AFRICAN SCHOOL OF REGULATION

SUSTAINABLE ENERGY FOR ALL

UNIVERSAL ACCESS TO ELECTRICITY

Making use of best regulatory and business practices to achieve universal access

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Contents

1. Introduction. 2

2. The best regulatory and business practices. 2

2.1. A plan that integrates all electrification modes to achieve universal access. 2

2.2. Scalable regulatory and business models. 3

2.3. Sustainable regulatory and business models. 3

2.4. Customer oriented business models. 4

2.5. Summary of the essential electrification requirements. 4

3. Financial constraints to be considered in the design of the electrification plan. 5

3.1. Public funding with governmental resources. 5

3.2. Concessional financing. 5

3.3. Private financing. 6

4. Best practices for reconciling the essential requirements of full electrification with financial constraints. The three intertwined steps of an electrification plan. 7

Step #1. The techno-economic plan. What must be done and what is the cost. 7

Step #2. The regulatory and business model. 8

Step #3. The financial plan. 10

5. Key implementation aspects. 13

5.1. The terms of reference of the tender to obtain the concession. 13

5.2. The incentive mechanisms. 13

Annex. A template to guide the adaptation and application to Zambia of the "basket of best regulatory and business practices". 17

1. Introduction.

This brief document aims to demonstrate how sound and proven regulatory and business practices, which have been successful and utilised worldwide in the power sector in the provision of reliable, affordable and sustainable electricity supply, can also be employed to achieve full electrification in countries that have not yet achieved universal access. These best practices were learned from countries that achieved full electrification decades ago, as well as from countries that still have a long way to go. While they are simple to understand and accept in principle, they may require significant technical, financial, and institutional effort to implement, depending on the initial conditions of each particular country. While these regulatory and business practices do not guarantee success in achieving universal access – for instance, political commitment and functional institutions are also needed – this objective will not be possible if they are ignored.[1]

Our long-term goal is to achieve sustainable, i.e., permanent, electrification for all customers in countries that have not yet achieved universal electricity access. While small- and medium-sized electrification projects undoubtedly improve the lives of the communities they serve, the rate of population growth in many sub-Saharan African countries equals or even outpaces the rate of electrification. Universal access will only be achieved through visionary, yet realistic, policies, regulations, and business models that can address the scale of the problem. The following pages describe our attempt to define these models. These models are based on proven experiences and are ready to be implemented.

2. The best regulatory and business practices.

2.1. A plan that integrates all electrification modes to achieve universal access.

Universal access must be obtained at the least possible cost while respecting any policy and social objectives that might have been established, for instance the specification of the minimum conditions of service that are considered "access", in terms of energy, capacity, reliability and quality of service and the target year in which full electrification of the country will be completed. In general, achieving this objective at least cost will require using some combination of the three electrification modes, i.e., extension of the main grid, mini-grids and stand-alone systems.[2]

This is our first best practice, which is the starting point of an electrification plan and of a power system in general: to provide electricity supply for all at a given time meeting constraints of quality of service, reliability, environmental impact, etc. at minimum cost using all available technologies. This requires detailed techno-economic planning. The techno-economic plan must specify which technology must be employed to provide electricity for each customer, the bill of resources and materials needed (input power from the main grid, poles, cables, transformers, meters, etc. for grid extension; solar panels, batteries, power converters, thermal back-up generation, meters, etc. for mini-grids; and stand-alone solar systems for the remaining customers). And how the electrification process will evolve from the present situation until the target time when universal access will be achieved and beyond, for whatever time is required by the financial plan to achieve a sustainable level.

[1] The African School of Regulation (ASR) has named the ensemble of these practices the Integrated Framework for Electrification (IFE).

[2] See the IEA report "Africa Energy Outlook", 2022.

2.2. Scalable regulatory and business models.

The techno-economic plan needs to be built, operated and maintained and this needs companies capable and willing to do it. Since we are trying to achieve universal access in the considered country, the institutions in charge of establishing the policies and regulation related to electrification, the actual policies and regulation and the business models that they make possible, must be such that no single customer is left behind.

This is very difficult to accomplish, because of two major reasons. In the first place, the amount of funding that is needed is frequently beyond the economic resources that developing countries can make available for electrification, by themselves or using their typically low borrowing capacity. In the second place, because the amount of funding is also beyond the capabilities of the development financial institutions and donors with interest in electrification.

Therefore, a substantial fraction of the funding necessary to carry out the electrification process must come from private sources, which are plentiful under the right conditions. This creates important restrictions in the design of the regulation and business models, which must be designed so that private investors may be willing to participate in companies that will supply electricity to all customers, regardless of their affordability and the incurred cost. In other words, the regulatory and business models must be scalable. Left to private initiative without external support, electrification will only reach to the fraction of the population who can afford the cost. We need to employ a second group of best practices; those learned from the vast experience with power systems worldwide where this scalability has been possible.

2.3. Sustainable regulatory and business models.

It is not sufficient to design regulatory and business models that can supply every customer at a given moment in time. Real access needs to be permanent, without any duration limit. This is the access that everyone has in most countries in the world: a permanent supply of electricity to meet each one's needs in exchange for a monthly payment. Therefore, we need to add the sustainability (i.e., permanence) feature – in addition to scalability – to the regulatory and business models to be designed.

