



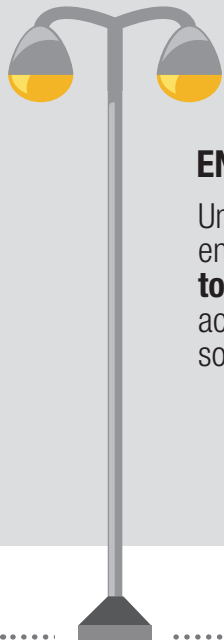
THE LEAST DEVELOPED COUNTRIES REPORT 2017

Transformational energy access

CHAPTER 1

Energy: The lifeblood
of sustainable development





ENERGY AND SDGs

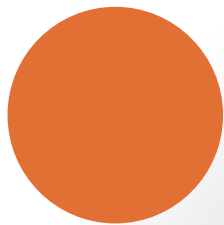
Universal access to modern energy is important **to other SDGs** across the economic, social and environmental fields



Electricity generation capacity per person in LDCs is

1/12 of that in **other developing countries** (ODCs) and

1/50 of that in **developed countries**



Developed Countries



ODCs



LDCs



62% of people living in LDCs

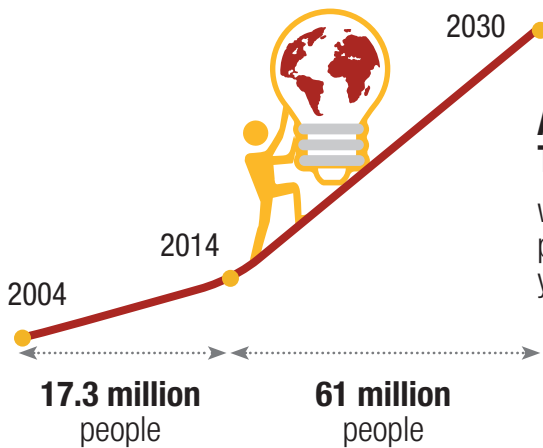
have no access to electricity



compared with **10%** in ODCs



of people without access to electricity worldwide **live in LDCs**



ACHIEVING UNIVERSAL ACCESS TO ELECTRICITY BY 2030

will require 3.5 times as many people in LDCs gaining access each year as in the last decade

CHAPTER 1

Energy: The lifeblood of sustainable development

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A. Introduction

Access to modern energy, and particularly to electricity, has gained ever greater attention as an issue since around 2000, and has been the subject of numerous high-profile reports and initiatives, focused on developing countries as a whole or on African countries in particular.¹ Although not included explicitly among the Millennium Development Goals, access to energy was recognized as essential to their achievement (Modi et al., 2005; IEA, 2010); and it has been given greater prominence in the 2030 Agenda for Sustainable Development (United Nations, 2015). Sustainable Development Goal (SDG) 7 establishes universal access to modern energy by 2030 as an agreed commitment of the global community.²

Although the terminology of “access to modern energy” is widely used, it remains a nebulous concept. On a conceptual level, according to the International Energy Agency (IEA) (IEA, 2016a: 2):

There is no single internationally-accepted and internationally-adopted definition of modern energy access. Yet significant commonality exists across definitions, including:

- Household access to a minimum level of electricity.
- Household access to safer and more sustainable (i.e. minimum harmful effects on health and the environment as possible) cooking and heating fuels and stoves.
- Access to modern energy that enables productive economic activity, e.g. mechanical power for agriculture, textile and other industries.
- Access to modern energy for public services, e.g. electricity for health facilities, schools and street lighting.

In practical applications, however, consideration is generally limited to the first two of these elements — including, for example, the IEA flagship *World Energy Outlook* report (IEA, 2016a) — partly as a result of data limitations. Similarly, the access targets under SDG 7 relate only to the proportion of the population with access to electricity and “with primary reliance on clean fuels and technology”.

The increase in attention to modern energy access partly mirrors the shift towards a more holistic approach to sustainable development embodied in the 2030 Agenda, and the major implications of access to energy in all three pillars (economic, social and environmental).

- The central role of energy in economic development is well established historically, starting with the role of coal and the development of the steam engine as drivers of the British industrial revolution in the late 18th and early 19th centuries (Wrigley, 2010).

The role of energy in transforming LDC economies is a critical issue that merits greater attention

- Equally, households’ access to modern energy is a critical element of their basic needs and social well-being, reflected in the concept of energy poverty (Nussbaumer et al., 2012).
- Both traditional biomass and electricity generation have major implications for the environment, in terms of greenhouse gas (GHG) emissions and ambient and indoor air pollution.

Consequently, energy access has a prominent place on the agendas of actors across in all three pillars.

Increased access to energy in development discourse also reflects technological progress and associated cost reductions in renewable energy, which are widely seen as having the potential to provide unprecedented opportunities for increasing access to electricity, particularly in rural areas, and for “win-win” scenarios in terms of social and environmental goals.

However, the focus of recent studies and initiatives has been overwhelmingly on the social and environmental dimensions of energy access. The primary emphasis has been on the *intrinsic* benefits of *household* access to modern energy, in terms of electric lighting, access to information and connectivity, and to a lesser extent the potential time savings and health benefits of access to non-solid fuels for cooking and heating. In a context of growing global concern about climate change, renewable energy options have been highlighted as a means of responding to this unmet notional demand without compromising efforts to reduce global GHG emissions.

While these issues are undoubtedly important, this focus has led to a relative neglect of the economic dimension of the issue: the *instrumental* importance of access to modern energy for *productive sectors*, through its contribution to economic development and structural economic transformation. This is a critical issue: only through faster and more solidly based economic development can least developed countries (LDCs) hope to achieve the extraordinarily ambitious goals set out in the SDGs; and limited, unreliable and often expensive access to modern energy is a critical constraint on such development. Although by no means the only aspect of modern energy access for productive use (as discussed in section C3 below), the versatility of electricity as an energy source (chapter 2) makes it the central issue.

54 per cent of people without access to electricity globally live in LDCs

This provides the primary focus of this Report: how LDCs can realize the potential of access to electricity and its use in productive sectors to accelerate the structural transformation of their economies, in the context of SDG 7 and developments in renewable energy and off-grid (particularly mini-grid) technologies.

Section B of this chapter provides a brief overview of LDCs' access to, and production and use of energy, highlighting the gap between LDCs and other developing countries (ODCs) in energy access and production, the obstacles to increasing access and the interrelationship between access and rural-urban differences. Section C discusses the contribution of energy to structural transformation, focusing on implications for the definition of access and the mechanisms that link access to structural transformation. Section E addresses energy issues related to sustainability and inclusivity in the context of the 2030 Agenda.

B. Energy and access in LDCs

This section provides data and analysis on issues relating to energy access and use in LDCs. Like the data and analysis presented in other chapters, this is based on widely used and accepted sources. However, it is important to emphasize that there is a serious lack of reliable and consistent data on most aspects of energy, especially in LDCs, and that there are major discrepancies between different sources (box 1.1). These caveats should be kept in mind in interpreting the data in this section and elsewhere in the Report.

1. The energy access gap

As in other aspects of infrastructure, there has long been a very wide gap between LDCs and ODCs in terms of access to electricity (UNCTAD, 2006).³ Since 1990, LDCs have made considerable progress in increasing such access, which more than tripled overall from 12 per cent in 1991 to 38 per cent in 2014 — an increase of 460 per cent, or nearly 300 million, in the number of people with access. However, the very low starting point, combined with relatively rapid population growth in many LDCs, resulted in an increase in the absolute number of people in LDCs without access to electricity, from 521 million people in 2000 to 578 million in 2014.

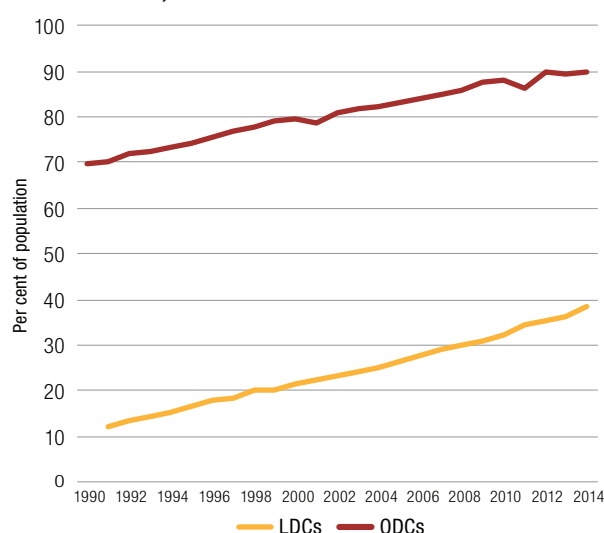
The 26-percentage-point improvement in electricity access in LDCs between 1990 and 2014 represents a greater absolute increase than the 20-point increase achieved by ODCs, reflecting a slowdown in ODCs

from 1.0 per cent per annum in 1991–2009 to 0.4 per cent in 2009–2014, possibly as a result of the 2008 financial crisis (figure 1.1). In terms of the proportion of households without access, however, the gap is wider than ever. In 1991, nearly three times as many people were without access to electricity in LDCs as in ODCs (88 per cent as against 30 per cent). By 2014, the gap had increased to a factor of more than six (62 per cent as against 10 per cent).

This widening gap is reflected in a major increase in

Figure 1.1

Proportion of population with access to electricity: LDCs and ODCs, 1990–2014



Source: UNCTAD secretariat estimates, based on World Bank, World Development Indicators database (accessed May 2017).

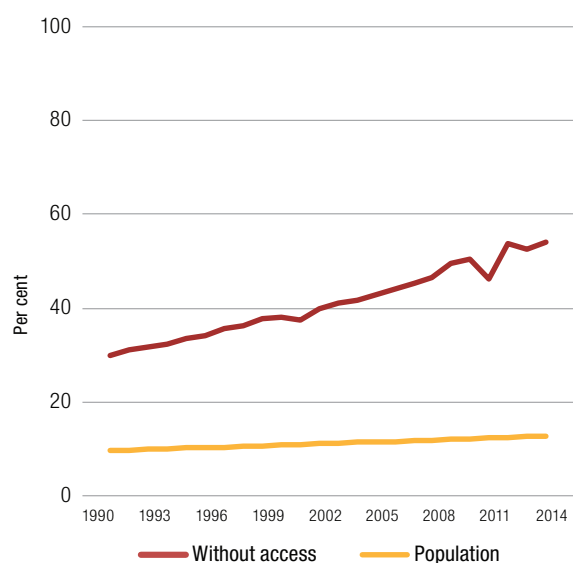
the proportion of people without access to electricity globally who live in LDCs, which almost doubled from 30 per cent in 1991 to 54 per cent (577 million of 1.066 billion) in 2014, while LDCs' share in world population rose only from 10 per cent to 13 per cent (figure 1.2).⁴ Of the 20 countries with the largest absolute numbers of people without access to electricity in 2014, 16 were LDCs (the others being India, Nigeria, Kenya and Democratic People's Republic of Korea) (Sustainable Energy for All, 2017). Thus, in energy as in other contexts:

The LDCs are the battleground on which the 2030 Agenda will be won or lost: This is where shortfalls from the SDGs are greatest and improving most slowly, and where the barriers to further progress are highest.

(UNCTAD, 2015: 35)

Figure 1.3 demonstrates the considerable scale of the access gap for the great majority of LDCs. Among the 35 LDCs with reliable data (box 1.1), only one (Bhutan,

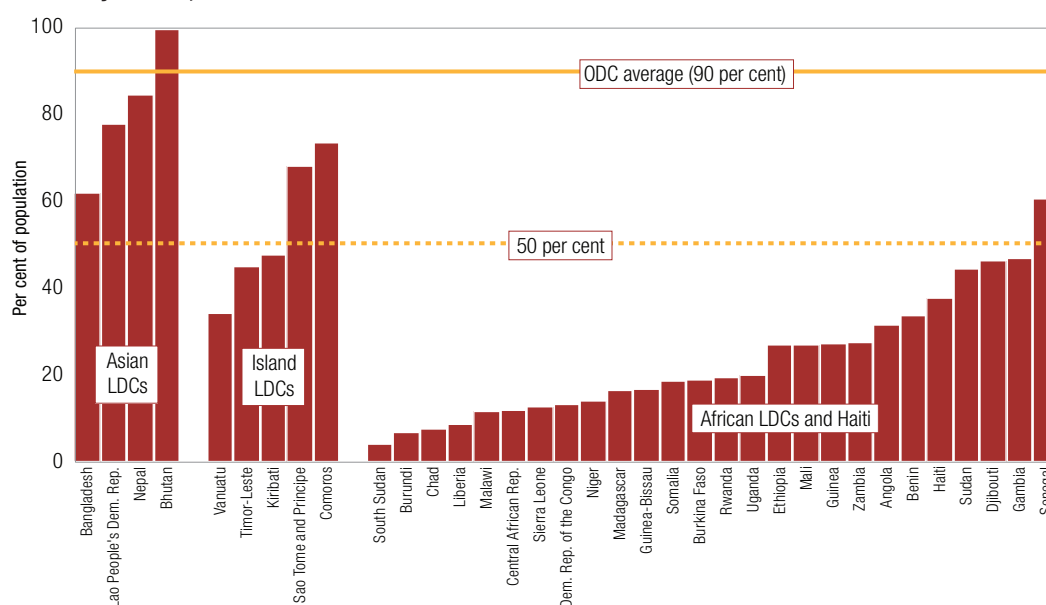
Figure 1.2
Share of LDCs in worldwide population without electricity access and in total world population, 1991–2014



Source: UNCTAD secretariat estimates, based on data from World Bank, World Development Indicators database (accessed May 2017).

at 100 per cent) has access to electricity above the ODC average of 90 per cent, while one more (Nepal, at 84.9 per cent) is close to this level. In six LDCs (including the two other Asian LDCs with reliable data), access is between 50 per cent and 80 per cent, indicating that between two and five times as many people lack access as in ODCs as a whole. In all but one of the LDCs in the Africa and Haiti group (Senegal), as well as three of the five island LDCs with reliable data, only a minority of people have access. In the majority of the African LDCs with reliable data, less than a quarter of the population has access to electricity, and in South Sudan the figure is less than 1 in 20.

