Global Commission to **End Energy Poverty**

2020 REPORT ELECTRICITY ACCESS

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CONTENTS

LETTER FROM THE CO-CHAIRS

A third of all humanity lacks access to reliable power. This blunt reality drives immense social inequities. Access to power spells the difference, literally, between darkness and light. It determines whether you have modern healthcare, transportation and telecommunications. Clean fuels for cooking and heating offer an escape from chronic respiratory illness. Reliable power opens the door to educational and economic opportunity.

Only by ending energy poverty can we end poverty itself.

This is why we assembled the Global Commission to End Energy Poverty.

This year of pandemic has driven home the urgent need to address the world's most glaring inequities. Energy plays a central role in modern healthcare, including in the treatment of Covid-19 and the eventual storage and delivery of vaccines. It will ultimately underpin the global economic recovery. Countries that lack adequate and affordable electricity to run their economies will recover more slowly. Many will lose ground in their efforts to expand energy access and industrialize.

We have seen the fragility of the electricity sectors of many countries exposed by the pandemic as tens of millions of households in Africa and Asia fell behind in paying their electricity bills. As a result, struggling utilities and off-grid startups are in dire straits. We could never have imagined when when the Commission first convened in 2019 that millions more people today would lack energy access. But it has happened. Our task is even more urgent and more challenging.

The international response must be rapid and sizable, but also far-sighted and sustained. Governments need vital support to fight and recover quickly from the pandemic in ways that reinforce the long-term viability of their energy sectors. That is the only way to create jobs and to power shops, factories, hospitals and schools – in short, to open the door to modernity itself for billions of people.

We must do all this in a sustainable way. Global shifts too often hit underserved societies the hardest, and so it is with climate change. We must expedite transition to clean energy. Greatly expanded energy access can be done via systems that take advantage of the opportunity emerging economies have to leap ahead with low-carbon solutions.

The Commission focused first on the pressing challenge of achieving universal access to adequate, affordable and reliable clean electricity. Our MIT-led research team adopted a practical on the ground approach and engaged directly with leaders and practitioners in government and the power sector, as well as with investors and the leaders of numerous developmental institutions, some of which are represented within our Commission.

The team's core work product is packaged in the form of an integrated framework and toolkit for reforming the fledgling electricity sectors of low-access countries. While comprehensive, the framework is not hard to grasp. Its

programs can be adapted to a wide range of national circumstances. This flexibility will be indispensable as we roll it out in dozens of countries, in close collaboration with all sectors and in partnership with committed political leaders. Throughout, we will meet our obligations and commitments as we hold ourselves and our partners accountable by measuring and publicly reporting our progress.

The energy poverty challenge is enormous in scale and scope – and our vision and ambition for future work as a Commission go well beyond the electricity sector. Therefore, while we now mark the end of the beginning for our Commission, we also mark the launch of a new and exciting phase.

Sincerely,

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President of the Rockefeller Foundation

Ernest J. Moniz
Cecil and Ida Green Professor of Physics and Engineering Systems Emeritus, Massachusetts Institute of Technology

Akinwumi A. Adesina
President, African Development Bank

COMMISSION AND RESEARCH TEAM

THE COMMISSION

The Global Commission to End Energy Poverty (GCEEP) comprises leaders from utilities, off-grid companies, multilateral development banks, academics, and others from across the electricity and development sectors. It operates under the joint chairmanship of the Rockefeller Foundation President Dr. Rajiv J. Shah; former U.S. Secretary of Energy Ernest Moniz; and Africa Development Bank President, Dr. Akinwumi Adesina. Members of the commission are as follows:

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Adnan Amin, Senior Fellow at the Belfer Center at the Harvard Kennedy School, USA; and Director General Emeritus, International Renewable Energy Agency (IRENA)

Fatih Birol, Executive Director, International Energy Agency (IEA)

Patrick Bitature, Chairman, Umeme Limited

Tony Blair, Former Prime Minister of Great Britain and Northern Ireland; Executive Chairman, Tony Blair Institute for Global Change

Hela Cheikhrouhou, Chairman and CEO, Nithio Holdings

Ashvin Dayal, Senior Vice President, Power and Climate Initiative, Rockefeller Foundation

Anton Eberhard, Professor Emeritus and Senior Scholar at the University of Cape Town, South Africa

Alain Ebobissé, CEO, Africa50 Investment Group

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Francesco Starace, Chief Executive Officer and General Manager Enel S.p.A; Chairman Sustainable Energy For All (SE4ALL) Administrative Board

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MIT ENERGY INITIATIVE AND ROCKEFELLER FOUNDATION TEAMS

This report was prepared by the MIT research team led by Ignacio Pérez-Arriaga, GCEEP Research Director and Robert Stoner, GCEEP Research Co-Director, along with Divyam Nagpal, and Gregoire Jacquot with substantive editorial and organizational contributions by Raanan Miller, Marika Tatsutani and Shivangi Misra. The Commission itself was conceived by the Rockefeller Foundation under the leadership of Ashvin Dayal, who along with his senior colleagues Suman Sureshbabu, Eric Gay, and Clare Boland played a central role in guiding its work, and also contributed extensively to this report. We also acknowledge the participation and contributions of Raquel de la Orden, Reja Amatya, and Andrés González-García.

OVERVIEW

Ending energy poverty is the necessary prerequisite to ending poverty itself. That central insight has driven our work since we first came together as the Global Commission to End Energy Poverty (GCEEP) in 2019. It is also at the heart of United Nations Sustainable Development Goal #7, which calls for universal access to affordable, reliable, sustainable and modern energy by 2030.

The COVID-19 pandemic has added urgency to the goal of ending energy poverty, highlighting the critical importance of access to electricity in particular, while also threatening to reverse decades of progress and putting hundreds of millions of vulnerable households and businesses at risk. But the current crisis also presents important opportunities to advance our agenda as governments undertake large investments in economic stimulus and recovery over the months and years ahead. These investments, as the International Energy Agency has pointed out "*will shape economic and energy infrastructure for decades to come and will almost certainly determine whether the world has a chance of meeting its long-term energy and climate goals.*"[1]

Against this backdrop, the quest to achieve universal access to electricity must be pursued with greater vigor than ever, and with an eye to challenges and consequences that will extend well beyond the pandemic. Developing innovative business models for both centralized and distributed energy solutions, deploying those models to attract greater private sector investment and participation, and formulating the policies and regulations needed to sustain progress toward a more equitable, sustainable, and prosperous energy future—these have been central themes of our work to date.

THE INTEGRATED DISTRIBUTION FRAMEWORK (IDF)

An early focus for the Commission has been addressing problems in distribution, which has emerged as the "weak link" in the power systems of many developing countries. To that end, we developed the IDF, which offers a flexible approach to large-scale electrification in a wide range of contexts. The IDF emphasizes the use of financially viable business models for the distribution of electricity to end consumers by all modes of electrification. Its key principles include:

i. A commitment to **universal access** that leaves *no one behind.* This requires permanence of supply and the existence of a utility-like entity with ultimate responsibility for providing access in a defined territory.

ii. Efficient and coordinated **integration of on- and off-grid solutions** (i.e., grid extensions, mini-grids and stand-alone systems). This requires integrated planning and appropriate business models for all types of consumers in a defined service territory.

iii. A **financially viable** business model for distribution. This will typically require some form of distribution concession to provide legal security and ensure the participation of external and mostly private investors, as well as subsidies for viability gap funding.

1 IEA (2020), Sustainable Recovery: World Energy Outlook Special Report, https://www.iea.org/reports/sustainable-recovery.

iv. A **focus on development** to ensure that electrification produces broad socio-economic benefits. This principle links expanded access to the delivery of critical public services (e.g., health, education) and to multiple economically beneficial end-uses.

Individually, all of these principles have been discussed for many decades. The power of the IDF lies in bringing them to bear *collectively* and *rigorously* to achieve a durable transformation of the entire distribution sector.

ACTIVITIES AND LESSONS LEARNED FROM THE COMMISSION'S FIRST YEAR

The GCEEP research team is actively engaged in efforts to apply the IDF approach in the countries of Colombia, Nigeria, Rwanda and Uganda and in the state of Odisha in India. Our experience so far suggests that the IDF can be applied in a range of contexts and to achieve a variety of goals, from expanding access to improving service quality. Successful implementation requires, first and foremost, a strong political commitment and an overarching vision and strategy that reflect the specific conditions and aspirations of individual countries. What we have found to be exciting and hopeful in our work with these "first action" countries is that each has an opportunity to meaningfully expand access—starting from its current situation, whatever that is.

Of course, many developing countries also face significant challenges in other key segments of the power sector. Overcoming these challenges requires identifying and disseminating the best regulatory and business models to spur investment in needed generation and transmission infrastructure, removing barriers to the deployment of medium and large renewable plants, and developing sound institutions and market rules to enable efficient regional trade. Thus, another important GCEEP activity over the last year has involved advising the West Africa Power Pool, following an initiative of the Tony Blair Institute, on regional-level reforms aimed at reducing operation costs, improving reliability, and supporting major renewable investments. Such reforms could deliver enormous economic and environmental returns for the countries of West Africa and provide a model for other regions that would benefit from increased integration and trade.

A CALL TO ACTION

Our action plan for the next phase of GCEEP activities aims to leverage the diverse perspectives, expertise, and influence of Commission members across a range of activities, including advocacy, research and technical assistance, engagement with key stakeholders, institutional and individual capacity building, and progress measurement. Ensuring that universal access is at the top of international and national agendas and economic recovery plans; further developing the IDF "toolkit"; working with committed governments and regional institutions to design and implement comprehensive access plans; and building capacity in critical areas such as regulation by helping to establish a new Africa School of Regulation will be among GCEEP's main priorities for the months and years ahead.

Throughout, we continue to see one of our most important roles as convening and providing a platform for the many actors who are already deeply engaged in the cause of ending energy poverty. Country leaders, development finance institutions, private sector lenders and investors, and utilities—all have indispensable parts to play. By actively bringing these diverse constituencies together and by rallying them to action—through our distinctive focus on practical solutions and with a consistent commitment to aligning global priorities and resources behind the best ideas—we remain firmly convinced that progress toward the goal of affordable, reliable, sustainable and modern energy for all is not only still possible, but very much in reach.

SUMMARY FOR DECISION MAKERS

INTRODUCTION

Launching the Global Commission to End Energy Poverty (GCEEP) in September 2019, we invoked a view of energy access as the "golden thread" that weaves together economic growth, human development, and environmental sustainability.[1]

In this report, as we take stock of the first year of GCEEP activities and chart a course for the Commission's next phase, we are even more firmly convinced that ending energy poverty, in broad alignment with United Nations Sustainable Development Goal #7, which calls for universal access to affordable, reliable, sustainable and modern energy by 2030, is the necessary prerequisite to eradicating poverty itself.

The emergence of the global COVID-19 pandemic has added urgency to our work, underscoring the human consequences of energy poverty and highlighting the centrality of electricity in delivering medical care and other essential services, in connecting people and societies, and in enabling remote work and learning. At the same time, the economic damages wrought by the pandemic have put many vulnerable households and firms at risk of falling back into energy poverty.[2] The International Energy Agency (IEA), for example, has predicted that the number of people without electricity in sub-Saharan Africa will increase in 2020—reversing several years of progress. The IEA further estimates that a rise in poverty levels worldwide may make basic electricity services unaffordable for more than 100 million people who already had electricity connections,

1 Former UN Secretary-General Ban Ki-moon, 2012. https://www.un.org/press/en/2012/sgsm14242.doc.htm
2 IRENA (2020), Post-COVID-19 recovery: An agenda for resilience, development and equality, https://irena.org/publications/2020/Jun/Post-COVID-19-Recovery

presaging a return for many to more polluting and inefficient sources of energy.[3]

Yet the COVID-19 crisis also presents new opportunities to accelerate progress toward a more sustainable and equitable energy future as governments invest in economic stimulus and recovery over the months and years ahead.

These investments will have to be large: the United Nations, for example, has estimated that a USD 2.5 trillion rescue package—including a near-term injection of USD 1 trillion of investment—is needed to help the world's emerging economies cope with the pandemic and its consequences.[4] They will also have long-lasting consequences. As the IEA pointed out in its 2020 World Energy Outlook Special Report, investments made in the wake of COVID-19 "*will shape economic and energy infrastructure for decades to come and will almost certainly determine whether the world has a chance of meeting its long-term energy and climate goals.*"[5] Similarly, Sustainable Energy for All has emphasized that governments have a "*unique, once-in-a-generation opportunity to reset their economies and address the underlying structures that enable development and competitiveness.*"[6]

Against this backdrop, the imperative to think big remains. Efforts to end energy poverty will certainly continue well beyond the current emergency and must be commensurate with the magnitude of the longer-term challenges and impacts that are at stake.

We continue to believe that our initial focus on access to electricity, the signature of modern societies, is appropriate as a readily available and effective means of making rapid progress. (The Commission intends to return to other critical aspects of energy poverty, such as access to clean cooking fuels, in the future.)

We also remain convinced of the need for substantial private sector participation, given the sizable investments needed to achieve full electrification, which can run into the billions of dollars even for small countries and into the tens of billions of dollars for larger countries with significant underserved populations. How such participation might be encouraged and appropriately channeled to advance energy access and other sustainable development goals—by public investment and by guarantees from governments and development finance institutions (DFIs), as well as by suitable policies and regulations and innovative business models that can support both centralized and distributed solutions—thus continues to be a central focus of our work.

SECTION 1

THE ECONOMIC, SOCIAL AND ENVIRONMENTAL CASE FOR INVESTING IN ELECTRICITY ACCESS

Investments in electricity access, if they are aligned with medium- and long-term climate and sustainability goals, will yield substantial socio-economic and environmental benefits and should be prioritized in the recovery strategies currently being developed by governments and international institutions. Now and in the post-COVID-19 world, universal access must be recognized as a necessary pillar of an inclusive economic recovery; a key contributor to delivering resilient services in healthcare, water, and education; and, when approached correctly, a

3 International Energy Agency (2020). "World Energy Outlook 2020". https://www.iea.org/reports/world-energy-outlook-2020
4 UN (2020), $2.5 trillion COVID-19-19 rescue package needed for world's emerging economies, https://news.un.org/en/story/2020/03/1060612
5 IEA (2020), Sustainable Recovery: World Energy Outlook Special Report, https://www.iea.org/reports/sustainable-recovery.
6 SEforAll (2020), The Recover Better with Sustainable Energy Guide for African Countries, https://www.seforall.org/publications/recover-better-africa.

crucial step toward achieving a clean and decarbonized economy.[7]

The role of electrification in catalyzing local economic activity, creating jobs and improving access to public services, especially in rural areas, is well documented. Evaluations of electricity investments in developing countries by development finance institutions (DFIs) have shown a significant impact on GDP; the effect is especially large in low-income countries with small power sectors.[8] In Senegal, GDP rose 1.7% with the commissioning of a 70 mega-watt (MW) generation project that reduced local electricity costs and increased the availability of power.[9] In Uganda, improvements in the electricity system, including the commissioning of a 250 MW hydropower plant, resulted in an estimated 2.6% boost to GDP.[10]

These types of projects create new jobs due to construction and operations, but their largest effects result from increased economic activity more broadly.[11] There is also growing evidence for the socio-economic benefits of off-grid solutions such as solar home systems. In East Africa, researchers estimate that one-third of the people who purchase such systems use them to extend the work day or boost enterprise activities, resulting in an average earnings increase of USD 46 per month, equivalent to a 14% increase in average income for the region.[12] Another analysis, discussed further in the main report, finds multiple economic benefits from linking rural electrification with the agriculture sector in Ethiopia.[13]

Finally, a strong case for universal electricity access can be made on environmental sustainability grounds since pathways to electrification can help accelerate the transition from traditional fuels to low-carbon energy sources.[14] An emphasis on energy efficiency and increasingly cost-competitive renewable energy solutions (both distributed and utility-scale), in particular, has the potential to deliver large net benefits by aligning the goals of expanded access, reduced climate impacts, and enhanced energy security and system resilience. Opportunities to realize such benefits are large. Globally, the capacity of backup generators in developing countries is estimated at 350–500 giga-watt (GW) spread across 20–30 million individual sites; annual CO^2 emissions from these generators are estimated to exceed 100 million metric tons.[15] Across sub-Saharan Africa, one out of every five liters of diesel and petrol is burned in a backup generator. The resulting emissions are equivalent to 20% of those from vehicles.[16]

The optimal trajectory for achieving universal access to electricity will, of course, vary depending on a host of country-specific considerations and priorities, including with respect to cost, development objectives, social aspirations, emissions, security and reliability of energy supply, and climate resilience and adaptation. These considerations, and the need in most cases to balance multiple objectives and constraints, will influence investment decisions across the power sector—from generation to last-mile distribution.

7 At its last meeting in July 2020, the key message of the High-level Political Forum, the United Nations central platform for reviewing progress on the 2030 Agenda for Sustainable Development, was a call for action for the next decade, keeping the focus on the Sustainable Development Goals (SDGs) while combatting the COVID-19 pandemic. The Forum also agreed that achieving universal access to energy (SDG #7) will "unlock substantial opportunities for billions of people through new economic prospects and jobs, as well as empower women, children and youth, enhance access to better education, water, sanitation and healthcare, more sustainable, equitable and inclusive communities, and provide greater protections from, and resilience to, climate change impacts." UN (2020), Summary by the President of the Economic and Social Council of the high-level political forum on sustainable development convened under the auspices of the Council at its 2020 session, https://sustainabledevelopment.un.org/content/documents/269252020_HLPF_Presidents_summary.pdf

8 CDC Group (2020), What is the impact of investing in power?, https://assets.cdcgroup.com/wp-content/uploads/2020/01/30151049/Whats-the-impact-of-investing-in-power.pdf

9 Steward Redqueen (2017), "The Link between Power Investments and Jobs in Senegal." London.

10 Steward Redqueen (2016), "What Is the Link between Power and Jobs in Uganda? Report to CDC Group PLC." London.

11 Ibid.

12 GOGLA (2020), Powering Opportunity: Energising Work, Enterprise and Quality of Life with Off-Grid Solar, https://www.gogla.org/sites/default/files/resource_docs/powering_opportunity_global_report.pdf

13 Borgstein, E., Wade, K., and Mekonnen, D. Capturing the Productive Use Dividend: Valuing the Synergies Between Rural Electrification and Smallholder Agriculture in Ethiopia, Rocky Mountain Institute, 2020. http://www.rmi.org/insight/ethiopia-productive-use/.

14 In fact, several analysies have concluded that the direct climate impacts of achieving universal access would be neglible relative to emissions from existing patterns of consumption and fuel use worldwide. World Bank (2017), The Climate Change-Energy Access Nexus, http://documents1.worldbank.org/curated/en/465151494924794652/pdf/115064-BRI-P148200-PUBLIC-FINALSEARSFClimateChangeweb.pdf. Also IEA (2017), Energy Access Outlook 2017. From poverty to prosperity.

15 International Finance Corporation, *The Dirty Footprint of the Broken Grid: The Impacts of Fossil Fuel Back-up Generators in Developing Countries (2020),* https://www.ifc.org/wps/wcm/connect/dfab4f4c-9247-46ed-8f35-b25fa527b636/20190919-Summary-The-Dirty-Footprint-of-the-Broken-Grid.pdf?MOD=AJPERES&CVID=mR9UXpH.

16 Ibid.

SECTION 2

THE INTEGRATED DISTRIBUTION FRAMEWORK (IDF)

The Commission has deliberated extensively on the actions that are needed to accelerate electrification, identifying challenges that exist throughout the power sector in many low-access countries. For reasons detailed in our Inception Report, we have focused particular attention on distribution as the weakest link in most of these countries.[17]

A common problem is that incumbent distribution companies ('discos') do not charge tariffs that would allow them to recover their costs, resulting in a vicious cycle of underinvestment, unreliable and low-quality service, customer dissatisfaction, and growing inequities in access. This is the case for the vast majority of discos in sub-Saharan Africa, which are in chronically dire financial straits, require frequent publicly-financed bailouts,[18] and cannot attract the substantial capital needed to undertake significant rural electrification efforts or make other long-term infrastructure investments. Figure ES.1 illustrates these difficulties; a fuller discussion is provided in the main report and in the GCEEP's Inception Report.

The economic fallout of the current COVID-19 crisis, for individual households and businesses and for national budgets, clearly has the potential to exacerbate these challenges in the near term, especially in countries that already have high debt levels and little fiscal latitude to undertake additional spending.[19] With public financing in short supply, the longer-term sustainability of the power sector in many developing economies – whether governments pursue universal access or not – will continue to rest squarely on tackling challenges in distribution. Private capital is sorely needed but will remain difficult to attract absent viable business models.

Strategies for overcoming distribution challenges and expanding access can nonetheless be implemented by the application of best practices in regulation, effective integration of on- and off-grid technologies, and smart use of development finance. To that end, we have focused on "last mile" distribution, understood in the broad sense of providing electricity to end customers by whatever supply technology—grid extension, mini-grids, or stand-alone systems—is most appropriate. We have also focused on advancing a set of principles and a framework, which we call the integrated distribution framework (IDF), to guide the design and implementation of electrification programs with the aim of mobilizing capital and expertise at the right scale to achieve universal electricity access. The IDF approach shifts most of the economic burden of maintaining, improving, and expanding distribution systems from governments to defined entities (whether public, private, or a public-private partnership) that are empowered to enter into long-term contracts (typically 20 or 25 years) and are guided by cost-of-service regulations.

2.1 FORMULATION OF THE INTEGRATED DISTRIBUTION FRAMEWORK

Aspects of the IDF have been implemented successfully by electrification programs across the developing world. Yet there are very few instances in which this framework has been fully deployed for the express purpose of expanding electricity access.[20] Based on the conceptual contributions of the GCEEP research team, guidance from Commissioners, and lessons from ongoing engagements in several "first action" countries, this section elaborates

17 The Global Commission to End Energy Poverty (2019). Inception Report.https://www.endenergypoverty.org/reports

18 Trimble, Christopher, Masami Kojima, Ines Perez Arroyo, and Farah Mohammadzadeh. 2016. "Financial Viability of Electricity Sectors in Sub-Saharan Africa: Quasi-Fiscal Deficits and Hidden Costs." Policy Research Working Paper 7788, World Bank, Washington, DC. http://documents.worldbank.org/curated/en/182071470748085038/Financial-viability-of-electricity-sectors-in-Sub-Saharan-Africa-quasi-fiscal-deficits-and-hidden-costs

19 IMF (2020), "COVID-19-19 Response in Emerging Market Economies: Conventional Policies and Beyond", https://blogs.imf.org/2020/08/06/COVID-19-19-response-in-emerging-market-economies-conventional-policies-and-beyond/

20 The electrification of Morocco in the late 1990s and the PERMER I project in the Jujuy province in Argentina (1999–2012) are largely successful past experiences that contain most of the features of the IDF. We have learned from these concrete experiences and have defined IDF in more general terms that can be adapted to basically any context.

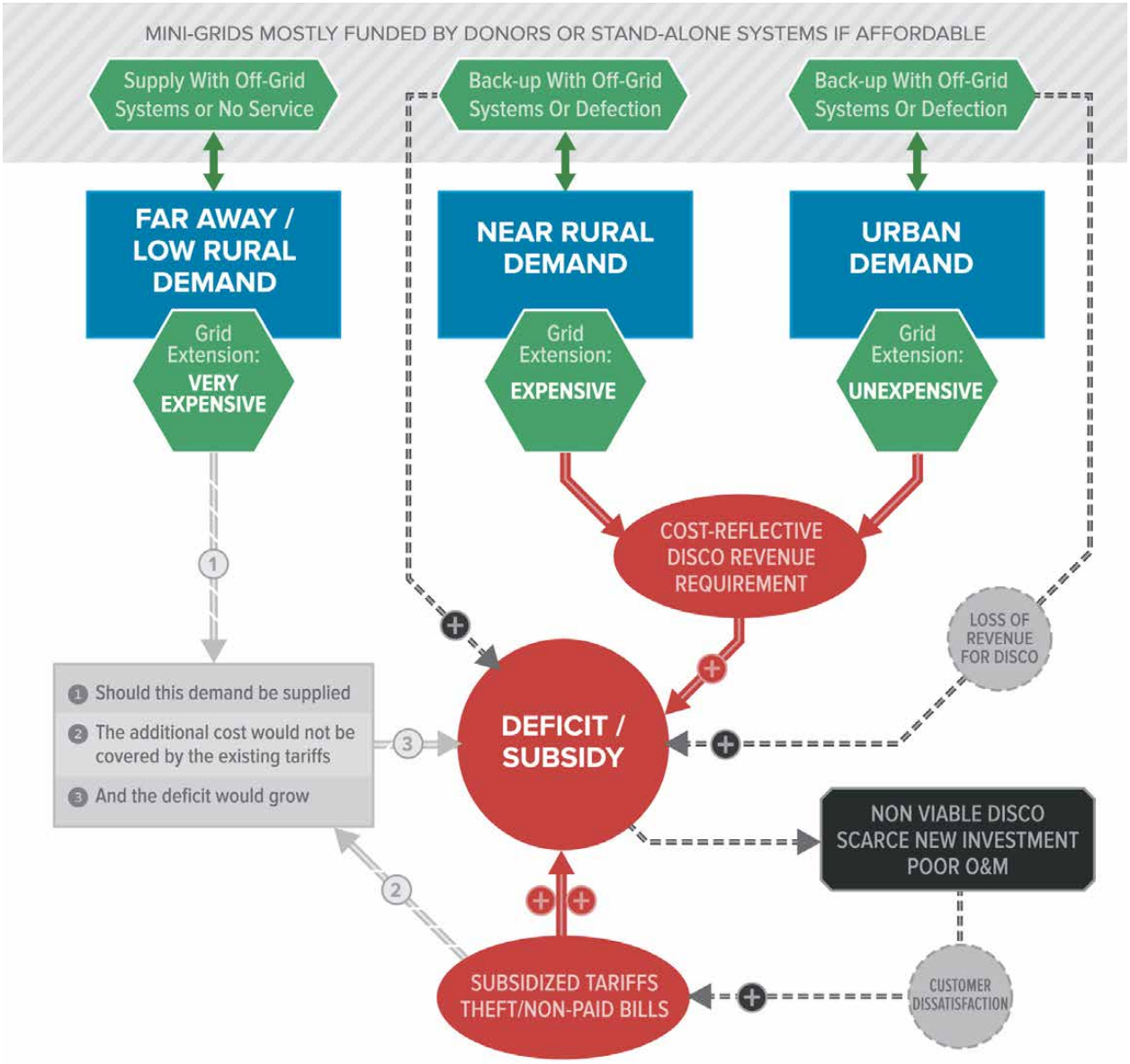


Figure ES.1 Viability challenges for distribution companies in low-access countries

on key principles and implementation guidelines for the IDF in a range of national contexts. A more detailed treatment can be found in the full report and in the collection of working papers prepared by the GCEEP research team.[21]

We have identified four guiding principles for the IDF:

- **A commitment to universal access that leaves no one behind. This requires permanence of supply and the existence of a utility-like entity with ultimate responsibility for providing access in a defined territory.**

21 Working Papers developed by the GCEEP research team can be accessed online here: https://www.endenergypoverty.org/reports

Figure ES.2 Pillars of the integrated distribution framework

- **Efficient and coordinated integration of on- and off-grid solutions (i.e. grid extensions, mini-grids and stand-alone systems). This requires integrated planning at the distribution level and appropriate business models that take a comprehensive view of all types of consumers in a defined service territory.**
- **A financially viable business model for distribution. This will typically require some form of distribution concession to provide legal security and ensure the participation of external and mostly private investors, as well as subsidies for viability gap funding.**
- **A focus on development to ensure that electrification produces broad socio-economic benefits. This principle links expanded access to the delivery of critical public services (e.g., health, education) and to multiple economically beneficial end-uses.**

Though simple in concept, the application of these principles in practice is often far from straightforward. Achieving all of them fully and from the outset, is often not possible—on the contrary, partial success may be the most that can be accomplished at points along the way. Ultimately, however, all four principles are essential and must be kept clearly in view as countries work to develop and implement effective strategies for expanding access.

The principle of universal access requires a **utility-like company or entity** (whether public, private, or a public–private partnership) that takes responsibility for a territory and commits to supplying its customers with at least a minimum level of service and reliability through an appropriate mix of on- and off-grid solutions. The entity would accept the role of default supplier (that is, the party responsible for ensuring that everyone has service) and supplier of last-resort (the party that actually provides service in the event a current supplier fails to do so). It is important to note that the requirement for **universality** entails **permanence**. This will guide investments in new connections, whether through on- or off-grid solutions, that are aligned with a **sound long-term vision** of the power sector, based on proven regulatory and business fundamentals.

Thus, permanence of supply and compatibility with a sound long-term vision of the power sector are additional requirements that follow from a commitment to universality. Unfortunately, both are frequently ignored in

electrification initiatives that focus solely on meeting short-term access targets while ignoring the regulatory and business model aspects of program design that are needed to guarantee continuous service far into the future.

Too often this results in electrification projects that become inactive after a few years because of the absence of proper maintenance, funding, or management, or when demand grows and equipment needs to be repaired, replaced, or upgraded.

Defining a long-term vision for the power sector in low-access developing countries is challenging, especially given the transformative technological changes taking place within the sector globally.[22] However, a century of experience with electricity policy and regulation provides some important lessons:

i. **Distribution companies, which are often ailing in developing countries, play a critical role.** As demand grows, the viability of grid extensions will increase relative to off-grid solutions, resulting in hybrid electricity systems with grid service augmented by distributed energy resources. Planning strategies and regulation must account for this dynamic interaction.

ii. **The regulated revenue requirement of the distribution activity must be cost reflective.** The distribution network activity must be remunerated using some version of the cost-of service method, perhaps adding performance-based incentives. Deviating from this basic regulatory approach increases the cost of capital, deters investment, and compromises service reliability and quality of service. The IDF applies this method to an expanded view of distribution that encompasses both on- and off-grid solutions.

In practical terms, guaranteeing the inclusivity conditions laid out above will require strong instruments, such as long-term concessions, to attract the private and public capital needed for universal access. So far, distribution concessions have generally been used in exclusive settings— only in urban or rural areas, and in technology-specific applications (i.e., mini-grids and stand-alone systems)—with mixed results.

The principle of **coexistence of on- and off-grid solutions** requires the development of a least-cost, integrated electrification plan that includes all electrification modes. Such a plan should provide (i) a roadmap for investment and project implementation that meets electrification targets at least cost, subject to the availability of funds and in accordance with political, social, development, or environmental priorities and (ii) estimates of the cost of supply, which are needed to calculate regulated tariffs and assess the need for subsidies.

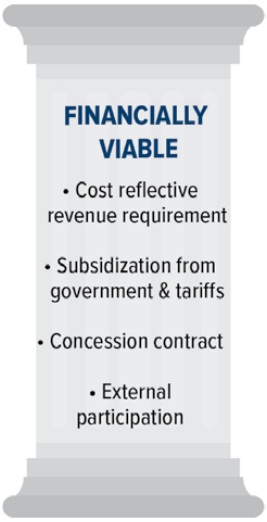
A sufficiently detailed plan can provide the bill of materials and the associated cost of the investments to be made every year, as well as the costs of managing, operating, and maintaining them. It will also contain the information needed to develop a business plan and identify financing needs, including estimates of demand and revenue based on the tariffs applicable to each type of customer.

On-the-ground surveys or geospatial tools combined with advanced machine learning techniques can be used to estimate demand and optimize electrification strategies (see Figure 3 in the full report). The plan can be adjusted over time to account for changes in demand, reliability of the main grid, costs of components, or wholesale energy prices.

Turning a geospatial plan into reality requires addressing additional challenges with respect to the design of mode-specific regulations for remuneration, the management of interfaces between modes, provisions for default and last-resort service, and the dynamic integration of different supply modes with changing demand over time. These challenges and potential solutions are discussed in detail in the full report.

Several developing countries have tested various approaches to developing the **financially viable**

22 See Pérez-Arriaga, I., et al. "The MIT Utility of the Future Study"(December 2016) for an analysis of the opportunities and challenges resulting from the growing presence of distributed energy resources (DERs) in power systems globally.



distribution business models needed to attract private partners who can mobilize investment capital, advanced technologies, and technical and managerial expertise. These have varied in design and outcomes. Some involved management contracts and the engagement of franchisees to conduct part or all distribution activities within a concession area. Under specific conditions, these interventions have yielded benefits in terms of reduced aggregate technical and commercial collection (ATC&C) losses, increased revenues, and improved customer engagement; however, they have generally focused on urban centers, where large gains are achievable at relatively low cost.[23]

Where investment mobilization needed is significant, long-term concessions usually covering a period of 20 years or more have proven to be effective instruments for mobilizing private sector expertise and capital, with successful examples emerging in a range of settings from Argentina, Morocco, and Uganda to India's capital city, Delhi. Less successful examples also exist, for instance in Senegal, that offer important lessons.[24]

Financial viability also requires *a stable and predictable regulatory environment*. A distribution company or concessionaire is dependent on the legal security in the country of operation, particularly if it works under an explicit mandate for electrification and relies on subsidy support for the viability of its business model. Governments, supported by DFIs, must provide the necessary backstops in the form of guarantees (e.g., payment security mechanisms, political risk guarantees, etc.).

Experience so far has shown that such guarantees are hard to secure in countries with poor investment climates and high perceived investment risks. These conditions are common in low-access countries, and they are likely being compounded by the COVID-19 crisis. The situation is even more difficult for privatized distribution companies. Such companies are exposed to the same regulatory and legal risks as public firms; yet they have less access to public financial support and face additional pressures and scrutiny from shareholders and consumers.

We have found that a long-term, investment-worthy concession can generally be an adequate instrument for delivering permanent, sufficient, reliable, affordable and universal access to electricity in a given area, provided its design is guided by a robust electrification plan and adequate public support to ensure cost-of-service recovery for all three electrification modes.

The goal of universal access goes well beyond just connecting customers. A top-down approach has to be complemented by the bottom up participation of electricity end-users. Other entities such as NGOs, foundations, and cross-sector agencies have important roles to play. No electrification scheme will work if the end customers do not receive quality service, and are not properly metered and billed. Beyond connection, productive and consumptive end-uses also need to be supported in ways that comport with community desires and priorities. In short, the electrification process must **focus on delivering socio-economic benefits**.

Focusing on these benefits will be particularly crucial in a post-COVID-19 world. It is already evident that the pandemic will leave millions of people in emerging economies unemployed and potentially resulting in the reverse migration from cities to rural areas in some countries. Thus, as governments and DFIs map out their recovery strategies, support for energy access and for improved livelihoods in rural areas must remain key priorities.

Stronger links between electricity supply and productive uses of electricity would also strengthen the financial

23 See Working Paper "How is the distribution sector in low-access countries attracting private sector participation and capital?" which reviews various approaches for increasing private sector engagement in the distribution sector.

24 See Jacquot et. al. (2019), "Assessing the potential of electrification concessions for universal energy access: Towards Integrated Distribution Frameworks", MIT Energy Initiative Working Paper.

viability of business models for expanding access.[25,26] It is now well known that access to modern energy, by itself, does not necessarily unlock the full potential of productive end-uses in rural and underserved communities.[27,28] Rather, access must be complemented by targeted efforts to facilitate the purchase of efficient appliances, consumer and enterprise financing, access to markets, capacity building, and data and information.[29] More attention is also needed to achieving gender equitable outcomes when promoting productive end-uses.[30]

Finally, institutions such as the World Health Organization, the World Bank, SE4All, DFID, IRENA and others have emphasized the critical role of energy access in the delivery of timely healthcare and other public services.[31] A concerted effort to deploy energy solutions for strengthening healthcare infrastructure in the short-term should align with a long-term perspective that advances resilience in both the health and energy sectors long after the pandemic abates.

2.2 IMPLEMENTING THE IDF

Given the stakes and the magnitude of the challenge, and based on experience in countries that have sought to expand access by applying aspects of the IDF,[32] we submit that success is not possible absent visionary leadership and strong political commitment. This commitment must be further backed by key DFIs and embedded in a lead ministry or public agency that can guide the efforts of the many stakeholders and participants who will be involved.

All of this suggests a dramatic change from the current piecemeal approach to expanding energy access in most developing countries, which has often suffered from the lack of an ambitious and comprehensive overarching vision and strategy.

Perhaps more problematic has been the tendency of energy access policy to be driven by the availability of specific concessional financing instruments in search of medium-sized investment problems to be addressed.

Our work shows that the IDF can be successfully tailored to the specific conditions of particular countries. Indeed, within its flexible set of guiding principles, it seems possible to design large-scale, comprehensive electrification programs backed by rigorous, quantitative business plans for a wide variety of situations.

The promising examples now unfolding in sub-Saharan Africa, Latin America and South Asia show that the IDF is not only a theoretical construct, but the basis for a practical methodology.

Assuming active public support and political leadership, as well as interest on the part of significant stakeholders the specific actions needed to implement the IDF are summarized in Figure ES.3, which draws upon lessons learned in our preliminary engagements with first action countries. Each of the key steps shown in the figure—developing an integrated electrification plan, preparing a preliminary business plan, identifying the most appropriate partnership model between various agents, defining a concession agreement and awarding the concession through an auction (tender) or direct allocation, and focusing on electricity as enabler of socio-economic growth—is described in more detail in the full report.

