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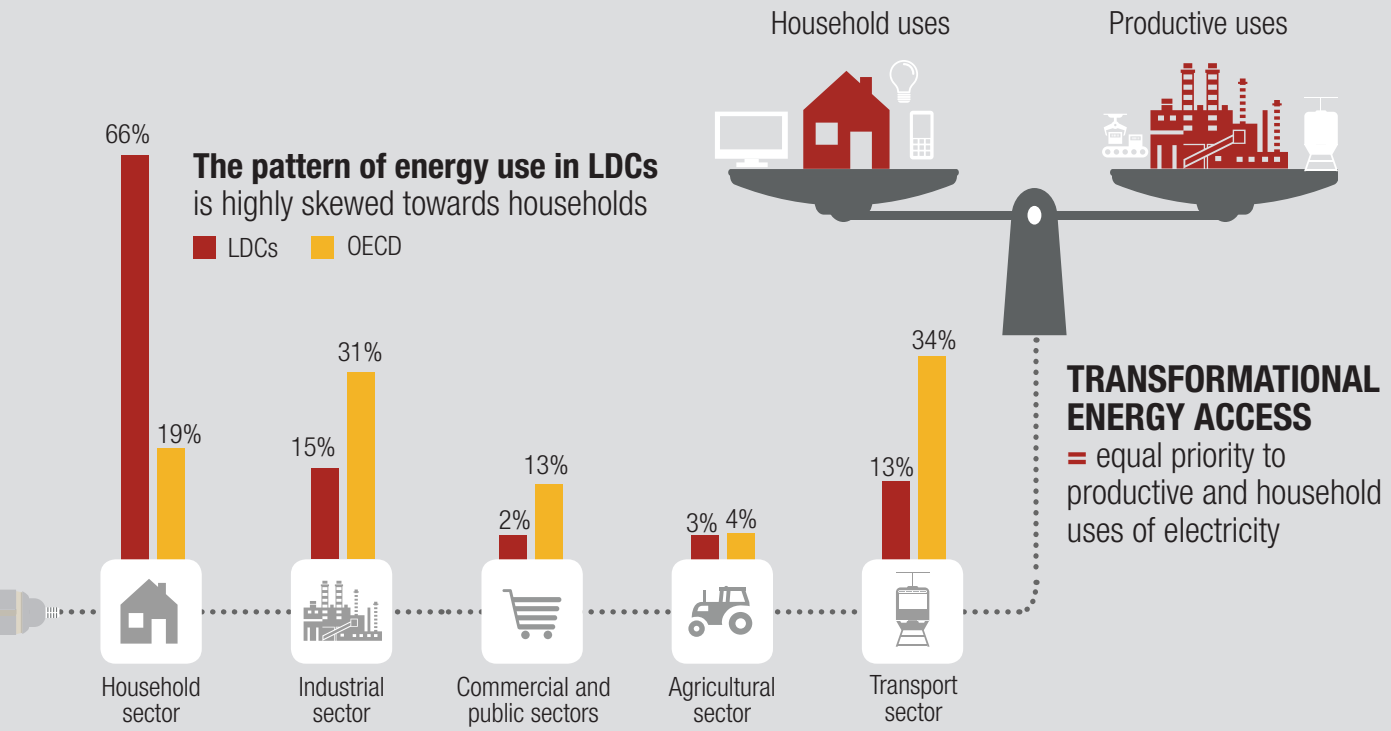
Transformational energy access

CHAPTER 4

Governance and policy in electricity provision



The pattern of energy use in LDCs is highly skewed towards households

LDCs OECD

TRANSFORMATIONAL ENERGY ACCESS

= equal priority to productive and household uses of electricity

A HOLISTIC AND COORDINATED APPROACH

is essential to the delivery of transformational energy access

INTERLOCKING POLICY INFLUENCES

underpin electricity policy

CHAPTER 4

Governance and policy in electricity provision

A. Introduction

Governance structures — the set of institutions, policies and regulations that frame ownership structures and operations, and the rights and responsibilities of actors in the electricity sector — are generally recognized as important determinants of sectoral performance, the quality of electricity services and private-sector participation and finance in the sector. Governance and finance choices today thus have major implications both for the future coverage, capacity, sustainability and viability of electricity systems, and for the financing of the investments needed. Since the nature of electrification systems affects the types of productive activities that develop, and thus the future competitiveness of the economy, governance options need to be carefully evaluated in the light of structural-transformation goals.

The environment for such choices will be affected by the new challenges and opportunities associated with climate change and the advent of distributed electricity provision, and by the current context of technological disruption, which highlights the importance of maintaining flexibility in a sector where the time-horizon for planning is typically 30-40 years (Bharath Jairaj, 2016). This chapter assesses the governance challenges and opportunities in least developed countries (LDCs) brought about by the rapidly changing context of the electricity sector.

B. Electricity fundamentals: Implications for governance

A full appreciation of the fundamentals of electricity sector governance is aided by the recognition that the sector is subject to the interaction of a combination of market, political and technical forces. Governance frameworks thus evolve in line with the weightings that national contexts and choices assign across these interlocking and always-present influences. The key market, political and technical forces underlying governance frameworks are discussed here.

1. Natural monopoly and the role of the public sector

Until the late 20th century, electricity provision generally relied on conventional technologies in the form of turbine generators fired by fossil fuels or hydropower, which are characterized by considerable economies of scale (Martin, 2009). This favoured large-scale centralized generation, which in turn fostered the development of transmission systems to provide power to users away from where generation took place, giving rise to interconnected grids. Typically, each area was served by a single transmission and distribution (T&D) network,

Electricity governance frameworks are shaped by a combination of market, political and technical forces

as duplicating such networks was economically unjustifiable, giving rise to geographical monopolies.

Like other network industries, such as transportation and telecommunications, the electricity sector is thus composed of complementary nodes and links that exhibit increasing returns to scale and scope in production or consumption. Consequently, it has traditionally been regarded as a natural monopoly. A natural monopoly arises where an entire market, by its nature, can be served at lower cost by a single supplier than by multiple suppliers (Corneli and Kihm, 2016), typically as a result of extreme economies of scale and scope, often associated with high fixed costs. The high fixed costs of centralized systems required a large and guaranteed market to generate reasonable returns on investment, which favoured population agglomeration; hence an apparent urban bias in developing-country contexts.

In the case of electricity supply in centralized systems, the natural monopoly is reinforced by significant barriers to entry by multiple providers (Besant-Jones, 2006). It is also reinforced by the need for a single-system operator to balance demand and supply continuously to keep up service quality and avoid costly blackouts in the absence of cost-effective technologies to maintain voltage, frequency and reliability automatically (UNCTAD, 2007).

This technical and economic evolution of electricity systems underlies both the active role the public sector has traditionally played in the electricity sector (Byrne and Mun, 2003) and the widespread organization of the sector as a vertically integrated industry, with a single entity responsible for generation, transmission and retail distribution within a given geographical area. In many developed and developing countries, electricity has been provided by public utilities with a legal monopoly, subject to price controls, as a means of capturing the cost advantages of economies of scale and scope while avoiding abuses of monopoly power, in order to ensure a high-access, low-cost service.

The natural-monopoly status of electricity transmission and distribution remains undisputed, and a well-regulated legal monopoly is widely recognized among economists as a more efficient response to natural monopoly than multiple competing firms. However, technological advances since the 1970s have conclusively challenged the natural-monopoly status of

electricity generation. Together with poor performance of some regulated industries, changes in the political economy of regulation, and an ideological shift in favour of free markets, this has led to the transformation of Governments' participation in, and governance of, the electricity sector, as part of a wider restructuring of network industries in many jurisdictions.

2. Private goods and public goods

According to economic theory, electricity supplied for domestic or business consumption is a private good because individual homes and businesses can be excluded from receiving electricity services. Consequently, it can be traded as a commodity.

In contrast, the availability and reliability of the electricity supply are classifiable as public goods. However, electricity continues to be widely perceived by many as a public good (Byrne and Mun, 2003) because it is the means of producing other important public goods, such as street lighting. Moreover, Governments in many developing countries and smaller markets continue to play a central role in the development of electricity infrastructure, reflecting the scale of the investments required for centralized generation and distribution and the essential nature of electricity. Its exploitation of natural resources (such as water and natural gas); public financing of its large ongoing fuel costs; and the historical role of the public sector in its provision mean that it remains widely viewed as a public service (Corneli and Kihm, 2016) in spite of liberalization efforts.

Even before the adoption of the Sustainable Development Goals (SDGs), a majority of developing countries had adopted universal access to electricity as a development objective (Scott and Seth, 2013). Its public provision provided a means of promoting both inclusiveness and affordability through cross-subsidization (Heald 1994: 38). It also enabled Governments to circumvent coordination challenges through centralized planning and system design.

