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Integrated Distribution Framework: Guiding principles for universal electricity access

AUTHORS
Ignacio Perez-Arriaga, Divyam Nagpal,
Grégoire Jacquot, Robert Stoner

MIT Energy Initiative

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Abstract

Universal access to electricity is hampered by failures in the distribution segment of the power sector in many low-access countries. Viability challenges have hindered the mobilization of the substantial public and private investment needed to expand electricity access, while the recent growth of off-grid solutions has taken place largely in silos. To reach universal access by 2030 – as targeted under Sustainable Development Goal 7 – a new business model for distribution is needed that leaves-no-one-behind, ensures permanence of supply, integrates the various electrification modes (on-grid and off-grid), and is aligned with the long-term development of the power sector. Advancing these principles, this paper proposes the Integrated Distribution Framework (IDF) built around the idea of an entity – public, private or a partnership – that is responsible for undertaking distribution activities in a given territory (e.g., through a concession) and with a mandate to deliver universal access within its service area by using an appropriate mix of electrification modes with a viable business plan supported by cost of service regulation, viability gap funding and adequate risk mitigation. Parts of the IDF have been successfully implemented across the developing world, and its structure and scope can be adapted to country contexts to scale electricity access.

1. Introduction

The quest for universal electrification is urgent and the need undeniable, but the reality of achieving this and Sustainable Development Goal 7 (SDG 7) seems stubbornly elusive. The challenge of electrifying pockets of remote and difficult to geographically access regions in Latin America, or the thousands of islands in Indonesia, and the underserved rural communities in India or the many regions in Africa that can barely cope with their demographic growth is enormous. It demands an ambitious, multipronged approach adapted to each context.

Such an approach must combine large economic resources – with public and private sectors fulfilling complementary roles – sound institutions and governance, innovative business models and regulatory approaches, tailored technology solutions, a focus on human and economic development, and decisive political willingness.

Convergence of technological advancements, political commitment around the Sustainable Development Goals (SDGs) and innovative financing and business models all make it an opportune moment to think differently and think big /at scale about tackling the issue of electrification. At the same time, one cannot ignore changes in immediate development priorities as a result of the global COVID-19 pandemic. The ongoing crisis calls for reflection and action on the critical role that reliable, inclusive, sustainable and affordable electricity access can play in addressing the immediate health and humanitarian challenge, as well as in the long-term recovery offering governments a more sustainable, resilient and inclusive socio-economic development pathway.

2. Present electricity access landscape

The electricity access landscape has evolved significantly over the past decade. The issue is increasingly in the spotlight of global and national development agenda which has driven improvements in electrification rates in several countries particularly in South Asia. New technology solutions have emerged in the form of mini-grids and stand-alone solutions whose adoption has grown in the recent years. However, despite these positive developments, the world is still not on track to meet universal electricity access by 2030 – a target under SDG 7[2].

Electrification rates improving but progress is inadequate

Important gains have been made over the past decade in expanding access to electricity. Between 2016 and 2018, an average of 136 million people gained access to electricity each year, substantially more than the average annual population growth of 84 million for the same period3. Off-grid technologies, such as stand-alone solar systems and mini-grids, have shown great promise in bridging the electricity access deficit. Over 170 million people had some form of access from off-grid renewables in 20184. However, the majority of those (136m) had access to under Tier 1 electricity services. Globally, at least 19,000 mini grids are already installed in 134 countries and territories, representing a total investment of USD 28 billion, providing electricity to around 47 million people[5].

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[2] 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

[3] 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

[4] IEA, IRENA, UNSD, World and WHO (2020).

[5] ESMAP (2019), Mini-grids for half a billion people, https://openknowledge.worldbank.org/bitstream/handle/10986/31926/Mini-Grids-for-Half-a-Billion-

It is estimated that in 2018, around 789 million people still lived without electricity access – 70% of them in sub-Saharan Africa. Meanwhile, hundreds of millions of people as well as enterprises continue to face unreliable, or insufficient electricity access in developing countries. It is estimated that 620 million will remain without access in 2030 – not even accounting for the impact of Covid-19. The International Energy Agency estimates that the number of people without access to electricity in sub-Saharan Africa will rise in 2020, reversing several years of progress[6].

It is clear that, despite some positive developments, significant challenges continue to remain in expanding electricity access at the necessary pace and scale. A principal challenge has been the lack of investments into the sector to expand access. In 2017, an estimated USD 12.5 billion[7] was invested in new connections compared to the at least USD 40 billion estimated to be needed annually to 2030[8]. Mobilizing investments at scale is in large part hindered by financial challenges in the distribution sector in majority of the low-access countries as well as the uncoordinated, silo-ed development of on- and off-grid electrification modes resulting in lack of permanence of supply and inclusivity.

Viability challenges in the distribution sector impeding progress

The distribution sector is at the heart of the electricity access challenge. Its proper functioning is necessary for ensuring adequate investments into networks, metering, billing and customer engagement, which directly influences the quality of electricity services delivered and the capacity to expand new connections. In majority of low-access countries, distribution companies – often publicly owned – face significant challenges owing to poor performance and financial unviability with several contributing factors[9].

