UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

UNCTAD

THE LEAST DEVELOPED COUNTRIES REPORT 2017

Transformational energy access

CHAPTER 6

Policies for transformational energy access

CHAPTER 6

Policies for transformational energy acces

A. Introduction

Universal access to modern energy could have a transformative effect on the economies of least developed countries (LDCs); but realizing this potential is critically dependent on the expansion of productive uses of modern energy, to increase productivity in existing activities and diversify output into new sectors and products. Equally, the expansion of productive energy use can play an important role in strengthening the electricity sector, by providing the demand needed to make investments viable, and possibly supporting the diversification of LDC energy sources.

Harnessing this synergetic relationship that lies at the heart of the energy-transformation nexus requires going beyond the social and environmental lenses that have tended to dominate discussions of energy access, and paying due attention also to the economic dimension. It requires proactive efforts to ensure "transformational energy access" and to promote the use of electricity in productive processes.

Energy requirements for productive uses differ widely across sectors/activities, but typically go far beyond the minimalist view of universal access as the physical connection of households to sources of electricity. Unless producers' energy needs are met — including in terms of adequate peak power, reliability, quality of supply and affordability — the unprecedented development opportunities offered by recent technological advances in electricity generation (and to a lesser extent storage) will be largely missed.

Serious efforts to achieve transformational energy access by 2030 will entail massive investments in physical infrastructure, and parallel improvements of the energy sector's institutional architecture. Such investments are very long-term in nature, and may give rise to an important element of path dependency. Pursuing an approach to universal access that fails to address adequately the current and prospective energy needs in a context of structural transformation thus risks locking LDCs into a suboptimal development path for decades to come. This has major implications for energy policy, for development strategies, and for the articulation between the two.

This chapter provides policy conclusions based on the earlier chapters, within the electricity sector, in the articulation of energy-sector policies with broader development strategies, and in relation to the international economic system.

Not integrating transformational energy access into universal access strategies risks locking LDCs into suboptimal development paths

B. Strengthening LDC electricity systems

1. System-wide energy planning and policy coordination

Transformational energy access requires the development of an electricity provision system that meets the needs of expanding productive sectors. This means ensuring, in addition to increasing physical access, an adequate, affordable and reliable supply of electricity in a context of accelerating energy demand to power the process of structural transformation.

The scale of this challenge is enormous in most LDCs. It is also immensely complex, requiring careful consideration of the particular circumstances of each locality, and weighing them against multiple rapidly evolving technological options and a changing business landscape. Some of the decisions required, notably regarding technology choices and business models, may arguably be decentralized to economic actors, such as independent power producers or household themselves; but some degree of central planning is needed to anticipate and address the system-wide implications of their investment choices and to fully exploit the potential synergies and complementarities across different technologies in integrating each country's power generation mix. The multifaceted challenges of strengthening LDC energy systems thus call for a combination of system-wide long-term planning and flexibility.

The effectiveness of system-wide energy planning hinges on policy consistency, realism and a sound information base. Grid extension inevitably leads to increased electricity demand. If generation capacity fails to keep pace with this increase, this will be reflected in reduced reliability of supply, impairing the developmental benefits of grid extension, and leaving producers and households to resort to higher-cost (and possibly more polluting) options. Thus, consistency

Strengthening LDC energy systems requires a combination of long-term system-wide planning and flexibility

between the pace of grid extension and the rate of increase in generation capacity is vital. The planned pace of increase in access and electricity production also needs to be realistic, taking into account not only the availability of finance and construction times, but also logistical and human-resource constraints, as well as likely delays in decision-making, access to finance and project implementation.

The foundations of any planning process lie in a sound information base. In this respect, the generalized lack of systematic, reliable and comparable statistics on LDC energy issues calls for a major strengthening of the relevant statistical capabilities, including through international initiatives to "mobilize the data revolution". The need for improved statistics is all the more pertinent in the context of increasing energy access (and redefining it along the lines proposed by the Sustainable Energy for All (SE4All) initiative, notably because related data requirements touch on a range of dimensions, from the site-specific resource potential to geospatial data, and from market prospects to demographic variables.

In this context, strengthening existing international initiatives to map energy-resource potential in LDCs (for instance, the Global Atlas for Renewable Energy of the International Renewable Energy Agency (IRENA), or the Renewable Energy Resource Mapping Initiative of the Energy Sector Management Assistance Program (ESMAP), as discussed in chapter 3) could go a long way towards enabling a sound evidence-based planning process, as well as helping to enable viable investment in renewables. Moreover, since much of the underlying data will also be needed for planning processes in other sectors (e.g. water, sanitation, health, education and transport), there are likely to be substantial economies of scale in developing a national intersectoral process for data collection, to coordinate information needs from geographical information systems, household and enterprise surveys, etc.

While predictability and transparency in the broad directions of long-term planning are needed from an investor perspective, the planning process must also have the flexibility to respond to changing circumstances, as the electricity sector continues to be subject to rapid technological changes, especially in the area of renewable technologies. Some degree of flexibility is hence needed to adjust to the evolving feasibility and relative costs of alternative technologies, which may be affected in the coming years by shifting incentives associated with efforts to promote universal access, and by changes in the climate and energy finance landscape.

The domestic context for grid extension and rural electrification is also subject to a particularly high level of uncertainty. Concerted efforts to achieve the Sustainable Development Goals (SDGs) can be expected to bring major changes in demand patterns for electricity, both by increasing domestic demand and through the establishment of new community facilities, such as schools and clinics. Electricity needs will further be affected by the consequences of energy-related policies, which may not be readily anticipated. This gives rise to a significant degree of endogeneity, in that policies need to respond to changes in demand which themselves arise in part from policies themselves. For example, policies to promote productive use will affect demand, while progress towards rural electrification may affect the rate of urbanization and rural settlement patterns. Changes in institutions, market structures, regulation, pricing systems and subsidies could also have important effects that may not be fully anticipated.

In light of the above, it is important to review long-term energy planning frameworks on a regular basis, to monitor progress, with a view to improving and coordinating implementation, and to reassess the appropriateness of the plan to the changing context.

The application of gender mainstreaming tools in national and local energy utility plans should be bolstered, as should building capacities for incorporating gendered approaches into energy programmes and projects at all levels of governance (ENERGIA, 2017). Greater integration of gender considerations into energy planning can also play a key role in harnessing the potential synergies between transformational energy access and enhancing women's economic participation and structural transformation (chapter 2). Examples of initiatives to promote gender mainstreaming include the Programme on Gender Mainstreaming in Energy Access (ECOW-GEN) of the Economic Community of Western African States (ECOWAS) and the integration of gender equity and social inclusion objectives, indicators and targets into Nepal's National Rural Renewable Energy Programme (ECREEE and NREL, 2015; ADB et al., 2015). However, effective design of gender-sensitive energy policies requires improving the availability of gender-disaggregated data on energy access and uses.

Despite the growing recognition of the importance of system-wide energy planning, especially in the context of greater penetration of renewable energy systems, this remains inadequately reflected in development assistance allocations. In addition to greater financial support for energy planning, LDCs and other developing countries (ODCs) could also benefit from the development of planning tools appropriate for their national contexts.

2. Scaling up supply and strategically diversifying the generation mix

The development of the electricity sector does not start with a blank slate, but builds on the existing (albeit inadequate) energy system. In light of the considerable increase in generation capacity that will be needed to achieve transformational energy access in LDCs, it would make little sense to decommission existing capacity or forgo related investment plans where these remain viable, irrespective of the technology used. It may, however, be desirable to improve or upgrade existing capacity to increase its efficiency and reduce greenhouse gas (GHG) emissions intensity (IPCC, 2014).