3. Energy security

Energy is essential to the fulfilment of many of the rights enshrined in the Universal Declaration of Human Rights and to the achievement of many of the SDGs, as well as being vital to structural transformation (chapter 2). Since the 1973 oil crisis, it has also been widely recognized as a strategic resource. Energy security — defined by the International Energy Agency (IEA) as "the uninterrupted availability of energy sources at an affordable price"[1] — is thus a major priority, whose absence threatens serious economic and social impacts.

A key part of this is reliable and affordable access to electricity, for which Governments are widely held responsible. Electricity access is commonly acknowledged as a basic need for human development (Scott and Seth, 2013), and has been described as a moral imperative, socially prudent and an economic necessity (GEA, 2016: 19). Aside from the public-good dimension of safe and reliable electricity supply, consumer protection and guaranteed access are important political-economy considerations (Bamber et al., 2014; Scott and Seth, 2013). Such energy-security concerns generally serve to reinforce State control and regulation of the electricity sector (Kuik et al., 2011).

Central concerns for electricity security are fuel security and adequacy and security of energy systems (IEA, 2016e). However, its interpretation is heavily influenced by national contexts, for example in terms of energy access, the energy mix and dependence on energy imports. For energy-importing countries (developed as well as developing), particular concerns are the resilience of energy systems to external supply shocks, the balance-of-payments effects of changes in international energy prices and diversification of energy suppliers (Yergin, 2006).

The challenge of electricity security in developing countries is inextricably linked with that of sustainable development, and the primary concerns remain meeting basic human needs at the household level and powering structural transformation and economic growth. However, the main focus has shifted from securing reliable low-cost supplies of fossil fuels for electricity generation and transport to identifying new and diversified sources of baseload power in the context of structural transformation and climate policy (Global Network on Energy for Sustainable Development, 2010).

4. Market power

The tendency towards natural monopoly in electricity provision and the significant barriers to entry by multiple providers give rise to a particular threat of abuse of monopoly power, even in liberalized electricity markets. While the nature of the industry lends itself to monopoly leveraging, predatory pricing and other anticompetitive uses of market power, the application of competition law and policy is far from straightforward (Kim and Kung, 2013; Pindyck, 2008). For instance, the complexity of electricity markets complicates the measurement of sunk costs under competition, precluding a simple test of the exercise of market power and giving rise to apparently similar behaviour among generators with and without market power (Hogan, 2002).

Consequently, electricity markets tend towards oligopoly rather than perfect competition (Murphy and Smeers, 2003). Even in the European Union in

2015, following decades of liberalization and regional regulations, the largest generator in at least 15 of the 28 member countries had a market share at or above the Organisation for Economic Co-operation and Development (OECD) dominance threshold of 40 per cent.[2] That share exceeded 50 per cent in 10 cases and 70 per cent in seven. This underlines both the key role of competition policy in liberalized and unbundled electricity markets and the complexity of liberalized electricity sectors relative to monopoly public utilities (UNCTAD, 2007). It also underlies the emphasis placed by experts on appropriate sequencing of electricity-sector reform and the importance of establishing strong regulatory institutions and comprehensive ancillary regulations ahead of liberalization (Besant-Jones, 2006; UNCTAD, 2009; Vagliasindi and Besant-Jones, 2013; Nepal and Jamasb, 2011; Jamasb and Pollitt, 2005; Kessides, 2012b; Joskow, 2008; Williams and Ghanadan, 2006; Heller et al., 2003; Wamukonya, 2003; Scott and Seth, 2013).

C. The evolution and status of market structures and governance in LDCs

1. Electricity-sector reform since the 1980s and 1990s

The electricity industry has experienced more than one cycle of reorganization since its inception. The predominant pattern of centralized provision by vertically integrated public monopolies (section B1) was itself the result of a deliberate shift away from mainly private and distributed provision of electricity services. This State-led model was encouraged both by the Cold War super-Powers and by multilateral development agencies, and was bolstered by economic growth, official development assistance (ODA) and expanding national budgets; and it proved largely successful (Kessides, 2012a; Williams and Ghanadan, 2006).

The 1980s and 1990s saw a new wave of reforms affecting market structures, private participation and regulatory regimes, reflecting a dramatic shift in attitudes towards ownership, organization and regulation in the electricity industry (box 4.1). This wave of reform largely bypassed the LDCs, although a few, such as Bangladesh (1996), Burkina Faso (1998), Chad (1999) Guinea-Bissau (1998), Nepal (1993) and Uganda (1997), implemented or experimented with various aspects of the reform model, with varying degrees of success. In Burkina Faso, for example, the sector was opened to private-sector participation in 1998 but had little success in attracting private-sector investment, while attempts at reform in Guinea-Bissau between 1998 and 2005 were frustrated by political instability.

Past energy reforms demonstrate the need for a pragmatic approach, based on local realities

Since 2000, many more LDCs have instituted reforms, partly driven by changes in the international development finance landscape. The Addis Ababa Action Agenda (adopted in 2015 at the third International Conference on Financing for Development) has reaffirmed the emphasis on the private sector's role in delivering developmental outcomes; lending policies of the World Bank and other multilateral donors combine investment lending with loans linked to institutional reform (Bacon and Besant-Jones, 2001); and electricity-sector reform has been included by multilateral development banks in financial rescue packages (Nakhooda, 2011; Woodhouse, 2006).

Private participation in electricity supply is also actively promoted by bilateral initiatives, such as the Power Africa Initiative led by the United States Agency for International Development[3] and the Energy Africa programme of the United Kingdom Department for International Development, both of which target increased off-grid access to electricity for households by private-sector providers. Power Africa implements a "reform-driven approach linking policy and regulatory reform to tangible power sector investment",[4] and compacts with national Governments include voluntary commitments to restructure electricity sectors (e.g. the Partnership Memorandum of Understanding between the Government of Liberia and Power Africa of 2014) and to implement cost-reflective tariffs (e.g. Malawi in 2016).

Further impetus to reform in LDCs has come from changes in the context of the electricity sector arising from technological advances and the challenge to the dominance of fossil fuel-based centralized generation associated with climate change and increasing emphasis on environmental sustainability. In LDCs that are heavily dependent on oil imports for generation, an additional factor has been pressure to diversify energy sources as a result of high and volatile oil prices, particularly in 2010–2014.

While the model of reform has evolved since 2000, the experience of the earlier reforms has important lessons for LDCs. In particular, it highlights the need for a pragmatic approach based on local realities rather than a particular school of economic thought, and the fundamental need for realism in terms of the complexity of reforms, countries' capacities for implementation and the time frame for delivery of their objectives. Of particular relevance to LDCs is recent empirical

evidence that unbundling is unlikely to be worthwhile when electricity systems are below an optimum size and markets below an optimum per capita income level (Vagliasindi and Besant-Jones, 2013).

One response to the problems with the wider reform agenda has been the promotion of long-term purchasing contracts (power purchase agreements, or PPAs), often for 20 years or more, with independent power producers (IPPs). This is seen as a relatively quick and straightforward way to introduce competition without extensive restructuring, while protecting social equity (Sen et al., 2016; Besant-Jones, 2006; Heller et al., 2003). Such arrangements have played a significant role in expanding generation capacity in many developing countries. However, the success of this model depends on a coherent policy framework and effective regulatory governance and capacity (Nepal and Jamasb, 2011), and it has been a major avenue for corruption and other governance failures in electricity sectors (World Bank, 2010; Eberhard et al., 2016). It has also proved very costly in countries without the technical skills necessary to negotiate favourable terms, and costs are often increased by "take-or-pay" payment structures delinked from actual electricity use, and/or by denomination in foreign currency.

Box 4.1. **The 1980s/1990s electricity-sector reform model**

The electricity-sector reforms of the 1980s and 1990s centred on the concepts of electricity generation as producing a tradable commodity, for which cost discipline and risk management were needed, and of T&D as a service business reliant on network management (Besant-Jones, 2006). They broadly followed the experiences of early reformers, such as the United Kingdom, Norway, Chile and the United States (Sen et al., 2016; Nepal and Jamasb, 2011), and targeted efficient pricing, long-term transmission rights and addressing market power.

A core element of the reforms was unbundling — separation of the potentially contestable generation subsector from the monopoly transmission and distribution segments (see box table 4.1) — to create a market structure conducive to competition. This takes four main forms (Jamasb and Pollitt, 2005):

- Accounting unbundling — the least drastic form, achievable within a vertically integrated enterprise – entails separation of the accounts of network and generation activities, to prevent cross-subsidization.
- Functional (or management) unbundling combines accounting unbundling with separation of operational activities and management.
- Legal unbundling entails corporatization, to locate transmission and generation in separate legal entities (although they may be owned by the same parent company).
- Ownership unbundling, the strictest form of separation, requires generation and transmission activities to be owned by independent entities confined to operation in only one segment of the industry.

