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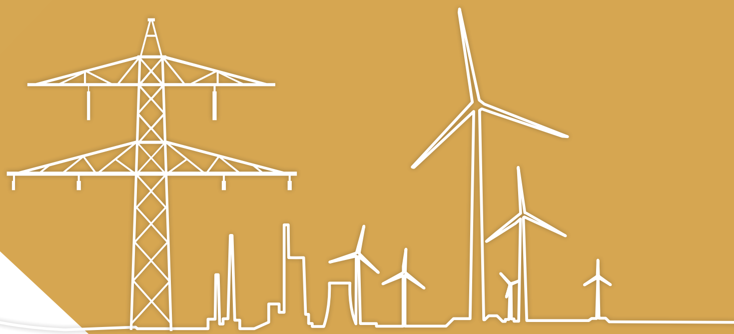
THE LEAST DEVELOPED COUNTRIES REPORT 2017

OVERVIEW



Transformational energy access

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FOREWORD

Unlike the Millennium Development Goals, the 2030 Agenda for Sustainable Development includes an explicit goal for energy — Sustainable Development Goal (SDG) 7, to “ensure access to affordable, reliable, sustainable and modern energy for all”. Access to modern energy plays a major role in economic structural transformation — a critical issue both for the least developed countries (LDCs) and for the 2030 Agenda more generally.

This year’s edition of UNCTAD’s *Least Developed Countries Report* focuses on transformational energy access for the LDCs, where 62 per cent of people have no access to electricity, compared with 10 per cent across other developing countries. Today, the majority of people worldwide who lack access to electricity live in LDCs — a proportion that has grown steadily from less than one third in 1990.

Importantly, this year’s Report finds that “energy for all” in LDCs requires more than access to energy for basic household needs. It requires that access to energy in LDCs also serves productive capacities directly, by powering the structural transformation of LDC economies and the development of more productive, modern activities and sectors with adequate and reliable energy supplies. Structural transformation, in turn, has a role in increasing energy access, by generating sufficient additional demand for electricity for productive uses to make viable the infrastructure investments required for universal access more broadly. Yet strengthening this energy-transformation nexus remains a massive challenge, given that installed generating capacity per person in LDCs is barely one twelfth of that even in other developing countries, and one fiftieth of that in developed countries.

The LDCs are the battleground on which the 2030 Agenda will be won or lost. The central role of access to modern energy in achieving the other SDGs means that meeting SDG 7 will be central to the success or failure of the 2030 Agenda as a whole. It is our intention that this Report will serve as a valuable input to the deliberations of the 2018 High-level Political Forum, which will review progress on Goal 7. Greater international support and more concerted collective action towards realizing transformational energy access in the least developed countries could be key catalysts for implementing the entire 2030 Agenda.

Mukhisa Kituyi
Secretary-General of UNCTAD

OVERVIEW

Energy, the lifeblood of development

Access to modern energy, especially electricity, has gained ever greater attention globally in recent years, which partly reflects its critical importance to all three pillars of sustainable development — economic, social and environmental. This growing global concern is embodied in Sustainable Development Goal (SDG) 7: to ensure access to affordable, reliable, sustainable and modern energy for all.

Previous editions of *The Least Developed Countries Report* have argued that the least developed countries (LDCs) are the battleground on which the SDGs will be won or lost, and SDG 7 is no exception. The LDCs have made extraordinary progress in increasing access to electricity, which has more than tripled from 12 per cent to 38 per cent since 1990. But this leaves 62 per cent of their people without access. Together with still more limited access to modern fuels for cooking and heating, this gives rise to two distinctive features of energy use in LDCs. First, it is dominated by residential use, which accounts for two thirds of the total; and second, it is heavily reliant on traditional biomass, such as fuelwood and charcoal, which accounts for 59 per cent of the total.

As access to electricity has increased to much higher levels in other (non-LDC) developing countries (ODCs), this has also resulted in an increasing concentration of energy poverty in LDCs in terms of lack of access to modern energy. By 2014, the majority (54 per cent) of people without access to electricity worldwide were living in LDCs — more than four times their share in the world population (13 per cent) and approaching double the proportion in 1990 (30 per cent).

Achieving universal access to modern energy globally is therefore critically dependent on achieving it in LDCs. But for most of them, doing so by 2030 — the target year for achieving the SDGs — will be an enormous challenge. Despite an impressive rate of progress in recent years, only four of the 47 LDCs could achieve universal access to electricity by 2030 without an acceleration of the rate of increase in access, while only seven more could do so even if they doubled their current rate of progress. In nearly a quarter of the LDCs, by contrast, achieving universal access by 2030 would require the number of persons gaining access annually to be 10 times higher in the coming years than over the past decade.