An evolutionary approach to the power sector is thus warranted, whereby planned capacity additions are integrated into existing assets, progressively expanding and upgrading supply while simultaneously affecting the power generation mix. As discussed in chapter 5, investments in electricity infrastructure have very long life cycles, which makes an appropriate and forward-looking choice of technologies for new capacity critical. From a system-wide perspective, the overarching objective is thus to strategically steer the portfolio of technologies, to attain a generation mix suited to the country's resources and future needs.

A simple comparison of levelized cost of electricity (LCOE) (chapter 3), while providing useful information on the relative costs across different technologies, is not appropriate — on its own — to identify the optimal role each technology can play in a country's power generation mix. Besides the benefits of diversification for risk-spreading and energy security purposes, different technologies can provide a distinct system value reflecting, inter alia, the scope, flexibility and time profile of their generation as well as its relative cost.[1] Moreover, the sensitivity of the LCOE estimates to assumptions related to future prices, financing conditions and environmental externalities deserves careful scrutiny from a policymaking standpoint, because of the specificities of the LDC context (chapter 3). An additional consideration may be the balance between capital and recurrent costs: to the extent that capital costs are funded by official development assistance (ODA) grants or other (non-debt-creating) official flows, these are not borne by the country itself,

LDCs need to diversify their generation mixes, selecting technologies according to local conditions…

so that the main consideration is relative recurrent costs of alternative technologies. This is likely to shift the balance of advantage decisively towards renewable technologies, where recurrent costs are a much smaller part of the total. However, while the availability of external financing is thus relevant to technology choices, it is important that such choices be driven by local circumstances, and not simply by the availability of financing.

Since LCOE computations focus on private cost elements, they neglect environmental and social impacts of distinct technological choices. From a societal point of view, these impacts are a critical aspect of integrated energy planning. Gradually internalizing environmental externalities, stemming from both local pollutants (notably particulates) and GHG emissions, is desirable in the long term. However, this should not preclude developmental opportunities linked to the use of fossil-fuel technologies, where these are otherwise the best option. In such cases, the international community should ideally provide the finance, technology transfer and technical support needed for pursuing further decarbonization of LDC power sectors. Similarly, environmental sustainability considerations call for an adequate assessment of the options for the safe disposal or recycling of generation apparatus containing potentially hazardous materials (notably solar panels), or — in the case of large-scale hydroelectricity projects — of their potential social and environmental impact on river-based ecosystems and related communities.

Particularly in the case of variable renewable technologies (wind and solar), adequate consideration should be paid to their intermittent nature and ensuing needs for complementary storage systems. While the costs of storage technologies have declined rapidly over the last few years and may make battery storage a feasible option in due course, this is not yet the case in all LDCs (at least not at mini-grid or utility scale). In the near term, continuity of supply may therefore entail the use of hybrid systems, combining variable renewables either with pumped hydro or with diesel or biofuel generation. Solar thermal energy may also become a viable option in the future, combining renewable generation with storage of thermal energy to allow greater flexibility in the time profile of supply; but this would depend on substantial cost reductions.

…and to combine grid extension and upgrading with appropriate deployment of off-grid solutions

On the other hand, the scalability of renewable energy sources (i.e. the potential to gradually increase electricity supply over time as demand rises) might facilitate their deployment by somewhat smoothing investment costs over time. Especially with reference to mini-grids, exploiting the modularity of solar photovoltaic (PV) and to a lesser extent wind generators could help facilitate a relatively fast initial deployment, while leaving room for gradual capacity increases as demand rises.

Overall, while the identification of the desired power generation mix is necessarily country-specific, and must reflect local endowments and resource potential, it is clear that the underlying evolution should ideally be oriented towards kick-starting structural transformation and should seek to maximize the development opportunities within the energy value chain. As discussed in chapter 3, this implies a continued and possibly increasing role for fossil fuel-based generation, especially in countries with significant fossil-fuel reserves and where sunk costs have already been incurred to expand fuel-based generation capacity. Nonetheless, increasing renewable generation could make a substantial contribution to transformational energy access as well as providing environmental co-benefits; and harnessing complementarities across technologies could widen options for grid-connected generation and foster more diversified, more reliable and less import-dependent electricity systems.

3. Extending and upgrading the grid

Achieving universal access to modern energy will require a combination of grid upgrading and extension in urban and peri-urban areas, with the deployment of mini-grids, and stand-alone solutions for dispersed rural populations (chapter 3). As productive use of energy often requires higher-power devices (typically consistent with grid or mini-grid connection), the realistic scope and rate of grid extension is a priority consideration from the perspective of integrated energy planning for structural transformation. This will be determined by a combination of logistical and economic considerations — particularly the relative costs of grid extension and mini-grids for rural communities — and the resources available for investment.

Beyond the potential scope of grid extension, priority areas for mini-grid and stand-alone home system deployment should be identified, taking account (among other factors) of community size, dispersion, energy demand and potential for productive use. Such assessments should also be informed by forward-looking consideration of the prospects for structural transformation and productive energy uses in each area, as greater energy demand tilts the optimal technology split towards mini-grids or, where possible, grid extension. Mini-grids may also play a role in peri-urban areas (and potentially in unserved urban areas, such as informal settlements) as a stepping stone to grid connection. Particularly where transmission capacity is a constraint, they can provide a means of establishing a local distribution network that can be connected to the wider grid later.

Sound planning, transparency and policy coordination are essential to this process, in order to ensure appropriate prioritization of investments, to avoid deterring potential investors and to allow mini-grids to be interconnected and/or integrated into an overall grid as appropriate at a later stage. Grid connection requires the adoption of technical standards compatible with the overall grid to ensure interoperability. Equally, investors in mini-grids need clarity about the likelihood and time frame for grid connection, and its financial implications for their investments.

As well as the extension of the distribution network, universal access will require a significant upgrading of the existing network in most LDCs, in order both to enable the flow of greater load and to tackle disproportionately high transmission and distribution losses, thereby enhancing energy efficiency. Moreover, the ongoing emergence of off-grid system and distributed generation is likely to affect the requirements for a supportive infrastructure, increasing the need for system flexibility and for effective management of bidirectional electricity flows. An upgraded grid, with adequate high voltage cables and interconnections, is also a precondition for more effectively integrating LDC energy systems at an international level, thereby allowing cross-border trade of electricity.

While the technical requirements of "smart grids" (and the need for interoperating end-use devices) mean that they are unlikely to be suitable for most LDC markets in the near future, the upgrading of distribution systems may still offer the opportunity to leapfrog to progressively more sophisticated grids within LDCs' technological constraints. This underscores the need for a proactive policy framework that supports and facilitates technological upgrading, by:

- Leveraging the regulatory framework to promote the adoption of appropriate technological standards;
- Emphasizing capacity development, both for grid developers and operators and for end-users, whose behaviour can strengthen the energy system value;

- Harnessing the scope for both North-South and South-South cooperation and technology transfer, and favouring experimentation and diversification across energy sources;
- Preserving a system-wide approach to energy planning.

4. Closer integration of regional energy markets

Cross-border trade in electricity can be conducive to achieving universal access and upgrading the power sector, with positive effects on development strategies more broadly. For some LDCs, particularly those with substantial hydroelectricity potential and large and relatively prosperous neighbours, electricity may offer significant potential for boosting export revenues. In some instances, however, this may give rise to trade-offs, where electricity exports are an important source of hard currency and macroeconomic stability but also contribute to domestic shortages that constrain demand and economic activity, or cannot be readily diverted for domestic supply.

For other LDCs, importing electricity may be a viable and lower-cost alternative to increasing domestic generation, depending on resource potentials and relative comparative advantages. However, any potential savings need to be weighed against the implications for energy security and dependence on supplying countries (and on the cross-border transmission infrastructure).

In particular circumstances, cross-border trade may also offer a means of energy storage. By exporting electricity at times of peak production and importing it at times of peak demand, a country can effectively import pumped hydro storage services. This can allow greater reliance on variable renewable technologies than would otherwise be possible without sacrificing continuity and reliability of supply.