Figure 1.3
Access to electricity in LDCs, 2014



Source: World Bank, World Development Indicators (WDI) database (accessed May 2017).

Note: Excludes LDCs for which major discrepancies exist between WDI and IEA data (box 1.1).

The energy access gap between LDCs and ODCs also extends to clean fuels for domestic use, although the attention devoted to this issue does not reflect the importance of domestic heating and cooking in energy demand in LDCs (Bhattacharyya, 2013). In only four LDCs (Angola, Bhutan, Mauritania and Yemen) do more than 40 per cent of people have access to clean fuels, compared with 80 per cent of ODCs for which data are available. In half of ODCs, access to clean fuels is greater than 90 per cent.⁵

2. Electricity access and the rural-urban divide⁶

The relatively early stage of the electrification process in most LDCs, particularly in Africa, has critically important implications for the evolution of access, notably in terms of the rural-urban balance. As shown in figure 1.4, increasing access to electricity follows a distinctive trajectory as development progresses. Initially, electrification is generally focused strongly in urban areas, at least partly reflecting the (historically) much greater ease and lower cost of provision in these areas through grid extension and the greater concentration of demand in urban areas. With only a handful of exceptions, it is only after urban access exceeds 80 per cent that rural access surpasses 20 per cent.

This gives rise to a relationship between overall access and rural-urban differences analogous to the Kuznets curve (showing an increase in income inequality as per capita incomes increase in the early stages of development, which is reversed at higher income levels). As overall access to electricity increases, rural-urban differences in energy access first increase

Box 1.1 Choice of data and related limitations

Despite the growing availability of energy data and ad hoc estimations, including those produced by private firms and research institutions, there is a dearth of comprehensive, reliable and internationally comparable time-series data on energy issues in LDCs (IEA, 2014a). This applies across a wide range of issues, including electricity access and energy balances. These limitations should be taken into account in interpreting the data presented in this Report.

In the case of energy access (the proportion of people with access to electricity in each country), there are wide differences in the estimates provided by the two primary sources, IEA (<http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/>) and the World Bank (<http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators&preview=off>). The estimates for LDCs in 2014 from these two sources are shown in box figure 1.1.

For the purposes of this Report, World Bank (World Development Indicators (WDI)) data are used, first, because these have comprehensive coverage of LDCs, whereas published IEA data include only 42 of the 47 LDCs; and second, because they provide historical data. However, discrepancies between these two sources are used as a quality control: countries for which the absolute difference between estimates exceeds 10 percentage points (indicated by the shaded area in box figure 1.1) are excluded from country-specific figures and text discussions relating to overall access to electricity, as this is taken to indicate a particularly high level of uncertainty regarding its true level. These countries are Afghanistan, Cambodia, Eritrea, Lesotho, Mauritania, Mozambique, Myanmar, Solomon Islands, Togo, the United Republic of Tanzania and Yemen.

With respect to energy balances, aside from regional aggregates, three main data sources are used in the literature:

1. The World Energy Balances, produced by IEA;
2. The Energy Statistics Database of the United Nations Statistics Division (UNSD).
3. The World Bank's Sustainable Energy for All (SE4All) database (also partly included in the WDI).

Their comparison in terms of country and time coverage is summarized in box table 1.1 below.

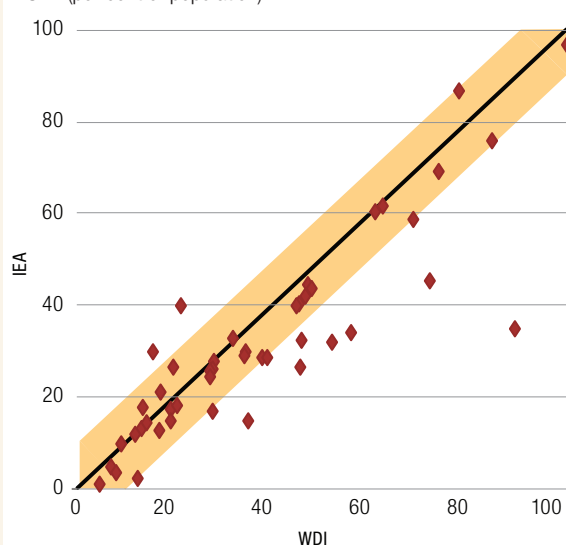
Data quality and reliability are often disputed in the literature and remain an area of concern, in the LDC context more than anywhere else. In addition to definitional issues regarding the various concepts and technologies, a particular challenge is capturing the evolving picture of distributed generation for residential purposes, including off-grid and mini-grid solutions.

The IEA World Energy Balances is generally regarded as the most dependable and internally consistent data source. For the purposes of the current Report, however, its coverage of LDCs is clearly unsatisfactory. A comparison of UNSD and SE4All (for the 19 LDCs covered by IEA, and taking IEA data as a benchmark), discrepancies across the two remaining databases do not indicate a clear preference for either (box table 1.2).

For the purposes of this Report, the UNSD database is used for energy and electricity production, in light of its better country coverage and its use of official data submitted by LDCs through the annual UNSD Annual Questionnaire on Energy Statistics. Where necessary, this is supplemented with data from other sources.

Box figure 1.1

Comparison of IEA and WDI estimates of electricity access, 2014 (per cent of population)



Source: World Bank, World Development Indicators database and IEA Energy Access database (<http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/>) (both accessed August 2017), supplemented with unpublished data provided by IEA.

Note: The solid line represents the position of all observations if estimates from the two sources corresponded exactly. The shaded area represents discrepancies in either direction up to ten percentage points.

Box table 1.1

Comparison of coverage across data sources

	IEA World Energy Balances	UNSD Energy Statistics	WB Sustainable Energy for All
Country coverage	19 LDCs	47 LDCs	46 LDCs
Time window	1980–2015	1990–2014	1990–2012

Source: UNCTAD secretariat compilation.

Box table 1.2

Discrepancies in gross electricity production across data sources (per cent)

	UNSD Energy Statistics	WB Sustainable Energy for All
Average discrepancy*	1.82	8.82
Median discrepancy*	0.00	0.00
Per cent of matching observations	53.21	75.92

Source: UNCTAD secretariat compilation.

Note: * Discrepancies are expressed as share of the corresponding IEA figure for the same year.

(as urban access expands, with little improvement in rural access), but then decline once urban access reaches around 80 per cent and begins to level off, while rural access grows more rapidly (figure 1.5). This pattern highlights the critical role of energy access in the emergence of urban bias in the early stages of development.

Figures 1.4 and 1.5 also highlight the implications of the access gap between LDCs and ODCs for the rural-urban divide. The great majority of ODCs are in the later stages of the process, clustered in the top right corner of figure 1.4 and the bottom right corner of figure 1.5, with overall access of 80 per cent, urban access near 100 per cent, and relatively small urban-rural differences. At this stage of the process, increasing electrification tends to narrow rural-urban differences, as rural access converges towards already very high levels of urban access. This is shown by the downward-sloping red ODC trend line in figure 1.5.

Most LDCs in the Africa and Haiti group, by contrast, remain in the initial phase, with urban access well below the 80-per-cent threshold, wherein increasing overall access tends to widen rural-urban gaps (shown by the upward sloping orange trend line in figure 1.5). Their overall access is generally below 50 per cent, rural access below 20 per cent, and urban-rural gaps between 20 and 60 per cent.

In the average LDC, 90 per cent of the rural population lack access to electricity

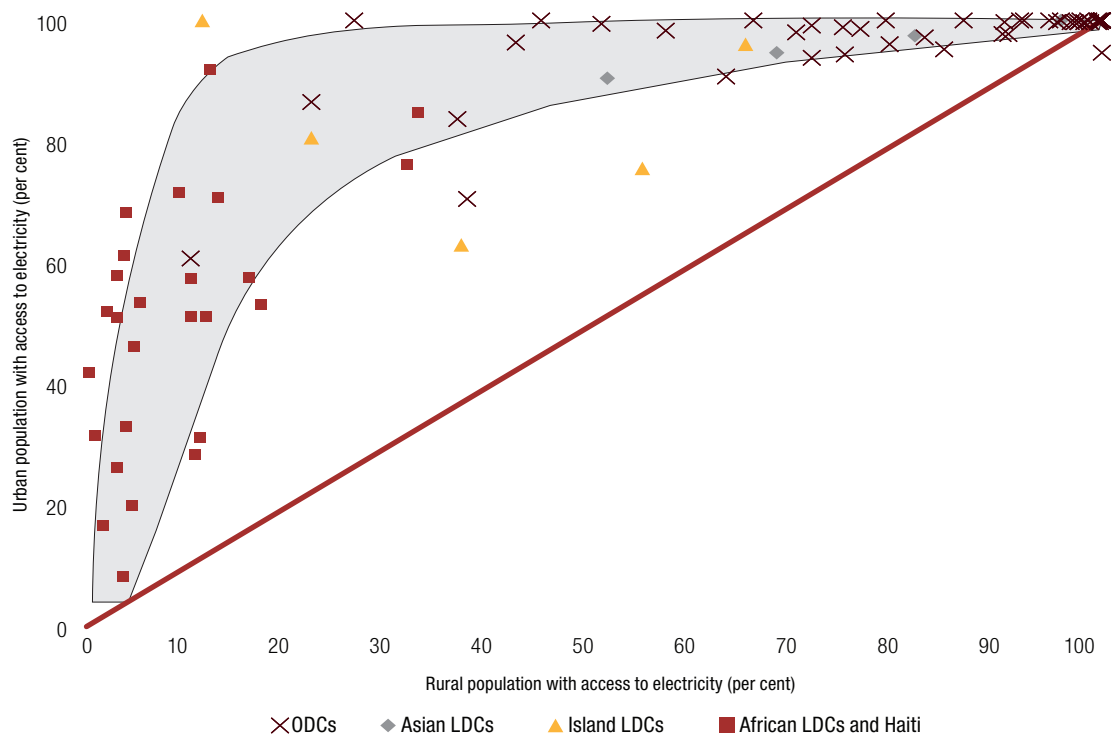
Most Asian and island LDCs are close to or above the 80-per-cent urban access threshold, so that further increases in overall access can be expected to narrow rural-urban gaps. With the exceptions of Kiribati and Vanuatu, they are also below the overall trend line in figure 1.5, indicating more limited urban-rural differences than suggested by their overall access.

This has two implications. First, access to electricity is systematically greater in urban than in rural areas (figure 1.6A). While 41.2 per cent of the urban population lacks access to electricity in the median LDC, in rural areas it is 89.3 per cent (and 94.9 per cent in the Africa and Haiti group). Access to non-solid fuels also shows substantial urban bias, but with lower overall access: only 13.1 per cent of people have access even in urban areas, and 2.4 per cent in rural areas (figure 1.6B).

Such wide rural-urban differences in access to electricity are a major factor in urban bias in LDCs, not only lowering living standards in rural areas, but also reinforcing other disadvantages of rural populations, for example by impeding the retention of health

Figure 1.4

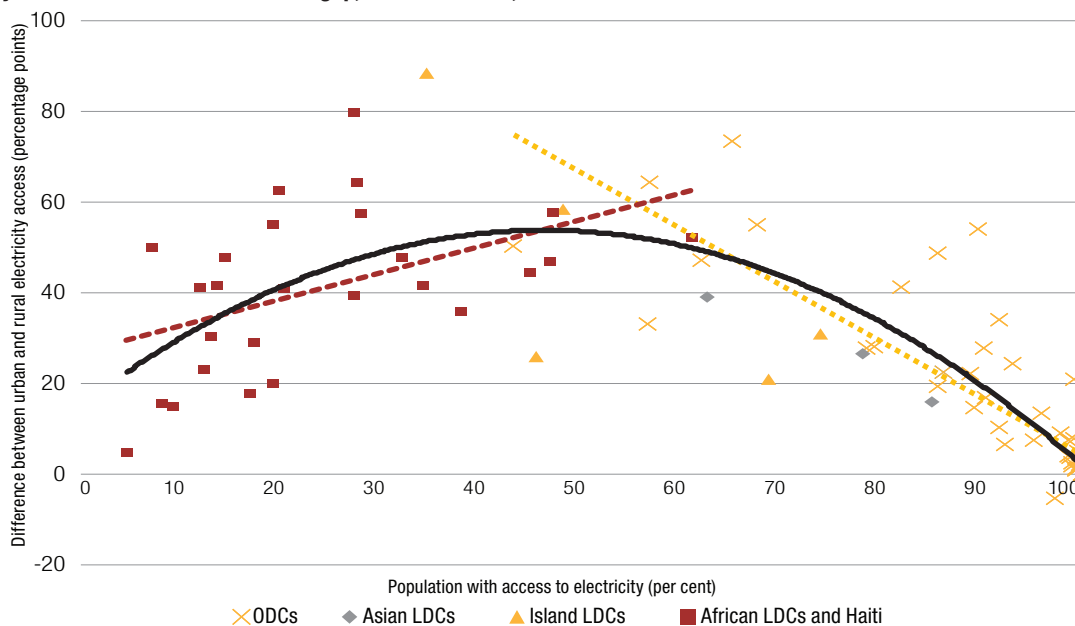
Rural and urban population with access to electricity, LDCs and ODCs, 2014



Source: World Bank, World Development Indicators database (accessed May 2017).

