	Volume ($MtCO_2e$)	Price ($/tCO_2e$)	Value (millions of $)	Volume ($MtCO_2e$)	Price ($/tCO_2e$)	Value (millions of $)	Volume ($MtCO_2e$)	Price ($/tCO_2e$)	Value (millions of $)	Volume ($MtCO_2e$)	Price ($/tCO_2e$)	Value (millions of $)
Nature-based solutions	11.11	4.33	48.10	12.47	5.40	67.36	40.23	5.78	232.54	21.92	10.14	222.30	15.96	9.72	155.12
Household	4.47	3.84	17.17	5.35	4.34	23.24	6.02	5.36	32.28	11.88	8.55	101.59	30.70	7.70	236.40
Renewable energy	0.36	1.42	0.51	0.55	1.08	0.60	0.96	2.16	2.07	0.91	4.16	3.80	0.92	3.88	3.56
Industry/ non-renewable energy	0.00	3.87	0.00	0.00	0.98	0.00	4.11	2.16	8.88	13.04	5.39	70.30	1.27	3.65	4.65
Waste	0.01	2.45	0.04	0.02	2.69	0.05	0.00	3.63	0.02	0.01	7.23	0.06	0.00	7.48	0.03
Total voluntary carbon market			65.82			91.24			275.77			398.05			399.76
Clean Development Mechanism	9.55	1.04	9.94	17.25	0.97	16.73	18.72	1.57	29.40	4.15	1.30	5.40	3.68	0.87	3.20
Total baseline and credit			75.80			108.00			305.20			403.50			403.00

Source: UNCTAD calculations, based on data from Forest Trends' Ecosystem Marketplace, 2021, 2022, 2023, 2024), the registries of the Gold Standard, Verra, Plan Vivo and Climate Forward, UNEP CDM pipeline and UNFCCC (2024).

Note: Due to rounding, some totals may not correspond with the sum of the separate figures. Certified emission reduction credit prices are based on average prices on the United Nations online platform for voluntary cancellation of certified emission reductions. Sectoral disaggregation for average certified emission reduction prices is not included in UNFCCC reports on this platform.

total market value of LDC-hosted mitigation projects in the voluntary carbon market and under the Clean Development Mechanism.

The value created by carbon markets is small compared to other external finance flows to the least developed countries

Overall, the value created by LDCs-hosted mitigation projects in carbon markets is small compared to other external finance flows to LDCs, which themselves are insufficient to meet the needs of LDCs (UNCTAD, 2023a). For instance, the market value of $403 million created by LDC-sourced carbon credits in 2023 corresponded to 1.3 per cent of the $31 billion of foreign direct investment (FDI) inflows, 1.1 per cent of net bilateral official development assistance (ODA) flows from Development Assistance Committee members and 0.6 per cent of the $66 billion remittances received by LDCs.[8] Moreover, the actual financial transfers to LDCs and communities hosting mitigation projects were significantly lower than the value created by downstream market transactions. This suggests that, so far, carbon markets have not made a significant contribution to sustainable development finance or to climate finance in the LDCs.

(b) The potential for land-based GHG mitigation in the least developed countries

Land-based emissions (i.e. emissions from land-use change, forestry and agriculture)[9] are responsible for the bulk of the LDCs' GHG emissions (UNCTAD, 2022). In 2021, total GHG emissions of the LDCs, including land-based emissions, amounted to 2.99 gigatons of CO_2-equivalent ($GtCO_2e$).[10] Of these, 1.35 $GtCO_2e$ (45 per cent) were from land-use change and forestry and 1 $GtCO_2e$ (33 per cent) was from agriculture. While the LDCs as a group were responsible for only 6 per cent of global GHG emissions in 2021, they accounted for 17 per cent of global GHG emissions from agriculture and for 42 per cent of GHG emissions from land-use change and forestry from all countries with net-positive emissions in this category. The Democratic Republic of the Congo accounted for the bulk of GHG emissions from land-use change and forestry in LDCs (630 $MtCO_2e$), followed by Myanmar (113 $MtCO_2e$) and Mozambique (73 $MtCO_2$). The three LDCs with the largest GHG emissions from the agricultural sector in 2021 were Ethiopia (124 $MtCO_2e$), Bangladesh (88 $MtCO_2e$) and Chad (82 $MtCO_2e$). These figures highlight the importance of land-based GHG emissions in LDCs and point to a significant potential in LDCs to contribute to global GHG mitigation efforts.

To assess the potential for land-based climate mitigation in LDCs, a dataset provided by Roe et al. (2021) is used.[11] It covers the forestry and agricultural sectors,[12] which also encompasses cookstoves and other household level interventions where mitigation is based on reduced collection of fuelwoods. This means that the sectoral scope of the analysis below of LDCs' mitigation potential covers the main projects currently funded through carbon markets in these countries, as nature-based credits and cookstoves make up 88 per cent of credits in the voluntary carbon market and 77 per cent of total credits issued through baseline and credit schemes (voluntary carbon market and Clean Development Mechanism combined).

Roe et al. (2021) cover projections up to 2050, and provide an assessment of country-level land-based mitigation potential disaggregated by sector. Their study also estimates both the technical

[8] Based on data from the *World Investment Report 2024* (UNCTAD, 2024), preliminary figures included in *ODA levels in 2023* (OECD, 2024), and the World Bank, World Development Indicators database, respectively.

[9] These emissions calculations are based on data in the Climate Watch online database, available at https://www.climatewatchdata.org/ghg-emissions (accessed 11 July 2024). The land-use change and forestry categories also include emissions from drained organic soils and fires.

[10] 1 $GtCO_2e$ = 1 000 $MtCO_2e$.

[11] See annex 2 for detailed notes on methodology notes for data usage and adaptation, based on Roe et al. (2021).

[12] In addition to forests, the data also cover peatland, grassland and mangroves, with the latter being one of the "blue carbon" ecosystems.

and cost-effective potential for mitigation. The cost-effective potential (the basis of the figures presented below) includes economically viable interventions at a carbon price of $100/tCO$_2$e. As this threshold is much higher than current prices for carbon credits, the estimates should be seen as an upper bound of a realistic potential. The global estimates of Roe et al. (2021) are in a similar range as previous assessments including IPCC (2015) and UNEP (2017). Naturally, the analysis presented in this chapter is subject to the caveats of Roe et al. (2021) such as the risk that future climate change impacts could reduce the potential for land-based mitigation.

For the period 2020–2050, the total cost-effective mitigation potential at $100/tCO$_2$e of land-based measures in LDCs is estimated to be 1 794 MtCO$_2$e/year, representing 15 per cent of the global cost-effective mitigation potential. Figure II.4 provides a breakdown of the cost-effective potential of different land-based measures as a percentage of total emissions. The data shows that the largest mitigation potential in LDCs lies in protecting forests and other ecosystems, accounting for 47 per cent of the total, followed by sequestering carbon through agricultural practices with a share of 28 per cent of the total potential. The restoration and management of forests and other ecosystems also have significant potential, at 14 per cent and 8 per cent, respectively.

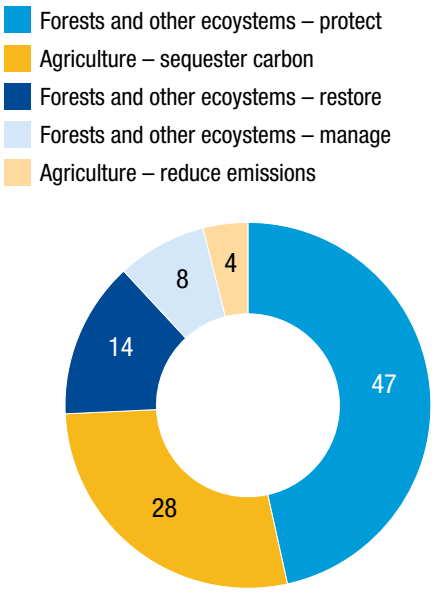
At the country level, the data shows significant variation in the mitigation potential (figure II.5). For instance, the Democratic Republic of the Congo shows the highest mitigation potential, at 382 MtCO$_2$e/year, mainly due to its vast natural forests and other ecosystems,[13] followed by Myanmar with 169 MtCO$_2$e/year and the United Republic of Tanzania with 123 MtCO$_2$e/year. The Democratic Republic of the Congo and Myanmar are among the top 15 countries worldwide with the highest cost-effective mitigation potential from land-based measures (Roe et al., 2021). At the other end of the spectrum, there are 17 LDCs where the cost-effective land-based mitigation potential is less than 10 MtCO$_2$e/year.

There are also significant differences between countries in terms of the sectoral composition of the land-based mitigation potential. For 16 LDCs, protecting forests and other ecosystems holds the largest potential, while the largest category for 22 LDCs is carbon sequestration in agriculture.

Figure II.4

Forests contain the bulk of land-based greenhouse gas mitigation potential in least developed countries

Shares of cost-effective annual mitigation potential (MtCO$_2$e) at $100/tCO$_2$ in least developed countries as a group, 2020–2050
(Percentage)



Source: UNCTAD, based on data from Roe et al. (2021).

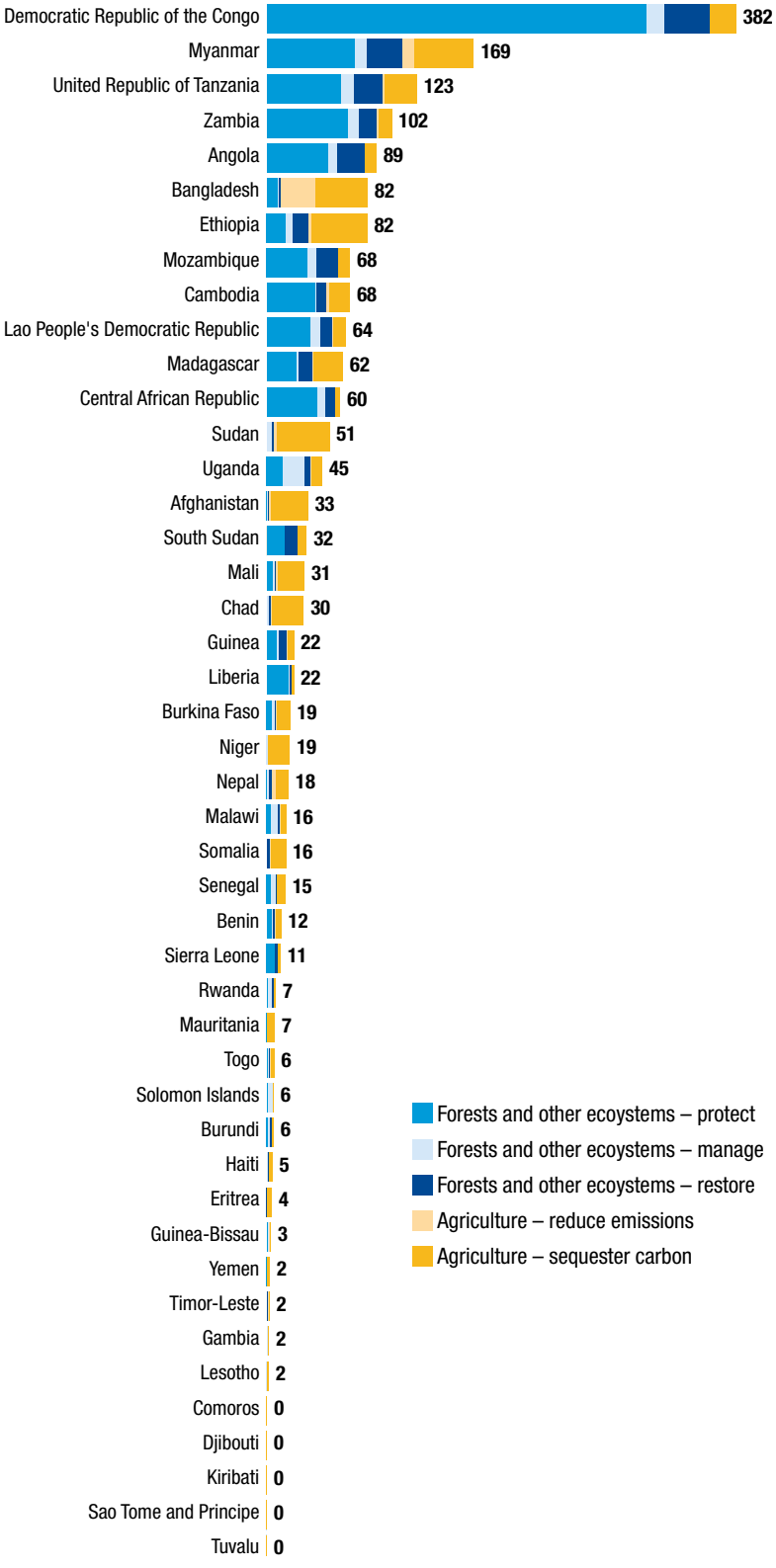
Note: Percentages may not total 100 due to rounding.