Energy access is particularly important to rural development, which, as the *Least Developed Countries Report 2015* highlighted, is central to poverty eradication. In the initial stages electrification typically occurs mainly in urban areas, while rural areas catch up only later. Consequently, access is much greater in towns and cities than in rural areas, and 82 per cent of people without access to electricity in LDCs live in rural areas.

This highlights what has historically been a key obstacle to electricity access in most LDCs: they have a characteristic combination of limited urbanization and sparsely populated rural areas, which makes conventional centralized generation systems economically unviable for most of the population, especially in a context of low incomes and limited resources for investment.

But this is now changing. Rapid technological progress in renewable energy technologies, and associated cost reductions, are opening up an unprecedented opportunity for electrification of rural areas through decentralized generation and mini-grids. The potential this creates for “win-win” scenarios across the social and environmental pillars of sustainable development is another reason for recent attention to the energy issue.

However, recent studies and initiatives have too often neglected the third potential “win” — the economic benefits of access to modern energy. At the heart of the 2030 Agenda for Sustainable Development is the inseparability and interdependence of the three pillars of sustainable development; and achieving its overarching goal of poverty eradication requires a coherent and holistic approach encompassing all three. This is the foundation of the PErSIST (Poverty Eradication through Sustainable and Inclusive Structural Transformation) framework presented in this Report.

The economic “win” of access to modern energy lies in its potential contribution to structural transformation of the economy, increasing productivity and providing new opportunities for the development of higher-value-added activities. This is essential to realizing in full its potential contribution to achieving the wider ambitions of the 2030 Agenda.

Central to this is ensuring that electricity is available, not only to meet such basic domestic needs as lighting, but also for use in productive processes. Equally, productive use of electricity is essential to making investment in electricity generation and distribution economically viable. The high capital costs require a certain level of demand to make investments viable; and productive use can both increase demand directly and strengthen residential demand by raising incomes.

This two-way relationship — from access to electricity, through productive use, to structural transformation, and from structural transformation, through increased demand, to increased investment in electricity supply and distribution — is central both to economic development and to the goal of universal access.

This has important implications for the approach to universal access. Focusing only on allowing households sufficient access to meet their basic needs will not be enough. Realizing the full benefits means taking account also of access by public facilities, such as schools and clinics, and by businesses; and ensuring that their needs are met, in terms of the level, continuity and reliability of supply. Energy access alone will not be enough; what is needed is *transformational* energy access, meeting the needs of producers for reliable and affordable supplies of the kinds of energy they need on an adequate scale.

This will require narrowing the "generation gap" with other developing countries. Despite strong growth since 2000 (following a decade of stagnation in the 1990s), LDCs' electricity generation capacity per person has failed to match either the increase in access to electricity or capacity growth in ODCs. Consequently, capacity has fallen by half, relative both to the number of people with access and to other developing countries. By 2014, LDCs' generation capacity per person was just one twelfth of the average for ODCs, at 50 watts compared with 600 watts.

Globally, a major concern in relation to increasing energy use is the potential effect on climate change. However, the starting point for greenhouse gas (GHG) emissions from electricity generation in LDCs is very low; and most LDCs have set themselves very ambitious targets for further reductions in the context of the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) (2015). As well as being limited by the use of renewable energy technologies, additional emissions from increasing electricity use will be substantially offset by the effects of reduced burning of traditional biomass, which will also help to slow forest degradation and deforestation. This highlights the importance, from an environmental perspective, of pursuing universal access to electricity as part of a broader agenda of access to modern energy, also encompassing modern fuels for cooking and heating.

Universal access to modern energy can contribute as well to the 2030 Agenda's core principle of inclusivity — "leaving no one behind". Besides allowing all those currently excluded from access to electricity and modern fuels to secure their benefits, it can make a major contribution to narrowing the gap between cities and the rural areas where most people in LDCs live.

Energy and structural transformation

Patterns of energy use are closely linked to incomes at the household level, and to stages of development at the country level. As incomes rise and countries develop, they climb an "energy ladder", from the use of traditional biomass, through fossil fuels to more advanced energy sources, such as electricity — although in each case, multiple fuels coexist at any point in time. LDCs remain close to the bottom rung of this ladder. As previously mentioned, two thirds of their energy use is by households; and households rely primarily on traditional biomass, which therefore remains the main energy source in most LDCs. In all but a few cases, the great majority of the remainder is oil products, largely for transportation.