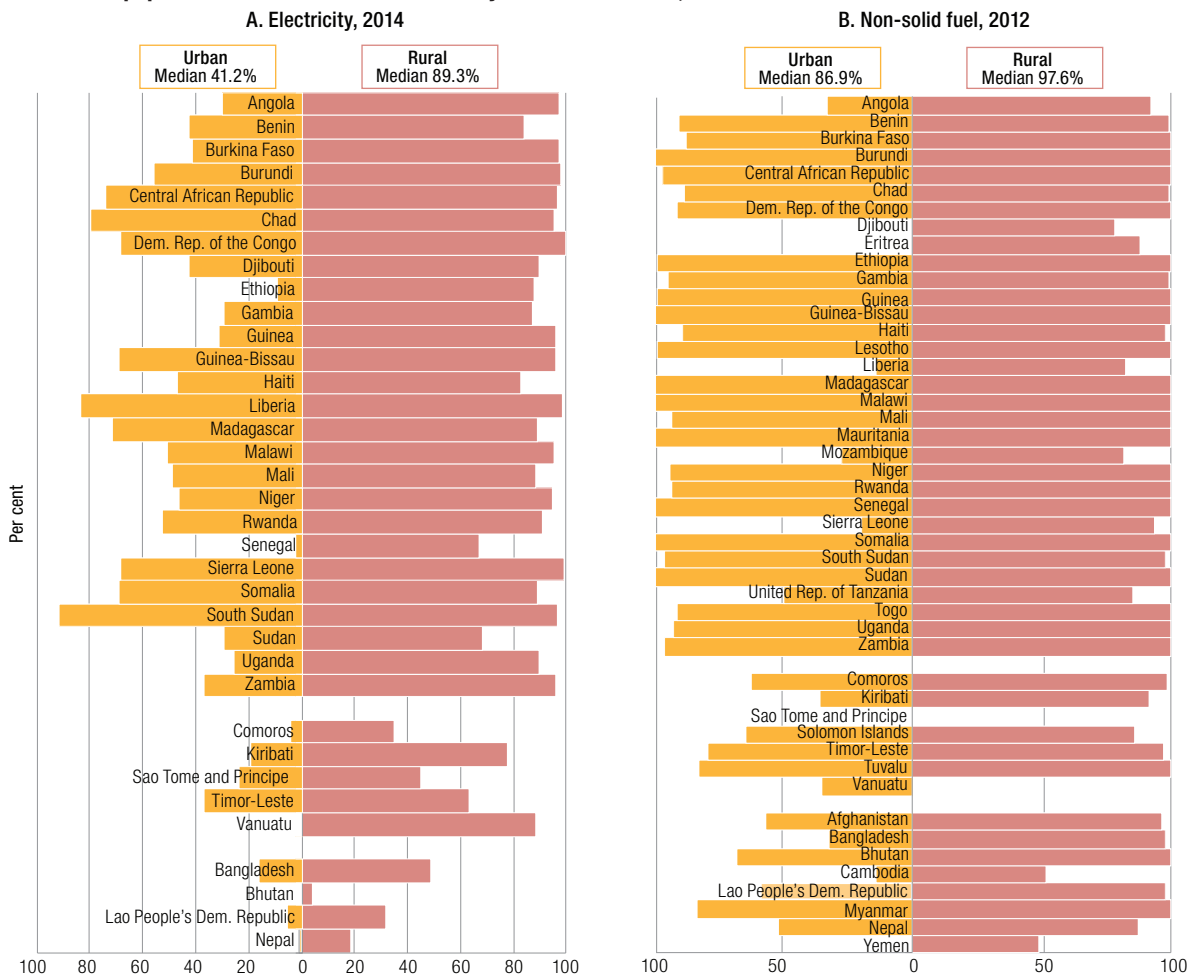
Note: Excludes LDCs and ODCs for which major discrepancies exist between WDI and IEA data, as described in box 1.1 (and those not included in IEA data, for which no consistency test is possible). The solid line represents the 45-degree line, corresponding to equal rates of access in rural and urban areas. The shaded area indicate the broad range of paths followed by actual observations in most LDCs and ODCs.

Figure 1.5
Electricity access and rural-urban access gap, LDCs and ODCs, 2014



Source: World Bank, World Development Indicators database (accessed May 2017).
 Note: Excludes LDCs for which major discrepancies exist between WDI and IEA data (box 1.1). The solid black line represents the polynomial trend line across all observations (degree two), that is, of the form $y = ax^2+bx+c$. The dotted lines represent the linear trend lines for African LDCs (in red) and for ODCs (in orange).

Figure 1.6
Rural and urban population without access to electricity and non-solid fuel, LDCs



Source: World Bank, World Development Indicators database (A: accessed May 2017; B: accessed March 2017).
 Note: At the time of writing, separate urban and rural estimates for population with access to non-solid fuels are no longer available in WDI. LDCs for which major data discrepancies exist between WDI and IEA data are excluded from A (box 1.1).

professionals and teachers. Rural electrification is thus an important contributory factor in ensuring that rural-urban migration is driven by choice rather than necessity, and in keeping the rate of urbanization within the bounds of sustainability (UNCTAD, 2015).

Second, the combination of urban bias in electricity access with predominantly rural populations in LDCs means that a large majority (82 per cent overall) of those without access to electricity are in rural areas (figure 1.7). In only one of the LDCs with reliable data (Djibouti) are a majority of those without access to electricity in urban areas, while two (Bhutan and Vanuatu) are estimated to have already achieved universal access in urban areas, so that all those without access are rural residents. In all three other Asian LDCs with reliable data, more than 90 per cent of those without access live in rural areas, reflecting very high levels of urban access, while the rural proportion is above 75 per cent in all island LDCs except Sao Tome and Principe (51 per cent). In the African LDCs and Haiti group, the rural dominance is relatively limited in Guinea-Bissau, Haiti and Liberia, at 55-60 per cent, but above 80 per cent in 12 of the other 23 cases. Since rural areas are also where electrification is most costly and problematic, this adds yet further to the challenge of electrification.⁷

3. Obstacles to extending access to electricity in LDCs

The electricity access gap is part of a broader infrastructure divide between LDCs and ODCs, largely reflecting the financial obstacles to their infrastructure development (UNCTAD, 2006). However, in the case

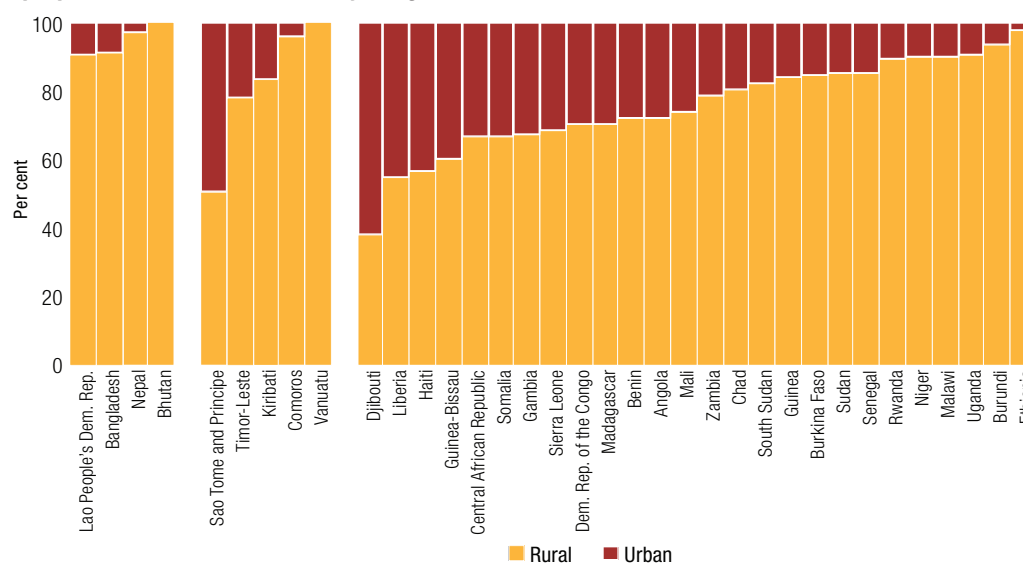
Limited urbanization, low rural population density and lack of demand in LDCs are major challenges to universal access

of electrification, these constraints are compounded by serious logistical challenges arising from a combination of limited urbanization and low population density in rural areas (figure 1.8). In 40 of the 46 LDCs for which data are available, the majority of the population lives in rural areas, compared with only 30 of 103 ODCs with available data. Moreover, LDCs generally have substantially lower rural population densities than most ODCs with similarly limited rates of urbanization. Consequently, 34 of the 47 LDCs, but only 10 of the 103 ODCs, have a combination of more than 50 per cent of their population living in rural areas and population density below 75 people per km².

This settlement pattern has historically represented a particular obstacle to electrification. Until recently, electricity supply (other than households and firms using their own generators) depended almost entirely on power plants using fossil fuels (coal, gas or oil) and/or on hydroelectric power. Since these have considerable economies of scale (partly reflecting high fixed costs), these technologies depend on a large market for their viability. Consequently, they are well suited to urban and immediate peri-urban markets, but particularly ill suited to sparsely inhabited rural areas: accessing a market of sufficient scale in this context requires transmission over a very considerable area, which greatly increases capital costs for the distribution network.

Figure 1.7

Proportion of people without access to electricity living in rural and urban areas, LDCs, 2014



Source: UNCTAD secretariat estimates, based on World Bank, World Development Indicators database (accessed August 2017).

Note: Excludes LDCs for which major data discrepancies exist between WDI and IEA data (box 1.1).

In recent years, this obstacle has become less absolute as costs have fallen for renewable generation technologies that are viable on a smaller scale, increasing the potential for rural electrification using village-level mini-grids and off-grid generation. While such models have as yet had little penetration in most LDCs, they could in principle represent a historic opportunity for a major acceleration in access to electricity, if the obstacles to their widespread use can be overcome (chapter 3).

However, settlement patterns are only part of the story: access in urban areas is also much lower in most LDCs than in ODCs (as seen in figure 1.6A), while ODCs with similarly sparsely inhabited rural areas have achieved much higher rural electrification rates. The other aspects of the issue, as in other infrastructure sectors, relate to financial constraints and state capacities.

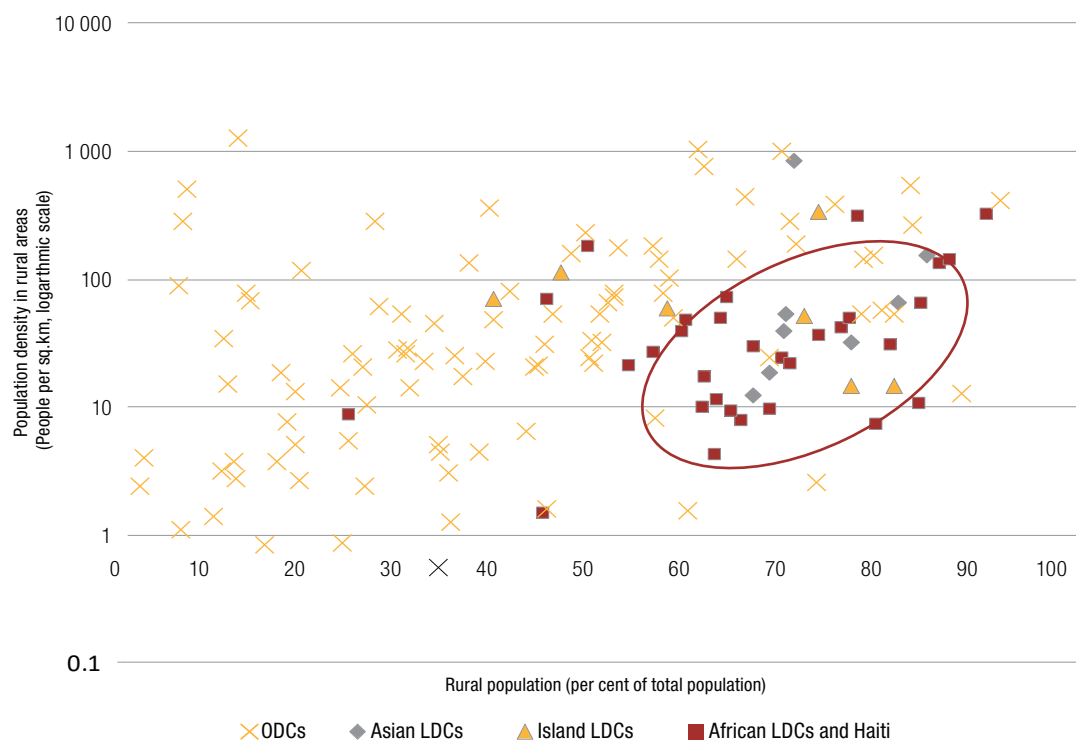
Low household incomes limit domestic demand for electricity, while the lack of industrialization and other modern activities in most LDCs limits demand for electricity by productive sectors. This lack of demand in turn limits the financial viability of commercial investments in electricity generation and distribution, especially in rural areas: here, incomes are lower and poverty more widespread and deeper, reducing demand; and this compounds the effect of thinly spread populations in increasing investment costs.