In all these contexts, regional power pools can play a substantial role, offering stable and durable frameworks for commercial energy exchanges. They facilitate joint systems planning and organization, and the equitable sharing of the cost of interconnecting transmission networks. Most importantly, they leverage differences in the mix of the generation capacities and sources of their members. In so doing they enable countries to achieve significant reductions in emissions by substituting electricity generated using renewable technologies in neighbouring countries. They also enable pool members to leverage the complementarity between their different generation technologies to mitigate the variability of renewable sources of energy.

Cross-border trade and cooperation in electricity can support universal access and power-sector upgrading

The possibility of crafting flexible purchasing agreements and leveraging solidarity amongst pool members can contribute significantly to energy security. For example, in line with the statutes of the Southern African Power Pool, South Africa was able to supply Zambia and Zimbabwe with emergency power in 2016, with voluntary and complementary action also taken by Swaziland and Lesotho to reduce consumption.

Regional power pools often comprise a mix of countries that are at different levels of development but face common challenges. In such circumstances, they can be a significant source of technical cooperation and technology transfer, given the potential benefits of joining forces in complex research and development (R&D) projects with positive but uncertain spillovers for pool members. Similarly, given their requirements for interoperability, policy harmonization, and maintenance of appropriate technical hardware and software, they offer substantial possibilities for skills pooling and exchange, and capacity-building at the planning, technical and regulatory levels.

Membership of regional power pools can thus offer the possibility of pursuing reliable and efficient access to energy while simultaneously obtaining a greater share of energy trade, and technical cooperation. However, the pursuit of these goals needs to be underpinned by measures to ensure adequate, efficient and affordable access to energy by all population segments to foster the growth and diversification of high-productivity economic activities.

Regional electricity trade often takes place among countries with varied generation capacities. Power pools need to be structured carefully to avoid the abuse of market power. In this context, the existence of regulatory institutions with regional scope, as in the European Union, constitutes a distinct advantage.

C. Electricity system governance and finance

1. Building effective governance frameworks for the electricity sector

Governance frameworks are critical to ensuring efficient electricity systems. Government's ability to visualize the electricity system a country wants and

Key goals of electricity governance include robust regulatory systems, diversification of energy sources, affordability and financial sustainability

needs, and to articulate and lead the implementation of that vision, is an indispensable factor that underpins all other processes and facilitates the setting of related benchmarks and system development targets. In this context, and as part of their governance frameworks, LDCs should buttress measures to accelerate universal access with clear benchmarks on the levels of access and quality of services required to meet transformational energy access goals.

While there is a discernible divide between developed and less developed electricity systems, there is no one-size-fits-all model for market structure. The design and governance of electricity systems is highly dependent on country-specific factors, technological innovation and disruptions, and the evolution of economic theory; and countries face different challenges in the evolution of their electricity systems when they seek to change their generation mix and market structure.

Electricity systems evolve, and market structures reflect this evolution. In developed economies, characterized by high generation capacity and falling demand, liberalized energy systems have emerged as the dominant (although not universal) model. In most LDCs and ODCs, however, electricity systems are neither served by a monopoly provider nor fully liberalized, but are situated between these extremes; and their domestic markets are characterized by insufficient generation capacity and rising demand. Virtually all developing countries have sought to allow private-sector participation either through concessions or power purchasing contracts, or through liberalization of the generation segment of electricity supply.

In seeking to transform their electricity sectors to take advantage of current technological innovations and sustainability requirements, it is important that LDCs avoid market structures that are overly demanding in terms of administrative and regulatory capacity. However, this does not rule out an eventual transition to fully liberalized systems. Gradual transition is a common feature of most successful cases of liberalization. Failure to take into account institutional, financial and human-resource capacity constraints could lead to negative outcomes and substantial economic costs in LDCs, given the complexity implied by liberalized systems both nationally and for regional power-pool arrangements.

It is also important that Governments maintain a clear vision of the roles of the public and private sectors in the electricity system, based on their national contexts, and put in place the institutions, supports or safeguards needed to achieve national developmental goals. Governance frameworks also play a central role in building regulatory trust and thus influence investments within and into national electricity sectors. Experience shows that electricity systems need to be steered, and that improvements in industry performance and consumption habits (energy efficiency) are incentivized by policy and regulation.

The focus of electricity sector governance is now primarily on what electricity systems should deliver, and on how to achieve energy security, rather than on ownership and structure. While energy-security issues vary widely across national contexts, the primary goal of adequate supply with maximum reliability and quality is universal. LDC governance frameworks for transformational energy access should therefore ensure:

- Sufficiently robust regulatory and governance systems, including clarity on regulatory processes;
- Universal access at the lowest long-term generation cost;
- A diverse and flexible mix of electricity sources and technologies underpinning electricity supply;
- Reasonable affordability for users in all segments of society, and the competitiveness of economic actors;
- Financial sustainability of operators;
- Appropriate conditions to leverage public and private finance to ramp up generation capacity and investments in network infrastructure.

Also important is a systemic and coordinated approach to electricity system development that takes into account multiple national development goals, a gendered perspective, energy efficiency goals, and complementary policies and investments in other sectors to sustain energy security.

While LDCs have made significant strides in all areas of their governance frameworks, policy and regulatory gaps or inconsistencies are evident with respect to many aspects of national electricity frameworks (chapter 4). The approach to the development of national electricity frameworks appears in some cases to be ad hoc, or in response to donor initiatives, rather than systemic. Rural electrification and efforts to meet climate change-related commitments may be particularly vulnerable to less coherent approaches to electricity systems development. Lack of coherence in electricity governance frameworks can weaken LDCs' ability to manage the trade-offs inherent in developing-country contexts effectively and pragmatically.

Trade-offs can arise in a variety of contexts in LDCs, and choices are often not clearcut, particularly in rural electrification. The concerted push to reach universal access in the context of renewables by the year 2030 embodies an opportunity for LDCs to further leverage the private sector in the provision of sustainable sources of electricity and innovative business models to serve diverse rural and urban settings. LDCs should thus continue their efforts to increase supply capacity in collaboration with the private sector. However, in rural areas characterized by dispersed populations or hostile terrain, trade-offs often exist between the achievement of economies of scale and scope in the provision of a differentiated service that supports transformational energy access on the one hand, and providing only for basic needs as the most profitable option on the other. Similarly, there may be tensions between the roll-out of stand-alone solutions and grid extension in areas where the latter could be a viable longer-term option.

In all these contexts, policymaking, planning, coordination and regulation within the energy sector all assume a primary focus. This further underlines the need for a system-wide approach to electricity system design and transition. The variety of delivery options and potential increase in the number of sector participants implied by distributed systems reinforces the need for enhanced regulatory oversight. For instance, it is essential that the quality and reliability of electricity installations is safeguarded not only for the benefit of electricity users, but also for the reliability of the grid. In this regard, the sector regulator will need to put in place the necessary rules to govern product, safety, and system interoperability. Similarly, the importance of affordability to achieving universal access in LDCs highlights the need to regulate and incentivize private providers to meet this goal. Since a reliable service is the result of cooperation and communication among all industry stakeholders, it will also be necessary to put in place effective mechanisms and rules governing the interaction of industry actors. This includes regulating to prevent the abuse of market power, which is a particular risk in the case of independent mini-grids that may have effective monopoly status in a particular locality. In electricity systems, liberalization is not a substitute for regulation.

Equally, there is no one-size-fits-all model for transition to low-carbon electricity systems. All countries encourage renewable energy generation to varying degrees, including LDCs. Accordingly, based on the national context, countries may seek to fit renewables to the grid or fit the grid to renewables (Matek and Gawell, 2015). A diverse mix of renewable energy sources is equally important for managing volatility and ensuring grid stability and security. In order to be effective, governance frameworks must clarify policy direction to guide investments and attract and develop the right market actors.