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 is poor. Supply costs are high since the distribution sector is plagued with technical and commercial losses. A large fraction of the electricity that is produced is lost due to technical network losses, and

People-Market-Outlook-and-Handbook-for-Decision-Makers-Executive-Summary.pdf?sequence=1&isAllowed=y

[6] IEA (2020). “World Energy Outlook 2020”. https://www.iea.org/reports/world-energyoutlook-2020

[7] SEforAll (2019), Energizing Finance: Understanding the Landscape 2019, https://www.seforall.org/publications/energizing-finance-understanding-the-landscape-2019

[8] IEA (2020), SDG7: Data and Projections, https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity

[9] 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.

in many countries a substantial fraction is stolen through illegal connections or may be unbilled, or – if billed – then not paid for. Meanwhile, wholesale electricity prices can also be frequently high due to lack of scale in generation plants, low capacity utilization and inefficient operation.

The combination of these factors results in collected revenues 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 that requires them to collect the revenues and pay the wholesale electricity costs.

In most low-access countries, the distribution segment is publicly owned, and the government is obliged to either deliver an annual subsidy, or bail out the distribution company whenever its financial situation becomes untenable, or to subsidize unpaid generators. In a few countries, distribution has been unbundled and privatized; this is a more complex situation, as public financial support is no longer available, and the distribution companies continue to incur losses and defaulting on their regulated obligations. A third case is that 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.

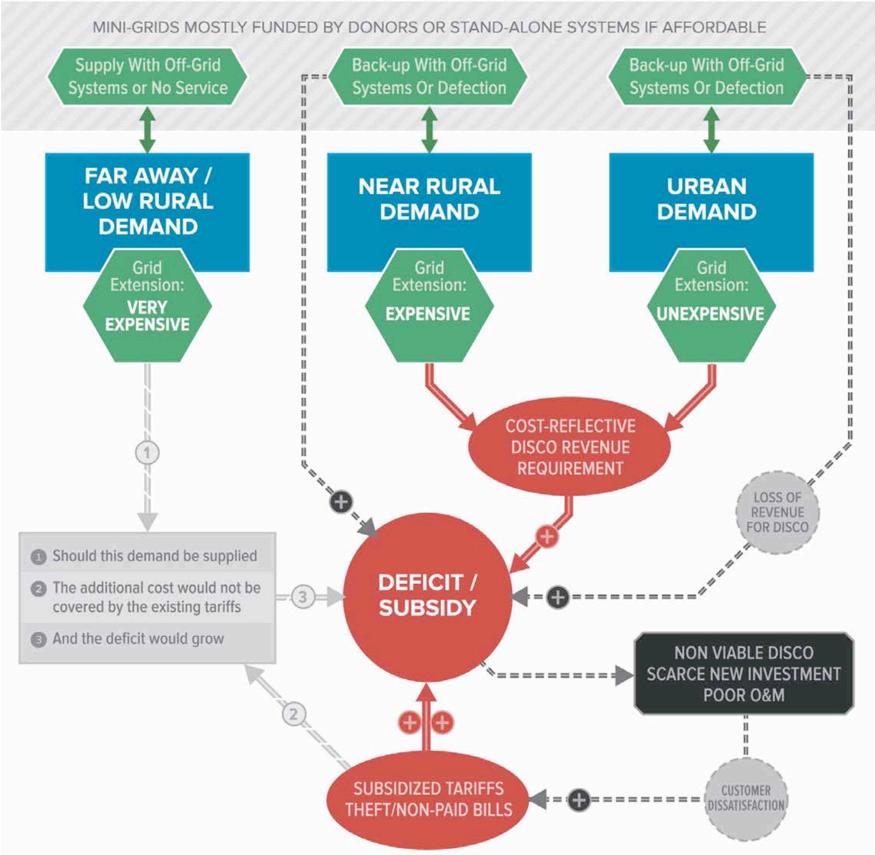
Whether public or privately owned, under the conditions of financial distress, a utility will be ill-equipped to raise capital and forced to defer maintenance and delay capital investments. Its priority must be to cover essential costs, meet regulated obligations and provide at least a minimum reasonable quality of service. Likewise, a distribution concessionaire, unless mandated to expand its network as part of its concession contract and remunerated accordingly, will seek only to meet its established minimum performance requirements while reducing costs and avoiding further investment – including in expanding access.

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 kWh) compared to urban areas. These per-unit costs increase as electrification goes dee per into more isolated areas, far from the existing grid. If the regulated revenue requirement for the discos were cost-reflective, the corresponding tariffs for all end customers would have to increase whenever new rural customers become connected since charging a cost-reflective local tariff in rural areas is politically fraught and often unaffordable for customers. In reality, in the vast majority of low-access countries, tariffs are set well-below costs and are equalized for each category of customers, regardless of their geographic location, or whether they are rural or urban. Thus, expanding access automatically results in a deficit in the remuneration of discos. Under existing conditions rural electrification is a “low hanging loss.”

The figure below illustrates the difficulties faced by discos. They are supposed to meet the entire demand, consisting of 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. However, in many low-access countries, only the first group of customers and some in the second group have electrical supply. Since the politically motivated subsidized tariffs are unable to cover the cost-reflective revenue requirement of the distribution activity, a deficit for the discos will accrue. The deficit-burdened discos will fail to deliver reliable and good quality power to their customers who are likely to resort to illegal connections, unpaid bills and grid defection. This further accentuates the existing deficit of the discos in a vicious cycle.

Any attempt to electrify rural areas with their high per unit distribution cost that the existing subsidized tariffs cannot meet would result in additional deficit, thus discouraging the discos from expanding electrification. The recent growth of low-cost, reliable distributed energy solutions backed by attractive business and financing models directly compete with the discos in urban and near rural areas for commercial, industrial and better-off customers. This trend further erodes the discos’ customer base, further adding to their deficit. These off-grid solutions, unfortunately, although helpful from the standpoint of augmenting supply in electrified areas and expanding electrification, cannot guarantee universal electricity access: mini-grids with mutually agreed tariffs often are unable to break even without grants from donors or strong cross-subsidization from anchor loads, when they exist; and unsubsidized standalone system companies only cater to those customers and areas where their services can be profitable.