[13] Initiatives and support mechanisms focused on leveraging the unique potential of the Democratic Republic of the Congo for REDD+ activities include the Central African Forest initiative, the National REDD+ Fund, the European Union REDD Facility and the Forest Carbon Partnership Facility.

Figure II.5

Land-based greenhouse gas mitigation potential varies across least developed countries

Estimated annual mitigation potential mitigation potential of the least developed countries, 2020–2050 ($MtCO_2e$) at $100/$tCO_2$



Source: UNCTAD, based on data from Roe et al. (2021).

At the sectoral level, the Democratic Republic of Congo shows the highest total mitigation potential in protecting forests and other ecosystems, with an estimated 310 $MtCO_2e$/year, or 37 per cent of the total LDC potential in this category. It is followed by Myanmar, Zambia, the United Republic of Tanzania and Angola, with potentials of 72 $MtCO_2e$/year, 67 $MtCO_2e$/year, 61 $MtCO_2e$/year and 51 $MtCO_2e$/year, respectively. In the "forest and other ecosystems – manage" category, the five LDCs with the highest mitigation potential are Uganda (18 $MtCO_2e$/year), the Democratic Republic of the Congo (14 $MtCO_2e$/year), Myanmar (11 $MtCO_2e$/year), the United Republic of Tanzania (10 $MtCO_2e$/year) and Zambia (8 $MtCO_2e$/year). Following a similar pattern, the highest mitigation potentials in restoring forests and other ecosystems lie in the Democratic Republic of the Congo (37 $MtCO_2e$/year), Myanmar (28 $MtCO_2e$/year), the United Republic of Tanzania (23 $MtCO_2e$/year) and Angola (18 $MtCO_2e$/year).

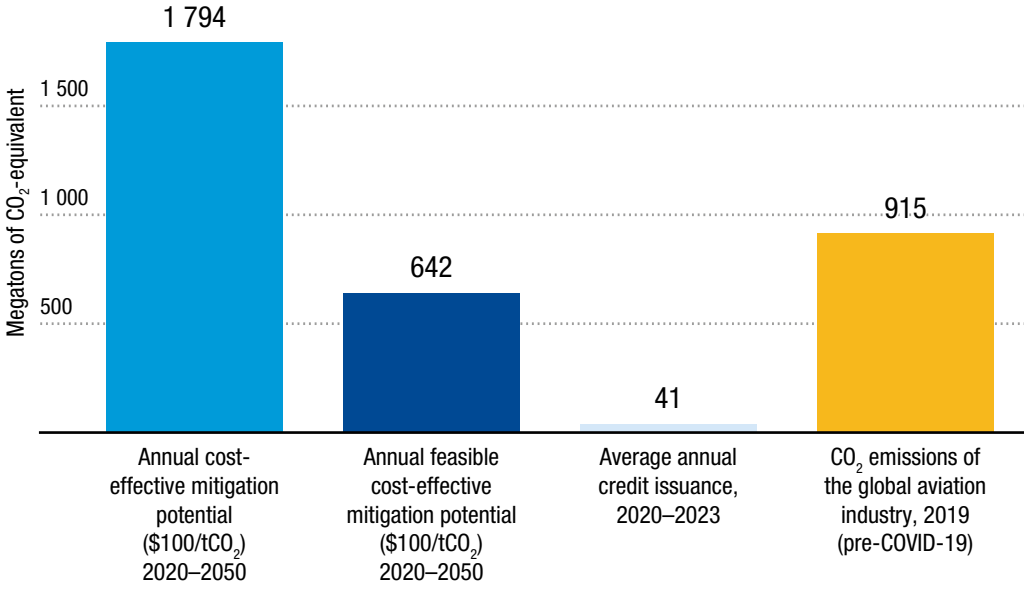
The country with the largest potential to sequester carbon in agriculture is Myanmar (48 $MtCO_2e$/year), followed by Ethiopia (45 $MtCO_2e$/year) and the Sudan (43 $MtCO_2e$/year). While emissions reduction in the agricultural sector accounts for only 4 per cent of the total cost-effective potential mitigation in the LDCs, it presents significant opportunities, particularly for Bangladesh, with a mitigation potential of 29 $MtCO_2e$/year, or roughly 45 per cent of the total for LDCs.

During the period 2020–2023, the average annual credit volume issued for nature-based solutions and household interventions in the voluntary carbon market and the Clean Development Mechanism amounted to 41 $MtCO_2e$ corresponding to 2.3 per cent of the 1,794 $MtCO_2e$ cost-effective land-based mitigation potential in LDCs (figure II.6). This figure shows that, so far, carbon markets unlocked only a minor share of the land-based mitigation potential of LDCs. However, there are significant differences at the country level. At the upper end of the spectrum, Malawi and Rwanda have a share of 29 per cent and 24 per cent, respectively, followed by Cambodia with

Carbon markets have harnessed **only a small share of land-based mitigation potential** in least developed countries

Figure II.6

Carbon markets have unlocked only a small share of land-based mitigation potential in least developed countries



Source: UNCTAD, based on data from Roe et al. (2021), the UNEP CDM pipeline, the registries of the Gold Standard, Verra, Plan Vivo and Climate Forward, and ICAO (2022).

15 per cent. Four other LDCs shares are in the range of 5–10 per cent (see annex table 1.1 for the shares of all the LDCs). There is also a stark contrast between the share of carbon removal in carbon credit volumes and total land-based mitigation potential in LDCs. While removals account for only 4 per cent of credit volumes issued in baseline and credit schemes, they contain an estimated share of 44 per cent of the cost-effective mitigation potential in LDCs.[14] Since credit prices for removal-based credits are significantly higher and more stable than for emission reductions, carbon removals represent an opportunity to expand carbon market activities in a particularly attractive market segment.

Improving the enabling conditions for investments in greenhouse gas mitigation in least developed countries is crucial

Two main factors that explain the low volume of land-based carbon credits issued compared with their cost-effective potential are the feasibility of mitigation projects in LDCs and the price of land-based carbon credits. The term "feasibility" here refers to the capacity of a country to effectively implement land-based mitigation projects. It includes all factors that determine the likelihood of cost-effective mitigation projects being undertaken. Feasibility scores in Roe et al. (2021) encompass enabling conditions across economic, institutional, geophysical, technological, sociocultural and environmental-ecological dimensions, based on the definition of feasibility by the Intergovernmental Panel on Climate Change (IPCC). The median feasibility score for implementing land-based mitigation measures in the LDCs is 36, which is low compared to ODEs (48) and developed countries (64). Thirty-three LDCs rank within the 25th percentile, while the remaining 12 rank within the 50th percentile, indicating that LDCs face significant barriers to implementing land-based mitigation measures. These figures also suggest that investments in strengthening the feasibility of land-based mitigation projects in LDCs, including through capacity-building, could contribute to unlocking their potential.

Using these country-level feasibility scores to scale the cost-effective mitigation potential at $100/t$CO_2$ in LDCs leads to an estimated feasible cost-effective mitigation potential of 642 $MtCO_2e$ per year (figure II.6). This corresponds to 70 per cent of the CO_2 emissions of the global aviation industry in 2019[15] (the last year before the COVID-19 pandemic caused a drop in air traffic), equivalent to 2 per cent of global anthropogenic CO_2 emissions.

An analysis of feasibility scores, combined with information on economy-wide emissions and mitigation potentials, provides a clearer picture of where investments can be the most effective. It also highlights specific challenges and opportunities faced by LDCs. Following Roe et al. (2021), figure II.7 plots the feasibility scores against the cost-effective potential as a percentage of GHG emissions. Based on this presentation, LDCs can be broadly categorized into six sections (A to F). Countries in sections A and B possess a land-based mitigation potential greater than 100 per cent of total country emissions and are thus potential carbon sinks. Countries in the middle sections (C and D) have potentials between 30 per cent and 100 per cent, while countries in sections E and F have less than 30 per cent mitigation potential relative to total emissions, primarily due to their low land-based mitigation potential.

Section A (very high potential, low feasibility) contains 10 LDCs, including the Democratic Republic of the Congo, Burundi and Myanmar, indicating high cost-effective potential but with existing implementation barriers. Section B (very high potential, medium feasibility) includes Rwanda and Uganda, which have high cost-effective potential with moderate feasibility. Section C (high potential, low feasibility) includes 18 LDCs, predominantly in Africa where the potential for land-based mitigation measures is significant, but the capacity