Five LDCs (Angola, Chad, South Sudan, the Sudan and Timor-Leste) rely heavily on exports of fossil fuels — and here, the energy sector is a major source of value added, foreign exchange earnings and public revenues, although its role in employment is more limited due to the capital intensity of extractive industries. In other LDCs, the sector is limited largely to the supply of electricity and fuels for domestic use and transportation, which represents only a small share of value added and employment, while imports of refined petroleum products are a major foreign exchange expense. But a few LDCs without fossil-fuel reserves have some exports either of electricity or of refined petroleum to regional markets.

However, despite this limited direct contribution to value added, employment and exports in most LDCs, the energy sector is of central importance to development, and particularly to structural transformation through its effects on other productive sectors. More reliable, affordable and efficient energy supplies can allow for the adoption of new production techniques and technologies, raise productivity and facilitate the introduction of new economic activities.

Electricity in particular is the quintessential general-purpose technology, opening up new opportunities across all sectors, so that innovations in electricity provision are propagated throughout the economy. It is also essential to other general-purpose technologies, such as information and communications technologies (ICTs), and plays a key role in technological development and innovation.

Conversely, failings in the electricity system can act as a brake on structural transformation — and nearly half of all firms in LDCs identify electricity as a major constraint on their full operation. Weak electricity systems in most of these countries result in unreliable supplies and frequent power outages, giving rise to income losses for producers and additional costs for imported back-up generators. Moreover, electricity costs are very high in African and especially in island LDCs, further increasing production costs.

Accessible, affordable and reliable electricity supplies can make a major contribution to all economic sectors. In agriculture, they can facilitate irrigation, reducing reliance on rain-fed production, as well as increasing value added through improved processing, while refrigeration can reduce crop losses. The limited availability of reliable and affordable electricity has conditioned the industrial structure of LDCs. Their limited manufacturing is dominated by light industry, which has relatively low energy intensity. A possibility for the expansion and diversification of manufacturing often recommended for LDCs is natural-resource processing — smelting and refining of metals, production of metal products, processing of fossil fuels, etc. However, these industries are energy-intensive and therefore require an adequate electricity supply. Therefore, improving the quantity and quality of electricity supply can foster industrial development in LDCs. Modern service activities, especially those linked to ICTs, are also critically dependent on adequate and reliable electricity supplies, and are important for supporting the development of other sectors.

The role of energy in promoting structural transformation has a notable gender dimension. The availability of modern energy, at both the household and the community level, can significantly reduce the time spent on domestic activities, including fuelwood collection — and such time savings are likely to benefit women disproportionately. However, such savings are not automatically translated into increased productive activity, or therefore into women's economic empowerment. This depends in large measure on the creation of new productive opportunities that are accessible to women, and on targeted policies to address the constraints women face in economic activities. Structural transformation provides the means of creating income-generating opportunities in sectors such as textiles and horticulture, which can often provide substantial benefits to women in particular.

Thus, access to electricity is essential to structural transformation. Equally, however, structural transformation is essential to electricity access, as the productive use of electricity that it engenders generates the demand needed to make investments in electricity access viable. This two-way relationship — the energy-transformation nexus — is central to the development process; and productive use of electricity is central to that relationship. It provides both the means by which access is able to transform the economy, and the additional demand that strengthens the viability of investments in the electricity sector.

However, harnessing this relationship effectively requires moving beyond a goal of universal access based on minimal household needs to a goal of transformational energy access. This in turn calls for an economically viable energy system able to access clean energy on the scale required for productive activities, with the reliability they require, at an affordable cost.

Technological opportunities – and challenges

As well as providing access to nearly four times as many people by 2030 in order to achieve universal access, realizing the potential of modern energy to stimulate structural transformation in LDCs will require a massive increase in electricity generation.

While 82 per cent of those without access to electricity in LDCs live in rural areas, as previously mentioned, rapid urbanization represents an important challenge to universal access even in urban areas, and has led to an increase in the absolute number of urban dwellers without access. For them, and for those without access in surrounding rural areas, grid extension remains the primary means of increasing access.

In more remote rural areas, the logistical challenges of electrification are much greater. However, recent technological advances have stimulated increasing interest in off-grid systems as a faster and more cost-effective alternative to grid extension beyond a certain "break-even" distance from existing grids. These include stand-alone home systems and pico-solar devices (which use small compact and light-weight solar photovoltaic panels to generate just a few watts of power in a wide range of small and portable applications) as well as mini-grids. However, while mini-grids provide greater transformational potential, stand-alone systems offer more limited potential for productive use and are more viable in dispersed communities unsuited to mini-grids.

Overall, achieving universal access in LDCs by 2030 would require grid extension to reach an estimated 571 million more people, mini-grids to serve 341 million, and stand-alone systems for 114 million.