Financial sustainability can only be obtained as the outcome of a financial plan for the electrification process, i.e., one that respects the techno-economic plan for its entire duration, applies to the companies that must carry out the electrification under the regulatory and business models that have been defined, makes use of the financial resources that are available with their specific conditions, and achieves a stable financial situation within a reasonable timeframe. Note that financial sustainability is necessary for each one of the companies involved in the electrification process and also for the process as a whole, which is the responsibility of the government.

The duration of the financial plan until stability is achieved can exceed the time required to achieve full electrification. It is understood that a stable financial situation of the country's power sector as a whole –with the three modes of electrification – requires that the total cost of supply be covered with the regulated tariffs paid by its customers, without the need of any subsidy external to the power sector.[3]

[3] A financially viable electrification plan may include social tariffs, lifeline rates, or minimum amounts of free consumption for vulnerable families. The cost of these subsidies can be provided by the national budget, by some special tax on electricity consumption, by some other source of funds specific to the country, or by some combination of the above.

The customary low level of economic development of the rural population in developing countries – in other words, the low affordability level – creates a major challenge for the design of sustainable regulatory and business models for electrification. This difficulty also frequently extends to peri-urban and even part of the urban populations that are still unelectrified. Putting it bluntly, most rural electrification projects in SSA countries – either by grid extension, mini-grids or stand-alone systems – are not financially viable if the costs must be covered by the beneficiary communities.

Hence, a third group of best practices that are successfully employed to finance the power sector will be necessary here. Unfortunately, there are abundant cases of electrification attempts employing unsustainable models, resulting in frustration of the customers and discredit of the involved organisations. For instance, business models for off-grid electrification that are only based on initial capital subsidies are likely destined to collapse, when the initial low tariffs must be increased substantially once new investments are necessary to replace worn out assets or to meet increased demand.

2.4. Customer oriented business models.

The ultimate purpose of universal access is to improve the living conditions of a country's entire population. Therefore, merely providing the physical means to consume electricity is insufficient. It is also necessary to build capacity and facilitate the use of electricity for more comfortable living, such as lighting and domestic appliances, as well as for improving community life, such as social activities, and engaging in occupations with commercial value, whether at home or in commercial or industrial activities. This requires access to the necessary tools, which must be easily available in nearby shops or customer service centres, as well as financing. Companies responsible for electrification in rural areas should be incentivised to promote these activities, either independently or in collaboration with other companies or organisations. Best practices in this area are underdeveloped and highly context-dependent, yet the success of the electrification plan hinges substantially on this aspect.

2.5. Summary of the essential electrification requirements.

The essential best practices that must be followed to succeed in achieving the full electrification of a country are those that have been employed worldwide in meeting the four essential requirements presented above in the power sector:

(i) Adherence to a least-cost techno-economic plan subject to policy, economic, political, and social requirements, among others.

(ii) Scalability of regulatory and business models.

(iii) Financial sustainability of the business models of the companies involved, as well as of the electrification plan as a whole.

(iv) The plan must also contain resources and incentives that encourage electricity utilisation, resulting in the human and economic development of electrified communities and households.

3. Financial constraints to be considered in the design of the electrification plan.

The implementation of the electrification plan requires the participation of diverse entities, including the corresponding ministries – typically energy and financing –, the electricity regulatory authority, the rural electrification agency – if there is one–, the publicly-owned electricity companies, the privately-owned companies specialised either in grid extension, mini-grids or stand-alone systems, and the diverse development financial organisations. All of them play critical roles in making possible the financial viability of the plan. However, some aspects of their internal functioning may create additional constraints in the development of the electrification plan. These constraints are discussed here.

3.1. Public funding with governmental resources.

Ultimately, the government of a country bears the responsibility of ensuring the financial viability of the electrification process towards achieving universal access. In most African countries the supply of electricity is in the hands of publicly-owned companies, which frequently are in financial distress and unable to make significant progress in electrification. The ministries, the governmental agencies and the publicly owned utilities may receive grants and concessional funds from DFIs, DPs and donors. Then, these governmental entities may subsidise and invest with public money in the various electrification activities, they determine the regulated revenues and set the regulated end customer tariffs, and they borrow from commercial banks if necessary. It is important to realise that electrification must compete with other important priorities in the use of public resources and fiscal space is tight in most SSA countries. Moreover, many SSA countries are saddled with debt repayment and they have little or no room to incur additional debt.

Therefore, the contribution of national public funding to the electrification process may be comparatively small in many SSA countries. Most of the funding typically comes from the tariffs paid by the end customers, from private investors in the companies that they own, from concessional funds – either grants or loans – and from various kinds of donors. The electrification process typically needs to be subsidised during the initial phase of heavy investment. As it was explained before, most of the population that remains unelectrified in SSA countries cannot pay the actual cost incurred in electrifying them. The electrification process can only be considered completed when, typically years after everyone in the country has electricity supply, an equilibrium situation has been attained with no need for subsidies that are external to the power sector itself, either grants from DFIs, DPs or donors, or governmental subsidies.

3.2. Concessional financing.

The commitment of disbursement funds of development financial institutions (DFIs), development partners (DPs) and typical donors in the energy space cannot be extended beyond a short number of years (five, for example). This is due to the budgetary plans of these organisations, which depend on contributions and internal financial plans that do not extend beyond these time horizons.

This fact has important implications. As indicated before, the cost of rural electrification projects – by any electrification mode – typically cannot be fully covered by the beneficiaries because of affordability limits. The ensuing financial viability gap must be filled somehow, and concessional grants, loans and guarantees are transitorily needed, until the financial plan achieves a sustainable state, something that usually takes much longer than five years.