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



Are we ensuring no-one-is-left-behind and permanence of supply?

The yet-to-be-addressed viability challenges in the distribution sector and the silo-ed development of various electrification modes raises important questions on whether the current electrification paradigm is likely to leave behind large segments of the populations and whether it guarantees permanence of supply necessary to advance socio-economic development?

In a large number of low-access countries, independent of the wider distribution sector, investible frameworks are being created for various electrification modes, such as mini-grids and solar home systems, that have been successful in mobilizing external capital into electricity access. However, there is no common framework that ensures that the summation of efforts in on-grid and off-grid leads to universal electricity access and permanence of supply for the consumers.

3. Value of integration to ensure universal access

The term “integration” has recently become a buzzword of choice used to characterize a multiplicity of approaches to accelerate electrification.[10] Some electrification approaches in the past have relied on different aspects of “integration”[11], but not until now has the value of “integration” truly become recognized by many practitioners and decision-makers as a key ingredient for success of electrification. Diverse organizations and initiatives use the term “integration” with different meanings and in different contexts.

The authors here present a holistic understanding of integration which 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 all types of end-customers 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 the distribution sector 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.

This paper proposes the Integrated Distribution Framework (IDF) which embodies a holistic thinking of integration in the realm of distribution for reaching universal electricity access. The focus on distribution results from the fact that there are proven

[10] 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. Implementation oriented programs have also been launched recently 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.

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

approaches and numerous experiences of bringing investments in generation and transmission to developing countries,[12] but turning insolvent distribution companies into viable businesses committed to achieve full electrification remains an unsolved challenge. Without a healthy distribution system universal access will never happen.

4. Defining the Integrated Distribution Framework

The IDF represents a set of guiding principles that can inform electrification programme design as well as help evaluate ongoing efforts. The essence of the IDF is captured through the following four principles:

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 standalone 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.

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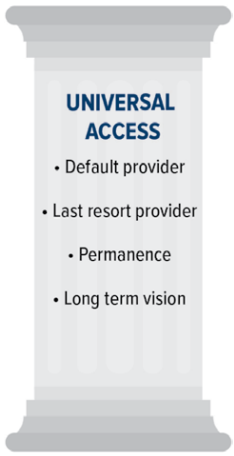
[12] See the GCEEP Inception Report, https://static1.squarespace.com/static/5d371cb401986300013881d3/t/5d6fe81b03b5ca0001497462/1567615021117/GCEEP+-InceptionReport-2019.pdf

The IDF comprises diverse pieces of regulatory approaches and business models that have worked well in several countries under different conditions, but had not been put together before with the explicit purpose of achieving universal electrification effectively and efficiently. It presents principles against which existing electrification programmes can be assessed, or as guiding principles for new initiatives. The IDF is also a useful framework to guide specific issues such as designing a mini-grid development program or enabling reliable power provision to rural health centers, a topic brought to the forefront by the ongoing COVID-19 pandemic.

Under each principle highlighted above, there are a number of concepts closely associated with the main idea. This section delves deeper into each dimension/principle.

4.1. Universal access



The principle of universal access requires that *no-one-is-left-behind*. The uncoordinated development of on-grid, mini-grids and stand-alone solutions is likely to leave many pockets of communities without electricity access.

Ensuring universality requires a **utility-like company or entity** (whether public, private, or a public–private partnership) that takes responsibility for a territory and commits to supply its customers with a minimum level of access and reliability. It further accepts the role of default and last-resort supplier (taking over in the event a current supplier fails). It is important to note that 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 the provision of an essential service like electricity always rests with the state, but its material delivery is in the hands of firms, either publicly or privately owned. Some ministerial department or governmental agency – like the rural electrification agencies that exist in many developing countries – may supervise the electrification process, but electricity is supplied by companies. As such, it is important to precisely define the obligations of these companies 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 is a “utility-like” company responsible of being the “default provider” and the “last resort provider” for all – existing and potential – customers in that territory. This responsible company can be selected via an auction or appointed directly.

A *default provider* must make sure that all potential customers in the considered territory receive electricity supply – according to some time schedule and with the appropriate least cost mode of electrification – by some independent supplier or by itself, but in any case by itself if no one does it, subject to the remuneration and other conditions established by regulation and the concession agreement, if this is the case. The default provider will be directly responsible for the installation and operation of any grid extension electrification in the territory, but it does not have exclusivity in the deployment or operation of mini-grids or standalone systems. Auctions may be used to select the mini-grid developers and service providers with standalone system that could operate in different areas of the territory.

Entities that have established themselves in the territory as independent mini-grid developers or providers of services with standalone systems may fail, leaving their customers without electricity access. The responsible entity, as *last resort provider*, must take over, making sure that the supply of electricity is not discontinued. Being ready to provide this service and actually doing it when needed has a cost, which has to be acknowledged in the regulation of this extended distribution activity.