At the same time, the domestic resources available for public investment in electricity production and supply are limited by low overall incomes, narrow tax bases and weak tax collection capacity, while borrowing capacity is limited by considerations of debt sustainability. This leaves public investment in electrification critically dependent on official development assistance (ODA); but this has been limited by persistent large shortfalls from the target level of 0.15-0.20 per cent of donor gross national income (GNI) (chapter 5). Issues in the financing of energy infrastructure are discussed in greater detail in chapter 5.

4. Universal access: A mountain to climb

Figure 1.9 highlights the scale of the challenge facing most LDCs in seeking to achieve universal access to electricity by 2030.⁸ Among the LDCs with reliable data, two Asian countries — Nepal and Bhutan — appear well on track towards this target, which requires substantially fewer new connections per year than over the last decade for which data are available. Lao People’s Democratic Republic could also achieve universal access by 2030 with around 10 per cent fewer new connections per year than over the last decade. While this understates the scale of the challenge (as those still requiring connections are likely to be the most problematic logistically or otherwise), the target

Figure 1.8
Rural share of population and rural population density, LDCs and ODCs, 2010

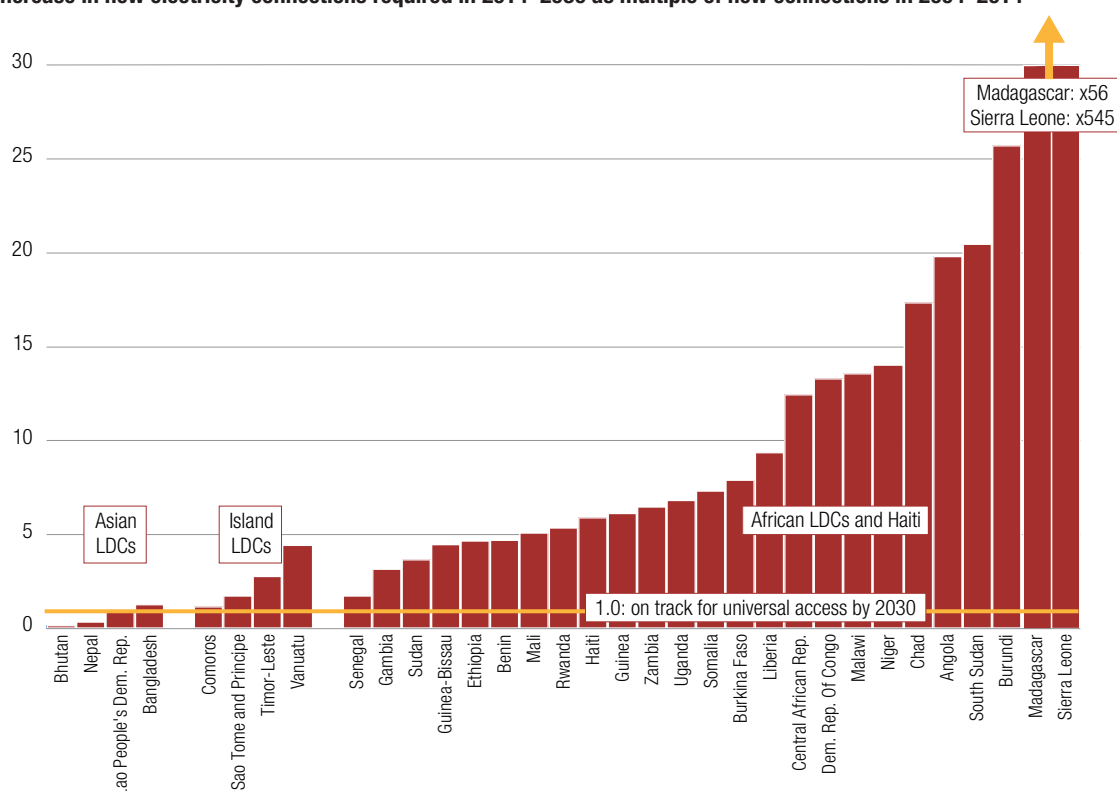


Source: UNCTAD secretariat estimates, based on World Bank, World Development Indicators database (accessed May 2017).

Note: For 18 of the 150 countries included in the graph, separate data are not available for rural land area. In these cases, rural population density was approximated by dividing rural population by total land area. It should be noted that there are marked differences in national definitions of rural and urban areas (UNCTAD, 2015: box 1.2), which affect the comparability of observations between countries.

Figure 1.9

LDCs: increase in new electricity connections required in 2014–2030 as multiple of new connections in 2004–2014



Source: UNCTAD secretariat estimates, based on access estimates from World Bank, World Development Indicators database and on population projections from UN DESA, World Population Prospects: The 2015 Revision database (both accessed May 2017).

Note: The baseline for Eritrea is 2001–2011, due to the unavailability of estimates for 2012–2014. In Djibouti and Kiribati, the number of people with access to electricity is estimated to have declined between 2004 and 2014, making estimation of a ratio impossible.

of universal access should nonetheless be achievable with an increase in policy attention and investment. The challenge will be substantially greater in Bangladesh and the Comoros, which require some 20–30 per cent more new connections per year, and still more so in Senegal and Sao Tome and Principe, where the increase required is around 75 per cent.

Elsewhere — and particularly in other African LDCs — the challenge is of an altogether greater order of magnitude. Only six LDCs in the Africa and Haiti group could achieve universal access by 2030 with less than a fivefold acceleration in their rate of progress, while 10 require a more than twelvefold acceleration. In the most extreme cases, Madagascar and Sierra Leone, annual connections need to increase by factors of 56 and 545 respectively. In Djibouti and Kiribati (not included in the figure), a reversal of the last decade's reduction in access will be required to achieve the 160–170-per-cent increase needed for universal access.

5. Electricity production: LDCs' power generation gap

After stagnating in per capita terms through most of the 1990s, electricity production in LDCs has grown

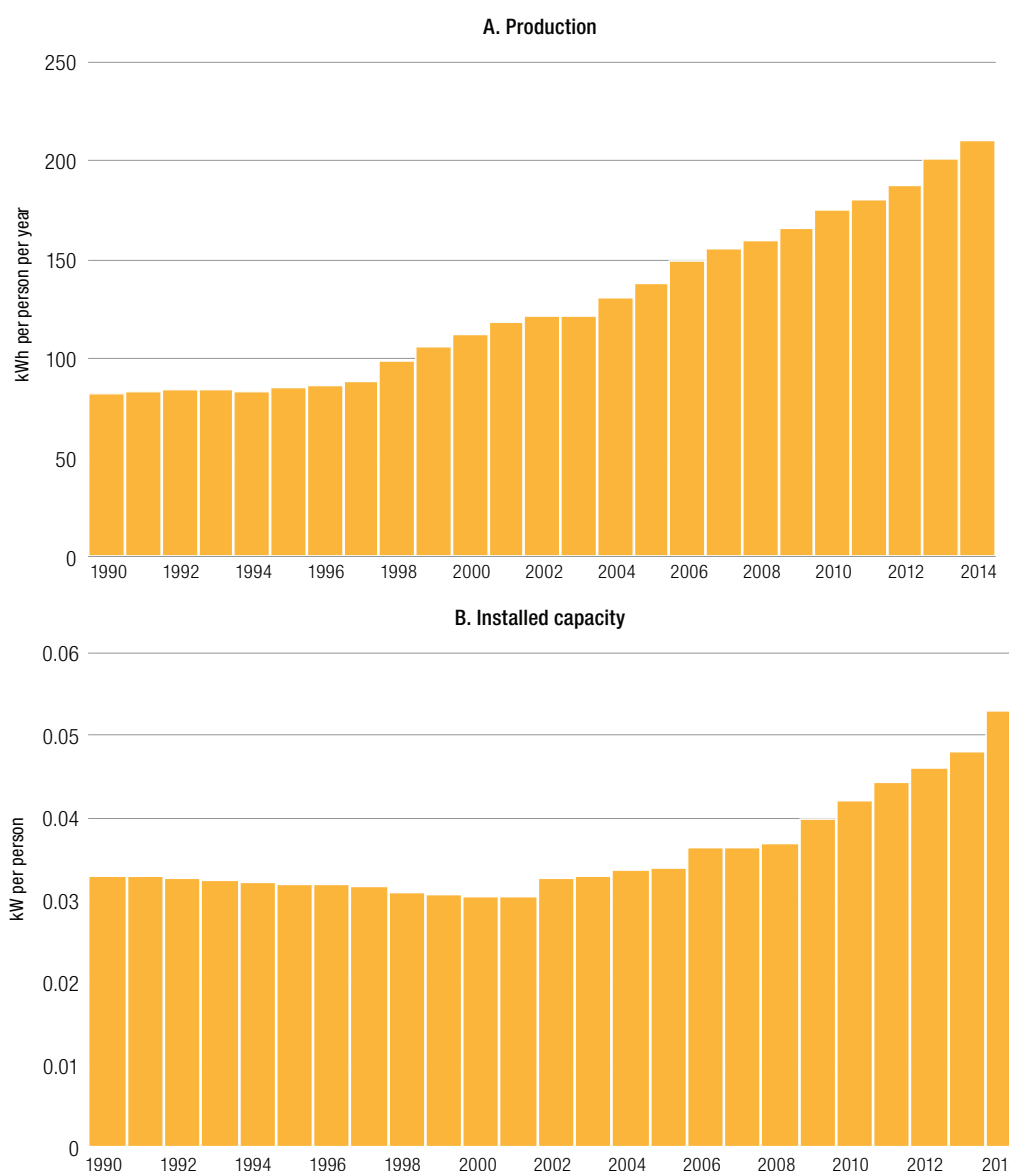
robustly since, more than doubling from 89 kilowatt-hours (kWh) per capita in 1997 to 210 kWh per capita in 2014 (figure 1.10A).⁹ This increase stemmed from a combination of increasing installed capacity, which nearly doubled from 0.030 kW per capita to 0.053 kW per capita between 2001 and 2014 after a progressive decline through the 1990s (figure 1.10B), and a broad improvement in the utilization of this capacity, demonstrated by an increase in the overall capacity factor from around 30 per cent to nearly 50 per cent.

The recent expansion of power generation has also been very broad-based (figure 1.11), gross electricity output rising between 2004 and 2014 in all 47 LDCs, with a median annual growth rate of 4.7 per cent, and double-digit rates in several cases (including both fossil-fuel exporters such as Angola, the Sudan and Timor-Leste, and other LDCs such as Bhutan, Cambodia, Ethiopia, Myanmar and Rwanda). Generating capacity also expanded significantly over the same period in almost all LDCs, with slight declines only in Afghanistan, Eritrea and Malawi.¹⁰

Impressive as this growth may appear, however, both capacity and production have failed to keep pace with the 460-per-cent increase in the number of people with access to electricity since 1991 (figure 1.12). Both fell

Figure 1.10

Gross electricity production and installed capacity per capita, LDCs, 1990–2014



Source: UNCTAD secretariat estimates based on data from UN DESA, Energy Statistics Database and World Population Prospects: The 2015 Revision database (both accessed February 2017).

sharply relative to the population with access until 1996, installed capacity continuing to decline until 2008. Both recovered only slowly and partially thereafter, so that, by 2014, installed capacity per person with access was barely half its 1991 level, while electricity production per person with access was one fifth below its 1991 level.