A consequence of this constraint of concessional funding is the proliferation of the business model known as Results Based Financing (RBF), which basically consists in a capital subsidy to the initial investment of an electrification project. This can be implemented in various ways. The RBF model perfectly adapts to the short horizon of concessional financing, but it is intrinsically unsustainable for most rural communities, as indicated before.

This concessional funding constraint also implies that concessional funds must be used only to finance CAPEX, because OPEX extends for the entire life of the assets, which, for most of them is much longer than five years. Financing OPEX would have to be interrupted while the assets still have many years of useful life.

Finally, although profitability is not the primary driver of the organisations that provide concessional financing, the lack of a comprehensive electrification plan – with the three components: techno-economic least cost mix of technologies, sound regulatory and business models for each one, and an integrated viable financial plan – is a deterrent of serious financial commitments. The consequence is that strong DFIs, DPs and large philanthropic donors only finance small and, at most, medium size electrification projects.

3.3. Private financing.

In general terms, private financing only happens when a profit is expected, i.e., an attractive return on the invested capital. The lower the risk to obtain a profit, the lower the return that is necessary to attract private capital. The role of the design of the regulatory and business models is to reduce the risk to the investor so that the total cost of the electrification project is minimised.

This translates into the basic rule that has made possible the development of the power sector worldwide at distribution level:[4] regulated monopolies, where the activity of distribution – which in an electrification process must include the three electrification modes – is remunerated for the efficient cost of providing the service (including the return on the invested capital) subject to some performance requirements, such as reliability, quality of service, losses, or number of new connections.

It is possible to attract private capital in the necessary amounts to make serious progress in achieving universal access only if the cost of service, including an attractive return on investment, is guaranteed with a low level of risk.

The next section presents the best practices for techno-economic planning, designing of regulatory and business models and financial planning, which comply with the essential requirements for achieving full electrification, while operating within the financial constraints of developing economies.

[4] With the exception of some countries that have the appropriate conditions, where markets can be implemented for those activities – large generation and retailing – that can be performed under competition.

4. Best practices for reconciling the essential requirements of full electrification with financial constraints. The three intertwined steps of an electrification plan.

Step #1. The techno-economic plan. What must be done and what is the cost.

Almost every developing country has completed one or more national electrification plans during the last decade, usually with support of a technical assistance facility funded by some DFI or DP. In most cases these plans only consist of what we have termed a techno-economic plan. Sometimes a very rudimentary financial plan is included stating that the total investment (O&M costs are usually ignored) should be split into X% public, Y% concessional and Z% private financing.

These techno-economic plans ignore that the cost of capital used for each technology in the least cost optimal mix is only known after the business models are defined and a financial plan is developed for each company and for the financial plan as a whole. Since the financial plan determines the blended cost of capital for each technology, the assumptions about the WACC made in the techno-economic analysis must be updated and the entire process must be repeated until the three steps – techno-economic analysis, regulatory and business model definition, and financial plan – are finally consistent.

But the outcome of a financial plan can bring a much harsher feedback to the techno-economic plan: the impossibility of financing a proposed techno-economic plan in the time horizon and under the conditions (e.g., the capacity of the solar home systems, the reliability and household capacity of mini-grid supply or the extent of grid extension) established as a target in the plan. When this happens, the techno-economic planners should go back to the drawing board and try a less ambitious electrification plan, both in terms of access level, the time when universal access must be completed and the time when financial sustainability (i.e., when the revenues from the regulated tariffs equal the annual revenue requirement of the power sector) will be reached. Unfortunately, this task, which requires performing steps 2 and 3 described below, typically falls beyond the remit of the consultants or the team in charge of the techno-economic plan. These incomplete electrification plans usually end up being ignored.

On the other hand, when the entire process is followed, depending on the country's initial electrification conditions, as well as any existing technical, social and policy constraints, the techno-economic plan will be bound by the availability of governmental subsidies and external grants, other accessible concessional and private financial resources and the affordable tariffs from the end customers. Depending on these factors, when adequate regulatory and business models and a financial plan are used, some SSA countries can achieve full electrification and financial viability in a reasonably short timeframe, roughly in compliance with the Sustainable Development Goal (SDG) 7.1. In these countries the techno-economic plan is characterised by a short period of a few years of intense investment in all electrification modes until universal access is achieved, followed by a longer period with a much lower level of investment and strong demand growth. Other SSA countries will require a much longer time to achieve full electrification, with moderate investment distributed during this period, as well as slow demand growth, as the affordability of the tariffs and the available funding allow.

The government must establish the priorities in the order of electrification among the regions, modes of electrification, types of loads and community characteristics. The techno-economic plan

must remain flexible to adapt to deviations in the initial assumptions during the long period until the completion of the electrification process.

Step #2. The regulatory and business model.

The design of electrification business models for grid extension, mini-grids, or stand-alone systems according to an established techno-economic plan that simultaneously meets the conditions of scalability, sustainability, and private sector participation in a SSA country with strong fiscal limits does not have many degrees of freedom. For the time being, in the discussion we shall ignore the constraints posed by concessional financing. In the next section we shall focus on the financial model, and we shall include these constraints.

Private sector participation.

