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The Integrated Framework for Electrification

A comprehensive approach to universal electricity access

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Ignacio J. Pérez-Arriaga, June 2023[1][2]

1. Introduction

Universal access to electricity is hampered by failures in the distribution segment of the power sector in many low-access countries. Reforms are needed in all activities of the electricity supply chain: centralised generation, transmission, distribution, retail, system operation, off-grid supply, management of distributed resources and cross-border electricity trade, as well as in the structure and institutional governance of the power sector. Our focus on distribution, however, stems from the fact that there are proven approaches and much experience in bringing generation and transmission investment to developing countries, as well as in how to approach the other activities, but turning insolvent distribution companies into viable businesses committed to achieving universal electrification remains an unresolved challenge. And without a properly functioning distribution system, universal access will never be achieved.

Financial viability challenges have hindered the mobilisation of the substantial public and private investment needed to extend the main grid to increase access to electricity, while the recent growth of off-grid solutions has been largely in silos and in small and, at most, medium-scale projects, well below what is needed to achieve full electrification. Achieving universal access requires a new business model for distribution - both on-grid and off-grid - that leaves no one behind, ensures continuity of supply, integrates different modes of electrification (on-grid and off-grid), and is aligned with sound long-term development of the power sector.

To achieve these goals, we propose a set of principles and a framework we call the **Integrated Framework for Electrification (IFE)**. The IFE is based on the idea of one or more entities – public, private or partnerships – each with responsibility for distribution in a given area (in principle through some form of concession) and with a mandate to provide universal access in its service area using one or an appropriate mix of electrification modes, with a viable business plan supported by cost of service regulation, viability gap funding and appropriate risk mitigation. Private capital is sorely needed in distribution, but will remain difficult to attract in the absence of viable business models.

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[2] The Integrated Distribution Framework and its preliminary implementation in several countries is the outcome of a collective effort of the researchers of the MIT / IIT-Comillas Universal Energy Access Lab, during the last five years, initially funded by the Shell Foundation and later working for the Global Commission to End Energy Poverty (GCEEP), supported by The Rockefeller Foundation. See https://universalaccess.mit.edu for other related publications on the same subject.

Aspects of the IFE have been successfully implemented in electrification programmes throughout the developing world. However, there are very few cases where this framework has been fully applied for the express purpose of scaling up access to electricity.[3]

2. The present situation of electricity distribution in sub-Saharan Africa (SSA)

A common problem in developing countries, which is pervasive in SSA, 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 (SSA), which are in chronically dire financial straits, require frequent publicly-financed bailouts,[4] and cannot attract the substantial capital needed to undertake significant rural electrification efforts or make other long-term infrastructure investments.

Figure 1 illustrates the difficulties faced by a typical 'disco', which 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.

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-

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[3] The electrification of Morocco in the late 1990s, the PERMER I project in the Jujuy province in Argentina (1999–2012) or the concessions for solar home systems in Peru are largely successful experiences that contain most of the features of the IFE. We have learned from these concrete experiences and have defined IFE in more general terms that can be adapted to basically any context.

[4] 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-viabilityof-electricity-sectors-in-Sub-Saharan-Africa-quasi-fiscal-deficits-and-hidden-costs

uses. Moreover, unsubsidized stand-alone system companies largely cater to customers and areas where their services can be viable, hence leaving others behind. This is also depicted in Figure 1.

However, all hope is not lost. Strategies for overcoming distribution challenges and expanding access can be implemented by applying best practices in regulation, effective integration of on- and off-grid technologies, and smart use of development finance. To this end, we have focused on 'last mile' distribution, broadly defined as the delivery of electricity to end-users through whatever delivery technology – grid extension, mini-grids or stand-alone systems – is most appropriate. The IFE must guide the design and implementation of electrification programmes to mobilise capital and expertise at the right scale to achieve universal electricity access.

The IFE approach shifts most of the economic burden of maintaining, improving, and expanding distribution systems from governments to defined entities (whether public, private, or public-private partnerships) that are empowered to enter into long-term contracts (typically 20 or 25 years) and are guided by cost-of-service regulations.