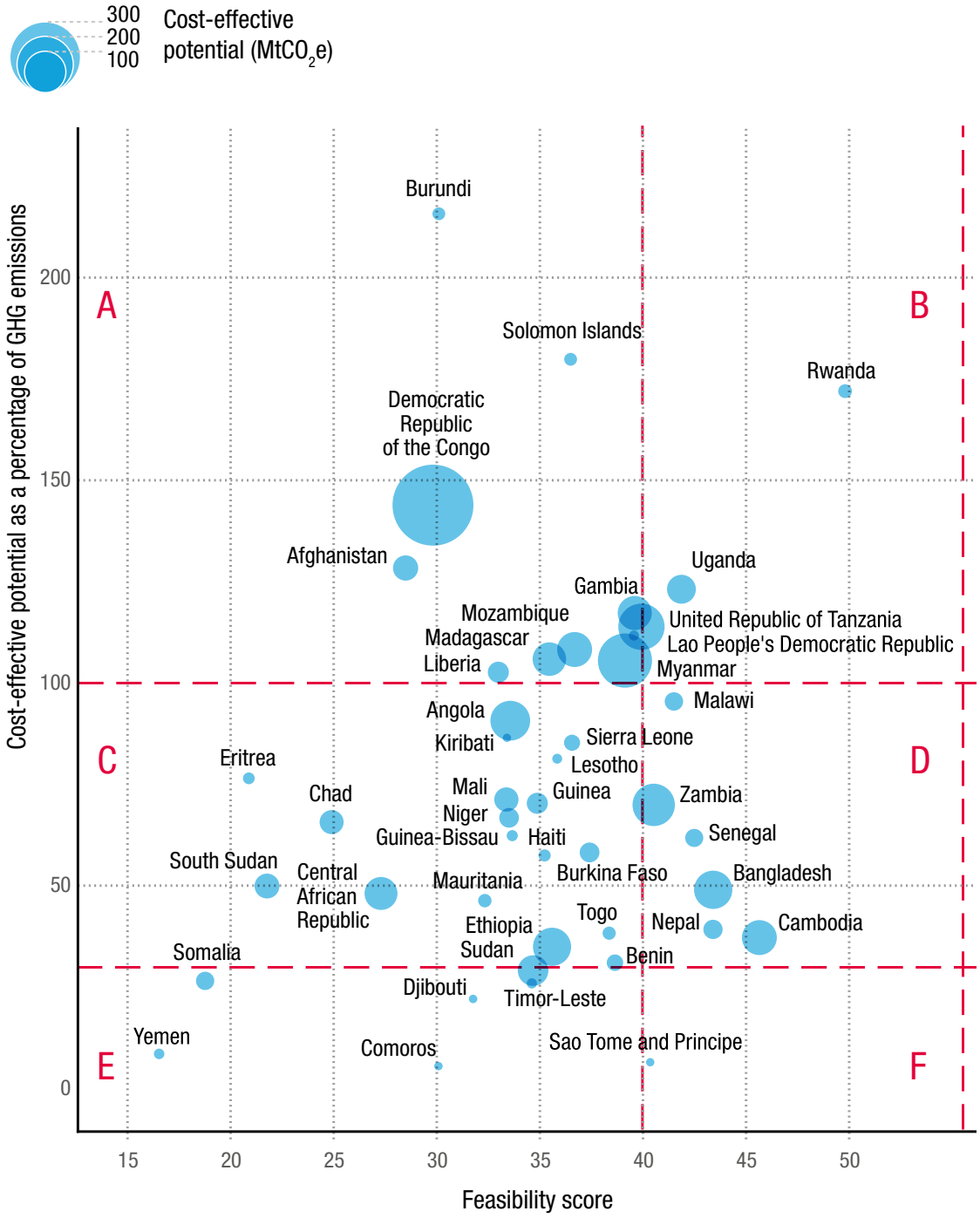
[14] See annex 2 for an explanation of the calculation of shares of emission reductions and carbon removals.

[15] The CO_2 emissions of the global aviation industry in 2019 are estimated at 915 $MtCO_2e$ (ICAO, 2022).

Figure II.7

Cost-effective potential and implementation feasibility vary across least developed countries

Feasibility scores and cost-effective mitigation potential as a share of total greenhouse gas emissions



Source: UNCTAD calculations, based on data from Roe et al. (2021).

Note: The feasibility score (0–100) is plotted against the total cost-effective land-based mitigation potential as a percentage of total country GHG emissions. Circles represent the relative size of the total cost-effective potential in $GtCO_2e$ per year. The vertical dashed lines indicate the global interquartile range of feasibility scores. The horizontal lines represent thresholds where land-based measures can deliver over 30 per cent of cost-effective mitigation potential (aligned with a global 1.5° trajectory) and over 100 per cent (indicating the capability to achieve net-zero or negative emissions solely through land-based measures).

Current carbon credit prices are too low to realize land-based mitigation potential in least developed countries

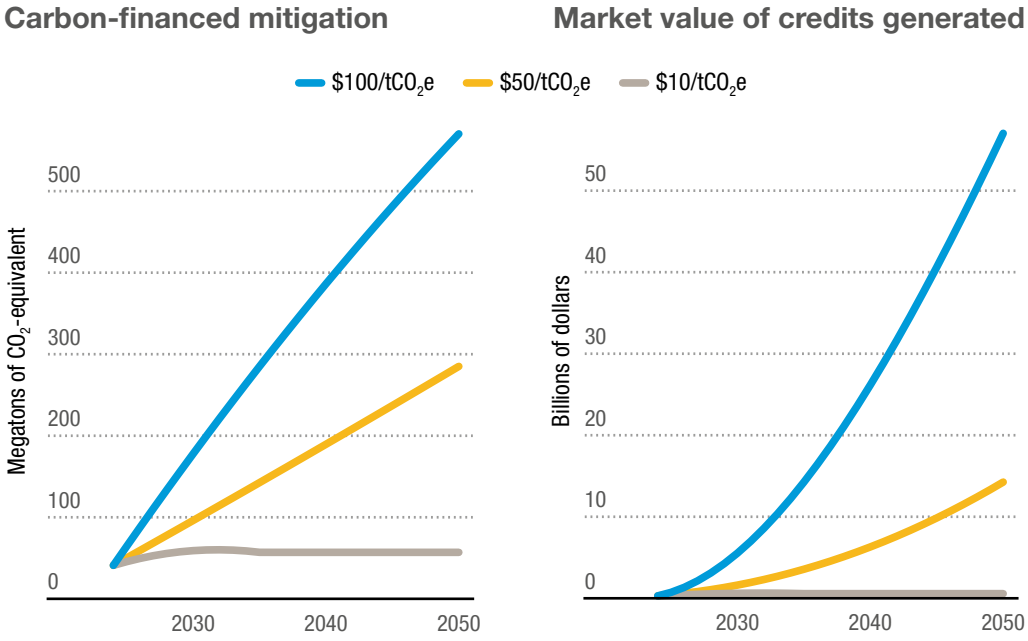
for realization remains a challenge. Section D (high potential, medium feasibility) covers LDCs where land-based mitigation measures are likely to be effective. Section E (low potential, low feasibility) includes the Sudan, Somalia and Yemen. Section F (low potential, medium feasibility), which features only Sao Tome and Principe, suggests that while relatively feasible, the cost-effective potential in this country is limited.

In addition to feasibility scores, which affect the likelihood of implementing mitigation projects, carbon credit prices can act either as drivers of or barriers to investments in mitigation projects in LDCs. Figure II.8 shows a simulation of carbon-financed land-based mitigation in LDCs and corresponding market values of generated carbon credits for the period 2024 to 2050. The simulation shows that, unless carbon prices increase substantially from current levels, only a marginal share of the land-based mitigation potential in LDCs will be realized through 2050. For instance, in a scenario where land-based carbon credit prices plateau at $10, 97 per cent of the mitigation potential in LDCs would remain unused through 2050. Given the huge potential of land-based mitigation in these countries, this would signify a missed opportunity to make a significant contribution to achieving the objectives of the Paris Agreement. In this

Figure II.8

At current carbon credit prices, most of the land-based mitigation potential in least developed countries would remain untapped

Simulation of land-based greenhouse gas mitigation and market value of carbon credits in least developed countries, 2024–2050



Source: UNCTAD.

Notes: The simulation shows three scenarios where carbon credit prices for land-based mitigation increase to $100, $50 and $10, respectively, by 2050, following a quadratic growth path. For the $100 and $50 scenarios, the midpoints of $50 and $25, respectively, are assumed to be reached in 2035, while for the third scenario, it is assumed that $10 is reached in 2035.The simulation assumes a linear price-credit volume relationship. The starting point of the simulation is a carbon credit price of $7.20 per tCO_2e (the weighted average over-the-counter price of land-based carbon credits issued for LDC-hosted projects in the period 2020–2023) and a credited volume of 41 $MtCO_2e$ (the average annual volume of land-based carbon credits issued for LDC-hosted projects in the period 2020–2023). The market value corresponds to the implied market value of carbon credits generated from LDC-hosted mitigation projects.

context, it must also be noted that a further drop in prices for nature-based carbon credits is possible. This is not a hypothetical scenario, as over-the-counter (OTC) prices for forestry and land-use-based credits fell from $10.14 in 2022 to $9.72 in 2023 (Forest Trends' Ecosystem Marketplace, 2024), and the prices of exchange-traded nature-based credits are much lower than reported OTC prices. For instance, the average front-month price of nature-based credit futures traded on the exchange platform CBL in 2023 was $1.75.[16]

(c) Renewable energy and carbon markets in least developed countries

Electricity is a fundamental pillar of development. It powers industry, fuels economic growth, and provides the basis for essential services such as health care, education and communication (IEA, 2011; Panos et al., 2016). Without electricity, people – primarily women and girls – need to spend hours fetching water, clinics cannot store vaccines, schoolchildren cannot do homework at night, people cannot run competitive businesses and entrepreneurship cannot thrive. Access to electricity also has a range of gender-specific impacts, affecting women and men differently in terms of health, education and economic opportunities (ENERGIA et al., 2018). The critical importance of access to electricity access is anchored in Goal 7 of the Sustainable Development Goals, which calls for ensuring access to affordable, reliable, sustainable and modern energy for all. Carbon markets could contribute to the modernization and diversification of the energy mixes in LDCs by enabling the development and/or expansion of renewable energy technologies that are underdeveloped in LDCs, such as solar photovoltaic and wind energy.

While carbon markets currently play only a minor role in the energy sector of LDCs, there is potential for scaling up as there are both large investment needs and GHG mitigation potential. Over the period of 2018–2020, around 26 per cent of energy-related GHG emissions originated from the electricity sector in LDCs. At the same time, LDCs are among the countries with the lowest electrification rate and have a long way to go before 2030 to be able to reach Sustainable Development Goal 7 (box II.1). Recent progress in expanding access to electricity has not been met with proportional increases in capacity and production. Even at low access rates, household electricity consumption accounted for 44 per cent of total electricity consumption in the LDCs in 2021.[17] This high share is indicative of low levels of industrialization and, more generally, of low productive capacities (UNCTAD, 2017).

Carbon markets could contribute to diversification of the energy mixes in least developed countries

The need to expand access and the scope for future growth are highlighted by the fact that LDCs as a group accounted for only 2 per cent of the world's household electricity consumption in 2021, but has 14 per cent of the world's population. According to UNCTAD calculations undertaken for this chapter, LDCs have experienced a rapid surge in household electricity consumption in recent years. Since 2010, electricity consumption has expanded at an average annual rate of 8.5 per cent, outpacing the world's average annual consumption growth rate of 2.3 per cent over the same period.

Despite recent growth, household electricity consumption per capita in the LDCs remained low at 95.2 kilowatt-hours (kWh) in 2021, compared to the world average of 829 kWh. It is noteworthy that the Lao People's Democratic Republic, which has achieved universal access to electricity, had the highest per capita consumption of 308 kWh, while the lowest was in

Household electricity consumption per capita in least developed countries remains low

[16] Calculated as the average monthly closing price of CBL Nature-Based Global Emissions Offset futures.

[17] Electricity consumption and production figures in this section are from UNCTAD calculations based on data provided by the United Nations Statistics Division, Energy Statistics Database, available at http://data.un.org/Explorer.aspx; data for the Gambia, Liberia and Somalia are missing.

the Central African Republic, Chad and Sierra Leone, where it did not exceed 10 kWh that year (annex table 1.2).