In cases where local buy-in is lacking, there is insufficient generation capacity, or where there is simply concern about sustaining an implementation program over many years—perhaps because of regional instability or for other reasons—implementation can proceed in a partial or phased manner. For instance, a number of independent

25 EEP. Opportunities and Challenges in the Mini-grid Sector in Africa: Lessons Learned from the EEP Portfolio, 2019. https://eepafrica.org/wp-content/uploads/2019/11/EEP_MiniGrids_Study_DigitalVersion.pdf

26 World Bank. Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers (Executive Summary), 2019. https://openknowledge.worldbank.org/bitstream/handle/10986/31926/Mini-Grids-for-Half-a-Billion-People-Market-Outlook-and-Handbook-for-Decision-Makers-Executive-Summary.pdf?sequence=1&isAllowed=y

27 IIED, Off-grid productivity: powering universal energy access, 2019. https://pubs.iied.org/pdfs/17492IIED.pdf

28 IEA, IRENA, UNSD, World Bank and WHO. *Tracking SDG 7: The Energy Progress Report, 2019.* https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/2019-Tracking-SDG7-Report.pdf

29 IIED and Hivos. *Remote but Productive: Practical lessons on productive uses of energy in Tanzania, 2019.* https://pubs.iied.org/pdfs/16652IIED.pdf

30 ENERGIA. *Unlocking the Benefits of Productive Uses of Energy for Women in Ghana, Tanzania and Myanmar*, 2019. https://www.energia.org/cm2/wp-content/uploads/2019/03/RA6-Unlocking-the-benefits-of-productive-uses-of-energy.pdf

31 World Bank (2020), "Energy access takes center stage in fighting COVID-19-19 (Coronavirus) and powering recovery in Africa", https://www.worldbank.org/en/news/opinion/2020/04/22/energy-access-critical-to-overcoming-COVID-19-19-in-africa

32 Later sections discuss the experience in a handful of "first action" countries that are in various stages of undertaking important access expansion programs consistent with IDF principles.

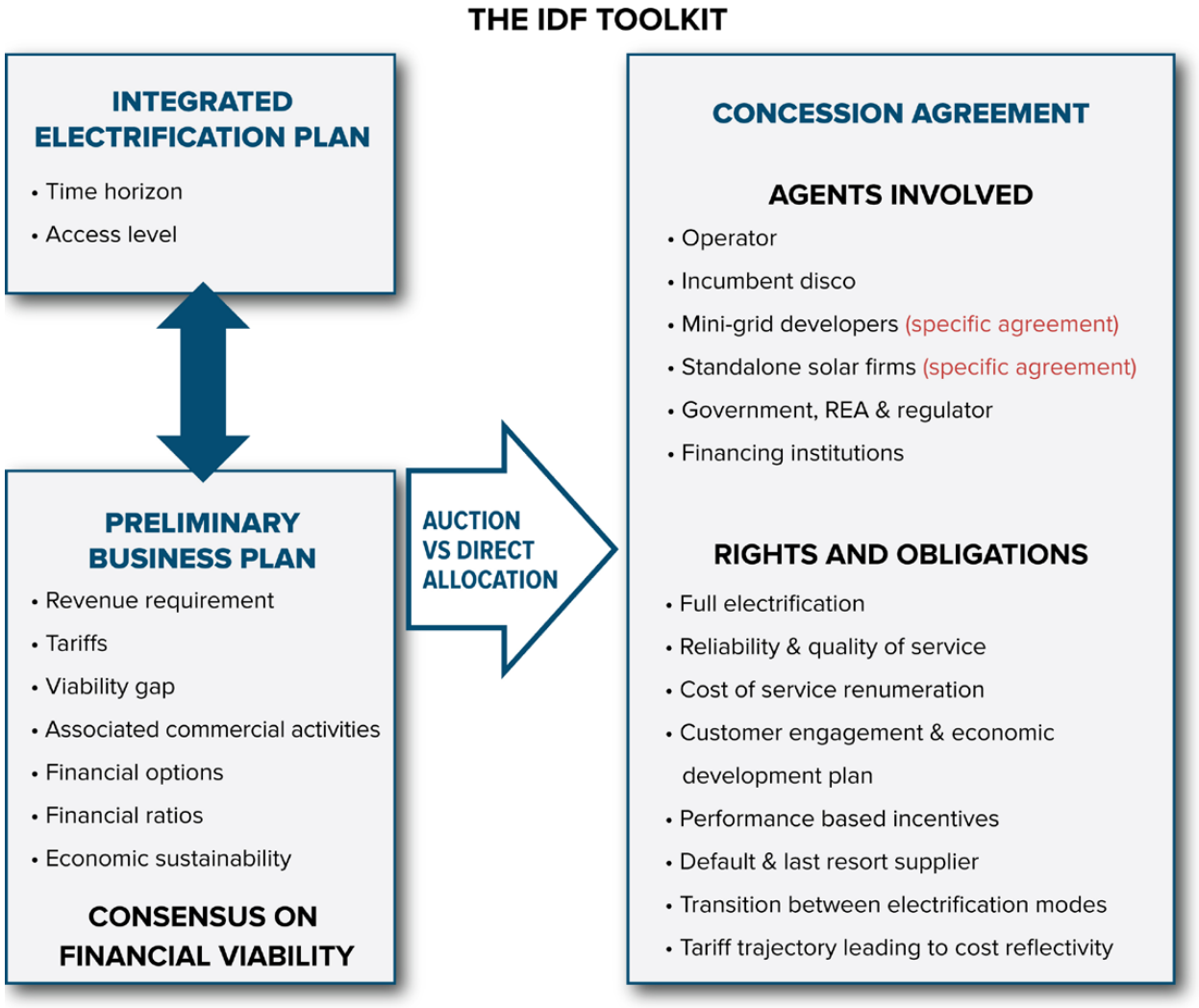


Figure ES.3 The integrated distribution framework toolkit

initiatives are currently underway to expand electricity access through single modes, such as mini-grids. Led by DFIs, foundations, private entities, NGOs and governments, these efforts can deliver important near-term gains in electrification, and so it is important to consider how they can eventually be integrated with the IDF approach, which requires broader regulatory support and a comprehensive business plan.

Rather than viewing targeted "bottom-up" programs as in conflict with the decidedly "top-down" IDF, we argue that these programs should be designed to include elements that provide for future integration into a regulated distribution business regime.[33] Indeed, the mindset that innovative bottom-up programs should be delayed or scaled back until after comprehensive integrated planning and reform of the distribution sector are in place must be resisted: rather, planning and reform must take successful bottom-up initiatives into account.

33 Examples of such design features could include: (i) stress tests of mini-grid business and financing models to shift from willing buyer/willing seller tariffs to a cost-of-service regime to identify optimum points of transition; (ii) the ability to anticipate and address information asymmetries to facilitate evaluation of mini-grid revenue requirements by regulators; (iii) providing clarity to mini-grids that may be subject to multiple regulatory regimes through project lifetime (e.g., mini-grid regulation, sub-concession/franchisee agreements); (iv) ensuring compatibility of mini-grid infrastructure with the grid to facilitate transition; and (v) building regulator capacity to assess mini-grid business and financing models.

SECTION 3

INTEGRATED DISTRIBUTION FRAMEWORK: ACTIVITIES AND LESSONS LEARNED

The GCEEP research team is actively engaged in efforts to apply the IDF approach in several "first action countries": Colombia, Nigeria, Rwanda and Uganda. In addition, we have been engaged in the somewhat unique

case of Odisha, India, where the largest distribution zone has transitioned to a private concessionaire.

We believe that the principles described in Section 2—universality of access, financial viability, integration of on- and off-grid solutions, and a focus on development outcomes—apply in all situations where countries face the dual challenge of improving the long-term viability of the distribution sector and achieving universal access, including by utilizing opportunities offered by distributed energy solutions. *Individually*, all of these principles have been widely discussed for many decades. The power of the IDF concept lies in bringing them to bear *collectively* and *rigorously* to achieve a durable transformation of the entire distribution sector.

Nevertheless, the IDF is not a one-size-fits-all solution—the fact that it can, and indeed must be, adapted to specific contexts means that its usefulness is not limited to a few countries with some favorable characteristics. Indeed, our experience has been that the IDF approach is applicable across a range of countries that have very little in common in terms of electricity sector regulation and business models. And while all the core principles of IDF are important and must be applied (as opposed to choosing some principles and leaving others out), they can be pursued incrementally as political economy, financial and human capacity, and experience permit. This is what we have found to be exciting and hopeful in our dealings with first action countries: each has an opportunity to make substantial progress toward achieving universal electricity access starting from its current situation, whatever that is.

3.1 A CANONICAL IDF EXAMPLE: THE CASE OF RWANDA.

The government of Rwanda has established an ambitious and comprehensive National Energy Sector Strategic Plan (ESSP)[34] that targets 100% electrification by 2024. With the support of multiple development partners, Rwanda successfully increased access to electricity from 10% of the population in 2010 to 43% in 2018, almost exclusively through grid extension.[35] But the pace of grid extension remains insufficient to meet the country's electrification target on schedule; in addition, increasingly cost-competitive off-grid solutions are now available.

With technical support from the national utility, Rwanda Energy Group (REG), and funding from the World Bank, the MIT/Comillas Universal Access Laboratory used its Reference Electrification Model (REM) software tool to develop a master electrification plan for the entire country. This plan describes a least-cost path to achieve universal access by 2024, subject to country-specific constraints and the national priorities laid out in the ESSP. Results from the modeling study can help inform prospective investors about off-grid market opportunities; they will also inform Rwanda's National Electrification

34 National Energy Sector Strategic Plan (ESSP) (2018), http://mininfra.gov.rw/fileadmin/user_upload/new_tender/Energy_Sector_Strategic_Plan.pdf
35 MININFRA and ESMAP et al. report "Rwanda: Beyond connections. Energy access diagnostic report based on the multi-tier framework", June 2018.

Strategy (NES) and National Electrification Plan (NEP).

In Rwanda, electrification is primarily a rural challenge: 77% of the urban population has access to electricity and receives high-tier service. By contrast, 84 % of the rural population has no access, with very few customers receiving high-tiers of service. Off-grid solutions are common in rural areas, but typically provide only low levels of service.

Because the country is small and densely populated, it will almost certainly be fully, or almost fully electrified through the national grid eventually. However, using grid extension to reach clusters with low demand is currently too expensive. In light of steep cost reductions in distributed solar technologies, the government has reconsidered its initial strategy, which was based on grid extension, and shifted focus to off-grid solutions that meet basic electricity needs for households. To enable the new approach, the government launched the MIT/ Comillas study, and has adopted new regulations for simplified licensing and development of small-scale mini-grids.[36]

In 2019, members of the GCEEP research team initiated conversations with key stakeholders in Rwanda about potentially adopting the IDF approach. Conversations have continued since, including with some GCEEP commissioners. The research team continues to examine the potential for a concession approach in Rwanda and, with support from SEforAll, is involved in ongoing discussions with the Ministry of Infrastructure, Transport, Energy and Sanitation (Mininfra) about drafting a electrification business plan.

In many objective respects, Rwanda is well-situated for a straightforward implementation of the IDF. Favorable conditions exist for each of the four IDF pillars and the government has made full electrification by 2024 a priority. Concentrated governance, and the existence of a single national utility capable of coexisting with mini-grid developers and stand-alone solution providers should help facilitate the design and adoption of a distribution concession agreement that encompasses the entire country.

The business plan developed so far by the GCEEP's research team includes a detailed quantitative template in spreadsheet format accompanied by an explanatory document. However, it addresses only the fraction of the distribution system that is still to be developed, including off-grid solutions, and will have to be expanded to include the existing distribution system under the Rwanda Energy Group (REG).[37] For the time being, the template is being used as a tool for discussion with key stakeholders, and to clarify and test the investment proposition for applying the IDF in Rwanda and elsewhere.

3.2 INTRODUCING IDF PRINCIPLES INTO A CONCESSION RENEWAL: THE CASE OF UGANDA.

Uganda's power sector has seen major changes over the last two decades as a result of comprehensive reforms adopted in 1999.[38] These reforms have yielded important results, particularly in generation where the country reached self-sufficiency, and currently has excess capacity. Unfortunately, limited investment and implementation challenges in the transmission sector are constraining the absorption of excess capacity. Uganda's priority now, in addition to expanding access, is to stimulate demand through industrialization, railway electrification, connection of large loads, and productive uses of electricity.

36 IRENA (2019). Policies and regulations for renewable energy mini-grids.

37 The detailed cost estimates provided by the MIT/Comillas electrification plan refer only to what remains to be electrified, not to what has to be done in the existing distribution network. The business plan can only be completed once this information is included in the financial analysis of the distribution concession business model.

38 World Bank Group (2019). Rethinking Power Sector Reform in the Developing World. https://www.worldbank.org/en/topic/energy/publication/rethinking-power-sector-reform

Extremely low rates of access represent a large and untapped demand opportunity for Uganda. Only 24% of the population has access to the grid compared to an average of 42% for Africa as a whole.[39] If off-grid sources are included, the access rate likely increases to 36%.

In 2005, Uganda Electricity Distribution Company Limited (UEDCL) leased its distribution assets, which were inherited from the Uganda Electricity Board (UEB), to Umeme Limited (a private entity) under a 20-year concession arrangement that was intended to reduce system losses, increase collection efficiency and attract private financing, and improve service for customers. Currently, the Umeme-operated network covers more than 90% of the entire electricity distribution network across major urban and peri-urban areas. It has almost no presence in rural areas. Umeme has been able to recover most of its tariff costs and has the distinction of being one of very few financially viable utilities in sub-Saharan Africa.

Besides Umeme, eight other service providers operate in Uganda outside Umeme's footprint. These consist mainly of small cooperatives with limited capacity, operating in rural areas with largely unviable business models. There is significant interest in developing mini-grids in areas where access is difficult and expensive, and in increasing the penetration of home-based solar systems. The level of activity in this area, mostly by private entities, has been remarkable.

In 2017, the MIT/Comillas Universal Access Lab partnered with GIZ to model the potential for using mini-grids to electrify Uganda's Southern Territory. Shortly afterwards, members of the present GCEEP research team, together with members of the Shell Foundation (SF), initiated contacts to discuss IDF with key stakeholders in Uganda. This relationship continues, facilitated by the presence of the Chairman of Umeme on the GCEEP. The director of the GCEEP research team is currently participating in a Technical Assistance Facility of the European Union to provide a better understanding of how distribution system reforms and concession agreements could be used to increase electricity access in Uganda. The GCEEP research team has also sent a technical note to relevant stakeholders in Uganda that highlights how the IDF could guide the design of the distribution business model in the next period and ensure that full electrification is a priority.[40]

3.3 APPLYING THE IDF TO ELECTRIFY THE LAST 5%: THE CASE OF COLOMBIA.

With support from the Inter-American Development Bank, the government of Colombia has embarked on a project of transforming and modernizing the country's power sector.[41] A component of this project involves designing a business model to extend access to some 3 million people (about 400,000 households) in "non-interconnected zones." These zones constitute around 51% of Colombian territory.

Colombia's existing level of electrification exceeds current averages for Latin American and the Caribbean. In fact, 97% of homes have access to electricity. Yet there are still more than 400,000 households without access, more than half of which are located in zones adjacent to the National Interconnected System (SIN). The rest are in non-Interconnected zones (ZNI), which are often difficult and expensive to access.

Achieving complete and sustainable electricity coverage in the ZNIs requires investment, especially by the private sector. The director of the GCEEP research team, in collaboration with Colombian experts, has been advising the government on designing a business model for the electrification of the non-interconnected zones. Preliminary recommendations were delivered to the

39 According to other sources, such as the National Development Plan III 2021–2025, the access rate is somewhat higher, at 28%. Uganda's overall population is estimated to be 41.2 million (population growth 3.02%) of which 84% is considered rural, with annual per capita GDP of USD 878. Uganda remains one of the poorest countries in the world, with 21.4% of the population living on less than USD 1.25 a day.

40 Pérez-Arriaga, I. and Stoner, R. "Uganda distribution sector diagnostic. Comments." Technical Note. January 2020.

41 The title of the project is: "Transformation and modernization of the power industry: Roadmap for the energy of the future."

Minister of Energy on November 15, 2019. A final report was presented in Bogotá on January 28, 2020, followed by meetings with the main stakeholders. The report strongly recommended direct application of the IDF, suitably adapted to the conditions of Colombia's ZNIs.

Details of the research team's recommended approach are described in the main report and in a GCEEP working paper. Broadly speaking, this approach encompasses (i) the need for integrated benchmark planning; (ii) a regulatory framework in line with the IDF that permits scalability and mobilization of all required efforts for universal service and long-term sustainability; and iii) an institutional framework as well as a governance structure.

In May 2020, the Colombian Institute for Planning and Promotion of Energy Solutions (IPSE) launched a project in the ZNIs with a group of experts coordinated by the director of the GCEEP research team and one of its members. The project, also funded by the IADB, has collected information about international best practices in the electrification of isolated rural areas with solar home systems. Project members issued IDF-aligned recommendations for application to Colombian ZNIs.

3.4 EXPERIENCES IN PURSUING IDF IMPLEMENTATION: THE CASE OF NIGERIA.

As the country with the largest population that still lacks access to electricity, Nigeria is a priority for efforts to reduce energy poverty. Nigeria is also among the few sub-Saharan countries that have a relatively progressive policy and regulatory environment; its distribution sector is privatized and comprises eleven discos. Nonetheless, the sector still faces severe liquidity and operational challenges that result in low quality of supply for consumers and low investments in expanding electricity access. Nigerians currently spend an estimated USD 14 billion annually on self-generation due to the poor reliability of grid-connected power.

In 2017, the MIT/Comillas Universal Energy Access Lab and Shell Foundation met jointly with key stakeholders in Nigeria (including several distribution companies). The objective was to define a viable large-scale distribution business model that could be deployed in one or more developing countries. This collaboration produced the concept of the "integrated distribution company" or, alternatively, the "energy company of the future"—a first version of the IDF concept. A start-up, called Konexa, was then created to implement it. Konexa applied MIT/ Comillas REM tool within the sub-concession area to determine the combination of grid extension and off-grid technologies that would provide adequate supply at least cost.

Another set of IDF-related activities in Nigeria involves the Abuja Electric Distribution Company (AEDC), a privately-owned disco. AEDC's total franchisee area represents about 15% of the entire country by land area. Much like other discos, AEDC is also facing substantial and mutually reinforcing challenges related to liquidity crunch, non-cost reflective tariffs, high AT&C losses, and high cost of service.

As part of its Performance Improvement Plan, AEDC has developed a "Distributed Energy Solutions Strategy" (DESSA) to attract third-party and private investments in distributed energy solutions in selected areas within its service territories.[42] (A pilot has already been conducted with the Wuse Market interconnected mini-grid.) With its focus on integrating grid-based and distributed solutions, creating a legal framework for private sector participation and capital, and advancing the long-term viability of the disco, DESSA is an important step in the direction of an IDF-like approach and could provide a blueprint for similar programs in Nigeria and elsewhere.

42 This includes the use of distributed generation, storage and demand side management solutions.

3.5 OFF-GRID SOLUTIONS UNDER THE GRID: THE EVOLVING CASE OF ODISHA AND TPRM IN INDIA

The state of Odisha, in India, offers an opportunity to apply the IDF in a situation where most consumers have grid connections and the focus is more on improving the quality of supply. Tata Power recently won a concession for the largest distribution zone in Odisha. The concession follows a similar public–private partnership structure that has been successfully applied in the city of Delhi but it covers an area that is largely rural and that has low population density and low rates of consumption.[43]

The recent launch of Tata Power Renewable Microgrid (TPRM) company is a key related development. With support from the Rockefeller Foundation, TPRM anticipates setting up 10,000 mini-grids in India by 2026.[44] To reach this goal, grid-compatible mini-grids will have to be developed in areas with an already existing infrastructure.

Implementation of the IDF in Tata Power's concession area in Odisha might begin with a least-cost planning assessment to identify areas that are more economically served by deploying distributed energy sources (including generation assets, storage, and some network developments) instead of extension and/or reinforcements of the main grid. The detailed nature of the underlying business models will depend on the regulatory regime for distribution in India, which is gradually evolving towards more public-private-partnerships (e.g., through sub-licenses and franchises).[45]

The GCEEP research team continues to monitor developments in India while engaging with key stakeholders (including regulators, the private sector, Tata Power and Smart Power India) to identify optimal ways of leveraging distributed energy solutions as part of the IDF approach in the Indian context.

3.6 WHAT LIES AHEAD

To advance beyond the present stage and enable IDF adoption by the many countries where we believe it could be applied requires continued effort on multiple fronts. A first priority is to **further develop the IDF implementation toolkit** so that it provides the additional detail needed to address practical challenges arising from IDF adaptation and implementation at the national level (for example, with respect to issues such as the design of concession agreements, financial analysis of electrification plans, and financing arrangements). Another task is to **evaluate and prioritize additional countries** that could be candidates for IDF implementation in the near term. This should be done in consultation with stakeholders (internal and external) and national governments, with the aim of identifying and engaging local champions and convening parties to create consensus.

Finally, further **advocacy and engagement** are needed to create broader understanding of the social and economic value of expanding electricity access through the IDF approach. This will involve continued interaction with relevant stakeholders—DFIs, governments, large energy companies and influential institutions—and efforts to mobilize resources for implementation.

43 Tata Power – DDL is a public-private-partnership between Tata Power (51% ownership) and the Government of Delhi (49% ownership) which has a concession to undertake distribution in one of four zones of Delhi. See Working Paper on "How is the distribution sector in low-access countries attracting private sector participation and capital?" for further details.

44 https://www.rockefellerfoundation.org/news/tata-power-rockefeller-foundation-announce-breakthrough-enterprise-empower-millions-indians-renewable-microgrid-electricity/

45 This point is reflected in the proposed amendments to the Electricity Act. See: https://economictimes.indiatimes.com/news/economy/policy/power-ministry-brings-new-draft-of-electricity-amendment-bill/articleshow/75220967.cms. See main report for further discussion of the interaction between regulation and viable business models.

SECTION 4

ISSUES IN GENERATION, TRANSMISSION AND REGIONAL TRADE

While distribution remains a key point of failure in many developing countries, a holistic view of the power sector—one that encompasses centralized generation, transmission, distribution with retail, and off-grid solutions—remains essential to achieve access and sustainability objectives.

For sub-Saharan Africa, in particular, key challenges include mobilizing the very large investments needed to finance major expansions of generation and transmission capacity, managing the rapid growth of variable renewable energy technology, improving resilience and mitigating and adapting to climate change, strengthening regional institutions, and realizing greater benefits from trade. Opportunities to make progress in the bulk power sector in individual countries and in the region as a whole are clear and very sizable. Natural resources are plentiful and potential future demand is enormous – but creating economic value from this potential will require commensurate investments in transmission and generation infrastructures. Cross-border trade can justify the installation of cross-border lines and the construction of power plants to unlock the outsized resources of individual countries, benefitting them and their neighbors. Sound regulations and business models, backed up trustworthy institutions, are the sine qua non conditions to attract the required amounts of private investment.

Our recommendations for these segments of the power sector can be summarized as follows: There is need to identify and disseminate the best regulatory and business model practices that can make possible large investments in transmission and generation infrastructures. Particular attention should be focused on removing barriers to the deployment of medium and large renewable plants. Best practices must be adapted to local situations, and their adoption must be promoted among the political leadership and other decision makers. The same can be said of regional trade, where it is not only necessary to revise market rules and transmission regulation at the regional level, but also to upgrade the regional institutions themselves so that they have real executive power and can make sure that opportunities for efficient power exchanges are not missed and transmission lines that are well-justified economically are built. [46]

On the issue of market rules for regional power trade and transmission regulation in particular, the GCEEP research team, following an initiative of the Tony Blair Institute, is advising the West Africa Power Pool (WAPP) on reforms aimed at reducing operation costs, improving reliability, and supporting major investments in renewable energy. West Africa is an appropriate candidate for enhanced trade—some countries have generation surpluses while others have deficits and high costs, and parts of the region have substantial renewable energy potential. In fact, the World Bank "*estimates that the economic benefits of a fully integrated power market are on the order of USD 5-8 billion per year for West Africa, with the potential to reduce the cost of electricity services by half in many countries in West Africa.*"[47] An analysis conducted by the Tony Blair Institute, USAID, and Power Africa estimates that USD 30 billion in savings could be achieved through mutually beneficial power trading and large-scale regional solar development.[48]

The transmission cost allocation methods proposed for WAPP so far, however, do not seem to reflect best practice internationally. For instance, allocating the costs of cross-border transmission infrastructures only to those parties engaged in cross-border commercial transactions is a major flaw that disincentivizes trade without any economic justification – even if the rule sounds "intuitively

46 There are currently five regional power pools in sub-Saharan Africa, all at varying stages of maturity. So far these power pools have largely performed below expectations – or just failed to start functioning.

47 The World Bank. 2019. "Burkina Faso Electricity Access Project." Project Information Document.

48 Tony Blair Institute for Global Change. 2019. "West Africa Power Trade Outlook." Power Africa Senior Advisors Group Program.

reasonable."[49] Sound regulations, by contrast, should: (i) facilitate investment in transmission by reducing as much as possible any economic justification for the stakeholders to oppose a beneficial project, and by reducing any unnecessary risks in the agreed remuneration of the project; (ii) promote investment in generation by reducing the risk of future uncertain transmission charges; and iii) facilitate efficient trade by avoiding charging enormous – and unjustified – fees to those who sign bilateral contracts with agents in other countries. A Working Paper by the GCEEP research team [50] addresses these issues in detail, highlighting the need for capacity building in development of operational rules for power pools in sub-Saharan Africa.

Indeed, capacity building in power sector regulation – and power trading in particular – is one of the main recommendations of the African Union-European Union High Level Energy Platform where several members of the GCEEP participate. An ambitious capacity building program on energy regulation is presently being prepared by a small group that includes several members of the GCEEP.

SECTION 5

THE WAY FORWARD

5.1 TAKING STOCK AFTER THE FIRST YEAR

The Commission's quest to design a flexible approach for expanding electrification through the use of financially viable business models has led us to develop the IDF concept described in Section 2 of this summary. As we have seen, the IDF approach has already gained traction in a number of countries. We have also collaborated closely with the Tony Blair Institute to establish a basis for informing decision-making about regional-scale transmission and generation projects in West and East Africa. A team of GCEEP members would be well-positioned to provide technical support as well as inputs at a political level to strengthen regional institutions across Africa.

Looking ahead, regulation stands out as an applied field of knowledge – blending engineering, economics, and law – that is essential to helping developing countries plan and implement the transition to a more inclusive, sustainable, and prosperous energy future. In an effort to support capacity building in power sector regulation, several GCEEP members, in collaboration with other institutions, are spearheading an initiative to launch an African School of Regulation (ASR). We envision a center of excellence, headquartered at some African academic institution, that supports independent discussion and knowledge exchange in support of higher-quality energy regulation and policy formulation. The ASR would bring together academics and practitioners, offer training courses, develop best-in-class tools and templates, and sponsor policy dialogue as well as applied research. It would engage not only with energy regulators but also with other key stakeholders who are affected by regulation and who have important roles to play in achieving the goal of universal access to affordable, reliable, sustainable, and modern energy.

Africans will shape the sustainable energy transition on the continent, enhancing or creating the institutions needed to build and operate their infrastructures. Training and education offer a low-cost opportunity to build increased capacity for addressing challenges, especially compared to the capital and operating costs of energy infrastructure. Moreover, encouraging local empowerment and ownership through capacity building can create a domino effect of improvements throughout the entire energy supply chain. The ongoing process of digitalization represents an opportunity to accelerate this process.

49 After long debates in the early 2000s, the regulation of the Internal Electricity Market of the European Union explicitly stated that transmission charges must not depend on commercial transactions. See Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the Internal Market for Electricity.

50 GCEEP research team Working Paper "On transmission cost allocation in the West African Power Pool (WAPP). The case of the OMVG transmission project", Ignacio Pérez-Arriaga, 2020.

Clearly, the context in which our Commission operates has changed in the past year. We find ourselves in the middle of a global pandemic and facing the prospect of a lengthy and uneven economic recovery that could compound inequalities and erase decades worth of progress on poverty alleviation. The urgency for governments to take strong action to address the health and socio-economic fallout from the current crisis cannot be overstated.

Thus, we strongly endorse the call by the United Nations' High-level Political Forum to place its 2030 Agenda at the heart of the COVID-19 recovery effort. We agree that the international community must respond by implementing a "Marshall Plan" for economic recovery in the developing world and by accelerating progress toward sustainable development goals, including the goal of achieving universal energy access.

In terms of GCEEP activities for the next year, we will continue supporting promising ongoing developments in the first action countries. We also propose to launch a portfolio of selected actions that will be centered on ending energy poverty and that can be included as a key component of larger "sustainable energy infrastructure" efforts to be undertaken in the context of COVID-19 recovery. Specific elements of a GCEEP action plan are discussed in the next section.

5.2 ACTION PLAN

GCEEP's action plan aims to leverage the diverse perspectives, expertise, and influence of Commission members to advance our mission of ending energy poverty around the world. It encompasses several categories of activity, including advocacy, technical assistance, stakeholder engagement, capacity building, and evaluation. Specific action items in each category are summarized below:

Advocacy

1. Universal energy access must be at the top of agendas for health, economic recovery, and sustainable energy. As the world fights the unprecedented crisis presented by COVID-19, a stubborn commitment to ending energy poverty by 2030 must remain central. Conveying this message at decision-making levels, convening the relevant stakeholders, and providing technical support for the adoption and implementation of the IDF in developing countries with access deficits is a critical part of the mission of the GCEEP. As governments and other institutions plan trillions of dollars of stimulus funding, investing in energy access in developing countries must be a priority in international and national efforts to "build back better" and be guided by sustainable development and climate objectives.

Research and Technical Assistance

2. In the short-term, extend technical and advisory support to governments and utilities to design mechanisms that enable end consumers (households, enterprises, and public institutions) adversely affected by the COVID-19 pandemic to remain connected. Tailored support will also be needed for enterprises in the power sector that have experienced significant financial and operational disruption.

3. Lead further development of the IDF toolkit through orderly engagement with low-access countries by one or more suitably staffed "engagement teams." These teams should include a full-time core of technical, regulatory and financial experts, as well as scholars and other specialists who participate on a part-time or case-by-case basis.

4. Facilitate the utilization – by governments, DFIs and other authorized stakeholders – of advanced software tools for key tasks such as electrification planning,[51] demand forecasting (and its relation to productive uses), and financial analysis.

5. Work with committed governments to develop comprehensive access programs based on IDF principles, and incorporating best practices from around the world, including in the area of blended finance.

Engagement with Regional Leadership on Energy Cooperation

6. Provide technical assistance and political support to regional institutions and governments in Africa to

51 An example is the suite of models for geospatial electrification planning developed by the MIT/Comillas Universal Energy Access lab, see http://universalaccess.mit.edu

reinforce these institutions and improve existing rules for regional trade in electricity.

7. Engage national political and business leaders to build support for regional cooperation on energy projects with the explicit goals of reducing costs, improving resiliency to natural and man-made disasters, and planning for a substantially decarbonized power system.

Institutional and Individual Capacity Building

8. Share innovative approaches and best practices from the accumulated experience of countries that are pursuing aggressive universal access programs consistent with IDF principles, including by making extensive use of online platforms and teaching opportunities.

9. Engage and leverage the skills of specialized institutions, such as the proposed Africa School of Regulation as well as MIT and other research universities that have active programs in fields such as energy regulation, planning, and low-carbon development.

Progress Measurement

10. Adopt a practical methodology to enable tracking and inform the design of successful programs to end energy poverty. Important dimensions to track include those that relate the IDF principles, as well as other factors such as affordability, reliability of service, and adequacy for healthcare and education. Periodic reporting on the progress countries have made will be important, both to sustain momentum and to develop insights about how efforts can be further accelerated.

A key role for the Commission in advancing this plan will be to help convene and provide a platform for the many actors who are already deeply engaged in the cause of ending energy poverty. All must be part of a call to action to achieve the goal of universal access to affordable, reliable, sustainable and modern energy.

Specifically, we call on **country leaders** to develop national plans aligned with the principles of the IDF for eradicating energy poverty by 2030, and to articulate commitments to specific programs and reforms designed to achieve this goal. We also call on country leaders to join us in seeking ways to increase investments in generation and transmission nationally and to facilitate regional trade in power.

We call on **DFIs** to explicitly link near-term recovery packages aimed at ensuring the continuity of essential services to the achievement of long-term investment in resilient infrastructure necessary for ending energy poverty and meeting multiple sustainable development goals. We also call on DFIs to dramatically increase the role of blended finance (with a focus on lowering financial risk to private investors in distribution utilities organized under IDF principles) and to identify and find ways to overcome barriers to private sector investment in distribution, generation, and transmission more broadly.

We call on **private sector lenders and investors**, notably pension funds and others that traditionally invest in utilities in advanced economies, to join with DFIs and national governments in blended financing arrangements for IDF-modeled distribution companies, and upstream transmission and generation projects. To facilitate the necessary dialogue, we propose to form an expert subcommittee on expanding private sector investment in the electricity sectors of low access countries.

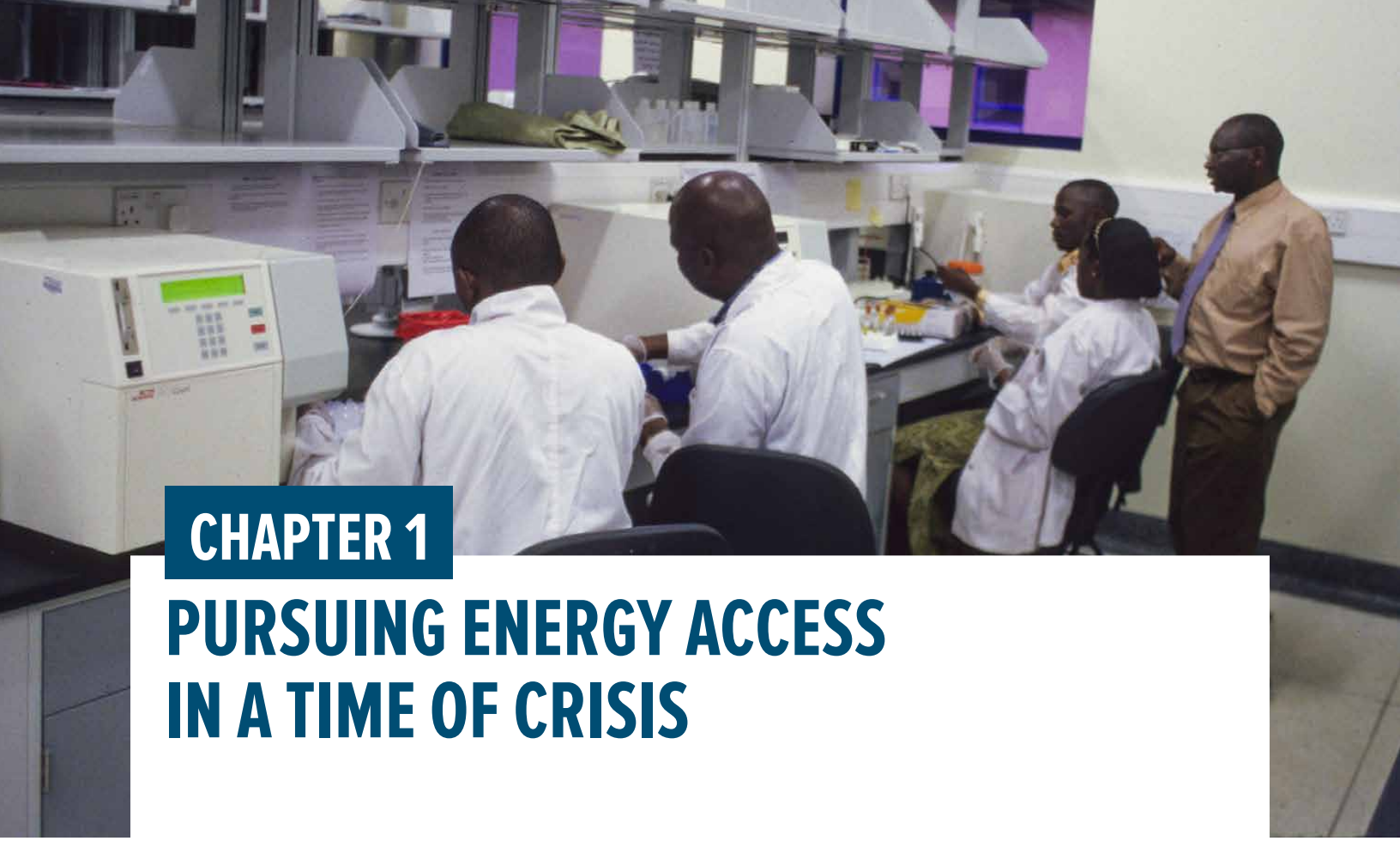
Finally, we call on **utilities** around the world to develop, in partnership with national governments, investable business plans for the distribution system that are aligned with IDF principles. We also call on utilities to provide financial support to critical training and capacity-building programs, such as the proposed Africa School of Regulation and other regional centers.

As for the GCEEP, we look forward to expanding our engagement with all relevant actors and with other key stakeholders as we advance critical energy and sustainable development goals in the months and years ahead. Throughout, we intend for our work as a commission to continue to be distinguished—both by a singular focus on practical solutions and by a commitment to consistently aligning global priorities and resources behind the best ideas.

2020 Report– Electricity Access

FULL REPORT

Global Commission to
End Energy Poverty



CHAPTER 1

PURSUING ENERGY ACCESS IN A TIME OF CRISIS

1.1 THE OBJECTIVE

Our Commission was first convened in September 2019 to begin its work of forging an actionable vision for ending energy poverty that would ultimately form the basis of this report. We aim to contribute to end energy poverty in all its forms – in broad alignment with the objective of United Nations Sustainable Development Goal (SDG) 7: ensuring universal access to affordable, reliable, sustainable, and modern energy by 2030. Ending energy poverty is a prerequisite to achieve many of the other SDGs and, in sum, to end poverty. Our report is a call for action to address critical areas where progress in ending energy poverty can be made faster, more efficiently, and at large scale.

