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**Working paper 12-2022**

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## **WORKING PAPER**

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# **Reforming Small Electricity Systems: Market Design and Competition**

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# Reforming Small Electricity Systems: Market Design and Competition

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## Abstract

The financial viability of electric utilities in sub-Saharan Africa (SSA) is a central energy policy issue. This follows a persistent under-recovery of costs despite having some of the highest electricity prices in the world. However, discussions on electricity price-cost margins often focus on the revenue aspects and tariff and utility reforms, but inadequately on costs and broader sector reforms. Through a synthesis of reform theories and case studies and using small electricity systems as a surrogate for liberalised sectors without competitive markets, this paper examines the connection between sector reforms and costs. It brings economic perspective to financial performance in SSA electricity systems and the need for a holistic approach for cost-recovery. We recommend the promotion of mobile power plants to facilitate contestability in generation and competitive procurement of new capacity to lower costs. Small systems should participate in regional power markets to neutralise the scale limitations of autarkic demand, and form platforms to share information on cost opportunities to inform procurement designs and regulatory benchmarks. Regional markets could partner with governments to develop subsidy schemes such as contracts for differences to remove rigidities in national power purchasing contracts to promote participation of small systems in regional markets. Yardstick competition in the distribution segment is viable in small electricity systems and should be pursued.

**Keywords:** Small electricity systems; sub-Saharan Africa; electric utilities; financial performance; cost under recovery; electricity prices.

**JEL classifications:** D47, D52, D61, E13, P41, P48, P18, L97.

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## **1. Introduction**

As articulated with the Structure–Conduct–Performance (SCP) paradigm of neoclassical economic theory of Industrial Organisation, the structure of a market is a fundamental determinant of firm conduct and its eventual performance. Specific to the electricity sector, it was asserted that the observed inefficiencies prior to reforms were the consequence of prevailing monopoly market structures. Subsequently, by eradicating these monopoly market powers in favour of more competition, firms will be incentivised to control costs (and prices) and improve the quality of their services (Jamاسب et al., 2006; Joskow, 1998a; Jamاسب, 2002; Demestz, 1973; Nepal and Jamاسب, 2015). Thus, the establishment of competitive electricity markets was a critical component of the reforms, especially in the pursuit of cost efficiency, improved service quality, and reduced prices (Nepal et al., 2022).

However, over the three decades since the initiation of reforms in SSA, no country in the region has successfully established a competitive wholesale or retail market. Electricity sectors remain partially deregulated, with public vertically integrated structures coexisting with elements of market-orientation (Gratwick and Eberhard, 2008; Foster and Rana, 2020; Sioshansi and Pfaffenberger, 2006; Kessides, 2012; Williams and Ghanadan, 2006; Jamاسب et al., 2017; Sen et al., 2018). Reforms remain investment-focused, especially as one in two sub-Saharan Africans do not have access to electricity, generation capacity remains inadequate in the region, and transmission and distribution networks are dilapidated.

In recent years, nonetheless, the effects of the absence of functioning markets in liberalised electricity systems in sub-Saharan Africa (SSA) have become evident, with surging cost of electricity supply and high prices which are unable to cover the full cost of service. Utilities in the region are thus faced with persistent under-recovery of costs that threatens their financial viability (Huenteler, 2017; Briceño-Garmendia and Shkaratan, 2011; Kojima and Trimble, 2016). A study of 39 countries in SSA found that only Seychelles and Uganda fully recovered their operational and capital costs, and only 19 of the 39 countries collected sufficient revenue to cover their operational costs (Kojima and Trimble, 2016). Subsequently, cost-recovery and the financial viability of utilities have become front and centre in energy policy discussions in the region.

However, discussions on prevailing revenue-cost margins focus heavily on the revenue aspects and inadequately on the cost side. Utility and tariff reforms are the new forms of reforms, with regulatory pressures to increase prices to cover costs and calls for privatization to improve the operational performance of utilities. The role of sector reforms and prevailing markets are often dismissed, with the main argument being that hybrid market structures and their corresponding inefficiencies are the result of incomplete reforms. Thus, electricity systems seeking to address these structural inefficiencies should focus on completing the deregulation process to establish markets.