Electricity production figures show a similar pattern. After stagnating, in per capita terms, through most of the 1990s, electricity production in LDCs has experienced robust growth since, nearly tripling, from 128 kWh per capita in 2000 to 351 kWh per capita in 2021. This increase can be attributed to the expansion of installed capacity, which rose from 0.03 kW per capita to 0.10 kW per capita between 2000 and 2021.[18] However, the efficiency of capacity utilization has seen a decline since the early 2000s, with the capacity factor dropping from around 53 per cent in 2000 to nearly 41 per cent in 2021.[19] The overall figures for electricity production conceal considerable heterogeneity among individual LDCs. Only 6 countries (Bangladesh, Cambodia, the Lao People's Democratic Republic, Mozambique, Tuvalu and Zambia) recorded electricity production exceeding 500 kWh per capita in 2021. Meanwhile, 21 countries fell within the range of 100 kWh to 500 kWh per capita, and 18 countries reported production below 100 kWh per capita, while the figure for 8 of them was even less than 50 kWh. Notably, the Lao People's Democratic Republic stands out as the sole country with production exceeding 1,000 kWh per capita, surging to 6,051 kWh in 2021.[20]

Least developed countries need to **expand access to electricity while also boosting capacity and production**

The recent expansion of electricity generation has been broad-based, with gross electricity output rising across most LDCs between 2010 and 2021. Exceptions to this positive trajectory were observed in the Central African Republic, Malawi and Yemen. The median compound annual growth rate for total electricity production in LDCs reached 6 per cent, with several countries experiencing double-digit growth rates. These included fossil fuel exporters such as Timor-Leste and other LDCs such as Benin, Cambodia, Ethiopia, Guinea, the Lao People's Democratic Republic, Nepal and Rwanda. Additionally, while the Central African Republic and Malawi experienced declining trends with compound annual growth rates of -0.9 per cent and -0.3 per cent, respectively, the most pronounced decline was observed in Yemen, where gross production of electricity fell by 8.5 per cent between 2010 and 2021. Meanwhile, installed capacity expanded significantly over the same period in almost all LDCs.

Impressive as this growth may seem, both capacity and production have failed to keep pace with the remarkable 184 per cent increase in the number of people gaining access to electricity in LDCs between 2010 and 2022. In fact, the average compound annual growth rates of both gross electricity production and capacity per person with access to electricity for all LDCs between 2000 and 2021 were negative, at -2 per cent.

This situation presents a classic case of the energy trilemma: security, affordability, and sustainability (World Energy Council, 2024). As access to electricity grows, so does its demand. However, if capacity and production lag, it can lead to energy insecurity, higher costs, and reliance on unsustainable sources. Therefore, LDCs need strategies that aim to expand access while also boosting capacity and production.

One important area for improvement is the updating of utility regulations. Modernizing these regulations can facilitate the transition towards access to sustainable energy and achieving Goal 7. A review

[18] UNCTAD calculations, based on data from by the United Nations Department of Economic and Social Affairs, Population Division, *World Population Prospects: The 2022 Revision* and the United States Energy Information Administration, International Energy Data.

[19] UNCTAD calculations, based on data from the United Nations Statistics Division, Energy Statistics Database, the United Nations Department of Economic and Social Affairs, Population Division, *World Population Prospects: The 2022 Revision*, and the United States Energy Information Administration, International Energy Data.

[20] The Lao People's Democratic Republic is among the few electricity exporters within the LDC group, owing mainly to its large hydropower production, including from the 1,285 MW Xayaburi plant on the Mekong River.

of international regulatory indicators on sustainable energy and its access shows there is significant room for improvement in LDCs. For instance, according to the 2021 Regulatory Indicators for Sustainable Energy (RISE),[21] the median energy access indicator, which measures the policies and regulations that support the expansion of reliable electricity services, is 49 for LDCs, which is significantly lower than the median score of 59 for ODEs. Moreover, the median renewable energy indicator, which measures the policies and regulatory support that countries have put in place to facilitate the integration of renewable energy sources into their energy mix, is 37 for LDCs compared with 54 for ODEs.

Box II.1
Access to electricity in the least developed countries

As recently as 2022, over 685 million people worldwide still lacked access to electricity, with 71 per cent of this population living in LDCs.[a] This is a highly disproportionate share, given that LDCs only accounted for about 14 per cent of the global population in 2022,[b] highlighting the need for effective solutions to address the electricity access deficit in these countries.

LDCs have made significant strides towards achieving universal access to electricity (figure II.9), with an average compound annual growth rate of 5 per cent since 2010. While some LDCs, such as the Lao People's Democratic Republic, Timor-Leste and Tuvalu, have achieved universal access to electricity, UNCTAD calculations show that even in 2022, 45 per cent of people residing in LDCs (or 496 million people) still lacked access to this basic human, social and economic necessity.

In 8 of the 45 LDCs, namely Burkina Faso, Burundi, the Central African Republic, Chad, the Democratic Republic of the Congo, Malawi, the Niger, and South Sudan, at least 78 per cent of the population lacked access to electricity, with countries such as Burundi and South Sudan surpassing the 90 per cent mark. This disparity is noteworthy, as this subgroup constitutes approximately one fifth of the LDC population and 37 per cent of the total LDC population lacking access to electricity.

UNCTAD projections indicate that at the current rate of progress the average electricity access rate in LDCs will only reach 73 per cent by 2030.[c] Moreover, the gap in electricity access rates between LDCs and ODEs is widening. For instance, based on current progress rates, LDCs will only reach the 2022 average electricity access rate of ODEs of 93 per cent by 2062 and will reach an average access rate of 95 per cent by 2066. These projections show that LDCs, together with development partners, need to significantly redouble their efforts in order to attain Goal 7.

Source: UNCTAD.

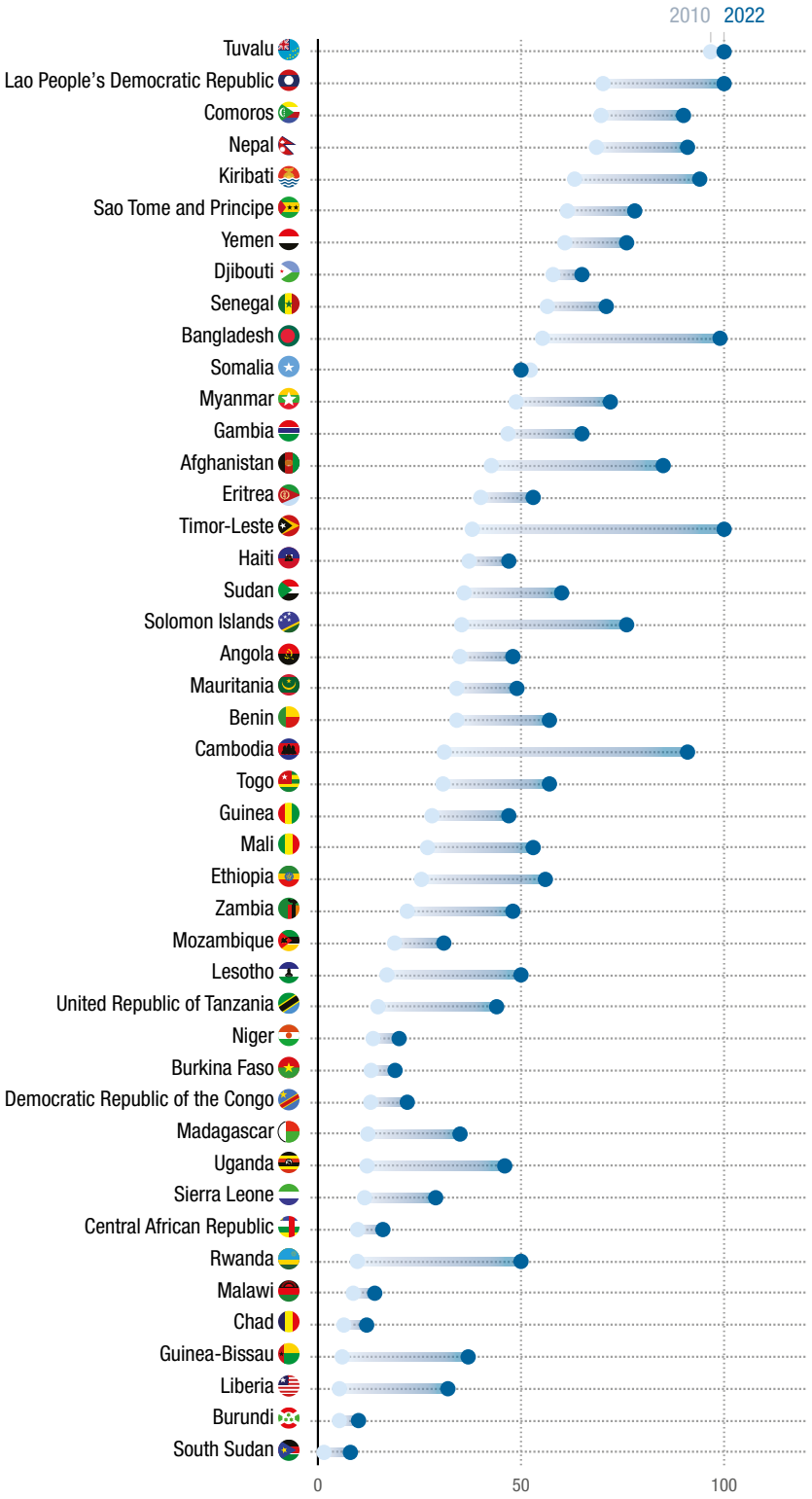
[a] UNCTAD calculations, based on the United Nations Department of Economic and Social Affairs Sustainable Development Goals Indicators Database (indicator 7.1.1), available at https://unstats.un.org/sdgs/dataportal/database.
[b] UNCTAD calculations, based the United Nations Department of Economic and Social Affairs, Population Division, *World Population Prospects: The 2022 Revision*.
[c] The projections are based on country-specific compound annual growth rates of SDG Indicator 7.1.1 observed for the period 2010 to 2022 (see annex table 1.3 for country-level projections).

[21] Based on RISE, a set of indicators developed by the World Bank to compare the policy and regulatory frameworks of countries in support of achieving Goal 7. The fourth edition of RISE captures data up to the end of 2021 and includes 30 indicators and 85 subindicators distributed across four pillars: electricity access, clean cooking, renewable energy and energy efficiency. Data are available for 36 of the 45 LDCs.

Figure II.9

Access to electricity in least developed countries remains a major challenge despite recent progress

Percentage of the population



Source: UNCTAD, based on data from the United Nations Sustainable Development Goal Indicators Database, available at https://unstats.un.org/sdgs/dataportal (accessed 5 June 2024).

The energy mix in LDCs is characterized by a high share of renewables (figure II.10), the average share being 60 per cent of their total final energy consumption (Sustainable Development Goal indicator 7.2.1) in 2021. Renewable power generation capacity is dominated by hydropower (table II.3), which accounts for 87 per cent of this category. In this regard, it is important to note that hydropower is vulnerable to climate change impacts such variations in rainfall, droughts and flooding, which can undermine its reliability and efficiency. Consequently, diversifying the renewable energy mix is crucial for enhancing systemic resilience and ensuring a stable energy supply. Low access to capital and financing is among the main obstacles to investments in renewable energy deployment. For instance, investment projects in the energy sector face higher financing costs and take longer to reach financial closure than in other developing economies (UNCTAD, 2023b).