Universal energy access is a baseline for addressing poverty and for an inclusive recovery from the COVID-19 crisis.

Universal energy access is a baseline for addressing poverty and for an inclusive recovery from the COVID-19 crisis. We want to align our efforts with the global and national recovery packages that governments and international institutions are currently developing on a scale that will shape infrastructure and industries for decades to come, aiming for long-term growth and sustainable development. Our recommendations pursue an energy system that is more inclusive, but also cleaner, more secure, resilient, and cost effective.

We have chosen to focus initially solely on the particular issue of *universal electrification*. We acknowledge that we are leaving aside all uses of energy resources other than electricity production and consumption, notably those employed in cooking, heating, and industrial processes. Indeed, such energy resources, including traditional firewood, account for most of the total energy consumed in many low-access countries. However, we believe that our initial focus on access to electricity, the signature of modern societies, is appropriate as a readily available and effective means of making rapid progress. The Commission intends to return to other critical aspects of energy poverty, such as access to clean cooking fuels, in the future.

The COVID-19 crisis has underlined the importance of a reliable, affordable and secure electricity supply. In the words of the International Energy Agency (IEA), electricity "*has enabled hospitals to provide care, food to be delivered, and allowed millions of people to work remotely and be home-schooled. It has also underpinned*

digital connections with family and friends. Where access to reliable electricity remains a challenge, the impact of this on health services, economic activity and the wellbeing of households during the crisis has served to underline the urgency of achieving universal access to energy."[1] The recovery from the crisis in emerging economies should be centered on advancing inclusive, climate-friendly energy infrastructure. In this context, the electricity sector will play a key role in supporting economic recovery, and an increasingly important long-term role in unlocking economic opportunities, local jobs and welfare in presently underserved areas.

Our approach to achieve universal electricity access must be commensurate with the magnitude of the challenge. In a few words: we must think big. Our mission is to achieve full electrification of entire provinces, countries, and even regions so that all citizens, public institutions, businesses, and industries have access to safe, secure, affordable, reliable, and adequate energy services. Even for small countries where a substantial fraction of the population lacks access[2] or for larger ones that are struggling to complete electrification,[3] the volume of required investment can be several billions of dollars, rapidly increasing to tens of billions in larger countries with low rates of electrification. This demands substantial participation by the private sector, supported by public investment and by guarantees from governments and development finance institutions (DFIs), as well as by suitable policies and regulations and innovative business models that can support both centralized and distributed solutions.

1.2 THE CONTEXT

Energy poverty comes in multiple forms. It exists in developed economies where families cannot afford to pay their energy bills. Mostly, however, energy poverty occurs in emerging economies where hundreds of millions of households, farms, firms, schools, and clinics have limited or no access to electricity and clean cooking fuels. This is the context where our Commission has focused its efforts.

With about a decade to go, the global community finds itself woefully short of achieving the target of the 2030 Agenda for Sustainable Development to reach universal access to affordable, reliable, sustainable, and modern energy services by 2030. As of 2018, 789 million people still did not have access to electricity.[4] Around 3.5 billion lacked access to reliable supply.[5] Investment levels have fallen well short of estimated requirements for reaching universal access by 2030. Financing to provide access to non-electrified populations reached USD 12.6 billion in 2017,[6] compared to the at least USD 40 billion estimated to be needed annually until 2030.[7] A step change in the ambition, resolve, and actions of all stakeholders is overdue if we are to reach universal access by 2030.

> With about a decade to go, the global community finds itself far short of the mobilization needed to achieve SDG 7

The onset of the COVID-19 health crisis and its social and economic implications have added to the urgency of the Commission's mission. Not only has the crisis shed light on the critical role of reliable electricity access in delivering critical care, it has also highlighted issues related to growing urbanization, resilient livelihoods, jobs, and local economic development. The imperative to overcome the COVID-19 crisis and to rebuild damaged economies brings a new exigence to the Commission's mandate of ending energy poverty and reordering priorities. Without losing the long-term perspective of our mission, we must place it in its present context where even more is at stake.

1 International Energy Agency (2020). "World Energy Outlook 2020". https://www.iea.org/reports/world-energy-outlook-2020
2 For instance, Rwanda, with about 12 million people and less than 40% electrification.
3 For instance, Colombia, with about 50 million people and 97% electrification.
4 IEA, IRENA, UNSD, World Bank and WHO (2020), Tracking SDG 7: The Energy Progress Report, https://trackingsdg7.esmap.org/data/files/download-documents/01-sdg7-executivesummary_0.pdf
5 John Ayaburi, Morgan Bazilian, Jacob Kincer, Todd Moss, Measuring "Reasonably Reliable" access to electricity services, The Electricity Journal, Volume 33, Issue 7, 2020, 106828, ISSN 1040-6190, https://doi.org/10.1016/j.tej.2020.106828.
6 SEforAll (2019), Energizing Finance: Understanding the Landscape 2019, https://www.seforall.org/publications/energizing-finance-understanding-the-landscape-2019
7 IEA (2020), SDG7: Data and Projections, https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity

COVID-19 has altered the context of the power sector. In the short term, ensuring reliable energy services to health and critical infrastructure must be given priority. Health centers need reliable power supply, yet only 28% of healthcare facilities in sub-Saharan Africa (SSA) benefit from it.[8] Further, the income and revenue shock faced by many vulnerable households and firms will often result in reduced expenditures on energy and payment delays to utilities, mini-grid operators, and solar home system companies. This has resulted in further operational and financial challenges for these companies, leading to additional working capital requirements to tide them over the crisis. Governments are also being forced to shift their immediate priorities, which is leading to delays in financing for expanding and improving electricity infrastructure.

For many people, falling back into energy poverty is a possibility.[9] Reversing several years of progress, the IEA estimates that the number of people without access to electricity in SSA will rise in 2020. At the same time the IEA further estimates that a rise in poverty levels worldwide may have made basic electricity services unaffordable for more than 100 million people who already had basic electricity access, presaging a return for many to more polluting and inefficient sources of energy.[10]

In the medium to long term, the power sector has the potential to play a critical role in economic recovery. Imminent recovery packages offer an unprecedented opportunity to invest in resilient, inclusive, and sustainable infrastructure, across sectors, to bolster growth and development. An estimated USD 2.5 trillion COVID-19 rescue package – including a USD 1 trillion investment injection – is urgently needed for the world's emerging economies.[11]

Governments must make important investment decisions in a short period of time. According to the IEA's 2020 World Energy Outlook Special Report, *"[t]hese decisions will shape economic and energy infrastructure for decades to come and will almost certainly determine whether the world has a chance of meeting its long-term energy and climate goals."*[12] Sustainable Energy for All emphasizes that governments have a *"unique, once-in-a-generation opportunity to reset their economies and address the underlying structures that enable development and competitiveness."*[13]

Achieving universal electricity access will affect and be critically influenced by these decisions. The pandemic has been a startling reminder of the importance of linking energy access with end-uses across sectors in order to ensure reliability, affordability, and sufficiency of supply. Access to electricity is a necessary – even if not sufficient – factor for inclusive economic development.[14] Reliable and affordable power from the main grid or from off-grid solutions enables delivery of critical public services in cities, towns, and villages. It also improves the competitiveness and profitability of millions of commercial and industrial customers who are presently relying on expensive fuel-based generators. Economic recovery and growth to close the gap between emerging and advanced economies can only happen with affordable and reliable power for all.

1.3 THE ECONOMIC, SOCIAL AND ENVIRONMENTAL CASE FOR INVESTING IN ELECTRICITY ACCESS

In this section we make the case that, when aligned with medium- and long-term global climate and sustainability goals, investing in expanding electricity access as part of COVID-19 recovery plans will yield substantial socio-economic and environmental benefits. There is a strong case to build electricity access in developing countries into the recovery strategies that governments and international institutions are now putting together.

COVID-19 forces us to think hard and adjust the ambition and focus of current electrification strategies. As governments in emerging economies face significant fiscal constraints, it is important for recovery stimulus to be directed at sectors that yield significant socio-economic dividends. Now and in the post-COVID-19

8 Sustainable Energy for All (n.d.), "Powering Healthcare: About Us", https://poweringhc.org/about-us/
9 IRENA (2020), Post-COVID recovery: An agenda for resilience, development and equality, https://irena.org/publications/2020/Jun/Post-COVID-Recovery
10 International Energy Agency (2020). "World Energy Outlook 2020". https://www.iea.org/reports/world-energy-outlook-2020
11 UN (2020), USD 2.5 trillion COVID-19 rescue package needed for world's emerging economies, https://news.un.org/en/story/2020/03/1060612
12 IEA (2020), Sustainable Recovery: World Energy Outlook Special Report, https://www.iea.org/reports/sustainable-recovery.
13 SEforAll (2020), The Recover Better with Sustainable Energy Guide for African Countries, https://www.seforall.org/publications/recover-better-africa.
14 Eberhard, A. and Dyson, G. (2020), What is the impact of investing in power?, https://assets.cdcgroup.com/wp-content/uploads/2020/01/30151049/Whats-the-impact-of-investing-in-power.pdf.

world, universal electricity access must be recast as a necessary pillar of an inclusive economic recovery. Moving forward, it must remain a key contributor to delivering resilient services in healthcare, water and education, and, when approached correctly, a step in the path towards a clean and decarbonized economy.[15]

1.3.1 Universal electricity access to strengthen economic growth.

Access to affordable, reliable and sufficient electricity catalyzes local economies, creates jobs and improves access to public services, especially in rural areas. Evaluations of development finance institution (DFI) electricity investments in developing countries have shown a significant impact on GDP; the effect is especially large in low-income countries with small power sectors.[16] In Senegal, GDP rose 1.7% with lower electricity costs and higher availability of power as a result of the commissioning of a 70 megawatt (MW) generation project.[17] Uganda witnessed an estimated 2.6% boost to GDP as a result of improvements in the electricity system, including the commissioning of a 250 MW hydropower plant.[18]

Investments in the electricity sector generate new jobs due to construction and operations; however the greatest effect is seen through increased economic activities.[19] There is also growing evidence for the socio-economic impacts of off-grid solutions such as solar home systems. In East Africa, one-third of the solar home systems purchased are used to extend the working day or boost enterprise activities. These purchases result in increased earnings by an average of USD 46 per month, equivalent to a 14% increase on average income in the region.[20]

1.3.2 Universal electricity access as a catalyst for inclusive development

The COVID-19 crisis has demonstrated the importance of linking electricity supply with end-uses to maximize socio-economic benefits. Delivery of public services such as healthcare, education and water is improved substantially with access to reliable and sufficient electricity, thus contributing to multiple Sustainable Development Goals. In the Indian state of Chhattisgarh, nearly 1200 health facilities (or 85% of all primary, community and district facilities) have been electrified using solar technology to deliver round-the-clock supply. Solarized health facilities have seen 50% more patients admitted, twice the number of monthly childbirths, and 90% of primary healthcare providers reporting cost savings and staff retention.[21]

Productive use of energy is also crucial to maximize the impacts of electrification on people's livelihoods. Focusing on rural enterprise development, job creation, gender-sensitive programming, and demand stimulation supports inclusive economic growth. Such focus also improves the viability of electricity service delivery in rural areas. In Ethiopia, linking agriculture and rural electrification could unlock USD 4 billion in benefits to smallholder farmers from improvements in agricultural productivity and processing. Further, communities could save another USD 120 million in fuel costs and improve the utility's annual revenue stream by USD 22 million.[22]

1.3.3 Universal electricity access as a component of the energy transition towards decarbonization

The energy sector is the largest contributor to greenhouse gas emissions globally; it will play a crucial role in the world meeting its decarbonization targets.[23] In

15 "A technologically advanced, sustainable, and resilient infrastructure can pave the way for an inclusive post-COVID economic recovery." Low and middle-income countries could see USD 4 return for every USD 1 spent on building infrastructure that focuses on long-term resilience, see WEF (2020), "How sustainable infrastructure can aid the post-COVID recovery," at: https://www.weforum.org/agenda/2020/04/coronavirus-COVID-19-sustainable-infrastructure-investments-aid-recovery/

16 CDC Group (2020), What is the impact of investing in power?, https://assets.cdcgroup.com/wp-content/uploads/2020/01/30151049/Whats-the-impact-of-investing-in-power.pdf

17 Steward Redqueen (2017), "The Link between Power Investments and Jobs in Senegal." London.

18 Steward Redqueen (2016), "What Is the Link between Power and Jobs in Uganda? Report to CDC Group PLC." London.

19 ibid

20 GOGLA (2020), Powering Opportunity: Energising Work, Enterprise and Quality of Life with Off-Grid Solar, https://www.gogla.org/sites/default/files/resource_docs/powering_opportunity_global_report.pdf

21 CEEW (2017), Powering Primary Healthcare through Solar in India: Lessons from Chhattisgarh, https://www.ceew.in/publications/powering-primary-healthcare-through-solar-india

22 Borgstein, E., Wade, K., and Mekonnen, D. Capturing the Productive Use Dividend: Valuing the Synergies Between Rural Electrification and Smallholder Agriculture in Ethiopia, Rocky Mountain Institute, 2020. http://www.rmi.org/insight/ethiopia-productive-use/.

23 IEA (n.d.), "Climate change: The energy sector is central to efforts to combat climate change", https://www.iea.org/topics/climate-change

the short to medium term, the implications of meeting SDG 7.1 (i.e., bringing electricity and modern cooking fuels to those who presently lack access) from an emissions standpoint have been declared largely negligible.[24] However, the long-term implications cannot be ignored as energy demand evolves, strengthening the case for holistic planning for the power sector that aligns access and environmental objectives. In contexts where electricity access already exists, efforts in the direction of improving the reliability of existing services through investments in infrastructure, including mini-grids and stand-alone systems, could displace substantial amounts of traditional polluting fuels. In developing countries, the total capacity of back-up generators is estimated at 350–500 gigawatts (GW) spread across 20–30 million individual sites.[25] Across SSA, one out of every five liters of diesel and petrol is burned in a back-up generator. The resulting emissions are equivalent to 20% of those from vehicles. Annually, such generators emit more than 100 million metric tons of CO^2 globally.[26]

The trajectory to universal electrification will vary from country to country. Yet its design must consider cost-effectiveness, people's long-term aspirations, socio-economic development objectives, energy security, and climate resilience and adaptation. These considerations will influence investment decisions across the power sector, from generation to last-mile distribution.

With the increasing cost-competitiveness of utility-scale and distributed renewable energy solutions, combined with the need to improve energy efficiency, an energy access trajectory can be defined that aligns multiple objectives. Depending on country contexts and locally available resources, comprehensive generation expansion plans are needed that make use of all available renewable energy resources and natural gas, while balancing economic, security, emissions, and resilience objectives over the long term.

1.4 A TIME FOR ACTION: THE PATH TO ACHIEVING UNIVERSAL ELECTRICITY ACCESS

The Commission has deliberated extensively on what actions are urgently needed in order to accelerate electrification. In the GCEEP Inception Report,[27] our research team thoroughly examined key aspects of the electrification challenge: large generation, transmission, international trade, the several distribution levels, off-grid electricity supply, and the services that electricity can provide. Although serious shortcomings were found at every segment of the industry, we concluded that it is in distribution where the need for intervention is most acute. With a few exceptions, and for a variety of reasons, incumbent distribution companies ('discos') in low-access developing countries are in dire financial straits. Because politically driven tariffs do not cover the cost of supply, which is frequently too high due to numerous inefficiencies, distribution companies – and often, in the end, national governments – are left to absorb the deficit.

> Shortcomings exist at every segment of the power sector impeding universal electricity access – distribution is where the need for intervention is most acute

Cash-strapped discos are unable to invest in connecting new customers and refurbishing and maintaining their networks. In many cases, discos stop purchasing electricity at prices that are not covered by tariffs, which leads to unreliable service and dissatisfied customers who refuse to pay their bills or even steal the power, thus further reducing revenues. This all-too-familiar vicious cycle typically lands discos in low-access countries in chronically perilious conditions. The publicly-owned discos

24 World Bank (2017), The Climate Change-Energy Access Nexus, http://documents1.worldbank.org/curated/en/465151494924794652/pdf/115064-BRI-P148200-PUBLIC-FINALSEARSFClimateChangeweb.pdf. Also IEA (2017), Energy Access Outlook 2017. From poverty to prosperity.

25 International Finance Corporation, The Dirty Footprint of the Broken Grid: The Impacts of Fossil Fuel Back-up Generators in Developing Countries (2020), https://www.ifc.org/wps/wcm/connect/dfab4f4c-9247-46ed-8f35-b25fa527b636/20190919-Summary-The-Dirty-Footprint-of-the-Broken-Grid.pdf?MOD=AJPERES&CVID=mR9UXpH.

26 International Finance Corporation, *The Dirty Footprint of the Broken Grid: The Impacts of Fossil Fuel Back-up Generators in Developing Countries (2020)*, https://www.ifc.org/wps/wcm/connect/dfab4f4c-9247-46ed-8f35-b25fa527b636/20190919-Summary-The-Dirty-Footprint-of-the-Broken-Grid.pdf?MOD=AJPERES&CVID=mR9UXpH.

27 The Global Commission to End Energy Poverty (2019). Inception Report. https://www.endenergypoverty.org/reports

periodically require publicly financed bail-outs, while discos that have been privatized often find themselves focusing their resources on a small number of profitable customers and unable to raise capital for expansion.

The increasing presence of off-grid electrification solutions – involving stand-alone systems and mini-grids, combined with novel business and financing models and innovations in appliances – has, on the one hand, provided a renewed thrust for delivering access through a complementary route, while also adding to complexities at the distribution level. Electricity delivered by mini-grids can be less expensive than power supplied by the grid in rural areas with low-demand clusters of consumers who are far away from the existing network. Indeed mini-grids, or stand-alone solar systems (including solar home kits or solar lanterns), may be the only options available to rural households when an incumbent distributor fails to extend the grid.

Nevertheless, even in situations where they are the least expensive option, present day mini-grids continue to face challenges related to affordability among rural consumers, regulations guiding tariff setting and licensing, and reliance on public funding to be viable, or on cross-subsidization from local large commercial, industrial or public off-takers willing to pay higher tariffs.[28] With a better understanding of funding needs, the introduction of dedicated regulations in many low-access countries, and improving economics, mini-grid adoption has gained pace. Meanwhile, stand-alone systems continue to see rapid growth, led in many markets by the active participation of the private sector; however, their penetration is limited by the purchasing power of customers. Altogether, the uncoordinated development of on-grid and off-grid solutions is likely to leave hundreds of millions of people unserved. To leverage the full potential of off-grid and on-grid solutions necessitates an integrated and coordinated approach.

The challenge is to make use of emerging technological opportunities and novel business models and regulatory approaches to integrate disparate delivery modes and applications into a medium- and long-term vision of inclusive, efficient and sustainable electrical supply for each of these countries.

1.4.1 The Integrated Distribution Framework (IDF): towards a viable distribution sector to deliver universal access

The focus of this report is on the distribution sector – the weakest and, so far, unresolved link in delivering universal and reliable electricity in emerging economies.

28 SEforAll (2020), State of the Global Mini-grids Market Report 2020, https://www.seforall.org/system/files/2020-06/MGP-2020-SEforALL.pdf

Only a handful of distribution companies in SSA recover costs with growing deficits requiring frequent publicly-financed bailouts.[29] Significantly burdened, the distribution companies are not able to undertake significant rural electrification efforts due to their inability to attract the substantial capital needed for infrastructure investments.

Approximately one third of all emerging market economies entered the COVID-19 crisis with high debt levels and little fiscal space to undertake additional spending.[30] With public financing in short supply, the long-term sustainability of the power sector in emerging economies – with or without the universal access goals – rests squarely on tackling the viability challenge in distribution. Private capital is sorely needed and, in the absence of a viable business model, attracting investors becomes challenging.

Investible frameworks to mobilize private capital in the distribution sector can be created by following best practices in regulation, integrating on- and off-grid technologies, and making smart use of development finance. **Chapter 2** of this report presents a comprehensive set of principles – the Integrated Distribution Framework (IDF) – which reconciles the objectives of universal access, power sector viability and an inclusive energy transition.

The IDF approach shifts most of the economic burden of maintaining, improving and expanding the power sector of a country from governments to an entity (public, private, or a public–private partnership). These entities enter into long-term contracts (typically 20 or 25 years) and are guided by cost-of-service regulations. This approach aims to create an investible framework in the distribution sector that can mobilize necessary investments in new and existing on-grid and off-grid infrastructure; improve reliability of supply for households, commercial entities, and industries; strengthen local economies; and underpin socio-economic development.

How can the IDF be adapted to different national contexts to accelerate electrification? Under the aegis of the GCEEP, engagements with five "first action" countries (FACs) – Colombia, Rwanda, Uganda, Nigeria and India – have been ongoing. **Chapter 3** addresses the application of the IDF to FACs that vary in economic status, power sector structure and regulation, geography, demography, and current status of both public and private actors' electrification efforts. The chapter presents the distribution concession model[31] as a key instrument in the IDF strategy for attracting capital and expertise at the right scale to achieve universal electricity access.

1.4.2 A holistic view to tackling the electrification challenge

While distribution remains a key point of failure for electrification, a holistic view of the power sector is still needed. This entails a continued focus on mobilizing investments in generation and transmission infrastructure (national and cross-regional) to ensure the availability and accessibility of low-cost electricity.

The template for attracting private sector investment in generation is increasingly well-understood and employed across the emerging economies. In Africa, investments in the power sector reached USD 27 billion in 2019, most of which was in generation (USD 18 billion).[32] Independent power producers (IPPs) now play a role in the generation sector of at least 29 countries in SSA.[33] Significant attention has been paid to structuring country-specific payment guarantees, power purchase agreements, and project financing to mobilize private capital into the building of new generation capacity. A portfolio of de-risking tools has largely been successful in shielding investors from risks posed by insolvent distribution companies. However, the existence of surplus generation in many low-access countries is evidence enough that investment in capacity, without regard for distribution, contributes little to ending energy poverty. In fact, it may be counterproductive, leading to increases in overall system costs.

29 Trimble, Christopher, Masami Kojima, Ines Perez Arroyo, and Farah Mohammadzadeh. 2016. "Financial Viability of Electricity Sectors in SSA: Quasi-Fiscal Deficits and Hidden Costs." Policy Research Working Paper 7788, World Bank, Washington, DC. http://documents.worldbank.org/curated/en/182071470748085038/Financial-viability-of-electricity-sectors-in-Sub-Saharan-Africa-quasi-fiscal-deficits-and-hidden-costs

30 IMF (2020), "COVID-19 Response in Emerging Market Economies: Conventional Policies and Beyond", https://blogs.imf.org/2020/08/06/COVID-19-response-in-emerging-market-economies-conventional-policies-and-beyond/

31 See Working Paper: Jacquot, G., Pérez-Arriaga, I., Stoner, R. and Nagpal, D. (2019), *Assessing the potential of electrification concessions for universal energy access: Towards integrated distribution frameworks. MIT Energy Initiative Working Paper.*

32 IEA (2020), World Energy Investment 2020, https://www.iea.org/reports/world-energy-investment-2020

33 Eberhard, A. (2019), Bulk Power Supply in Africa: Challenges, Constraints and Opportunities.

Further, as generation capacity grows and power flows increase, the volume of investments needed to develop and upgrade transmission infrastructure also rises. Africa alone is estimated to require as much as USD 4.3 billion of annual transmission investments until 2040.[34] However, most countries still finance transmission directly from utility revenues or government budgets, while others rely on concessionary DFI financing or grants from donor countries. With public finance increasingly scarce, mobilizing private investments in the transmission sector – much like other segments of the power sector – is more a necessity than a choice.

Many countries have successfully introduced private sector participation in the development, operation and maintenance of transmission infrastructure. Privately financed transmission has been introduced in emerging economies, particularly in South Asia (e.g., India, Philippines) and Latin America (e.g., Brazil, Chile, Peru).[35] In SSA, by contrast, private sector participation in transmission has been very limited.

While there have been successes with attracting private investments in generation (through IPPs), we must build on those successes by developing a model for transmission in order to bridge existing financing gaps. We can also avail ourselves of best practice examples to develop enabling policies and regulations, mitigate country- and off-taker risks, adapt concessional financing for transmission, and build long-term planning capacity.

Expanding on the importance of increased investment in generation and transmission, **Chapter 4** of this report discusses regional trade and power pools in greater detail. SSA hosts five regional power pools which are in varied stages of maturity. Meanwhile regional trade is increasingly on the agenda in South and Southeast Asia. Indeed, regional trade is an important means of lowering electricity costs and improving reliability and resilience of supply. That power pools have so far largely performed below expectations – or just failed to start functioning as such – in SSA is a serious issue. The Commission recognizes both the need and opportunity afforded by its diverse and influential membership to address it.

1.5 THE TASK AHEAD

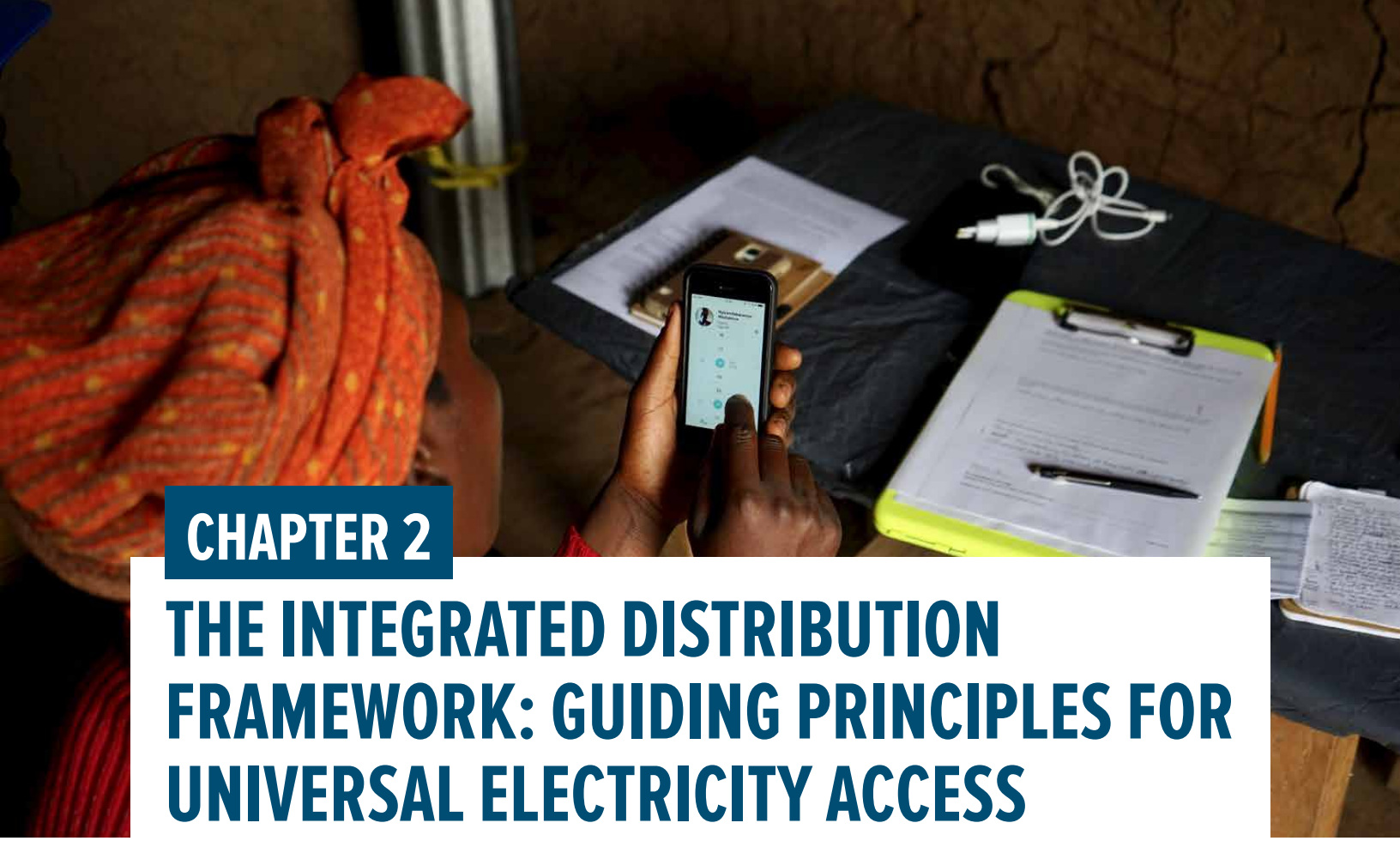
Our Commission is a unique and wide-ranging community of stakeholders in electrification, representing the international development banks, private investors, utility leaders, policy makers, philanthropists, project developers and entrepreneurs, and diplomats. The Commission's advice will be directed largely to its own members, and to others like us.

In the fifth and **final chapter** of this report, we look expansively toward the future and examine the future role of the Commission as a platform for convening and helping to coordinate the work of key international, public and private sector actors, and for supporting the governments of low-access countries in their efforts to end energy poverty. After one year of research, reflection and interaction with multiple organizations and the main stakeholders in a few selected FACs, the Commission presents its conclusions and an action plan with a short list of initiatives that we believe can mean a turning point in the process of achieving universal electrification access.

We are encouraged by recent developments, including the influential work of Sustainable Energy for All (SEforAll) to promote supportive policy for off-grid access; new initiatives of the major development banks to encourage the use of new technologies, including computerized optimal integrated planning methods using on- and off-grid technologies; a resurgence of interest in distribution concessions, notably in India, Colombia and among the countries of West Africa; and renewed interest among African leaders in regional power pools. We are also encouraged by recent calls to establish new knowledge sharing and training platforms including an African School of Regulation, intended to train and advise utility regulators and all professionals in the energy field as they work through the challenges of revitalizing and expanding their power sectors while advancing the cause of universal access. We look forward to continue serving as an independent honest broker that keeps the need to end energy poverty in the public consciousness, and advances ideas and knowledge that can help us succeed.

34 African Development Bank (2019), "Africa needs bolder private financing models for power transmission lines - energy experts," https://www.afdb.org/en/news-and-events/press-releases/africa-needs-bolder-private-financing-models-power-transmission-lines-energy-experts-24422.

35 World Bank (2017), Linking Up- Public-Private Partnerships in Power Transmission in Africa, Washington DC.



CHAPTER 2

THE INTEGRATED DISTRIBUTION FRAMEWORK: GUIDING PRINCIPLES FOR UNIVERSAL ELECTRICITY ACCESS

2.1 INTRODUCTION

As we observed in Chapter 1, failures in the distribution segment of many low-access countries' power sector hamper universal access to electricity. Viability challenges hinder the mobilization of the substantial public and private investment needed to expand grid-based electricity access. Recent growth of off-grid solutions – stand-alone systems and mini-grids – has occurred largely in silos. To reach universal access by 2030 – as targeted under Sustainable Development Goal 7 – we need a new business model for distribution that leaves no one behind, ensures permanence of supply, integrates the various electrification modes (on-grid and off-grid), and aligns with a vision for the long-term, sustainable development of the power sector.

The GCEEP proposes the "integrated distribution framework" (IDF). The IDF is built around the idea of an entity – public, private or a public–private partnership (PPP) – responsible for undertaking distribution activities in a given service area (e.g., through a concession) with a mandate to deliver universal access by using an appropriate mix of electrification modes with a viable business plan supported by cost-of-service regulation, viability gap funding and risk mitigation.

Some of the principles underpinning the IDF – universality of access, integration of on- and off-grid solutions, financial viability of distribution and a focus on development – have been pursued by electrification programs across the developing world. Yet there are very few instances[36] in

> Reaching universal access by 2030 requires a new business model for distribution that leaves-no-one-behind, ensures permanence of supply, leverages on- and off-grid solutions and advances long-term sustainability of the power sector.

36 The electrification of Morocco in the late 1990s and the PERMER I project in the Jujuy province in Argentina (1999–2012) are largely successful past experiences that contain most of the features of the IDF. We have learned from these concrete experiences and have defined the IDF in more general terms that can be adapted to basically any context.

which these principles have been employed all at once for expanding electricity access. The IDF is centered on the belief that the implementation of all four principles to their ultimate consequences is central for achieving universal electricity access that can underpin inclusive socio-economic development.

Based on the conceptual contributions of the GCEEP research team, guidance from Commissioners and learnings from ongoing engagements in several "first action" countries to implement the IDF, this chapter discusses the challenge the IDF intends to address and consequently describes the IDF – its key principles, and guidelines for implementation in a wide range of national contexts. More detailed discussions concerning options and challenges in the implementation of the IDF can be found in the collection of working papers prepared by the GCEEP research team (listed in an annex).[37]

2.1.1 Viability challenges in the distribution sector impeding progress

A properly functioning distribution sector is necessary to ensure ongoing investment in networks, billing and customer engagement operations, and metering. Each of these elements directly influences the quality of electricity services delivered and the capacity of the utility to add new connections. In the majority of low-access countries, distribution companies – often publicly owned – face significant challenges owing to poor performance and financial unviability.[38]

Prominent among them is the existence of regulated tariffs that are insufficient to cover the actual costs of supplying electricity. Raising tariffs is a politically sensitive issue, particularly when the reliability and quality of the service are poor. Supply costs are high in many low-access countries due to a combination of factors. Distribution companies are plagued with technical and commercial losses. A large fraction of the electricity produced is lost due to technical network losses. In many countries, a substantial fraction is stolen through illegal connections, or may be unbilled, or – if billed –not paid for. Meanwhile, wholesale electricity prices are often high due to lack of scale in generation plants, low capacity utilization and inefficient operation.

The combination of these factors causes collected revenues to fall well below incurred costs. Depending on the power sector structure in each country, the deficit accrues to the vertically integrated utilities or to the unbundled distribution companies, which are subject to regulation. In turn, they are required to collect the revenues and pay the wholesale electricity costs.

In most low-access countries, the distribution segment is publicly owned. The government is obliged to either deliver an annual subsidy, bail out the distribution company whenever its financial situation becomes untenable, or subsidize unpaid generators. In a few countries, distribution has been unbundled and privatized. This situation is more complex: public financial support is no longer available, and the distribution companies continue to incur losses and default on their regulated obligations. There are also cases of private firms holding long-term concessions to manage distribution activity in a given territory. Depending on the specific conditions of the concession and how efficiently it is managed, the business model for the concessionaire can be financially viable, even if the incumbent publicly owned utility may not fully recover its own historical investment costs.

Regardless of whether it is public or privately owned, a financially distressed utility will be ill-equipped to raise capital and will often be forced to defer maintenance and delay capital investments. Its priority must be to cover essential costs, meet regulated obligations and provide at least a minimum reasonable quality of service. Unless mandated to expand its network as part of its concession contract and remunerated accordingly, a distribution concessionaire will seek only to meet its established minimum performance requirements while reducing costs and avoiding further investment, notably in expanded access.

> A financially distressed public utility is often forced to defer maintenance and delay capital investments, notably in expanding electricity access

37 Working Papers developed by the GCEEP research team can be accessed online here: https://www.endenergypoverty.org/reports

38 Kojima, Masami; Trimble, Chris (2016), Making Power Affordable for Africa and Viable for Its Utilities. World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/25091

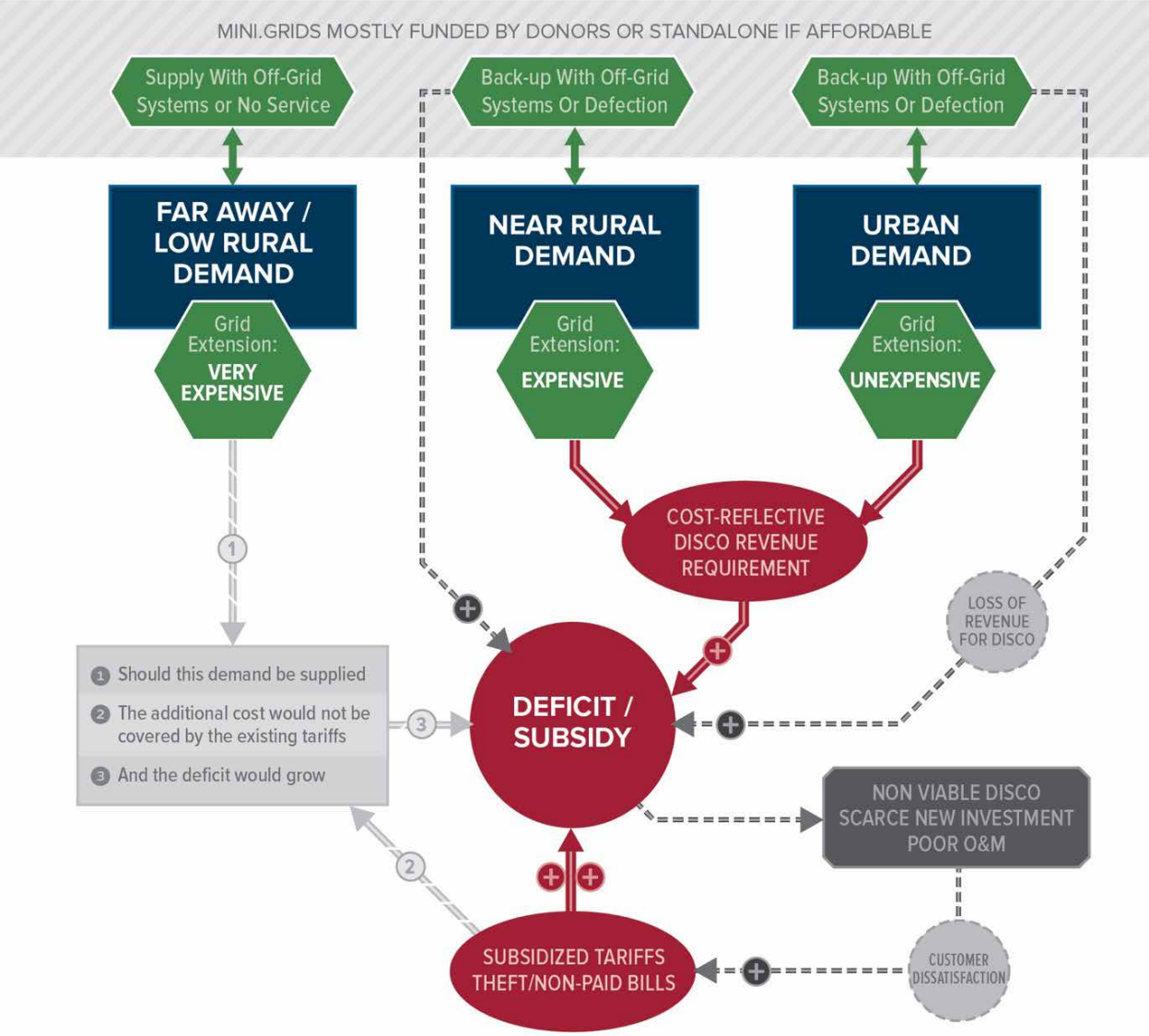


Figure 1 Viability challenges for distribution companies in low-access countries

An additional challenge in financing rural access is its high cost. Supplying geographically dispersed low-level rural loads is much more expensive per connection (and per kilowatt-hour) than supplying urban areas. Per-unit costs increase as electrification goes deeper into isolated areas, far from the existing grid. If the regulated revenue requirement for the distribution companies were cost-reflective, the corresponding tariffs for *all end customers* would increase whenever new rural customers become connected, since a cost-reflective *local tariff* in rural areas is politically fraught and would be unaffordable for many customers. In reality, in the vast majority of low-access countries, tariffs are set well below costs at a uniform level for all residential customers, regardless of geographic location or whether customers are rural or urban. Thus, expanding access automatically results in a deficit in the remuneration of distribution companies, ensuring that rural electrification is a “low hanging loss.”