This perfunctory referrals to incomplete reforms have been obliquely used to justify the superficial and little effort put in examining the structural problems of liberalized electricity systems without markets. However, for many SSA countries, completing the reforms may not be a viable option due to inherent structural issues with an exemplary illustration being small electricity systems which cannot support multiple competitors at an efficient scale. For these electricity systems, emerging hybrid electricity sector structures have proven to be steady state structures and not transitory, indicating the unviability of traditional reform models in delivering cost efficiency in these contexts.

Despite a general acknowledgement of small electricity systems in the reform literature, there is a lack of explicit guidance on alternate pathways to cost efficiency for electricity systems that cannot support competition. In this study, we conduct a synthesis of market-based reforms in the context of small electricity systems. We discuss the key challenges that emerge in liberalised electricity systems without markets and how they impact electricity costs and prices. We assess the regulatory approaches and privatisation models that have been adopted in place of competition to facilitate contestability and improve the operational performance of utilities drawing on various case studies across the region (Baumol et al., 1982). The purpose of this study is to provide guidance to managing liberalised electricity systems without markets. However, the focus on small electricity systems is to provide a stable analytical framework insulated from dismissive references to non-economic factors that inhibit reform implementation. Thus, this analysis is not intended to diminish the reform experiences of larger electricity systems that struggle to establish markets, but in fact has several relevant and useful implications and instructions for these systems as well.

The remainder of this study is organised as follows. Section 2 contextualizes small electricity systems from the point of view of reforms. Section 3 presents the key challenges in the

generation segments of liberalised small electricity systems and the regulatory approaches used to minimise generation costs. In Section 4, we examine the main operational challenges observed in the distribution segments of small electricity systems and the approaches that have been adopted to improve quality of service and reduce costs and prices. Section 5 concludes the study with recommendations for policy.

## **2. Reforming Small Electricity Systems**

A major challenge in the economic analysis of smallness is finding an objective definition for the concept (Fisher, 1967). Staley and Morse (1966) suggest that one can escape the complications of crisp definitions by using a ‘functional’ definition, i.e., a definition based on the context in which it is used (Staley and Morse, 1966). A useful definition of smallness is by Gal (2003) which when adapted to the electricity sector typifies a small electricity system as one that cannot support the optimal number of competitors when catering to demand. In such electricity systems, there is no real risk to losing market share due to economies of scale and scope or barriers such as high transaction costs.

Generally, the literature on small economies attempt to conceptualize smallness in terms of measurable demand-side variables such as population (Brigulio, 2020), economic activity, and geographic size (Gal, 2003; Brigulio, 2020) whether combined or individually. In the case of electricity systems, other key determinants of demand or market size include population distribution, electricity access rates and the degree of regional integration or isolation. For instance, a jurisdiction may be large with a corresponding high demand, but with populations widely dispersed, sub-jurisdictional markets may emerge creating small systems. An example of this is mini grid systems that are emerging as a popular electrification solution in rural SSA (Kirubi et al., 2009). Similarly, a small system within a power pool could be regarded as part of the larger market the pool has created, negating the scale limitations of its sole demand. In addition to these demand factors, in regions with high poverty levels, there can be high latent and suppressed demand due to low access rates, unaffordable electricity prices and service interruptions which create discrepancies between actual and effective demand.

While smallness is best explained from the point of view of demand, its economic implications are best articulated from a supply position. In production economics, there is a Minimum Efficient Scale (MES) at which firms produce at the lowest long-run marginal cost and beyond

which there is diseconomies of scale. In the electricity sector, this corresponds to the maximum size of a power plant (which is identical to the firm) to produce electricity at the least-cost.<sup>1</sup> This is largely determined by the technological characteristics of the plant (e.g., hydro, solar, CCGT or nuclear), as well as other factors such as the age of the plant or the type of fuel used, amongst others. For instance, the MES of a hydropower plant will be significantly different from that of a CCGT plant or grid-connected solar plant.