The responsibility for electricity supply, with adequate reliability and quality, including the functions of default and last resort provision, can be shared, with some form of partnership, between an incumbent disco and some external company, so that one takes the main responsibility of supply and the other has the role of providing backup power, keeping the voltage within limits, or directly supplying electricity to singular loads with standalone systems or customers that prefer being supplied by the second company. We can classify under this category some forms of partnership that are emerging in SSA and India, such as the DESSA initiative by Abuja Electric in Nigeria, the pilot project of the firm Konexa also in Nigeria, and the development of mini-grids by the company Tata Power Renewables Microgrid in some Indian states. The recently coined term of "mini-grids under the grid"[13] depicts this reality, which is unfolding either formally or not. Some of these experiences will be discussed in Chapter 3.

Permanence of supply.

Permanence is one of the key components of a sustainable supply. Unfortunately, this is frequently ignored in numerous electrification initiatives, which place all the effort in making sure that supply begins for some consumers at a given moment in time, without providing the means for its indefinite continuity in time. This continuity is taken for granted in developed countries and the large cities of the developing world, but is frequently lacking in projects that become inactive after a few years because of the absence of proper maintenance, funding, or management, when demand grows or the equipment needs to be repaired or replaced.

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

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

The permanence of electrification approaches is strongly related to its compatibility with a sound long-term vision of the power sector, i.e. the structure of the companies in charge of the different segments of the electricity supply chain, the business models adopted by these companies, and the regulation of the ensemble, all meant for a better service of the final customer.

There is an obvious difficulty in defining what this long term vision could be for the power sector in low-access developing countries, since we do not even know what a sound long term vision is in well-established power systems in developed countries, where the ways and means of provision of electricity are changing quite dramatically

[13] Rocky Mountain Institute (2019), Electrifying The Underserved: Collaborative Business Models for Developing Mini-grids Under the Grid, https://rmi.org/insight/under-the-grid/

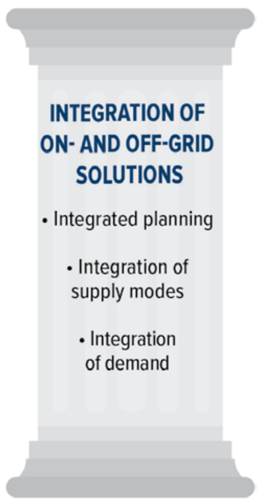
in the midst of a worldwide clean energy transition.[14] However, from a century of experience with policy and regulation for electricity supply, a few simple lessons have been learnt that can be applied to make the distribution segment in low-access developing countries viable.

i) *These ailing discos are very important.* Integration of supply and integration of demand provide multiple benefits, among them better reliability and lower cost per kWh than with off-grid solutions. The more the demand grows, the larger is the percentage of grid extension in the least cost solution electrification planning. We must use a substantial amount of off-grid technologies at the current stage of electrification in most developing countries, but taking into account that, little by little, grid extension will prevail, and the planning strategy and the regulation must account for this. With lots of connected distributed resources, no doubt about it.

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, adding some performance-based incentives. Deviations from this basic regulatory approach increase the cost of capital, deter investment and result in poor 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.

4.2. Coexistence of on- and off-grid solutions

In delivering electricity access, a wider view of the distribution segment is needed 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 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 the other activities: i) developing the roadmap for investment and project implementation to meet the electrification targets at the least possible

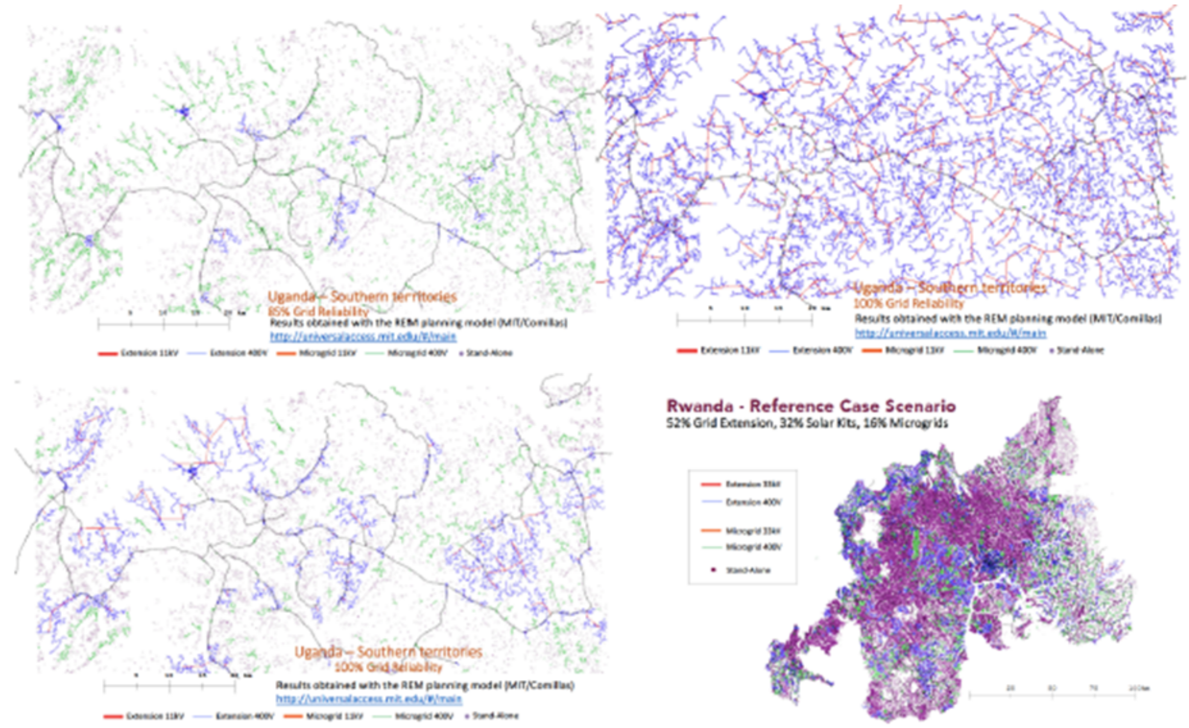
[14] See Pérez-Arriaga, I., et al. “The MIT Utility of the Future Study”, December 2016, for an analysis of the challenges, opportunities and uncertainties that the growing presence of distributed energy resources (DERs) brings to the power sector in any country.