Figure 1 illustrates the difficulties faced by a typical distribution company (‘disco’). It is supposed to meet the entire demand due to urban customers with low

distribution network costs per unit of energy supplied, near rural or peri-urban customers with higher per unit costs, and far away and dispersed demand in rural areas with very high cost of service. In many low-access countries, however, only the first group of customers and some in the second have electricity access. Since politically influenced tariffs are unable to cover the cost-reflective revenue requirement of the distribution activity, a structural deficit for the disco accrues. Consequently, the deficit-burdened disco will fail to deliver reliable and good-quality power to its customers, who in turn are likely to resort to illegal connections, unpaid bills and grid defection. This scenario creates a vicious cycle and compounds the distribution company's deficit until the government has no option but to intervene with a bailout in some form – an expensive *ex post* approach to subsidization that effectively perpetuates the financial and operational failure of the disco. Any attempt to electrify rural areas with their high per-unit distribution cost that existing subsidized tariffs cannot meet would result in larger deficit, thus discouraging the discos from expanding electrification.

> Distribution companies in many low-access countries are entrapped in a vicious cycle involving non cost-reflective tariffs, lack of investment to ensure reliability of supply and poor customer engagement.

The recent growth of low-cost, reliable distributed energy solutions backed by attractive business and financing models has created severe competitive pressure for distribution companies in urban and near-rural areas for commercial, industrial and affluent residential customers. This encourages those who can afford to self-generate to defect, further undermining the distributor's viability. These off-grid solutions, while effective from the standpoint of augmenting supply in electrified areas and expanding electricity access rapidly, cannot alone guarantee universal electricity access. To be viable, mini-grids often require donor support or strong cross-subsidization from anchor loads such as local productive end-uses. Moreover, unsubsidized stand-alone system companies largely cater to customers and areas where their services can be viable, hence leaving others behind.

Our focus on distribution follows from the fact that there are proven approaches and numerous experiences with bringing investments in generation and transmission to developing countries.[39] Turning insolvent distribution companies into viable businesses committed to achieving full electrification, however, remains an unsolved challenge. Without a healthy distribution system that supports all electrification modes in a coordinated manner, universal access will never happen. That said, the cost and reliability of generated power remains a critical factor affecting the viability of the disco. In Chapter 4, we examine the power sector in low-access countries from a bulk power system perspective. There, we offer insights and recommendations related to generation, transmission and regional trade.

2.1.2 The value of integration to advance universal access

The term "integration" has become a buzzword used to characterize various approaches to accelerating electrification.[40] Some electrification approaches in the past have relied on different aspects of integration,[41] but not until very recently has the value of integration truly become recognized by practitioners and decision-makers as a key ingredient for any successful electrification strategy. Diverse organizations and initiatives use this term with different meanings and in different contexts.

39 See the GCEEP Inception Report: https://static1.squarespace.com/static/5d371cb401986300013881d3/t/5d6fe81b03b5ca0001497462/1567615021117/GCEEP+-InceptionReport-2019.pdf

40 Sustainable Energy for All (SE4All) in 2019 launched its report Integrated *Electrification Pathways for Universal Access to Electricity: A Primer* offering perspectives on planning approaches and policy measures that support using grid, mini-grid and off-grid technologies to provide electricity services. Recently, implementation-oriented programs have been launched covering various facets of an integrated approach to electrification, including financing (e.g., SE4All's proposed Universal Electrification Facility), business and financing model pilots (e.g., Utility 2.0 in Uganda), among others.

41 See the GCEEP Research Team Working Paper: Jacquot, G. (2020c), *Reaching universal energy access in Morocco: A successful experience in solar concessions*.

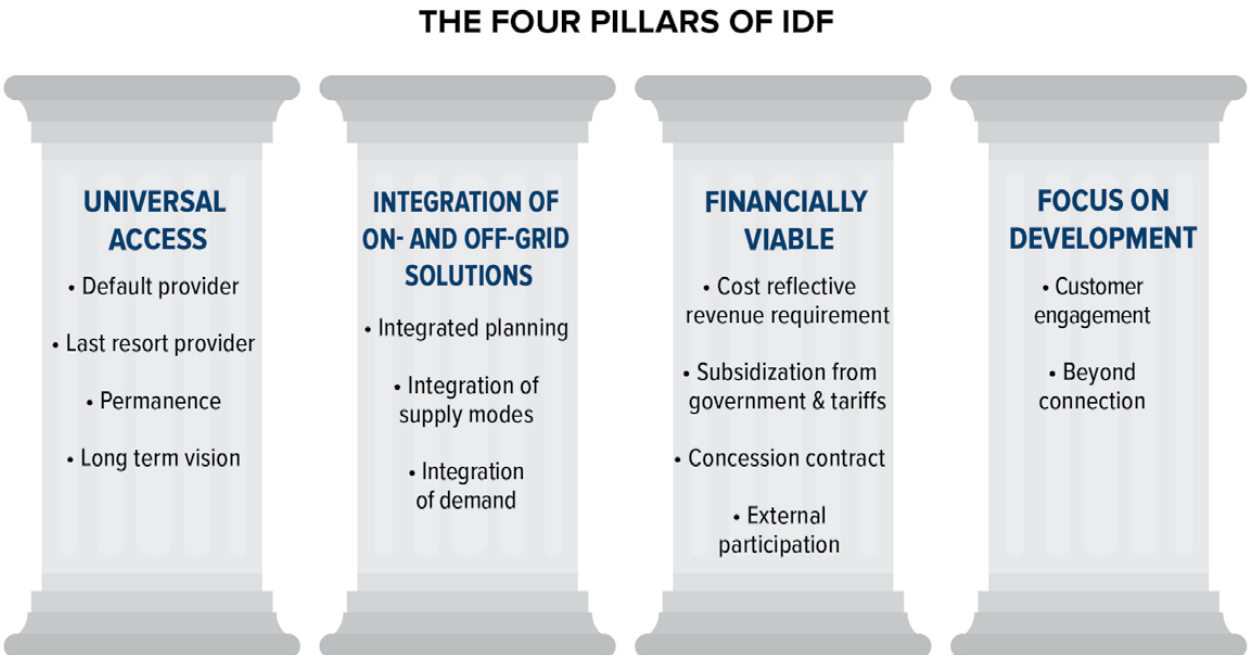


Figure 2 Pillars of the Integrated Distribution Framework

A holistic understanding of integration encompasses multiple aspects in the supply and use of electricity:

i. Integration at the distribution level of the three modes of electrification – grid extension, mini-grids and stand-alone systems – both in planning for the least-cost mix of technologies to supply demand, and in dynamically following the evolution of this mix as demand grows.

ii. Integration of electricity supply with residential, community and productive uses through technologies (e.g., appliances) that can maximize socio-economic benefits.

iii. Integration of different consumer categories under a common overarching scheme of power supply, complementing demand patterns and tariff cross-subsidization programs.

iv. Integration of the public and private sectors in distribution with clearly defined roles, allowing sustainable financing schemes and mobilization of capital for electrification to proceed at the necessary pace and scale.

v. Integration of the power systems of neighboring countries into regional pools that can plan and deploy generation and transmission projects of regional dimension, thus benefiting from complementarity of resources and economies of scope and scale.

The IDF, further elaborated in the next section, embodies a holistic approach to integration in the realm of distribution in order to achieve universal electricity access.

2.2 FORMULATION OF THE INTEGRATED DISTRIBUTION FRAMEWORK

The yet-to-be-addressed viability challenges in the distribution sector, as well as the silo-ed development of various electrification modes, raise important questions. Is the current electrification paradigm likely to leave behind large segments of society? Will it guarantee permanence of supply necessary to advance socio-economic development?

The formulation of the IDF is motivated by our conviction that successful universal electrication ultimately requires integration in numerous forms, and a strict adherence to the following four guiding principles (Figure 2):

i. A commitment to **universal access** that leaves no one

behind. This requires permanence of supply and the existence of a utility-like entity with ultimate responsibility for providing access in a defined territory.

ii. Efficient and coordinated **integration of on- and off-grid solutions** (i.e. grid extensions, mini-grids and stand-alone systems). This requires integrated planning at the distribution level and appropriate business models that take a comprehensive view of all types of consumers in a defined service territory.

iii. A **financially viable** business model for distribution. This will typically require some form of distribution concession to provide legal security and ensure the participation of external and mostly private investors, as well as subsidies for viability gap funding.

iv. A **focus on development** to ensure that electrification produces broad socio-economic benefits. This principle links expanded access to the delivery of critical public services (e.g., health, education) and to multiple economically beneficial end-uses.

To reach universal access efficiently, faster, and in a way that maximizes the social impact of electrification, strict adherence to all four of these fundamental IDF principles is crucial. All of the principles matter and they work collectively to accomplish the objective. Principles may be partially implemented along the way, but ultimately all must be present. They look deceptively simple, but they are not. The power of the IDF concept lies in bringing them to bear *collectively* and *rigorously* to achieve a durable transformation of the entire distribution sector.

Assessing existing and new initiatives through the lens of the IDF principles will ensure that the summation of efforts – whether they are grid-based or involve mini-grids or stand-alone systems, and whether they apply across the spectrum of possible end uses – will contribute to the final objective of attaining access for all, establishing a viable distribution sector and maximizing socio-economic outcomes.

The implications of enforcing each principle in practice are discussed in greater depth in the following sections.

2.2.1 Universality

Universality requires that *no one is left behind* in the expansion of access. The uncoordinated development of on-grid, mini-grid and stand-alone solutions, while speeding up connections, is likely to leave many communities without access or underserved.

Ensuring universality requires a **utility-like company or entity** that takes responsibility for a territory and commits to supplying its customers with at least a minimum level of service and reliability. This entity further accepts the role of a default supplier (that is, the party responsible for ensuring that everyone has service) and supplier of last resort (the party that actually provides service in the event a current supplier fails to do so). It is important to note that the requirement for **universality** entails **permanence**. This will guide investments in new connections, whether through on- or off-grid solutions, that are aligned with a **sound long-term vision** of the power sector, based on proven regulatory and business fundamentals.

Default, last resort and special forms of partnership in electricity provision

The “ultimate” responsibility for providing an essential service like electricity always rests with the state, but its material delivery is in the hands of either publicly, privately, or jointly-owned firms. Some ministerial department or governmental agency – like the rural electrification agencies that exist in many developing countries – may administer the electrification process, but electricity is largely supplied by firms that are typically wholly or partly state-owned. As such, it is important to define the obligations of these firms regarding universal service. Exclusivity of supply in the considered territory is not required and probably not advisable since each electrification mode requires specific capabilities and organization. What is needed, as noted above, is a “utility-like” company with the responsibility of being the “default provider” and “last-resort provider” for all existing and potential customers in that territory. This provider can be selected via an auction or appointed directly (discussed further in 2.3).

A *default provider* must make sure all potential customers in the considered territory receive electricity supply

according to some time schedule and with the least-cost mode of electrification. The default provider may secure an independent supplier or deliver electricity access by itself (subject to remuneration and other conditions established by regulation and the concession agreement). The default provider will be directly responsible for the installation and operation of any electrification by grid extension in the territory. However, the default provider does not necessarily have exclusivity in the deployment or operation of mini-grids or stand-alone systems. Auctions may be used to select mini-grid developers and stand-alone service providers who may operate within the entire territory or be assigned sub-territories.

Entities that have established themselves in a territory as independent mini-grid developers or providers of stand-alone systems and services may fail, leaving their customers without electricity access. In this case, the responsible entity – as a *last-resort provider* – must take over in order to ensure continuous supply. Being prepared to provide this service, and actually providing it when needed, has a cost which must be acknowledged in the regulation of this extended distribution activity.

The responsibility for providing electricity with high reliability and quality, encompassing the roles of default and last-resort provider, can be shared by an incumbent distribution company and an external company under partnership arrangements recently dubbed "mini-grids under the grid."[42] Typically, one company is responsible for grid supply, while the other provides back-up power, voltage control services, or stand-alone service to customers who opt to be supplied by the second company. Partnerships of this sort are emerging in SSA and India. They include the DESSA initiative by Abuja Electric in Nigeria and the pilot project of the firm Konexa (also in Nigeria). In another example, the company Tata Power Renewables Microgrid is developing mini-grids in several Indian states. Some of these experiences are discussed in Chapter 3.

Permanence of supply

We argue that permanence is an essential attribute of a sustainable supply. Unfortunately, this attribute has been frequently ignored in numerous electrification initiatives, which have focused solely on meeting access targets in the short term while ignoring the regulatory and business model aspects of program design that are needed to guarantee continuous service far into the future. This continuity requirement is taken for granted in developed countries and in the large cities of the developing world, but it is frequently lacking in electrification projects that become inactive after a few years because of the absence of proper maintenance, funding, or management, or when demand grows or equipment needs to be repaired or replaced.

> Permanence is an essential attribute of sustainable electricity supply – a frequently ignored aspect in many electrification initiatives

What we mean by a "utility-like" responsible company is a company that, under the appropriate regulatory conditions, has adopted a business model whose raison d'être is to supply electricity indefinitely. If such a company becomes insolvent– as Pacific Gas & Electric did recently in California – the conditions are such that the electricity supply activity will continue under another name or ownership but without any doubt about its permanence.

Compatibility with a sound long-term vision of the power sector

The goal of achieving permanent electrification requires a sound, long-term vision of the power sector. The structure of the entities in charge of different segments of the electricity supply chain, as well as the business models adopted by these entities and the regulation of the ensemble, must together aim at providing quality service to the final customer.

Defining a long-term vision for the power sector in low-access developing countries is challenging. It is made all the more challenging by the transformative technological changes taking place within the sector

42 Rocky Mountain Institute (2019), Electrifying The Underserved: Collaborative Business Models for Developing Mini-grids Under the Grid, https://rmi.org/insight/under-the-grid/ . Also see GCEEP Working Paper: Nagpal, D. and Perez-Arriaga, I. (2020a), Towards actionable electrification frameworks: Mini-grids under the grid.

globally.[43] However, from a century of experience with electricity policy and regulation, we can avail ourselves of important lessons in an effort to make the distribution segment in low-access developing countries viable.

i. *The ailing distribution companies are important and play a critical role*. Integration of supply and integration of demand, as described above, provide multiple benefits, including better reliability and lower cost per kilowatt-hour than with off-grid solutions. As demand grows, so does the use of grid extension relative to off-grid service in least-cost electrification planning. We must use off-grid technologies extensively at the current stage of electrification in most developing countries, At the same time, it is important to take into account the fact that grid extension will tend to become increasingly viable and subsume areas served initially by off-grid technologies, resulting in hybrid electricity systems with grid service augmented by distributed energy resources. Planning strategy and regulation must account for this.

ii. *The regulated revenue requirement of the distribution activity must be cost reflective*. The distribution network activity must be remunerated using some version of the cost-of service method, perhaps adding performance-based incentives. Deviating from this basic regulatory approach increases the cost of capital, deters investment, and compromises service reliability and quality of service. The IDF proposes to apply this same method to the extended view of the distribution activity that encompasses both on- and off-grid solutions. Cost-reflective – i.e., cost-of-service – remuneration is a sine qua non condition to attract serious private capital to distribution.

In practical terms, guaranteeing the inclusivity conditions laid out above will require strong instruments, such as long-term concessions, for effective enforcement and engagement of entities with the capacity to raise the private and public capital needed for universal access. So far, distribution concessions have been used in exclusive settings – in urban and rural electrification, and in technology-specific applications (mini-grids, stand-alone systems) – with mixed results. Box 1 discusses how inclusivity can be guaranteed in electrification programs building on experience and lessons from the use of concessions.

43 See Pérez-Arriaga, I., et al. "The MIT Utility of the Future Study"(December 2016) for an analysis of the opportunities and challenges resulting from the growing presence of distributed energy resources (DERs) in power systems globally.

Box. 1 Using concessions to guarantee universality in electrification programs

Achieving universal access by 2030 will require that electrification programs, whether at the national or territorial level, guarantee inclusivity in all respects as defined in section 2.2.

With respect to implementation, a utility-like company or entity should be responsible for providing a territory's population with a minimum level of access and reliability. Legal security and viability for the entity will be required to attract external capital under long-term arrangements such as a concession contract.

Concessions have been tried and tested in various formats in SSA and Southeast Asia[44]. It is important to note that a concession does not mean privatization – the basic concession model preserves the prior ownership of distribution but transfers full control over management and investment decisions for the term of the concession. PPP models for concessions have also been implemented successfully, particularly in India where the state retains equity in the entity holding the long-term concession.

The effectiveness of a concession depends on its design. A well-defined concession must lead to a viable business model. Since 2005, Uganda's 20-year distribution concession to a private entity (Umeme) has brought significant benefits in terms of mobilizing private capital into distribution, reducing technical and commercial losses, improving services, and adding new connections within its service area. A robust concession agreement has ensured a stable investment environment and revenue stream through measures such as pre-setting returns on capital investments (in USD), establishing escrow accounts as payment security for government obligations, giving rights to make necessary modifications to the distribution system (subject to approval of investment plan), and provisioning for investments not yet recovered through tariffs at the time of transfer.

Rural electrification is not one of the primary objectives of the Umeme concession. However, the Uganda experience provides a strong foundation for expanding the scope of concessions to include universal access as one of the primary objectives. Stringent universality requirements in concession agreements that state obligations to supply and support demand growth of households and other economic sectors should be complemented with additional safeguards to maintain business model viability.

Generally, distribution concessions that entail a universal electrification mandate would involve a consortium of entities led by an experienced operator. This operator would sign a concession agreement with the incumbent utility (publicly owned or not, vertically integrated or not)/public body to fully manage the distribution activity for a specified period of time. The concessionaire will have a mandate to achieve universal electrification by a certain date, meeting estimated demand using the least-cost mix of solutions, which may involve the participation of third-party off-grid developers. The concessionaire must be remunerated with cost-of-service regulation and performance-based incentives, and will generally pay a rental fee (positive or negative) for the use of existing distribution assets, receiving the residual value of the capital investments at the end of the concession period if there is no renewal.

It is important to recognize that the record of concessions in stimulating faster rural electrification in SSA has been mixed. Among the various types of concessions designed – technology-specific (mini-grids, solar home systems), zonal and national utility – those focusing on utilities have seen successful cases (e.g., in Uganda, Cameroon, Côte d'Ivoire) and have achieved improvements in operational performance, reduced fiscal burden and increased density of electrification. Also, when encouraged to contribute to expand access, these concessions have achieved positive results[45].

Concessions exclusively focused on rural electrification (through specific technologies or zones) have often been unsuccessful due to several factors, including concession design and the legal security it provides, guarantee of cost-of-service remuneration and information asymmetries with respect to the nature of demand and real cost of service. Fundamental among these factors has been the lack of viability to undertake rural electrication to attract private sector investment. It is argued that with the availability of GIS-based integrated planning, cost-effective decentralized energy solutions and a strong concession design that focuses on viability through cost-of-service regulations (for all modes) and transparent commitment of public financing, an effective utility concession approach can be pursued to increase access and improve services for connected areas, benefiting from decades of experiences in SSA, South Asia and Latin America.

44 See Jacquot et. al. (2019), "Assessing the potential of electrification concessions for universal energy access: Towards Integrated Distribution Frameworks", MIT Energy Initiative Working Paper.

45 Richard Hosier, Morgan Bazilian, Tatia Lemondzhava, Kabir Malik, Mitsonuri Motohashi, and David Vilar de Ferrenbach. 2017. Rural Electrification Concessions in Africa: What Does Experience Tell Us? Washington, DC: World Bank.

2.2.2 Coexistence of on- and off-grid solutions

In delivering electricity access, we need a wide view of the distribution segment – one that encompasses both on-grid and off-grid electrification modes as well as upstream infrastructure. In an integrated approach, the electrification modes engage in an efficient, complementary and dynamic manner to reach universal access.

The need for an integrated electrification plan

A least-cost integrated electrification plan that includes both on- and off-grid technologies forms a critical starting point, or basis for all additional activities. These include i) developing a roadmap for investment and project implementation that meets electrification targets at the least possible cost, is subject to the availability of funds, and respects any political, social, development, or environmental priorities; and ii) estimating the costs of supply that, in turn, are required for calculating regulated tariffs and any subsidies needed to meet a cost-reflective revenue requirement for distribution (either through on-grid or off-grid solutions).

The electrification plan is the first and indispensable step in building a business plan for the electrification of a given service territory – typically, a district, province, state, or entire country. A sufficiently detailed plan can provide the bill of materials and the associated cost of the investments to be made every year, as well as the costs of managing, operating and maintaining them. The plan contains estimates of demand to be served; from the tariffs applicable to each type of customer, revenues can be computed. The income left for distribution is what remains of the total revenues collected from tariffs after paying the costs of the other components of the electricity supply chain (generation, transmission and system operation) and other regulated charges. Once all this information is obtained from the electrification plan, the business plan can be developed to identify appropriate financing needs.

On-the-ground surveys or geospatial tools combined with advanced machine-learning techniques can be used to estimate demand. Optimization techniques allow for the design of least-cost electrification strategies that integrate the three electrification modes into a single plan, which can then be adapted to the specifications established by regulators or distribution companies regarding minimum service reliability and quality levels, the types of components to be used or the electrification code to be followed. The plan can also be adjusted over time to account for changes in demand, reliability of the main grid, costs of components, or wholesale energy prices.

> An integrated electrification plan is the first and indispensable step providing valuable insights on the appropriate mix of solutions, costs and financing needs for viability

Figure 3 illustrates electrification plans generated by researchers at MIT and Comillas University using the Reference Electrification Model (REM). The upper left figure shows the reference least-cost electrification plan for a 40 x 60 km^2 area within the Ugandan Southern Territory, with a mix of electrification modes. The upper right figure shows the least-cost plan where only grid extension is allowed; this plan is 20% more expensive than the reference case. The figure on the lower left shows the difference with respect to the reference least-cost plan (upper left) when the reliability of the main grid increases from 85% to 100%; this scenario obviously favors grid connection. Finally, the lower right figure shows a least-cost plan obtained with the REM model for Rwanda.

Integration of supply modes

Geospatial electrification tools assume that all three electrification modes will co-exist and jointly cover an entire territory. Yet several challenges have to be overcome to turn a geospatial plan into reality.

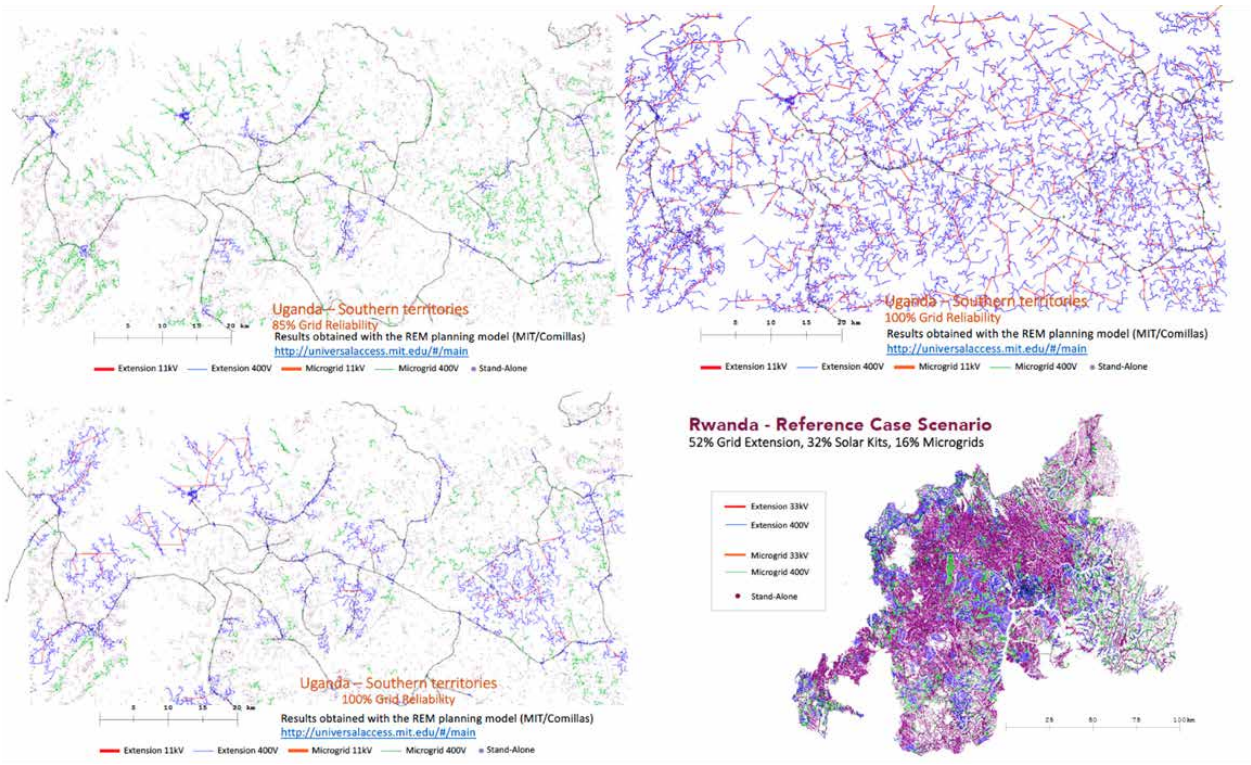


Figure 3 Electrification planning tool applied to Uganda and Rwanda

The proposed new utility-like entity responsible for a given territory – most likely a concessionaire organized as a special purpose vehicle (SPV) – will be in charge of managing, operating and expanding the existing distribution network. This entity may not initially have the experience or capacity to undertake resource-intensive activities involved in off-grid electrification. These tasks may be better managed by specialized mini-grid, or stand-alone solar companies, some of which might already be operating in the territory or country. With time and demand growth, the situation may evolve, with some stand-alone consumers obtaining mini-grid connections from the same or different entities, or being connected to the main grid, and with the responsible entity acting as default and last-resort provider when necessary.

In such a scenario, several IDF implementation issues have to be addressed: (i) designing the regulation – especially the remuneration – that will incentivize on- and off-grid companies to meet the targets established by the least-cost electrification plan in a way that leaves no one without electricity; (ii) regulating the interface and smoothing the transition between electrification modes to manage risks for both customers and involved private entities; and (iii) ensuring that the regulation of default and last-resort provision is complete and clear to ensure electrical supply to all consumers.

Designing remuneration regulation for electrification modes

Cost-of-service[46] remuneration, complemented in some cases with performance-based incentives, is the general approach to follow for each electrification mode. There is substantial experience in the application of this method to the traditional distribution company, although the presence of distributed energy resources connected to the distribution company may bring some complexities.[47] There is less regulatory experience in estimating the cost of supply to demand clusters with mini-grids, but models

46 Cost of service regulation focuses primarily on ensuring that utilities earn revenues that reflect their costs of service. Under such regulation, regulators review and identify a firm's cost of production and then establish allowed revenues that match this cost of production, including a reasonable return on capital invested.

47 See the MIT report "The utility of the future", https://energy.mit.edu/wp-content/uploads/2016/12/Utility-of-the-Future-Full-Report.pdf

to estimate this cost are available and can be obtained through auctions for mini-grid supply in specified areas.

While there are some successful instances of supplying electricity from stand-alone solar home systems under regulated conditions, such cases are rare.[48] Again, auctions can reveal the efficient cost of reaching out to potential electricity customers with stand-alone systems, while meeting a prescribed quality-of-supply target.

A cost-of-service remuneration that guarantees reasonable returns under acceptable legal conditions enables investors to attract the right blend of financing for each electrification mode.

A cost-of-service remuneration that guarantees reasonable returns under acceptable legal conditions can enable investors to attract the right blend of equity and debt for each electrification mode to meet prescribed targets.

A central aspect of cost-of-service remuneration is a regulated revenue requirement, accompanied by regulated tariffs. While the revenue requirement must correspond to incurred costs, the tariffs to be applied to end customers can be subject to diverse policy considerations. Tariffs may not necessarily be cost-reflective, either for each category of customers (thus allowing cross-subsidization) or at a system level, or both. In such cases, a subsidy will be needed if aggregated revenue collection with existing tariffs is insufficient to cover total costs (which is typically the case for rural electrification).

Caring for the interfaces between electrification modes

A major cause for concern among off-grid entities (especially mini-grid operators) is the possibility that the main grid will at some point arrive in communities they serve, profoundly undermining their business models. Many countries have developed specific regulations to address this situation. These regulations typically offer alternatives for the mini-grid and utility that include continued independent operation, compensation or the ability to interact at the point of connection (as a small power producer or distributor would).[49] Whatever the case may be, the IDF facilitates an orderly transition by coordinating the competing service providers under a single, responsible utility-like entity – a consortium of firms under the legal format of a SPV, for instance – guided by an integrated electrification plan. For mini-grids developed by the utility-like entity, the transfer from one mode to another is likely to be simpler, from an institutional and end-consumer standpoint, than under the silo-ed approach.

The IDF provides a solution for an orderly transition between electrification modes guaranteeing permanence, investment certainty and real-time alignment with community aspirations for energy

The coexistence of mini-grids developed under the IDF regime and mini-grids deployed independently by private investors under willing-seller/willing-buyer conditions will be difficult, since the former will apply regulated tariffs that are likely to be lower than the ones negotiated under the latter. A likely solution is to establish a transition period and process to migrate all independent mini-grids to the regulated regime of cost-reflective revenue requirement, regulated tariffs and guaranteed subsidy as viability gap funding (discussed further in 2.3.3).[50]

Customers supplied with stand-alone systems present different challenges. Commercial and industrial (C&I) customers, as well as large residential customers or

48 Acciona Microenergía in Peru.

49 See IRENA (2018), Policies and regulations for renewable energy mini-grids.

50 See Nagpal, D. and Pérez-Arriaga, I. (2020), Integrating isolated mini-grids with an IDF-compliant regulated distribution sector: A long-term perspective towards universal electricity access (GCEEP Working Paper)

others who are able to pay full cost, can be supplied under willing-buyer/willing-seller arrangements, since they do not need subsidies. On the other hand, subsidized tariffs – mainly designed on the basis of capacity to pay – will be needed for the majority of rural residential customers. The responsible utility-like entity, in coordination with the regulatory authority, can manage tariff cross-subsidization from on-grid and mini-grid customers towards rural customers with solar kits, supplemented by a government subsidy. The treatment of stand-alone solar systems, within the context of a transition between the three electrification modes, must take into account the unique capabilities and possibilities of these systems: [51]

i. The customer data collected by solar home system companies has strategic and therefore commercial value for mini-grid companies or the incumbent distribution company, especially when considering expanding into territory currently serviced by solar home systems.

ii. High-capacity, stand-alone solar equipment can support productive uses of electricity, thereby helping isolated communities to bootstrap themselves economically, increasing demand and, eventually, becoming more attractive for mini-grids or the main grid.

iii. It is possible to go beyond the standard "pay-as-you-go" business model, in which there is no service commitment beyond the contractual period. Consider, for instance, the business model of the company Acciona Microenergía in Peru. With the support of the regulator and the government, it is capable of offering permanent "energy as a service," with a true, utility-like commitment to the end customer.

iv. In an interesting and recent development of the pay-as-you-go model, some companies are exploring separating (unbundling) into various independent business models – R&D, with or without manufacturing; financing; transport and installation logistics; and consumer relations – in order to segment activities and risks, thus facilitating investments.[52]

Default and last resort provision

The responsible utility-like entity must become the default supplier of electricity – under previously established regulated conditions – in areas reserved for off-grid solutions when no independent companies are interested in providing the service, either spontaneously or as a result of an auction.

This same entity, as last-resort supplier, must be ready to take over the service of any off-grid company that withdraws or is unable to meet the minimum conditions established in its supply contract with customers. The regulation must recognize the cost of being ready to furnish this service whenever this need occurs.

An interesting case of integration of electrification modes occurs when the incumbent distribution company is unable or unwilling to provide reliable or sufficient service in some part of its network, and instead partners with a third-party private entity that has the needed skills, capacity and resources to play the role of back-up, or primary service provider.

Integration of demand

End customer tariffs are universally adjusted by policymakers and regulators to make them more acceptable to the public. For instance, regulators might establish a uniform tariff for the same class of consumers – regardless of whether customers are urban or rural – over an entire province, state or nation. Or they may lower tariffs for electricity-intensive industrial customers as an industrial policy measure to increase competitiveness. This is a powerful tool in the developing world. Used with care, it can help reduce the need for government subsidies for rural electrification without creating serious economic distortion. The efficacy of the measure is obviously reduced when the percentage of rural consumers is high.

When the conditions in a distribution company make it difficult to pursue a full-fledged universal electrification program, it may still be feasible to identify clusters of existing and/or potential customers – typically with a high proportion of industrial, commercial and large residential customers – who are willing to pay a premium for reliable

51 See Jacquot, G. (2020), Towards actionable electrification frameworks: Reassessing the role of stand-alone solar (GCEEP Working Paper)

52 These developments have been discussed at the Off-Grid Energy Access Forum, in October 2019 in London. https://www.pv-magazine.com/2019/11/23/the-weekend-read-offgrid-goes-global/?utm_source=dlvr.it&utm_medium=linkedin

and sufficient power supply. If the distribution company – with or without the support of some external company that provides local embedded generation connected to the distribution network – can agree on a cost-reflective, sufficient and reliable supply, these clusters can serve as steppingstones to final full electrification.

Box 2 outlines how, beginning with the electrification plan, a dynamic electrification process can be facilitated using the three supply modes to achieve full electrification.

Box 2. Providing the foundations for dynamic integration of electrification modes

As the electrification process unfolds over time, the proportions of the three electrification modes will change continuously; the number of customers connected to the main grid will increase; and the presence of distributed energy solutions that improve reliability of electricity supply in grid-connected areas will grow. It is a dynamic process as demand grows, aspirations of households and enterprises change, and the optimal electrification mix evolves accordingly.

This process should rely on a regularly updated, least-cost electrification plan that determines both the optimal electrification mix at a given time as well as its future trajectory, with the various modes coordinating and interacting with one another in a dynamic way. Each mode could serve as a steppingstone for another, with stand-alone systems, for instance, building the base for mini-grids and grid connection.

In practical terms, enabling such a dynamic interaction between the three modes requires a clear governance framework such as a concession contract. Each mode will involve unique stakeholders, such as grid-based distribution companies, mini-grid developers and stand-alone systems providers. In broad terms, and depending on how these stakeholders engage as part of a concession, two types of distribution concessions can be defined.

A “tight” distribution concession model comprises a legal entity. It is essentially an SPV that includes a traditional utility (grid operator) plus mini-grid and stand-alone system companies. The SPV has the entire spectrum of expertise required to undertake distribution activities for a given territory and expand electrification using the most appropriate electrification mode. Much like a typical distribution company, the SPV would be subject to an annual revenue requirement for each electrification mode based on cost-of-service principles and performance-based incentives.

A “loose” distribution concession model includes the concessionaire as a single entity with the experience of managing distribution activities and grid extension. Engagement of mini-grid and stand-alone system entities takes place bilaterally with the concessionaire through sub-concession/franchisee agreements. This model involves a larger set of entities, with the concessionaire taking on the responsibility for coordinating different actors while also acting as the default/last-resort provider.

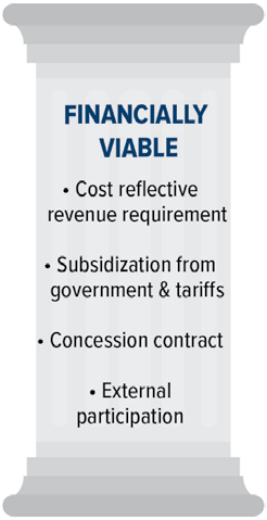
In either case, an electrification plan is assumed to exist for the subject territory. The plan is based on cost-minimization or other reasonable criteria; it aims to predefine, either as an indication or as a mandate, the electrification mode appropriate at the level of granularity defined in the plan (e.g., individual building, block, village, municipality, district).