There is considerable potential and political ambition to expand renewable energy in LDCs to meet their growing energy needs. Renewable energy can help improve access to electricity by increasing grid capacity, as can off-grid solutions in rural areas where the lack of access is particularly prevalent (UNCTAD, 2017). In their NDCs, the LDCs have committed to a combined 105 gigawatts (GW) of renewable installed capacity by 2030 (IRENA, 2023),[22] more than double the 47 GW installed in 2023 (IRENA, 2024). As the LDCs as a group already rely heavily on renewable energy in the power sector, where renewables accounted for a share of 48 per cent of installed capacity in 2023, the renewable energy plans included in their NDCs are paramount to increasing total installed electricity capacity by 59 per cent from 2023 to 2030. Of the additional 58 GW of renewable energy, 28 GW are to be built unconditionally and an additional 30 GW are conditional on external financial support, mainly for emerging technologies such as solar and wind (IRENA, 2023), the shares of which are currently very small within the renewable energy mix (table II.3).

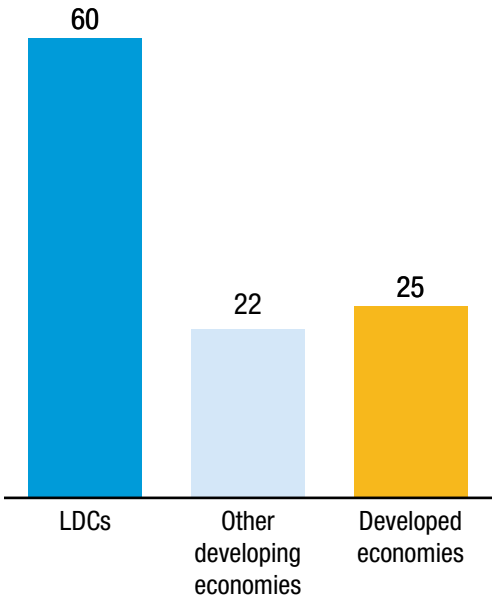
Large investments, underpinned by a massive scaling up of financial flows to the renewable energy sectors of LDCs, will be necessary to achieve these targets, particularly since recent data show that the LDCs received less than 1 per cent of total global investments in renewable energy in 2013–2020 (IRENA and CPI, 2023).

The energy mix in least developed countries contains a **high share of renewables**

Figure II.10

Least developed countries have a higher share of renewables in their energy mix than other country groups

Average share of renewable energy in total final energy consumption, 2021* (Percentage)



* Sustainable Development Goal indicator 7.2.1.

Source: UNCTAD calculations, based on data from the United Nations Sustainable Development Goal Indicators Database, available at https://unstats.un.org/sdgs/dataportal (accessed 9 May 2024).

[22] This figure includes Bhutan, which graduated from the LDC category in December 2023.

Table II.3

Hydropower accounts for the bulk of installed renewable power generation capacity in the least developed countries

Shares of renewable technologies in total renewable power generation capacity, 2023

Technology	Installed capacity (Megawatts)	Share in total (Percentage)
Hydropower (excl. pumped storage)	40 912	87.14
Solar energy	4 114	8.76
Bioenergy	1 204	2.57
Wind energy	713	1.52
Geothermal energy	7	0.02
Total	**46 950**	

Source: UNCTAD calculations, based on data in IRENA (2024).

2. Article 6: Opportunities and risks for least developed countries

While no final decisions on rules on Article 6 of the Paris Agreement were made at the twenty-eighth Conference of the Parties to UNFCCC (COP28) in 2023, previous COP decisions laid out a framework that was sufficient for countries to start operationalizing Article 6.2.[23] On 15 December 2023, the first ever internationally transferred mitigation outcome transaction under this article took place between Thailand and Switzerland.[24] Furthermore, although no new projects can be registered under Article 6.4 before detailed rules are decided by the Conference of the Parties that serves as the meeting of the Parties to the Paris Agreement, the projects that successfully transition from the Clean Development Mechanism to the Article 6.4 mechanism will lead to its de facto operationalization.

(a) Article 6.2 arrangements

As of June 2024, 82 arrangements under Article 6.2 were in place worldwide, including 14 in 9 LDCs (table II.4). In addition to these existing arrangements, numerous LDCs have expressed an interest in Article 6 cooperation in their NDCs or other policy documents. For instance, 29 of the 45 LDCs have stated their intention to use voluntary cooperation under that article in their NDCs.

LDCs, like most developing economies, are host countries of these arrangements, which is to say that they are on the supply side of the Article 6 carbon market, while the majority of buyers of internationally transferred mitigation outcomes are developed countries. From the buyers' perspective, the costs and benefits are clear: they acquire internationally transferred mitigation outcomes to be counted towards their NDCs and achieve emission reduction targets at a lower cost. This is because their domestic mitigation costs are higher than in host countries. In other words, they are reaping low-hanging fruits.

[23] See chapter 1 for a detailed description of Article 6 of the Paris Agreement.

[24] See https://unepccc.org/article-6-pipeline/#:~:text=On%2015%20December%202023%2C%20the,6.2%20of%20the%20Paris%20Agreement.

From the host country's perspective, the ramifications are less straightforward, as internationally transferred mitigation outcomes trigger a corresponding adjustment to the host country's emissions. Consequently, adjusted emissions reported by the host country are higher than actual emissions (figure II.11), while the opposite is the case for the buyer country. This raises several questions with regard to domestic climate policy in the host country.

First of all, mitigation projects underlying "exported" internationally transferred mitigation outcomes are no longer available for the host country. It is therefore important for LDCs to differentiate in their NDCs

Table II.4

The least developed countries are among the early movers under Article 6.2 of the Paris Agreement

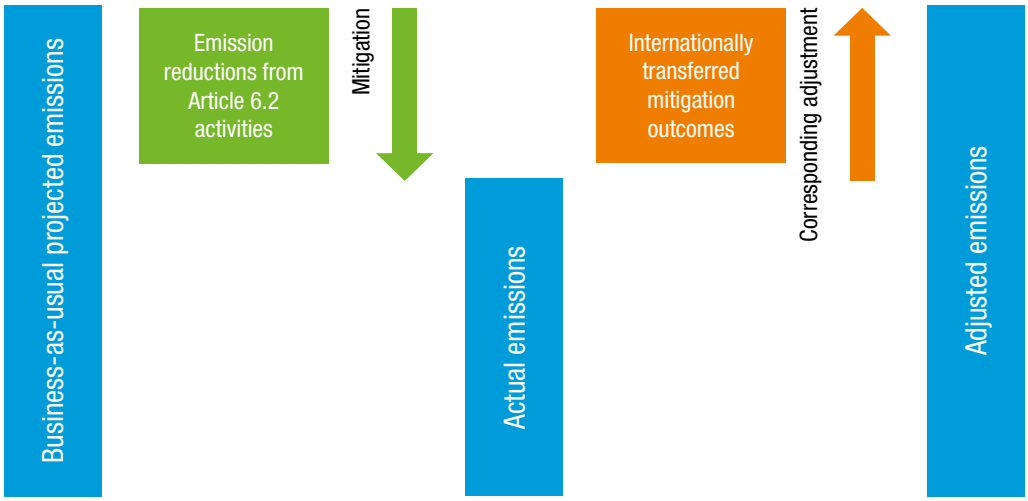
Article 6.2 arrangements with least developed country participation as of June 2024

LDC host	Buyer(s)
Bangladesh	Japan
Cambodia	Japan, Singapore
Ethiopia	Japan
Lao People's Democratic Republic	Japan, Republic of Korea
Malawi	Switzerland
Myanmar	Japan
Nepal	Sweden
Rwanda	Kuwait, Singapore
Senegal	Japan, Norway, Singapore, Switzerland

Source: UNCTAD, based on information in the Article 6 pipeline database of the UNEP Copenhagen Climate Centre, available at https://unepccc.org/article-6-pipeline (accessed 3 July 2024).

Figure II.11

The transfer of internationally transferred mitigation outcomes leads to upwards adjustment of an exporting country's emissions



Source: UNCTAD.

Buyers of internationally transferred mitigation outcomes focus on low-hanging fruit

between unconditional mitigation activities (those mitigation activities that host countries are committing to undertake on their own, without external support) and mitigation activities that can be included under Article 6 cooperative frameworks. This is no easy task and not generally a feature in the existing NDCs of LDCs. For instance, the updated NDC of Uganda (2022) clearly specifies quantified conditional and unconditional NDC targets for 2030. It also lists detailed mitigation measures by sector and quantifies their contribution to overall mitigation targets. However, its NDC does not provide a distinction between unconditional and conditional measures at the sectoral or subsectoral levels, so it is unclear how individual mitigation projects would be classified. Therefore, it might be helpful for LDCs to develop systems allowing them to distinguish between conditional and unconditional activities at the project level to ensure a clear separation between tradable and non-tradeable emission reductions and thus safeguard their ability to reach their own NDCs. Furthermore, for the preparation of future NDCs, LDCs will need to take into account the fact that only mitigation activities within the conditional scope of NDCs can be used to mobilize finance through the transfer of internationally transferred mitigation outcomes and plan their activities accordingly.

Second, where individual projects have different unit mitigation costs, there is a risk that buying countries will focus on cheaper mitigation projects (the low-hanging fruits), which could leave LDCs with the task of implementing the most expensive projects to reach their own NDC targets. This risk extends across NDC periods, and LDCs need to be aware that exporting internationally transferred mitigation outcomes in the current NDC period could lead to rising average abatement costs in future NDC periods. In other words, selling low-hanging fruits makes the pursuit of a policy of increasing mitigation ambition in the spirit of the Paris Agreement more expensive. This source of risk can be mitigated by ensuring that a fair share of emission reductions from Article 6.2 arrangements remains in LDCs. In this context, it is important that the principle of "equitable sharing of mitigation benefits between the participating Parties", as specified in Article 6.4 rules, modalities and procedures (UNFCCC, 2021), is also upheld in bilateral arrangements under Article 6.2.

Third, there is the risk of time inconsistency of internationally transferred mitigation outcome transactions. Given that LDCs can sell internationally transferred mitigation outcomes from mitigation projects only once, the question arises as to how to time and sequence mitigation projects within and between Article 6.2 arrangements. If the value of internationally transferred mitigation outcomes increases as climate policy is tightened around the world and marginal abatement costs in developed countries increase, it might be more beneficial from the perspective of a host country to wait rather than to sign off on mitigation projects and internationally transferred mitigation outcome transfers on less favourable terms.

Fourth, for LDCs that have engaged, or intend to engage, in Article 6.2 arrangements with multiple bilateral partners, the question of transaction costs needs to be assessed. As each bilateral agreement is negotiated individually, and has its own terms and conditions, the administrative burden associated with supervision and coordination increases with the number of bilateral partners. In this regard, developing national systems in LDCs and requiring bilateral partners to adapt to them could help limit transaction costs and administrative burdens of Article 6.2 arrangements.

Finally, another source of risk for host countries is that internationally transferred mitigation outcome buyer countries are generally developed countries (i.e. those that are also providers of climate finance). From the perspective of a buyer country, the possibility of receiving internationally transferred mitigation outcomes in return for investments in mitigation activities could create an incentive to redirect climate

finance flows towards Article 6.2 activities. There is some evidence that, in the past, there has been a relabelling of ODA funds towards climate finance (Miller et al., 2023). In this context, it is important to safeguard additionality of climate finance and ensure that there is no rechannelling of scarce climate finance flows towards Article 6.2 arrangements. Otherwise, it could result in further geographic concentration as well as a stronger focus on mitigation. However, it is adaptation finance that is a greater priority for LDCs as they are among the most climate-vulnerable countries in the world (UNCTAD, 2023a).