Private participation demands a rate of return on investment with a value that depends on the existing risk of getting a sufficiently attractive return. The role of the design of the regulatory and business models for the various electrification modes is to reduce this risk at its root, before any ad hoc financial instruments must be employed.

For instance, let's consider the business model for a mini-grid developer. The obvious problem is that only a fraction – apparently small, as can be guessed from the fact that the immense majority of existing or planned mini-grids are subsidised – of the total number of mini-grids that are needed in SSA countries[5] can recover their costs of investment, operation and maintenance with the tariffs that the customers can afford. Therefore, without some guaranteed external subsidy it will be impossible to attract private capital. The only option to get participation of private capital is to guarantee a regulated remuneration based on an estimation of the efficient cost of service of building, operating and maintaining the mini-grids, including a rate of return on investment sufficiently attractive, or, alternatively, on the outcome of a competitive tender where the total cost of supply is estimated by the bidder. The "financial viability gap" between the total cost of supply and the revenue that can be obtained from affordable tariffs that are defined by the regulator must be filled by a regulated subsidy.[6]

How to ensure that private organisations will supply electricity to everyone and not only to profitable areas or communities? The business model will be scalable if this guaranteed remuneration applies in any region of the country, using the least cost technology, at whatever cost of providing the service efficiently. And the business model will be sustainable if it is formulated in a "utility-like" fashion, i.e., with a mutual commitment between the mini-grid developer and the regulator for a long enough period of time (20 or 25 years, for instance, which is reasonable, taking into account the lifetime of the involved assets) with possibility of renewal. Therefore, we are talking about some form of concession.

The same reasoning applies to stand-alone systems. The regulated tariff (a fixed amount) that will be paid by the customers every month must be established at an affordable level, which typically will not be sufficient to cover the cost of the solar home systems (of a capacity able to supply some

[5] 200,000 in SSA, according to reports from AMDA, IEA, etc.

[6] The criteria for the determination of the regulated revenue requirement and the regulated tariff for the end customers will be discussed later in the STEP#3 section.
The usual practice of regulatory authorities when establishing the remuneration of a regulated activity is to distribute the remuneration of investments over their economic lifetimes, and not for their actual costs incurred during any given year.

prescribed minimum services) or of any adequate stand-alone systems to meet the power needs of commercial or industrial customers. Therefore, a subsidy must be paid to the supplier company to cover its total costs of purchasing the systems, deploying them in the customers' premises, fixing and replacing them when needed, billing and collecting the payments, and being available in some commercial establishment not too far from the beneficiary communities for customer attention, including the sale of appliances for domestic and suitable productive uses of electricity. And making a reasonably attractive profit from this activity. This is the "energy-for-a-service" model for stand-alone systems, whereby the customers do not own any assets and pay monthly for a service, as the reader of this document surely does. As in the case of the mini-grids, a long-term mutual commitment between the regulator and the company is needed to guarantee the sustainability of the model. Again, we are talking about some form of concession.

The case of grid extension is different, since the incumbent distribution company already exists. A radical solution, in case the distribution company (or the distribution segment of a vertically integrated public utility) is in a dire financial situation – as is the case in almost the totality of SSA countries – is a concession for the entire distribution with the main grid, including the existing infrastructure and all the future grid extension specified in the techno-economic electrification plan. There is abundant experience on best practices in the design of these concessions, with two possible options: i) a full concession including all necessary investments, operation and maintenance, and ii) a concession only for procurement, operation and maintenance, plus minor investments, with major investments being made with public funds; in francophone countries this type of concession is called "affermage" or "délégation de service publique (DSP)".

When this radical solution is not possible, or it may take a long time to implement, an alternative could be to award separate full concessions for any necessary grid extension projects according to the techno-economic electrification plan. At a convenient time, these concessions will end, and the assets will be transferred to the incumbent public utility, with the concessionaires receiving a buy-out compensation for the residual value of any assets that they have invested in. The Rural Electrification Agency, or a similar publicly owned entity, could participate being in charge of some of these concessions, if there is sufficient funding from the government, DFIs, DPs or donors to support it. In both cases – the radical option or the piecemeal one – the newly connected customers will pay the same tariff as the customers already connected to the main grid. Therefore, a subsidy will be also necessary to recover the total cost, since the cost of extending the grid in new, less populated and dispersed areas with poor customers with typically low power consumption, cannot be recovered with the average tariff, computed on the basis of mostly urban customers located in densely populated areas.

What kind of concessions are needed? Should concessions be structured by geographic area or by technology type? We think that the best solution is context dependent.

Technology neutral territorial concessions should be long-term (20 years or more), based on the outcome of the techno-economic electrification plan or on some agreed further refinement made for the specific purpose of the concession. The territories would be allocated through competitive tenders, awarded on minimum public funding while meeting access and quality targets, with clear KPIs, step-in rights, and penalties to incentivise delivery.

Alternatively, concessions – either territorial or for a group of communities – could be awarded to mini-grid developers based on the minimum requested public funding. The developers'

remuneration will be completed with the revenue collected from the regulated tariffs paid by the customers. Again, prescribed access and quality targets must be met, with clear KPIs, step-in rights, and penalties to incentivise delivery.

Developers of solar home systems and other stand-alone off-grid solutions must have territorial concessions, under an energy-as-a-service regulatory approach and regulated tariffs, plus a subsidy which will be determined by the competitive tender. The terms of the tender must specify the minimum capacity of the equipment, and the quality of the customer attention service, with penalties to incentivise delivery.