2.2.3 Transition to a viable distribution business model

A viable distribution sector is critical for the sustainability of the power sector and for ensuring that sufficient, reliable and affordable electricity is universally accessible. Distribution companies – particularly those struggling financially – need to be placed on a trajectory towards long-term viability. They need capital to meet investment needs within existing coverage areas as well as for expanding access. What does that trajectory look like?

Several developing countries have tested various approaches to engaging the private sector in distribution in an effort to attract investments, technology and expertise. The approaches have varied in their design and outcomes. Short- to medium-term interventions have involved management contracts and engagement of franchisees to conduct some or all distribution activities within a concession area. These interventions have yielded benefits in terms of reduced aggregate technical and commercial collection (ATC&C) losses, increased revenues and improved customer engagement. However, they have focused largely on urban centers, allowing

them to make large gains with limited capital expenditure. Most franchise agreements do not explicitly address remuneration conditions to recover significant capital investments. As a result, franchisees must rely on revenue gains from ATC&C losses and other revenues to finance capital expenditures.[53]



Long-term concessions, usually covering a period of 20 years or more, have proven to be an effective instrument for mobilizing private sector expertise and capital with a view toward improving the viability of the distribution sector. One can find successful examples of concessions across the emerging economies, from Uganda to the city of Delhi in India. While a majority of the successful concession cases cover urban regions, lessons also exist from their application for rural electrification (e.g., in Senegal).[54] In addition, the concession approach is being tested in urban-rural compacts, such as in the state of Odisha in India.

A viable business model for distribution companies will typically involve some form of concession that provides legal security and attracts the participation of external private actors and investments. A central pillar of a robust concession design is assurance that the *cost of service* will be recovered along with risk-equivalent returns. Typically, this will be ensured through suitable regulations to guide the determination of a cost-reflective revenue requirement along with regulated tariffs and subsidies that ensure pre-determined returns over capital investments, as outlined in the previous section.

With electrification as one of the central objectives, concessions must be adapted to ensure that the *cost-of-service principles are applied to all electrification modes (grid, mini-grids and stand-alone systems)*. A least-cost electrification plan that employs complex tools can identify areas most suited for on- and off-grid solutions for a given level of electricity service. It can also offer guidance on the cost of service to inform decision-making on investment and subsidy needs. A concession with an electrification mandate will require subsidies due to the higher cost of service in rural areas compared to urban settings. The nature of the subsidy will vary, ranging from tariff cross-subsidization, to direct payments and to incumbent distribution companies or territorial concessionaires. Further, the subsidy should be tailored for on- and off-grid solutions.

A viable business model for distribution companies will typically involve some form of concession that provides legal security and attracts the participation of external private actors and investments

As noted earlier, the electrification plan provides an important starting point for building a business plan for an IDF approach and gaining clarity on investment needs and subsidy requirements. Consider, for instance, the specific case of Rwanda (further explained in Chapter 3) where MIT/Comillas Universal Energy Access, with support from the World Bank, developed a least-cost electrification plan. Financing a multi-mode electrification plan to reach universal electrification by 2024 will require an investment in the distribution segment of over USD 1 billion spread between 2020 and 2024, while also incurring operations and maintenance (O&M) costs of about USD 24 million per year. As expected in any large, mostly rural electrification project, a substantial annual regulatory deficit will exist under present tariffs. Insights on investment needs and regulatory deficit allow the government, development finance institutions and the private sector to design appropriate funding instruments that will support implementation of the electrification plan.

Attracting large amounts of private capital for universal electricity access requires a *stable and predictable*

53 See GCEEP Working Paper (Nagpal, D. and Perez-Arriaga, I. (2019), How is the distribution sector in low-access countries attracting private sector participation and capital?) which reviews various approaches for increasing private sector engagement in the distribution sector.

54 See Jacquot et. al. (2019), "Assessing the potential of electrification concessions for universal energy access: Towards Integrated Distribution Frameworks", MIT Energy Initiative Working Paper.

regulatory environment. A distribution company or concessionaire is dependent on legal security in the country of operation. This dependency increases when the company has an explicit mandate for electrification and relies on subsidy support for the viability of its business model. Governments, supported by development financing institutions, must provide the necessary backstops in the form of guarantees (e.g., payment security mechanisms, political risk guarantees, etc.).

Experience so far has shown that such guarantees are hard to secure in countries with a poor investment climate and high perceived investment risks. These conditions are common in low-access countries, and they have been compounded by the COVID-19 crisis. The situation is even more difficult for privatized distribution companies. Such companies are exposed to the same regulatory and legal risks as public firms, yet they have less access to public financial support and face additional pressures and scrutiny from shareholders and consumers.

We have found that a long-term, investment-worthy concession can in general be an adequate instrument to deliver permanent, sufficient, reliable, and affordable access to electricity for all in a given area. The design of a concession must be guided by a robust electrification plan and adequate public funding support to ensure cost-of-service recovery for all three electrification modes (Box 3). In this manner, the concession can deliver on the dual objective of improving viability of distribution in the long term and expanding access in a manner that leaves no-one behind.

Box 3. Deploying the appropriate financing mix for universal electrification

A concession agreement must be anchored in a viable distribution business model. The transition from a debt-ridden distribution entity – which now commits to achieve universal access in its territory and to provide reliable and affordable service to all – to a viable concession includes several steps.

First, the cost-reflective revenue requirement for all necessary distribution activities, including the three modes of electrification (the revenue requirement for the term of the concession, e.g. 20 years, can initially be estimated from the electrification plan) must be established. Second, a comprehensive list of efficiency improvements – such as technical and commercial loss reductions – must be produced, and the trajectory of plausible tariffs for end customers and expected revenues from the application of these tariffs must be estimated. Third, a blended mix of public and (mostly) private financing tools, with DFIs providing grants and concessional loans along with private investments and commercial debt, must be designed to comport to the extent possible with regulatory accounting for capital and operating expenditures. Finally, there must be an acknowledgment that in almost every case, the business plan will have an annual viability gap that the government must close. For a well-planned and successfully executed plan, this gap will eventually shrink until it applies solely to lifeline tariffs for vulnerable consumers, to the extent these consumers are covered through tariff cross-subsidization.

Tariff reforms and a strong political commitment to bridge the viability gap and guarantee enforcement of cost-of-service regulations will be crucial. Subsidies will be an inherent part of any business model that targets universal electrification in a given territory; however, subsidies need to be smartly designed and targeted.

The GCEEP research team has worked on a detailed business plan for the electrification of Rwanda. The plan is based on a 2019 report developed by the MIT-IIT Universal Energy Access Laboratory. It establishes a roadmap to rapidly achieve universal electrification by 2024 through a least-cost mix of grid and off-grid technologies. The business plan assumes a 20-year concession and makes reasonable assumptions about various factors including demand growth, price of wholesale energy and tariff evolution. This preliminary study seems to indicate that it is possible to design a viable long-term distribution concession model in a low-access country so that universal electricity access will happen in a reasonable time span.

2.2.4 Focus on social and economic development outcomes

Access to electricity goes well beyond a connection. A top-down approach has to be complemented by the bottom-up participation of end-users of the electrification process. Other entities such as NGOs, foundations, and cross-sector agencies must also play a role in supporting the ecosystem for demand growth and overall human development through productive and community uses.

No electrification scheme will work if the end customers do not receive a quality supply of electricity that is properly metered and billed. Beyond connection, productive and consumptive end-uses of electricity also need to be supported and communities engaged in some form in the process. In short, the electrification process must focus on delivering socio-economic benefits.

The new IDF-based distribution company must create a new type of engagement with the customer. Reliable, affordable and sufficient electricity access can play a catalytic role in advancing socio-economic development by creating employment opportunities through micro-enterprise development, facilitating improved educational outcomes and underpinning the improved delivery of healthcare and other public services.[55] It can also reduce pollution and support ecosystem conservation while contributing to climate change mitigation and adaptation.[56]

None of these objectives will be possible if the electricity supply does not meet minimum requirements of reliability and quality of service. It will be impossible to reduce illegal connections and non-paid bills if the customers are not satisfied with the product or service they receive from the distribution company. Beyond reliability and quality, social engagement has been proven effective and mutually satisfactory from a company–client viewpoint.[57]

In a post-COVID-19 world, maximizing the socio-economic impact of energy access will be particularly crucial. In emerging economies, it is evident that the pandemic will leave millions of people unemployed, potentially resulting in reverse migration from cities to rural areas in some countries. The impact on emerging economies will not be fully known until the pandemic eases. However, it is certain that hundreds of millions will be left in economic distress and that recent successes in reducing global poverty will be reversed.

Thus, as governments and DFIs map out their recovery strategies, support for energy access and for improved livelihoods in rural areas must remain key priorities. Supporting resilient livelihoods in rural areas will be a critical catalyst for creating local opportunities and helping to address large economic migration to urban centers once the pandemic is over. Across productive sectors, such as agriculture, dairy, cottage industry, carpentry, and tourism, there are a number of applications of distributed energy solutions which, when combined with efficient productive appliances, can support income-generating activities in rural areas (Box 4).

> The electrification process has to be development- and consumer-centered. Beyond a connection, productive end-uses of electricity needs to be actively supported.

Rapid improvements in distributed energy solutions and cost reductions have furnished new opportunities for consumers and governments. Through innovative business and financing models, as well as digitization, it is possible now for end-consumers to deploy distributed technologies that can transform livelihoods, increase income, reduce drudgery, and, importantly, enhance resilience. Solar pumps for irrigation, for instance, can increase annual incomes for framers by up to 50% or more compared to relying on rain-fed agriculture.[58] Across the agriculture and dairy sector, a wide range of

55 IRENA (2020), Post-COVID recovery: An agenda for resilience, development and equality, https://irena.org/publications/2020/Jun/Post-COVID-Recovery; and Eberhard, A. and Dyson, G. (2020), What is the impact of investing in power?, https://assets.cdcgroup.com/wp-content/uploads/2020/01/30151049/Whats-the-impact-of-investing-in-power.pdf.

56 EUEI PDF (2017), Energy and Climate Change Adaptation in Developing Countries, http://www.euei-pdf.org/sites/default/files/field_publication_file/euei_pdf_2017_energy_and_climate_change_adaptation_in_developing_countries.pdf; and SEforAll (2020), The Recover Better with Sustainable Energy Guide for African Countries, https://www.seforall.org/publications/recover-better-africa.

57 See, for instance, the case of Tata Power Delhi, https://www.tatapower-ddl.com/customers/solutions/customer-centricity

58 GOGLA (2019), "How solar water pumps are pushing sustainable irrigation", https://www.gogla.org/about-us/blogs/how-solar-water-pumps-are-pushing-sustainable-irrigation

demonstrated applications now exist that combine distributed energy solutions with energy-efficient productive appliances for pumping, processing, cold storage, transport, and retail.[59]

Achieving a stronger link between electricity supply and productive use of energy is crucial to stimulate electricity demand in rural areas and to maximize the socio-economic benefits of energy access.[60,61] Doing so effectively would also strengthen the sustainability of energy access business models whether through the grid, stand-alone systems or mini-grids.[62,63] Yet it is now well known that without targeted efforts, access to modern energy does not necessarily translate into unlocking the full potential of productive end-uses in rural and underserved communities.[64,65] Sufficient and reliable energy supply needs to be complemented by specifically targeted efforts to facilitate the purchase of efficient appliances, consumer and enterprise financing, access to markets, capacity building, and data and information.[66] We also need to pay more attention to achieving gender-equitable outcomes from productive end-use promotion.[67]

Reliable electricity access is also critical for the delivery of essential public services such as education and healthcare. Distributed energy solutions are already being rolled out as part of national COVID-19 response strategies to strengthen the reliability of electricity supply at healthcare centers in both urban and rural areas. In Nigeria, solar-hybrid mini-grids have been installed and deployed at a record pace to support dedicated health infrastructure.[68] In India, the state of Chhattisgarh has already seen more than 1,200 health centers and district hospitals electrified using distributed solar solutions. As a result, there has been a 50% increase in patient admissions, a doubling of successful childbirths per month and improved day-to-day care.[69]

> Reliable electricity access enables delivery of critical public services across health, education and water sectors warranting a focus beyond household electrification.

Globally, institutions such as the World Health Organization, the World Bank, SE4All, the Department for International Development, the International Renewable Energy Agency, and others have emphasized the critical role of energy access in the delivery of timely healthcare and other public services.[70] A concerted effort to deploy energy solutions for strengthening healthcare infrastructure in the short term should align with a long-term perspective that advances resilience in both the health and energy sector beyond COVID-19.

59 SELCO Foundation. *Sustainable Energy Livelihoods: A collection of 65 livelihood applications*, 2019. http://www.selcofoundation.org/wp-content/uploads/2019/05/SELCO-Foundation-Sustainable-Energy-Livelihoods-65-Appliances.pdf

60 International Renewable Energy Agency (IRENA). Off-grid renewable energy solutions to expand electricity access: An opportunity not to be missed, 2019. https://www.irena.org/publications/2019/Jan/Off-grid-renewable-energy-solutions-to-expand-electricity-to-access-An-opportunity-not-to-be-missed

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62 EEP. Opportunities and Challenges in the Mini-grid Sector in Africa: Lessons Learned from the EEP Portfolio, 2019. https://eepafrica.org/wp-content/uploads/2019/11/EEP_MiniGrids_Study_DigitalVersion.pdf

63 World Bank. Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers (Executive Summary), 2019. https://openknowledge.worldbank.org/bitstream/handle/10986/31926/Mini-Grids-for-Half-a-Billion-People-Market-Outlook-and-Handbook-for-Decision-Makers-Executive-Summary.pdf?sequence=1&isAllowed=y

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66 IIED and Hivos. Remote but Productive: Practical lessons on productive uses of energy in Tanzania, 2019. https://pubs.iied.org/pdfs/16652IIED.pdf

67 ENERGIA. Unlocking the Benefits of Productive Uses of Energy for Women in Ghana, Tanzania and Myanmar, 2019. https://www.energia.org/cm2/wp-content/uploads/2019/03/RA6-Unlocking-the-benefits-of-productive-uses-of-energy.pdf

68 Takouleu, J. (2020), "REA urgently installs mini-grids for COVID-19 care centres", https://www.afrik21.africa/en/nigeria-rea-urgently-installs-mini-grids-for-COVID-19-care-centres/

69 Severi, L. (2018), "In conversation with: Chhattisgarh State Renewable Energy Development Agency (CREDA)", http://poweringhc.org/in-conversationwith-chhattisgarh-state-renewable-energydevelopment-agency-creda/

70 World Bank (2020), "Energy access takes center stage in fighting COVID-19 (Coronavirus) and powering recovery in Africa", https://www.worldbank.org/en/news/opinion/2020/04/22/energy-access-critical-to-overcoming-COVID-19-in-africa

Box 4. Linking energy supply with local enterprise development and customer engagement

Utilities, mini-grid operators and stand-alone system providers increasingly recognize the need to support local enterprise development to stimulate demand and advance socio-economic development in rural areas. A number of national electrification programs are now linked to targets for productive end-uses of energy. Since other sectors in addition to electric power (e.g., agriculture, banking, transport, health, or communications) must be involved, targeted programs require robust interagency cooperation.

For instance, under Tanzania's Rural Electrification Densification Program (REDP), the national grid was extended to 392 villages in six regions by 2019. A component of the REDP focused on promoting local enterprise development in order to maximize benefits from electricity access by increasing awareness among entrepreneurs (including agro-processors, carpenters, retailers, etc.) and stimulating electricity use by small businesses. The effort served to boost local economic development. Nearly 350 enterprises across 59 villages received support resulting in an almost 90% increase in profits. Electricity consumption has grown 80%, with grid electricity often replacing fuels such as diesel.[71]

Several programs are also extending dedicated funding to enterprises to facilitate the purchase of machinery and appliances. For example, in Tanzania, a grant fund was established to help stimulate demand for electricity generated by the 300-kilowatt Mawengi hydro electric plant. Grants were made to businesses to purchase machinery in productive end-use industries such as milling, oil-seed pressing and carpentry, among others. This helped the operator (LUMAMA) to quickly reach break even, with businesses accounting for 58% of its revenue and comprising 30% of its customers. In Uganda's Lake region, some mini-grid operators and other utilities have established in-island communities using ice production as an anchor for energy demand to meet needs for fishing, restaurants and hotels.[72]

In Ethiopia, where almost eight of every ten workers are connected to agriculture, substantial social and economic gains are available from linking agricultural transformation and rural electrification efforts through productive uses of energy. Across key agricultural value chains and processing opportunities (e.g., horticulture irrigation, grain milling, bread and injera baking, milk cooling and coffee washing), the economic opportunity amounts to, at least, USD 4 billion. Improving electricity access across such value chains would further develop a USD 380 million local market for appliances while also adding an estimated USD 22 million in annual revenue for utilities and off-grid electricity providers.[73]

Beyond promoting productive end-uses, utilities are also partnering with entities to strengthen customer engagement in rural areas. In the Indian state of Odisha, for instance, Smart Power India (a subsidiary of the Rockefeller Foundation) together with the state regulatory commission embarked on a program to engage 120 local women (Bijulee Didis) to engage with metering, billing, collection, and redressal of customer complaints across an area that includes more than 550,000 people in 630 villages. The efforts considerably increased distribution company revenues, increased monthly household consumption and reduced the rate of failure of the distribution transformer by 7% on a year-on-year basis. Smart Power India has also partnered with the distribution company in the state of Bihar to deploy enhanced Rural Revenue Franchisees to strengthen distribution and enhance customer services leading to enhanced metering, billing and collections.[74]

71 Energy4impact (2019)," Electrification sparks business transformation in rural Tanzania", https://www.energy4impact.org/news/electrification-sparks-business-transformation-rural-tanzania#:~:text=Over%20the%20life%20of%20the,Impact%20has%20supported%20349%20enterprises.&text=Electricity%20take%20up%20has%20increased,of%20energy%20such%20as%20diesel.

72 Shell Foundation (2017), Promoting Productive Use of Energy in Uganda: Status and Potential for Growth, https://shellfoundation.org/app/uploads/2018/10/SF-OCA-Uganda-Accelerator-_-Productive-Use-Technology.pdf

73 Borgstein, E., Wade, K., and Mekonnen, D. Capturing the Productive Use Dividend: Valuing the Synergies Between Rural Electrification and Smallholder Agriculture in Ethiopia, Rocky Mountain Institute, 2020. http://www.rmi.org/insight/ethiopia-productive-use/.

74 Smart Power India (2020), Smart Power Connect: Empowering Rural Communities & Transfroming Lives, https://www.rockefellerfoundation.org/wp-content/uploads/2020/09/FInal-SPC-2020-Net-Spread-02-09-2020.pdf.

2.3 IMPLEMENTING THE IDF

Dysfunction within the distribution segment of the electricity sector is a enduring factor that stands in the way of achieving universal electricity access. We offer the IDF as a general solution that can be adapted to a wide range of national circumstances. It is now appropriate to ask what measures a given country should take to successfully implement a universal access program consistent with the IDF principles.

First, we argue that the IDF needs an ambitious vision for universal electrification supported by resolute political buy-in at the highest level. This vision must also be embedded in a lead ministry, or public agency – backed by key DFIs– which can champion the idea and guide the efforts of several stakeholders towards implementation.

Secondly, a well-structured action plan must be defined with clearly defined objectives and a program of activities that embody the IDF principles and their implications, as described earlier in this chapter.

Finally, the IDF may be implemented in a staged manner, if necessary, subject to economic, political or social circumstances.

> No reform of the distribution sector and universal energy access strategy will succeed without a national vision and strong political commitment.

The following three sections spell out these topics in more detail.

2.3.1 Political buy-in and leadership

In the great majority of low-access countries, establishing a sound and resilient electricity distribution system will require the mobilization of significant human, technical and financial resources. Such an investment is justified by the substantial potential socio-economic impact of expanding electricity access and achieving a well-functioning power sector. Given the stakes and the magnitude of this challenge and what we have learned from the "first action" countries (FACs)[75] and other experiences, we submit that no reform of the distribution sector and universal energy access strategy will succeed without the development of a very strong local political commitment. Success also requires a national "vision"

75 We use the term "first action" countries to denote countries that are in various stages of undertaking important access expansion programs consistent with IDF principles.

backed by the government and subsequently transposed into operational plans.

This will require a dramatic change from the current piecemeal approach to energy access in most developing economies. To date, projects in distribution have typically had limited impact due to the lack of an ambitious and comprehensive overarching vision and strategy. Perhaps more importantly, lack of positive impact is often due to energy access policy being driven by the availability of specific concessional financing instruments in search of medium-sized investment problems to be addressed.

We have searched for another way, characterized by ambitious, well-resourced and sustainable reforms of the distribution sector, and informed by nationally determined visions for the electricity sector specific to each country. Indeed, national governments, backed by key technical ministries such as ministries of energy, economy and finance, infrastructure, and planning, are necessary local "champions." Only they can effectively plan, carry out and sustain the transformation needed to reach universal access.

Addressing the distribution segment of the electrification challenge in its entirety is a winning proposition for end consumers who will receive reliable and affordable power. Governments will also benefit, as they will be freed from the cycle of bail-outs for distribution companies. In turn, distribution companies will be better able to fund expanded access and targeted lifeline service for the poor.

As will be further discussed in this chapter and the next, our work shows that the IDF can be tailored to the specific conditions of a particular country. Indeed, within its flexible set of guiding principles, it seems possible to design large-scale comprehensive electrification programs backed by rigorous, quantitative business plans in a wide variety of situations. Promising unfolding examples in SSA, Latin America and South Asia show that the IDF is not only a theoretical concept but the basis of a practical methodology.

Going forward, an important role for the Commission will be to work across emerging economies as facilitator and convenor advocating and gaining support for IDF adoption at national and, when appropriate, subnational scale. As discussed in Chapter 3, the Commission can now work to bring together key stakeholders to further refine the approach and build consensus concerning implementation. However, in every case, it is **governments**, represented by one or more ministries or agencies, that must lead and ensure that energy access is placed at the top of the political agenda, and receives sufficient resources. DFIs and other financial partners clearly have a supporting role to plan in assisting governments in refining their business plans, defining the terms of concession contracts and auction processes (assuming a concession or concession-like model is adopted) and facilitating interactions with other key public and private stakeholders. The Commission may also assist during this process as an independent advisor or overseer. Chapter 3 describes in some detail the status of ongoing conversations with governments and other stakeholders concerning the potential implementation of the IDF in several FACs.

2.3.2 The IDF standard implementation toolkit

Assuming active public support and leadership, as well as interest on the part of significant stakeholders in adopting the IDF principles, in a non-specific, low-access country context where there are no apparent obstacles to IDF deployment – political, technical, legal, or economical – what are the specific actions needed to implement the IDF?

From our preliminary interactions with FACs, we have identified a number of tasks that must be followed in sequence, in one form or another. They are represented in Figure 4 and are described below.

i. *Develop an integrated electrification plan*. Begin with an integrated electrification plan for the entire country/territory to reach universal electricity access in a given timeframe (e.g., 2030). The plan should account for all the actual constraints imposed by policymakers, including defining the initial level of access. For each year until the target year, the plan must specify the electrification mode (on-grid, mini-grids, stand-alone systems) to be adopted in each part of the territory, the corresponding bill of materials, as well as the annual investment, operation and any other costs. Demand growth – including new demand being supplied and defected demand being recovered – should first be estimated to prepare the plan and then confirmed as the plan is completed. In addition, the plan must include estimates of the cost of the work to be done in order to improve the existing network and meet prescribed standards.

ii. *Prepare a preliminary business plan*. The business plan is critical to developing consensus among key stakeholders on the viability of the electrification plan. It also serves as a necessary pre-condition for ensuring the plan's implementation and long-term financial sustainability (e.g., annual public financing outlay from government, need for concessional financing/grants from DFIs, guarantee mechanisms, ideal terms of private financing needed). The business plan will be based on cost projections from the electrification plan (at least 15 or more years), cost of improving and replacing the existing network, projections of income from a forecast of tariffs and future demand, and estimation of charges (rent) for the utilization of the existing distribution network in the case of a concession. The government must be directly involved in the preparation of the business plan, which also requires support from the utilities concerned and consultation with DFIs. The GCEEP could play an active role in providing technical assistance and convening significant stakeholders.

Ensuring the long-term financial sustainability of the electrification business plan is critical. This requires a two-pronged approach comprising (a) economic growth via demand stimulation through economic activities and (b) a gradual path toward cost-reflective tariffs. By "cost-reflective tariffs" we mean tariffs that, as an ensemble, can cover the annual revenue requirement, except, as is the case everywhere, for some free or subsidized lifeline rates for low-income customers that the government should be able to cover from the national budget or with donor support. Combined with a robust and transparent electrification strategy, the business and financing plan can reduce important information asymmetries that have been major sources of risk for the private sector, and for DFIs, to design appropriate funding instruments to tackle the electrification challenge at scale.

iii. *Identify the most appropriate partnership model between various agents*. With an electrification plan that outlines parts of the territory suitable for grid-based, mini-grid and stand-alone solutions, various actors will need to work in tandem guided by the objectives of the concession agreement. As noted in Box 2, the choice between a "tight" versus "loose" distribution concession model will need to be made, depending on the local conditions. In either case, mini-grid developers or stand-alone solutions providers will provide utility-like services subject to regulated remuneration, tariffs and subsidies, and performance requirements with penalties and incentives. Regulations will be needed to safeguard investments

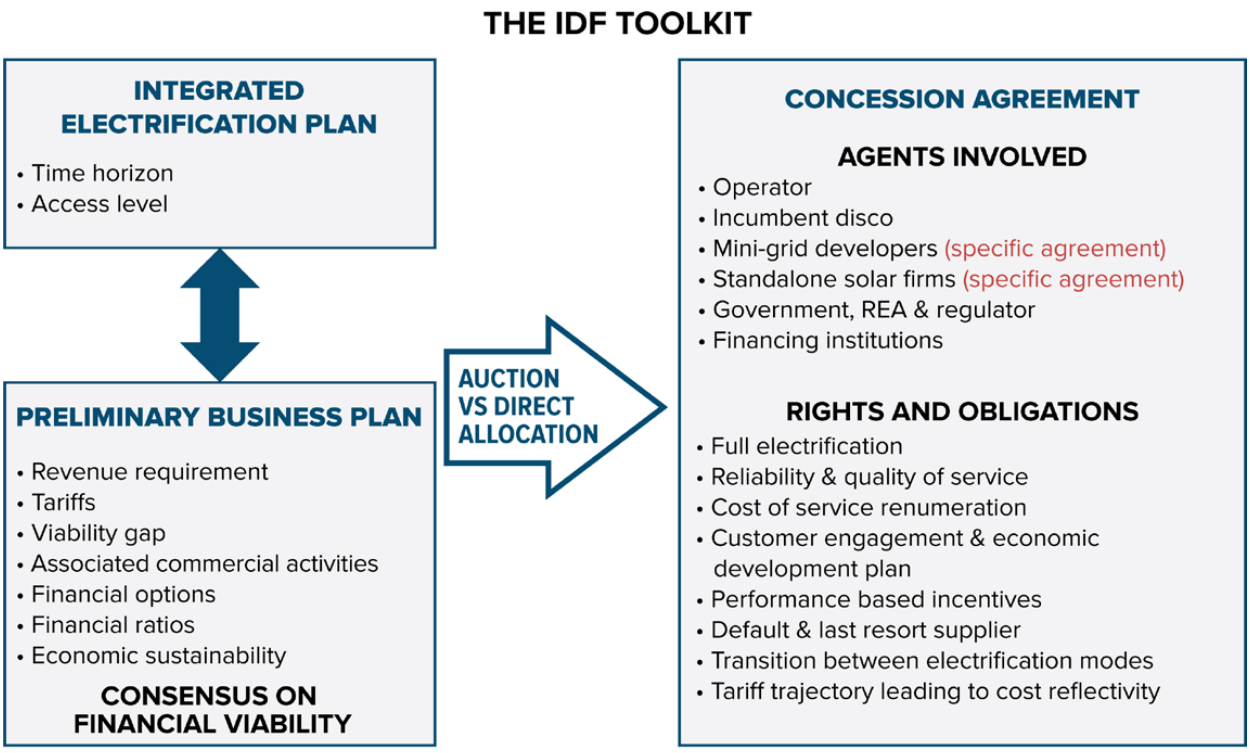


Figure 4 The IDF implementation toolkit

in the event of the arrival of grid or mini-grids. For mini-grids that already exist under willing-buyer/willing-seller tariff arrangements in the territory, a transition period must be established for them to converge to the regulated uniform tariff regime under the IDF (discussed further in 2.3.3).

iv. *Define a concession agreement and award it through an auction (tender) or direct allocation*. On the basis of the business plan, a concession must be designed to manage, operate and invest in the distribution of electricity in the considered territory, under a cost-reflective revenue requirement (collected via tariffs and any required subsidies), subject to some performance targets (with associated penalties and credits), and for a substantial period of time (e.g., 20 years). The concession can be awarded through an auction[76] and several evaluation metrics are possible.[77] The winner (typically some sort of SPV, where the government or the national utility may also participate) will: (a) be mandated to implement the electrification plan by the specified time; (b) have exclusivity in extending the distribution network in the licensed territory not meant to be serviced through off-grid solutions; (c) be the default and last-resort provider in the region; (d) be remunerated according to cost-of-service principles; and (e) have to comply with performance requirements. The concession contract, the credibility of the institutions and legal system of the country concerned and any guarantees provided by DFIs will furnish legal and financial security to the concessionaire. This will be particularly important to ensure continued payment of any government subsidies that are required to supplement the revenue collected from regulated tariffs. The price of wholesale energy will be a passthrough in the regulated tariffs.

v. *Focus on electricity as enabler of socio-economic growth*. The design of auctions to award concessions and the regulation of these concessions must promote the integration of electricity supply with end-use services, especially those services related to productive and community uses that positively impact local socio-economic development outcomes. It is appriopriate to include metrics for consumer engagement in the competitive concession auction plan, as well as for demand stimulation and for public services, and to consider the cost of the plan in the regulated revenue requirement.

As multiple experiences have shown, electricity access by itself cannot bring substantial economic growth. Other services – transport, communication, sanitation, health, education, and access to markets and financing – must be available. The direct involvement of local and central governments – with specific projects dedicated to the promotion of productive and community uses of electricity – is also critical, as shown by the successful experience of the Global Rural Electrification Programme (PERG) in Morocco.[78]

2.3.3 Partial and phase-wise implementation of the IDF

The previous section discussed guidelines for implementing the IDF in a canonical or standard case. Full application of the IDF principles at the country level might be possible in comparatively small countries with a centralized institutional structure and good governance, particularly where a master electrification plan already exists and a sufficiently diverse group of off-grid developers is available. **Rwanda** could be an example, but others in SSA are in this situation as well. An interesting case is **Uganda**. Here, a successful 20-year concession with a private consortium named Umeme has operated successfully since 2005 under well-defined

76 Other business model formats are possible, as described in the Working Paper: "How is the distribution sector in low-access countries attracting private sector participation and capital?" The concession license could be also awarded without an auction, through a bilateral partnership agreement of the government with a willing SPV. This alternative depends on legislation and the situation of the power sector in each country.

77 In so-called "input franchises", the metric is the price of wholesale energy that the concessionaire is willing to pay in order to be responsible for the distribution activity under some specified performance conditions. This implicitly includes utilization of the existing network, as well as responsibility for its improvement and maintenance, and for implementing any prespecified electrification plan. A hybrid form recently used by the state of Odisha in India included three components: (i) the amount to pay the government to get the concession; (ii) commitments to meet performance targets, such as loss reduction (the only one required in the case of Odisha), reliability metrics or number of new connections whose level of realization will be subject to penalties or credits; (iii) a detailed business plan whose soundness will be evaluated in addition to the other two components.

78 Morocco successfully pioneered an integrated approach to electrification (PERG) in the 1990s, combining grid extension, mini-grids and solar home systems under the coordination of the national utility, ONE. However, scarce socio-economic development was derived from PERG and a new program (PVER) was launched a few years later. The latter program focused on productive uses of electricity, coordinated by ONE as well, and enlisted the collaboration of local stakeholders and ministries in charge of agriculture, water, industry, tourism, etc.

performance conditions; however, the concession did not require an extended electrification effort beyond what was in the immediate vicinity of already electrified areas. With the concession coming up for renewal soon, the IDF requirements could serve as the basis for modifications to the current agreement that could be acceptable to both the government of Uganda and Umeme. The new concession could extend its footprint to the entire country or part of it.

In Colombia, an approach based on the IDF is presently being considered to reach last-mile electrification in large territories of the country (covering a total area larger than Spain) where close to half a million households live without access.

Odisha, in India, is another potential case for full adoption of the IDF. Tata Power, a private company with multiple subsidiaries, has recently taken over distribution activities (modeled as a PPP concession model already tested in other mostly urban states) covering a third of the territory of the state. With a significant mix of rural and urban consumers, it has potential for IDF implementation due to its high penetration of grid infrastructure, a focus on service quality improvements and a recently established Tata Power Renewable Microgrid Ltd. (supported by the Rockefeller Foundation).

Partial IDF implementations

Comprehensive adoption of the IDF may face initial hurdles in some countries. These hurdles may include, for example, a lack of local buy-in, insufficient capacity in one or more parts of the electrification ecosystem or an unwillingness among investors to mobilize (and local economy to absorb) the substantial financing needed for the new business model. There may simply be concerns about sustaining the momentum of the implementation program over many years within the context of, for example, regional instability or change.

Faced with the urgency to tackle the electrification challenge, governments and other development partners often concentrate on short-term actions. Partial implementations of the IDF that prove useful in the short term must be welcomed so long as they gradually evolve toward full realization of the IDF principles in the medium to long term. Interesting examples of these partial IDF approaches can be found in several countries.

Nigeria is emerging as an example of fast-track IDF implementations. The Distributed Energy Solutions Strategy for AEDC (DESSA) that is being formulated by one of the private distribution companies, Abuja Electric Distribution Company (AEDC), focuses on engaging the private sector through distributed energy solutions in order to service clusters of commercial and industrial

(C&I) consumers within its service territory. Creating islands of viable distribution businesses by attracting private capital and improving quality of service, although not aligned with electrification objectives, could arguably strengthen the capacity of distribution companies by retaining and bringing in valuable C&I consumers.

Another case in Nigeria which more closely resembles a complete implementation of the IDF is that of Konexa. The distribution company (Kaduna Electric) has entered into a sub-concession agreement with Konexa to service a given area within its service territory and ensure universal access using all electrification modes. The Konexa approach is beginning at pilot scale and with a customer mix that avoids the need for subsidies until the pilot extends to a territory with a higher rural make-up. The challenge here is to design an implementation model that meets as many of the principles and requirements of the IDF as possible while identifying pathways that will eventually lead to the full-fledged IDF.

Presently, a number of independent initiatives are underway to expand electricity access through programs dedicated to just one of the three modes. Led by DFIs, foundations, private entities, NGOs, and governments, these initiatives can deliver important gains in electrification. Over time, we will need to be able to assess how well they can constructively engage with the IDF approach.

In the specific case of isolated mini-grids, for instance, significant steps are being taken by governments, regulators and DFIs to create conditions for the private sector to scale-up mini-grid deployment. In particular, initiatives based on the results-based financing (RBF) approach, such as the "universal energy facility,"[79] can mitigate some of the administrative risk associated with accessing financing support and components and managing the procurement hurdles and inefficiencies that presently plague private mini-grid companies in developing countries.