(b) The Article 6.4 mechanism

Detailed rules of the Article 6.4 mechanism are still under development. Nevertheless, the existing rules, modalities and procedures include provisions that are particularly relevant for the LDCs.

In line with the principle of common but differentiated responsibilities under the UNFCCC, there is a waiver of all administrative fees for LDCs, including for registration, inclusion of component project activities in a registered programme of activities, credit issuance, renewal and post-registration changes to project activities (UNFCCC, 2022a).

Another relevant feature of Article 6 rules, modalities and procedures for LDCs, in particular, which was adopted at COP26, is that suppressed demand should be recognized by methodologies under the mechanism. The concept of suppressed demand[25] was introduced under the Clean Development Mechanism with the aim of enabling the participation of countries with low historical and contemporaneous emissions levels, such as most LDCs. Suppressed demand exists, for example in areas that have in the past not been connected to a power grid, and where emissions from electricity use are low or zero. In such areas, the deployment of renewable energy solutions, such as renewable mini grids, might not lead to emission reduction compared to historical emissions. However, accounting for suppressed demand could increase the volume of creditable emission reductions under Article 6.4, which is particularly relevant for many LDCs, where the lack of access to energy of rural populations is alarmingly prevalent.[26] Suppressed demand could also play a role in new grid-connected renewable energy plants, which could lead to higher electricity consumption due to income and price effects (Spalding-Fecher, 2015). Also, in this case, accounting for suppressed demand could lead to higher volumes of creditable emission reductions.

In recommendations included in its annual report for 2023 (UNFCCC, 2023a), the Article 6.4 Supervisory Body specifies that suppressed demand will be recognized where the current level of "services provided to a population are insufficient to meet basic human needs (such as the minimum amount of electricity for lighting and for heating or cooling) owing to barriers, including low income or lack of infrastructure, and where the growth in emissions resulting from meeting such needs requires special consideration when assessing Article 6.4 baseline scenarios". The Supervisory Body will develop guidance as to how suppressed demand will be built into the mechanism, in particular in baseline setting, which is a crucial element for calculating Article 6.4 emission reduction amounts and, thus, the profitability or viability of individual mitigation projects. Including such latent demand increases the creditable amount for a given mitigation project. Thus, recognizing suppressed demand considerable potential in LDCs, where the basic human needs of large segments of their population are not being met, particularly in relevant infrastructure services such as power

[25] Suppressed demand refers to the concept of considering the latent, unmet demand for basic services in underdeveloped areas, which, when eventually met, would lead to higher emissions.

[26] The average rate of access to electricity in rural areas in the 41 LDCs for which data are available was 78 per cent in 2022.

supply (see section A.1.c. above, on renewable energy and carbon markets).

Suppressed demand is an important factor in many least developed countries

Rules relating to establishing additionality are another relevant issue for LDCs. According to Article 6.4 rules, modalities and procedures, the only activities eligible for crediting are those that "would not have occurred in the absence of the incentives from the mechanism, taking into account all relevant national policies, including legislation, and representing mitigation that exceeds any mitigation that is required by law or regulation, and taking a conservative approach that avoids locking in levels of emissions, technologies or carbon-intensive practices" (UNFCCC 2021). In this context, LDCs need to be aware that activities included under its unconditional NDC targets might not be considered additional, as they have already been committed to, and might therefore be ineligible for carbon crediting. Furthermore, the reference to avoiding lock-in of carbon-intensive practices could mean that new fossil-fuel-based installations, such as gas-fired power plants or fuel-switching activities in the industry, might not be creditable. While this category has not seen significant crediting activity for the LDCs under the Clean Development Mechanism, it could play a larger role in the future. For instance, Angola, Mozambique and Myanmar are natural gas producers and exporters but had not achieved universal electrification as of 2022.

When it comes to the modalities establishing additionality, Article 6.4 rules, modalities and procedures require a "robust assessment that shows the activity would not have occurred in the absence of the incentives from the mechanism". However, draft recommendations by the Supervisory Body of the Article 6.4 mechanism state that "simplified approaches for demonstration of additionality for least developed countries or small island developing States will be developed by the Supervisory Body when a request is made by a least developed country or small island developing State" (UNFCCC, 2023b). In this context, it is important that such simplified approaches are made available quickly to facilitate project planning and implementation in LDCs. Furthermore, the use of positive lists and automatic additionality, as was the case under the Clean Development Mechanism, could help lower barriers by limiting transaction costs and enhancing predictability for project developers. For instance, under the latest Clean Development Mechanism positive list, renewable-energy-based rural electrification activities by grid extension were automatically considered additional in LDCs (UNFCCC, 2022b).

B. Summary and policy considerations

Many LDCs seek to mobilize funds from carbon markets to complement their scarce climate finance flows and to fund development in key areas of the Sustainable Development Goals. However, so far, carbon markets have not unlocked sufficient financial resources or significant shares of LDC mitigation potential. Carbon credits issued by baseline and credit schemes in LDCs are highly concentrated within the LDC group and are sourced primarily from mitigation projects in sectors with limited structural transformation co-benefits and a heightened risk of market downturn. To mitigate market risks and strengthen the role of carbon markets for sustainable development and structural transformation in LDCs, a focus on high-quality and pro-development types of credit would be beneficial. Furthermore, LDCs need to formulate holistic and robust climate policy strategies that take into account the links between their NDCs and emissions trading under Article 6 of the Paris Agreement. Development partners should assist LDCs by scaling up support for capacity-building and ensuring that the principles of common but differentiated responsibilities and equitable sharing of benefits are upheld across all Article 6 activities. Finally, LDCs should apply a cautionary approach when estimating future financial flows from carbon markets and in their expectations of the potential of carbon markets to drive structural transformation.

Carbon markets are seen by many developing countries, including LDCs, as a vehicle to mobilize large-scale financial flows and drive investments that contribute to broader development objectives. For instance, the Africa Carbon Markets Initiative plans to massively expand Africa's participation in the voluntary carbon market, and thereby unlock $6 billion in revenue by 2030 and over $120 billion by 2050 (ACMI, 2022). Of the 45 LDCs, 29 have explicitly stated their willingness to participate in Article 6 activities in their NDCs.

The analysis in this chapter suggests that, so far, the value created in carbon markets from LDC-hosted mitigation activities has been small compared to other external finance flows to the LDCs, such as ODA and climate finance. And even these latter have been insufficient to meet the needs of LDCs (UNCTAD, 2023a). Specifically, in 2023, baseline and credit schemes in all LDCs combined generated an estimated market value of $403 million, which corresponds to about 1 per cent of net bilateral ODA flows of $37 billion from DAC members to the LDCs (OECD, 2024), or about 1.3 per cent of the $31 billion worth of FDI inflows to these countries (UNCTAD, 2024). This suggests that carbon markets have not made a significant contribution to sustainable development finance or to climate finance in LDCs.

Moreover, LDCs receive only a small share of the market value created by downstream carbon credit transactions, as brokers and other intermediaries extract significant shares of that market value. This is a key element to consider in assessing the potential financial benefits accruing to LDCs

from carbon markets. According to one study, while 90 per cent of intermediaries in the voluntary carbon market do not disclose their fees publicly, the average fee of the 10 per cent who have disclosed their fees was 15.5 per cent (Carbon Market Watch, 2023). The average published fee is likely to be an underestimation of the share of the total market value going to intermediaries because those who disclose their fees are likely to have the lowest fees, and intermediaries can increase the price of a carbon credit before applying the fee. For example, an intermediary could buy a credit from a project developer at $5, sell it to a company at $10 and apply a 15 per cent fee on the $10 selling price. In addition, carbon credits could be transacting through multiple intermediaries, hence increasing the share that remains with intermediaries. In this context, LDCs that participate in carbon markets would benefit from improved financial transparency in across carbon market value chains including the secondary market.

Data presented in this chapter also suggest that carbon markets have not unlocked significant shares of mitigation potentials in the LDCs. For example, during the period 2020–2023, baseline and credit schemes in the LDCs issued carbon credits corresponding to 2.4 per cent of the estimated cost-effective land-based mitigation potential in these countries.

The value created in carbon markets is small compared to official development assistance and foreign direct investment flows to the least developed countries

Part of the reason why carbon markets have not delivered financial flows on a larger scale, and have only unlocked a small percentage of the existing mitigation potential, is that market prices are far too low to create the incentives needed to broaden and deepen investment flows to LDCs. There is no obvious solution to this issue, and prices for the main credit types are unlikely to rise to the levels needed for carbon markets to have a meaningful impact in LDCs unless there is increased demand, including from compliance markets in developed countries. At present, ETS and carbon taxes do not offer significant entry points for LDC-sourced carbon credits generated in the voluntary carbon market or through the Article 6.4 mechanism, the successor to the Clean Development Mechanism. However, this situation may evolve, particularly if internationally transferred mitigation outcomes with specific properties, such as corresponding adjustments in host countries begin to see increased demand from compliance markets. The aviation industry could also play a larger role in the future as demand for CORSIA-eligible carbon credits is forecast to reach around 2.5 billion tons of CO_2 between 2021 and 2035 (ICAO, 2019).

The bulk of carbon credits issued by baseline and credit schemes is concentrated in a few LDCs and project types. Five countries account for more than two thirds of all credits issued by such schemes in the 45 LDCs. Moreover, 76 per cent of issued carbon credits are nature-based (largely from forestry projects) and household-based (primarily cookstoves projects). These figures indicate that, for the majority of LDCs and the majority of sectors, carbon markets have not had a major impact.

Carbon markets have not contributed substantially to a wider deployment of renewable energy technologies in LDCs for which these countries have considerable potential, coupled with political ambition, to expand access to energy in line with Goal 7. This is particularly the case for the voluntary carbon market, where only 2 per cent of issued carbon credits come from renewable energy projects in LDCs. While the share is much larger for the Clean Development Mechanism (41 per cent), the overall volume of certified emission reduction credits from renewable energy projects remains small. In this context, broader energy market conditions could play a role and LDCs could help promote investments in the deployment of renewable energy technologies by fostering a transparent, stable policy framework based on long-term, system-wide planning (UNCTAD, 2017).

Carbon markets have been volatile and subject to shocks in the past, and the market outlook is fraught with risks and

uncertainties. For instance, criticism of the integrity of carbon credits contributed to a staggering 61 per cent drop in the overall market value of the voluntary carbon market, from $1.87 billion in 2022 to $723 million in 2022 (Forest Trends' Ecosystem Marketplace, 2024). Regulatory and corporate decision-making in developed countries, beyond the reach of LDCs, can also fuel market instability. For example, the decision taken by the European Union to change the rules regarding the use of certified emission reduction credits in the European Union Emissions Trading System contributed to a collapse in demand and market prices (World Bank, 2014). At the same time, oversupply of allowances depressed permit prices in the European Union ETS, and thus of prices paid for eligible certified emission reduction credits. These regulatory factors had a disproportionate impact on LDCs, as they were latecomers to the Clean Development Mechanism (see section A.1.a.), and, although benefitting from an exception allowing access to LDC-sourced certified emission reduction credits during the third phase of the European Union ETS, almost all of LDC-sourced certified emission reduction credits (99.6 per cent) were issued after 1 January 2013 (i.e. after the prices of certified emission reduction credits and allowance traded on the European Union ETS had fallen).