Exclusivity rights must be defined carefully. Anyone can purchase a solar home system or a larger stand-alone system for commercial or industrial purposes anywhere, but they will not enjoy the advantages of the subsidised regulated business models. No mini-grid licences should be given within areas dedicated to grid extension or stand-alone systems in the techno-economic electrification plan. Existing mini-grids under other regulatory regimes will be invited to join the concessions under the same regulatory regime: regulated remuneration, subsidy and end consumer tariffs, all established by the regulator.

The role of institutions.

The implementation of an electrification plan must be customised to each country's power sector structure, institutions, regulation, macroeconomic, and technical conditions, as well as to political economy considerations. The role of each organisation must be defined accordingly.

A high-level governmental entity will be necessary to ensure that continuous political commitment to universal access is realized through the implementation of the integrated techno-economic plan, with sound regulations and business models, and a viable financial structure. This high-level supervisory role must correspond to the ministries of energy and finance, and/or any agency linked to them.

The electricity regulatory authority and/or some governmental agency will be responsible for organising the tenders for concessions and establishing the end-customer tariffs as well as the subsidies for the supplier companies.

A publicly owned entity (FinanceCo, with participation of the major funders) must centralise and manage all funding of the electrification plan coming from sources different from private investors in mini-grids, stand-alone systems and the distribution concessions. FinanceCo will monitor and ensure the overall financial viability of the plan. More details about the role of FinanceCo will be given in the next section.

Step #3. The financial plan.

An electrification plan is not complete until a viable integrated financial plan has been developed for the entities implementing each electrification mode and for the Government. The financial plan must secure funding for expanding capacity, managing, operating, and maintaining the distribution utility (or the distribution segment of a vertically integrated utility) and the electrification plan.

Permanent external subsidies to a national electrification plan are not acceptable. A sustainable electrification plan must reach an equilibrium point with no need for external subsidies in a reasonable timeframe. After some transitory period, a stable financial situation must be reached in which the only source of funds will be the regulated tariffs, with any internal tariff cross-

subsidisation as needed.[7] Some governmental permanent subsidies to vulnerable customers are acceptable, but preferably from a permanent source of funds different from tariffs (this is a social programme that should be supported by general taxes, not the electricity customers).

It helps in making the electrification plan financially viable to remove from the regulated tariffs those policy or other costs that do not belong in there, to facilitate affordability and prevent or at least reduce grid defection.

A specialised financial intermediary, "FinanceCo", which will be a government-affiliated entity with external participation in its governance, will act as a central hub for channelling financing to distribution companies and off-grid developers. The involvement of all these players in the governance structure of FinanceCo, alongside the government's ministries of energy and finance will ensure oversight and proper control of finances. It would be very convenient, time and effort wise, if FinanceCo could be established by upgrading or adding responsibilities to an existing institution with similar duties, such as the "electrification funds".

FinanceCo will be the meeting place of the funding organisations, will be in charge of keeping the entity within standard financial indicators, and will transfer the money to each one of the concessionaires as needed. FinanceCo will coordinate all financing sources, including government subsidies and equity contributions, grants and concessional loans from Development Partners (DPs), loans and equity provided by private banks and investment funds, and the revenues from regulated tariffs paid by the customers. FinanceCo's unique position will allow it to access concessional funding and grants from DPs, which can be supplemented by private investors. This blend of financing sources will help achieve optimal funding conditions for electrification.

The government of the country bears the ultimate responsibility regarding the success of the plan. By intervening in the value of the tariffs to the end consumers[8] it also affects the volume of subsidies that will be needed. Participation of the government with equity in FinanceCo would give confidence to other investors, aligning their interest and unlocking grant participation from DPs. The existence of a thorough and viable financial plan and the commitment of the government to it can provide confidence that the national power sector will be able to reach a sustainable financial situation at the end of the plan; this should reduce the pressure on the level of guarantees.[9]

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[7] Tariff cross-subsidisation (for instance, equal tariffs for consumers connected to mini-grids or the main grid) is the centrepiece of the long-term financial stability of the financial model. Tariff cross-subsidisation exists presently in all countries. For instance, same tariffs for urban and rural customers connected to the same grid, and cross-subsidies from residential to industrial customers or vice versa.

[8] This is a legitimate policy decision. The remuneration of the companies that supply electricity must be strictly cost reflective and determined by the regulator, but the end customer tariffs can be subject to political intervention via cross-subsidisation, both inter and intra on-grid and off-grid customers. If tariffs are globally set below costs, subsidies from the government or from external sources will be needed.

[9] A particular feature of the electricity sector is that it is regulated with a high degree of quantitative precision (i.e. the cost of service and the retail tariffs are carefully calculated and implemented, typically on an annual basis). There are uncertainties, such as fuel prices or future demand, but regulators can adjust tariffs or expansion plans to accommodate changes in their original estimates and keep their plans financially viable. Therefore, if an electrification plan is initially shown to be financially viable (including external commitments from DFIs, DPs and various donors), and if the means to monitor and adjust its implementation are well established, it is very likely that no additional external subsidies will be needed and that the plan will end in a sustainable state.

Overcoming the financial constraints of supporting entities.

As described in section 3.2, donor programmes often operate in 4 to 5-year disbursement windows, while electrification concessions require 15 to 20-year financial sustainability. How can short donor cycles be made compatible with long-term service delivery?