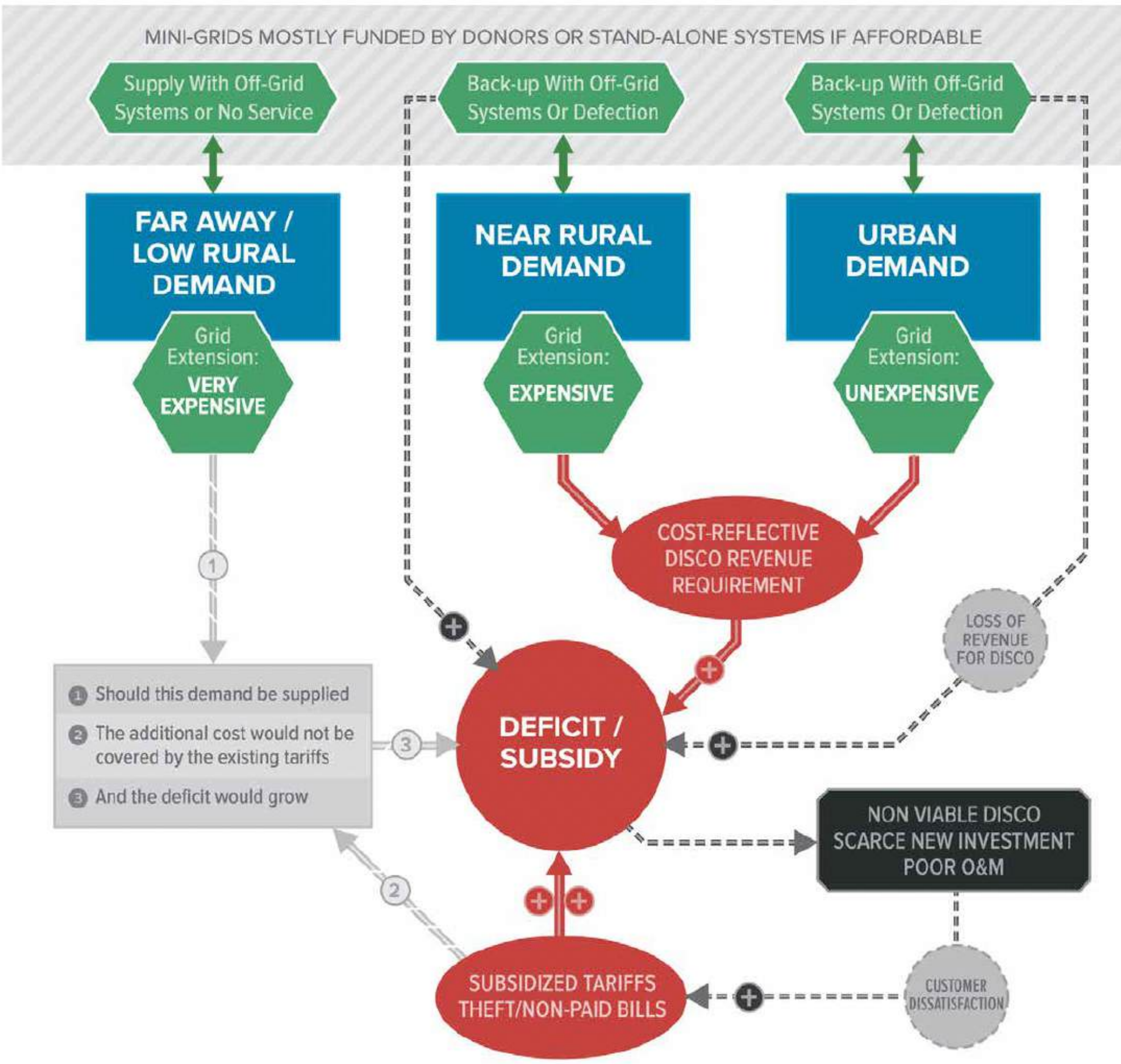

Figure 1. Viability challenges for distribution companies in low-access countries

3. Defining the Integrated Framework for Electrification (IFE)

The IFE represents a set of guiding principles that can inform electrification program design as well as help evaluate ongoing efforts. The essence of the IFE 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.

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.

In practical terms, meeting the requirements laid out above will require strong instruments, such as long-term concessions, to attract the private and public capital needed for universal access.