Developing countries were encouraged to unbundle their electricity utilities, vertically and horizontally, to create independent regulators and make space for private-sector participation — an approach actively promoted by the World Bank from 1990 until 1996 through a "no-lend" policy for the sector in the absence of substantial reforms aimed at commercialization and independent regulation (Woodhouse, 2006: 133).

Liberalization and unbundling fundamentally change the structure of the sector, necessitating changes in governance frameworks. In the electricity sector, competition leads, not to less regulation, but to different regulation (Hogan, 2001), as the much greater number of actors involved requires more elaborate governance frameworks that spell out the roles of all industry players and define the role of the State, with an independent regulator to establish and enforce regulations governing interactions amongst the various actors. The resulting shift to more complex systems dependent on specialist skills and regulation also gives rise to a greater legislative burden to create competitive electricity wholesale markets and trading arrangements, establish system operators and independent regulators, and prevent abuse of market power.

The nature, extent and final outcomes of the 1980s reforms differed widely between countries, particularly between developing and developed countries, largely reflecting differing initial conditions and motivations for reform (Wamukonya, 2003; Vagliasindi and Besant-Jones, 2013; Kessides, 2012b; UNCTAD, 2007), as shown in box table 4.1. While developed countries broadly followed the standard reform model, reform efforts were reversed or went awry in many developing countries, so that most have incomplete unbundling, and are expected to retain such intermediate structures for the foreseeable future. Many national electricity industries, reformed as well as unreformed, continued to perform poorly, financially and operationally, many years after reform (Williams and Ghanadan, 2006).

The shortcomings of the reforms of the 1980s and 1990s are now widely recognized, including the undue weight given to techno-economic considerations rather than implications for national energy sectors in the light of existing resources, institutions and capacities (Heller et al., 2003), and underestimation of the complexity of reforms and the time required to achieve lasting outcomes (Zhang et al., 2008). The limited implementation of reforms has been attributed to "differing views and a degree of theoretical ambiguity in the economic literature on the effectiveness of unbundling and competition", and "a large gap in understanding about power market structures" due to a focus on the extremes of vertical integration and complete unbundling to the neglect of intermediate options (Vagliasindi and Besant-Jones, 2013: 19, 26).

2. Electricity market structures in LDCs: A typology

While a typology of market structures in LDCs is complicated by the fluid nature of policies and current or prospective reforms and legislation, most can be divided into five broad categories of sector structures.

- **Vertically integrated:** the traditional centralized structure in which a single entity operates generation, transmission, distribution and supply (including public utilities co-existing as single buyers with IPPs, build-operate-transfer contracts or concessions and/or operating disconnected grid systems). This model exists in Burundi, Central African Republic, Chad, Democratic Republic of the Congo, Djibouti, Eritrea, Guinea, Guinea-Bissau, Haiti, Lao People's Democratic Republic, Nepal, the Niger, Sao Tome and Principe, Senegal, Timor-Leste and Zambia.
- **Partial vertical disaggregation:** functional or legal unbundling of the public utility, operating as a single buyer, with only generation opened to private participation. This is an increasingly common structure amongst LDCs, and exists in such countries as Bangladesh, Bhutan, Cambodia, Ethiopia, the Gambia and Rwanda.
- **Vertically disaggregated:** several companies active in all segments of the electricity supply chain. This model operates in Uganda, one of the few LDCs to undertake legal unbundling of the national utility, where nine IPPs feed into the grid, including a 20-year concession to operate the former public utility's generation assets, and the publicly owned West Nile Rural Electrification Company. However, the

Box 4.1 (contd.)

Box table 4.1

Motives and drivers of 1980s reform

Country group	Initial conditions	Motives for reform	Drivers of reform
Developed countries	**Sector** • Surplus generation capacity and low investment needs • Developed transmission networks • High construction and operating costs • High retail tariffs • Tolerable performance • Universal access **Institutional** • Established law, skills and experience • Institutions able to facilitate arm's-length regulation of natural monopolies and private-sector ownership	**Sector** • Promise of more economically efficient sector with advent of smaller, lower-cost and higher-efficiency electricity generation technologies • Quest for lower retail prices and enhanced consumer choice through retail competition **Institutional** • New institutional arrangements providing long-term benefits to society	• Ideology • European Union Electricity Directives of 1996 and 2003 required member States to move towards independent regulation and system operation, stronger network unbundling, regulated grid access and full consumer choice by 2007 (a third EU liberalization package to improve the functioning of the internal energy market and resolve structural problems followed in 2007)
Developing countries	**Sector** • Highly subsidized low retail tariffs alongside theft and chronic non-payment of utility bills in some countries • Insufficient generation capacity compounded by high distribution losses; frequent power outages • Underdeveloped transmission networks • High infrastructure investment needs for expansion, maintenance, upgrading or modernization • Pent-up and rising demand • Very low access and persistent urban/rural divide in electricity distribution **Institutional** • Inability to self-finance modernization, expansion and maintenance of infrastructure on account of lack of public finance; low customer base with constrained ability to pay; and uneconomical tariffs • Widespread mismanagement of public utilities • Low capacity to implement reform and regulate at arm's length, with few precedents to learn from	**Sector** • Desire for economic growth and development, and social equity • Expanding supply, quality and reliability to sustain productive activity • Broadening access to address energy poverty **Institutional** • Reducing fiscal stress/sovereign debt	• Financier conditionality exacting the substitution of self-regulating markets for political governance of electricity provision • Reform-targeted loans and blueprints from donors and multilateral agencies • Priority given to financial over social concerns (e.g. universal access, affordability, etc.) • Privatization often prioritized

Source: UNCTAD secretariat, based on Wamukonya (2003); Vagliasindi and Besant-Jones (2013); Kessides (2012b); UNCTAD (2007).

LDCs have a wide variety of electricity market structures

challenges of insufficient generation, limited access, high T&D costs and power outages remain, while subsidized domestic consumption coexists with tariffs above the regional average (Mawejje et al., 2013). Myanmar also has a vertically disaggregated model, with a number of Ministry of Electric Power companies operating in each segment of the supply chain; corporatized entities responsible for distribution in Yangon and Mandalay; and IPPs in generation and distribution.

- **Locally disaggregated:** generation, transmission and distribution are fragmented by locality. This is by no means a new phenomenon in developing countries, but a long-standing practice of national utilities to address rural electrification, notably in Africa (AfDB and SE4All Africa Hub, 2017) and Asia (chapter 3), and a necessity in many island States. This model is typical of island LDCs (e.g. Comoros, Kiribati, Solomon Islands, Tuvalu and Vanuatu), in some cases with vertically integrated local utilities on larger islands. In Afghanistan and Angola, vertically integrated public utilities operate regionally disconnected grids, in the latter case with a number of smaller vertically integrated municipal operations.
- **Hybrids:** a combination of the above structures. In Mozambique, the public utility owns the major national grid, while smaller regional grids exist under the control of district authorities. The sector is based on a concession system, the national utility holding 50-year hydro concessions, while 25-50-year concessions are awarded by tender. Electricity sales are governed by bilateral agreements, and tariffs are generally unregulated. In Liberia, the Government has historically engaged the private sector through concessions (USAID, 2015), and all segments can now be licensed to the private sector, although the national utility can also continue to operate (Government of Liberia, 2015). Micro-utilities below a size threshold, operated by entrepreneurs, are permitted to operate and distribute power without a licence.

It is important to maintain the distinction between ownership and structure, as publicly owned utilities can adopt commercial principles and practices. Some vertically integrated public utilities (e.g. in Afghanistan and Lesotho) have undergone accounting or legal unbundling; and some developing countries have used management contracts as an alternative to privatization of public utilities.

Benin and Togo are unique among LDCs in operating a binational system with partially disaggregated public utilities. Generation is mainly undertaken by a binational generation company that also functions as a single buyer of electricity from IPPs or imports, while a public T&D utility in each country also maintains some generation activity. Privatization of electricity distribution in Togo in 2001–2005 was reversed due to unsatisfactory performance.

Electricity-sector structures in many LDCs reflect historical factors, such as conflict or strong regional identities. Somalia, for example, has a number of mainly private vertically integrated local operations, reflecting its difficult political environment and extensive destruction of electricity infrastructure. In the Somaliland region, a consolidation of IPPs (reflecting the industry's tendency towards oligopoly) has led to some attaining the scale of medium-sized utilities. In most cases, the grid is owned by IPPs, and parallel distribution networks coexist in the same locality.