Let's use mini-grids as the case study, which can be extended to any electrification mode. Mini-grids serving poor rural communities in Africa cannot function sustainably on cost-reflective tariffs. Concessions require predictable revenue support in the face of low initial consumption, slow productive-use buildup, high unit costs, imported (USD-denominated) equipment and maintenance and, most important, low affordability of the beneficiary communities. An escrow account, combined with FX-risk protection mechanisms, solves this mismatch.

An escrow account is a ring-fenced mechanism where donors deposit funds upfront, which are then disbursed over many years according to predetermined rules. It provides: i) predictability, i.e., guaranteed funding for mini-grid operators across the full concession period (e.g., 20 years), even after donor projects close; ii) fiduciary integrity, since funds cannot be reallocated by central treasuries or affected by political cycles; iii) performance linkage, as payments occur only when service KPIs are met (connections, kWh, reliability); iv) bankability, because predictable cashflows reduce risk, attract private capital, and improve the financial viability of market-based access programmes.

However, an escrow account alone is not enough, because new investments will be necessary over the lifetime of the concession – battery replacements, inverters, controllers, software, diesel backup, additional poles and wires, spare parts, tools and technical services – many of whose costs are USD-denominated. Revenues, however, are in local currency and tariffs are often capped or politically constrained.

If the local currency depreciates significantly over 20 years, imported replacement costs will increase very significantly in local currency, while revenues will not. As a result, a mini-grid that was viable in year 0 may become financially impossible in year 10 even with an escrow. To avoid this, an FX-risk management instrument must be part of the subsidy architecture. Therefore, a sustainable model requires at least one – and ideally several – of the following policy tools:

A) A USD-denominated escrow tranche, i.e., a portion of the subsidy fund will be held in USD and used for imported lifecycle costs (e.g., batteries, electronics).
B) FX-indexed subsidy formulas, whereby local-currency subsidies are adjusted annually according to changes in the USD/Local Currency exchange rate, preserving operator viability.
C) FX Buffer Reserve. A dedicated reserve within the escrow that activates only when local currency depreciation exceeds a defined threshold (e.g., 10% per year).
D) Tariff Adjustment Factor, so that an annual adjustment mechanism for cost-reflective tariffs that includes inflation + FX pass-through is automatically applied, while the tariff-gap subsidy (from escrow) keeps consumer tariffs stable.

In summary, long-term mini-grid concessions are not viable without FX protection. Escrow accounts must integrate USD components, FX indexation, and buffer mechanisms.

5. Key implementation aspects.

This section addresses several critical implementation aspects of the regulatory, business model and financial design of the off-grid concessions. Getting these features right is critical to reduce the risk of the concessionaire and of the beneficiaries of the electrification during the entire life of the concession and to ensure a satisfactory performance of the concessionaire. The aspects to be reviewed here are: i) the key aspects of the concession agreement that must be included in the terms of reference (ToR) of the tender; ii) the design of the incentive mechanisms to promote demand growth, reduce technical and commercial losses, and ensure satisfactory reliability and service quality.

To facilitate the discussion, instead of considering a national electrification plan as we have done in this document until now, in the remainder of this section it will be assumed that the concession is meant to electrify a rural area where the techno-economic plan has concluded that the least cost solution only includes mini-grids and stand-alone systems for the duration of the concession. Other areas – not considered here – will have a different mix of electrification modes, for which the guidelines presented here will have to be adapted. The Annex to this document contains a comprehensive list of all aspects that must be considered in the design of a national electrification strategy.

5.1. The terms of reference of the tender to obtain the concession.

The concession will specify the territory to be electrified, which typically will encompass several communities with different levels of geographical dispersion of their members. Based on the existing techno-economic plan, the regulator establishes that, at the end of the first 3 years of the concession all members of these communities will have access to electricity (if so they wish).[10] Out of those with electricity service at the end of the 3 years, N% must be connected to mini-grids – with at least tier #2 and a maximum capacity level of consumption of MAX W – and the rest to stand-alone systems, with solar home systems for domestic customers, also with at least tier #2. [11] The estimated annual demands to be supplied during the first three years by the mini-grids for the domestic and small C&I customers – the "3-year reference demands" – are RD1, RD2 and RD3 kWh. The demand of each individual consumer must be met with a prescribed minimum reliability and quality of service level, same for all mini-grids and – with different metrics – same for all domestic and small C&I customers supplied with stand-alone solutions.

Any interested bidders must go through a pre-qualification phase, where bidders must show their record in the electrification activity and also what their plans are regarding the electrification in the considered area, in a first approximation.

The bidders must present offers for the total cost of supplying RD1, RD2 and RD3, making explicit the objectives to be achieved each year of this first 3-year period – number of mini-grid connections achieved and of solar systems installed – until full electrification is achieved at the end of the third year. The bidders must also present their investment plans at a sufficient level of detail as to be able to estimate the cost of investment during these three years, as well as the proposed value of WACC1 with which the CAPEX presented in the bid for the years of the first 3-year period

[10] Mini-grid experts in African countries believe that once a concession is signed with a developer, the project can be finalised in significantly less time.

[11] This requirement must be based on the results of a prior geospatial, least-cost, techno-economic analysis.

and also for the 17 following years has been calculated. The OPEX for the first three years must also be offered.