The challenges inherent in incorporating larger shares of renewables into electricity systems reinforce the need for a managed and regulated transition. Accordingly, LDCs should plan and implement the necessary investments in human and institutional capacity to enable effective governance. Donors should also give more priority to supporting electricity regulation, which is currently not funded by ODA, in their development assistance.

2. Balancing affordability and cost-reflectiveness

Financial sustainability through cost-reflective tariffs is a critical factor in electricity systems, underpinning service quality, innovation and adequate investments in infrastructure, maintenance and upgrading. It also has a bearing on whether, and how rapidly, electricity systems grow. LDC Governments have traditionally succumbed to popular pressure to maintain uniform national below-cost electricity tariffs, but often at the expense of fiscal distress, compounding chronic underinvestment by public utilities and poor quality of power supply. Under these conditions, vicious circles of low access, small customer bases and customer shedding due to poor quality service exacerbated financial deterioration and became entrenched.

Momentum is growing for transitioning to cost-reflective tariffs, driven largely by fiscal distress, universal access commitments in the context of the global development agenda and associated incentives for private-sector participation.

The right tariff structure determines the efficiency and effectiveness of the utility's cost recovery effort. In addition to increasing tariffs, modifying tariff design can offer a route to matching the structure of the tariff to the structure of electricity supply costs. This is important because the bulk of electricity infrastructure investment is directed at meeting peak demand. Tariff structures vary in regulatory complexity in terms of design and implementation. While they have evolved in line with successive tariff theories ever since electricity was discovered, distributed generation has exposed failings in existing rate designs in unbundled and liberalized electricity systems. The roll-out of new technologies, such as smart and pay-as-you-go meters, has in turn facilitated the implementation of such new tariff structures as time-of-use tariffs, which address demand-side management goals and possible inequities in cost allocation that might arise between low-demand and high-demand customers under traditional tariff structures.

LDCs should consider moving towards cost-reflective tariffs, cushioning distributive impacts with social policies and job creation

LDCs should study, and where possible exploit, the opportunity presented by technological changes to boost the financial sustainability of their utilities. However, some tariff structures may imply a level of regulatory sophistication that is beyond the reach of some of these countries. In addition, the deployment of digitized technologies like smart meters is reliant on LDCs making the necessary complementary investments in information and communication technologies (ICTs); new or upgraded grid infrastructure; and relevant human-resource capacities. LDCs should also be aware that digitized technologies heighten security risks. Unlike developed countries, LDCs have not invested as much in ICT or digital security, and both the public and private sectors are likely to lack sufficiently skilled data managers.

LDCs can also tackle the issue of financial sustainability by accelerating the number of electricity customers connected to the grid. A significant proportion of urban and peri-urban populations in these countries are close to a grid but remain unconnected, often because of connection charges. Easing the conditions for connection is a priority for growing the customer base and stimulating demand, particularly as demand may be limited until customers acquire electrical appliances.

A change in tariff structure may also contribute to the reduction of subsidies and the incidence of cross-subsidization. Very large, explicit and hidden subsidies for energy, including electricity, are a prevalent feature in both developed and developing countries. In LDCs, such subsidies can have a crippling effect on public budgets. The entry of the private sector into LDC energy sectors can sometimes result in tariff and subsidy increases (section G2). Subsidies can increase because Governments with weak negotiating capacity enter into disadvantageous power purchasing agreements with independent power producers or high capital costs for investment (chapter 4). While initial tariff increases may be necessary to attain cost recovery levels, later tariff increases may rather reflect the private sector's fundamental need to seek profits.

As with general electricity system transition, tariff transitions benefit from strategic foresight. Experience shows that the gradual phasing-in of tariff increases contributes to their acceptability by end-users. The chances of sustaining such increases are also significantly improved when implemented under favourable economic conditions. For instance, a number of developing countries took the opportunity to scale back on energy subsidies during the period of sustained low international oil prices (IMF, 2013). That said, tariff hikes and changes are generally underpinned by strong political will. A commitment to transparency and effective communication campaigns to engage end-users to explain the reasons, nature and impacts of the programmed changes is an additional success factor. In LDC contexts, the need to make adequate provision for safety nets and lifeline tariffs is a critical consideration that should help maintain and extend gains in universal access, while also supporting the financial viability of infrastructure investments.

However, social policies to cushion the impact of a move to cost-reflective tariffs may not be sustainable unless underpinned by concerted measures to facilitate structural transformation and meaningful job creation. LDCs should thus aim to strengthen their capabilities to implement renewables auctions, as these have proved to be a lower-cost option that delivers cheaper services which are less burdensome for public budgets. Auctions may prove to be a pragmatic approach, given the need to structure feed-in tariffs to a specific generation technology and a specific locality's cost structure. In the rural context, end-users can often face differentiated tariffs by locality and technologies, which can raise equity issues and present challenges in terms of the type of productive activities that can be fostered in a given location. Unforeseen impacts on internal migration and social discontent might therefore arise. The international development community should also prioritize the development of LDC capacity in the area of renewables auctions for development assistance.

The sustainability of electricity provision and access could be in doubt in LDCs where it relies on feed-in tariffs largely financed by donor funding. Sustainability could also be jeopardized by reliance on microcredit to facilitate private-sector provision, especially with respect to rural electrification. Over-indebtedness is increasingly a concern among microcredit clients in developing countries. It also affects the viability of microcredit institutions (Schicks and Rosenberg, 2011). For these reasons, excessive reliance on microcredit should be avoided and LDCs should maintain their vigilance over the sector.

3. Greater mobilization of domestic sources of finance

LDCs need increasingly to seek cheap sources of development finance. Developments on international markets are raising concerns about the availability of long-term finance in the form of ODA and private finance (section G2). The advantages of domestic credit markets include lower exposure to currency risk; lower vulnerability to capital flow reversals; the possibility of using countercyclical monetary policy to mitigate external shocks; the strengthening of local financial markets development; contributing to a lessening of aid dependence; and increasing the availability of long-term finance for network investments, which typically attract less private-sector interest. Expanding and deepening domestic financial markets should also have positive effects on the growth of local industry, including in the electricity sector.

There is thus a strong case for prioritizing public funding and the development of domestic capital markets to drive needed investment in national electricity sectors. LDC Governments need to assume policy leadership in the development and diversification of domestic debt instruments that will be attractive to various domestic and external institutional investors. Efforts should focus on increasing the availability of de-risking instruments, including insurance and guarantee products to protect investors, although limited institutional and human capacities are an important constraint. LDCs that have significant diasporas with the necessary financial means should also seek to attract diaspora direct investment.

The development community, including impact and infrastructure fund investors, may wish to consider giving enhanced priority to LDC efforts to nurture domestic debt markets. While the number of international and regional initiatives to stimulate domestic debt instruments and capital markets is on the increase, LDCs may require special attention and complementary assistance.

The energy-transformation nexus is critical to policy frameworks for structural transformation

D. Harnessing the energy-transformation nexus

1. Integration of energy policies and structural transformation strategies

The central role of the energy-transformation nexus in sustainable development highlights the importance of integrating electrification and access to modern energy fully into development strategies. A development process based on sustainable and inclusive structural transformation implies an increased supply of modern energy to producers in agriculture, industry and services as well as to the residential sector and community facilities. In turn, the resulting demand growth can make investments in energy production and distribution systems more viable, helping to reap the benefits of scale economies and higher overall efficiency. Equally, however, if this demand remains unsatisfied then the process of structural transformation may itself be slowed down or disrupted.