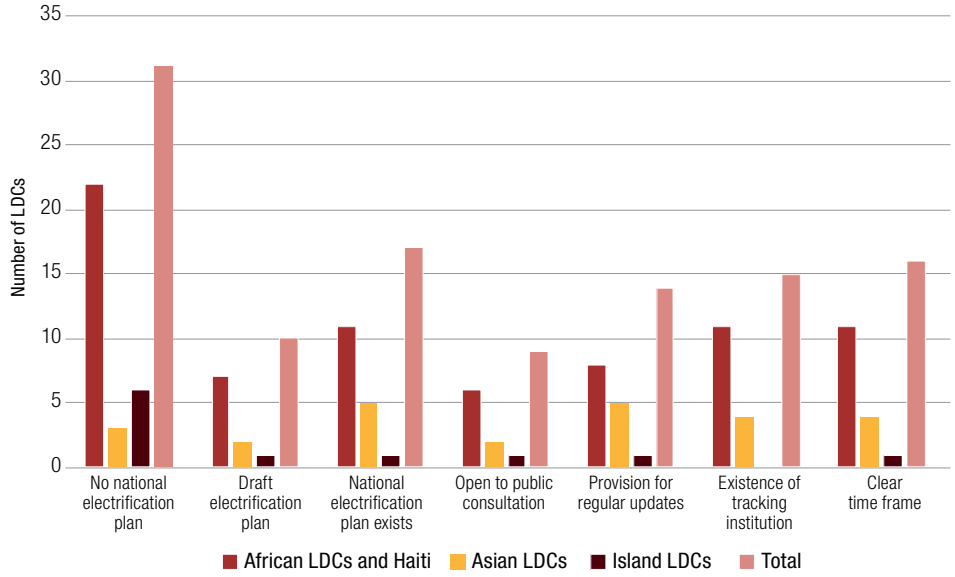
3. Current plans, policy frameworks and regulatory arrangements

While continued investment in infrastructure and capacity-building are firmly on the agendas of most LDCs, reflecting the inadequacy of capacity to meet current and future demand, their preparedness varies. Not all have detailed sector development plans, frameworks or strategies in place (figure 4.1); not all existing plans have been updated to reflect current realities; and not all national planning institutions have the skills required for such updating. The absence of such plans hinders the reconciliation of consumer, producer and market needs, the identification of least-cost alternatives, and estimation of financing needs. While some LDCs, such as Bhutan, Lao People's Democratic Republic and Senegal, have successfully expanded access without national electrification plans under their centralized systems, most LDCs are unlikely to be able to do so, given current global conditions in the electricity sector and low levels of access. Seventeen of the 47 LDCs have renewable-energy policy frameworks (figure 4.2).

Energy-efficiency targets and performance standards are needed to implement energy-efficiency programmes effectively, to prioritize funding and to devise scalable strategies. Twenty-one LDCs have energy-efficiency plans, although four do not include explicit targets, and in six LDCs the targets feature in their energy policies rather than in energy plans (figure 4.3). While technologies linked to smart grids are efficiency-enhancing and could in principle improve the economic viability of existing centralized systems, smart grids are not simply plug-in additions to existing networks, but require new approaches to electricity network design and operation.

Figure 4.1

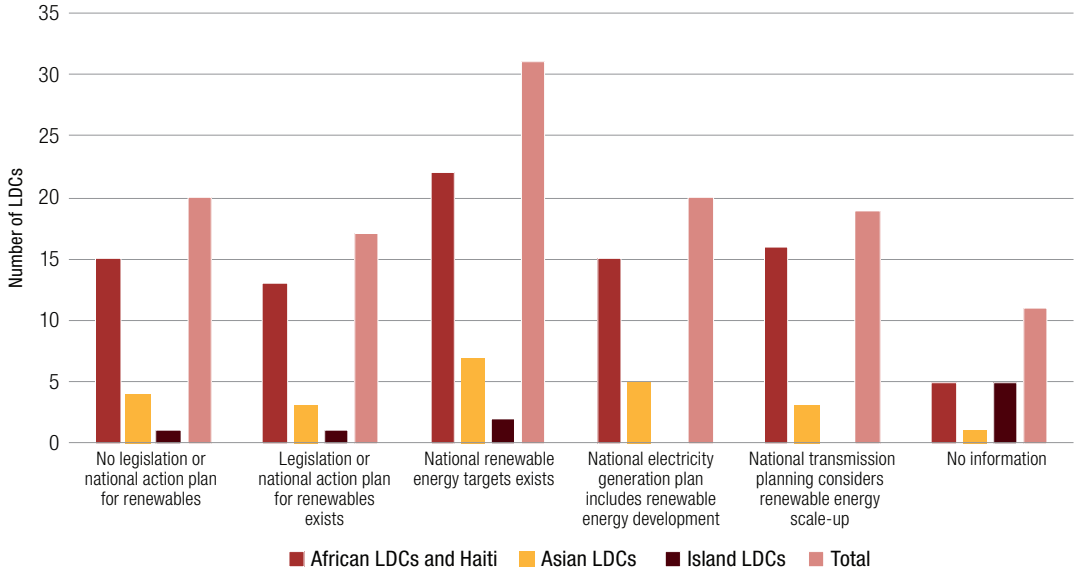
Prevalence of LDC electrification plans



Source: UNCTAD secretariat estimates, based on data from World Bank, Readiness for Investment in Sustainable Energy (RISE) database and Renewable Energy and Energy Efficiency Partnership (REEEP) Policy Database (accessed April 2017).

Figure 4.2

Prevalence of LDC renewable energy policy frameworks



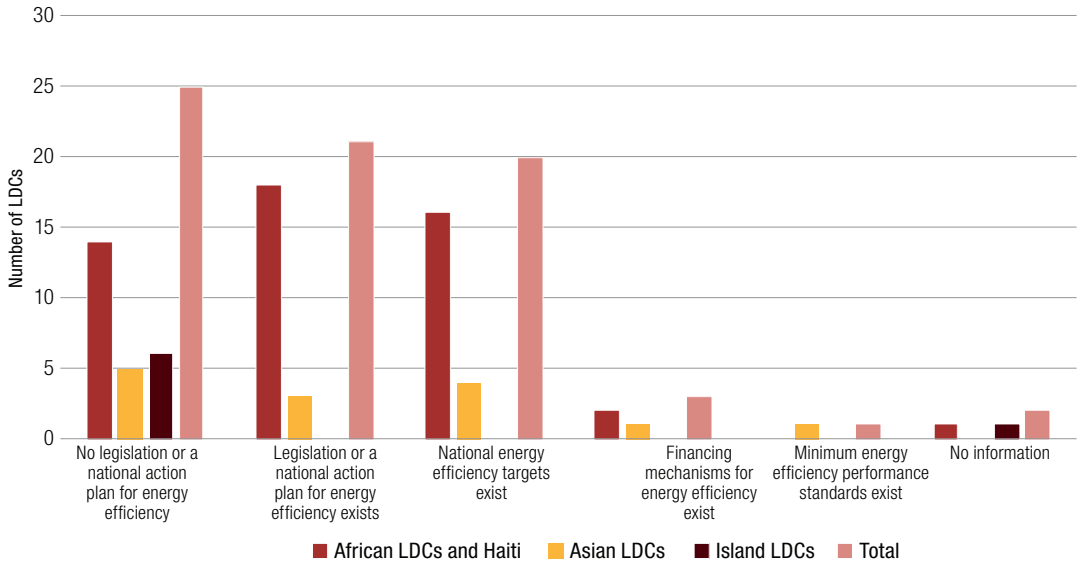
Source: UNCTAD secretariat estimates, based on data from World Bank RISE database (accessed April 2017).

Virtually all LDCs have a rural electrification agency or programme (figure 4.4). A significant number also have legal frameworks for mini-grids, although these are often inadequate or incomplete. In some cases, the private sector is permitted to own and operate mini-grids and receive some type of public support in the absence of a legal framework, and only a minority of LDCs specify technical standards for mini-grids. These limitations of legal and institutional frameworks have implications for the viability and profitability of private-sector investments in mini-grids, because the ability to recoup investment in a mini-grid depends on how long it operates before the area it serves is reached by the national grid and the conditions of its integration into the grid. Mini-grids capable of sustaining semi-industrial and industrial activity at a lower cost have high upfront costs, and uncertainties arising from inadequate policy frameworks are an important constraint to private investors' access to commercial finance (ESMAP, 2017; IRENA, 2016b; Berthélemy and Béguerie, 2016; Béguerie and Pallière, 2016; GMG MDP, 2017).