Finally, the bid must also include the WACC2 to be applied to any additional investment – to be approved by the regulator – that will be necessary to meet the growing demand and maintain the target of reliability and quality of service until the end of the concession.[12] Once approved and built, these additional investments will be included in the rate base and the new annual remuneration will be updated. Penalties will be applied for not reaching the committed numbers of customers supplied each year for mini-grids and stand-alone systems during the first 3-year period, and also for failing to reach the required levels of reliability and quality of supply.

The Government, informed by the regulator, will establish the tariff (LC/kWh, where LC stands for "local currency") that will apply to the customers supplied by mini-grids. In general, it is recommended that this tariff should be equal to that of equivalent customers who are connected to the main grid.[13] Likewise, the regulated tariff for the solar home systems will be established. The difference between the amount bid by the winner of the tender and the estimated revenue from the application of the regulated tariffs (including some prudent estimate of non-paid bills) will be the subsidy to be given to the concessionaire.

Larger C&I customers, like medium size industrial or commercial facilities, schools, health centres or other substantial demands larger than a prescribed annual value $PUmin$ will require a different treatment. The bids must only include the plan and cost for the smaller customers, plus a plan to electrify the larger C&I customers, under the same WACC1. The total additional remuneration for supplying demand for productive uses PUD1, PUD2 and PUD3 will be established by the regulator applying the standard procedure of CAPEX remuneration, using the associated rate base with a value of WACC1, plus an efficient OPEX calculated using some reference benchmark. The regulator will also establish the regulated tariff to be applied to all productive uses with an estimated annual demand larger than PUmin. All other PUs will be treated as domestic demands.

The concession will provide exclusivity of supply with mini-grids in the considered area. Any customers will be free to purchase any stand-alone system from a vendor different from the concessionaire, but they will not have the right to pay a subsidised tariff for its use.

5.2. The incentive mechanisms.

It is now necessary to verify that the concessionaire is properly incentivised to: increase the responsible use of electricity; reduce technical and commercial energy losses; provide satisfactory reliability and service quality; and increase the number of potential customers who accept supply and pay the cost. Once again, only mini-grids and stand-alone systems within an area of the country will be considered, although the considerations in this section have a broader application.

[12] Whether WACC1 and WACC2 must be equal is an open issue. Here, we have chosen to give the developer this degree of freedom. Why? We believe that the financial characteristics of raising the initial capital to quickly complete the area's electrification and expand existing infrastructure to meet natural demand growth are different. These differences justify having different capital structures and remuneration.

[13] It is not advisable to follow this recommendation in situations where the national tariff for grid-connected consumers in the low demand levels is so low that the resulting subsidies in the electrification plan will be impossible to sustain.

Demand growth.

The procedure that has been outlined in the preceding section must be completed to create the correct incentives for the concessionaire to be motivated to connect all customers with the requirements stipulated above, and also to increment the demand for electricity for all kinds of customers meaningfully (note that it is in the self-interest of the customers to use electricity efficiently to reduce their consumption and therefore also their monthly electricity bill, while capturing its benefits). This can be achieved by establishing that the revenues from the application of the regulated tariff for mini-grid customers and that for solar home system customers will be fully retained by the concessionaire.

During the first 3-year period, depending on the specific conditions of the considered area, as well as the marginal costs of expanding the supply beyond the estimated reference demands RD1, RD2 and RD3, the concessionaire may be interested in promoting residential demand as high as possible while the marginal incurred costs are lower than the regulated tariff. The incentive for the mini-grid developer will be larger if, in addition to its core business building and operating mini-grids, this developer could get involved in selling domestic appliances and in participating in the PU businesses.

Therefore, in reality, the concessionaire must evaluate all these factors before making any decisions, being aware that some factors cannot be changed – the subsidy estimated for each year, the regulated tariff or the targets of customers supplied, reliability and quality of service – while others can be stimulated or not, like the demand, and others can be decided, like the volume of investment in mini-grids and stand-alone systems.

Penalties must be applied to the concessionaire if she/he is not able to connect all potential customers within the considered area, and also for increasing the number of stand-alone systems to the detriment of the prescribed percentage of mini-grid-connected solutions by the end of the 3-year initial period. The amount of the penalty will be proportional to the gap in the number of connections of each kind.

During the second period, from years four to twenty, the regulator and concessionaire must engage in the same dialogue that distribution companies and regulators have engaged in for decades: estimating demand growth, debating the need for new investments, and arguing about the WACC that should be applied (which in this case has been established from the outset by the winning bid at a value WACC2) and how much the O&M costs can be reduced.

The regulator can now compute the subsidy for any year N by subtracting from the regulated cost of service – CAPEX from the updated rate base, with some assets valued at WACC1 and others at WACC2, plus the associated OPEX – the income derived from the regulated tariff applied to the estimated demand (assuming some acceptable fraction of non-paid tariffs). Once the subsidy has been established, the concessionaire must evaluate how much effort she or he must place in stimulating the demand during the year, by considering the following factors: additional income from the additional demand, additional investment effort to meet this demand (perhaps using existing spare capacity at no cost), and extra revenues associated to commercial businesses facilitated by electricity access, perhaps in separate companies within the same industrial group.

Technical and commercial losses.

No regulations should be applied to incentivise reducing technical losses because the concessionaire must produce the lost energy herself. Therefore, enough incentive already exists.

On the other hand, once the subsidy for a year has been fixed with some accepted commercial losses, the concessionaire has a clear natural incentive to improve the revenue collection, since it results in additional revenue at minimum or no cost.

Reliability and quality of supply.