Mini-grids are thus likely to play a key role in rural electrification in LDCs — for which there are favourable historical precedents in India and China. However, despite the potential offered by recent technological advances, parallels with the

"ICT revolution", and the associated opportunity for technological leapfrogging, appear premature. The market for off-grid systems in LDCs remains relatively limited, often skewed towards small-scale low-end products, and its dynamism is partly dependent on external support. Mini-grids also face significant financial, technical, economic and institutional obstacles, including large upfront costs; tariffs that are often higher than those charged to on-grid consumers; the need for tailoring to site-specific conditions; and institutional arrangements to minimize regulatory uncertainty, manage potential conflicts and ensure adequate maintenance.

There is also some ambiguity as to the extent to which off-grid solutions are a stepping stone towards, or an alternative to, grid extension, giving rise to potential tensions between the two, if off-grid systems reduce the demand for on-grid electricity below the level needed to make the necessary investment viable. This highlights the need for a carefully planned and forward-looking approach to widening electricity access. With appropriate planning (including consistent technical standards and protocols for grid interconnection), mini-grids can be integrated into larger networks, as has been done in China and India.

LDCs' transmission and distribution (T&D) networks also need to be strengthened, to reduce the high incidence of T&D losses in these countries and to enhance energy efficiency. Weak T&D infrastructure also means that firms in LDCs suffer twice as many outages as those in ODCs, causing double the financial losses and forcing the majority to rely on their own back-up generators, at additional cost. In some African LDCs, the economic impact of these inefficiencies is estimated at up to 6 per cent of GDP. Over time, progress towards universal access, structural transformation and increasing reliance on variable renewable technologies will further increase the need for improvements in T&D infrastructure.

The increase in generation capacity required for wider access to electricity to contribute effectively to structural transformation is considerable. Across LDCs as a whole, raising electricity production to the minimum level needed for productive use would mean an increase by a factor of between 3.4 and 6.8, while reaching the minimum threshold for modern societal needs would require production to increase by a factor of 13.5.

Currently, LDCs have a distinctive dualistic pattern in their power mix for electricity generation. About half rely almost entirely on fossil fuels for electricity generation, a quarter rely mostly on hydroelectric power supplemented by fossil-fuel generation, and a quarter have a more even balance between the two. Unlike most other country groups, fossil-fuel generation in most LDCs mainly uses oil products, although gas products are the primary fuel in a few large LDCs, making this the predominant source across the group as a whole.

Given the scale of the increase in generation required by 2030, and the minimal contribution of generation in LDCs to global GHG emissions, fossil fuels are likely to remain an important part of the generation mix in most of these countries. However, a progressive move towards renewable technologies, for both grid and mini-grid systems, could make a substantial contribution to transformational energy access as well as offering environmental benefits. As yet, the uptake of renewable technologies (other than large-scale hydro) remains incipient in most LDCs, especially for utility-scale generation; but 24 LDCs have pledged, as members of the Climate Vulnerable Forum, to achieve 100 per cent renewable generation by 2050.

Structural transformation depends on appropriate technology choices for electricity generation and distribution, in order to provide suitable, reliable and affordable energy services to enhance labour productivity and foster the emergence of higher value added activities and the diffusion of ICTs.

At the project level, the choice among alternative energy systems is determined primarily by their relative cost-effectiveness, which depends on local energy-resource potential and the technical performance of alternative technologies. The standard measure of the relative cost-effectiveness of such technologies — the levelized cost of electricity — provides a useful metric from a private investor point of view. But this alone is insufficient for policy decisions on the roles of different technologies in a country's power generation mix. In particular, this measure typically reflects only private costs, and not wider social costs and benefits. It is also very sensitive to assumptions about technological performance, prices for fuels and other inputs, the cost of capital and the internalization of environmental externalities, which may differ significantly between LDCs and other contexts.

Important as appropriate technology choices at the project level are, the systemic dimension of technology choices is also critical — and this is largely beyond the scope of cost-effectiveness comparisons. It requires attention to the interactions and complementarities among technologies and to their appropriate roles within the electricity supply system, given their different time profiles of generation, location, cost structures and resilience to shocks. From this perspective, the choice is not of a single optimal technology, but of a set of technologies which, together, will provide the basis for meeting national energy needs.

System-wide considerations suggest four priorities for LDCs:

- Becoming "early followers" of new energy technologies;
- Diversifying the power generation mix, while taking account of each country's resources and comparative advantages;
- Strengthening grid flexibility and upgrading monitoring and control capabilities, to ensure grid interoperability and manage the increasing complexity of power flows;
- Adopting system-wide approaches to electricity markets, including energy-efficiency practices and demand-side management.