cost, subject to the availability of funds and respecting any political, social, development, or environmental priorities; and ii) estimating the costs of supply that must be used to calculate the reg ulated 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 to build a business plan for the electrification of a district, a province, a state, or an 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 the estimates of the demand to be served, and from the tariffs to be applied to each type of customer the revenues can be computed. The income left for distribution is what remains of the total revenues collected from the tariffs after paying the costs of the other components of the electricity supply chain (generation, transmission and system operation), the costs of institutions, and other regulated charges. Once all this information is obtained from the electrification plan, the business plan can be developed to address the financing aspects.

Existing tools related to geospatial analysis, machine learning applied to demand estimation and intensive optimization techniques allow electrification planning to be undertaken with a remarkable level of accuracy. The three electrification modes can be integrated in a single plan, which can 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 as the time evolves to account for changes in demand, reliability of the main grid, costs of components, or wholesale energy prices.

The figures below illustrate electrification plans performed by the MIT Energy Initiative using their 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, obtained with the MIT/Comillas REM model. The upper right figure shows the least cost plan where only grid extension is allowed, which is 20% more expensive. 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%, obviously favouring grid connection. Finally, the lower right figure shows a least cost plan obtained with the REM model for Rwanda.



Integration of supply modes

According to least cost electrification planning, the three electrification modes must co-exist. However, in practice several challenges have to be overcome to turn this into reality.

The proposed new responsible utility-like entity for a given territory – most likely a concessionaire under the format of a special purpose vehicle, SPV, as will be discussed later – will be in charge of managing, operating and expanding the existing distribution network. The entity may initially, at least, not have the experience or capacity to undertake resource-intensive activities involved in off-grid electrification modes. These 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 off-grid assets transforming into mini-grids under the same or different entities, or being connected to the main grid, 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 – mostly the remuneration – that will incentivize the on- and off-grid companies to meet the targets established by the least-cost electrification plan such that nobody is left without electricity; ii) regulating the interface and smooth transition between the 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[15] 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 it may bring some complexities.[16] There is less regulatory experience in estimating the cost of supply to demand clusters with mini-grids, but models to estimate this cost are available and can also be obtained through auctions for mini-grid supply in specified areas.

There is also scarce experience with electricity supply from stand-alone solar home systems under regulated conditions, although some successful instances exist.[17] Again, auctions can reveal the efficient cost of reaching out to potential electricity customers with a stand-alone systems, while meeting a prescribed quality of supply target.

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

A central piece of cost-of-service remuneration is a regulated revenue requirement which is accompanied by regulated tariffs. While the revenue requirement must correspond to incurred costs, the tariffs to be applied to the end-customers can be subject to diverse policy considerations and 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 the aggregated revenue collection with the existing tariffs is insufficient to cover the total costs, which is typically the case for rural electrification.

Caring for the interfaces between electrification modes

The uncertainty of grid arrival is a major cause for concern for off-grid entities, especially mini-grid operators due to significant disruptions in their business model. Many countries have developed specific regulations to address this situation, typically offering various alternatives, ranging from the continuation of independent operation, interacting with the grid at the connection point (as small power producer or

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[15] Cost of service regulation focuses primarily on ensuring 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.

[16] 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

[17] Acciona Microenergía in Peru.

distributor), to dismantling the mini-grid and being compensated for the residual value of its assets[18]. Under the IDF, given the necessary requirement for coordination of the three electrification modes under a single responsible utility-like entity guided by an integrated electrification plan, the uncertainty is likely to be significantly reduced. For those mini-grids developed by the responsible utility-like entity, the transfer from one mode to another is straightforward. In all cases, if the regulated tariffs under grid-connection and mini-grids are the same – and reliability could also be similar – the transfer must be transparent and smooth for the customers.

Coexistence between the mini-grids developed under the IDF regime and the pre-existing and new ones developed independently by private investors under willing-seller, willing-buyer conditions can be difficult, since the former mini-grids will normally apply regulated tariffs that will be lower than the ones negotiated under the latter. Understandably, it will be difficult to deploy new independent mini-grids and there might be complaints from the customers of the existing mini-grids. The only practical solution is likely to establish a transitory period to migrate all independent mini-grids to the regulated regime of cost-reflective revenue requirement, uniform regulated tariff and subsidy paid for the viability gap.

Customers that have to be supplied with stand-alone systems present different challenges. Commercial and Industrial (C&I) customers, as well as large residential customers, or any others that can pay the full costs 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 the capacity to pay – will be needed for majority rural residential customers and other public facilities. 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, complemented by a government subsidy. Within the context of the interface between the three electrification modes, capabilities and possibilities of stand-alone solar systems must also be mentioned here: [19]

i) The customer data collected by solar home system (SHS) 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 SHS.