Less than two thirds of LDCs have separate sector regulators for the electricity sector, while in a few the public utility performs the regulatory and planning functions (figure 4.5). In a number of LDCs, electricity

Figure 4.3

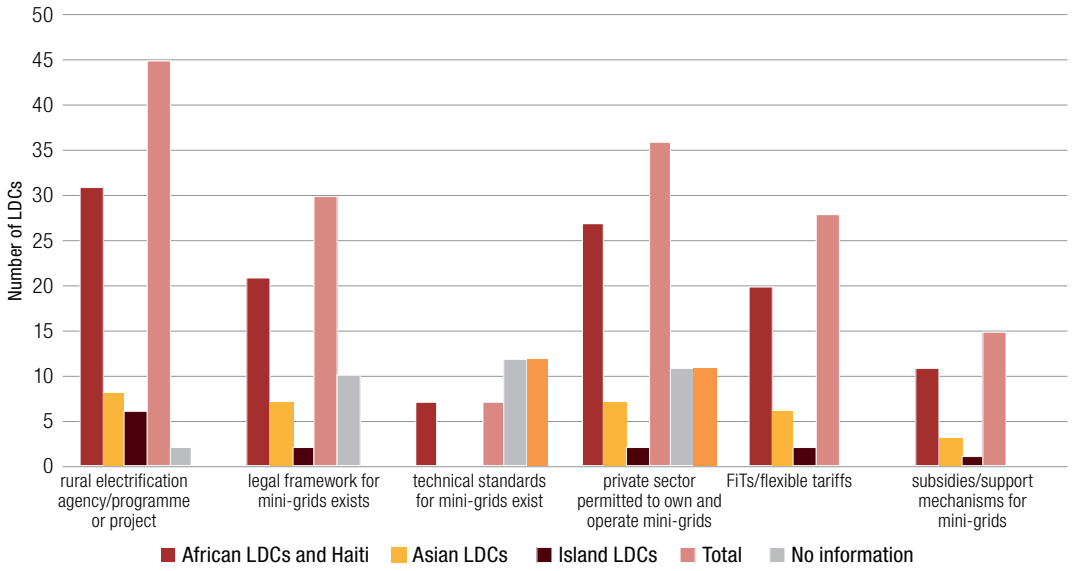
Prevalence of LDC energy efficiency policy frameworks



Source: UNCTAD secretariat estimates, based on data from World Bank RISE database and REEEP Policy Database (accessed April 2017).

Figure 4.4

Prevalence of mini-grid frameworks in LDCs



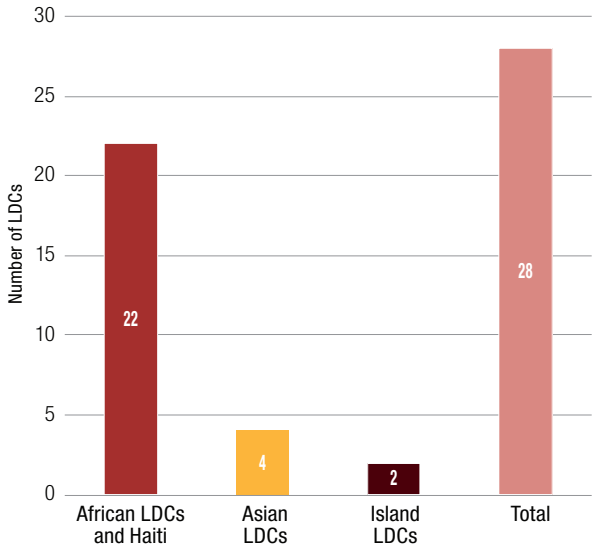
Source: UNCTAD secretariat estimates, based on data from World Bank RISE database and REEEP Policy Database (accessed July 2017); UN DESA (2014).

is regulated by a multisector regulator, in many cases combined with water supply and in one instance with telecommunications. The African LDCs and Haiti as a group have the highest proportion of countries with a dedicated sector regulator. Where there are regulatory bodies, their powers may be limited or shared with a supervisory ministry. It should also be noted that the existence of sectoral legislation does not indicate that it is effective: it is not uncommon for regulatory bodies established by law to be constrained by the absence of complementary rules and regulations necessary for their effective operation.

Approaches to electricity regulation in LDCs vary, ranging from regulation by a minister, alone or assisted by a board, through a regulatory commission chaired by a minister, to regulation by separate autonomous institutions. As the major role of some Governments in setting electricity tariffs demonstrates, some aspects of the regulatory function remain outside the domain of the sector regulator in some LDCs.

Figure 4.5

Electricity regulator prevalence in LDCs



Source: UNCTAD secretariat estimates, based on data from World Bank RISE database and REEEP Policy Database (accessed July 2017).

D. Key issues in electricity governance in LDCs

The global energy landscape has bifurcated between markets characterized by rapid demand growth and capacity constraints (including most LDCs and other developing countries (ODCs)), and markets with flat or decreasing demand and overcapacity (including most developed countries). These divergent trajectories strongly shape planning strategies and opportunities for power-system transformation (NREL, 2015), and require different tools and skills. Conditions of rapid demand growth represent a much more complex and challenging environment for assessing, planning and implementing investments.

These challenges are all the more important because of two fundamental changes faced by electricity industries worldwide: a shift from centralized fossil fuel-based generation towards more distributed generation with greater reliance on renewable energy (Lammers and Diestelmeier, 2017); and an increasing information and communication technology (ICT)-based sophistication of grid systems, which (inter alia) allows consumers to take a more active role, proactively controlling their electricity use and potentially feeding into the grid as "prosumers" (electricity consumers who also produce electricity). Such technological changes are occurring at a very rapid pace for an industry accustomed to planning on a 30-40-year time horizon, creating significant uncertainty (Bharath Jairaj, 2016). At the same time, the entry of actors new to the electricity sector, and the active engagement of consumers as a result of these new technologies, raises multiple technical, commercial and regulatory issues, requiring a "whole-system" approach and fresh thinking about electricity supply chains.

Rapid demand growth and capacity constraints are major challenges to assessment, planning and implementation of energy investments

Some observers have highlighted the opportunity for "less-gridded" countries to leapfrog carbon-intensive industrialization (e.g. The Economist, 2015; Harvey, 2015; Oh et al., 2016); and LDCs such as Bhutan, Nepal, Senegal and the United Republic of Tanzania have succeeded in stimulating rural electrification projects by mainstreaming renewables and implementing distributed generation as a central option in national energy strategies (UNEP, UNCTAD, UN-OHRLLS, 2011).

However, other observers advocate caution (e.g. Lee et al., 2016).[5] The transition towards non-hydro renewables remains at a relatively early stage in LDCs, partly reflecting technical, economic and institutional challenges (chapter 3) and the need for policy frameworks to foster their implementation. The cost of renewable technologies remains relatively high for LDCs even after recent dramatic reductions (chapter 3);

Box 4.2. **The Internet of Things**

One area where developing countries are considered by some to have a potential technological advantage is the application of the Internet of Things (IoT) in electricity provision. The IoT is defined by the International Telecommunications Union as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things, based on existing and evolving interoperable ICTs. An example of electricity-sector applications is the use of ICT to facilitate remote monitoring of the functioning and output of solar photovoltaic (PV) systems by the Kenyan solar energy company M-Kopa.

However, the growing digital divide between LDCs and ODCs in all indicators of ICT access and usage (except mobile-broadband prices) may be a constraint on their use of ICTs in the electricity sector, especially in rural areas where the relevance of such applications is greatest, but ICT penetration is weakest. While the development and success of mobile money indicates the possibility of IoT use in the absence of supporting infrastructure, optimism about its potential in LDCs is premature in the absence of LDC-specific research.

Source: ITU (2015, 2016a, 2016b).

A holistic sector and systems approach to energy planning and policy is needed in LDCs

and renewables markets globally continue to be driven largely by government incentives or regulations (REN21, 2017). Adoption of new technologies is also often constrained by the absence of the capabilities required for technology access, transfer and deployment, due to the inadequacy of absorptive capacity and effective industry institutions and regulations. Some technologies with potential benefits for the electricity sector in LDCs, such as the "Internet of Things", remain out of reach for most of these countries (box 4.2).

Nonetheless, increased reliance on off-grid and non-hydro renewable energy in LDC electricity sectors in the coming years may foster a rethink of sectoral governance arrangements, particularly in conjunction with the increasing role of developed country-based private energy companies with a greater propensity to apply such new technologies. This rapidly evolving context has important implications for governance of the sector, potentially raising questions as to whether current sectoral governance arrangements remain fit for purpose (Scott, 2015).

1. Sector-wide policy and planning

The evolution of LDCs' electricity systems, as they seek to leverage new technologies and energy sources, will be shaped by the spectrum of electricity market structures and by national contexts. Beyond the standard model of reform (section C1), there is now a growing body of knowledge on the potential pathways for planning and policy (IEA, 2017a; NREL, 2015). The principal pathways are outlined in figure 4.6. Of these, the structural challenges and limited access characteristic of LDCs point towards three, based on vertical integration or partial unbundling:

- An adaptive pathway, with a vertically integrated utility prioritizing the delivery of value rather than minimizing cost;
- A reconstructive pathway, using new markets to facilitate the integration of clean energy sources and optimize systems, learning the lessons of past experiences of restructuring;
- A "bottom-of-the-pyramid" coordination pathway, focused on applying new technological options and business models to accelerate access.