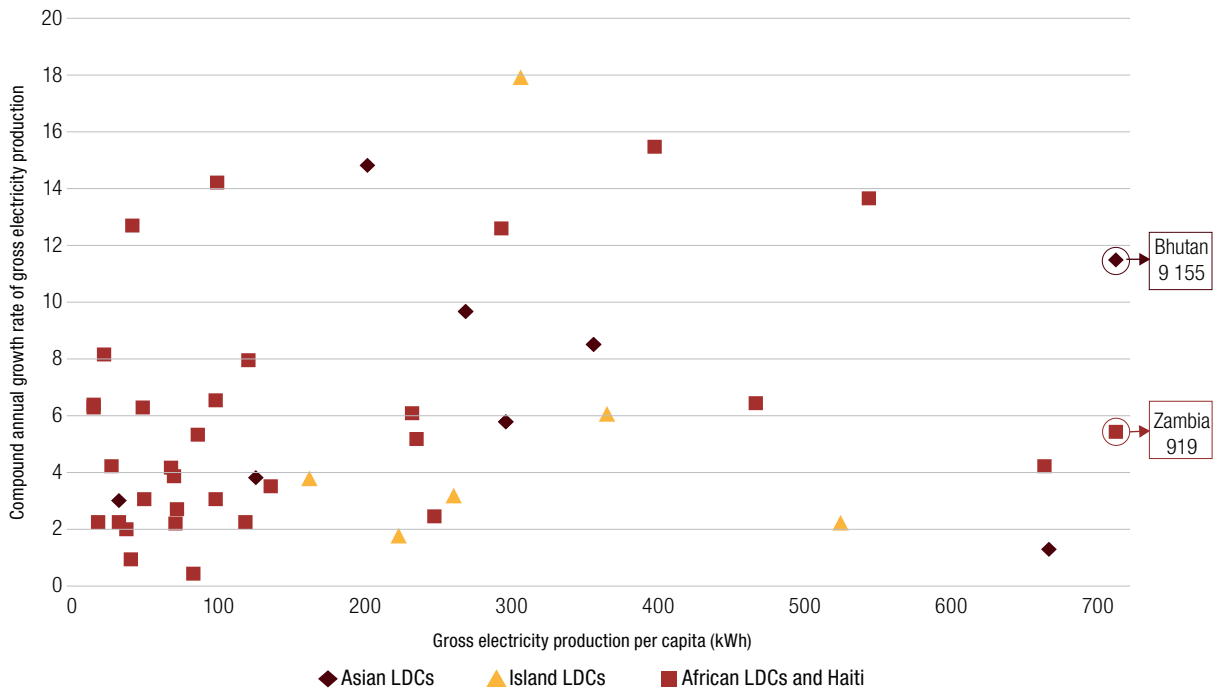
Equally, while the increases in electricity capacity and installed capacity from the 1990s onwards represented a convergence towards the world average, LDCs' share in world electricity production remained only 0.8 per cent in 2014, compared with their 13-per-cent share in global population.¹¹ The increases were also insufficient to prevent a rapidly widening gap between LDCs and ODCs (figure 1.13). In 1990, LDCs' installed capacity per capita was 17.8 per cent of the ODC

average, and their electricity production was 11.5 per cent of the ODC average. By 2014, these figures had fallen respectively by more than half to 8.7 per cent and by more than a quarter to 8.5 per cent. This represents a very considerable gap between LDCs and ODCs — and the gap between LDCs and developed countries is much wider still (figure 1.14).

As can be seen in figure 1.11, the overall figures for electricity production also conceal considerable heterogeneity among individual LDCs. Only five countries in the group (Bhutan, Lao People's Democratic Republic, Mozambique, Tuvalu and Zambia) had electricity production in excess of 500 kWh per person per year in 2014, while 20 were between 100 kWh and 500 kWh, and 22 below 100 kWh (of which 12 were 50 kWh).

Figure 1.11

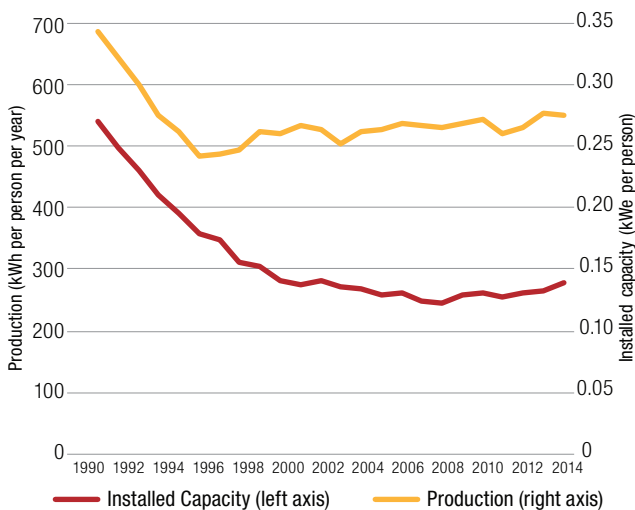
LDCs: Gross electricity production per capita, level (2014) and growth rate (2004–2014)



Source: UNCTAD secretariat estimates, based on data from UN DESA, Energy Statistics Database (accessed February 2017).

Figure 1.12

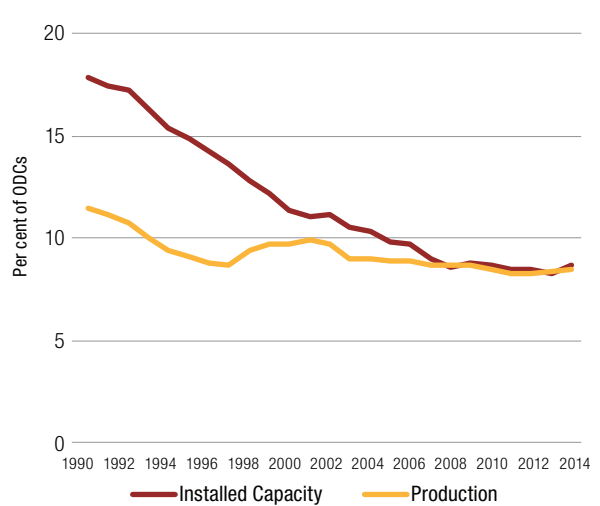
Gross electricity production and installed capacity per person with access, 1990–2014



Source: UNCTAD secretariat estimates, based on data from UN DESA, Energy Statistics Database and World Population Prospects: The 2015 Revision database (both accessed February 2017).

Figure 1.13

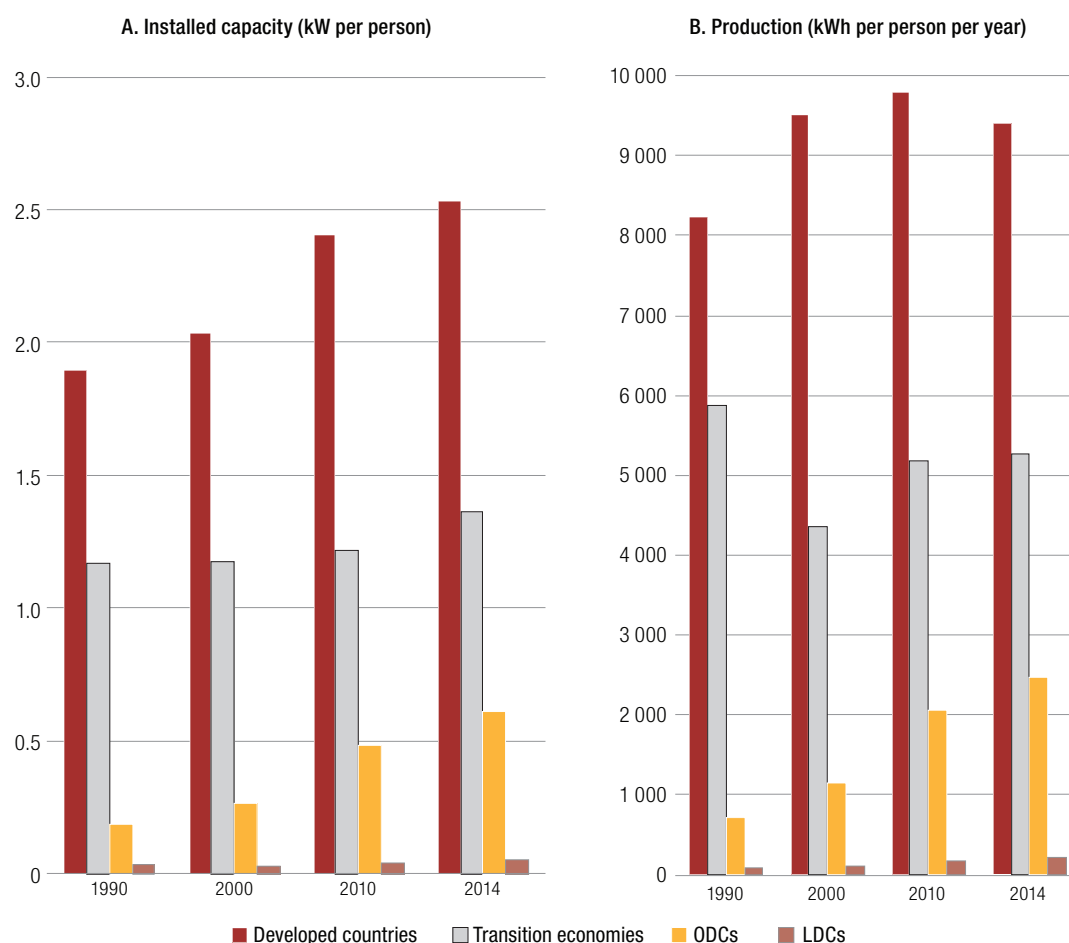
Gross electricity production and installed capacity per capita, LDCs, 1990–2014



Source: UNCTAD secretariat estimates, based on data from UN DESA, Energy Statistics Database and World Population Prospects: The 2015 Revision database (both accessed February 2017).

Figure 1.14

Gross electricity production and installed capacity per capita: LDCs, ODCs, transition economies and developed countries, 1990–2014



Source: UNCTAD secretariat estimates, based on data from UN DESA, Energy Statistics Database and World Population Prospects: The 2015 Revision database (both accessed February 2017).

C. Energy and structural transformation

1. Structural transformation and productive capacities

Development is not merely a matter of economic growth. Rather, it is about structural economic transformation – a progressive shift of the structure of the economy from that which characterizes LDCs (low overall productivity, limited industrialization and a predominance of traditional agriculture and low-value services) towards higher productivity and a greater role of manufacturing and higher-value services. It is akin less to the growth of an organism than to the metamorphosis of a caterpillar into a butterfly – a change, not only in the scale of the economy, but also in its nature (UNCTAD, 2014).

The core of this process is increasing overall levels of productivity, in two dimensions:

- Increasing productivity within existing economic activities;

- Shifting productive resources from sectors and activities with relatively low productivity (notably traditional agriculture and low-value services, especially in the informal sector) to those with higher productivity (particularly manufacturing and high-value services).

This requires the continual generation of new dynamic activities characterized by higher productivity and increasing returns to scale, through successive waves of introduction and diffusion of new economic activities, in order to diversify the economy into progressively more technology-intensive and higher-productivity activities and production processes. This is not a passive outcome of the growth process, but rather an active determinant of growth potential.

Of particular importance in the early stage of development that characterizes LDCs is the structural transformation of rural economies, through a parallel process of agricultural upgrading and the complementary development of rural non-farm activities (UNCTAD, 2015a). Given LDCs' predominantly rural populations and agrarian economies, such a process is essential to

a broad-based transformation of the national economy as a whole, and to limit rural-urban migration to a rate at which migrants can be productively absorbed by reducing the underlying economic “push” factors.

Structural transformation requires, in particular, the development of productive capacities (UNCTAD, 2006), which may be categorized as:

- Productive resources (natural and human resources, and financial and physical capital);
- Entrepreneurial capabilities (core competencies and technological capabilities);
- Production linkages (including forward and backward linkages, information and resource flows, production clusters, global value chains and links between firms of different types and sizes).

Central to structural change and the development of productive capacities are capital accumulation, through investment to increase stocks of natural, human and physical capital; and innovation, through the introduction of new products, production methods, equipment and skills.

While access to modern energy can make an important contribution to structural transformation (chapter 2), it is clearly not enough. Lack of access to energy is only one of a range of constraints to the development of productive capacities, in terms of physical infrastructure (for transport, information and communication technology (ICT), water supply, waste disposal, etc.); institutional weaknesses (notably in relation to firms, financial systems and knowledge systems); and demand constraints (UNCTAD, 2006). Successful structural transformation therefore requires carefully planned and coordinated action to overcome all these constraints, and to address other essentials for development, particularly education and training to provide the necessary human resource base; the development of effective public institutions; and improvements to domestic resource mobilization.

2. (Re)defining access to modern energy

In practice, as discussed in the introduction to this section, access to modern energy is often defined, explicitly or implicitly, as physical connection of households to the electricity grid and their use of clean non-solid fuels for cooking. However, this definition is unduly narrow and potentially misleading. In particular, it does not address issues relating to agents other than households, to the amount of energy to which households have access, to attributes of the energy supply to which they have access, or to the use of energy for productive or other non-domestic purposes (Culver, 2017; Bazilian et al., 2010).