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

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

[19] See Jacquot, G. (2020), Towards actionable electrification frameworks: Reassessing the role of standalone solar (GCEEP Working Paper)

iii) It is possible to go beyond the standard “pay-as-you-go” (PAYG) business model, in which there is no service commitment over time beyond the physical or contractual duration of the apparatus. This is the case, for instance, with the business model of the company Acciona Microenergía in Peru – with the support of the regulator and the government – which offers permanent “energy-as-a-service”, with a true utility-like commitment to the end customer.

iv) In an interesting and recent development of the PAYG model, some companies are exploring its separation (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.[20]

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

An interesting case of integration of electrification modes occurs when the incumbent distribution company does not provide reliable or sufficient service in some zone of its network and an external off-grid company partners with the incumbent to improve the capacity and the reliability of supply, as a backup or as the primary supplier in this area.

Integration of demand

End customer tariffs are universally adjusted by policymakers and regulators to make them more acceptable to the public – for instance, by establishing a uniform tariff for the same class of consumers, regardless of whether they are urban or rural – over an entire province, state or nation. Or lowering the tariffs for electricity intensive industrial customers, as a measure of industrial policy to increase their international competitiveness. This is certainly a powerful tool in the developing world, which can be carefully used to reduce the need for government subsidies for rural electrification, while trying to minimize economic distortion. The efficacy of the measure is obviously

[20] 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

reduced when the percentage of rural consumers with respect to the total consumers is high.

When the conditions in a distribution company make it difficult to address a full-fledged universal electrification program, an initiative in the right direction worth considering is 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 and sufficient power supply. If the distribution company – with or without the support of some external company providing local embedded generation connected to the distribution network – can agree on a cost-reflective, sufficient, and reliable supply, these clusters can serve as solid stepping stones for a final full electrification stage.

4.3. How to create a viable business model out of an incumbent insolvent disco?

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 to mobilize sufficient capital to meet investment needs within existing coverage area as well as for expanding access. What does that trajectory look like?

Several developing countries have tested various approaches to engage the private sector in distribution with a view to attract investments, technology and know-how. The approaches have varied in their design and outcomes. Short- to medium-term interventions have involved management contracts and engagement of franchisees to conduct part or all distribution activities within a concession area. These have yielded benefits in terms of reduced aggregate technical and commercial collection (ATC&C) losses, increased revenues and improved customer engagement; however, they have largely focused on urban centers, allowing them to make large gains with limited capital expenditure. The majority of the franchise agreements do not explicitly address remuneration conditions to recover significant capital investments, limiting franchisees to rely on revenue gains from ATC&C losses and other revenues to finance capital expenditures[21].

[21] See Working Paper on "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.

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 to improve the viability of the distribution sector. Successful examples of concessions are aplenty across the emerging economies from Uganda to the state of Delhi in India. While majority of the successful concession cases also cover urban regions, lessons also exist from their application for rural electrification (e.g., in Senegal)[22]. Further, the concession approach is also 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 guiding determination of a cost-reflective revenue requirement along with regulated tariffs and subsidies that ensure pre-determined returns over capital investments, as explained in the previous section.

With electrification as one of the central objectives, the concession will need to 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 utilizing complex tools can identify areas most suited for on- and off-grid solutions for a given level of electricity service, as well as offer guidance on *cost-of-service* to inform decision-making on investment and subsidy needs. A concession with an electrification mandate will inevitably require subsidies given the relatively higher cost-of-service in rural areas compared to urban settings. The nature of subsidy will vary, ranging from tariff cross-subsidization to direct payments to incumbent distribution companies or territorial concessionaires. Further, the subsidy will need to be tailored for on- and off-grid solutions.

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. For instance, in the specific case of Rwanda – further explained in Chapter 3 – where a least-cost electrification plan was developed by the MIT/Comillas Universal Energy Access with support from the World Bank, financing a multi-mode electrification plan to reach universal electrification by 2024 will require an investment of over USD 1 billion spread between 2020 and 2024, as well as incurring O&M costs of about USD 24 million per year. As expected in any large mostly rural electrification project, under the present tariffs a substantial annual regulatory deficit will exist. Insights on investment needs and regulatory deficit allow for effective

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

planning by the government, development finance institutions and the private sector to design appropriate funding facilities to support implementation of the electrification plan.

Attracting the large amounts of private capital to reach universal electricity access requires a *stable and predictable regulatory environment*. A distribution company or concessionaire is dependent on the legal security in the country of operation, even more so when it has an explicit mandate for electrification and dependent 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).

Experience so far has shown that such guarantees are not easily obtained in countries with a poor investment climate and high perceived investment risks – conditions common among low-access countries and further compounded by the Covid-19 crisis. The situation is even more difficult for privatized distribution companies, which are exposed to the same regulatory and legal risks as public firms but have less access to public financial support and face additional pressures and scrutiny from shareholders and consumers.

In general, delivering permanent, sufficient, reliable and affordable access to electricity for all in a given area requires a long-term, investment-worthy concession. Its design must be guided by a robust electrification plan and adequate public funding support to ensure cost-of-service recovery for all the three electrification modes. 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.

4.4. What really matters to the electricity customer?

Access to electricity goes well beyond a connection. A top-down approach has to be complemented by the bottom up participation of the end-users of the electrification process, as well as other entities such as NGOs, foundations, and cross-sector agencies who can play a role in supporting the ecosystem for demand growth and overall human development through productive and community uses. No electrification scheme will ever work if the end customers do not receive an electric supply of quality, are properly metered and billed, they are trained in the uses that electricity can provide, and they are engaged in some form in the process. The electrification process has to be development centered.