Harnessing the opportunities offered by recent technological advances in energy for development will thus require a stepped-up policy effort and long-term policy commitment, while maintaining the flexibility to respond to further changes in the technological landscape. Since increasing access will not automatically bring increases in productive use, this requires additional policy attention.

Technology transfer is also essential to this process. While LDCs have gained broader access to energy technologies through expanding international trade in related equipment, effective technology transfer also requires the acquisition of related knowledge and capabilities, both by actors in the energy supply chain and by end users. However, international technology-transfer mechanisms have a rather inadequate track record in this regard. Weak local absorptive capacities and innovative capabilities in LDCs thus highlight the need for greater emphasis on capacity development in energy-related projects; robust science, technology and innovation (STI) policy frameworks; greater involvement of local research institutions in energy-related activities; and efforts to promote experience-sharing and mutual learning in energy-related research. South-South and triangular cooperation may play a leading role in this area, given the similarities in energy-related challenges faced by LDCs and ODCs and the increasing importance of South-South trade for LDCs' access to electricity-related technologies.

Conducting electricity: market structures and governance

Historically, the principal model of the electricity sector worldwide has been one based on provision by publicly owned utility companies with legal monopolies in the generation and distribution of electricity. The considerable economies of scale of the main generation technologies (fossil-fuel-based generators and in some cases hydroelectric power) led to strongly centralized electricity systems, which relied on extensive transmission and distribution systems for delivery to users. With scale economies in both generation and distribution effectively acting as barriers to entry, electricity supply in this context was effectively a natural monopoly — a market which, by its very nature, can be served at a lower cost by a single supplier than by multiple suppliers.

Although electricity consumption itself is a private good, the energy distribution network is a public good, as well as being essential to other public goods, such as street lighting. It is also essential to the fulfilment of many of the rights enshrined in the Universal Declaration of Human Rights and to the achievement of the SDGs, and is widely acknowledged as a basic need for human development.

The essential nature of electricity, and of energy more generally, has also made energy security — the uninterrupted availability of energy sources at an affordable price — a central policy concern. This encompasses a safe and reliable supply of electricity, guaranteed access and affordability. In many fuel-importing LDCs, additional concerns are vulnerability to changes in international energy prices and the resilience of the energy system to supply shocks.

These factors — the essential nature of electricity, its strategic importance and its natural-monopoly and public-good aspects — together with the historical (and in many countries continuing) role of the State in the provision of electricity, have led to a widespread view of electricity supply as a public service. Starting in the 1970s, however, a combination of technological changes and shifts in attitudes to the roles of the public and private sector have led to a move away from the predominant role of public-sector monopolies in electricity production and distribution.

Through the 1980s and 1990s, a wave of reforms spread from developed countries across much of the developing world. These reforms centred on "unbundling" electricity supply through various forms of separation between generation, transmission and distribution, together with an increase in the role of private companies, under an independent regulator. However, the results of the reforms were mixed, largely reflecting differences in motivations and starting conditions, particularly between developed and developing countries.

While relatively few LDCs engaged in reforms during the 1980s and 1990s, many more have done so since 2000. This partly reflects changes in international development finance, latterly including the reaffirmation of the role of the private sector in the delivery of development outcomes in the Addis Ababa Action Agenda (adopted in 2015 at the Third International Conference on Financing for Development), the policies of multilateral lenders and bilateral donors' energy programmes. However, while an increasing role for the private sector remains a common feature of reforms, they have evolved in the light of widespread recognition of the shortcomings of the approach promoted in the 1980s and 1990s. A range of market structures, based on vertical integration or partial unbundling, are now recognized as potentially suitable to the limited access and structural challenges characteristic of LDCs.

Consequently, electricity market structures vary widely across these countries, partly reflecting differences in country circumstances and the stage reached in ongoing reform processes. While some LDCs retain vertically integrated systems combining generation, transmission, distribution and retail under a single entity, others are partially or wholly disaggregated. Some are locally disaggregated, with systems fragmented by locality (notably between islands in many island LDCs); and others have hybrid systems, combining one or more of these structures. The extent of plans and policy frameworks is similarly varied, as are regulatory arrangements.

The environment for the electricity sector is evolving rapidly, with major shifts in technologies and their relative costs, coupled with climate change and increasing emphasis on environmental goals. Together with the goal of universal access and rapidly rising demand with serious capacity constraints, this is creating a number of challenges to sectoral governance in LDCs.