Under each principle highlighted above, there are a number of concepts closely associated with the main idea. The next subsections delve deeper into each dimension/principle. A more detailed treatment can be found in several reports and in a collection of working papers prepared by the MIT / IIT-Comillas Universal Energy Access Lab.[5]

3.1. Universal access

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.

The principle of universal access requires "utility-like" companies or entities (whether public, private, or public-private partnerships) so that each one takes responsibility for a territory and commits to supplying its customers with at least a minimum level of service and reliability with the electrification mode that has been determined by some national electrification strategy.

A "utility-like" company, is a company that, under the adequate regulatory conditions, has adopted a business model whose *raison d'être* is to supply electricity indefinitely. Should this company become insolvent because of whatever circumstances, the business model and regulation must be such that the electricity supply activity will continue, under any other name or ownership, but without any doubt about its permanence.

Sustainability, understood as permanence.

Permanence 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 rural areas in developing countries where electricity supply depends on 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.

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 sector. 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.

[5] Reports and working Papers developed by the GCEEP research team can be accessed online here: https://universalaccess.mit.edu

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 in the midst of a worldwide clean energy transition.[6] However, from a century of experience with policy and regulation for electricity supply, a few simple lessons have been learnt that appear to have universal validity.

First, connection to the main grid must be the norm and not the exception in the medium and certainly in the longer term, to exploit the advantages of economies of scale, reliability and resiliency that a well meshed network that integrates all kinds of distributed resources can provide.

Second, substantial private investment in any activity – electricity distribution in this case – is only possible with a remuneration that covers the cost of providing the service efficiently, including an attractive rate of return to the invested capital, and with an acceptable risk. Remuneration of the activity must be strictly cost reflective. The end customer tariffs, may not be cost reflective, but then a subsidy must be given to the distribution company to fill the gap.

The default supplier and the last-resort supplier.

For each territory, some entity must accept the role (and be remunerated for it) of default supplier – that is, the party responsible for ensuring that everyone has service – and supplier of last-resort – that is, the party that actually provides service in the event that a current supplier fails to do so.

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.

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.

[6] 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. See also AFD, APUA, 2019 "Speeding up the energy transition. Solutions for African Electricity operators."

Special forms of partnership in electricity provision.

The responsibility for electricity supply, with adequate reliability and quality, can be shared, with some form of partnership, between an incumbent disco and some external company, so that one takes the main responsibility of bulk energy supply and the other has the role of providing backup power, improving and operating the network infrastructure, keeping the voltage within limits, or directly supplying electricity customers with a sub-franchise in some area that has been agreed to be carved out from the incumbent disco.

Several examples in Nigeria fall under this category: the DESSA initiative by Abuja Electric starting with the Wuse market, the pilot project of the firm Konexa, or the Premium Grid project promoted by GIZ. Also 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"[7] depicts this reality, which is unfolding either formally or not.

3.2. The integration of on- and off-grid solutions.

In an integrated approach, the electrification modes engage in an efficient, complementary and dynamic manner to reach universal access. The coexistence of on- and off-grid solutions requires the development of a least-cost, integrated electrification plan that includes all electrification modes, which we shall term the techno-economic electrification plan. This is the necessary **first step** in any sound electrification process, which answers the question: **what has to be done?**

This 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 techno-economic 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 any other 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. 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.

Figure 2 below illustrates the electrification plans performed by the MIT/IIT-Comillas Universal Energy Access Lab 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. The upper right figure shows the least cost plan where only grid extension is allowed, which is 25% more expensive. The

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

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.