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. It offers the opportunity to create prosperity and jobs at home and allows for education, reduced pollution, and improved human health and conservation of ecosystems, while contributing to climate change mitigation and adaptation.

None of these things will be possible if the supply of electricity does not meet some satisfactory minimum requirements of reliability and quality of service. It will be impossible to reduce the illegal connections and the non-paid bills if the customers are not satisfied with the product and the service that they receive from the distribution company. Beyond reliability and quality, social engagement has been proven effective and mutually satisfactory from a company-client viewpoint, as multiple experiences have shown.[23]

In a post-COVID world, maximizing the socio-economic development impact of energy access will be particularly crucial. In emerging economies, it is evident that the pandemic will leave behind millions of people unemployed, compelling a mass-migration in many cases back to rural areas. The impact on emerging economies will truly be known only as the pandemic eases, although it is certain that it will leave behind hundreds of millions in economically vulnerability and risk wiping out recent advancements made in lifting people out of poverty.

As governments and development finance institutions map out a recovery strategy, energy access must remain a key priority. It is a critical catalyst to support resilient livelihoods in rural areas that can create local opportunities and help address large economic migration to urban centers once the pandemic is over. Across productive sectors, such as agriculture, dairy, cottage industry, carpentry and tourism, a number of applications of distributed energy solutions now exist that combine with efficient productive appliances to support income-generating activities in rural areas.

Rapid improvements in distributed energy solutions and cost reductions have enabled new opportunities for consumers and governments to harness. 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 those relying on rain-fed agriculture[24]. Across the agriculture and dairy sector, a wide range of demonstrated applications now exist that combine distributed

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

[24] 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

energy solutions with energy efficient productive appliances for pumping, processing, cold storage, transport and retail[25].

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[26,27]. The combination of the two outcomes also strengthen the sustainability of energy access business models whether through the grid, stand-alone systems or mini-grids[28,29]. However, 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.[30,31] Sufficient and reliable energy supply needs to be complemented by efforts to improve access to efficient appliances, consumer and enterprise financing, access to markets, capacity building and data and information[32]. Greater attention also needs to be given to achieving gender equitable outcomes from productive end-use promotion[33].

Reliable electricity access is also critical for the delivery of crucial public services such as education and healthcare. Distributed energy solutions are already being rolled-out

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[25] 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

[26] 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

[27] United Nations. *Accelerating SDG 7 Achievement: SDG 7 Policy Briefs in support of the High-Level Political Forum 2019*, 2019. https://sustainabledevelopment.un.org/content/documents/22877un_final_online_webview.pdf

[28] 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

[29] 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

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

[31] 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

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

[33] 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

as part of national COVID response strategies to strengthen 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 record pace to support dedicated health infrastructure for tackling the pandemic[34]. In India, the state of Chhattisgarh has already seen more than 1200 health centers and district hospitals electrified using distributed solar solutions recording several health-linked benefits: a 50% increase in patient admissions, a doubling of successful childbirths per month, and improved day-to-day care[35].

Globally, institutions, such as the World Health Organization, the World Bank, SE4All, DFID, IRENA and several others, have emphasized the critical role of energy access in the delivery of timely healthcare and other public services[36]. 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 the COVID.

5. The IDF standard implementation toolkit

The previous section outlined the fundamentals of the IDF. This section presents actionable guidelines for the implementation of a canonical IDF case, i.e. the IDF in a non-specific low-access country context where all the features of the IDF apply.

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. For each year until the target year, the plan must provide the electrification mode (on-grid, mini-grids, stand-alone sytems) 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

[34] 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/

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

[36] 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

of the cost of the work to be done to improve the existing network to meet prescribed standards.

ii) *Prepare a preliminary business plan.* For the implementation of the electrification plan for a timeframe adequate for a financial analysis (at least 15 or more years), a business plan should be prepared by the government with support from the utilities and DFIs, to assess the viability and financing needs. The business plan will be based on the cost projections from the electrification plan, cost of improving the existing network, projections of income from a forecast of tariffs to the estimated demand, and estimation of charges (rent) for the utilization of the existing distribution network.

iii) *Identify the most appropriate partnership model between various agents.* With the electrification plan outlining parts of the territory suitable for grid-based, mini-grids and stand-alone solutions, various actors will need to work in tandem guided by the objectives of the concession agreement. A “tight” or “loose” distribution concession model[37] could be envisaged depending on the local conditions. In either case, the 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 in the event of arrival of grid or mini-grids. For already existing mini-grids under willing-buyer/willing-seller tariff arrangements in the territory, a transition period must be established for them to converge to the regulated tariff regime.

iv) *Define a concession agreement and award it through an auction or direct allocation.* On the basis of the business plan, design a concession license to manage, operate and invest in the distribution of electricity in the considered territory, subject to some performance requirements and for a substantial period of time (e.g. 20 years). The concession can be awarded through an auction[38] with the key evaluation metrics being the requested revenue requirement over

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[37] A “tight” distribution concession model comprises a SPV which includes a traditional utility (grid operator) along with 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. A “loose” distribution concession model, on the other hand, includes a single entity with the experience of managing the 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 the coordination of different actors as well as acting as the default/last-resort provider.