As mentioned above, successful development of the electricity sector in this context requires a system-wide approach, encompassing planning, coordination and effective regulation. Planning is particularly important to the electricity sector because of the mismatch between the time required to build distribution networks and that required to build generation facilities, and the complementarities among generation technologies; furthermore, the timescale of planning needs to be commensurate with the 30-to-40-year time horizon of investments in new facilities. Given the large number of stakeholders involved, maximizing the contribution of increasing access to other development goals requires strong coordination, under the clear leadership of a lead agency.

The need for effective regulation is reinforced by the need to increase the resilience of electricity systems while integrating variable renewable energy sources. However, regulatory capacity in most LDCs remains limited, reflecting in part the time needed to build such capacity and the recent establishment of many regulatory agencies, most of which have been in existence only since 2005. While experience of sectoral reform is an important aspect of building capacity, even some LDCs with long-standing reforms still face major challenges in this regard.

Trade in electricity can play a supplementary role, helping to lower prices, mitigate shocks, relieve shortages and facilitate the transition to renewable energy sources; and many LDCs have bilateral, regional or multilateral approaches to coordinating and pooling their efforts in the sector.

A key consideration in electricity policy and planning is the relationship between rural-urban linkages and migration, rural electrification and structural transformation of rural economies, and the role of this relationship in inclusive and sustainable development. "Energy sprawl" — the impact of energy technologies on land use — is an important factor to bear in mind in the deployment of such technologies in both rural and urban areas.

Circular rural-urban-rural migration is increasing the expectations of rural communities with respect to electricity access, and urban-rural remittances make a substantial contribution to their purchasing power. This is contributing to the growing perception of rural electrification as a commercial opportunity. In LDCs, however, it is primarily the private sector that is involved in providing household stand-alone systems and devices in rural areas. Purely commercial models for grid electrification remain rare, reflecting high costs and limited demand, and rural electrification schemes emphasizing cost recovery and financial viability have proved neither affordable nor sustainable.

Investing in electricity for transformation

Current global estimates suggest that the investments required to achieve universal access to electricity in all LDCs by 2030 are of the order of $12 billion to $40 billion per year. However, domestic resources for investment in LDCs fall far short of these levels, and even after a rapid increase over the past decade, official development assistance (ODA) to the electricity sector in LDCs is barely one tenth of this level, partly reflecting the continued serious shortfalls from donor commitments in successive Programmes of Action for the LDCs.

This mismatch between investment needs and the financing available from domestic and external official sources has contributed to increasing emphasis on a potential role for external commercial financing of electricity-sector (and other infrastructure) investment needs for sustainable development. However, there are important tensions between the nature of the investments required in the electricity sector and the motives and appetites for risk of private investors.

Private investors typically seek safe long-term investments that generate a favourable rate of return on capital. However, investments in electricity infrastructure, particularly in LDCs, do not fit well with these criteria. Investments also have a particularly long time horizon, with asset lives of typically 25-to-60 years preceded by long pre-construction processes and construction periods. Considerable investments are required, giving rise to substantial sunk costs, before any cash flow is generated; and the nature of production and distribution systems means that they cannot readily be sold, making investment decisions difficult to reverse. This leaves investors seriously vulnerable to risks, which are especially high in LDCs. Such risks are both highly complex (encompassing a combination of political, regulatory, macroeconomic, business and technical risks) and difficult to assess, particularly due to the lack of transparency that often characterizes infrastructure projects, in particular because of their one-off nature and dependence on context-specific factors. This combination of large sunk costs, long project lives and high and uncertain risks both deters private investment in electricity infrastructure and creates a strong incentive for investors to delay such investments.

Reliance on private provision also reinforces the tension between the affordability of electricity supply — a key aspect of universal access – and the financial viability of investments in its provision. If investments are to be viable, tariffs for electricity need to cover (at least) the full costs of generation, transmission and distribution. However, the tariffs that can be charged are constrained by high rates of poverty and limited purchasing power, while investment costs in rural areas are increased by the geographical and logistical challenges of power supply. Similar issues arise where a public utility acts as a single buyer of electricity from independent power providers: while the utility serves as a buffer between users and suppliers, its financial viability depends on its ability to charge tariffs that adequately reflect the costs of generation and distribution; and any risk to its financial viability is reflected in higher premiums in its purchasing contracts. To date, however, only one of the 47 LDCs (Uganda) has reported the successful adoption of such cost-reflective tariffs.

Reducing or eliminating subsidies for fossil fuels is increasingly seen as a potential source of funding for renewable energy, with the additional benefit of reducing incentives for fossil-fuel use. However, such subsidies are generally relatively limited in LDCs, and the potential for them to follow certain developed countries in achieving a revenue-neutral switch of subsidies from fossil fuels to renewable energy is questionable, particularly as this might well have adverse effects on some low- and middle-income households.