Increasing access to modern energy can only be fully effective in promoting structural transformation within an overall development strategy oriented towards this objective. Broad policy recommendations to foster

Box 6.1. **Development strategies for structural transformation**

Previous editions of the Least Developed Countries Report have identified the following key policy priorities to foster structural transformation in LDCs:

- Pursuing a development-oriented macroeconomic policy, preserving macroeconomic stability while fostering investment and employment creation;
- Harnessing public investment to relieve key bottlenecks for productive sectors (especially in labour-intensive infrastructure projects), so as to crowd in private investment;
- Enhancing the mobilization of resources (public revenues, foreign direct investment (FDI), ODA and new sources of development finance) and their strategic allocation towards key sectors/activities;
- Pursuing proactive agricultural and industrial policies to strengthen backward and forward linkages (especially in relation to FDI) and spur the emergence of more sophisticated, higher value added activities;
- Promoting financial inclusion, broadening access to credit for SMEs and smallholder farmers, and supporting the emergence of effective financial systems;
- Building capabilities in science, technology and innovation (STI), particularly for the absorption, adaptation and application of new technologies;
- Preserving existing policy space and exploiting it strategically to foster structural transformation.

Source: UNCTAD (2006, 2014, 2015a, 2016b).

structural transformation, drawn from previous editions of the Least Developed Countries Report, are outlined in box 6.1; the main text focuses instead on articulating the links between those recommendations and energy policies.

Many of the policies outlined in box 6.1 are intimately linked with energy access and supply. As discussed in chapter 2, poor and unreliable access to modern energy triggers additional costs for firms, creating a competitiveness wedge that penalizes LDC producers vis-à-vis their competitors. In light of this, the natural-monopoly tendencies of the electricity sector (chapter 4) mean that electricity infrastructure is arguably a form of social overhead capital, which allows public investment to crowd in private investment by relieving bottlenecks in productive sectors.

Widening access to modern energy and improving the quality of modern energy provision enable the shifting of LDCs' comparative advantage towards progressively more sophisticated activities, creating new opportunities for dynamic "entrepreneurs by choice" (as opposed to survivalist "entrepreneurs by necessity"). The nature of these opportunities (and their location within the geographical pattern and time frame of widening access) needs to be factored into the design of rural development and industrial policies.

There are also a number of more indirect synergies between wider access to electricity and the broader needs of structural transformation. As noted in chapter 4, information on grid connections can help identify taxpayers and businesses for tax collection purposes, while the availability of electricity for productive use could reinforce the incentives for microenterprises to join the formal sector. Wider access to electricity can also help unlock the development potential of ICTs, which play a growing role in financial inclusion through "mobile money" systems like Kenya's M-PESA and in disseminating market information and knowledge of productive technologies.

The energy-transformation nexus highlights the critical importance of the feedback relationship between demand and supply, to policy frameworks for structural transformation. The economic viability of investments in electricity generation, transmission and distribution is highly dependent on an adequate level of demand. In this context, productive use is not merely additional to domestic use, but often complementary, as it helps smooth the time profile of electricity consumption: while the peak period for domestic use is the evening (for lighting and entertainment), productive use occurs primarily during the day. Accordingly, the expansion of productive uses of energy may also be conducive to supporting the penetration of variable renewable technologies, especially in the case of solar energy.

Demand for modern energy is affected not only by households' and producers' incomes, but also by the overall level of economic activity. In line with box 6.1, tackling supply-side constraints within a context of strong demand growth and investment dynamism is thus a key factor in successful development strategies. As for other infrastructure projects, the multiplier effects of energy investments in LDCs are expected to be particularly pronounced, at least during the initial phase, owing to the labour requirements for the construction of power plants (especially large hydroelectric dams), and transmission and distribution networks. Energy-related infrastructure could thus play a prominent role in a "big push" strategy for LDCs.

2. Leveraging technological options towards rural electrification and development

The structural transformation of rural economies is critical to development in LDCs, and its importance is further reinforced by the goal of poverty eradication and the principle of "leaving no one behind". In the average LDC, less than 11 per cent of people in rural areas have access to electricity, compared with 59 per cent in urban areas. Since populations in most LDCs are predominantly rural, this means that 82 per cent of those currently without access to electricity in LDCs live in rural areas (chapter 1).

Thus, in most LDCs, the potential impact of broadening electricity access is much greater in rural areas than in urban ones, where reliability of supply is likely to be of greater importance. The ongoing emergence of scalable renewable-energy technologies and mini-grids provides an unprecedented opportunity to realize this ambition, if the technical, economic and institutional constraints identified in chapters 3-5 can be overcome.

Fostering a coordinated process of agricultural upgrading and diversification into non-agricultural activities is key to rural structural transformation and to harnessing intersectoral linkages between farming and non-farming activities. Extending access to modern energy could thus relax an important supply-side constraint (mainly on non-farming activities), while the labour-intensive nature of the underlying infrastructure investments could sustain local demand. This is an early priority in a sequenced approach to rural economic transformation. However, complementary measures are also necessary, notably in agriculture, finance, and training and human-resource development (UNCTAD, 2015a).

It is important to acknowledge, though, that rural electrification will not necessarily lead to an immediate and rapid expansion of its use for productive purposes. As discussed in chapter 3, it is more likely to trigger a slow and disruptive process of creative destruction, whereby traditional activities are shaken up by the gradual introduction of electrical equipment into production processes. Leveraging electrification for LDC rural transformation is thus likely to require proactive support to facilitate this transition, supporting the adoption of previously unavailable technologies and production methods and fostering the establishment of new dynamic enterprises. This could be promoted, for instance, through in-kind microgrants of electrical equipment for use in economic activities for which there is local demand (UNCTAD, 2015a). Proactive support of rural firms and cooperatives embarking on the processing of agricultural crops could, for example, enhance local value addition, while simultaneously creating that "anchor load" which generates substantial electricity demand, increasing the viability of mini-grids.

Given realistic time frames for achieving universal energy access in LDCs, it is also in rural areas that the issue of energy options prior to electrification is most pertinent, with a view to avoiding undue delays in rural economic transformation for the most remote communities. While electricity is the most versatile form of energy, most of the energy services it provides can also be furnished — albeit in some cases imperfectly — by alternative energy sources: mechanical power by wind or flowing water, lighting by kerosene, product and space heating by biomass, and even product cooling by evaporation fridges. Such intermediate-technology options (and others, such as improved stoves) can play an essential role in initiating structural transformation prior to electrification, increasing agricultural productivity and facilitating the development of non-farm enterprises. These technologies offer major opportunities for local production, as they are not particularly sophisticated, and often need to be tailored to context-specific needs and preferences.

Many such interim energy solutions have the additional advantage of possessing greater potential for local production and uptake than relatively more sophisticated generation equipment, and they also provide the scope for below-the-radar innovation. Fostering the emergence of a viable supply chain for the production of such equipment, including by providing access to the technologies involved (many of which are not subject to intellectual property protection), training in their production and adaptation to local needs, and facilitating access to the necessary inputs and finance, can thus be an important component of a wider strategy for pre-electrification rural transformation.

Pre-electrification technologies can help to initiate rural structural transformation ahead of rural electrification

3. Complementary policies for structural transformation and productive energy use

Electricity access stimulates structural transformation in part through a process of creative destruction. Those enterprises better able to access electricity and to exploit its potential through complementary investment in electrical equipment may gain considerably, but partly at the expense of those less able to do so. Equally, greater penetration of fuel-efficient stoves and increased access to modern fuels may result in a reduction of employment and economic opportunities in the production and supply of woodfuel for the charcoal supply chain, which is often an important source of income, particularly in peri-urban areas.

Unattended, these effects will at least partly undermine structural transformation and poverty-eradication efforts, by increasing underemployment and reducing the incomes of those so displaced. Reaping the full benefits of the energy-transformation nexus thus requires complementary policies to foster economic diversification and promote alternative employment.