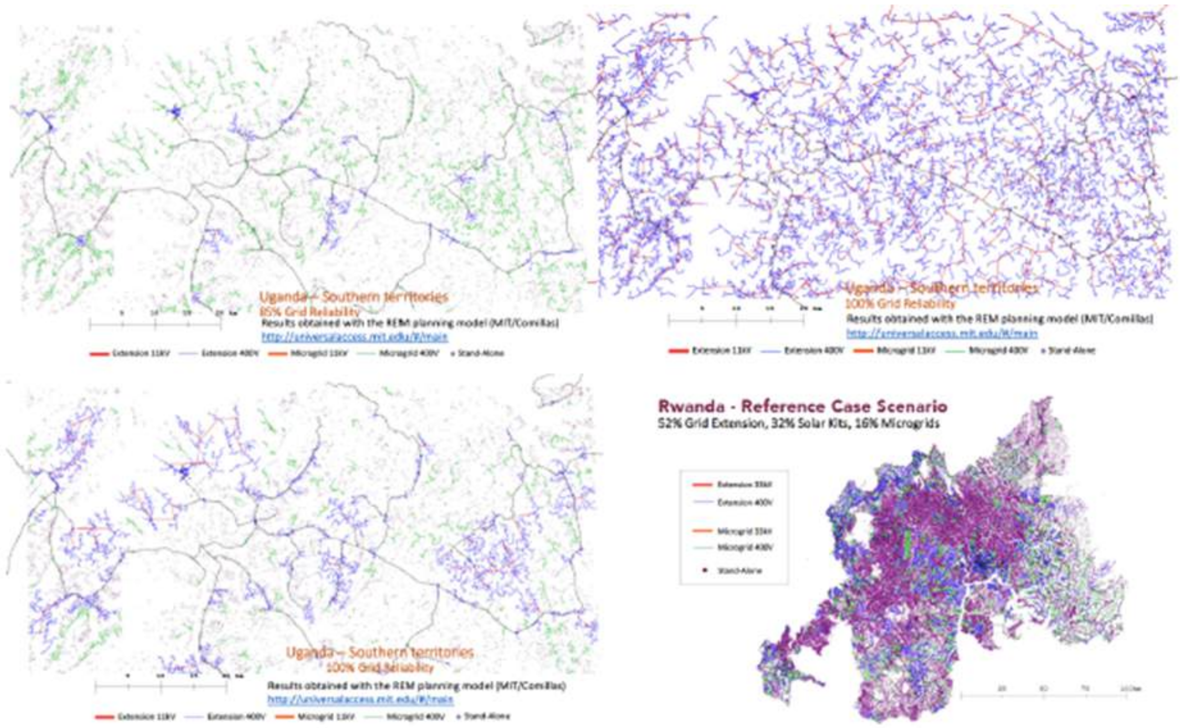

Figure 2. Electrification planning tool applied to Uganda and Rwanda.

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

The implementation of a techno-economic electrification plan requires overcoming additional challenges related to the design of mode-specific remuneration schemes, the management of interfaces between modes, default and last resort service provisions, and the dynamic integration of different modes of supply with changing demand over time.

The regulatory and business models.

The first challenge to be overcome is to define a business and regulatory model capable to implement the techno-economic plan. Several developing countries have tried various approaches to developing the financially viable distribution business models needed to attract private partners who can mobilize investment capital, advanced technologies, and technical and managerial expertise. This is the **second step** of the electrification process, which must answer the question: **who will do it and how?** The answers that have been tried or proposed, differ in design and outcomes. They must comply with the requirements to achieve universal access that were presented with the first principle in section 3.1, as well as to make business sense and to be compatible with the existing regulation, perhaps with some modifications to be proposed.

Where the investment mobilization needed is significant, long-term distribution concessions usually covering a period of 20 years or more have proven to be effective instruments for mobilizing private sector expertise and capital. A full concession or concession agreement for a distribution business – either on- or off-grid – is a grant of rights to manage, operate, and perform any necessary investments in this business for a prescribed period of time.

A concession is not a privatization. The concessionaire must return all assets – including any new investments, subject to an economic compensation – to the original owner at the concession end. The original owner may have a participation in the concession business. The concessionaire usually must pay concession fees for the use of the business, including the existing physical assets, to the party that grants the concession. These fees and the rules under which they may change are generally described in great detail in the concession contract.

When supported by the government, properly incentivized, and placed within an appropriate legal framework, concessions can be a useful tool for attracting private resources, managerial expertise, and technical know-how to address the enormous challenge of rural electrification as well as to improve the performance of electricity supply in urban centers.

When properly designed, concessions have yielded benefits in terms of reduced aggregate technical and commercial collection (ATC&C) losses, acceptable reliability and quality of service, and stable tariffs. However, so far concessions have been generally implemented in urban centres, where large gains are achievable at relatively low cost. To achieve full electrification of a country a government may need to sign a concession for the incumbent disco(s) to do its part extending, improving, operating and maintaining the grid, and also with off-grid companies to make sure that all the minigrids and standalone systems in the techno-economic electrification plan are deployed, operated and maintained sustainably for the duration of the concessions.