Ultimately, demand for carbon credits in the voluntary carbon market is based on the willingness and ability of private sector actors to use carbon offsetting as part of their corporate sustainability strategies. This in turn depends on the credibility of claimed emission reductions. If consumers do not believe in the integrity of carbon credits, corporations will have no incentive to buy them. The risks associated with the credibility of corporate sustainability claims is highlighted by recent criticism of the integrity of forestry-based carbon credits, which has led to a decline in demand and prices as major corporations re-evaluate their offset programmes. Also, regulatory decisions can impact the demand side of the voluntary carbon market. The European Union's proposed Green Claims Directive (European Commission, 2023) is a case in point, as it would require, inter alia, that corporations report the use of offsets separately from emissions from their own operations and thereby lower the value of carbon credits in corporate sustainability management and communication. To mitigate such risks, focusing on high-integrity carbon credits could benefit LDCs, as buyers can, and do, distinguish between credit qualities.

Regarding Article 6 activities, there are several issues that LDCs need to consider. Mitigation projects underlying "exported" internationally transferred mitigation outcomes are no longer available to the host country, and if the emissions reductions from low-cost mitigation projects (low hanging fruit) are transferred to other countries, LDCs could be left with projects that have higher implementation costs for their own NDCs. It is therefore important to demarcate unconditional NDC activities (i.e. those activities which host countries have committed to undertake on their own, without external support), from mitigation activities that can be included under Article 6 cooperative frameworks. This also means that plans regarding Article 6 participation need to be considered carefully when the next editions of NDCs are formulated, as unconditional mitigation activities might not pass the additionality test under Article 6, thus excluding them from generating carbon credits. In essence, LDCs need to take a holistic view encompassing domestic climate policy and strategies when participating in international carbon markets.

Given carbon markets' modest performance to date and numerous market risks, LDCs should take a cautionary approach when estimating future financial flows from carbon markets and forming expectations about their potential to drive structural transformation. While the potential for increased demand for internationally transferred mitigation outcomes and high-integrity carbon credits exists, risks related to regulatory changes and other demand-

Carbon markets are volatile and subject to shocks, and the market outlook is fraught with risks and uncertainties

side shocks persist. Given these risks, a focus on tangible, positive sustainable development impacts might be preferable to a focus on uncertain financial flows.

At the international level, there are several entry points for development partners to enhance the performance and impact of carbon markets in LDCs. First, there needs to be greater support for capacity-building and technical assistance to enable more LDCs to participate in and benefit from the Article 6 mechanism. Also, upholding the basic principles of the UNFCCC and the Paris Agreement, including equitable benefit-sharing and common but differentiated responsibility in all cooperative frameworks with LDCs, is critical. Moreover, as Article 6 operationalization becomes more widespread, it is crucial that the specificities of LDCs are considered both in the design and practical application of rules, including for baseline setting and establishing additionality. With regard to the voluntary carbon market, enhancing transparency and integrity are critical factors for ensuring that carbon credits are based on real emission reductions, that credit prices provide strong investment signals and that a fair share of the value generated in carbon markets remains in the host countries of mitigation projects.

Least developed countries should be cautious when estimating financial flows from carbon markets

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Annex 1. Country-specific data on land-based mitigation potential, electricity and selected geographical features of least developed countries

Table 1.1
Land-based mitigation potential and issued credits in the least developed countries

Country	Annual cost-effective land-based mitigation potential 2020–2050 ($MtCO_2e$)	Average credit volume 2020–2023 ($MtCO_2e$)	Share of issued credits in potential (Percentage)
Afghanistan	33.46	0.00	0.00
Angola	89.26	0.02	0.02
Bangladesh	82.24	2.75	3.35
Benin	11.81	0.09	0.73
Burkina Faso	18.97	0.11	0.60
Burundi	5.58	0.47	8.51
Cambodia	67.85	10.27	15.14
Central African Republic	59.93	0.06	0.10
Chad	29.97	0.01	0.03
Comoros	0.15	0.00	0.00
Democratic Republic of the Congo	382.29	4.82	1.26
Djibouti	0.09	0.00	0.00
Eritrea	4.10	0.38	9.19
Ethiopia	81.75	2.56	3.13
Gambia	1.89	0.02	1.08
Guinea	22.14	0.00	0.00
Guinea-Bissau	3.22	0.08	2.35
Haiti	4.62	0.03	0.63
Kiribati	0.03	0.00	0.00
Lao People's Democratic Republic	64.41	0.19	0.30
Lesotho	1.70	0.04	2.25
Liberia	22.06	0.00	0.00
Madagascar	62.12	0.60	0.97
Malawi	15.93	4.63	29.07
Mali	30.66	0.12	0.39
Mauritania	6.54	0.00	0.00
Mozambique	67.91	0.44	0.65
Myanmar	168.75	0.64	0.38
Nepal	17.82	1.21	6.80
Niger	18.72	0.01	0.05
Rwanda	7.12	1.72	24.18
Sao Tome and Principe	0.01	0.00	0.00
Senegal	15.21	0.06	0.40
Sierra Leone	11.23	0.51	4.58
Solomon Islands	5.62	0.02	0.39
Somalia	15.58	0.41	2.61
South Sudan	32.35	0.00	0.00
Sudan	51.12	0.03	0.05
Timor-Leste	2.10	0.02	0.81
Togo	6.19	0.07	1.19
Tuvalu	0.00	0.00	0.00
Uganda	45.10	4.35	9.66
United Republic of Tanzania	122.51	1.46	1.19
Yemen	2.42	0.00	0.00
Zambia	101.77	2.84	2.79
LDCs total	**1 794.00**	**41.00**	**2.29**

Source: UNCTAD calculations, based on data from Forest Trends' Ecosystem Marketplace (2021, 2022, 2023, 2024), Roe et al. (2021), the registries of the Gold Standard, Verra, Plan Vivo and Climate Forward, UNEP CDM pipeline and UNFCCC (2024).

Table 1.2

Electricity access, production, capacity and household consumption per capita in the least developed countries

Country and group median	Access (Percentage of population) 2022	Gross production per capita (kWh) 2021	Capacity per capita (kW) 2021	Household consumption per capita (kWh) 2021
Afghanistan	85	35.14	0.01	85.40
Angola	48	427.22	0.21	248.80
Bangladesh	99	563.79	0.13	238.10
Benin	57	86.71	0.04	27.20
Burkina Faso	19	75.06	0.02	16.40
Burundi	10	20.91	0.01	11.30
Cambodia	91	612.37	0.19	236.70
Central African Republic	16	26.48	0.01	9.90
Chad	12	19.53	0.01	7.00
Comoros	90	165.40	0.04	80.60
Democratic Republic of the Congo	22	136.97	0.01	56.60
Djibouti	65	113.61	0.14	293.40
Eritrea	53	106.32	0.06	49.70
Ethiopia	56	129.18	0.04	48.70
Gambia	65	195.65	0.05	--
Guinea	47	221.30	0.09	66.20
Guinea-Bissau	37	39.74	0.01	23.80
Haiti	47	90.22	0.04	15.40
Kiribati	94	293.31	0.08	77.60
Lao People's Democratic Republic	100	6 051.21	1.55	308.10
Lesotho	50	233.18	0.03	142.90
Liberia	32	91.96	0.04	--
Madagascar	35	78.62	0.02	24.40
Malawi	14	98.29	0.04	33.20
Mali	53	181.21	0.05	64.20
Mauritania	49	295.66	0.15	113.30
Mozambique	31	588.05	0.08	49.70
Myanmar	72	410.33	0.13	147.40
Nepal	91	321.88	0.07	128.70
Niger	20	26.06	0.01	29.00
Rwanda	50	72.52	0.02	11.40
Sao Tome and Principe	78	487.66	0.13	143.40
Senegal	71	386.06	0.10	148.30
Sierra Leone	29	29.81	0.02	5.90
Solomon Islands	76	149.78	0.05	25.20
Somalia	50	22.44	0.01	--
South Sudan	8	54.20	0.01	22.20
Sudan	60	367.41	0.08	198.70
Timor-Leste	100	387.01	0.21	108.70
Togo	57	98.04	0.04	68.50
Tuvalu	100	787.22	--	277.80
Uganda	46	104.01	0.05	17.00
United Republic of Tanzania	44	136.30	0.03	50.10
Yemen	76	88.37	0.05	57.70
Zambia	48	909.89	0.17	229.90
Median LDCs	50	136.30	0.04	60.95
Median ODEs	100	2 454.31	0.58	605.97
Median developed countries	100	5 666.87	2.04	1 650.74

Sources: UNCTAD calculations, based on data from the Energy Statistics Database, the United Nations Statistics Division, World Population Prospects: The 2022 Revision; and the United States Energy Information Administration, International Energy Data.

Table 1.3

Electricity access projections for the least developed countries

(Percentage of population)

Country	Access			
	2030	2062	2065	2070
Afghanistan	100.00	100.00	100.00	100.00
Angola	58.30	100.00	100.00	100.00
Bangladesh	100.00	100.00	100.00	100.00
Benin	78.05	100.00	100.00	100.00
Burkina Faso	25.46	82.12	91.65	100.00
Burundi	14.78	70.53	81.66	100.00
Cambodia	100.00	100.00	100.00	100.00
Central African Republic	22.12	80.75	91.17	100.00
Chad	16.23	59.08	66.70	81.66
Comoros	100.00	100.00	100.00	100.00
Democratic Republic of the Congo	61.63	100.00	100.00	100.00
Djibouti	69.80	92.79	95.30	99.63
Eritrea	62.92	100.00	100.00	100.00
Ethiopia	90.87	100.00	100.00	100.00
Gambia	79.56	100.00	100.00	100.00
Guinea	64.50	100.00	100.00	100.00
Guinea-Bissau	100.00	100.00	100.00	100.00
Haiti	54.27	96.51	100.00	100.00
Kiribati	100.00	100.00	100.00	100.00
Lao People's Democratic Republic	100.00	100.00	100.00	100.00
Lesotho	97.12	100.00	100.00	100.00
Liberia	96.76	100.00	100.00	100.00
Madagascar	66.61	100.00	100.00	100.00
Malawi	20.61	96.86	100.00	100.00
Mali	80.27	100.00	100.00	100.00
Mauritania	61.14	100.00	100.00	100.00
Mozambique	42.03	100.00	100.00	100.00
Myanmar	91.47	100.00	100.00	100.00
Nepal	100.00	100.00	100.00	100.00
Niger	25.36	65.52	71.62	83.07
Rwanda	100.00	100.00	100.00	100.00
Sao Tome and Principe	90.38	100.00	100.00	100.00
Senegal	81.72	100.00	100.00	100.00
Sierra Leone	51.24	100.00	100.00	100.00
Solomon Islands	100.00	100.00	100.00	100.00
Somalia	48.64	43.54	43.09	42.35
South Sudan	10.06	32.18	35.91	43.12
Sudan	82.16	100.00	100.00	100.00
Timor-Leste	100.00	100.00	100.00	100.00
Togo	83.25	100.00	100.00	100.00
Tuvalu	100.00	100.00	100.00	100.00
Uganda	100.00	100.00	100.00	100.00
United Republic of Tanzania	86.03	100.00	100.00	100.00
Yemen	87.19	100.00	100.00	100.00
Zambia	77.58	100.00	100.00	100.00
LDCs, average	**70.66**	**93.77**	**95.05**	**96.66**

Sources: UNCTAD, based on data from the Sustainable Development Goal Indicators Database (indicator 7.1.1); and the United Nations Statistics Division, World Population Prospects: The 2022 Revision.