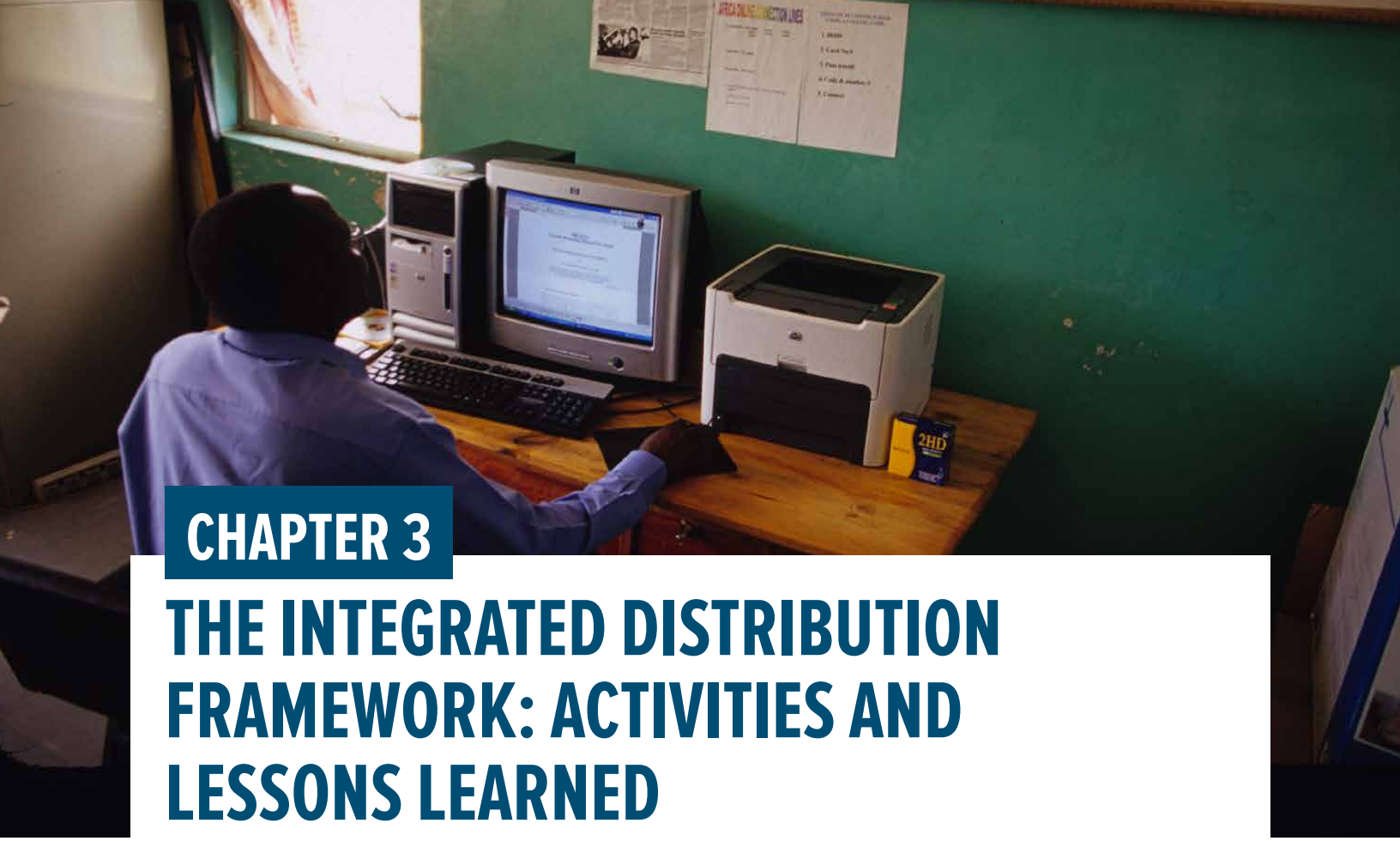
Being subject to light-handed regulation or no regulation at all, the deployment of mini-grids under this kind of arrangement can be fast, with obvious advantages for the as-yet-unserved population. However, with a limited track record, concerns may arise about the long-term inclusiveness (i.e., leaving no one behind) and permanence (i.e., financial sustainability, vocation) of such approaches once they are left to meet demand growth over the project lifetime and beyond.

Compared to targeted initiatives such as scaling up mini-grid deployment (e.g., through the RBF), the IDF requires broader regulatory support and a comprehensive business plan that covers all electrification modes. Also, its implementation will necessarily be slower. However, rather than viewing the two as conflicting approaches, we argue, given the longevity of electricity assets and distribution activities, that the design of mini-grid programs could eventually include elements that provide the building blocks for integrating isolated mini-grids into a regulated distribution business.

Some of these design features include: (i) stress-test mini-grid business and financing models to shift from willing-buyer/willing-seller tariffs to a cost-of-service regulation regime and to identify optimum points of transition; (ii) the ability to anticipate and address information asymmetries in order to facilitate evaluation of revenue requirements for mini-grids by regulators; (iii) clarification for mini-grids that may be subject to multiple regulatory regimes over the project lifetime (e.g., mini-grid regulation, sub-concession/franchisee agreements); (iv) provisions to ensure the compatibility of mini-grid infrastructure with the grid to facilitate future transition; and (v) provisions for building regulator capacity to assess mini-grid business and financing models. Actions across these areas – as well as efforts to anticipatie and plan for the transition – will help address potential regulatory risks and internalize the transition in mini-grid business and financing models.

In summary, the implementation of the IDF will have to be tailored to the local conditions of each country. This is evident from the ongoing engagements of our efforts in the FACs: Nigeria, Uganda, Rwanda, Colombia, and India. The next chapter offers an in-depth view of these activities.

79 The Universal Energy Facility is a multi-donor, results-based financing facility which aspires to be a USD 500 million facility by 2023 (USD 100 million by 2021). It also aims to deliver approximately 2 million electricity connections and 300,000 clean cooking solutions by 2023.



CHAPTER 3

THE INTEGRATED DISTRIBUTION FRAMEWORK: ACTIVITIES AND LESSONS LEARNED

3.1 FIRST ACTION COUNTRIES AND BEYOND

The objective of the GCEEP is to build consensus among key stakeholders around actions to accelerate electrification in the developing world. This objective goes well-beyond publishing a report detailing the key elements of an ambitious and comprehensive electrification strategy. Accordingly, since September 2019, the GCEEP research team has not only met with key stakeholders and commissioners to codify our integrated approach, but has also actively engaged stakeholders in a number of countries. We refer to these as "first action" countries, or FACs.

The IDF offers a set of principles – universality of access, financial viability, integration of the three electrification modes, and a focus on development outcomes – that apply universally in situations where countries face the dual challenge of (1) improving the long-term viability of the distribution sector and (2) reaching universal access to electricity by effectively utilizing opportunities offered by distributed energy solutions.

We recognize that these principles have *individually* been widely discussed for many decades. The power of the IDF lies in bringing them to bear *collectively* to achieve enduring benefits. Nevertheless, the IDF is not a one-size-fits-all solution, but rather one that must be adapted to specific contexts.

The applicability of the IDF is not limited to a few countries with some favorable characteristics. Indeed, our experience has been just the opposite when we have explored the adoption of the IDF in countries that have very little in common in terms of electricity sector regulation and business models. This is simply an outcome of our process of identifying the set of principles that has guided successfully electrified countries, and insisting that these principles cannot be applied selectively. They may, however, be adopted incrementally as political economy, financial and human capacity, and experience permit. This is what we have found to be exciting and hopeful in our dealings with FACs: that every country can make

> The IDF is not a one-size-fits-all solution, but rather one that can be adapted to a given country context

substantial progress toward achieving universal electricity access starting from its current situation, whatever it is.

This chapter describes case studies for five FACs, indicating the various ways in which a country can employ the IDF. The chapter begins with the case of **Rwanda**, where the implementation of IDF seems to be straightforward, conceptually at least. Other countries present prominent features that may require a departure from the "canonical" approach. We continue with the case of **Colombia**, where electrifying communities in semi-isolated areas is the major challenge. We then consider **Uganda**, which, paradoxically, has both a well-functioning and viable private distribution concession, and yet an extremely low rural electrification rate.

Nigeria, which has the largest electricity access deficit globally, is also emerging as a testbed for innovative regulatory and business models through its privatized distribution companies. Both Abuja Electric Distribution Company (AEDC) and Kaduna Electric have initiated programs that are inspired by and consistent with the IDF principles. We discuss AEDC's Distributed Energy Solutions Strategy (DESSA), which tries to create partnerships with private agents to deploy systems – such as solar generation, storage and even mini-grids – to be connected to the main grid to improve the reliability and affordability of supply locally. Meanwhile, Kaduna Electric recently signed a sub-concession agreement with Konexa – a company that tries to implement the IDF principles directly – to undertake distribution activities within part of its territory.

We also discuss the unique case of **Odisha, India**, where the largest distribution zone has transitioned to a private concessionaire. The PPP model adopted there has been successful in urban situations such as in the city of New Delhi. With the rural Odisha concession area already largely grid-electrified, the IDF serves as a guide to decision-making on cost-effective means to improve reliability of supply, support demand stimulation in rural areas, reduce losses, and ensure universal coverage.

In each one of these FACs, engagement with relevant stakeholders to examine the possible implementation of the IDF has already begun and attained different levels of progress, as described in the sections that follow.

3.2 A CANONICAL IDF EXAMPLE: THE CASE OF RWANDA.

3.2.1 Background

The government of Rwanda has established an ambitious and comprehensive National Energy Sector Strategic Plan (ESSP),[80] which includes a 100% electrification target by 2024 to contribute to economic growth and poverty alleviation. With the support of multiple development partners, Rwanda has successfully accelerated the rate of access to electricity from 10% in 2010 to 43% in 2018; this has been achieved by grid extension almost exclusively.[81] Yet the pace of grid extension is insufficient to achieve the established access target. In addition, increasingly cost-competitive off-grid solutions are now available that can meet the current demand of many in the still unelectrified population.

With technical support from the national energy company, Rwanda Energy Group (REG), and funding from the World Bank, the MIT/Comillas Universal Access Laboratory has been able to use its electrification planning software REM to develop a master electrification plan for the entire country. This plan specifies a least-cost path to meet the national electrification target, subject to constraints that were necessary to ensure technical viability and consistency with the priorities laid out in the ESSP. In addition to a sound estimation of investment and operation costs, the results obtained can also inform prospective off-grid investors about areas that are not being considered for grid extension within the timeline of the plan, i.e., out to 2024. The detailed results of this study will inform the implementation of the National Electrification Strategy (NES) and help prepare for the National Electrification Plan (NEP).

80 National Energy Sector Strategic Plan (ESSP) (2018), http://mininfra.gov.rw/fileadmin/user_upload/new_tender/Energy_Sector_Strategic_Plan.pdf
81 MININFRA and ESMAP et al. report "Rwanda: Beyond connections. Energy access diagnostic report based on the multi-tier framework", June 2018.

In Rwanda, electrification is primarily a rural challenge: 77 % of the urban population is electrified and receives high-tier service. By contrast, 84 % of the rural population has no access to electricity and very few rural customers receive high-tiers of service. Off–grid solutions are common in rural areas but typically provide only low levels of access.

Rwanda is a small, densely populated country that will ultimately be fully, or almost fully, electrified through the national grid. However, grid extension to reach clusters with low demand is too expensive. Off-grid technologies, which provide lower-tier service but are more affordable under these conditions, can provide an important interim solution. The high cost of grid extension and steep cost reductions in off-grid solar solutions has compelled the government to reconsider its strategy for expanding electricity access. The current plan is to emphasize off-grid solutions that meet basic electricity needs for households that would have difficulty affording even a subsidized grid connection. To enable the new approach, the government launched the MIT/Comillas study and has put in place new regulations for simplified licensing and development of small-scale mini-grids.[82]

At present, tariff revenues from end customers, collected by REG, are insufficient to recover the cost of service. Rwanda's electricity supply is expensive due to limited domestic energy resources and non-competitively procured generation capacity. Tariffs are subsidized, to protect low-income customers, and the gap is covered through public financing allocations to REG. Even at a subsidized rate, firms in Rwanda pay a higher price of electricity compared to firms in neighboring countries, which negatively affects their competitiveness and constrains private investment flows into the economy. Without a drastic increase in demand from accelerated electrification, an estimated generation surplus post-2020 will create further upward pressures on tariffs and, if tariffs are not increased accordingly, will require more government subsidies.

Historically, the governance of Rwanda's power sector has been concentrated in the hands of the government, with relatively little independent decision-making in key matters for the utility. In 2013, the government restructured key energy sector institutions with the aim of achieving regulatory independence, financial sustainability, and increased private sector engagement. REG was created to take over electric utility functions while also carrying out power sector planning and development. While the government retains ownership of REG, REG's affiliated companies are governed under company law as opposed to public service law. RURA is the sector regulator; it has a track record of independent tariff decisions and utility performance reviews.

Rwanda has been a leading reformer among African economies in "ease of doing business" indicators,[83] ranking second in Africa in enabling an attractive business environment. Rwanda's prudent macroeconomic policy has enabled the country to achieve high economic growth and stability in the past decade. The World Bank/ International Monetary Fund assessment of Rwanda's debt sustainability analysis indicates continuation of low risk of debt distress.

3.2.2 IDF-related activities

In 2019, members of the GCEEP research team initiated conversations with key stakeholders in Rwanda about the potential adoption of the IDF approach. Conversations have continued since, including with some GCEEP commissioners. The research team continues to examine the potential for a concession approach in Rwanda. With support from SEforAll, conversations with the Ministry of Infrastructure, Transport, Energy and Sanitation (Mininfra) are ongoing to discuss a draft quantitative electrification business plan prepared by the team.

From an objective viewpoint, Rwanda is a highly suitable country for a straightforward implementation of the IDF. Favorable conditions exist for each of the four IDF pillars. The government has made full electrification by 2024 a priority in its comprehensive strategic plan for the

> Rwanda is a highly suitable country for a straightforward implementation of the IDF with favorable conditions across each of the four pillars.

82 IRENA (2019). Policies and regulations for renewable energy mini-grids.
83 http://www.doingbusiness.org/data/exploreeconomies/rwanda#getting- electricity

energy sector. Rwanda's concentrated governance and the existence of a single national utility capable of coexisting with mini-grid developers and stand-alone solution providers should help to facilitate the design and adoption of a distribution concession agreement encompassing the entire country. Such an agreement would include the mandate for inclusivity, provision of default and last-resort service, compatibility with a sound long-term vision, and the objective of permanence.

The business plan developed by the research team – a detailed quantitative template in excel spreadsheet format, accompanied by an explanatory document – currently accounts for only the fraction of the distribution system that is still to be developed, including through off-grid solutions. This business plan must be expanded to include the existing system under REG.[84] For the time being, the template is being used as a tool for discussion with key stakeholders and for clarifying and testing the investment proposition of the IDF in Rwanda and elsewhere.

Finally, Rwanda has ongoing initiatives that link electricity access with productive and community uses, thus reinforcing the nexus of electricity with other sectors to maximize development outcomes.

For the government of Rwanda and other stakeholders to pursue the IDF and attract the private sector to participate in the electrification process, the business plan for the entire distribution system should be completed. In addition, the relevant stakeholders should follow the application of the standard (or canonical) IDF toolkit described at the end of Chapter 2. Rwanda has made good progress toward preparing an integrated electrification plan and preliminary business plan. Following Chapter 2, the following steps remain: (iii) identification of the most appropriate partnership model between various agents; (iv) definition of a concession agreement to be awarded through an auction (tender) or direct assignment; and (v) integration of the electrification plan with Rwanda's plans for productive use to foster economic growth. Finally, we note that the implementation of the entire IDF model may have to proceed in phases at a pace consistent with the availabilty of resources and the accumulation of experience.

The research team stands ready to support Mininfra and all interested stakeholders to provide technical assistance and perform the role of convener to achieve a potential consensus on the implementation of the IDF in Rwanda.

3.3 INTRODUCING IDF PRINCIPLES INTO A CONCESSION RENEWAL: THE CASE OF UGANDA.

3.3.1 Background[85]

Over the last two decades, Uganda's power sector has witnessed major changes with a redefined role for government in distribution and extensive private sector investment and participation in management. These changes originated in 1999 with the passage of a comprehensive power sector reform strategy that sought to make the sector investable and commercially viable, reduce dependence on government subsidies and improve access to electricity throughout the country. The reform strategy also sought to improve operational efficiency within the sector, strengthen reliability and improve the quality of the electricity supply.

To implement these reforms, the government passed the 1999 Electricity Act, which: (i) established an independent Electricity Regulatory Authority (ERA) to regulate all sector activities; (ii) unbundled the vertically integrated Uganda Electricity Board (UEB) into separate entities for generation, transmission and distribution; and (iii) established the Rural Electrification Board (REB) to oversee the implementation of rural electrification activities, with the Rural Electrification Agency (REA)

84 The detailed cost estimates provided by the MIT/Comillas electrification plan refer only to what remains to be electrified, not to what has to be done in the existing distribution network. The business plan can only be completed once this information is included in the financial analysis of the distribution concession business model.

85 EU Technical Assistance Facility (TAF) terms of reference for a mission on Stocktaking in the Energy Sector in Uganda, April 2020.

serving as its secretariat. The Ministry of Energy and Mineral Development (MEMD) retained responsibility for policy formulation in the sector and overall sector coordination and planning.

The reforms have yielded important results, particularly in generation where the country reached self-sufficiency and is currently in a situation of oversupply. The mismatch between supply and demand could increase total electricity costs by over USD 950 million per year and increase the cost of service to more than USD 0.30 per kilowatt-hour (kWh). Unfortunately, limited investment and challenges in the implementation of transmission projects are constraining the absorption of the oversupply. The priority is demand stimulation through industrialization, electrification of the railway, connection of big loads, and productive uses of electricity.

> Uganda's extremely low electricity access rate – despite having surplus generation – represents a large and untapped demand opportunity.

Uganda's extremely low electricity access rate represents a large and untapped demand opportunity. Only 24% of the population – or 28% according to other sources, such as the National Development Plan III (2021–2025) – has access to the grid compared with an average of 42% in Africa as a whole.[86] When off-grid sources are included, the access rate is likely to reach 36%. Average consumption remains very low, at 100 kWh per annum, compared to an average of 518 kWh in Africa. The government wants to raise average consumption to 578 kWh within the next National Development Plan.

Legal and regulatory frameworks in Uganda are widely considered to be detailed, transparent and well-structured. Increased participation by the private sector has contributed to reducing technical and commercial losses in the existing distribution network. It has also improved performance levels, increased the number of connections and attracted significant amounts of investment in the distribution sector. Yet the current frameworks have not fully permitted an adequate institutional set-up, nor have they provided sufficient incentives for achieving significant electricity access.

In 2005, Uganda Electricity Distribution Company Limited (UEDCL) leased their distribution assets, which were inherited from UEB, to Umeme Limited (a private entity) under a 20-year concession arrangement. The main objectives for the Umeme concession were to: (i) reduce the fiscal burden by reducing system losses, increasing collection efficiency and attracting private finance for distribution network investment and (ii) improve standards of service for existing customers. Currently, the Umeme-operated network covers over 90% of the entire electricity distribution network and traverses major urban and peri-urban areas, with almost no presence in rural ones. Umeme has been able to recover the majority of its tariff costs and has the distinction of being one of very few financially viable utilities in SSA.

Besides Umeme, eight other service providers (SPs) operate in Uganda, outside Umeme's footprint. These SPs consist mainly of small cooperatives with limited capacity, operating in rural areas with largely unviable business models.

In Uganda, there has been significant interest in the development of mini-grids in areas where access is difficult and expensive, as well interest in increasing the penetration of solar home systems. The level of activity and technical and commercial innovation in Uganda, and the growth seen in the solar home system industry, have been remarkable. Whilst there has been some government support for this market – for example, through tax exemptions for solar home systems – the majority of the activity has been carried out by private entities.

3.3.2 IDF-related activities

In 2017, the MIT / Comillas Universal Access Lab partnered with GIZ to apply the REM model to examine the potential of mini-grid solutions for electrifying Uganda's Southern Territory. Shortly afterwards, members of the present GCEEP research team, together with members of the Shell Foundation, initiated contacts to discuss the IDF (or, as the Shell Foundation called this approach, "the energy

86 Uganda's population is estimated to be 41.2 million (population growth 3,02 percent) of which 84% is considered rural population, with a per capita GDP of USD 878. Uganda remains one of the poorest countries in the world, with 21.4% of the population living on less than USD 1.25 a day.

company of the future") with key stakeholders in Uganda. This relationship continues, facilitated by the presence of the Chairman of Umeme on the GCEEP. The director of the GCEEP research team is presently participating in a Technical Assistance Facility of the European Union to provide a better understanding of reforms needed in the electricity distribution sector and concession agreements to increase electricity access in Uganda.

Uganda presents a very special case for the potential implementation of the IDF: it has had a well-performing distribution concession with a private investor for the last 15 years. Creating a long-term distribution concession with a private investor is one of the key features of the IDF. Because decisions about whether a concession will be continued or cancelled must be made ahead of time, discussions on renegotiating Umeme's concession (beyond 2025) have already begun.

Achieving 100% electricity access by 2030 (including approximately 50% access from the main grid) is a major task. It will require connecting approximately 6.1 million new customers between 2019 and 2030 and a minimum of USD 5.5 billion of investment to ensure distribution network expansion and new on- and off-grid connections. It seems unlikely that the eight current SPs will have the capacity to meet these objectives as their current pace of electrification would soon be offset by population growth.

Technically and financially, Umeme is stronger than the other SPs. It presently distributes nearly 98% of the energy that transits Uganda's distribution networks. It also supplies 93% of electricity customers in the country. Over 700,000 new domestic customers have been connected to the main grid by Umeme over the last decade. The company has invested nearly USD 500 million over the same period. While Umeme has a limited footprint and impact on electricity access, recent partnerships illustrate growing interest in electrification (see box below).[87] It is important to realize, however, that in the case of Umeme the neglect of unelectrified areas is a direct consequence of the lack of a clear mandate or economic incentives for electrification in the concession contract. Adequate regulation and a redesign of the future concession contract could reverse the situation. This is not an intrinsic problem of a concession model.

Admittedly, there is a lack of political and social support in Uganda for exclusive private ownership of distribution assets. The different roles of concessionaire and owner, however, have to be clearly distinguished. Achieving full managerial control of a distribution company by a private investor for a long period of time (e.g., 20 years) via a concession contract does not require ownership of the distribution company. Partial, total or no ownership is compatible with a long-term concession.

The IDF is a potentially promising approach under the present circumstances in Uganda. Successful experience with the distribution concession should be leveraged while defining the new concession for beyond 2025. The new concession should include rural electrification as a key objective. Contrary to the present business model, which is economically viable without subsidies, the proposed new concession – involving the three electrification modes as default and last-resort provider – would require the government to complement revenues from regulated tariffs with subsidies to complete the cost-reflective revenue requirement.

> The IDF is potentially a promising approach in Uganda leveraging its successful experience with the private sector distribution concession to include rural electrification as a key objective.

The GCEEP research team has sent a technical note to relevant stakeholders in Uganda that highlights how the IDF could guide the design of the distribution business model in the next period and ensure that full electrification is a priority.[88] Sound regulation guides the behavior of companies in their natural pursuit of profitability. The GCEEP research team is ready to continue conversations with stakeholders, investigate the best options and provide advice as needed, with the support of the GCEEP Commissioners.

87 Umeme has partnered with Power for All around an initiative called Utility 2.0, which aims to explore the relationships and interfaces between on- and off-grid solutions for distribution.

88 Pérez-Arriaga, I. and Stoner, R. "Uganda distribution sector diagnostic. Comments." Technical Note. January 2020.

Utility 2.0 and the IDF: Informing Uganda's pathway towards universal electricity access.

The Utility 2.0 framework has been designed to test integrated energy solutions in Uganda. It aims to develop a series of proof-of-concept pilots whose purpose is to demonstrate how decentralized and centralized energy infrastructure could work together to increase connections in grid and grid-edge settings. Utility 2.0 partners with Umeme and comprises a consortium of implementation partners.[89] The pilots are expected to demonstrate the value of integrated energy solutions for the utility by stimulating demand growth and improving the business case for servicing previously unserved and underserved consumers.

Umeme's performance record is unique in the distribution sector in SSA as well as among other emerging economies. It has managed to mobilize substantial private capital to improve quality of service and reduce losses within its concession area. A key success factor has been the effective design of the concession contract which, in turn, provided the basis for cost recovery and an assured return on equity investments. In contrast, however, Uganda's electrification rate has only reached around 25%. The majority of the population that lacks access lives in rural areas outside of Umeme's concession area.

Experience and knowledge generated through pilots supported by Utility 2.0 will play a crucial role in outlining the case for Umeme to adopt decentralized energy solutions to expand access within its concession area and in proximity to its existing networks. Reaching universal access in Uganda, however, will require a broader, integrated approach at the national level. Such an approach must consider the entire power sector and outline a sustainable business and financing model – one that includes the significant subsidies needed to deliver access through the three electrification modes.

The proposed approach will identify least-cost electrification options, assess cost-of-service delivery in remote areas, assign responsibility to deliver access, and design tailored subsidies for utilities and decentralized actors with a focus on universality of access and permanence.

The IDF precisely tackles these aspects. With Umeme's concession renewal under negotiation, Uganda has a unique opportunity to integrate rural electrification as a key objective backed by a business model that integrates the three modes and offers adequate public financial support. In ongoing discussions with Umeme and other stakeholders (e.g., the EU), the IDF approach is being advanced to ensure that these perspectives are integrated in the new concession design process.

In summary, Utility 2.0 and the IDF are complementary initiatives that bring value to Uganda's electrification agenda and to Umeme. On the one hand, Utility 2.0 illustrates the value to Umeme of engaging decentralized energy solutions to service grid and grid-edge consumers. Meanwhile, the IDF works broadly at the national level to put in place the building blocks of a concession that could provide the means and tools for a concessionaire, such as Umeme, to accelerate rural electrification throughout the country, using all three modes, while also ensuring sustainability of the distribution sector.

3.4 APPLICATION OF THE IDF FOR THE ELECTRIFICATION OF THE LAST 5%: THE CASE OF COLOMBIA.

3.4.1 Background

With support from the Inter-American Development Bank, the government of Colombia has embarked on a project named "Transformation and modernization of the power industry: Roadmap for the energy of the future." A component of this project is the regulatory and institutional design of a business model suitable for the electrification of the three million people (about 400,000 households) who live in "non-interconnected zones." These zones constitute around 51% of Colombian territory.

Colombia's electrification coverage exceeds the Latin

89 CLASP, East African Power, EnerGrow, Equatorial Power, Fenix International, NextGrid, Power for All, Rocky Mountain Institute, The Rockefeller Foundation, Zola Electric, the University of Massachusetts, Amherst.

American and Caribbean average. In fact, 97 of every 100 homes have access to electricity. Yet there are still more than 400,000 households without access, more than half of which are located in zones adjacent to the National Interconnected System (SIN). The rest are in non-interconnected zones (ZNI), which are often difficult to access and where providing electricity services is expensive.

> Last-mile electrification in Colombia requires new business models that make use of new technologies enabled by regulations that guarantee permanence and tailored supply.

Electrification in these areas requires new business models that can efficiently make use of new technologies and regulations that are designed to make these business models possible. The solutions must be sustainable, compatible with a long-term energy model, sufficient to ensure permanence of supply, and adapted to the specific conditions of these areas.

To achieve complete and sustainable electricity coverage in the ZNIs, it is necessary to attract investment, especially private investment. As explained throughout this report, attracting investment requires a business model with a revenue requirement that contains a reasonable rate of return to the investors. It also requires legal security, including a regulatory regime that is reasonably stable over time. Such a model must be compatible with a vision of the future that guarantees the adequate functioning and structure of the electricity sector in the medium and long term.

The director of the GCEEP research team, with the collaboration of Colombian experts, has been responsible for advising the government on the design of a suitable business model for the electrification of the non-interconnected zones. Preliminary recommendations were delivered to the Minister of Energy on November 15, 2019.[90] A final report was presented in Bogotá on January 28, 2020, followed by meetings with the main stakeholders. The report strongly recommended direct application of the IDF, suitably adapted to the conditions of the non-interconnected zones in Colombia.

3.4.2 IDF-related activities

The recommended approach

Recommendations for increasing coverage under sustainable conditions have been grouped under three blocks: (i) the need for integrated benchmark planning, (ii) a regulatory framework in line with the IDF that permits scalability and mobilization of all required efforts for universal service and long-term sustainability and (iii) an institutional framework as well as a governance structure that coordinates and promotes agents who can, by means of political and legislative tools, boost the actions required to expand coverage and achieve universal access in Colombia.[91]

The proposal involves the adoption of a territorial concession model with responsibility for universal service in the assigned zone, both as the default provider and as a last-resort provider. Exclusivity would be reserved for supply through the extension of the interconnected grid and not for isolated solutions (whether mini-grids or stand-alone systems).

Whatever the mode of electrification, the provider will be compensated for providing a service (as a utility-like entity) and not for selling a means of electricity production or a device, even when dealing with stand-alone systems. The ownership and maintenance of the equipment will be the responsibility of the service provider, which will have a utility-like relation with its clients regardless of the mode of supply.

The electrification process

The starting point in the electrification process will be demarcating the ZNI's electrification zones and developing a least-cost plan for universal electricity access (subject to whatever limits of energy policy that are imposed) for each zone. Next, each zone will invite

90 See GCEEP Working Paper: Pérez-Arriaga, I. and Rutty Paola Ortiz Jara, R. (2020), Proposal to achieve universal electricity access in Colombian rural isolated communities.
91 This section summarizes topic (ii). See the Working Paper: Pérez-Arriaga, I. and Rutty Paola Ortiz Jara, R. (2020) for a complete description of this activity.

bids from all potential operators who fulfill the minimum qualification requirements to identify the most attractive (least-cost) bid to execute the plan in accordance with a fixed timeline for project development. The offers must also have a social welfare component, which includes creating demand through productive and consumptive activities supported by energy efficiency measures.

The winning bid will determine the revenue requirement. Tender requirements may impose environmental restrictions, such as caps on fossil-fuel usage in mini-grids, to fulfill other complementary goals of the electrification plan.

The revenue requirement of stand-alone solutions must be approached in a manner similar to that for traditional regulated distribution: revenue must be sufficient to repay the total cost of efficient service provision, including an appropriate return for invested capital. This principle is applicable to grid extensions as well as to mini-grids and stand-alone systems. In each case, remunerable assets, O&M costs, and financial and management costs must be considered. The procedure must follow the usual revenue practices for distribution employed by the Colombian Energy Regulatory Authority (CREG), but in this case including necessary components for the functioning of mini-grids and stand-alone systems, taking into account the useful economic life and necessary replacements for these components, as with any other assets.

This unified approach simplifies the regulatory supervision of the distribution system as well as the tasks of the distribution company. It ensures that all modes of distribution and all clients are treated equally – or delegated to subsidiary mini-grid companies and/or stand-alone systems – under service provisions with established quality requirements, revenue requirements, consumers with regulated tariffs, and receipt of subsidies.

Regulations must acknowledge the need for subsidies and their inclusion within planning. Likewise, regulations must foresee how subsidies could be reduced as far as possible – based on the evolution of consumers' purchasing power – until the difference between the revenue from applying electricity tariffs and the revenue requirement has disappeared. This does not include the amount dedicated to solidarity allowances for those low-income consumers in the zone, as a preferential rate without a defined time limit.

Regulations must also establish how mini-grids or stand-alone systems will eventually be linked or completely connected to the national grid at some point in the future, and what the options are for continued service and associated conditions to be offered so that investing entities receive appropriate revenue or compensation.

Further work

In May 2020, the Colombian Institute for Planning and Promotion of Energy Solutions launched a project in the ZNIs (IPSE) with a group of experts coordinated by the director of the GCEEP research team and one of the team's members. The project, also funded by the Inter-American Development Bank, has collected information about international best practices in electrifying isolated rural areas with solar home systems. Project members issued IDF-aligned recommendations for application to Colombian ZNIs.

3.5 EXPERIENCES IN PURSUING IDF IMPLEMENTATION: THE CASE OF NIGERIA.

3.5.1 Background

Nigeria is the country with the largest population that lacks access to electricity. It must therefore be a priority in the effort to reach universal access. In SSA, Nigeria is also among the few countries with a relatively progressive policy and regulatory environment, as well as a privatized distribution sector comprising eleven discos. Yet, despite progressive reforms, the country's distribution sector still faces severe liquidity and operational challenges. While some challenges are within the discos' realm—e.g., very high AT&C losses, poor customer service, low customer growth, and lack of investment—other challenges emanate from inefficiencies in generation (e.g., high cost of generation), insufficient transmission capacity and reliability, unreliable gas supply to generators, problems

in the regulatory environment (e.g., non-cost reflective tariffs), and macro-economic conditions (e.g., currency devaluation).

Challenges in the distribution sector – compounded by failures upstream in the bulk power system – result in low quality of supply for consumers and low investments in expanding electricity access. Fixing distribution alone would therefore not be enough to ensure a reliable supply to end customers. Nigerians currently spend an estimated USD 14 billion annually on self-generation due to the non-availability of grid power.

> Nigeria has emerged as an epicentre for regulatory and business model innovation to integrate on-grid and off-grid solutions for augmenting supply and expanding access.

On the other hand, Nigeria offers great growth opportunities, particularly with commercial and industrial customers who are largely outside the centralized power system. In part from necessity, Nigeria has experimented with innovative regulatory approaches, including a methodology to remunerate on- and off-grid distribution based on cost of service (even if that methodology is not yet being applied with the right parameters). In addition, a draft franchise regulation entitled "Consultation Paper on the Development of a Regulatory Framework for Electricity Distribution Franchising in Nigeria" has been circulated for comment. The proposed regulation signals a positive development, as it can be made compatible with IDF principles.

As a result of meetings with stakeholders in Nigeria, including the World Bank, Power Africa, Nithio, EDF, Engie, Enel, the African Development Bank, and the European Investment Bank, our research team better understands the difficulties and the opportunities associated with Nigeria's distribution business.

3.5.2 IDF-related activities: The case of Konexa

In 2017, the MIT/Comillas Universal Energy Access Lab and Shell Foundation met jointly with key stakeholders in Nigeria (including several distribution companies). The objective was to define a viable large-scale distribution business model that could be deployed in one or more developing countries in an effort to accelerate energy access and attract private investors. The concept of the "integrated distribution company" or, alternatively, the "energy company of the future" was developed as a result of this collaboration. The start-up Konexa was then created to implement this concept. Konexa applied the MIT/Comillas REM tool within the sub-concession area to determine the combination of grid extension and off-grid technologies that would yield the lowest overall supply cost.

Over the last two years, Konexa has carried out an exhaustive assessment of the customer base in its assigned territory. It has met with commercial and industrial customers individually in an effort to understand their needs and ensure local power supply with embedded generation in the network of Kaduna Electricity Distribution Company (KAEDCO). Konexa has also evaluated the cost of necessary reinforcements to the existing grid to meet targets for reliability and service quality.

A major success of Konexa from a regulatory standpoint is the recent approval by the Nigerian Electricity Regulatory Commission of the sub-concession agreement between KAEDCO and Konexa. The latter is considered to be an integrated energy distribution company that is attempting to accelerate much-needed improvements in service delivery within a sub-concession of KAEDCO's distribution territory.

Under the approved arrangement, Konexa will be an independent, self-contained distribution company. Like others companies subject to Nigeria's new distribution franchise regulation, Konexa will be exempted from existing regulated tariffs and will be allowed to charge negotiated service rates – with the overall revenue requirement subject to regulatory approval. Konexa is expected to make investments in network infrastructure that will guarantee 24/7 supply within the sub-concession area to all interested customers. These include large commercial and industrial off-takers that are currently dependent on diesel-fueled self-generation and can expect lower costs and improved reliability, as well as underserved and unserved residential customers. To meet the full range of customer needs, Konexa will also

roll out new metering technology, deploy off-grid solutions, such as mini-grids and solar home systems, and install embedded generation capacity where required.

In this first phase of the project, Konexa has all of the essential aspects of the IDF, with cross-subsidizing tariffs fully covering the cost-reflective revenue requirement. New challenges will undoubtedly appear in a second phase when the concessioned territory will cover a larger proportion of rural areas. Despite not having to face the financial viability challenges of implementing the IDF for a major distribution company, the experience with Konexa can provide valuable information about the steps needed to evaluate the business model and deploy the right technologies.

3.5.3 IDF-related activities: The case of DESSA by Abuja Electric.

Abuja Electric Distribution Company (AEDC) is one of the privately owned discos in Nigeria. It provides electricity services across the nation's capital and in three other states. AEDC's total franchisee area represents about 15% of the entire country by land area. Much like other discos, AEDC is facing substantial and mutually reinforcing challenges related to liquidity crunch, non-cost reflective tariffs, high AT&C losses, and high cost of service.

As part of its Performance Improvement Plan, AEDC has developed the Distributed Energy Solutions Strategy (DESSA). The aim is to attract third-party and private investments in distributed energy solutions[92] to improve quality of service in selected areas within AEDC's service territory. The areas to be selected will mostly comprise C&I consumers (and some households) that have the strongest incentive to switch back to more affordable and reliable grid-based solutions. A pilot has already been conducted with the Wuse Market interconnected mini-grid.

When implemented, projects under DESSA could provide win–win investment opportunities for AEDC and the firms with which it partners. Successfully developed and financially viable clusters can strengthen AEDC's overall business model over the long run by retaining large consumers within the disco while providing reliable and affordable electricity services. The private sector entity will have secured its return on investments (and any residual value of assets) and leave once the term ends, as in any concession.

Many initiatives in the region develop distributed solutions in silos, without attempting to create a more constructive relationship with incumbent distribution companies. A welcome development with DESSA is the promotion of distributed solutions by a distribution company. DESSA has the potential to serve as a blueprint for similar programs in Nigeria and elsewhere in SSA.

With its focus on integrating grid-based and distributed solutions, creating a legal framework for private sector participation and capital, as well as advancing the long-term viability of the disco, DESSA is an important step in the direction of an IDF-like approach. Its initial focus is not to achieve universal electrification in Nigeria, although it represents a step in the right direction, particularly given present circumstances. DESSA's success will indirectly contribute to achieving the universal access objective by improving the viability of the disco and increasing exposure to the design and implementation of sub-concession models that may be adapted to rural electrification initiatives (like Konexa's).

Exploring alternative routes to a full-fledged IDF is warranted, especially in complex conditions such as in Nigeria. DESSA is well-aligned with the long-term vision for Nigeria's power sector in that it moves in the direction of a sound distribution company, a creditworthy off-taker, and the ability to deliver reliable, affordable and sustainable electricity to all customers in a given territory. One of the key design features of DESSA is the willing-buyer/willing-seller negotiation of tariffs with end-consumers. Negotiating tariffs introduces flexibility and ensures that both parties are satisfied with the mutually agreed deal. It facilitates bringing large customers to the grid in the short term. However, there are no regulatory safeguards in the event of future disputes about tariffs. Moreover, the power system will eventually end up with many different tariff regimes in a given concession area. This is certainly not ideal, but it may be acceptable in the short to medium term so long as AEDC-regulated tariffs become attractive over the long term and the consumers in these clusters are able to transition toward regulated tariffs, ideally within a timeframe that is consistent with the end of sub-concession agreements.