“Transformational energy access” for productive sectors is important as well as universal household access

More recently, however, there have been efforts in the context of the Sustainable Energy for All (SE4All) initiative to broaden understanding of access to energy in various dimensions (Bhatia and Angelou, 2015):

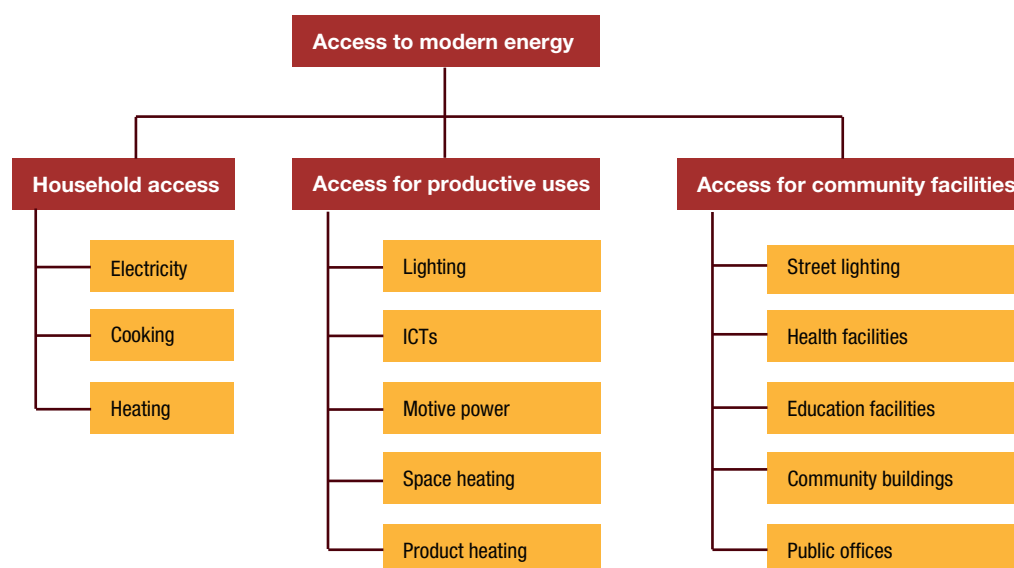
- From a focus on households to encompass businesses and public and community facilities;
- From electricity supply to encompass modern fuels for cooking and (where needed) heating;
- From access to energy to technologies for its use (particularly improved and energy-efficient stoves);
- From a binary definition (of having or not having access) to a continuum, reflected in several tiers of access;
- From physical connection or availability to include attributes of supply, including quantity, reliability, continuity and safety;
- From physical supply to affordability;
- From access at a point in time to a progressive upgrading in access over time.

Figure 1.15 sets out an adapted version of the typology of modern energy access proposed in a recent conceptualization report published by the SE4All Knowledge Hub (Bhatia and Angelou, 2015), elaborating the “access for productive uses” component in line with the other two components on the basis of the discussion in that report.

The same report also proposes five tiers of access, defined by various criteria, including for productive access (Bhatia and Angelou, 2015: table ES.6). While a much-needed move in the right direction, however, it is not clear that the criteria for these tiers of access adequately represent what is required for structural transformation. This largely reflects the basis of the approach “on the energy access experienced by individuals rather than enterprises”, so that data can be collected through household surveys rather than enterprise surveys (Bhatia and Angelou, 2015). Specifically, the capacity criteria are the same as for households, while the availability criteria are significantly less demanding. Tier 1 allows no more, and tier 2 little more, than lighting and telephone charging. The daily supply criterion for tier 3 would not be sufficient for a domestic refrigerator; and even that for the highest tier (5) is well below what is required for a domestic oven. These thresholds appear low relative to electricity needs for the type of productive activities entailed in

Figure 1.15

Typology of modern energy access



Source: Adapted by UNCTAD secretariat from Bhatia and Angelou (2015), figure ES.1 and chapter 9.

a substantial economic transformation; and reliability, quality, affordability, convenience and safety are not considered at all below tier 4.

Such relatively undemanding thresholds appear oriented towards a development process characterized by a proliferation of household-level microenterprises, and may offer some benefits in this context. Typically, such a process arises as “entrepreneurs by necessity” are driven by lack of employment opportunities and/or inadequate farm incomes to resort to low-productivity survivalist activities in the informal sector. While characteristic of the current situation of many LDCs, however, achieving the SDGs will require a much more transformative development process in LDCs, founded upon the dynamic growth of enterprises run by “entrepreneurs by choice”, generating productive employment opportunities, which can be expected ultimately to form the basis of a vibrant formal sector (UNCTAD, 2015). This is likely to require an altogether more demanding framework for energy access for productive use.

While practical limitations to data collection may confine monitoring of energy access to this framework, it is therefore important that policies should be oriented towards a much more ambitious concept of access for productive use — what might be termed “transformational energy access”. This concept is discussed in greater detail in chapter 2. In particular, due attention should be given to the energy needs of enterprises as well as households. Even for households engaged in productive activities, more demanding standards may be appropriate for capacity, availability and reliability if energy is not to be a constraint on productive potential.

3. Energy for structural transformation before electrification

Like the SDGs as a whole, universal access to modern energy is an immensely ambitious goal, and nowhere more so than in the LDCs. Even if universal access is achieved by 2030 — which is far from certain — this will leave many households without access to modern energy for the next 13 years. Escaping the constraint that limited access to energy imposes on economic development and structural transformation thus requires consideration of the energy needs of productive enterprises ahead of access to electricity (Karekezi, 2002). This is of particular importance in rural areas, as it is here that lack of access to electricity represents the greatest obstacle to structural transformation.

The energy needs of many rural enterprises are for motive, mechanical or thermal energy, which can be provided by non-electrical technologies before electricity is available. Woodfuel (firewood and charcoal) plays a substantial role, often being used as an energy source by bakeries, restaurants, food stalls, breweries and forges and for brick-making (Schure et al., 2010). Key contributions can be made by the adoption of improved and fuel-efficient stoves, solar stoves, ovens, kilns and water heaters, and more purpose-specific technologies such as solar tunnels for drying agricultural produce. Potentially important technologies for motive and mechanical energy include animal traction (in agriculture), wind or hydraulic pumps (e.g. for irrigation), water-driven equipment for food processing, etc., while evaporation fridges can allow refrigeration without access to electricity.

Much of this equipment can also be produced locally, allowing it to be tailored to local needs and preferences, as well as potentially making a significant contribution to employment creation, structural transformation and the diversification of rural economies.

Programmes such as the multifunctional platform programme operated in several African countries by the United Nations Development Programme (UNDP) can also make a contribution. The multifunctional platform is a small diesel- or biodiesel-driven engine mounted on a platform, operated commercially at the village level by women's cooperatives, which is capable of powering various equipment for milling, de-husking, pressing, etc., directly, or of generating electricity to charge batteries for lighting, water pumps and productive equipment such as drills and saws.

4. Mechanisms connecting energy with structural transformation

The energy sector is an important part of the economy in its own right. This is most obvious in the case of fuel-exporting LDCs, where fossil-fuel production makes a major contribution to national income, the balance of payments and public finances; and to a lesser, but nonetheless substantial, extent in electricity-exporting countries such as Bhutan and Lao People's Democratic Republic (chapter 2). But even in other LDCs, the energy sector is a significant source of value addition and employment. Its expansion, as electricity production and access are expanded, thus represents a significant part of structural transformation in its own right; and the shift from reliance on traditional biomass to modern forms of energy represents a considerable upgrading within the sector, from predominantly low-productivity activities (collection, processing and distribution of traditional fuels) to much higher-productivity activities (production and distribution of electricity and modern fuels).

However, the role of energy in promoting structural transformation across the economy as a whole greatly exceeds the direct contribution of employment and production in the energy sector itself. This role can be divided into four broad categories of effects: direct impacts of energy access; secondary effects; synergies; and feedback effects.

Direct impacts relate to effects of energy use or access on the sectoral composition of production and productivity within activities. Access to electricity, in particular, can have a major direct impact on structural transformation of the economy, notably by:

- Allowing the adoption of production technologies that increase labour productivity within existing activities;

Access to energy can promote structural transformation through direct and secondary effects, synergies and feedback effects

- Allowing the production of new goods and services that would not otherwise be viable;
- Allowing individuals and enterprises to work for longer or more flexible hours, through the use of electric light.

Secondary effects are those which operate through the availability or increased efficiency of ancillary and support services. Such effects can also be important, both across the economy as whole — as in the case of business support services, whose development can be facilitated by the greater availability of ICTs following electrification — and for individual sectors. In agriculture, for example, the availability of refrigeration can greatly increase the efficiency of agriculture by reducing post-harvest losses, while electric, hydraulic or wind-driven pumps can facilitate irrigation.

Both direct and secondary effects depend on the scale, continuity and reliability of electricity supply, as well as on access.

Synergies with structural transformation arise from the production of modern energy itself, or from measures to reduce biomass use, some of which can also make a substantial contribution to structural transformation. Such synergies arise most notably in the agricultural sector: conventional hydroelectric power generation can provide irrigation, while production of biogas can produce organic fertilizer as a byproduct, both of which help to increase agricultural productivity. Likewise, reduced use of crop residues for energy allows them to be used to fertilize and replenish agricultural land. As well as avoiding or reducing the financial cost of purchasing mineral fertilizers, such use of organic matter provides a much wider range of nutrients, including in particular the organic carbon essential to microorganisms that enhance nutrient cycling (Sanchez, 2002; Modi et al., 2005: box 6.1).

Other examples of synergies beyond the agricultural sector include the use of lakes and reservoirs created by large-scale hydroelectric dams for leisure or tourism facilities; and local production of improved and energy-efficient stoves.

Feedback effects are positive effects on structural transformation that arise over the long term as a result of the effects of access to modern energy on poverty, environmental sustainability and inclusivity:¹²

Energy plays an important role in structural transformation, sustainability, inclusivity and poverty reduction

- Reductions in time devoted to collection of fuelwood and domestic activities free up time, some of which may be devoted to productive activities.
- Improvements in health (as a result of reduced ambient and household air pollution, electrification of health facilities, increased access to information and increased time for rest and recreation) increase labour productivity.
- Improvements in education (through improved child health, reduced time devoted to fuel collection and electrification of schools) increase human capital formation and future labour productivity.
- Reduced income poverty can reinforce these effects by further improving health and education.
- More sustainable use of forest resources can increase the long-term economic contribution of the forest sector.
- Reduced ambient air pollution in rural areas through reduced use of biomass can improve agricultural productivity, particularly in the vicinity of homes.

While these effects are subject to very long and uncertain time lags, and are therefore unlikely to be reflected in empirical analyses of energy and structural transformation, their long-term contribution to structural transformation may be considerable.

D. Energy, sustainability and inclusivity

Sustainability and inclusivity are as central to the 2030 Agenda as economic development. However, structural transformation and the development of productive capacities in LDCs will not, in and of themselves, ensure inclusivity. Equally, while they play a central role in promoting the economic sustainability of development and of poverty eradication, additional consideration is required of other dimensions of sustainability in the environmental, financial, social and political spheres.

Integrating these considerations is thus vital to a coherent approach to achieving the SDGs. This objective provides the basis for the PErSIST (Poverty Eradication through Sustainable and Inclusive Structural Transformation) framework (box 1.2), which seeks to develop a comprehensive and coherent framework for the assessment of the development needs and policies of LDCs in the new and different context presented by the 2030 Agenda.

1. Energy, environmental sustainability and climate change

Globally, the key issue in energy and sustainable development is climate change. However, LDCs have very low CO₂ emissions from electricity generation and industrial fossil-fuel use — the main sources globally. They account for 42 of the 50 countries with the lowest such emissions in per capita terms in 2014, with median per capita emissions less than one fiftieth of some developed countries and major oil exporters (Boden et al., 2017).

Nonetheless, most LDCs have set themselves extremely ambitious emission-reduction targets in their intended nationally determined contributions (INDCs) under the United Nations Framework Convention on Climate Change (UNFCCC) (Australian-German Climate and Energy College, 2016). Three quarters (35) of the LDCs have set targets entailing a reduction in their per capita GHG emissions from their 2010 level by 2030, half by between 14 per cent and 48 per cent (excluding land use, land-use change and forestry). If all countries fulfilled their INDCs, 32 LDCs would rank lower in 2030 than in 2010 in terms of emissions per capita, and the number of LDCs among the 30 countries with the lowest per capita emissions globally would rise from 21 to 24.¹³

For some LDCs, particularly fossil-fuel producers, fossil-fuel-based generation is likely to play an important role in generation for grid extension, increasing their GHG emissions (although off-grid solutions based on renewable generation will be more appropriate in many rural areas, as discussed in chapter 3). However, such increases can in principle be offset by emissions reductions through increased access to modern fuels and/or adoption of more fuel-efficient stoves to reduce the use of traditional biomass. While carbon emissions from burning dead wood are offset by those that would otherwise have arisen from its decomposition, this is not the case where trees are cut down or wood is cut from live trees, as is more often the case for urban supply. Moreover, other emissions (of black carbon (soot), methane, carbon monoxide and volatile organic compounds) account for 58-66 per cent of the total on climate forcing (Baillis et al., 2015); and these only occur if wood is burned. Thus the net reduction in GHG emissions resulting from reduced burning of traditional biomass is substantial.