Table 1.4

Least developed countries: Selected geographical statistics

(Thousands of hectares)

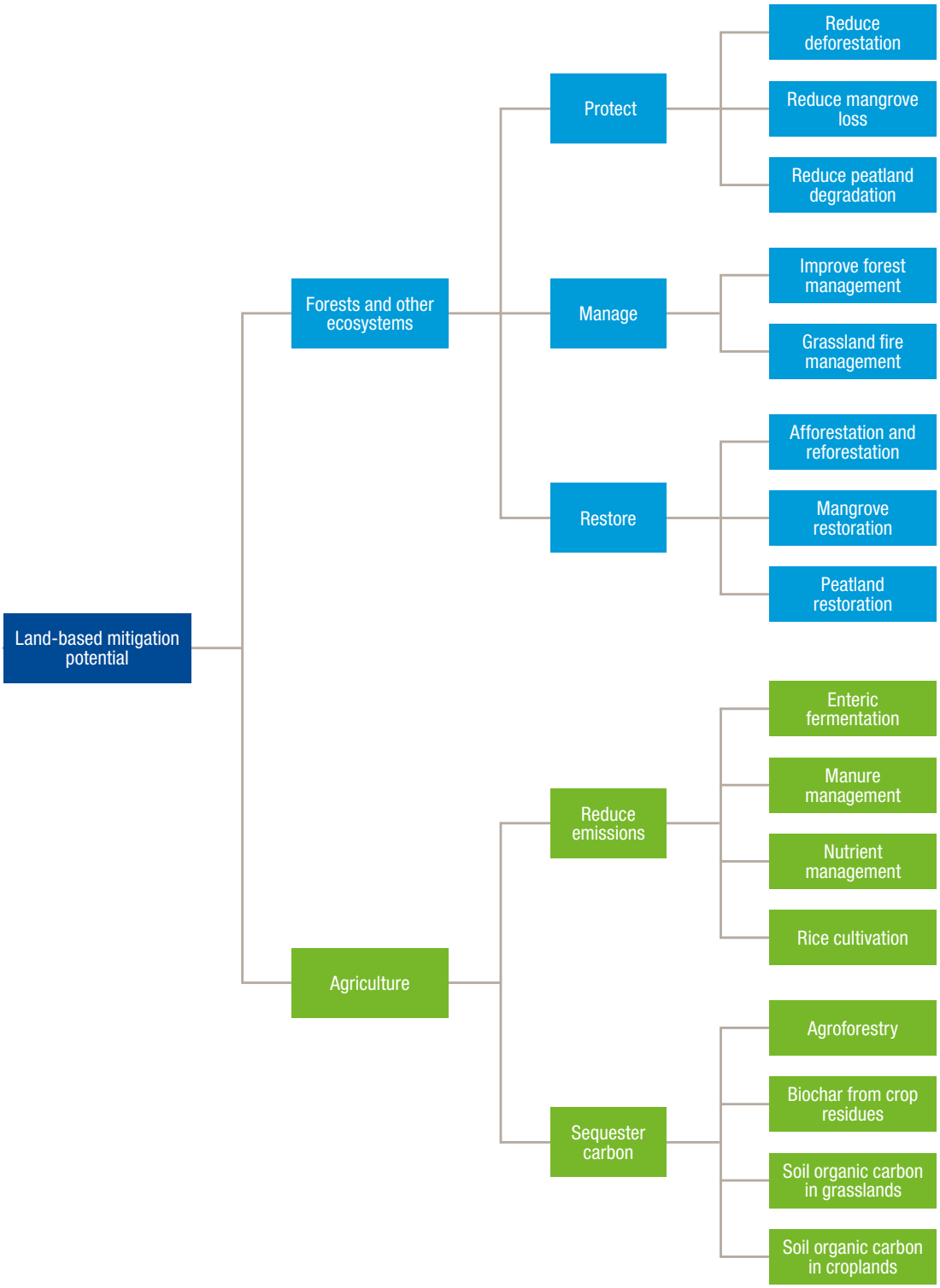
Country	Land area	Agricultural land	Arable land	Forest land	Planted forest	Primary forest
	2021	2021	2021	2021	2021	2017
Afghanistan	65 223.00	38 313.00	7 829.00	1 208.44	0.00	0.00
Angola	124 670.00	45 897.00	5 373.00	66 052.31	800.47	0.00
Bangladesh	13 017.00	10 068.00	8 110.00	1 883.40	158.07	411.00
Benin	11 276.00	3 950.00	2 800.00	3 085.15	24.67	0.00
Burkina Faso	27 360.00	12 740.00	6 100.00	6 166.40	182.53	0.00
Burundi	2 568.00	2 103.00	1 270.00	279.64	112.97	40.00
Cambodia	17 652.00	6 099.14	4 120.14	7 912.68	615.91	322.00
Central African Republic	62 298.00	4 910.00	1 800.00	22 273.00	2.00	1 988.00
Chad	125 920.00	50 338.00	5 300.00	4 201.33	20.10	0.00
Comoros	186.10	133.00	65.00	32.48	0.10	8.00
Democratic Republic of the Congo	226 705.00	33 898.00	13 680.00	125 053.86	57.70	102 686.00
Djibouti	2 318.00	1 703.90	3.00	5.87	0.27	0.00
Eritrea	12 104.08	7 592.00	690.00	1 052.10	44.73	0.00
Ethiopia	112 857.13	38 595.00	16 314.00	16 995.50	1 249.56	0.00
Gambia	1 012.00	634.00	440.00	236.93	1.78	0.80
Guinea	24 572.00	14 638.00	3 100.00	6 149.00	57.33	63.00
Guinea-Bissau	2 812.00	815.11	300.00	1 971.57	1.09	0.00
Haiti	2 756.00	1 795.00	1 005.00	344.19	32.00	0.00
Kiribati	81.00	34.00	2.00	1.18	--	0.00
Lao People's Democratic Republic	23 080.00	2 031.00	1 224.00	16 561.00	1 788.80	1 193.73
Lesotho	3 036.00	2 433.00	429.00	34.52	8.67	0.00
Liberia	9 632.00	1 923.04	500.00	7 587.18	27.90	175.00
Madagascar	58 180.00	40 895.00	3 000.00	12 416.60	312.00	2 993.00
Malawi	9 428.00	6 050.00	4 000.00	2 199.70	73.60	845.00
Mali	122 019.00	43 131.00	8 341.00	13 296.00	568.00	0.00
Mauritania	103 070.00	39 710.00	450.00	307.37	44.68	0.00
Mozambique	78 638.00	41 413.83	5 650.00	36 497.60	76.39	0.00
Myanmar	65 267.00	12 980.00	10 990.00	28 254.18	427.09	3 192.00
Nepal	14 335.00	4 121.00	2 113.70	5 962.03	220.60	526.00
Niger	126 670.00	46 595.00	17 700.00	1 067.28	125.00	220.00
Rwanda	2 467.00	2 004.46	1 268.40	277.00	151.00	7.00
Sao Tome and Principe	96.00	42.00	4.00	51.28	0.00	27.00
Senegal	19 253.00	9 511.00	3 830.00	8 028.16	32.00	1 508.00
Sierra Leone	7 218.00	3 949.00	1 584.00	2 515.15	21.98	85.20
Solomon Islands	2 799.00	120.00	23.00	2 522.24	24.03	1 105.40
Somalia	62 734.00	44 129.00	1 100.00	5 903.25	3.00	0.00
South Sudan	63 193.00	28 252.70	2 394.70	7 157.00	187.90	0.00
Sudan	186 800.00	112 664.84	20 994.84	18 187.39	130.00	1 344.70
Timor-Leste	1 487.00	341.40	111.50	919.70	0.00	0.00
Togo	5 439.00	3 820.00	2 650.00	1 206.31	62.04	0.00
Tuvalu	3.00	1.80	--	1.00	0.00	0.00
Uganda	20 052.00	14 415.00	6 900.00	2 296.64	475.00	0.00
United Republic of Tanzania	88 580.00	39 521.20	13 502.50	45 276.00	553.04	0.00
Yemen	52 797.00	23 452.00	1 158.00	549.00	0.00	0.00
Zambia	74 339.00	23 839.00	3 800.00	44 625.81	51.86	0.00
LDCs, total	**2 035 999.31**	**821 602.42**	**192 019.78**	**528 604.42**	**8 725.86**	**118 740.83**

Source: UNCTAD, based on data from the Food and Agriculture Organization of the United Nations, database, available at https://www.fao.org/faostat/en/ (accessed 1 July 2024).

Annex 2. Notes on methodology used to calculate land-based greenhouse gas mitigation in the least developed countries

This annex aims to clarify and provide detailed information on the data processing and extraction performed on the dataset contained in Roe et al. (2021). The initial step involved extracting cost-effective averages across 16 categories, which are divided into two primary sectors: (a) forests and other ecosystems and (b) agriculture. Figure B1 below details these categories and the corresponding data sources.

Figure 2.1
Categories of land-based mitigation measures



Source: UNCTAD, based on Roe et al. (2021).

Note: The original dataset from Roe et al. includes additional categories on bioenergy with carbon capture and storage and increased clean cookstoves to calculate the land-based mitigation potential. However, to avoid double counting when calculating this potential, these datasets are not shown separately in this flowchart. Instead, bioenergy with carbon capture and storage data is covered within the afforestation and reforestation category, while data on clean cookstoves is covered in the reduce deforestation category.

Land-based measures are grouped into two primary categories: GHG emission reduction and GHG removal. The classification specifies which measures, within the forest and agriculture sectors, contribute to either GHG reduction or GHG removal.

Activities aimed at reducing emissions are categorized as reduction measures, while those facilitating carbon sequestration fall under the removal category. For example, forest and other ecosystems protection initiatives are classified as reduction measures, while those geared towards restoration and reforestation are considered removal measures.

However, the management subsector straddles both categories with certain practices categorized as reduction (e.g. grassland and savannah fire management and forest management – global) and others as removal (e.g. forest management – tropics). Consequently, to prevent double counting for the "forest management total" indicator, which represents the average of both "tropics" and "global" indicators, adjustments are made to allocate 50 per cent weight to each indicator. The following table provides details on the calculation of both categories.

In order to present the cost-effective potential of each category, the subtotals of the included measures are calculated.

As illustrated in figure 2.1, the dataset covers one of the blue carbon ecosystems, namely mangroves. Other blue carbon ecosystems, including salt marshes and seagrass meadows, also store significant amounts of carbon and should be protected to avoid the release of GHGs. The quantities sequestered by these ecosystems are small compared to estimated land-based mitigation potentials. For instance, the global annual carbon sequestration of salt marshes and seagrass meadows is estimated at 57 $MtCO_2$ (Bertram et al., 2021), while the annual cost-effective land-based mitigation potential in LDCs alone is estimated to be 1,794 $MtCO_2$.

Table 2.1

Removal	Reduction
Agriculture (sequester carbon)	Agriculture (reduce emissions)
Total forest and other ecosystems (restore)	Total forest and other ecosystems (protect)
50 per cent of forest management – global	Grassland and savannah fire management
	50 per cent of forest management – tropics