Successful examples of concessions are aplenty across the emerging economies from Uganda to the state of Delhi in India. The majority of the existing successful concession cases cover urban regions. Lessons can be learned from the application of concessions for rural electrification with mixed results (e.g., in Argentina, Morocco or Senegal)[8]. Further, the concession approach is also being tested in urban-rural compacts such as in the state of Odisha in India.

By definition, a freely negotiated concession must look like a viable proposition for the concessionaire for the duration of the concession period. A concession contract provides legal security and should attract 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 a reasonably attractive return on investment. Typically, this will be ensured through suitable regulations guiding the determination of a cost-reflective revenue requirement along with regulated affordable tariffs and subsidies that allow to complete the recovery of the revenue requirement. With universal electrification as a central objective, the *cost-of-service principle must apply to all electrification modes – grid extension, mini-grids and stand-alone systems*. [9]

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

[9] See the African School of Regulation (ASR) 3-Day virtual Conference on xxx concessions xxx link xxx

The financial plan.

Once the techno-economic plan is available and a decision has been made about the business models to be employed, the immediate next question is **how to finance this plan**? Providing the answer is the **third step** that completes the preparation of the electrification plan. The answer corresponds to the government, and it is clear from the governmental perspective that the financial plan must integrate financing the three electrification modes simultaneously, as none of them can be left behind. Thus, the need for integration appears in the techno-economic plan, in the coordination among the business and regulatory models for the three electrification modes, and in the governmental effort to define a financial plan that brings together all financial agents to cover the cost of the complete electrification plan, reaching a stable financial situation compatible with universal power access.

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 for specific electrification modes or for a suitable mix of them. Further, the subsidy will need to be tailored for on- and off-grid solutions. The financial plan must combine the evolution of end customer tariffs over the concession period or even longer, the estimated cost of supply – investment costs and operation and maintenance costs –, any available governmental subsidies and external grants, and an adequate proportion of equity and concessional and commercial debt, so that the combination may be appealing to an operator that will lead the concession and to all those that must contribute the different financial components.

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.

Other regulatory considerations with impact on business models and financing.

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 distributor), to dismantling the mini-grid and being compensated for the residual value of its assets[10].

Coexistence between the mini-grids developed under the IFE 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: [11]

i) 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.

ii) It is possible to go beyond the standard "just purchase" or "rent-to-own" business model with the "pay-as-you-go" (PAYG) technology, in which there is no service commitment over time beyond the physical or contractual duration of the apparatus and adopt a "utility-like" approach.[12]

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.

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

[11] See Jacquot, G. (2020), Towards actionable electrification frameworks: Reassessing the role of standalone solar. GCEEP Working Paper https://www.endenergypoverty.org

[12] 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 or the Foundation Rural Energy Services (FRES), a Dutch not-for-profit that advances electrification in rural Africa by establishing commercial electricity companies under local management.

The efficacy of the measure is obviously reduced when the percentage of rural consumers with respect to the total consumers is high.

3.4. What really matters to the electricity customer?

The goal of universal access goes well beyond just connecting customers. No electrification scheme will work if the supply of electricity does not meet some satisfactory minimum requirements of reliability and quality of service and if the end customers are not properly metered and billed. 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 their electricity supplier.

Beyond reliability and quality, social engagement has been proven effective and mutually satisfactory from a company-client viewpoint, as multiple experiences have shown.[13] The top-down technical approach must be complemented by the bottom up participation of electricity end users so that the implementation of electrification responds to the desires and priorities of the communities. In short, the electrification process must focus on delivering socio-economic benefits. 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[14,15]. More attention is also needed to achieving gender equitable outcomes when promoting productive end-uses.[16]

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, and it may also contribute to climate change mitigation and adaptation. 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

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

[14] 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

[15] 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

[16] 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

productive appliances to support income-generating activities in rural areas. [17][18] Reliable electricity access is also critical for the delivery of crucial public services such as education and healthcare.