The scale of GHG emissions from traditional biomass in LDCs means that a large-scale substitution towards modern fuels could achieve a meaningful reduction in their overall emissions. GHG emissions from woodfuel in the 37 LDCs for which estimates are available total

Box 1.2. The PErSIST framework

The PErSIST (Poverty Eradication through Sustainable and Inclusive Structural Transformation) framework represents an attempt, on the one hand, to adapt UNCTAD's traditional focus on structural economic transformation to the greater emphasis on the social and environmental pillars of sustainable development embodied in the 2030 Agenda; and, on the other hand, to highlight and make more explicit the essential role of structural economic transformation in the achievement of the SDGs in LDCs.

The PErSIST framework comprises four closely interrelated elements:

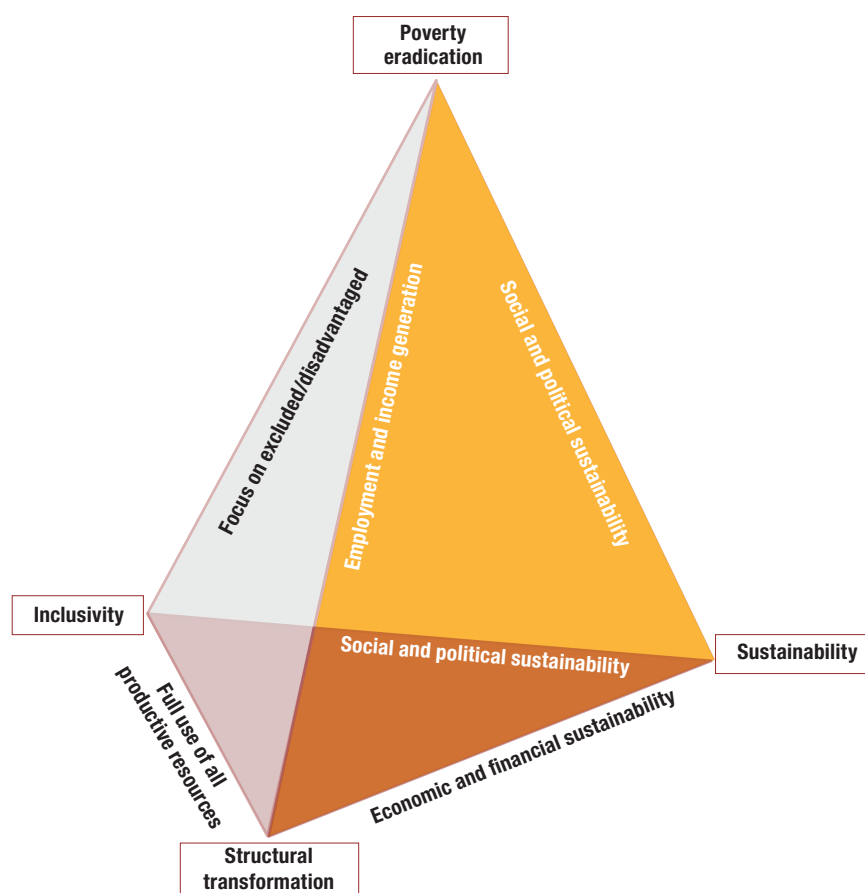
- **Structural transformation** of the economy through the development of productive capacities (section C1);
- **Poverty eradication**, encompassing income poverty (highlighting the need for full employment at incomes above the poverty line), time poverty and multidimensional poverty, based on the capabilities approach (Nussbaum and Sen, 1993) underlying the human development index developed by UNDP;
- **Inclusivity**, in terms of equality of economic opportunities and equity of outcomes for all, irrespective of gender, rural or urban residence, age (including youth and the elderly), race and ethnicity, including people with disabilities and chronic illnesses, refugees and displaced people;
- **Sustainability**, broadly defined to include not only environmental sustainability (based on the concept of ecosystem services and distinguishing between sustainability of national strategies and global environmental externalities), but also economic, financial, social, political and functional^a sustainability.

The framework highlights a number of requirements for sustainable development (as defined by the SDGs) within each of these areas (box table 1.3), while emphasizing the critical interdependence of the different elements (box figure 1.2).

The PErSIST framework, and its application to energy, is elaborated in a background paper for this Report.

Box figure 1.2

The PErSIST Framework: Interdependence of the core components



^a Functional sustainability is defined, within the PErSIST framework, as the ability of systems, facilities, installations, equipment, etc., to remain fully operational over the long term.

Box 1.2 (contd.)

Box table 1.3

The PERsIST Framework: Key principles

Component		Requirements	
Sustainable and inclusive structural transformation	Structural transformation	Increasing productivity within economic sectors	
		Shift of productive resources from sectors and activities with lower productivity to those with higher productivity	
	Environmental	National	Resource use and environmental impacts should remain within or fall progressively towards (nationally) sustainable limits, defined as a level of use of ecosystem services that does not impair the capabilities of future generations
		Global externalities	Generation of global environmental externalities, fully supported by additional external finance and technology transfer
	Economic		Structural transformation
			Effective use of the proceeds of non-renewable resource exploitation to promote the broader development process, so as to reduce dependence on them
	Financial		Essential services provided on a commercial basis should generate an adequate rate of return whilst ensuring affordability to users, including those below the poverty line
			Recurrent costs to the public sector arising from the development process should not exceed its financial capacity
			Limitation of public sector liabilities, including contingent liabilities, in line with capacity to service them
			External liabilities should not exceed the country's long-term capacity to service them
		Dependency on ODA should be progressively reduced over time	
Functional		Systems, facilities, installations, equipment, etc, should remain fully operational over the long term	
Social/political		The development process should not undermine political stability, and the risk of social tensions (eg as a result of increasing vertical or horizontal inequality or serious economic, human or social costs for particular areas or population groups) should be minimized	
Poverty	Income		Full employment, with minimum labour productivity sufficient to generate incomes above the poverty line, taking account of household size and composition and the labour share in value added
	Time		Limitation of working time (including domestic work) to allow adequate time for rest and leisure
	Multidimensional capabilities		Minimum hourly incomes sufficient for all households to reach the income poverty line while limiting working hours sufficiently to ensure adequate time for rest, recreation and reproductive activities
		Creating a political, social and economic environment which allows material resources to enhance capabilities	
Inclusivity		Progressive improvement in the incomes and capabilities of all disadvantaged groups relative to the remainder of the population and to identifiable advantaged groups	
		Progressive reduction in vertical inequality of income and wealth distribution	

Source: Woodward (forthcoming).

some 260-390 Mt of CO₂ equivalent, around 30 per cent of the world total from this source. This represents some 20-50 per cent of total emissions in Burkina Faso, the Gambia, Guinea-Bissau, Malawi, Mozambique, Somalia and the United Republic of Tanzania; and 50-80 per cent in Bhutan, Burundi, Eritrea, Ethiopia, Haiti, Lesotho, Liberia, Nepal, Rwanda and Uganda (Bailis et al., 2015).

Burning of traditional biomass is also an important source of ambient (outdoor) and more particularly household (indoor) air pollution, respectively the sixth and eighth greatest risks to health globally (Forouzanfar et al., 2016). Both exposure levels and health impacts are especially high in non-island LDCs,¹⁴ two thirds of which are among the top one third of all countries

in terms of exposure, while the associated burden of disease is on average twice as great in non-island LDCs as in ODCs.

The difference between LDCs and ODCs is still greater in terms of indoor air pollution, of which traditional biomass is the main source. LDCs account for 39 of the 45 developing countries with the greatest health burden, and suffer an average health impact 10 times that in ODCs. Health effects can be reduced by switching from traditional biomass to modern fuels or through the use of improved stoves, although the latter may not lower household air pollution below the threshold level at which health risks are substantially reduced (Tielsch et al., 2016; Mortimer et al., 2017).

While it plays a limited direct role in deforestation, woodfuel use is a potentially important cause of forest degradation (reducing biomass density within forests), which can contribute to later deforestation, as well as having substantial direct implications for climate change (Hosonuma et al., 2012). Forests typically account for between 10 and 50 per cent of the land area of LDCs; and the great majority of them experience a significant degree of deforestation, with reductions of forest area generally between about 5 per cent and 25 per cent between 1990 and 2010. Woodfuel typically accounts for between 85 and 95 per cent of total wood production in LDCs (FAO, 2011: tables 2 and 4; FAO, 2014: annex 3). In woodfuel “hotspots” across LDCs in East Africa and South Asia, and in Haiti, less than 50 per cent of total fuelwood use is estimated to be replaced by natural growth (Bailis et al., 2015).

Woodfuel supply to urban areas, being larger in scale and more commercialized in nature than collection for domestic use in rural areas, gives rise to more intensive wood extraction, contributing to forest degradation across a radius as wide as 200-300 km around major cities such as Bamako, N’Djamena and Kinshasa (Hansfort and Mertz, 2011; van der Plas and Abdel-Hamid, 2005; Schure et al., 2010).

Thus, integrating wider access to electricity with more efficient use of biomass and access to modern fuels as part of a broader agenda for universal access to modern energy can generate synergies, rather than tensions, between energy access and environmental goals. Not only are potential increases in GHG emissions from increased electricity generation limited by the use of renewable technologies, but they are also offset by emissions reductions and avoidance of deforestation and forest degradation from reduced reliance on traditional biomass.

However, this hinges in part on transformational energy access raising incomes through structural economic transformation. When households gain access to modern fuels, they typically substitute only partly for traditional biomass — a process known as “fuel stacking” (Sepp, 2014; Sepp et al., 2014). A decisive reduction in the use of traditional biomass requires the availability of modern fuels to be accompanied by higher incomes (Nilsson et al., 2012; Pachauri et al., 2012; Sepp, 2012, 2014). It also depends on access to the external finance, technology transfer and technical support needed to facilitate the adoption of renewable energy technologies, as discussed in later chapters.

Access to modern energy can reduce poverty through effects on job creation, productivity and structural transformation

2. Energy, inclusivity and poverty

The core principle of the 2030 Agenda is one of inclusivity — “leaving no one behind” — and this applies as much to universal access to modern energy as to other SDGs. Universal access means access for all socially excluded or disadvantaged population groups, whether defined by age (youth and the elderly), gender, race, ethnicity, religion or residence, and equally encompassing people with disabilities and chronic illnesses, indigenous peoples, migrants, refugees and displaced people. Access to energy is of particular importance in terms of the rural-urban divide (section B3).

Access to modern energy also has the potential to reduce poverty in various dimensions. The two-way relationship between income poverty and limited access to basic energy services gives rise to a potential energy-poverty trap — a vicious circle that contributes to the poor remaining poor (Karekezi et al., 2012) in many respects, a vicious cycle in which people who lack access to cleaner and affordable energy are often trapped in a re-enforcing cycle of deprivation, lower incomes and the means to improve their living conditions while at the same time using significant amounts of their very limited income on expensive and unhealthy forms of energy that provide poor and/or unsafe services. Access to cleaner and affordable energy options is essential for improving the livelihoods of the poor in developing countries. The link between energy and poverty is demonstrated by the fact that the poor in developing countries constitute the bulk of an estimated 2.7 billion people relying on traditional biomass for cooking and the overwhelming majority of the 1.4 billion without access to grid electricity. Most of the people still reliant on traditional biomass live in Africa and South Asia. Limited access to modern and affordable energy services is an important contributor to the poverty levels in developing countries, particularly in sub-Saharan Africa and some parts of Asia. Access to modern forms of energy is essential to overcome poverty, promote economic growth and employment opportunities, support the provision of social services, and, in general, promote sustainable human development. It is also an essential input for achieving most Millennium Development Goals. Access

Access to modern energy can empower women to participate more effectively in structural transformation

to energy is constrained by lack of income, but itself constrains income by limiting economic opportunities, productivity, time budgets and mobility, especially in rural areas.

The primary effect of access to modern energy on income poverty occurs through its contribution to job creation, increased productivity and structural transformation.¹⁵ However, the net effect depends on the balance between employment creation effects, increased capital intensity of production arising from greater use of mechanical equipment in production, and reduced income opportunities in woodfuel supply, particularly to urban areas. Thus, promoting favourable labour market outcomes is a key policy issue in relation to modern energy access, particularly in the context of the 2030 Agenda.

For many households, especially in rural areas, access to modern energy also has important implications for time poverty, due to the time spent in collecting traditional biomass, particularly fuelwood (Woodward, forthcoming). Reducing biomass consumption can thus free up time, either for income-generating activities (where opportunities exist) or for rest and recreation.

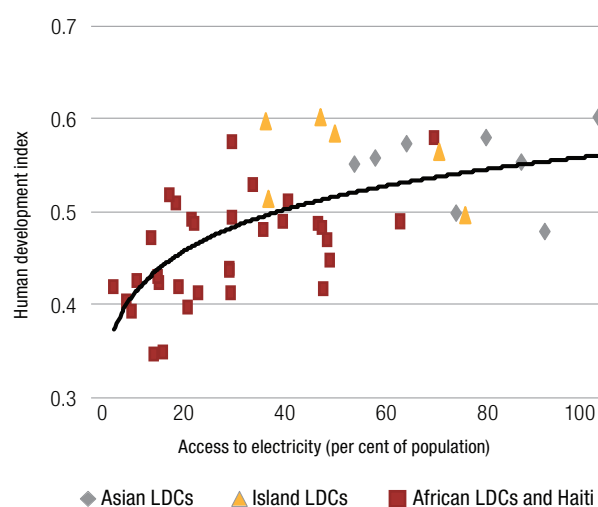
Health benefits from reduced indoor air pollution are important as well (section E2); and education may also be enhanced by increased access to information (through radio, television and ICT), freeing up children's time from fuel collection, and allowing study in the evenings. Additional benefits to health and education may arise from the electrification of facilities, and in rural areas from improved retention of health professionals and teachers. These effects are reflected in a positive correlation between electricity access and the human development indicator among LDCs (figure 1.16). Limited energy access is thus an important mechanism underlying the vicious circle of economic and human underdevelopment that constrains the development of LDCs (UNCTAD, 2014: 47, chart 20).