Such models imply a considered and coordinated approach to electricity system development from the outset, taking account of local contexts, sector-specific and other developmental goals and priorities, financing needs, and regulatory requirements and capacities.

Planning is particularly important for electricity systems because of the mismatch between the time required to build distribution networks and that required to build generation facilities, highlighting the need for coordination of planning processes for generation and transmission (Chattopadhyay et al., 2014; Bhattacharyya and Palit, 2016), as well as the complementarities among generation technologies (chapter 3). This is especially relevant in the context of efforts to expand access and integrate renewables in electricity systems through an optimal mix of centralized and distributed generation (Chattopadhyay et al., 2014).

Optimal reliability of electricity systems based on all available options and technologies for generation and distribution at the lowest cost requires planning on a

Figure 4.6

Electricity system transformation pathways

Starting conditions		Pathway options
• Low levels of access • Structural challenges (high cost of providing access and low ability to pay of large segments of the population) • Publicly owned utility is a single buyer	Vertically integrated/ partially unbundled	**Adaptive** pathway with vertically integrated utilities evolved to prioritize delivery of value rather than cost minimization (realignment)
		Reconstructive pathway of new power markets to facilitate clean energy integration and system optimization that incorporates lessons learnt from the past restructuring (revolution)
		Bottom-of-the-pyramid coordination pathway prioritizing accelerated access through new technology configurations and business models that facilitate both grid extension and socially customized access solutions (incremental)
• Competitive wholesale and retail power markets established • Autonomous transmission and distribution system operators operate	Fully unbundled	**Evolutionary** pathway with distribution system operators innovating to drive clean generation deployment and system flexibility, incentivized by realigned regulatory and policy frameworks

Source: UNCTAD secretariat compilation, based on NREL (2015); IEA (2017a).

timescale commensurate with the 30-40-year time horizon of investments in new facilities and the process of system development. Planning should encompass choices between private and public provision of electricity, and private and public financing. For example, public provision through centralized systems provides an opportunity for cross-subsidization to increase affordability, while distributed or stand-alone systems locally operated by the private sector usually aim to be financially self-sustaining with full recovery of operating and maintenance costs.

A holistic sector and systems approach is important to safeguard the economic viability and affordability of existing centralized systems as off-grid solutions develop. While LDC grids commonly serve urban and peri-urban areas, where the concentration of industrial activity is usually located, the low quality and unreliability of supply often motivates large clients, such as international hotels and medium-to-large firms, to rely on own-generation[6] as the main source rather than supplementary ones. This deprives the public utility of the most profitable parts of the customer base and sustains a vicious cycle whereby public utilities are unable either to cover operational costs or to finance necessary infrastructure investments.

The inability to expand access is thus both a cause and a consequence of the financial malaise of public utilities' struggling to attain financial viability. It can also contribute to larger consumer subsidies and fiscal distress where the majority of consumers have low capacity to pay, but there are limited possibilities for cross-subsidization, an issue of first-order importance in LDCs (Estache et al., 2015). In LDCs that use the single-buyer model of electricity supply, adverse effects on the public utility's financial position are compounded by higher premiums to IPPs for offtake risk under PPAs, and may even discourage IPP participation.

The ability or inability of centralized systems to provide low-cost electricity has potential knock-on effects on structural transformation and productivity. Should the transition towards renewables give rise to a high-cost environment for industrialization, this would be at odds with the basic principle of common but differentiated responsibility under the United Nations Framework Convention on Climate Change (UNFCCC), given the very limited contribution of LDCs to greenhouse gas (GHG) emissions (Bowen and Fankhauser, 2011).

2. Policy coordination

Effective planning and management of the transition to cleaner and more affordable electricity systems requires the involvement of multiple stakeholders under the clear leadership of a lead agency, to ensure that all the relevant development goals and priorities are taken into account, including investment promotion, access to technology, industrial development, gender equity, rural and urban development, poverty reduction and environmental sustainability.

Coordination among stakeholders, rural-urban linkages and gender considerations require due consideration

Policymaking structures in the electricity sector are not always conducive to clear and effective leadership. In many LDCs, ministries responsible for electricity governance may have limited or shared authority. In the Solomon Islands and Somalia, for example, energy policy is fragmented amongst several government bodies that have direct or indirect influence on the sector. In Myanmar, eight ministries are involved in the energy sector (Nam et al., 2015). In the absence of effective coordination, the involvement of multiple actors raises governance challenges and concerns around policy development, coherence, implementation and evaluation; and it inhibits holistic perspectives and approaches to national planning, policy formulation and sector governance.

The predominance of rural residents among those without access to electricity (chapter 1) has led a growing number of LDC Governments to place rural electrification (often excluding large hydro) under separate governance structures that prioritize distributed systems and renewables, in some cases under a different ministerial authority from that of long-established centralized systems. This may in part reflect a recognition of the different governance structures required for distributed systems and the need to avoid the delays associated with adapting existing governance frameworks. However, this approach may not always be indicative of a deliberate policy action backed by an adequate governance framework, effective institutions and coordinated planning.

Effective coordination can also enhance the contribution of the energy sector to other developmental goals. As well as facilitating access to a variety of services, including financial inclusion (particularly as utility bills are commonly accepted as proof of identity or address), grid extension can potentially contribute to domestic resource mobilization and combating tax evasion. In the presence of weak institutional capacities and high levels of informality, grid connections can help to broaden the tax base by identifying clandestine property development and facilitating the compilation of property registers and the collection of property taxes.[7]

By spreading the tax burden more widely, this can also help to nurture the wider State-citizen relationship (Carnahan, 2015; IMF, 2015). However, the availability of stand-alone home systems as an alternative to grid connection may limit the effectiveness of such measures.

3. Rural-urban dynamics

Electricity industries in LDCs are often dualistic, combining traditional centralized systems in cities, large provincial towns and industrial centres with poorly served rural areas, where grid extension is constrained by low incomes and/or logistical constraints. Energy-sector planning in LDCs therefore requires careful consideration of the relationship between rural-urban linkages and migration, rural electrification and structural transformation of rural economies, and the role of this relationship in inclusive development.

Developing countries are urbanizing at unprecedented rates, leaving little room for experimentation and adjustment (Henderson, 2002), and giving rise to risks of infrastructure failure and social instability. Many rapidly growing cities in LDCs are characterized by expanding or consolidating slums with increasing poverty and sometimes inequality, and around half of slum dwellers across developing countries as a whole access electricity through illegal connections (UN-Habitat, 2016). This leads to costly outages, increased reliance on own-generation, and revenue losses through electricity theft, jeopardizing the quality and stability of supply and the financial viability of public utilities. It is also incumbent on urban planners to understand the implications of inequitable access to infrastructure (UN-Habitat, 2016). Where a large proportion of urban households without access to electricity live in informal and unauthorized settlements, efforts to extend access may be constrained by lack of legal tenure, possibly requiring resettlement and complementary measures.

Rural-urban linkages also have important implications for rural electrification. Many countries in Asia and Africa have a pattern of temporary and circular rural-urban-rural migration whereby agricultural workers seek work in urban areas as domestic workers or seasonal staff in the hospitality sector during agricultural slack seasons (IOM, 2015; Srivastava and Kumar Pandey, 2017). This means that rural dwellers are by no means necessarily unfamiliar with modern electricity or electrical appliances. Expectations of rural electrification initiatives may thus be very high, and disappointment with initiatives limited to basic needs may give rise to social discontent, potentially fuelling pressure for unplanned and costly grid extensions (Acquah et al., 2017). While an incremental approach to rural transformation may be appropriate in some national contexts, rural transformation should not be assumed to be a linear process.

Internal, regional and international migration also contribute substantially to rural household income in LDCs through remittances, which are likely to be a significant factor underlying the observed "willingness to pay" for electricity among rural communities.[8] While some 75 per cent of remittance flows are estimated to be allocated to meeting immediate needs, and patterns of use vary widely between countries and sources of remittances, they can also contribute significantly to education, productive investment and entrepreneurship. Remittances from abroad are typically larger and more readily used for investment in physical capital (IFAD, 2017; Ratha et al., 2011).

Some rural electrification projects, for example in Bangladesh, recognize that lack of access and unreliability of electricity supply may disproportionately affect women's income-generating activities, and therefore seek to promote women's participation in decision-making and to identify entrepreneurial opportunities created for women. However, it is not always clear that such initiatives contribute to women's empowerment, particularly as they may be vulnerable to appropriation by men once a certain level of profitability is reached, and their impact is dependent on other cross-cutting issues (ENERGIA, 2016). Neither do they necessarily contribute to structural transformation if the income-generation opportunities they provide are no greater than traditional pursuits. A more active, concerted and comprehensive planning approach may therefore be needed to achieve meaningful contributions to gender equity and women's empowerment.