A first key policy priority in this respect is fostering the emergence of a domestic supply chain in modern energy and fuel-efficiency business. The precise strategies to attain such an objective are contingent on each country's power generation mix, and other structural features. In general, though, the overarching objective should be to enhance intersectoral linkages and create the conditions for scaling up modern energy provision without exacerbating import dependence (for instance by establishing adequate refining capacities in fuel-producing LDCs, or promoting the sustainable production of bioenergy from local agricultural inputs).

Similarly, the processing and distribution of modern fuels for cooking (e.g. gas canisters) can provide major opportunities in this area. LDCs may also be able to benefit, to varying degrees, from increased employment in electricity production and supply, notably renewable-energy technologies. While few of them are likely to be able to compete with established suppliers in the manufacture of sophisticated equipment, such as solar panels or wind turbines, there is potential for job creation in certain segments of the renewable-

Policies for transformational energy access include building modern-energy supply chains and fostering linkages with other sectors

energy sector value chain (e.g. installation, operation and maintenance of solar equipment and pico-solar devices) and in locally appropriate applications (IRENA, 2012).

The promotion of backward linkages calls for targeted efforts to tackle the main bottlenecks to the emergence of a viable domestic supply chain, strengthening policy coordination across all actors involved, and promoting the development of viable business models. Relevant energy-related activities thus represent important targets in such areas as industrial policy, enterprise development, access to finance, training and vocational education, and STI policy.

A second policy priority lies in promoting forward linkages between modern energy provision and downstream activities, capitalizing on electrification to enhance productivity in existing businesses and above all to spur the emergence of new higher value added activities. Vocational training and skills upgrading programmes — in financial literacy and general business skills, and in the use of electrical equipment — can play a major role in facilitating the process of labour reallocation associated with structural transformation. Broadening access to credit and financial services is also a crucial priority to enable technological upgrading and adoption of (mainly electrical) productive equipment, especially on the part of SMEs. Importantly, however, the ability of firms to reap the benefits of electrification is inevitably contingent on the provision of a broader range of social overhead capital and each sector's specific conditions and dynamics. This underscores the importance of close coordination between energy policies and other macroeconomic and sectoral policies for structural transformation.

While the objective of universal access to modern energy is often assumed to be gender-neutral, its welfare impacts are inevitably mediated by the socioeconomic context and cultural norms. As highlighted in chapter 1, though, the discussion on these issues is often simplistic and overgeneralized. If men are better able than women to harness the potential economic benefits of access to electricity, increasing access to electricity could even exacerbate gender inequality in some contexts. Sound and context-specific research is thus needed to shed more light on intra-household and broader socioeconomic factors that hamper women's access to (and productive use of) modern energy, thereby supporting evidence-based policymaking.

An important aspect of the benefits of access to modern energy is the prospect of reducing the time spent by women in collecting fuelwood and in other domestic tasks. However, translating this into an improvement in women's economic empowerment depends critically on the creation of income-earning opportunities for them. Proactive interventions to address the constraints they face in accessing income, inputs, technology, credit and markets can both contribute to their empowerment and simultaneously enhance the overall viability of the energy system, by raising the prospects for energy demand and productive use.

Access to modern energy can greatly reduce the time required for some economic activities in which women traditionally play a substantial role in many cultures, potentially allowing them to benefit considerably. Food processing is particularly important in this regard, not only because of its potential scale, but also because of its key role in rural structural transformation, as a critical part of the non-farm economy and a facilitator of agricultural development (UNCTAD, 2015a). Some energy-related activities may also be highly conducive to women's entrepreneurship and employment, especially in the conception and design of end-use equipment, such as cook stoves and other electrical appliances (Puzzola et al., 2013). This may also provide an entry point into a much wider range of other (often male-dominated) small- and medium-scale manufacturing activities.

4. Science, technology and innovation policies for transformational energy access

The successful scaling-up of modern energy provision in LDCs hinges on a successful process of technology transfer, whereby these countries strengthen their national capacities to acquire modern energy technologies, adapt them to local contexts, and integrate them effectively into national energy systems. Technological capability acquisition is all the more critical in the context of the ongoing penetration of renewable-energy technologies, which have witnessed rapid technological advances and whose performance is often determined by site-specific conditions.

This process will require a wide range of skills with varying degrees of specialization, ranging from the installation and maintenance of modern energy equipment to more complex sets of skills for system regulation, or standard-setting and testing. Boosting investments in education and training programmes

— particularly in science, technology, engineering and mathematics — is hence of primary importance both to support modern energy access and to fully exploit the development potential of the energy value chain itself.

As the experience of India's Barefoot College in several LDCs demonstrates (chapter 3), formal education is not necessarily a precondition for all skilled occupations, even in high-technology sectors. Vocational training and apprenticeship schemes can also serve an important role, as may other, less conventional, approaches promoting circular rural-urban-rural migration to enhance urban-rural skills transfer (UNCTAD, 2015a).

More broadly, the fundamental importance of technological upgrading to the energy-transformation nexus calls for proactive STI policies aimed at strengthening the local innovation systems, by improving both domestic absorptive capacities and innovation capabilities to engage in R&D activities. The latter can be expected to play a prominent role not only in the pursuit of radical innovation, but also to engineer incremental technical improvements in existing devices, facilitating their adaptation and use in productive sectors. This also warrants proactive efforts to support the emergence of sustainable business models in the energy sector, to enable the deployment of modern energy technologies in ways consistent with the goal of leaving no one behind.

An STI policy framework paying adequate attention to modern energy technologies, especially renewable-based ones, can thus help LDCs to harness their transformative potential (UNCTAD, 2011a).

Such a framework should perform the following functions:

- Define STI policy strategies, goals and targets;
- Enact policy incentives for strengthening technology-absorptive capacity and related R&D activities;
- Promote domestic resource mobilization for modern energy technology adaptation/adoption, including through closer collaboration among research institutions, utilities and relevant private actors;
- Explore alternative ways to improve innovation capacity in modern energy technology, including through South-South collaboration and shared regional research and testing facilities.

A promising area that might be covered by STI policy frameworks is the establishment of research institutions oriented towards the development, adaptation and dissemination of pre-electrification intermediate technologies for mechanical energy. Close consultation with prospective users of such technologies would be a crucial aspect, as their adoption and use is critically dependent on their ability to meet locally and culturally specific needs and preferences. The scope for greater involvement by women in the conception and design of efficient stoves and other end-use appliances deserves specific attention here.

The participation of foreign direct investors in the energy sector must not crowd out domestic actors

E. International dimensions

1. Enhancing the impact of foreign direct investment

Private-sector participation has played a pivotal role in the rapid increase in generation capacity recorded by LDCs since 2006. However, LDCs continue to be less attractive to private-sector investment than ODCs because of their particular logistical challenges with electrification. Depending on the various national contexts in LDCs, private-sector participation in their electricity sectors has expanded from the commercial management of national utilities and the operation of concessions by transnational corporations to the ownership of distributed electricity systems in rural settings (such as mini-grids) and the provision of various stand-alone electricity products and solutions. LDCs stand to benefit from the advent of distributed generation technologies, whose modular application is particularly relevant to accelerating universal access in diverse contexts. However, the potential of distributed modes of electricity using renewable energy is constrained by high upfront capital costs. Beyond basic needs services and stand-alone systems and products, renewable energy tends to rely on public funding to sustain profitability.

The crowding-out of domestic companies continues to be a significant concern in LDCs. There is typically a dearth of companies with advanced technologies in legacy or renewable generation in developing countries. Foreign transnational corporations, including utility companies, have traditionally been the most active in developing-country electricity sectors (UNCTAD, 2008, 2010); and the combination of low demand in their home markets with rising demand in LDCs suggests this trend will persist. The situation is no different for distributed generation, including in the rural setting. Moreover, foreign utilities have the added advantage of an established track record in the electricity business when it comes to raising capital in international financial markets. Utility companies based in ODCs are also beginning to play a role in LDC electricity sectors. Chinese investors, for example, are active in greenfield

Sovereign borrowing to finance energy infrastructure investments may be constrained by debt sustainability

investments, and Chinese firms have become the most significant players in electricity-sector construction contracts, the value of which dwarfs that of their investments in the sector.