92 This includes the use of distributed generation, storage and demand side management solutions.

From a design perspective, the precise business and financing models[93] DESSA will follow are still under consideration, even as feasibility studies to identify potential clusters for such interventions are underway. Based on the financial assessment for each cluster, however, a viability gap may emerge with respect to delivering the expected return on capital (approximately 13% to 15% in USD terms) in some cases. "Viability gap funding" may be needed for projects that are "close to commercial terms" and that could benefit from concessional debt or equity. Proposed funding facilities (such as the Universal Energy Facility) can be effective tools to support such IDF-oriented programs. A major challenge will arise when, in a later phase of the project, universal access is attempted in rural areas, thereby expanding the need for viability-gap funding, A mechanism to fund the gap will need to be estimated, designed and delivered. This will change the nature of the business plan, which would then be clearly dependent on subsidies to remain financially viable (see Box below).

The Universal Energy Facility: The Energy Access Results Based Financing Initiative

The Universal Energy Facility (UEF) aims to transition from traditional procurement mechanisms (which are based on up-front financing of inputs) toward "results-based financing" (RBF) in which funding is unlocked on the basis of verified connections. The objective is to catalyze private capital and speed up delivery of energy connections to reach universal access objectives by 2030. The UEF is envisaged as a large financing vehicle that pools donor funding to provide RBF for developers of off-grid solutions. Transitioning away from traditional procurement methods, it allows governments to benefit from greater private sector participation while adding regulatory certainty for developers. The UEF–RBF facility draws on the experience of Nigeria's National Electrification Program within which mini-grids developed through the RBF had much shorter timeframes compared to mini-grids rolled out under the minimum-subsidy tender scheme.

The UEF addresses crucial financing gaps faced by the off-grid energy access sector and thus constitutes a welcome step towards a coordinated approach to delivering financing for the sector. Under the program, participating governments will be required to undertake an integrated energy access plan and, accordingly, identify result-based subsidy zones before accepting applications from utilities/developers for verified connection payments. A challenge will be to estimate the gap to commercial viability depending on local context and for various electrification solutions: on-grid and off-grid.

The RBF design will also need to incorporate the costs associated with O&M, battery replacement, generation and grid extension investments, and meeting load growth. Further, the focus on shifting funding support away from capital costs shifts the responsibility for raising requisite debt and equity to meet capital expenditure requirements to the developers based on future cash flows and RBF support. This may create a barrier to entry for local companies with limited experience and capacity to raise sufficient capital and participate in the sector.

The UEF also tackles only a part of the electrification challenge – improving the commercial viability of, mainly, off-grid energy projects to speed up deployment. It does not address the broader electrification ecosystem and the sustainability of the power sector as a whole, which is needed to ensure permanence of supply. While the integrated energy access plan can alleviate certain concerns, the lack of both a holistic approach and engagement between off-grid solutions and distribution companies can result in long-term conflicts as the power system evolves.

Nonetheless, the UEF is an important step in the direction of mobilizing collective action and financing to tackle energy access. Recognizing the scale of the challenge and the importance of an integrated approach, the UEF is well-positioned to serve as an umbrella framework for tailored funding facilities that focus on different aspects of the electrification challenge – stand-alone and mini-grid solutions, and distribution companies. At the national level, the UEF and other funding facilities should be guided by the core principles of the IDF – an integrated energy access plan that emphasizes integration of the three modes, permanence, universality, and a long-term vision for the power sector.

93 The three major models for structuring DESSA include: fund structure (project-level funds disbursed through a fund manager); Holdco Special Purpose Vehicle (SPV) (comprising AEDC, developers and investors raises capital and on-invests into DER projects for each cluster); and AssetCo (similar to Holdco SPV, however consortiums of Engineering, Procurement and Construction company, Operation and Maintenance company and Metering, Billing and Collection company will be created to deploy DERs in pre-determined sites).

3.6 OFF-GRID SOLUTIONS UNDER THE GRID: THE EVOLVING CASE OF ODISHA AND TATA POWER RENEWABLE MICROGRIDS IN INDIA

3.6.1 Background

A unique context in which to apply the IDF is when the majority of consumers within a concession area have grid connections and the focus is on improving the quality of supply in the most cost-effective manner. In India, for example, there has been a thrust to increase village- and household-level electrification in recent years. As a result, distribution companies have been expanding grid infrastructure at a rapid pace. Yet servicing many low-consumption and less-lucrative rural areas is expensive. Distribution companies typically have limited bandwidth for capital mobilization, leading to further deterioration of financial health, under-investment in rural infrastructure and lack of quality supply.

Consider, for example, Odisha in India where Tata Power recently won a concession for the largest distribution zone in the state. The concession follows a similar PPP structure that has been successfully applied in the city of Delhi,[94] although with some inherent differences in the nature of the concession area. The concession in Odisha has a large rural component with low population densities and consumption. Further, the distribution infrastructure already reaches many parts of the concession area, although high losses, service quality and universal coverage remain key concerns.

When it comes to improving supply quality and efficiency of distribution in rural areas while also attracting private capital, distributed energy solutions (such as mini-grids) have long been touted as the model for distribution companies to adopt. This approach is sound in principle. In India, however, practical experience involving traditional distribution companies integrating mini-grid solutions within their business activity has been limited, primarily due to the lack of enabling regulations.

3.6.2 IDF-related activities

The GCEEP research team views the new concession in Odisha as a unique opportunity to implement the IDF in an urban–rural compact. It offers an excellent blueprint for other distribution companies in India that are seeking to improve quality of supply in rural areas where the grid has already been extended due to the recent government push. This is particularly the case given the recently launched Tata Power Renewable Microgrid (TPRM) company. With support from the Rockefeller Foundation, TPRM anticipates setting up 10,000 mini-grids in India by 2026.[95] The first phase is being rolled out in the state of Uttar Pradesh. The effort involves developing grid-compatible mini-grids in areas with an existing infrastructure. However, a scalable model to reach 10,000 mini-grids will require an integrated approach involving both private mini-grid developers and the distribution companies. An integrated approach further advances efficiency in the overall development of the distribution sector by minimizing investments in redundant infrastructure and leveraging synergies between the main grid and off-grid solutions.

Implementation of the IDF in Tata Power's concession area in Odisha might begin with a least-cost planning assessment. Doing so would enable the identification of areas that are more economically served by deploying distributed energy sources (including generation assets, storage and some network developments) instead of extension and/or reinforcement of the main grid. Suitable areas could involve clusters of consumers where consumption is presently low to justify capital investments in upgrading distribution infrastructure, or areas where existing and future economic activity can be fostered

94 Tata Power – DDL is a public–private partnership between Tata Power (51% ownership) and the government of Delhi (49% ownership) which has a concession to undertake distribution in one of Delhi's four zones. See GCEEP Working Paper: Nagpal, D. and Perez-Arriaga, I. (2019), How is the distribution sector in low-access countries attracting private sector participation and capital? for further details.

95 https://www.rockefellerfoundation.org/news/tata-power-rockefeller-foundation-announce-breakthrough-enterprise-empower-millions-indians-renewable-microgrid-electricity/

through reliable supply. In the identified areas, a partnership with a private entity (such as TPRM) may be required to undertake the activities of deploying and operating distributed energy solutions as well as carrying out distribution tasks (including metering, billing and collection). The private entity may also be required to develop relationships with local entities to improve collection efficiency, and to support communities and enterprises for productive end-use development to stimulate demand.

The business model will strongly depend on the regulatory regime, which, in India, is gradually evolving toward more PPP models in distribution through sub-licenses and franchises.[96] Should the regulations permit the concessionaire to incorporate capital expenditure (CAPEX) investments in mini-grids to determine its annual revenue requirements (thereby securing a guaranteed return on its investments), then the concessionaire may choose to be directly involved in investing in and operating the mini-grids. However, the high cost of conducting various distribution activities locally may be a hindrance.

When the regulations do not allow CAPEX investments in distributed energy sources to be covered while determining the annual revenue requirement (as is the case in Odisha), concessionaires can engage different partnership models. For example, they can participate in sub-concession agreements and input-based franchisees with private entities that are willing to deploy assets and undertake distribution activities for a given cluster for a defined period of time. The private entity can utilize the existing distribution assets of the concessionaire, either through a lease model or a distribution use-of-service charge. Here, tariffs for consumers serviced by the mini-grids may be regulated (based on the terms of the agreement with the concessionaire) or they may be unregulated and directly negotiated.[97]

The research team continues to monitor developments in India and engage with key stakeholders (including regulators, private entities, Tata Power, and Smart Power India) to identify optimal ways to leverage distributed energy solutions as part of the IDF approach in India's context. Success in this regard will improve quality of service in rural areas and ensure inclusive (i.e., universal and permanent) electricity coverage.

Planners should engage as soon as possible in the development of business models tailored to local contexts and funding constraints. We encourage practitioners to work collaboratively with the private sector, development institutions, local public authorities, and NGOs to facilitate deployment and maximize long-term benefits in the health and energy sectors.

3.7 BRINGING THE IDF TO A WIDER ARRAY OF AUDIENCES AND INSTITUTIONS

The IDF is a comprehensive approach to electrification that can be adopted by governments, DFIs, private firms, think tanks, or commercial banks as part of their activities. The more the IDF is disseminated, understood and tried, the better. Our Commission has played an important role in informing opinion and disseminating our findings among influential development sector institutions – many of which are represented on the Commission. Going forward, the GCEEP research team has been invited to make presentations on the IDF and participate in high-impact activities where this concept can reach a wide audience. Several representative examples are described below:

- The Africa–Europe Alliance for Sustainable Investment and Jobs, which launched in 2018, works to address key challenges in employment and inequality in Africa. Four sectoral task forces on agriculture, energy, digital economy, and transport have been set up as thematic platforms for high-level policy dialogue. The task forces have also brought together experts, politicians, academics, and private-sector representatives from both continents. The Energy Task Force, the Africa–Europe High Level Platform for Sustainable Energy Investments (SEI Platform), [98] consists of about fifty organizations, representing both the public and private sectors, financing institutions, international organizations, academia, and civil society from both

96 This point is reflected in the proposed amendments to the Electricity Act. See: https://economictimes.indiatimes.com/news/economy/policy/power-ministry-brings-new-draft-of-electricity-amendment-bill/articleshow/75220967.cms

97 As proposed under the AEDC's DESSA strategy in Nigeria, although a key shortcoming with directly negotiated tariffs is the emergence of multiple tariff regimes within a concession area.

98 European Commission, "Africa-Europe Alliance: Boosting investment and trade for sustainable growth and jobs," accessed October 2019 at https://africa-eu-partnership.org/en/eu-africa-high-level-platform-sustainable-energy-investments

continents. It has been chaired by Mr. Kandeh Yumkella (who is a member of the GCEEP); the director of the GCEEP research team chairs the Regulation Working Group. The research team has been active in the elaboration of the Task Force report, which was made public in November 2019 during the Africa Investment Forum, where the IDF was proposed as one of several recommended priority actions.[99]

- Another key recommendation of the Africa–Europe Energy Task Force is to launch a comprehensive capacity-building program for Africa. The program would focus on regulatory and business models that can help accelerate electrification. Several members of the GCEEP are participating in the preparation of a proposal to launch an African School of Regulation. The IDF has been incorporated in the syllabus of courses at MIT and the Florence School of Regulation.

- Several organizations have requested detailed presentations about the IDF approach and about preliminary IDF implementation initiatives. These organizations include institutions that are members of the GCEEP, such as the World Bank Africa Energy team (West and Central Africa), the company Gridworks of the CDC Group, and the UK Government's Development Finance Institution. The GCEEP research team is collaborating with the Tony Blair Institute in promoting the IDF concept in Rwanda, as well as in capacity-building activities related to improving institutions and market rules for power pools in Africa (see Chapter 4).

- Finally, the electrification planning activities of the MIT/Comillas Universal Energy Access Lab,[100] along with applications of the Reference Electrification Model (REM) in several countries (Rwanda, Mozambique, Indonesia, the Gambia, Cambodia, Colombia, and Ecuador, among others), have facilitated the dissemination and adoption of the IDF concept in recognizing integrated electrification planning as a necessary step.

3.8 WHAT LIES AHEAD

There is much work to do to bring the IDF into practice at scale and in more countries. We are encouraged that the process of disseminating knowledge, informing opinion and motivating stakeholders in several countries is already being made. Key elements for success are: (i) gaining high level political support, leading to the designation of an empowered local champion in each country; (ii) supporting that local champion with a dedicated team that is knowledgeable about different aspects of the IDF; and (iii) successfully convening the key actors who, with strong backing from DFIs, must provide the concessionary investment and guarantees needed to reduce commercial risk for the future concessionaire.

To advance beyond the present stage, and enable IDF adoption by the many countries where we deem this approach to be applicable would require the following:

i. **Further development of the IDF implementation "toolkit"** to take the approach to a level of detail that addresses the practical challenges arising from IDF adaptation and implementation at the national level, for instance in the design of distribution concession agreements, financial analysis of electrification plans and blended financing arrangements leading to the definition of a suitable asset class.

ii. **Evaluation and prioritization of potential IDF candidate countries** in consultation with internal and external stakeholders, and national governments, including identifying and engaging with a local champion and convening all of these parties to create consensus.

iii. **Advocacy and engagement** around the social and economic value of expanding electricity access through the IDF. This would involve continued interaction with relevant stakeholders – DFIs, governments, large energy companies, and influential institutions – and mobilizing resources for implementation.

99 https://ec.europa.eu/international-partnerships/system/files/report-africa-europe-high-level-platform-sei-summary_en.pdf. The Executive Summary of the report begins with the following statement: "T*his report focuses on solutions to the climate and energy access crisis in sub-Saharan Africa (SSA), to achieve universal access to energy by 2030 and underpin an energy transition for sustainable development. It recommends an integrated approach to distribution, enhancing regional electricity trade, and facilitating increased investment in renewable energy, energy efficiency and clean cooking investments. A new distribution model that brings together on- and off-grid distribution services under an* ***integrated distribution framework is proposed****, to leave no one behind. Reinforcing transmission and power pools for greater regional integration are key elements of this transition.*"

100 http://universalaccess.mit.edu/#/main

CHAPTER 4

COMPLETING A HOLISTIC VIEW OF ELECTRIFICATION: LARGE GENERATION, TRANSMISSION AND REGIONAL TRADE

"In Sub-Saharan Africa, the largest infrastructure deficit is in the power sector. Whether measured in terms of generation capacity, electricity consumption, or security of supply, Africa's power infrastructure delivers only a fraction of the service found elsewhere. The 48 countries of Sub-Saharan Africa (with a combined population of about one billion) generate roughly the same energy as Spain (with a population of 45 million). Power consumption, at 124 kilowatt hours per capita per year, is only a tenth of that found elsewhere in the developing world, barely enough to power one 100-watt incandescent bulb for three hours a day. The lack of access to modern and reliable energy is one of the most important bottlenecks for development of higher value added services and industries across Sub-Saharan Africa. Improving energy security is a vital tool for reducing vulnerabilities to external price shocks and for building the foundations for sustainable growth."

European Investment Bank, 2018.[101]

All segments of the power supply chain – centralized generation, transmission, distribution with retail, and off-grid solutions – are needed to ensure universal reliable, sustainable, and affordable access to electricity. Although estimates vary from country to country,[102] a sizeable segment of the presently unelectrified population will still receive access through the main grid. Yet distributed solutions, such as mini-grids, are likely to remain the least-cost option to service a sizeable proportion of the unconnected population for decades. These solutions may offer building blocks for future distribution networks. In the medium to long term, as demand evolves, electricity users may increasingly connect to the main grid, with distributed energy solutions augmenting supply.

Least-cost generation mix and efficient transmission infrastructure are both critical to a well-functioning distribution system. The reliability and quality of distribution, which may over time come to include

101 European Investment Bank (2018), Energy finance in sub-Saharan Africa, https://www.eib.org/attachments/country/energy_finance_in_sub_saharan_africa_en.pdf

102 The African Development Bank's New Deal on Energy for Africa launched targets universal electricity access on the continent by 2025 with over 60% of new connections delivered through the grid. Meanwhile, the International Energy Agency in its 2019 SDG 7: Data and Projections report notes that decentralized solutions are the least-cost way to provide power to more than half of the population gaining access by 2030, with the estimated low levels of rural demand in most countries. Indeed, with the decreasing cost of decentralized solutions, the least-cost electrification mix is likely to continue to evolve, and it will depend on local country conditions as well as assumptions for electricity access service delivery.

embedded generation, depends on the presence of an efficiently operated and adequately supplied bulk power system. A system of this sort will be comprised of centralized generation and transmission infrastructure. The environmental impact of electrification will also depend critically of the mix of technologies used in bulk power generation. The wholesale price of electricity is key to the affordability of electricity supply for grid consumers; in this sense, it controls the relative affordability of grid versus off-grid service. This is important because high wholesale costs undermine the viability of the grid and, in turn, inhibit industry and economic development.

> A least-cost generation mix and efficient transmission infrastructure are both critical to a well-functioning and inclusive distribution system.

This chapter summarizes key challenges in centralized generation, transmission and cross-border electricity trade. It presents actionable recommendations that sector stakeholders could consider to support these other parts of the electrification process. It also offers solutions to some electricity distribution problems, including removing existing barriers to private investment in transmission lines and to a clean bulk generation mix. Other possible solutions include promoting the integration of African national power systems into regional entities where joint investment and operation of power infrastructures can occur efficiently.

4.1 TRANSMISSION

Transmission plays a critical role in the rapid expansion of the power sector in emerging economies. As generation capacity grows to meet demand and power flows increase, the volume of investments needed to develop and upgrade transmission infrastructure rises. SSA alone is estimated to require as much as USD 4.3 billion of annual transmission investments until 2040.[103]

Most developing countries still finance transmission directly from utility revenues or government budgets, while others rely on concessionary DFI financing or grants from donor countries. With public finance increasingly scarce, mobilizing private investments in the transmission sector – much as in other segments of the power sector – is more a necessity than a choice.

Many countries have successfully introduced private sector participation in the development, operation and maintenance of transmission infrastructure. Privately financed transmission has been seen in emerging economies, particularly in South Asia (e.g., India, Philippines) and Latin America (e.g., Brazil, Chile, Peru).[104] In SSA, by contrast, private sector participation in transmission has been uncommon, although some efforts are being made in this direction.

Consider, for example, the Mozambique Transmission Company (MOTRACO), a joint venture between Mozambique Electric (EDM), Eskom Holdings Limited (Eskom) and Swaziland Electricity Company (SEC). MOTRACO operates and maintains transmission lines from South Africa to the Mozal aluminium smelter in Mozambique. Additionally, the Transmission Company of Nigeria and Kenya Electricity Transmission Company are laying the groundwork for PPPs to upgrade the country's transmission infrastructure.[105,106]

In developing countries, weak private investment in transmission is due to the absence of enabling policy, gaps in regulation (for example, relating to payment security, construction agreements, cost-sharing arrangements, and right-of-way permits) and unmitigated country-specific risk. This is unfortunate; adequate business models are known and viable, and standardized transmission projects can be designed and financed with private capital based on revenues generated.

103 African Development Bank (2019), "Africa needs bolder private financing models for power transmission lines - energy experts", https://www.afdb.org/en/news-and-events/press-releases/africa-needs-bolder-private-financing-models-power-transmission-lines-energy-experts-24422

104 World Bank (2017), Linking Up- Public-Private Partnerships in Power Transmission in Africa, Washington DC.

105 Okafor, C. (2018), "Nigeria: TCN Mulls PPP to Upgrade Transmission Network", https://www.allafrica.com/stories/201808230538

106 KETRACO (2020), Technical Assistance for Public-Private Partnerships in Transmission Lines, https://www.ketraco.co.ke/opencms/export/sites/ketraco/tenders/downloads/Public-Private-Partnerships/Request_for_Expression_of_Interest_EOI_PIIP.pdf

The World Bank has examined in detail the most common business models for private sector participation in transmission. [107] It concludes that, although the most appropriate model for private sector participation depends on the local context, independent power transmission (IPT) tenders are seen as most promising for national and regional-level investments in SSA. In IPTs, private owners assume the rights and obligations associated with a transmission line or a package of several lines.

In most cases, governments have implemented this model by tendering a long-term contract, with payment dependent on the availability of the line (not on its level of utilization[108]). Developing countries including Mexico, Peru, Brazil, Chile, and India have used this approach. IPTs have led to substantial private investments and significant cost savings. In India, tariff-based competitive bidding has resulted in tariffs that are, on average, 30%–40% lower than cost-plus tariffs.[109]

Hybrid public–private models are also possible. Utilities can set up an SPV with third-party equity participation. SIEPAC in Central America employs this approach, as does India, allowing private entities to bid in transmission tenders in their own right, or to form joint ventures with the state-owned central transmission utility (PGCIL).

4.1.1 Applicability of IPT tenders

Transmission is a regulated activity involving assets that should be determined based on centralized planning and remunerated through a cost-reflective revenue requirement and performance-based incentives. The IPT model can utilize different PPP structures, most commonly "build–own–operate–transfer" (e.g., Brazil, Peru, India) and "build–own–operate" (e.g., Chile).

The construction and ownership of transmission infrastructure could be allocated to investors through competitive bidding processes. Private entities generally bid an annual payment after commissioning until expiry of the license period based on the project's availability. As with IPPs in generation, a clear understanding of the revenue stream for investors and a tariff that ensures risk-equivalent returns is crucial to attract private sector financing.

Indeed, to ensure fair competition in a tender process, it is important that all participating actors compete on equal footing. In India, private entities have raised concerns over the participation of state-owned PGCIL in IPT tenders, since PGCIL has access to low-cost funds and government support. PGCIL has won about 40% of the contracts auctioned so far on a competitive tariff basis, arguably because it is able to cross-subsidize transmission projects with the help of the low-cost, AAA-rated debt it can raise through its cost-plus assets.[110]

A key challenge for implementing the IPT model in SSA is the financial weakness of the power sector. Its weakness currently inhibits the recovery of transmission costs needed to provide required returns to private investors. One possible way to address this challenge is using revenue escrow arrangements to ring-fence consumer payments. Where escrow arrangements are deemed insufficient to make a project bankable, governments may also have to use government and multilateral guarantees to back payment obligations to IPTs. In India, adequate payment security is made available to the transmission service provider, including a letter of credit backed by credible escrow mechanism.[111]

Legislation, licenses and other legal instruments will have to be amended to allow for multiple transmission providers. Meanwhile, concessional finance

> Scaling-up private sector participation in transmission requires amendments to legislations and licencing regime, as well as concessional financing structures and guarantee mechanisms to ensure cost-recovery.

107 World Bank (2017), Linking Up- Public-Private Partnerships in Power Transmission in Africa, Washington DC.

108 The cost of providing transmission services – building, operating and maintaining the network infrastructures – does not depend on the amount of power being transported.

109 Sterlite Power (2019), "Competitive Bidding: A Rationale for Efficient Transmission Sector in India", https://www.sterlitepower.com/blog/competitive-bidding-rationale-efficient-transmission-sector-india.

110 Singh, S. (2019), "Private power transmission companies move CCI, regulator against power grid pricing", The Economic Times, https://economictimes.indiatimes.com/industry/energy/power/private-power-transmission-companies-move-cciregulator-against-power-grid-pricing/articleshow/69191201.cms?from=mdr.

111 Ministry of Power (2016), Tariff based Competitive-bidding Guidelines for Transmission Service, https://powermin.nic.in/sites/default/files/uploads/Guidelines(i).pdf.

has to be adapted to the IPT model in the same way that debt and equity support has been extended to IPPs. Depending on local conditions, different project structures (e.g., purely private, SPV) will need to be tested along with different payment structures. In addition, in-house capacity will need to be developed as part of transmission service agreements (TSAs) to identify projects, design tenders, evaluate bids, and award contracts.

Long-term and timely planning is equally important given the lead-times associated with developing and commissioning transmission infrastructure. Coordinated power sector planning, which is often based on a long-term, least-cost approach, generally covers demand forecasts, generation, transmission planning, and investment needs.

In the specific case of power pools (discussed further in 4.3), coordinated planning among individual pool members is critical. For instance, in 2019, the Economic Community of West African States (ECOWAS) presented its updated Master Plan for Regional Power Generation and Transmission Infrastructure 2019–2033 to develop the West Africa Power Pool (WAPP). The Master Plan identifies 28 priority transmission projects – mostly cross-border interconnectors and some national projects – requiring an investment of over USD 10 billion.[112] Power pool market structures can also inform future transmission investments. In the Southern African Power Pool (SAPP), the day-ahead market provides transparency on the frequency and materiality of network congestion across the region.

IPTs show promise for attracting private sector investment in transmission. However, this approach has to be pursued cautiously. Moreover, it is appropriate only in countries that have adequately prepared for IPTs in the manner described previously. The implications of PPP models in terms of cost-of-service delivery and the efficiency of service provision need to be studied. Finally, tailored approaches must be designed according to country context. Adopting this approach to transmission investment requires capacity building and commitments from governments and regulatory authorities. The GCEEP can be instrumental in this regard.

4.2 GENERATION

The IEA Stated Policy Scenario forecasts that electricity output in SSA[113] will soar from 225 terawatt-hours (TWh) in 2018 to 900 TWh in 2040. The more ambitious Africa Case Scenario indicates that electricity ouput will increase to 1,760 TWh. With a significant share of the population expected to gain electricity access through grid extension,[114] the development of the centralized generation sector will be important.

The dual objectives of SDG 7 and the Paris Agreement on climate change must inspire generation expansion strategies in countries with a large unelectrified population. Under these far-reaching goals, a number of local factors must be considered. These include the economics of various technologies, the need for flexibility to facilitate integration of large amounts of wind and solar generation in the power system, energy security, transmission adequacy, and the creditworthiness of distribution companies as off-takers. Expected demand growth, regional cooperation and trade, as well as the comparative situation of the emerging economies with access deficits with the rest of the world must also be considered.[115]

The IEA estimates that solar photovoltaics (PV) could account for close to a quarter of electricity supply in SSA (excluding South Africa) in 2040, compared to just 1% in 2018. Gas and hydropower are expected to continue to play major roles in power provision, going from 24% and 51% of the electricity mix, respectively, in 2018 to 27% and 26% in 2040. Wind would participate with a 6% share. Strong demand growth will require substantial capacity

112 Lam, J. (2019), "Leveraging private investment in power transmission infrastructure in West Africa", https://www.dlapiper.com/cs/global/insights/publications/2019/11/africa-connected-issue-3/leveraging-private-investment/.

113 Excluding South Africa.

114 According to IEA estimates, at least 300 million people are projected to be connected through grid extension by 2040. This number will likely increase as national grids further expand and take on areas covered by mini-grids and stand-alone systems in the longer term. IEA (2019), World Energy Outlook 2019, IEA, Paris, available at: https://www.iea.org/reports/world-energy-outlook-2019.

115 According to the IEA Sustainable Development report (2020), over 500 GW of coal-fired capacity was in the planning phase globally at the start of 2020, including 180 GW in China, 100 GW in India and 95 GW in Southeast Asia. For SSA, electricity consumption per capita is around 500 kWh/yr, as compared to a world average of 3,133 kWh/yr and over 7,700 kWh/yr for OECD countries [World Bank (n.d.), Electric power consumption (kWh per capita), https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?locations=ZG-1W-OE]. According to the Tracking SDG7 Report, Africa has significant recoverable fossil fuel reserves – in particular, 100 trillion cubic meters of natural gas with which to provide baseload power until large-scale energy storage to complement renewables becomes more widely affordable. Forty percent of global gas discoveries for the period 2011–2018 took place in Africa – mainly in Mozambique, Tanzania, Egypt, Senegal, Mauritania, and South Africa.

expansions in solar, wind, gas-fired and hydro generation – including a four-fold increase in hydro capacity.[116]

When considering cost-effectiveness, security, and climate mitigation and resilience, the importance of a diversified power mix cannot be overstated. Hydropower represents a significant source of electricity production in eastern and southern Africa. For example, 90% of electricity generation in Ethiopia, Malawi, Mozambique, Namibia, and Zambia currently comes from hydropower.[117] As climate variability worsens, large dams will be increasingly vulnerable to changes in rainfall patterns, thus threatening the power supply at a regional scale. The Kariba Dam, for instance, which currently supplies half of Zambia's electricity, has been incapacitated by ongoing droughts, threatening the stability of the entire power sector.

Renewable energy solutions – especially solar PV and onshore wind – continue to see rapid cost reductions across SSA and have attracted significant investments. Since 2015, renewables have accounted for well over 40% of total investments in the power sector followed by natural gas and oi, which together represent most of the remainder share.[118] Natural gas is increasingly recognized as a low-emission alternative to coal-based solutions; it has the potential to complement variable renewables-based generation by facilitating integration with the provision of adequate flexibility. The discovery of significant natural gas reserves in low-access countries such as Mozambique, Nigeria, Ghana, and Senegal further reinforces the case for utilizing domestic energy resources to expand access to electricity and clean cooking technologies, and to strengthen energy supply in industry.[119]

> Beyond structural reforms in the power sector, attracting private investment in generation requires adequate risk mitigation, robust contractual frameworks and concessional financing.

Power sector planners must devise generation expansion plans that can leverage available renewable energy resources and natural gas while also balancing multiple objectives related to economics, security, emissions, and resilience over the long term.

Investments in centralized generation

The "traditional" business model of investment in large generation in Africa has remained heavily dependent on export credit agencies (most commonly Chinese), with a growing role played by IPPs with long-term contracts that are often supplemented by de-risking instruments from DFIs. In 2018, about USD 1.8 billion was invested in SSA's power sector through IPPs compared to over USD 5 billion of funding from China.[120]

Building generation infrastructure at scale to meet growing demand will require significant investment. In Africa, investment needs exceed USD 100 billion per annum until 2040,[121] compared to USD 27 billion in 2019, most of which has been in generation (USD 18 billion).[122] Public financing or development funds alone will be unable to meet these needs. The private sector will therefore have a fundamental role to play.[123] With regulatory reforms in generation, a large number of emerging economies have seen the growing participation of IPPs. Across SSA, IPPs now play a role in the generation sector in at least 29 countries.[124]

116 IEA (2019), Africa Energy Outlook 2019, IEA, Paris, available at: https://www.iea.org/reports/africa-energy-outlook-2019.
117 Conway, D., Dalin, C., Landman, W.A. et al. Hydropower plans in eastern and southern Africa increase risk of concurrent climate-related electricity supply disruption. Nat Energy 2, 946–953 (2017).https://doi.org/10.1038/s41560-017-0037-4.
118 IEA (2020), World Energy Investment 2020, https://www.iea.org/reports/world-energy-investment-2020.
119 WEF (2020), "12 reasons why gas should be part of Africa's clean energy future", https://www.weforum.org/agenda/2020/07/12-reasons-gas-africas-renewable-energy-future/
120 Eberhard, A. (2019), Bulk Power Supply in Africa: challenges, constraints and opportunities, presentation at GCEEP first Commissioners' Meeting.
121 Res4Africa and Enel Foundation (2020), *Scaling Up Africa's Renewable Power*, Res4Africa, available at: https://www.res4africa.org/wp-content/uploads/2020/07/RES4Africa-Foundation-Scaling-up-Africas-renewable-power.pdf
122 IEA (2020), World Energy Investment 2020, https://www.iea.org/reports/world-energy-investment-2020
123 Res4Africa and Enel Foundation (2020), *Scaling Up Africa's Renewable Power*, Res4Africa, available at: https://www.res4africa.org/wp-content/uploads/2020/07/RES4Africa-Foundation-Scaling-up-Africas-renewable-power.pdf
124 Eberhard, A. (2019), Bulk Power Supply in Africa: Challenges, Constraints and Opportunities.

Governments in low-access countries traditionally have limited capacity to prepare, structure and manage IPP projects. As a result, it is difficult to attract the interest of larger, more experienced developers with lower cost of capital. Existing political and credit risks further raise the cost of IPP projects.[125] Most market structures involve IPPs entering into a long-term power purchase agreement (PPA) that reduces revenue risk for project investors. Yet the off-taker, which is (usually) a state-owned utility company, can bring significant credit risks.

Challenges for investments in generation

Mobilizing greater investments in generation will require addressing perceptions of high risk, particularly in relation to regulatory and policy frameworks and financing.[126] A recent survey[127] of key stakeholders in Africa's energy sector found that while significant opportunities exist for the private sector in generation, investors continue to perceive risks as being high. Policy and regulatory constraints are a major challenge, as are lack of access to low-cost financing, lack of capacity among public bodies to structure deals, the risk of political intervention, and the lack of a clear roadmap for generation technologies, including renewables.

National experiences point to several factors that contribute to successful IPP investments at both the country and project level: stable macroeconomic conditions; a clear policy framework; transparent, consistent and fair regulation; coherent planning; and competitive bidding practices are all relevant to successful IPP investment at the country level. At the project level, conditions that contribute to successful investment include creditworthy off-takers, robust PPAs, security mechanisms, credit enhancement, and risk mitigation instruments.[128]

While structural reforms are being implemented to improve the technical and financial performance of distribution utilities, concurrent measures must be introduced to improve the conditions for attracting IPP investment. Several steps have been taken in this direction. To address the off-taker risk, countries such as India have focused on empowering a creditworthy intermediary between renewable energy IPPs and the distribution companies, further backstopped by payment security mechanisms.[129] Novel models to address off-taker risks are also emerging. The firm Africa GreenCo, for instance, has proposed to act as an intermediary off-taker by buying renewable energy from small to medium IPPs through take-or-pay PPAs and selling the power to utilities and private off-takers through long-term contracts. Africa GreenCo also offered to execute short-term trades within SAPP. It would assume the credit risks of utilities, thereby allowing for lower tariffs.[130]

> Public financing or development funds alone will be unable to meet $100 billion investment needed in generation annually in Africa. The private sector will have a fundamental role to play.

Technology-specific risk mitigation instruments are often needed as well. The Green Climate Fund recently approved a de-risking package for geothermal development in Indonesia. The package combines several instruments, from concessional loans to convertible bonds and grants, to finance 600–900 MW of geothermal capacity.[131] Also, climate financing from the Climate Investment Fund has been used to support

125 IFC (2019), https://www.ifc.org/wps/wcm/connect/f4df6171-1018-4003-ad9d-938ce4866c15/scaling-infra-solar-08.pdf?MOD=AJPERES&CVID=mSCZFCY

126 Res4Africa and Enel Foundation (2020), *Scaling Up Africa's Renewable Power*, Res4Africa, available at: https://www.res4africa.org/wp-content/uploads/2020/07/RES4Africa-Foundation-Scaling-up-Africas-renewable-power.pdf

127 The survey conducted by African Business Magazine sought views of 176 professionals in the energy sector, including project developers, investors, policy makers, technology innovation actors and regulators. The findings are presented in African Energy (2020), Keeping the Green Transition on Track, https://africa-energy-portal.org/reports/africa-energy-yearbook-keeping-green-transition-track.

128 Eberhard, Anton; Gratwick, Katharine; Morella, Elvira; Antmann, Pedro. 2016. Independent Power Projects in SSA: Lessons from Five Key Countries. Directions in Development--Energy and Mining. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/23970 License: CC BY 3.0 IGO.

129 MNRE (2019), Payment Security Mechanism Guidelines for VGF Schemes, New Delhi, https://mnre.gov.in/sites/default/files/webform/notices/sec.pdf.

130 Africa GreenCo (2019), Africa GreenCo - An Overview, https://africagreenco.com/wp-content/uploads/2019/08/AGC-Overview.pdf.

131 GCF (2019), "GCF supports Indonesia's energy transition with de-risking geothermal development, Green Climate Fund", www.greenclimate.fund/news/gcf-supports-indonesia-s-energy-transition-with-de-risking-geothermal-development.

exploratory drilling and steam-gathering infrastructure at geothermal sites in Tanzania where there is high resource potential.[132]

Further, to create a robust framework for generation investments, efforts are underway to develop standardized templates for PPAs and other key contracts. The World Bank, for instance, has developed sample PPAs for fossil-fuel power plants and renewable energy projects.[133] To facilitate solar investments, the Terawatt Initiative and the International Renewable Energy Agency have undertaken a Global Solar Energy Standardization Initiative that provides standardized contract templates covering not only PPAs, but also supply agreements, operation and maintenance agreements, finance facility agreements, and project development guidelines.[134]

Rather than taking a piecemeal approach, there is an increasing need at the country level for comprehensive toolkits that can contribute to market activation. These toolkits are intended to help achieve scale in terms of the generation investments needed in low-access emerging economies.[135] The renewAfrica Initiative is an EU–Africa partnership that aims to fill existing gaps by combining current programs and offering targeted services to lower risks for renewable energy investments in Africa.[136]

There is an increasing need for comprehensive country-level toolkits that contribute to market activation and help scale investments.

The International Finance Corporation's Scaling Solar program illustrates the importance of an end-to-end approach to attract substantial private capital into the generation sector. The program brings together a suite of World Bank services – including debt, insurance and guarantee products – under a single engagement based on a template approach to create viable markets for solar power at the country level. It is being implemented in Zambia, Senegal, Madagascar, Ethiopia, and Togo. The program's suite of solutions has led to record-low prices from competitive auctions for new solar capacity.[137]

Expanding generation for universal access

Across low-access countries in SSA and South Asia, further development of the generation sector will be an important determinant for achieving universal electricity access by 2030. With significantly lower per capita electricity consumption compared to the rest of the world, the continued expansion of centralized power generation in SSA, alongside distributed renewables deployment, will be crucial for ensuring reliable and low-cost supply. Oddly, while many low-access countries face deficits, several have excess installed capacity (e.g., Ghana, Kenya and Uganda). Yet underinvestment in transmission and distribution has meant that a large segment of the population remains without access. A shortage of cross-border transmission capacity, inadequate institutions and the absence of rules to organize effective regional trade (discussed further in the next section) add to the problem.