Gender considerations also reinforce the importance of ensuring adequate and appropriate levels of access. A real change in gender dynamics is likely to require a sufficient level of access to electricity to allow women to break out of the labour-intensive productive activities that dominate the agricultural sector, in which they are typically confined in certain countries.

An important issue in both rural and urban areas is the substantial impact of renewable-energy technologies on land use — the so-called "energy sprawl" (Moroni et al., 2016; Trainor et al., 2016). The management of land and natural resources is among the most critical challenges facing developing countries (United Nations Interagency Framework Team for Preventive Action, 2012). As well as being an important economic asset and source of livelihoods, land is closely linked to community identity, history and culture. Land issues thus readily lend themselves to conflict.

The land requirements of renewable energy projects are therefore a significant consideration in energy planning,

requiring careful attention in the light of local land tenure systems, which vary widely both between LDCs and often within them. Targeted action by Governments may be necessary with respect to the siting of energy projects, social acceptance and societal factors, limiting competition in land use, and protection of biodiversity and landscape.

4. Private and community roles

Rural electrification is fast becoming established as a commercial opportunity. "Base-of-the-pyramid" customers are increasingly viewed as a major potential market for energy and novel business models for electricity supply, estimated at $37 billion per year globally (IFC, 2012); and such estimates are viewed as indicative of a high willingness to pay for energy services among poor households. This perception is putting pressure on LDC Governments to put in place frameworks and support measures to facilitate and increase the commercial viability of private for-profit provision of electricity to unserved rural populations.

In rural areas of LDCs, the private sector is active primarily in providing household-level devices and systems, such as solar lanterns, solar home systems and improved biomass cookstoves. It is also involved in community-level mini-utilities (often powered by hydro or diesel generators, but increasingly using biomass, solar and wind energy) (IFC, 2012). The latter range from those that supply sufficient electricity to power two light bulbs and one appliance per household (Power to the Poor initiative in Lao People's Democratic Republic), to utility-like interventions providing sufficient power for such activities as water pumping, milling, and grinding.

While entrepreneurial activities can support the growth of stand-alone home-energy systems, mini-grids with the potential for productive use require an institutional context for planning, operation, pricing and maintenance (PwC, 2016; Bhattacharyya and Palit, 2016; Tenenbaum et al., 2014; IFC, 2012). Consequently, the divide between purely private and public provision in this segment is often blurred.

Purely commercial models for grid electrification remain rare, reflecting high costs and limited consumption by low-income users (Bhattacharyya and Palit, 2016; Pueyo et al., 2013; Acquah et al., 2017; IFC, 2012). Rural electrification schemes with an emphasis on cost recovery and commercial viability have proved neither necessarily affordable for most poor households nor sustainable. Private-sector interest in poorer and more remote areas is by no means guaranteed, and the emphasis on productive uses has generally been limited (Bhattacharyya, 2012).

Cooperatives (either non-profit or for-profit) are potential drivers of sustainable development, and offer a successful model for rural electrification with local control. In India, household connection rates are four times higher in villages serviced by energy cooperatives than in villages served by the State electricity board (ILO, 2013). Energy cooperatives operate, for example, in Bangladesh, Cambodia, South Sudan and Uganda. Bangladesh's programme, inspired by the United States model (box 4.3), is considered one of the most successful in the developing world. Subsidies and grants play a significant role in setting up such cooperatives. However, initiatives may fail to gain traction where there is a history of failed projects (ILO, 2013), or where the tier of service is too low to sustain interest (Acquah et al., 2017); and complementary support to income-generating activities is important to sustainability.

5. Regulation and regulatory capacity

The adoption of renewables may diversify energy mixes and accelerate rural access to electricity; but, if it is to increase system resilience, it needs to be accompanied by appropriate policies, regulations and codes (Cox et al., 2016). However, most LDCs have limited capacity for electricity regulation, reflecting both a lack of staff with the requisite skills and experience and financial constraints.

Building regulatory capacity is a process that typically takes a number of years; and electricity regulatory institutions in most LDCs are quite young. Very few

Box 4.3. **Rural cooperatives in the United States**

In the 1930s, 90 per cent of rural homes in the United States lacked access to electricity, while 90 per cent of urban homes had access, leaving most rural economies critically dependent on agriculture. Since high development costs and low profit margins deterred investor-owned utilities from expansion into rural areas, as in LDCs today, most rural electrification occurred through consumer-owned, not-for-profit electric cooperatives. Created in 1935 as part of the New Deal, the Rural Electrification Administration (REA) spearheaded the Electric Cooperative Corporation Act passed by Congress in 1936. By 1953, funds made available by REA to cooperatives to build lines and provide service on a not-for-profit basis allowed electricity access to more than 90 per cent of United States farms. By 2009, cooperatives served 12 per cent of national consumers (42 million people) in 47 states.

REA is now the Rural Utilities Service (RUS), operating under the United States Department of Agriculture.

Source: Deller et al. (2009); https://www.electric.coop/our-organization/history/ (accessed July 2017).

Regulatory capacity is limited in most LDCs, reflecting human-resource and financial constraints

were established before 2000, a majority after 2005, and a significant number since 2010. In a highly complex and increasingly multidimensional sector, many of these institutions are thus unlikely to possess mature regulatory skills or the high level of expertise and access to resources and information required for effective use of regulatory tools.

Experience of structural reform in the electricity sector — learning by doing — is itself a key aspect of strengthening regulatory capacity. However, even LDCs that have undertaken extensive reforms and benefited from technical assistance on sectoral and regulatory policy over a prolonged period can still face challenges in terms of regulatory capacity. Mali, for example, has implemented a series of reforms and a host of legislative and statutory instruments in the electricity sector since 1998, notably the 2006 Politique Energétique Nationale (National Energy Policy) and the Stratégie Nationale pour le Développement des Energies Renouvelables (National Strategy for Renewable-Energy Development), opening the sector to private operators and redefining the role of the State. The Rural Electrification Fund (Fonds d'Electrification Rurale) was also established in 2005, and strategies have been developed on biofuels and climate-change adaptation. Even in 2011, however, neither the National Energy Directorate nor the regulator (Commission Nationale de l'Energie) was functional, and the role of the latter remained poorly defined. Cohesion among the various mechanisms and institutions created was weak, implementation of existing policies poor, and there was no effective mechanism to evaluate and update the National Energy Policy (AfDB, 2015).

Distributed and local electricity systems further increase regulatory needs and challenges, as they often imply local management and a high level of beneficiary participation; and rural citizens play a key role in the prevention, detection and solution of problems in rural renewable electricity provision. From a regulatory perspective, this implies a potential proliferation both of market players and of local institutions in national energy sectors. It also confers on Governments the primary responsibility for mapping out the roles of different actors; establishing rules of engagement and ensuring their enforcement; setting technical and safety standards; and planning for human development. Consumer protection, and protections against the abuse of market power, may also be a consideration where micro- or mini-grid owners attain effective monopoly status locally.

6. International trade and regional cooperation

Trade in electricity can help to lower prices, mitigate power shocks, relieve shortages and facilitate the transition to cleaner energy, while also increasing flexibility in the integration of variable renewables by fostering market integration (Pollitt and Mckenna, 2014; REN21, 2017). A transition to more environmentally sustainable systems can lead to shortages of generation capacity — as has been the case even in some European countries (Deloitte, 2015). The particular vulnerability of LDCs to extreme weather, climate-change impacts and electricity shortages reinforces the potential gains from trade in electricity, as well as from the potential

Table 4.1

Regional cooperation on electricity trade

Initiative	Date of cooperation	LDC members
Africa Clean Energy Corridor Initiative	2014	Angola, Burundi, Democratic Republic of the Congo, Djibouti, Ethiopia, Lesotho, Malawi, Mozambique, Namibia, Rwanda, Sudan, Uganda, United Republic of Tanzania, Zambia
ASEAN Plan of Action for Energy Cooperation (APAEC) 2016–2025	2016	Cambodia, Lao People's Democratic Republic, Myanmar
Eastern Africa Power Pool (EAPP)	2005	Burundi, Democratic Republic of the Congo, Ethiopia, Rwanda, Sudan, Uganda, United Republic of Tanzania
Greater Mekong subregion	1992	Cambodia, Lao People's Democratic Republic, Myanmar
Southern African Power Pool (SAPP)	1995	Angola, Democratic Republic of the Congo, Lesotho, Malawi, Mozambique, United Republic of Tanzania, Zambia
West African Power Pool (WAPP)	2006	Benin, Burkina Faso, Gambia, Guinea, Guinea Bissau, Liberia, Mali, Niger, Senegal, Sierra Leone, Togo
South Asian Association for Regional Cooperation (SAARC) "framework agreement" for regional cooperation on electricity	2014	Afghanistan, Bangladesh, Bhutan, Nepal

Source: UNCTAD secretariat.