Many of these effects, particularly exposure to indoor air pollution and time poverty, vary significantly by gender — another important dimension of inclusivity. However, discussion of the gender aspects of these issues is often subject to oversimplification and overgeneralization. This highlights the complexities of gender issues, whose critical dependence on local cultures makes careful consideration of the specific context essential.

While women often bear a disproportionate share of the time costs of collecting fuelwood, evidence from LDCs suggest that this pattern is by no means as universal or as pronounced as is sometimes assumed.¹⁶ It also appears to be limited to adults in rural areas, and is subject to marked local and seasonal differences. National analyses suggest that the overall amount of time spent collecting wood is relatively limited (between 8 and 32 minutes per person per day, even among rural women); but time costs are much greater in particular localities and for the minority of people engaged in wood collection.

Of greater importance may be the less direct impacts of energy access on the time spent on other domestic activities. Lack of access to electricity (and deficiencies in basic services more generally) may reinforce gender differences in time use within households and in labour allocation, by increasing the time required for domestic activities which are traditionally undertaken by women. For example, access to modern fuels or improved biomass stoves can reduce cooking times; household access to electricity can reduce food preparation times by allowing mechanized processing;¹⁷ and availability of electricity at the community level can contribute to access to water, reducing the time required for water collection. Such changes can have a significant effect in freeing up women's and girls' time for other activities (Energia, 2017). Cooking, for example, is a more universal household activity, takes substantially more time overall, and is more strongly and more consistently gendered across cultures and contexts, for both children and adults (e.g. Kammila et al., 2014: figure 9), and has the additional benefit of reducing women's (and men's) exposure to household air pollution.

Figure 1.16
Access to electricity and the human development index, LDCs, 2014



Source: World Bank, World Development Indicators database and UNDP Human Development Index database (accessed June 2017).

Notes: The solid line indicates the logarithmic trend across all observations.

While there is little doubt that women are more exposed than men to indoor air pollution, estimates of the associated burden of disease suggest that this greater exposure is not translated into systematically greater health impacts. Asian LDCs are equally divided between those where the burden of disease from household air pollution is greater for women and those where it is greater for men; and it is greater for men in a majority of the Africa and Haiti group and all but one (Sao Tome and Principe) of the island LDCs (figure 1.17). This appears to be because men have higher background levels of the major diseases involved (lung cancer, cardiovascular disease and chronic obstructive pulmonary disease), so that a given level of exposure is more likely to result in chronic illness, disability or death (less serious health effects not being reflected in the data) (Smith, 2012).

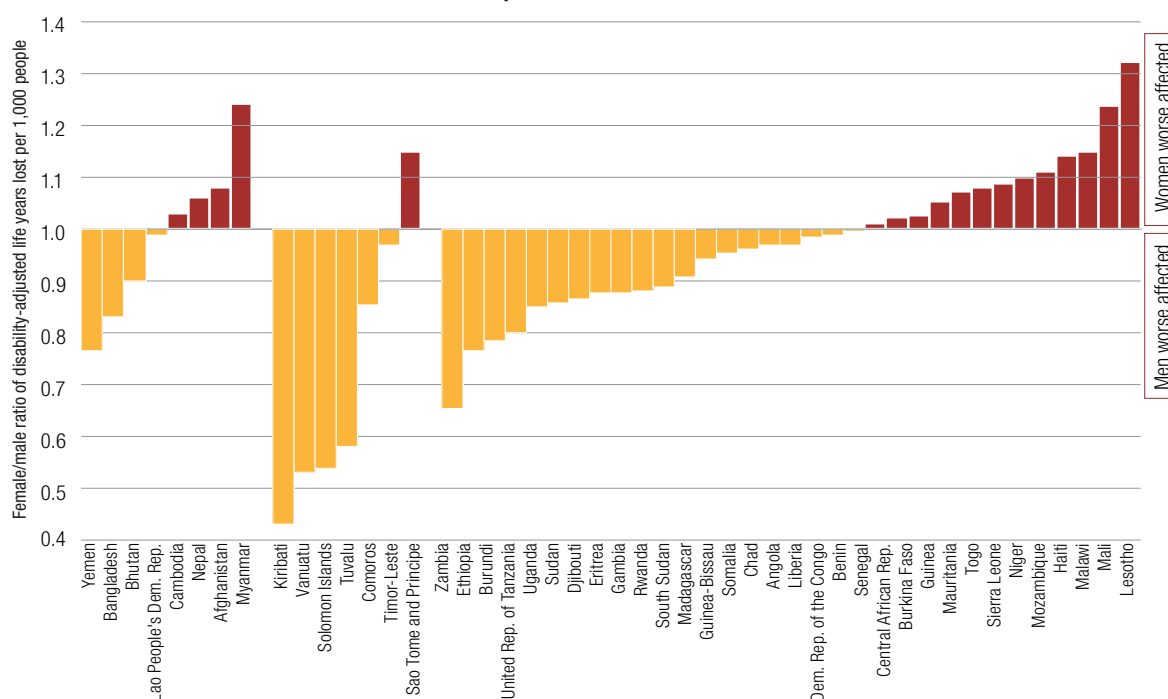
Two other aspects of electrification have particularly important gender dimensions. First, access to electricity can increase access to information through radio, television and ICT, which may benefit women's empowerment and well-being, particularly in rural

areas, by exposing them to information, ideas and influences beyond their communities. This may contribute to changing social norms, improve women's health and increase their educational opportunities through distance learning, especially in areas where there are constraints to their access to formal education. Second, the availability of electricity is essential to street lighting, which can increase women's freedom of movement (and potentially their options for participation in economic activities) by improving their physical security.

Gender roles in decision-making are also critical to the adoption of new energy-using technologies such as stoves, as women are typically the primary users of energy within the home, while men are the primary decision makers on technology adoption. Gender sensitivity is thus particularly important in promotion and marketing, as is engagement of women in the design of improved stoves, to ensure that designs meet women's (culturally specific) needs and expectations (Puzzola et al., 2013).

Figure 1.17

Gender balance of burden of disease from household air pollution



Source: UNCTAD Secretariat estimates, based on data from World Health Organization: Household air pollution burden of disease by country, 2012: All countries, <http://apps.who.int/gho/data/view.main.HAPBYCAUSEBYCOUNTRYv>, and population data from World Bank, World Development Indicators database (both accessed March 2017).

Note: The burden of disease is an estimate of the premature death and disability caused by different diseases and risk factors, expressed as disability-adjusted life years lost. The number of years for which people are affected by a disability is weighted according to the severity of the disability.

By increasing demand, transformational energy access can help make investments in energy systems more viable

E. Conclusion

SDG 7 establishes universal access to modern energy as an agreed goal of the global community. This has profound implications for the LDCs, which account for the majority of people worldwide without access to electricity, reflecting a very wide and growing access gap between LDCs and ODCs. In large measure, this in turn reflects the historical effects of LDCs' particular geographical and economic circumstances — a characteristic combination of limited urbanization, low rural population density and lack of resources that represents a serious impediment to the establishment of centralized generation systems. New and emerging renewable energy and mini-grid technologies (and associated reductions in their costs) have a

revolutionary potential to overcome these challenges, if the obstacles to their widespread application can be overcome; and universal access by 2030 remains an immensely ambitious goal, whose achievement will be critically dependent on action by the global community commensurate with this ambition.

Access to energy plays a critical role in the sustainable and inclusive structural transformation that is essential to poverty eradication and the achievement of the other SDGs. Central to this role is the productive use of electricity, which both translates access into structural economic transformation and helps to generate the demand needed to make investments in generation and distribution viable. However, this requires going beyond an exclusive focus on social and environmental aspects of energy that results in a neglect of its economic role, and beyond definitions of access that are limited to the physical connection of households to sources of electricity for domestic use. Realizing the full developmental potential of access to modern energy requires “transformational energy access” — energy supplies and technologies that meet the needs of producers and of structural economic transformation.

Notes

- 1 Major initiatives include Sustainable Energy for All (SE4All); Power Africa, initiated by the United States Agency for International Development; and the Energy Africa initiative of the United Kingdom Department for International Development. Major reports on the subject in recent years have included the 2011 edition of the International Energy Agency's flagship World Energy Report (IEA, 2011), which included a section on Energy for All; the Africa Progress Panel's 2015 Africa Progress Report and their follow-up study Lights, Power, Action: Electrifying Africa (Africa Progress Panel, 2015, 2017); and the World Bank's State of Electricity Access Report (World Bank, 2017b).
- 2 As well as “ensur[ing] universal access to affordable, reliable and modern energy services” (7.1), the SDG targets for 2030 include “enhanc[ing] international cooperation to facilitate access to clean energy research and technology... and promot[ing] investment in energy infrastructure and clean energy technology” (7a) and “expand[ing] infrastructure and upgrad[ing] technology for supplying modern and sustainable energy services for all” (7b).
- 3 The definition, concept and measurement of energy access are discussed in section D1 of this chapter.
- 4 The irregularities in the trend shown in figure 1.2 reflect changes in the estimated worldwide figures, largely as a result of apparent year-to-year inconsistencies in the recorded level of access in India. In particular, the recorded access rate fell from 59.6 per cent in 2000 to 55.8 per cent in 2001, and from 76.3 per cent in 2010 to 67.6 per cent in 2011.
- 5 Based on data from WDI (accessed May 2017).
- 6 It is important to note, in interpreting statistics which disaggregate between rural and urban areas, that there is no internationally agreed definition of the distinction between the two, and that there are significant differences between national definitions. Among LDCs, the broadest definitions of rural areas are in Cambodia, Ethiopia and Liberia, which classify all settlements with more than 2,000 inhabitants as urban (with additional criteria relating to population density and agricultural production in Cambodia). Other countries use definitions based on administrative status, the narrowest definition being in Burundi, which considers only the capital, Bujumbura, to be urban, classifying the remainder of the country as rural. These variations give rise to inevitable issues of cross-country comparability in all data relating to rural and urban areas, especially in the latter category, as relatively large towns and areas of an urban nature outside the administrative boundaries of designated towns may be classified as rural (UNCTAD, 2015a: 21; UN DESA, 2016a: 118–122).
- 7 It should be noted that these figures do not accurately reflect the rural-urban split of the increase in access

required for universal access by 2030, which will also be affected by rural-urban migration in the years leading up to then. However, this issue is complicated, as the rate of rural-urban migration is itself likely to be affected by changes in rural and urban access to electricity.

- 8 It should be emphasized that this assessment is indicative of the order of magnitude of the acceleration required in the rate of increase in access, rather than as providing precise estimates. Aside from the high level of uncertainty regarding current access levels even in those countries excluded from the analysis (box 1.1), this also depends on population projections, which are inevitably subject to uncertainties. In addition, it implicitly assumes that the average household size in each country will change at the same rate in 2014–2030 as in 2004–2014, although in practice this may be affected by changes in the evolution of demographic variables.
- 9 For comparison, one hour of light with a typical 60-watt incandescent bulb requires 0.06 kWh, and keeping it lit continuously requires 500 kWh per year.
- 10 The time trend of net installed capacity typically combines long static periods with occasional abrupt jumps, corresponding to the deployment or decommissioning of large-scale generators. Consequently, growth rates, even over long periods, can be highly sensitive to the precise period considered.
- 11 For comparison purposes, generating capacity across all LDCs is only slightly higher than the total net installed capacity of Sweden (about 40 Gigawatts in 2014), and somewhat lower than that of Thailand (53 Gigawatts).
- 12 These are the other elements of the PErSIST (Poverty Eradication through Sustainable and Inclusive Structural Transformation) framework outlined in box 1.2.
- 13 UNCTAD secretariat estimates, based on INDC targets from Australian-German Climate and Energy College (2016).
- 14 Most island LDCs have low levels of ambient air pollution, reflecting their particular geography, with populations widely spread across multiple islands far from external sources of pollution.
- 15 Additional benefits in terms of income poverty may arise from financial savings, where electricity becomes available at a lower cost than existing means of lighting (primarily kerosene).
- 16 Men have been found to spend more time collecting fuel in Madagascar, three of four areas studied in Bangladesh, and by a particularly wide margin in Tigray (Ethiopia) (Charmes, 2006; Practical Action, 2016; Kammila et al., 2014). A more detailed picture of the available evidence on gender patterns of time use in wood collection in LDCs is provided in Woodward (forthcoming).
- 17 It should be noted, however, that domestic electrical appliances are often unavailable in rural markets, even where there is access to electricity, reflecting the dominance of men in decision-making (Cabral et al., 2005).