The regulator must establish reasonable reliability and quality of service targets for the electricity supply with mini-grids and – separately – for stand-alone systems (large PU customers are special cases with specific needs, and each one must be treated individually). It must be noted that, once an acceptable level of reliability of supply has been reached, the cost of improving the level of reliability by a small percentage can be very costly.

The reliability of mini-grid supply can be measured with various metrics: amount or percentage of energy non supplied, number of interruptions, or total time of interruption in a period of time, like one year. Or a combination of some of them. The main factor to consider in the quality of electricity supplied by a mini-grid is the voltage level, which must stay always within a band about the reference value, and the content of harmonics (distortions of the voltage waveform).

Under the energy-as-a-service business model, supply failures must be fixed by the concessionaire and, therefore, what matters is the quality of the technical and commercial service of customer attention. Solar home systems and appliances must comply with technical quality standards.

In all cases, acceptable targets must be established and penalties or credits will apply, depending on the actual performance of the concessionaire.

Annex. A template to guide the adaptation and application to Zambia of the "basket of best regulatory and business practices".[14]

The Government of Zambia has selected your team to turn the REMP into an executable programme. Your mandate is clear. Scale access nationwide. Leave no one behind. Make the service financially and operationally durable so it lasts forever.

You must design a plan that is least cost, bankable, and institutionally sound. Align technologies with demand and geography. Match subsidies and tariffs to affordability and cost recovery. Define who does what and how performance is enforced.

You face real constraints. Fiscal space is tight. Donor funding is short cycle. Utility finances are weak. Regulation is evolving. Climate risk threatens supply. Use the information provided to craft a sequenced path that delivers results.

Answer the questions in Steps 1, 2, and 3 to propose a credible implementation strategy.

STEP 1 – WHAT SHOULD BE DONE?

- **Realism of the Plan:**
    - To what extent do the REMP investment and connection targets reflect Zambia's actual implementation capacity?
    - How can the estimated US$4 billion total and roughly US$600–700M per year through 2030 be mobilised sustainably? How about the remainder of the total plan till 2040?
    - What key assumptions support the proposed technology mix (55 % grid, 25 % mini-grids, 20 % stand-alone systems)? Do we trust them?
    - How might the plan remain flexible if investment levels or timelines need revision?
- **Understanding the Ambition:**
    - What opportunities and challenges arise from such rapid expansion?
    - Could the rollout create pressure on existing institutions such as ZESCO or REA?
- **Prioritisation and Sequencing:**
    - Should certain regions or user groups (e.g. schools, clinics, productive enterprises) be served first?
    - How to balance reaching remote rural villages versus densifying nearer-grid areas to maximise impact?

STEP 2 – WHO SHOULD DO IT AND HOW?

- **Institutional Responsibilities:**
    - How should roles be divided among MoE, ERB, REA, REF and ZESCO?

[14] This is a case study presented to the participants in the course taught by the ASR in Zambia in November 2025. It is included here to show the wide range of topics that is necessary to consider in the design of an electrification plan at national scale.

- Are current mandates aligned with REMP implementation?
- How could the REF be managed effectively?

- **Private Sector Involvement:**
  - What is the optimal role for private developers in the implementation of the REMP?
  - How can they be included?
  - What type of contract or agreement could ensure that they connect everyone and not only the profitable areas?

- **Sustainability Guarantees:**
  - What financial, institutional, and regulatory measures are required to ensure that all business models—on-grid, mini-grid, and stand-alone—remain viable in the long term?

- **Regulation and Tariffs:**
  - How should tariffs be structured to balance affordability for rural customers with the need for cost recovery and investor confidence?
  - Should Zambia maintain a uniform national tariff, or adopt differentiated tariffs for off-grid and remote areas?
  - What mechanisms could allow cross-subsidies from on-grid to off-grid consumers while keeping the system transparent and fair?

- **Regulatory Framework and Concession Design:**
  - Which aspects of the existing framework (tariffs, revenue-requirement methodology, subsidy design, or licensing) should be updated to reflect the diversity of the potential new business models that will appear in the REMP implementation?
  - What conditions should define a rural-electrification concession—its duration, exclusivity, service obligations, and technology scope?
  - Should concessions be structured by geographic area or by technology type?

STEP 3 – FINANCE, POLITICAL ECONOMY AND SUSTAINABILITY

- **Donor Funding Alignment:**
  - Donor programmes often operate in 4–5-year disbursement windows, while electrification assets and concessions require 15–20-year financial sustainability. How can short donor cycles be made compatible with long-term service delivery?

- **Role and Reform of REF:**
  - Is the Rural Electrification Fund the right instrument to channel subsidies and grants under a scaled programme?
  - How could REF governance, disbursement rules, or levy structure be improved to enhance transparency, predictability, and private-sector participation?

- **Financial Targets and Viability:**
    - If the current plan is unlikely to be financially viable by 2030, how should investment targets or timelines be iterated?
    - How can Zambia develop a financial plan with a specific, realistic target (e.g., phased universal access by 2032–2035) while avoiding discrimination among communities waiting for service?
- **Political Economy – Leadership and Buy-in:**
    - Who should champion the electrification agenda and provide continuity—Ministry of Energy, REA, ZESCO, or a cross-ministerial task force?
    - How can political buy-in be maintained when the power sector faces droughts, generation shortages, fiscal constraints, or leadership changes?
    - What communication, stakeholder engagement, and accountability measures would help secure long-term commitment?