[38] Other formats of business models 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, in a bilateral partnership agreement of the Government with a willing SPV. This will depend on the legislation and the situation of the power sector in each country.

the concession period, broken down by electrification mode.[39] Another important metric is the annual charge (rent) for the utilization of the existing network. 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 the 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 concerned country, and any guarantees provided by DFIs will furnish legal security to the concessionaire. This will be particularly important to ensure the certainty for the continued payment of any governmental subsidies required to complement the estimated revenue collected from the regulated tariffs to eventually meet cost-reflective distribution revenue requirement. 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 the concessions and the regulation must promote the integration of electricity supply with services, especially those related to productive and community uses that positively impact local socio-economic development outcomes. It is appropriate to include metrics in the competitive concession auction plan for consumer engagement, as well as the promotion of electricity uses for demand stimulation and meeting public services, and to consider the cost of the plan in the regulated revenue requirement.

6. Implementing the IDF

The previous section discussed the guidelines for the implementation of the IDF in a canonical case. The authors recognize that the full adoption and implementation of all features of the IDF will take a significant amount of time in most countries, which is unacceptable given the urgency to advance towards universal electricity access. Therefore, adaptations of the IDF in the short-term that make progress in the general direction must be welcomed, while maintaining focus on the IDF principles in the medium- to long-term.

Nigeria is emerging as typical example of fast-track IDF implementation. The Distributed Energy Solutions Strategy being formulated by one of the private

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[39] Auction may also be carried based on other evaluation metrics. In the so-called input franchises the metric is the price of wholesale energy that the concessionaire is willing to pay to be responsible for the distribution activity under the specified performance conditions.

distribution companies, Abuja Electric, focuses on engaging the private sector to service clusters of C&I consumers within its service territory through distributed energy solutions. 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 is that of Konexa which more closely resembles a more complete implementation of the IDF. 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 higher rural make-up. The challenge here is to design implementation approaches that meet as many of the principles and requirements of the IDF as possible, and the transitory pathways that will finally converge to the full-fledged IDF.

On the other hand, in some countries the best approach can be attempting a full direct implementation of the IDF. This may be possible in smaller countries with a more centralized institutional structure and higher quality of governance, where a master electrification plan already exists, and there is a sufficiently diverse group of off-grid developers. Rwanda is a clear example, but others in sub-Saharan Africa are in this situation as well. An interesting case is Uganda, where a successful 20-year concession with a private consortium named Umeme has operated successfully since 2005 under well-defined 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 of modifications to the current concession agreement that could be acceptable to both the Government of Uganda and Umeme.

In Colombia, an approach based on the IDF is being proposed to reach last-mile electrification in large territories of the country (a total area larger than Spain) where close to half a million households live without access. In India, a private entity, Tata Power, has recently taken over distribution activities (modeled as a PPP concession model that has been tested in other mostly urban states) covering a third of the territory of the state of Odisha. With a significant mix of rural and urban consumers, it also resembles a candidate for IDF implementation especially with high penetration of grid infrastructure, a focus on service quality improvements and the recently set-up Tata Power Renewable Microgrid Ltd. (supported by the Rockefeller Foundation).

The MIT Energy Initiative and the Universidad Pontificia Comillas has been working across a number of low-access countries in the implementation of the IDF. Under the aegis of the Global Commission to End Energy Poverty, the MIT Energy Initiative has engaged stakeholders in five First Action Countries – Nigeria, Uganda, Rwanda, Colombia and India – with a view to advance actions towards the IDF and universal electrification.

The implementation of the IDF involves a wider set of in-depth solutions that need to be identified. What is the nature of public-private partnership that is most suitable? How will the concession agreement need to be designed? What are the financing needs and the instruments needed to meet these? What is the appropriate mix of on-grid and off-grid electrification solutions? What is the starting point in terms of existing conditions of the power sector? A detailed analysis of the specific implementation aspects of the IDF at the country-level is being published separately[40].

7. Conclusions

Achieving universal electricity access under a business-as-usual approach – uncoordinated development of on-grid and off-grid solutions, unviable distribution sectors, lack of focus on permanence and inclusivity, and limited public and private investments – will not be possible by 2030.

With a number of low-access countries experiencing rapid population growth largely concentrated in rural areas, the ambition about electrification has to be commensurate with the size of the problem. This entails electrification planning and programs at the scale of provinces, states, countries or even entire multi-country regions, mobilizing large financial, human, and technological resources. From a financial perspective, thinking big implies attracting private sector participation and investment on a large-scale. And, in turn, this means that the business models to be designed have to be financially viable.

The IDF approach outlined in this paper notes that given the precarious situation of most distribution companies in low-access countries, some sort of special purpose vehicle – probably a concession, in most cases – will be needed to define from scratch a partnership (whether public, private or a public-private partnership) which undertakes the distribution activities in a given area for a long period of time, e.g. 20 years, under a carefully drafted set of conditions. It has to be clearly acknowledged from the outset that this concession-based business model will need guaranteed governmental subsidies to be viable, since the high incremental costs of rural electrification cannot be covered by the existing tariffs for the already-connected customers, even in the ideal case if these tariffs were cost-reflective.

Over the long-term, electrification approaches should be aligned with the well-tested fundamentals of the distribution business i.e., long-term remuneration schemes based

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[40] See GCEEP Working Paper: Pérez-Arriaga, I. and Jacquot, G., (2020), Integrated Distribution Framework: An implementation perspective.

on a cost-reflective revenue requirement that is computed every year based on the actual needs and efficient management assumptions. Implementing the IDF requires applying these principles to all three electrification modes recognizing that the initial optimum mix of grid- and off-grid solutions will vary from country-to-country. But this should be done within an integrated framework that makes sure that supply is inclusive, sustainable – in time, environmentally, and financially – and addresses the actual needs of human development.