In light of the constraints on other potential sources of financing, some LDCs have resorted to external commercial borrowing to meet the considerable needs for infrastructure investment if the ambitions of the 2030 Agenda are to be fulfilled, in some cases using their natural resources as collateral. However, as the experience of the 1980s and 1990s clearly demonstrates (particularly in the case of African LDCs), a great deal of caution is required in this regard to avoid the risk of financial crises, as the attendant adjustment process can have serious detrimental effects on economic and human development. This risk is intensified by the fact that the lion's share of ODA to the electricity sector in LDCs is in the form of concessional loans rather than grants, and that much South-South financing (and some other official financing) is non-concessional lending.

The need for massive injections of capital in LDCs to achieve universal energy access (and the other SDGs) comes at a time of marked uncertainty in the international development finance architecture. Political developments and continued economic stress in some traditional donor countries are giving rise to pressure on ODA budgets and funding of some multilateral agencies, while there is increasing emphasis on the use of ODA to catalyse private financing and movement towards making multilateral funding for electricity conditional on private-sector involvement. At the same time, the implementation of the Basel III international regulatory framework for banks is expected to act as a brake on investment and lending by banks and other institutional investors in view of the illiquid nature of infrastructure-related investments. However, the prospects for South-South financing, notably from China, appear more favourable.

There has also been an explosive growth in the number of international funds offering infrastructure and climate finance; but they are generally insufficiently focused on LDCs, and the resulting fragmentation of the international development finance architecture gives rise to a complexity that is difficult to navigate, particularly for LDCs with limited institutional capacity.

There may be some potential to increase domestic financing, to the extent that countries are able to reduce illicit financial flows, and to augment that financing from diaspora direct investment. However, generating substantial resources from domestic resources is likely to require the development of domestic instruments for infrastructure-related debt. While some initiatives are under way to support domestic resource mobilization, their coverage of LDCs is variable and beneficiaries have been mainly ODCs.

Overall, the prospects for increasing financing for electricity infrastructure needs are mixed. They also fall far short of what is required to achieve universal access to electricity by 2030. Increasing the resources available for investment in LDCs' electricity sectors will thus be critical to the fulfilment of SDG 7, and still more so to achieving transformational energy access. However, this is only one aspect of a much greater set of challenges, for LDC Governments and the international community alike.

Policies for transformational energy access

Increasing access to electricity has the potential to stimulate structural transformation of LDCs' economies. Conversely, however, pursuing an approach to universal access that fails to address energy needs for structural transformation adequately risks locking them into a sub-optimal development path for decades to come. This has important implications for energy policy, for development strategies, and for the articulation between the two.

The complexities of the electricity sector make long-term system-wide planning essential, especially if it is to achieve transformational energy access. Such planning needs to be based firmly on the particular circumstances and resource potential of each locality. It must also maintain the flexibility needed to respond to a rapidly evolving technological environment, to adjust to unpredictable changes in the pattern of demand as access is increased, and to respond to changes in the business landscape as structural transformation progresses. Equally, however, predictability and transparency are needed to attract private investment into the sector.

Since the development of the electricity sector in LDCs necessarily starts from an existing (inadequate and often financially unsustainable) energy system, an evolutionary approach is needed, strengthening and building on this base. Scaling up generating capacity is a major policy priority, to ignite and sustain structural transformation. As new capacity is added (and outdated plants are replaced), the planning process should steer the energy mix towards a progressively more diversified and balanced combination of energy sources suited to the country's resources and future needs, taking account of the technical and economic characteristics, and the environmental and social impacts of different technologies. While this is likely to entail a continued role for fossil-fuel generation, given the context of sharply rising electricity demand, increasing renewable generation can make a substantial contribution. However, close attention to system-wide interdependence is needed as diversification of the energy mix brings a wider range of energy technologies, in order to build additional system flexibility and resilience, and to harness complementarities across different technologies.

In parallel with increasing generation, a second key priority is grid extension and upgrading. Improving electricity distribution requires a combination of grid extension and mini-grid development, together with deployment of stand-alone solutions for dispersed rural populations. The scope and rate of grid extension is a primary consideration for planning, in light of its greater transformational impact, supplemented by the identification of priority areas for mini-grid deployment. Sound planning, transparency and policy coordination are essential to avoid uncertainty deterring private investors and to allow future interconnection.

Regional integration of LDC energy markets could allow for more intensive exploitation of lower-cost energy sources and could increase flexibility by creating greater scope for diversification, geographically and possibly across energy sources. For some LDCs, importing electricity from neighbouring countries through regional power pools may provide a viable alternative to domestic generation, although effective integration into international or regional energy markets hinges on significant progress being made in upgrading grids and interconnections.