LDC Governments are looking to tap new growth options from green growth, and to leverage low-carbon FDI to grow local private-sector providers. In order to do so, however, they require the necessary policy space. In the renewables sector many countries use local content rules as a policy measure for green industrial development. While some countries have successfully linked local content rules to their renewables auctions, as noted in chapter 5, LDCs have a limited capacity to put in place fiscal and regulatory measures. They can, however, ensure that fiscal and regulatory support measures in the electricity sector afford the same support to domestic as to foreign providers in the local market. LDC Governments and firms should also seek to make use of existing preferential measures (for example, flexibilities under the World Trade Organization (WTO) Agreement on Trade-related Investment Measures (TRIMs) or the WTO Agreement on Subsidies and Countervailing Measures) to support their legitimate industrial policy goals. However, effective use of such measures also depends on institutional capacities, financial resources and productive capacities (UNCTAD, 2016a). Similarly, the various energy infrastructure initiatives and funds that have been initiated by a variety of global actors can ensure that funding equally targets the development of local industries.

2. Leveraging debt without compromising sustainability

As discussed in chapter 5, investors perceive the attendant risks of investing in LDC electricity sectors as very high. This has the detrimental effect of raising the costs of capital because perceived high risks are reflected in high interest-rate premiums and the need for government-backed credit guarantees for borrowing in international markets. As a consequence, costs remain unsustainably high for both centralized and distributed systems. Even renewable technologies, whose costs have fallen dramatically and continue to fall, can in many instances remain a high-cost proposition for LDCs. The risk associated with these technologies is generally higher because they are relatively new, and renewables projects have not yet established a track record in LDC contexts. There is correspondingly insufficient availability of risk management resources, including risk expertise, industry data and insurance cover.

High credit costs translate into high end-user tariffs and, crucially, low competitiveness in international trade for LDCs. To lower capital costs they should intensify their efforts to reduce risk factors that fall within their scope of direct action, including sovereign, political and regulatory risk factors.

The perceived high risk associated with LDCs is compounded by current and emerging developments in global financial markets. These developments include stringent liquidity requirements in the financial sector associated with Basel III implementation, which mandate banks to hold a buffer of liquid assets and skew incentives away from higher-risk investments (Bertholon-Lampiris, 2015; BIS, 2016; UNCTAD, 2015c). Infrastructure is considered to be an illiquid asset. Basel III is thus likely to significantly constrain the availability of commercial long-term finance, and loans in particular. Private-sector participation in infrastructure projects in developing countries is often linked to commercial capital in the form of syndicated loans, which constitute the main alternative to bilateral and multilateral loans for such projects. Under Basel III, these loans are likely to be more costly to administer and manage (LMA, 2015). In a climate where institutional investors continue to favour liquid over illiquid assets, a shortage of long-term finance is potentially on the horizon. At the very least, long-term finance could become a lot more costly than it is already. In this context, private interest in LDCs' infrastructure development, which is already lower than in other developing countries (UNCTAD, 2008), may dwindle.

The high cost of private finance raises the economic value of public finance. There is a strong case for the development finance community, including donors and multilateral finance institutions, to prioritize traditional public development finance channels for electricity, and the infrastructure sector generally. The current trend in development finance is to prioritize the use of public resources to leverage private-sector financing. In view of the projected shortages in long-term finance in the financial sector globally, this may not be a least-cost strategy for developmental finance.

The high cost of private finance likely also skews private-sector participation towards the household sector, with a particular focus on services that meet basic needs, whereas structural transformation goals favour a differentiated service that takes into account the growth of different types of businesses with varying load requirements. The latter level of service typically requires higher levels of investment and is more onerous in terms of project development – as well as carrying higher risk. It will be important for LDCs and their development partners, including impact and other infrastructure fund asset investors, not to neglect assistance to this transformational aspect of universal access.

Sovereign borrowing may assume a prominent role as a consequence of current developments in global financial markets and policies to prioritize private finance in development funding that lead to further declines in ODA (section G3). LDCs, especially in Africa, are increasingly turning to international bond markets to raise development finance, particularly to address infrastructure deficits. International investor interest is high. Crucially, this represents a significant change in creditor compositions. This change may have implications should debt restructuring be required. Bond restructuring tends to be more complex because of the number of different creditors involved.

LDC sovereign borrowing abroad to finance infrastructure investments can make economic sense (chapter 5). More so than in other developing countries, LDC domestic banks tend to be risk-averse; banking-sector imperfections can raise costs; and credit markets are largely underdeveloped. However, external borrowing is not without its risks, including sudden and drastic currency-related cost escalations that dramatically worsen debt sustainability. The present combination of persistent low-growth, low-interest rates, and low commodity prices in the global economy raises parallels with the conditions that precipitated the 1980s debt crisis. Eleven of the 36 LDCs for which assessments have been undertaken are at high risk of debt distress (Afghanistan, Burundi, Central African Republic, Chad, Djibouti, Haiti, Kiribati, Lao People's Democratic Republic, Mauritania, Sao Tome and Principe, and Tuvalu), while three (the Gambia, South Sudan and the Sudan) are already in debt distress (IMF, 2017b).

LDC Governments should therefore continue to exercise caution in external borrowing to finance investments in electricity, particularly as the projected impacts of Basel III, if realized, will increase the severity of reputational spillovers from debt defaults. Moreover, an increased tendency to borrow on international markets increases LDCs' exposure to global financial shocks while also heightening risks that offshore markets will draw liquidity away from domestic markets (Black and Munro, 2010).

There is a strong case for scaling up ODA to finance energy investments in LDCs, and for adequate technology transfer

3. Official development assistance and climate finance

The cost of the infrastructure investment needed to ensure universal access to electricity in ways consistent with structural transformation is far beyond the means of LDCs' domestic public finances. Estimates presented in this report suggest the total investment cost for basic universal access by 2030 to be in the order of $12-$40 billion per year across LDCs as a whole; and increasing supply to fulfil the needs of transformational access would raise these costs considerably. While there is some potential for greater mobilization of domestic and external sources of financing towards energy-sector investments, this is very limited relative to the resulting gap. In practice, therefore, achieving universal access — and still more transformational access — will be critically dependent on ODA and other official external financing, mainly in the form of grants, given most LDCs' debt sustainability constraints. Securing this financing will require a very considerable increase in such financing for the power sector (chapter 5).

Official grant financing is particularly appropriate to investment in renewable electricity generation. While there are some local environmental benefits from such technologies in terms of reduced ambient air pollution, the primary reason for preferring renewable technologies to fossil-fuel generation is the reduction in GHG emissions. Grant financing from developed countries, whose historical emissions give rise to the need to reduce emissions in the future, provides a means of internalizing these externalities in accordance with the "polluter pays" principle (Principle 16 of the Rio Declaration on Environment and Development) and the principle of common but differentiated responsibilities established in the United Nations Framework Convention on Climate Change (UNFCCC).[2] The cost structure of renewable generation also lends itself particularly well to grant financing, as the recurrent costs are limited to equipment operation and maintenance.

This makes a strong case for the use of official financing on grant terms for the development of renewable energy sources in LDCs. By allowing these countries to avoid the capital costs of increasing capacity, grant financing of the purchase and installation of equipment for renewable generation can also allow a lower level of cost-reflective tariffs than in the case of fossil-fuel generation, given the more limited recurrent costs of the former. This can provide an important means of reconciling the tension between affordability and financial sustainability.