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.[19][20] 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.[21] In a virtuous cycle, stronger links between electricity supply and productive uses of electricity will also strengthen the financial viability of business models for expanding access.[22][23]

To achieve these objectives, on- and off-grid distribution companies must create a new type of engagement with the customer, one that goes beyond the usual retailing activity to include the commercial tasks that have just been mentioned. The distribution company is the best positioned candidate to play this role. However, strict orthodox regulation asks for the unbundling of regulated activities (the distribution infrastructure function) and commercial activities (retailing & demand growth). The regulation of such an "enhanced disco" in the rural electrification context is an open regulatory topic.

4. Implementation of the IFE

The previous section presented the principles of the IFE. Its implementation must follow the three steps that were outlined in the previous section, without deviating from these principles.

Step 1. Develop an integrated techno-economic electrification plan.

Start with an integrated electrification plan for the whole country/territory to achieve universal electricity access within a given timeframe (e.g. 2030). The plan should take into account all real constraints imposed by policy makers. For each year up to the target year, the plan should indicate the electrification mode (grid extension, mini-grids, standalone systems)

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[17] 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

[18] 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

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

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[22] 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

[23] 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

to be adopted in each part of the territory, the corresponding bill of materials, and the annual investment, operating and other costs. Demand growth - including new demand to be met and lost demand to be restored - should be estimated at the outset of the plan and then confirmed as the plan is finalised. In addition, the plan must include estimates of the cost of the work required to improve the existing network to meet the required standards.

Step 2. Design a regulatory and business model that is well adapted to the power sector structure, energy policy and regulation in the considered country.

As indicated in section 3, a concession agreement looks like an attractive solution to be proposed in a “standard situation”, if such a thing exists. Every country has its specific circumstances, which must be factored in the regulatory and business model to be proposed. It is important that the model is consistent with the IFE principles, in particular the requirements for sustainability and scalability, and that it is compatible with a sound medium- and long-term vision for the country's power sector.

Step 3. Do a best effort to finance the electrification plan that has resulted from the steps 1 and 2.

The finance team has to play with a large number of design variables to ensure that the proposed electrification plan is financially viable. The design variables that the finance team can play with - within limits - are the evolution of electricity tariffs, the sequencing of the implementation of the plan, and the mix of financing sources - government grants, external grants, equity, concessional loans and commercial debt - each with its specific requirements. If the resulting best effort financial plan is not viable, it will be necessary to go back to steps 1 and 2 and modify the target date for achieving universal access, the level of acceptable minimum demand, the tariff evolution or the business model adopted, and then try again to achieve a viable financial plan until an acceptable solution is reached.

Achieving financial viability becomes more difficult if the percentage of customers to be electrified relative to the total population of the country is very large, if the population to be electrified is poor, if the country is already heavily indebted, and if the target date is too close. For countries where most or all of these conditions exist, achieving universal electricity access in the next decade will require a strong component of grants and concessional loans in amounts well beyond the current practices and financial instruments of the present development finance institutions.

5. Conclusions

Achieving universal electricity access with the current business-as-usual approach - uncoordinated development of on-grid and off-grid solutions, unprofitable distribution sectors, lack of focus on permanence and inclusiveness, and limited public and private investment - will not be possible for many countries for a long time, let alone by 2030.

The level of ambition and the approaches to achieving universal electrification must be commensurate with the scale of the problem and the circumstances of each country. These range from a small percentage of the population in semi-isolated communities in some Latin American countries, to more than half of the population in many sub-Saharan countries, mostly in rural areas. In all cases, this means planning and programmes for electrification at the level of provinces, states, countries or even entire multi-country regions, mobilising adequate financial, human and technological resources. From a financial perspective, in most

SSA countries this means attracting large-scale private sector participation and investment. This in turn means that the business models used to implement these techno-economic plans must be financially viable.

Given the precarious situation of the distribution segment of most utilities in low-access countries, only a comprehensive approach such as the IFE, which considers the techno-economic, regulatory, business, financial and social aspects of the electrification process together, while adhering to a small set of indispensable principles, can succeed in realistically addressing the difficult problem of achieving universal electricity access in its full dimension. Preliminary attempts to propose and implement the IFE in very different countries have shown that the method is applicable everywhere and deserves serious consideration by development finance institutions, think tanks and governments that consider universal electrification to be a major priority.