Effective sectoral governance frameworks are essential to successful development of electricity systems. There is no one-size-fits-all model for market structure or for transition to low-carbon electricity systems, as both are heavily dependent on country-specific factors. While LDCs should continue their efforts to increase supply capacity in collaboration with the private sector, it is important to avoid market structures that are overly demanding relative to their institutional, financial and human-resource constraints.

Financial sustainability through cost-reflective tariffs is a critical factor for the viability and quality of electricity systems. However, this needs to be balanced with affordability, in a context characterized by widespread income poverty, a major shortfall in access to modern energy and burgeoning demand associated with structural transformation. Incentives and regulation can play an important role in this regard; and changes in tariff design, if carefully crafted and backed by political will, can offer a means of matching tariff structures to the structure of electricity supply costs. However, distributional impacts require particular attention. Well-designed auctions for electricity from renewable sources could provide a means of fostering greater penetration of utility-scale renewables, without unduly burdening the public budget, and capacity development in this area is a priority for international support.

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. This means ensuring that the nature, quantity and quality of energy supply and access meet the needs of structural transformation, and that development policies generate the demand for electricity needed to make the necessary investments in generation, transformation and distribution viable.

Rural development is critical to structural transformation in LDCs, as well as to energy access. By unlocking opportunities in rural non-farming activities and strengthening their linkages with agriculture, an ambitious programme of rural electrification can provide a substantial boost to the transformation of rural economies. At the same time, the use of labour-intensive methods in building electricity infrastructure can provide a corresponding demand-side “kick start”. However, the transition is unlikely to be smooth, and leveraging electrification for rural transformation is likely to require complementary interventions to facilitate the adoption of modern technologies and the emergence of new economic activities. Facilitating access to intermediate (non-electrical) technological options, such as solar water pumps and evaporation fridges, can also make an important contribution prior to electrification, as well as providing opportunities for local production.

Reaping the full benefits of the energy-transformation nexus also requires complementary policies to foster economic diversification and job creation, which can furthermore help to offset the effects of the “creative destruction” brought about by electricity access and reduced employment in charcoal and fuelwood supply chains. Priorities include fostering the emergence of a domestic supply chain in modern energy and fuel-efficiency business, and capitalizing on electrification to foster the rise of new higher value added activities.

The transformational impact of modern energy access can be further enhanced through complementary interventions in skill and technological upgrading, business development, access to credit and financial services, small and medium-sized enterprises and women's economic empowerment. STI policies can also contribute to harnessing the energy-transformation nexus, by strengthening local absorptive capacities and domestic capabilities for both radical and incremental innovation. Appropriate measures in this area include incentivizing collaboration between research institutions and broader stakeholders, to promote technology adaptation and diffusion, as well as investing in education and vocational training.

The considerable cost of universal access, and still more of transformational access, highlights the importance of efforts to mobilize and channel domestic and foreign financial resources towards these goals. In the current international environment, enhancing domestic resource mobilization is an imperative. 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. Efforts in this area should focus on increasing the availability of de-risking instruments, including insurance and guarantee products, while avoiding excessive accumulation of contingent liabilities. LDC efforts to nurture domestic debt markets therefore merit increased priority in the development community. Leveraging foreign direct investment more effectively will depend on the ability of LDCs to attract investors strategically in ways supportive of their industrial and energy policy objectives.

While international borrowing could represent an additional source of capital, debt sustainability remains an important concern, especially in light of the current volatility of global financial markets and exchange rate fluctuations. Already high financing costs associated with perceptions of high risk in LDCs may be increased further by impending changes in the international financial regulatory environment.

There is a clear case for increased ODA to fill the financing gap for electricity infrastructure investment; and fulfilment of donors' long-standing and long-unmet aid commitments towards LDCs would make a major contribution. For renewable technologies particularly, grant financing would be appropriate, reflecting the principle of "common but differentiated responsibilities"; but despite clear pledges in the context of the UNFCCC and the Paris Agreement, climate finance for LDCs falls far short of their needs, as well as being fragmented among multiple channels, funds and sources.

The international community could also strengthen its support to the LDCs through transfer of technology. The current framework for the transfer of energy-related technologies is underfunded, and its effectiveness at best uneven; and bilateral, South-South and triangular cooperation initiatives have yet to play a decisive role. The recently established Technology Bank for LDCs could potentially improve this situation, by acting as a hub for these countries. The United Nations Conference on Trade and Development (UNCTAD) could play a role in collaboration with the Bank on issues related to the transfer of energy technologies, from the perspective of productive use of energy and structural transformation.