While the capital costs of universal access are considerable, fulfilment of donors' existing financial commitments with respect to ODA (to provide 0.15-0.20 per cent of their gross national income (GNI) in ODA to LDCs) would go a long way towards meeting that goal. As discussed in chapter 5, this would provide an additional $34-$54 billion of ODA per year. Substantial further resources could be generated if developed countries honoured their commitments with respect to climate finance.

Moreover, a strong case can be made for increasing the ODA target for LDCs, particularly in the context of the 0.7-per-cent overall target. If donors provided 0.7 per cent of their GNI in total and allocated 0.15-0.20 per cent of this to LDCs, given their relative populations, per-capita ODA to LDCs would be 1.8-2.6 times that allocated to ODCs. This falls far short of reflecting the major differences in their development needs and domestic capacity to meet those needs.

This discrepancy is further underlined by the 2030 Agenda for Sustainable Development. The overall and LDC targets for ODA imply that 21-29 per cent of total ODA should be allocated to LDCs. However, their share in global shortfalls from the standards set by the SDGs, together with their more limited financial capacity, suggests that a proportion in the order of 50 per cent would be more appropriate (UNCTAD, 2015a). As noted in chapter 1, 54 per cent of people without access to electricity globally lived in LDCs in 2014, a proportion that has almost doubled since 1991. LDCs also accounted for 45 per cent of those without access to an improved source of water in 2014, and for 40-50 per cent of those in extreme poverty globally in 2013. The former figure has more than doubled, and the latter almost tripled, since 1990.[3]

In conjunction with the 0.7-per-cent commitment for total ODA, a target that at least half of total ODA should be allocated to LDCs would imply approximately doubling the target ODA for LDCs to 0.35 per cent of donor GNI. As noted in chapter 5, this would provide additional resources of $118 billion per year.

Of particular relevance to renewable energy are the developed countries' additional commitments on climate financing, as well as those on aid effectiveness under the 2005 Paris Declaration on Aid Effectiveness, the 2008 Accra Agenda for Action and the 2011 Busan Partnership for Effective Development Co-operation (OECD, 2005, 2008, 2011). Particularly important are donors' commitments to "Respect partner country leadership and help strengthen their capacity to exercise it" and to "Base their overall support — country strategies, policy dialogues and development co-operation programmes — on partners' national development strategies" (OECD, 2005: paras. 15, 16).

Donors have also committed themselves to "ensure that existing channels for aid delivery are used and, if necessary, strengthened before creating separate new channels that risk further fragmentation and complicate co-ordination at country level" (OECD, 2008: para.19(c)). However, the opposite has been the case in the context of climate finance, giving rise to an extraordinarily complex financial architecture that represents a significant obstacle to LDCs' access to finance, as well as unnecessary costs, loss of economies of scale and administrative burdens. This proliferation of funding channels should be reversed by consolidating the multiplicity of institutions and financing windows. Until this is done, there is a case for establishing a finance facilitation mechanism to match the particular funding requirements of each LDC's own development programme with the available sources, and to limit the administrative and technical burdens associated with the identification of sources, application processes and multiple inconsistent monitoring and reporting processes (UNCTAD, 2016b).

4. Access to technologies

The UNFCCC and its Kyoto Protocol create clear obligations for developed countries to transfer to developing countries such technologies as may be needed to reduce GHG emissions in all relevant sectors (explicitly including energy) where these are publicly owned or in the public domain; to create an enabling environment for the transfer of such technologies where they are not in the public domain; and to provide financing to meet the full incremental cost of their transfer. Developing countries' emissions reduction commitments under the Convention are explicitly conditional on developed countries' fulfilment of these obligations.

Outcomes of recent global conferences have contained much weaker language. The Addis Ababa Action Agenda (adopted in 2015 at the Third International Conference on Financing for Development), for example, contains much weaker commitments, and falls far short of recognizing the obligations to promote, cooperate in, facilitate and finance technology transfer, stating only (in paragraph 120):

> We will encourage the development, dissemination and diffusion and transfer of environmentally sound

> technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed.

However, this does not in any way modify or dilute the legal obligations of signatories under the Convention, which should therefore be implemented in full.

A more specific obligation on developed countries arises under Article 66.2 of the WTO Agreement on Trade-related Intellectual Property Rights (TRIPs), which states that:

> Developed country Members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least-developed country Members in order to enable them to create a sound and viable technological base.

Nevertheless, fulfilment of this obligation has been very limited, as has the extent of the resulting technology transfer to LDCs (Moon, 2008, 2011). A more rigorous implementation of this provision of the TRIPS Agreement in respect of energy-related technologies (including end-use technologies) could provide a means of operationalizing the technology-transfer provisions of the UNFCCC. This could usefully be supported by a more systematic approach to monitoring WTO Members' compliance with their obligations under this Article 66.2 (UNCTAD, 2016b).

International support measures for technology transfer and absorption could include an international innovation network for LDCs, to facilitate knowledge accumulation and innovation on energy technologies; global and regional research funds for the deployment and demonstration of such technologies, focused on adaptation and incremental innovations oriented towards local contexts; an international fund to facilitate private-private and private-public technology transfer; and an international energy-technology training platform to promote capacity-building and skill accumulation. South-South and triangular cooperation mechanisms can also help to facilitate the sharing of technological learning and knowledge. South-South technology cooperation might include training LDC nationals abroad in the use and maintenance of energy technologies and supporting research to adapt existing technologies to local needs, as well as grants of energy-related intellectual property rights (IPRs) or licensing on concessional terms (UNCTAD, 2011a).

In this context, the Technology Bank for LDCs, foreseen in the Istanbul Programme of Action for the LDCs and formally established on 23 December 2016 (through General Assembly Resolution A/RES/71/251), could potentially play an important role in supporting LDC access to energy-related technologies. Acting in close cooperation with relevant United Nations institutions — such as the United Nations Conference on Trade and Development (UNCTAD), UNFCCC or the United Nations Environment Programme (UNEP), as well as with other entities with sector-specific knowledge, such as ESMAP, IRENA and the International Energy Agency (IEA) – the Technology Bank could be perfectly placed to assist LDCs in the identification of the key bottlenecks to effective technology transfer in the energy area, and in tackling these barriers. UNCTAD's involvement could be particularly beneficial, with a view to fostering not only the attainment of SDG 7 as an end in itself, but more fundamentally the sustainable provision of modern energy for productive uses, thereby enhancing the synergies between energy policies and structural transformation. The involvement of the Technology Bank in energy-related Technology Need Assessments and similar support initiatives would fall squarely within its mandate and its three-year Strategic Plan, and could turn the Bank into a key hub to facilitate and coordinate international support in this area.

Notes

1 System value is defined as "the net benefit arising from the addition of a given power generation technology" (IEA, 2016c).

2 Principle 16 of the Rio Declaration states that "National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment". Paragraph 1 of Article 3 of the UNFCCC, which establishes the principles on which the Convention is based, states: "The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof." The 16th Conference of the Parties to the UNFCCC explicitly acknowledges in paragraph 35 of its decision 1/CP.16 "that the largest share of historical global emissions of greenhouse gases originated in developed countries and that, owing to this historical responsibility, developed country Parties must take the lead in combating climate change and the adverse effects thereof".

3 Data on access to water are from the World Bank's World Development Indicators database. Poverty figures are UNCTAD secretariat estimates using data from the World Bank's PovcalNet database. No poverty data are available for Afghanistan, Equatorial Guinea, Eritrea, Myanmar, Somalia or Yemen. The estimate of 20-50 per cent allows for average headcount ratios across these countries of between 17 per cent and 77 per cent in 2013 (compared with an average of 36.3 per cent in those LDCs for which data are available). The equivalent range for 1990 is 15-18 per cent, allowing for a range of 24-97 per cent across countries for which data are unavailable (compared with 59.3 per cent for countries with available data).