Due to significant public financing constraints, private sector participation is necessary to meet investment needs for generation expansion. As discussed earlier in this section, increased private sector participation will require favorable conditions at both the country and project level, as well as long-term planning to make sound decisions regarding the desired generation mix.

Creditworthy off-takers also remain an important piece of the puzzle. Experience has shown that, on a project-by-project basis, risk mitigation and payment security mechanisms can de-risk investments to a certain extent. However, both the state and DFIs may have limited capacity to backstop a significant share of generation investment. Eventually, creditworthy off-takers will be needed to attract the necessary low-cost capital into utility-scale generation.

132 AfDB (2017), "Tanzania wins US$21.7 million from Climate Investment Funds to advance geothermal exploration and transform its energy sector," www.afdb.org/en/news-and-events/tanzania-wins-us-21-7-million-from-climate-investment-funds-toadvance-geothermal-exploration-and-transform-its-energy-sector-17202/
133 The World Bank's online Public-Private Partnership Legal Resource Centre has available template Power Purchase Agreements and Energy Purchase Agreements.
134 IRENA and TWI (2019), A Guide to Open Solar Contracts, IRENA and Terawatt Initiative, Abu Dhabi.
135 Res4Africa Foundation (2020), Scaling-up Africa's renewable power, https://www.res4africa.org/2020/07/15/scaling-up-africas-renewable-power/
136 ibid
137 World Bank (2019), https://www.scalingsolar.org/wp-content/uploads/2019/07/Scaling-Solar_External-Presentation_Global_Eng.pdf

Abundant good international practice exists in the design of wholesale regional markets and transmission network regulation which could be adapted to SSA

Wholesale markets could be a solution in the long term. However, developing such markets requires time, a certain level of sector maturity and scale, all of which are lacking in the majority of low-access countries. Regional markets (discussed in the next section) may help achieve scale but require investments in cross-border transmission infrastructure, as discussed in the previous section. Experience suggests that even in large competitive wholesale markets, most generators have long-term financial contracts. Moreover, only small amounts of surplus and deficit are traded. Therefore, creditworthy counterparties will continue to remain critical for the expansion of the generation sector in emerging economies. This provides additional motivation for focusing in this report on fixing distribution, and on the IDF as a key component of the solution.

4.3 REGIONAL POWER TRADE

Regional integration of national or large sub-national power sectors can have a positive impact on the overall electrification process, particularly in SSA. It can reduce electricity production costs by offering participating countries access to low-cost wholesale electricity supply, enabling economies of scale in power generation. Integration can also allow balancing and optimization of supply and demand over the entire region, including in particular compensating the variability of some renewable resources. The ripple effects can be felt throughout all segments of the power sector, including in distribution – with improvements in the reliability of wholesale supply to distribution companies. Moreover, regional integration can incentivize investment in new interconnections and generation plants.

There is an abundance of good international practice in the design of wholesale regional markets and transmission network regulation in a multinational context. These best practices could be easily adapted to the SSA context. The difficulty resides in gathering the political commitment to either establish new regional institutions – regional regulatory authorities and regional system and market operators – with sufficient executive power, or reinforce the existing ones. Doing so would help make existing knowledge available to all concerned parties and encourage them to adopt and implement this knowledge.

It may appear that facilitating regional electricity trade is “low-hanging fruit,” since establishing an advanced power trading platform with sound rules and institutions does

not require substantial financial resources. It does, however, require aligning the interests of involved governments and parliaments. Such an alignment is needed to promote trade through the adoption of common trading rules and the sharing of generation and transmission utilization and cost, and by empowering regional institutions, which requires relinquishing responsibility for some trade regulation and operational decisions. Development of regional regulations requires specialized knowledge and understanding of their implications. Better rules for regional trade and empowered regional institutions are beneficial from the point of view of improving overall efficiency and facilitating investment in generation and transmission. However, adopting these measures could also create conflict by threatening the privileges of entrenched stakeholders in some countries.

Across SSA, a number of power pools presently exist, each of which is at a different level of maturity. Next in this section, we present the broad issues that are currently at play in the deployment and consolidation of power pools in SSA. We refer specifically to the West Africa Power Pool (WAPP) and to WAPP's current difficulties in establishing adequate transmission cost allocation rules, as a case study.[138]

4.3.1 Current challenges for power pools in SSA

A power pool is created when several interconnected electric utilities sign an agreement to coordinate activities, such as exchanging power or planning and installing generation and transmission infrastructure for common utilization. When properly designed and implemented, regional power pools can lower the cost of electricity supply and improve the quality of delivered electricity services, thereby driving socio-economic development. Power pools provide these benefits when they include regional-scale generation plants and adequate cross-border transmission infrastructure. These prerequisites can only be met under sound power pool rules and governance.

Regional power pools are particularly relevant in the specific context of SSA. The size of the national power system in at least 20 countries in this region is presently below the efficient level of output for a single power plant. Also, some countries have sufficient renewable resources (e.g., hydro, geothermal or solar) to not only meet domestic demand but to also export excess power. Four power pools have been established in SSA – West, East, Central and South – with the most advanced (the Southern Africa Power Pool) launched in 1995.

Regional power pools are particularly relevant for SSA. The size of the national power system in at least 20 countries is presently below the efficient level of output for a single power plant.

Regrettably, the potential of these power pools remains largely untapped due to technical and political barriers. The main obstacles to achieving the benefits of well-designed power pools include ineffective regional governance and flaws in the rules for regional trading and network cost allocation.[139] These flaws discourage investments in transmission infrastructure and regional-scale generation plants, especially when there is a lack of trust among states. Barriers to investment also include a lack of willingness to liberalize markets, concerns over the preservation of national autonomy and sovereignty, and a preference for bilateral contracts over regional agreements.

Ineffective regional governance

While many SSA countries struggle with insufficient or unreliable power, others are beginning to be in a situation of excess capacity. A challenge of this scale requires a regional as well as a national approach. Trading power is also essential. Complex coordination both within and between countries is needed in investment, regulations and system operations. Cooperation of this sort will only be possible with political commitment and leadership.

138 A more detailed account of the situation of the West Africa Power Pool and the current debate on transmission cost allocation can be found in the GCEEP research team working paper: "On transmission cost allocation in the West African Power Pool (WAPP). The case of the OMVG transmission project", Ignacio Pérez-Arriaga, 2020. This working paper critically examines present rules for transmission cost allocation in WAPP. It proposes detailed guidelines to improve the present situation in the form of a process that should evolve toward the vision of a "single system paradigm."

139 Global Commission to End Energy Poverty (GCEEP), "Inception Report", September 2019. https://www.endenergypoverty.org/reports

Despite its potential benefits, regional integration is frequently hampered by the absence of strong regional institutions and enabling regulations. Existing power pools generally lack executive powers and capacity in two key regional institutions: the system operator and the regulator. This undermines a regional perspective on generation expansion, effective transmission planning and coordinated regional operation. The result is poor regulatory harmonization.

Flawed rules of regional trade

The guiding principle in the design of a power pool is the "single market" paradigm. According to this principle, a power pool must be as close as possible in its operation and planning decisions, transmission regulation and governance to that of a single country. In practice, loss-of-sovereignty concerns and implementation issues limit the reach of this principle.

When existing power pool rules fall short of the single market ideal, the efficiency and security of supply deteriorate. For instance, in the SSA power pools, current physical bilateral contracts frequently distort the economic dispatch of generation and demand. The 2020–2023 WAPP Master Plan states: "*Indeed, up to now, contracts for the exchange of electricity between States are subject to bilateral agreements with a fixed rate for a long period and are monitored by a meter on the interconnection line. These contracts that proved their value in a radial market could be ineffective or sub-optimal in a large interconnected network in which all generation, options should be able to compete.*" [140]

Flawed transmission cost allocation rules

Transmission regulation is critical to successful power pools. The absence of sound procedures to allocate transmission costs will deter potential investors due to the increased risk of not receiving sufficient compensation. Inadequate charges for cross-border transactions that use regional interconnections will stifle trade until sound transmission pricing rules are implemented. Power-pool-wide congestion management rules are needed to establish priorities in the efficient use of scarce network capacity.

4.3.2 The case of the West Africa Power Pool (WAPP)

The institutional context

Since its creation in 1975, the Economic Community of West African States (ECOWAS)[141] has been promoting economic cooperation and regional integration as a tool for the accelerated development of the West African economy. Regional integration remains the most viable and appropriate tool for achieving and accelerating sustainable development in West African countries.

ECOWAS established WAPP in 1999 to foster a regionally integrated power market and facilitate the balanced development of diverse energy resources for the region's collective socio-economic benefit. WAPP members comprise public and private power generation, transmission and distribution entities involved in the operations of the power network system in West Africa. Presently, WAPP has an Information and Coordination Center (ICC) which, according to the WAPP 2020–2023 Business Plan, will become a regional system and market operator (SMO) within the period.

The ECOWAS Regional Electricity Regulatory Authority (ERERA) was established in 2008 as the regional regulator for cross-border electricity interconnections in West Africa. ERERA's general mission is to regulate cross-border electricity exchanges between ECOWAS member states while also developing the regional market.

The recently concluded West Africa Master Plan 2020–2023 sets out a vision for integrating the power systems of the region that will reduce energy costs and increase reliability.[142]

This institutional setting would be perfectly adequate if the regional institutions had well-defined responsibilities, the material resources and the technical capability to make sound decisions regarding the planning and operation of regional power infrastructures. These institutions also lack the executive power to ensure their decisions are implemented.

140 http://www.ecowapp.org/en/documentation?keys=&field_type_doc_tid=All&field_date_news_value[value]&field_date_news_value_1[value]&page=1

141 Member States of ECOWAS: Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leona, and Togo.

142 https://www.ecowas.int/

A critical issue in the successful completion of a transmission project is the allocation of its costs among the beneficiaries of the project.

Regional trade in the WAPP

Energy surpluses in some countries, and large deficits and high costs in others, make West Africa an appropriate candidate for regional trade, especially given the region's substantial renewable energy potential. The World Bank "*estimates that the economic benefits of a fully integrated power market are on the order of USD 5–8 billion per year for West Africa, with the potential to reduce the cost of electricity services by half in many countries in West Africa.*"[143] Additionally, analysis conducted by the Tony Blair Institute, USAID, and Power Africa estimates USD 30 billion in savings through mutually beneficial power trade and the potential for large-scale regional solar development.[144] There are significant benefits to optimizing the energy resources across the region, given the varying endowments and load profiles in each country.

Despite wide consensus on the benefits of regional electricity trade, the level of cross-border trade is currently low, representing only 8.5% of the region's total electricity production in 2018.[145] Furthermore, existing interconnection transmission lines are underutilized: only 42% of line capacity was used in 2017. This fact suggests the presence of non-infrastructure related barriers to electricity trade in the region.

According to the WAPP Master Plan, massive investments in renewable energy over the medium term, as well as the development of the interconnected network, can reduce the marginal costs for the whole region. These costs will vary from USD 80.6 per megawatt-hour (MWh) in 2022 to USD 49/MWh in 2029.

Transmission cost allocation in the WAPP[146]

A critical issue in the successful completion of a transmission project is the allocation of costs among the beneficiaries of the project. Simplicity in allocation rules is

143 The World Bank. 2019. "Burkina Faso Electricity Access Project." Project Information Document.
144 Tony Blair Institute for Global Change. 2019. "West Africa Power Trade Outlook." Power Africa Senior Advisors Group Program.
145 World Bank Group. 2019. "ECOWAS- Battery Energy Storage Systems and Synchronization." Project Information Document.
146 See GCEEP Working Paper: Pérez-Arriaga, I. (2020a), On transmission cost allocation in the West African Power Pool (WAPP): The case of the OMVG transmission project

always welcome, but over-simplicity might have undesirable consequences. Parties that estimate that their benefits will not be larger than the costs allocated to them will not be interested in the project and may try to impede its realization.

At present, some major sub-regional transmission and generation projects have been proposed and have reached diverse levels of implementation in West Africa. Among them is the Organisation pour la Mise en Valeur du fleuve Gambie (the Gambia River Basin Development Organization, OMVG). This project, which we adopt here as a case study, is in the process of negotiating with the parties, closing financing and starting procurement.[147] The objective of the OMVG interconnection project is to extend the WAPP transmission network by enabling electricity trade between the Gambia, Guinea, Guinea-Bissau, and Senegal.

Regional market rules for WAPP were approved in June 2018. They establish that the approval by ERERA of the Regional Transmission Pricing Methodology shall be one of the required conditions for the commencement of Phase 1 of the regional electricity market. ERERA designed a cost allocation methodology for cross-border transmission in 2015 but technical implementation rules must still be proposed by WAPP for ERERA to approve. In the meantime, the OMVG project is moving ahead while trying to develop its own cost allocation rules.

If possible, regional regulations for transmission cost allocation must avoid applying multiple methods within the region and at the same time avoid posing difficulties that would impede the progress of necessary transmission projects as a result of not having regulations ready. This can be accomplished by designing cost allocation rules that stay as close as possible to fundamental principles adopted in other power pools and that represent best international practices. Unfortunately, this does not seem to be the case in the methods proposed so far. For instance, allocating the costs of cross-border transmission infrastructure only to those parties that are engaged in cross-border commercial transactions is a major flaw that disincentivizes trade without any economic justification – even if the rule sounds "intuitively reasonable."[148]

Sound regulation of transmission cost allocation should: (i) facilitate investment in transmission by reducing as much as possible any economic justification for the stakeholders to oppose a beneficial transmission project, and by reducing any unnecessary risks in the agreed remuneration of the projects; (ii) promote investment in generation by reducing the risk of future uncertain transmission charges; and (iii) facilitate efficient trade by avoiding charging enormous – and unjustified – fees to those who sign bilateral contracts with agents in other countries. A working paper by the GCEEP research team[149] addresses these issues in detail, highlighting the need for capacity building in the operational rules of power pools in SSA.

4.3.3 GCEEP involvement

The GCEEP research team and the Tony Blair Institute are presently establishing a joint effort to work with ERERA in an advisory role on market and transmission rules for the WAPP. This effort also aims to address capacity building on power pool related matters. Contacts have also been maintained with the African Development Bank in this regard, focusing on enhancing power pools through stronger governance and better rules.

Through former Kenyan Prime Minister Raila Odinga (who is presently the High Representative for Infrastructure at the African Union), the GCEEP research team has been invited to play an active part in preparations for an incoming Head of State Conference. The conference will explore a new approach to the development of the Inga hydroelectric project in CDR and the development of the power pools in SSA.

Capacity building in power sector regulation – and power trade in particular – is one of the main recommendations of the African Union–European Union High Level Energy Platform where several members of the GCEEP participate. An ambitious capacity building program on

147 OMVG: https://projects.worldbank.org/en/projects-operations/project-detail/P146830?lang=en

148 After long debates in the early 2000s, the regulation of the Internal Electricity Market of the European Union explicitly stated that "transmission charges must not depend on commercial transactions." See Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the Internal Market for Electricity, Section 2, Article 18.6: "There shall be no specific network charge on individual transactions for cross-zonal trading of electricity." See also Article 18.1: "Charges for access to networks, use of networks and reinforcements… will not be distance-related."

149 GCEEP Research Team Working Paper "On transmission cost allocation in the West African Power Pool (WAPP). The case of the OMVG transmission project," Ignacio Pérez-Arriaga, 2020.

energy regulation is presently being prepared by a small group of promoters that includes several members of the GCEEP. These activities respond to the GCEEP priority objective formulated in the Inception Report:

> *"To be effective, any regional plan requires a clear economic justification and the buy-in of the political leadership. We hypothesize that progress can be made by taking advantage of political momentum and ongoing efforts to further regional integration to identify gaps and opportunities that can be addressed through expanded dialogue and analysis. We believe that the Commission can play a significant role—by shaping opinion and facilitating political action—in reinforcing regional institutions. The Commission can also, by promoting capacity building, help improve market rules following well-established international practices."*[150]

4.4 WHAT LIES AHEAD

Opportunities to make progress in the bulk power sector in individual SSA countries and in the region as a whole are clear and very sizable. Natural resources are plentiful and the potential future demand for power from households, industries of all sizes and commercial activities is enormous. However, creating economic value from this demand will require commensurate investments in transmission and generation infrastructure. Cross-border trade can justify the installation of cross-border lines and the construction of power plants to unlock the outsized natural resources of individual countries, benefitting these countries and their neighbors. Sound regulations and business model designs, backed by trustworthy institutions, are sine qua non conditions to attract the required amounts of private investment.

We summarize the recommendations of this chapter as follows: There is a need to identify and disseminate the best regulatory and business model practices that can make possible large investments in transmission and generation infrastructure. Particular attention should be given to removing barriers to the deployment of medium and large renewable plants. These best practices must be adapted to local situations, and their adoption must be proposed to decision makers. The same can be said of regional trade, where not only market rules and transmission regulations must be revised at the regional level but regional institutions themselves must be upgraded so that they have real executive power and can make sure that opportunities for efficient power exchanges are not missed and transmission lines that are well-justified economically do happen. In the next and final chapter we offer further reflections and recommendations as to how available knowledge in these areas can be effectively consolidated and channeled.

150 Global Commission to End Energy Poverty (GCEEP), "Inception Report", September 2019. https://www.endenergypoverty.org/reports

CHAPTER 5
THE WAY FORWARD

The High-level Political Forum – the United Nations central platform for reviewing progress on the 2030 Agenda for Sustainable Development – convened in July 2020 under the theme "Accelerated action and transformative pathways: realizing the decade of action and delivery for sustainable development." The key message of the Forum was a call for action for the next decade, keeping the focus on sustainable development goals (SDGs) at this time of unprecedented crisis, while also combatting COVID-19.

The Secretary-General's SDG Progress Report[151] states that one-third of the way into the SDG journey, progress has been uneven, and acceleration is needed in many areas. The world has a shared responsibility to (i) safeguard development gains and ensure that the response to COVID-19 is guided by the principle of leaving no one behind, and (ii) ensure that the recovery leads towards more equal, inclusive and sustainable economies, and more resilient societies.

Building back better after COVID-19 means acting where we will have the greatest impact on the SDGs – i.e., protecting and advancing human well-being, and ending poverty. Advancing these goals is fundamental to the achievement of the 2030 Agenda and cuts across multiple SDGs and targets, requiring action on many fronts.

The Forum also agreed that achieving SDG 7 – and thereby ensuring access to affordable, reliable, sustainable and modern energy for all by 2030 – will unlock substantial opportunities for billions of people through new economic prospects and jobs, as well as empower women, children and youth; enhance access to better education, water, sanitation, and healthcare; build more sustainable, equitable and inclusive communities; and provide greater protections from, and resilience to, climate change impacts. In the words of former UN Secretary-General Ban Ki-moon, "Energy is the golden thread that connects economic growth, social equity, and environmental sustainability."[152]

> Energy is the golden thread that connects economic growth, social equity, and environmental sustainability.

151 UN(2020), Summary by the President of the Economic and Social Council of the high-level political forum on sustainable development convened under the auspices of the Council at its 2020 session, https://sustainabledevelopment.un.org/content/documents/269252020_HLPF_Presidents_summary.pdf

152 Former UN Secretary-General Ban Ki-moon, April 20, 2012. "Energy is the golden thread that connects economic growth, social equity, and environmental sustainability. I know this from my own experience. When I was a boy in post-war Korea, I studied at night by a dim and smoky oil lamp. Only when I prepared for examinations was I allowed to use a candle. Candles were considered too expensive to use for ordinary homework. This memory has stayed with me. My country changed, and my prospects changed, with the advent of affordable modern energy in Korea. But too many others have not been so lucky. Widespread energy poverty condemns billions to darkness, to ill health, to missed opportunities. Energy poverty is a threat to the achievement of the Millennium Development Goals. It is inequitable and unsustainable." https://www.un.org/press/en/2012/sgsm14242.doc.htm

The objective of the GCEEP has been to understand the causes of energy poverty and develop an actionable consensus about how to end it. We have focused initially on the challenge of providing universal electricity access, developing strategies and business models, regulatory procedures, financial instruments, and capacity assistance to accelerate processes aimed at delivering sustainable electricity access for all.

This final chapter takes stock of what has been achieved during the Commission's first year; positions our work within the present context of the health crisis, economic recovery, and climate-compatible energy transition; and proposes a way forward, with an action plan for the future.

5.1 TAKING STOCK OF GCEEP ACTIVITIES IN THE FIRST YEAR

Our quest to design a flexible approach – adaptable to multiple contexts – to expand electrification through financially-viable business models has led to the development of the integrated distribution framework or IDF (Chapter 2), which has already gained traction in some countries (Chapter 3). Our focus has been on the distribution segment because we have found that dysfunction in this segment is currently the major impediment to universal electricity access. We have also examined, and proposed measures to overcome, barriers to electrification that originate from the lack of investment in transmission networks and large generation projects (particularly in renewables), as well as barriers that arise from the weakness of regional institutions and from rules for power pools that inhibit taking advantage of the substantial efficiency gains that could be derived from power trade, particularly in SSA (Chapter 4).

5.1.1 The Integrated Distribution Framework

During the last year, we have focused on "last-mile" distribution – understood in the broad sense of providing electricity to end customers by whatever supply technology is most cost-effective: grid extension, mini-grids or stand-alone systems. The poor financial viability of the distribution sector and the uncoordinated development of on-grid and off-grid solutions are major impediments to rapid progress towards universal electrification.

This has led us to focus on integration within the sector on several dimensions, and ultimately to formulate the IDF. The IDF proposes a set of guiding principles to inform existing and new electrification programs. It adopts a holistic view of the power sector and reconciles mutually reinforcing objectives of viability in the distribution sector, rapid electrification and the use of both grid-based and off-grid solutions.

Having established the IDF's potential through dialogue with numerous stakeholders, we started engaging with countries to advocate for and endeavor to actualize the IDF at the right scale and with the right stakeholders. Our learning from experience with so-called first action countries, as reported in Chapter 3, illustrates the steps to be followed to implement the IDF anywhere: (i) getting access to the key energy policymakers, (ii) supporting a local institution that can champion the IDF and adapt this framework to the country's particular requirements, and (iii) helping to convening the relevant stakeholders for actual implementation.

The potential of the IDF to accelerate electrification should not be underestimated. Once successfully implemented, the IDF can attract the necessary amount of investment and guarantee achieving universal electricity access efficiently, integrating all electrification technologies dynamically and maintaining the focus on economic development for communities. At the moment, various levels of implementation of the IDF are being proposed or considered in South Asian, sub-Saharan African, and Latin American countries.

Interacting with each country potentially interested in adopting the IDF is a lengthy process, which requires finding the right interlocutors, adapting the IDF to the particular conditions of the country, and ultimately helping to design a workable and tailor-made business plan for implementation. The business plan should include elements of electrification planning, business models and financial analysis, power sector regulation, and political economy. This activity is presently taking place under different formats and with various levels of progress in several countries in parallel.

5.1.2 Bulk power supply

While distribution remains the weakest link in the majority of low-access countries, a holistic view of the power sector is crucial to complete the electrification puzzle. Gaps in centralized generation or transmission infrastructure can substantially limit the effectiveness and

long-term impacts of electrification programs, especially given that a substantial share of the unelectrified population will be connected to the grid and given that reliable and affordable services will rely on the strength of upstream segments of the power sector. We encourage the adoption of sound, well-known regulatory approaches and business models that can facilitate private investment in transmission and generation infrastructure.

Over the course of the year, our research team has collaborated with the Tony Blair Institute to establish the basis for informing power pool enhancement processes and analyses of regional-scale transmission and generation projects in West and East Africa. A similar high-caliber team would be well-positioned to provide technical support as well as inputs at a political level to regional institutions and governments in Africa with the aim of reinforcing institutions and improving existing rules for regional electricity trade. We offer specific recommendations in this regard at the conclusion of this chapter.

In the short term, the impact of achieving universal electricity access on overall greenhouse gas emissions at the planetary scale is estimated to be very small because of the expected low levels of demand associated with recently electrified and mostly rural populations.[153] This will not be the case in the long term, when demand from these populations will grow and become increasingly grid connected. Creating from the outset the conditions for adequate investment in transmission and generation, and efficient regional trade, will facilitate the deployment of a clean generation mix, which will have beneficial short-term impacts on electricity access as well as beneficial long-term impacts on efforts to mitigate climate change and achieve the SDGs.

5.1.3 The central role of regulation[154]

The transition to a sustainable energy future in emerging economies – one that guarantees universal energy access and aligns with climate goals – requires new approaches to policy, regulation, technology, innovation, and to acquiring the skills to achieve this goal. Capacity building with a specific focus on power sector regulations is urgently needed to address these challenges in a wide range of fields across the electricity, clean cooking and heating value chains. Regulation stands out as an applied field of knowledge – blending engineering, economics and law – that is essential to guide developing countries in designing and implementing this transition. We support a strong effort in capacity building in power sector regulation.

Several members of the GCEEP are spearheading an initiative to launch an African School of Regulation (ASR). We envision a center of excellence, headquartered at some African academic institution, that would support independent discussion and knowledge exchange with the purpose of improving the quality of energy regulation and policy in Africa. The ASR would bring together the worlds of academia and practice and would offer training courses, best-in-class tools and templates, and policy dialogue, as well as applied research.

As regulation impacts multiple stakeholders, the ASR would focus on enhancing the knowledge of not only energy regulators, but also of policy makers, academics, utilities, NGOs, energy companies, etc. A multi-perspective, integrated approach would be essential to fast track the steps needed for Africa's energy transition – not only to meet 2030 targets but also to lay a foundation for achieving the Africa 2063 Agenda. As a hub of regulatory knowledge, the ASR will aim to bring together key energy sector stakeholders to develop and disseminate tools and resources to support effective regulatory frameworks.

Africans will shape the sustainable energy transition on the continent, enhancing or creating the institutions needed to build and operate their infrastructures. Training and education offer a low-cost opportunity to scale up their ability to address existing energy sector challenges. Capacity building is very cost-effective compared to the capital and operating costs of energy infrastructures. Moreover, by encouraging local empowerment and ownership it creates a domino effect, resulting in improvements throughout the entire energy supply chain. Ongoing digitalization in Africa represents an opportunity to accelerate this capacity building momentum.

In the next and last section, we propose a line of action to continue and expand on current efforts to disseminate

153 IEA (2017), Energy Access Outlook 2017. From poverty to prosperity.

154 "The crisis has underscored the critical role of governments and reinforced the perception that – if 2020 is to mark a turning point for the energy sector – then it will be government policies and recovery strategies that drive the necessary changes. There is a strong case to build energy and sustainability into the recovery strategies that governments are now putting together." IEA (2020) World Energy Outlook 2020.

and implement the IDF, attract investment in bulk power infrastructures, enhance the performance of power pools, and provide the capacity building that developing countries need to eradicate energy poverty. The Commission must make sure that these actions to end energy poverty are duly inserted into the wider initiatives for economic recovery and sustainable energy transition that are urgently needed.

5.2 THE WAY FORWARD

The context in which our Commission operates has clearly changed over the past year. We find ourselves in the middle of a global pandemic and facing the prospect of a lengthy and uneven economic recovery that will likely compound inequalities. Vulnerable populations in emerging economies are potentially worst affected, and could see decades worth of progress on poverty alleviation wiped out. The urgency with which governments need to address the current health and socio-economic crisis cannot be overstated.

We strongly endorse the UN High-level Political Forum's call to place the 2030 Agenda at the heart of COVID-19 recovery efforts. While the pandemic is pushing the poorest and most vulnerable people further behind, the international community must respond to the crisis by accelerating action during the next decade to achieve the SDGs.[155]

A "Marshall Plan" for economic recovery in the developing world – including a commitment to the creation of inclusive, sustainable energy infrastructure on a global scale – to be led by the major DFIs and supported by the governments of the developed nations must be launched to advance climate-friendly infrastructure and end poverty. Our Commission emphatically states that ending energy poverty is a prerequisite to end poverty and meet some of the other SDGs. Our report is a call for action to address areas in the power sector that are critical to achieving sustainable access to electricity for households, communities and businesses.

The GCEEP has resolved to continue activities for the next year. There are promising ongoing developments in the FACs that must continue.[156] To keep the focus on the most important challenges, and to leverage the lessons learned from these ongoing encouraging experiences, the Commission proposes to launch a portfolio of selected actions, centered on ending energy poverty, that should be integrated as a key component of the "sustainable energy infrastructure" effort for economic recovery.

The GCEEP will support these actions, to be adopted and championed by local and regional stakeholders at the scale necessary. This effort, extending over multiple countries with very diverse contexts, will involve different GCEEP members, acting either jointly or by themselves or in cooperation with other professionals or entities that are willing to contribute to the activities included in our action plan.

5.2.1 The Action Plan

The GCEEP seeks to make use of the diversity of perspectives of its members, their accumulated knowledge, their influential positions, and their ability to mobilize financial and technical resources to make sure that adequate measures to end energy poverty are incorporated in major plans to promote economic recovery in the developing world.

As a Commission, we will promote actions in **advocacy** to bring attention to universal energy access and to place it at the top of agendas for health, economic recovery and sustainable energy. The GCEEP will continue to analyze business, regulatory and political economy models to accelerate electrification and will provide **technical assistance to national champions** in the actual implementation of these models, providing the necessary

155 "Reversing several years of progress, our analysis shows that the number of people without access to electricity in sub-Saharan Africa is set to rise in 2020. … We estimate that a rise in poverty levels worldwide may have made basic electricity services unaffordable for more than 100 million people who already had electricity connections, pushing these households back to relying on more polluting and inefficient sources of energy." IEA (2020). World Energy Outlook 2020.

156 These developments include the following: Completion of a detailed IDF-based business plan for electrification in Rwanda. An in-depth examination of the distribution segment and the concession of Umeme in Uganda. Innovative approaches to mini-grids under the grid and IDF-based pilots in Nigeria. Collaboration with the Government of Colombia to design the electrification of the non-interconnected zones under IDF-principles. Joint effort with the Tony Blair Institute to advise the regional regulator of the Western Africa Power Pool. Collaboration with Tata Power in the innovative on- and off-grid approaches to last-mile distribution that are being implemented in several Indian states. The business models and regulatory approaches promoted by the GCEEP – the IDF in particular – are taking hold in several francophone African countries, and there are ongoing conversations to examine the IDF in-depth with some of the largest DFIs as a potential key ingredient in the utility of the future in developing countries. Finally, bringing the regulatory knowledge acquired via these activities and the GCEEP members and other partners into the creation of the Africa School of Regulation.

tools and capacities. We will engage with regional leaders and governments in Africa to reinforce institutions and improve existing rules for the **regional trade** of electricity and to build support for regional cooperation on energy projects. The GCEEP will support **capacity building** activities, both from an institutional perspective and by providing technical resources. Based on the deep experience of our members and the capabilities of our research team, the GCEEP will propose a methodology to **evaluate the progress made** by countries and programs, and the adoption of specific technologies for reducing energy poverty.

More specifically, the GCEEP's action plan encompasses the following activities:

Advocacy

1. Universal energy access must be at the top of the agendas for health, economic recovery and sustainable energy. As the world fights the unprecedented crisis presented by COVID-19, a stubborn commitment to ending energy poverty by 2030 must remain central. Conveying this message at decision-making levels, convening stakeholders, and providing technical support for the adoption and implementation of the IDF in developing countries with access deficits is a critical part of the mission of the GCEEP. As governments and other institutions plan trillions of dollars of stimulus funding, investing in energy access in developing countries must be a priority in international and national efforts to "build back better" and in ways that are guided by sustainable development and climate objectives.

Research and technical assistance

2. In the short-term, extend technical and advisory support to governments and utilities to design mechanisms that enable end-consumers (households, enterprises and public institutions) adversely affected by the COVID-19 pandemic to remain connected. Tailored support will also be needed for enterprises in the power sector that have seen significant financial and operational disruptions.

3. Lead further development of the IDF toolkit through orderly engagement with low-access countries by one or more suitably staffed "engagement teams." These teams should include technical, regulatory and financial experts, as well as scholars and other specialists who participate on a part-time or case-by-case basis.

4. Facilitate the utilization – by governments, DFIs and other authorized stakeholders – of advanced software tools for electrification planning,[157] demand forecasting and its relation to productive uses, design of energy efficiency programs, or financial analysis of electrification plans, for instance.

5. Work with committed governments to develop comprehensive access programs that are based on IDF principles, incorporate best practices from around the world, including in the area of blended finance, and could also address the rising cost of capital in emerging economies as a result of the COVID-19 crisis.

Engagement with Regional Leadership on Energy Cooperation

6. Provide technical assistance and political support to regional institutions and governments in Africa to reinforce these institutions and improve existing rules for regional trade of electricity.

7. Engage national political and business leaders to build support for regional cooperation on energy projects with the explicit goals of reducing costs, improving resiliency to natural and man-made disasters and, in the long run, planning for a substantially decarbonized power system.

Institutional and Individual Capacity Building

8. Share innovative approaches and best practices from the accumulated experience of countries that are pursuing aggressive universal access programs consistent with IDF principles, including making extensive use of online platforms and teaching platforms.

9. Engage and leverage the skills of specialized institutions – the future Africa School of Regulation (ASR), as well as MIT and other research universities

157 An example is the suite of models for geospatial electrification planning developed by the MIT/Comillas Universal Energy Access lab, see http://universalaccess.mit.edu

being obvious choices – that have active programs in fields such as regulation, planning and low-carbon development.

Measuring Progress

10 Adopt a practical methodology to enable tracking and inform the design of successful programs to end energy poverty. Important dimensions must include aspects of the IDF, such as permanence and universality of access, and contribution to economic growth, as well as other factors such as consumer affordability, reliability of service and adequacy for healthcare and education. A report will be issued periodically to provide an appraisal of the progress being made by countries to end energy poverty and insights on how efforts can be further accelerated.

A key role for the Commission in advancing this plan will be to help convene and provide a platform for the many actors who are already deeply engaged in the cause of ending energy poverty. All must be part of a **call to action** to achieve the goal of universal access to affordable, reliable, sustainable and modern energy.

Specifically, we call on **country leaders** to develop national plans aligned with the principles of the IDF for eradicating energy poverty by 2030, and to articulate commitments to specific programs and reforms designed to achieve this goal. We also call on country leaders to join us in seeking ways to increase investments in generation and transmission nationally and through regional trade.

We call on **DFIs** to explicitly link near-term recovery packages aimed at ensuring the continuity of essential services to the achievement of long-term investment in resilient infrastructure necessary for ending energy poverty and meeting multiple sustainable development goals. We also call on DFIs to dramatically increase the role of blended finance (with a focus on lowering financial risk to private investors in distribution utilities organized under IDF principles) and to identify and find ways to overcome barriers to private sector investment in distribution, generation, and transmission more broadly.

We call on **private sector lenders and investors**, notably pension funds and other funds that traditionally invest in utilities in advanced economies, to join with DFIs and national governments in blended financing arrangements for IDF-modeled distribution companies, and to finance upstream transmission and generation projects. To facilitate the necessary dialogue, we propose to form an expert subcommittee on expanding private sector investment in the electricity sectors of low-access countries.

Finally, we call on **utilities** around the world to develop, in partnership with national governments, investable business plans for the distribution system that are aligned with IDF principles. We also call on utilities to provide financial support to critical training and capacity-building programs, such as the proposed Africa School of Regulation and other regional centers.

As for the GCEEP, we look forward to expanding our engagement with all relevant actors and with other key stakeholders as we advance critical energy and sustainable development goals in the months and years ahead. Throughout, we intend for our work as a commission to continue to be distinguished—both by a singular focus on practical solutions and by a commitment to consistently aligning global priorities and resources behind the best ideas.

ANNEX

The following working papers have been developed (and can be accessed here: need web link.....) that further expand on the technical issues discussed in the main report::

1. Jacquot, G., Pérez-Arriaga, I., Stoner, R. and Nagpal, D. (2019), *Assessing the potential of electrification concessions for universal energy access: Towards integrated distribution frameworks.* MIT Energy Initiative Working Paper.
2. Nagpal, D. and Perez-Arriaga, I. (2019), *How is the distribution sector in low-access countries attracting private sector participation and capital?*
3. Pérez-Arriaga, I., Nagpal, D., Jacquot, G. and Stoner, R. (2020), *Integrated Distribution Framework: Guiding principles for universal electricity access.*
4. Pérez-Arriaga, I. and Jacquot, G., (2020), *Integrated Distribution Framework: An implementation perspective.*
5. Jacquot, G (2020a), *Towards actionable electrification frameworks: Reassessing the role of stand-alone solar.*
6. Nagpal, D. and Perez-Arriaga, I. (2020a), *Towards actionable electrification frameworks: Mini-grids under the grid.*
7. Nagpal, D. and Pérez-Arriaga, I. (2020b), *Integrating isolated mini-grids with an IDF-compliant regulated distribution sector: A long-term perspective towards universal electricity access.*
8. Nagpal, D. and Pérez-Arriaga, I. (2020c), *Retail Tariff Comparison Across Selected Countries in Sub-Saharan Africa.*
9. Pérez-Arriaga, I. and Paola Ortiz Jara, R. (2020), *Proposal to achieve universal electricity access in Colombian rural isolated communities.*
10. Pérez-Arriaga, I. (2020a), *On transmission cost allocation in the West African Power Pool (WAPP): The case of the OMVG transmission project.*
11. Jacquot, G. (2020b), *Reaching universal energy access in SSA: The promises of pay-as-you-go business models under comprehensive electrification planning.*
12. Jacquot, G. (2020c), *Reaching universal energy access in Morocco: A successful experience in solar concessions.*
13. Nagpal, D. (2020a), *Stand-alone solar systems in India: Emerging lessons.*
14. Pérez-Arriaga, I. and Stoner, R. (2020), *Abuja Electric Electrification DESSA Project.*
15. Ciller, P. et al. (2019), *Integrated electrification planning. Proceedings of IEEE Special Issue.*