Box 4.4. **International trade in electricity**

Trade agreements (as evidenced by initiatives described in table 1) have tended to underpin international trade in electricity, either by providing a basis for power pools or through bilateral power trading contracts and memoranda of understanding or accords. Most regional generation projects are started by electricity utilities, although there are exceptions, such as the Manantali dam completed in 1987, a joint initiative of Mali, Senegal and Mauritania to develop the agricultural and hydropower potential of the Bafing River, which was initiated by their joint water organization (Organisation pour la Mise en Valeur du fleuve Sénégal).

Trade agreements or legal and regulatory frameworks compensate for the current inadequacy and fragmented framework of World Trade Organization (WTO) rules on trade in electricity. The latter arises partly because electricity provision and trade combines goods and services (see section B), and involves other policy objectives (Oseni and Pollitt, 2014: 23; Cossy, 2009; WTO, 2010). WTO law does not contain any specific provisions on electricity. Indeed, energy services were not included in the Uruguay Round negotiations. However, electricity is classified as a "good" in international trade statistics, and the WTO Customs Valuation Agreement (CVA) is among the relevant WTO rules under the General Agreement on Tariffs and Trade (GATT) for the trade of electricity. In addition, the General Agreement on Trade in Services (GATS) provides a framework for cross-border trade in services, inclusive of aspects of electricity trade that involve its transmission. However, neither the GATT nor the GATS enables an integrated, comprehensive or coherent regulation of electricity and energy trade. To date, few GATS commitments have been undertaken on energy transportation services under the Agreement.

Electricity trade may take the form of a single-buyer model, in which only one agent is allowed to import (export) electricity from (to) other interconnected control areas. This model is common in LDC and ODC markets dominated by a legislated monopoly provider (sections B1 and C2). Alternatively, all or several of the agents operating in one jurisdiction may be permitted to import and/or export energy from/to other interconnected control areas. This model is mandated in the European Union and many other liberalized jurisdictions in the United States, Canada and Latin America where multiple operators in different segments of the electricity supply chain are present and participate in international trade in electricity.

Electricity cooperation and trade can bring economies of scale in investments; strengthen electricity-sector financing capability; enhance competition and improve sector efficiency; increase load and fuel diversity; enable cost-effective renewable electricity penetration; address seasonal variability in generation; provide emergency support; provide a market for surplus generation; and generally increase the security and robustness of participating national electricity systems.

Trade in electricity demands considerable infrastructure to ensure the interconnection of different electricity transmission systems across national borders. In addition, complementary network codes for the cross-border transmission infrastructure and related arrangements should be selected, agreed and implemented to facilitate the interoperability of nationally designed systems. Moreover, efficient cross-border trade in electricity requires harmonization of rules across interconnected electricity markets. Interoperability and trade facilitation can be advanced through the creation of an umbrella regulatory body such as the Regional Electricity Regulators Association of Southern Africa (RERA), established in 2002. Among its duties is to facilitate harmonized industry policy, legislation and regulations for cross-border trade; elaborate the terms and conditions of access to transmission capacity; and set cross-border tariffs and make recommendations on issues that affect the economic efficiency of electricity interconnections and electricity trade among members. RERA issued regulatory guidelines in 2010.

Regional agreements for power-sector cooperation and trade and for the planning, development and implementation of related infrastructure can take time to achieve. For example, electricity-sector cooperation in the Greater Mekong subregion has a timeline spread over two decades, and continues to evolve. Similarly, it was not until 2015 that WAPP, created in 2006, took steps to design and develop the market models and rules for power exchanges between its member utilities.

Across all jurisdictions, whether developed or developing, slow progress in the operationalization of cross-border electricity trade can be attributed to technical, operational, political and commercial issues. While liberalized markets often rely on market-based procedures for electricity trade, developing countries have tended to rely on long-term supply contracts that lend somewhat greater stability in prices and supply and mitigate trading-partner political and commercial risk.

It should be noted that regional trade in electricity is not exempt from the exercise of market power. For example, there are concerns over possible predatory pricing behaviour within SAPP. While sophisticated market design and regulation is not a prerequisite for trade in electricity, eventual consideration of competition regulation may be desirable, especially in the developing-country context.

Source: Oseni and Pollitt (2014); European Parliament (2016); World Bank (2008); Singh et al. (2015); Marhold (2013); Cottier (2011).

for "islanding" (independent operation of local grids in the event of wider grid failure) afforded by distributed generation.

LDCs in several regions pursue bilateral, regional or multilateral approaches to coordinating and pooling efforts to create common infrastructures and facilities with the aim of reducing individual countries' capital investment requirements and lowering system operational costs (World Bank, 2008). While many LDCs are members of power pools or trade initiatives (table 4.1), some are constrained by lack of interconnection or by transmission congestion within transit countries. The Southern African Power Pool (SAPP) may represent a regional trade market capable of being leveraged to attract investment (ICA, 2011).

To the extent that national, subregional and regional electrification plans prioritize the extension of national grids and regional interconnections, coherence with rural electrification programmes is necessary, underlying the need for policy coordination and whole system approaches. Some rural areas close to generation facilities in neighbouring countries may most readily or cheaply be supplied by imports of electricity. Equally, renewable energy sources in such areas may provide opportunities for electricity exports to adjacent areas in neighbouring countries.

E. Conclusion

The context for electricity market structures and governance arrangements is once again in a state of flux. Current developments suggest an increased private-sector role in LDC electricity systems that were largely bypassed by earlier rounds of sector liberalization. LDCs have the opportunity to learn lessons from the shortcomings of reforms in the ODCs over the previous 20 years when seeking to leverage private-sector participation in their national systems. Electricity governance systems are often adapted or adaptable to national conditions or around national peculiarities. The fact that electricity is a service with monopolistic characteristics and of great social and economic importance is at the heart of many of its governance challenges in LDCs. Political considerations, reinforced by the sustainable development goals (SDGs) and affordability considerations, can be expected to retain their relative importance alongside technological and market fundamentals in shaping electricity-sector governance into the foreseeable future.

Equally, the environment for the electricity sector is evolving rapidly as a result of major shifts in technologies and their relative costs, coupled with climate change and increasing emphasis on environmental goals. Incorporating renewable sources of electricity generation has potentially significant impacts on the efficiency, expansion and upgrading of national electricity systems. However, the manner in which renewables are incorporated into existing systems will have an impact on the viability and cost of services delivered, and concurrent investments in ICT and regulatory capacity are a significant contingent factor in maximizing efficiencies and fully leveraging the potential of new technologies. Energy security concerns linked to achieving structural transformation will demand a great deal of LDCs in terms of foresight and technical knowledge. A wide range of legitimate societal interests and a diverse number of policy and user interests will need to be addressed in this respect. In a context of serious institutional capacity constraints, this is giving rise to numerous challenges to sectoral governance.

Strategic planning and regulatory capacity are expected to be critical factors for accelerating investment and coordinating investments by more, and likely non-public, investors. While best practice-sharing is desirable and useful, LDCs are subject to conditions significantly different from those in earlier transforming countries. Electricity sectors can be structured in different ways and electricity transformations can take different pathways depending on past legacy, as well as on previously achieved stages of transformation. Initial conditions will matter in this respect and will strengthen the case for adopting considered, joined-up and measured approaches to market and governance reforms, taking into account country specificities. In addition, it is unlikely that leapfrogging can take place by accident; LDCs will have to actively target leapfrogging as a specific policy goal.

Central to meeting these multiple challenges will be policy coordination, bringing together stakeholders across all relevant dimensions of development under the clear leadership of a single agency.

Notes

1 Available at https://www.iea.org/topics/energysecurity/.

2 Based on data from EUROSTAT electricity production, consumption and market overview (http://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_production,_consumption_and_market_overview, accessed April 2017).

3 Power Africa includes the collective resources of the Governments of Canada, France, Japan, Norway, Sweden, United States; institutions such as the World Bank Group, African Development Bank, European Union, Development Bank of Southern Africa, African Union's New Partnership for Africa's Development, United Nations Sustainable Energy for All initiative, International Renewable Energy Agency, Industrial Development Corporation of South Africa, United Kingdom Department for International Development; and over 100 private companies (https://www.usaid.gov/powerafrica/partners, accessed April 2017).

4 https://www.mcc.gov/initiatives/initiative/power-africa, accessed April 2017.

5 See also Ola (2016).

6 This is also a common practice with respect to large mining or tourism activities located away from urban and grid-serviced areas.

7 Country case studies in the context of research on measures being employed in African countries to combat illicit financial flows undertaken by the United Nations Economic Commission for Africa in 2016 revealed that grid extension had proved an effective tool in this respect.

8 Some of the new remittance transfer channels developing to exploit these markets allow electronic payment of relatives' bills, including for electricity, in countries of origin.