Given a level of demand, the MES determines the number of efficient firms that can be accommodated in an electricity market, with the number of efficient firms related to the size of demand, approaching infinity (perfect competition) as demand increases and approaching zero (monopoly) as demand falls. For the electricity sector, it is estimated that effective competition requires at least five generating plants of dispatchable technologies.<sup>2</sup> Against this backdrop, researchers have attempted to define a numeric threshold for categorising electricity system size into small or large. For instance, 1000MW of peak demand has been indicated to be the minimum size for an electricity system to be considered large (Besant-Jones, 2006; Vagliasindi and Besant-Jones, 2013). Foster and Rana (2020) indicate that an electricity sector of at least 3GW of peak demand or 20 TWh of annual energy demand may be considered as large. Based on this rule of thumb, we identify 30 of the 48 SSA countries (electricity systems) as being small when using the metric of installed generation capacity below 1000MW. When using the metric of 3TWh annual peak demand, 31 countries are identified as small (Table 1).<sup>3</sup> It is, however, important to note that smallness is a short run concept subject to changes in demand characteristics and technological progress over time. Thus, in the long-run, many small electricity systems evolve and become large.

The relevance of system size is most apparent during sector restructuring, and more specifically during unbundling. An integrated electricity sector can be unbundled vertically and horizontally. Vertical unbundling involves the separation of the potentially competitive

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<sup>1</sup> In a competitive wholesale market, the MES is at the plant level, i.e., the plant and the firm are the same.

<sup>2</sup> A dispatchable source of electricity refers to an electrical power system, such as a power plant, that can be turned on or off, i.e., they can adjust their output supplied to the electrical grid on demand. Most conventional power sources such as coal or nuclear power plants are dispatchable to meet the constantly changing electricity demand. In contrast, many renewable energy sources are intermittent and non-dispatchable, such as wind power or solar power which can only generate electricity while their primary energy flow is input on them.

<sup>3</sup> SSA countries with gross energy demand below 3TWh as at the end of 2020 are included. The list is presented in descending order of demand.



segments of the ESI (generation and retailing) from the natural monopoly networks segments (transmission and distribution). Unbundling can take three forms, i.e., functional/accounting unbundling, legal unbundling, and ownership unbundling, with each form differing from the others by the degree of separation.

**Table 1. Description of Sub-Sahara Africa electricity Systems in numbers (2019)<sup>4</sup>**

Country	Population	Generation Capacity (MW)	Electrification Rate (%)	Peak Demand (GWh)
Guinea-Bissau	1,920,917	28	31.0	82
Sao Tome and Principe	215,048	29	75.0	86
Comoros	850,891	35	84.3	95
Central African Republic	4,745,179	44	14.3	149
Lesotho	2,125,267	75	44.5	933
Chad	15,946,882	86	8.4	297
Burundi	11,530,577	87	11.4	336
South Sudan	11,062,114	131	6.7	576
Gambia The	2,347,696	137	62.1	312
Sierra Leone	7,813,207	143	22.7	250
Seychelles	97,625	157	100.0	516
Eswatini (Former Swaziland)	1,148,133	193	76.9	1,531
Liberia	4,937,374	195	23.1	433
Cabo Verde	549,936	221	91.4	497
Eritrea	6,081,000	226	50.9	461
Rwanda	12,626,938	228	40.4	889
Togo	8,082,359	230	52.4	1,538
Niger	23,310,719	324	19.0	1,562
Burkina Faso	20,321,383	390	18.4	1,799
Benin	11,801,151	508	40.3	1,620
Madagascar	26,969,306	546	31.0	2,134
Equatorial Guinea	1,355,982	554	66.6	750
Namibia	2,494,524	600	55.2	4,350
Malawi	18,628,749	603	11.2	2,167
Congo Republic	5,380,504	606	48.4	3,223

<sup>4</sup> 2019 is used as benchmark year as it is the most recent year with the most complete data.

Mauritania	4,525,698	608	45.8	1,479
Guinea	12,771,246	621	42.2	1,979
Botswana	2,303,703	761	70.0	3,951
Gabon	2,172,578	784	90.7	2,694
Mauritius	1,265,711	844	100.0	3,192
Somalia	15,442,906		49.2	367
Mali	19,658,023	1,015	47.8	2,929
Uganda	44,269,587	1,256	41.3	4,157
Senegal	16,296,362	1,432	70.4	4,724
Tanzania	58,005,461	1,530	37.7	7,918
Cameroon	25,876,387	1,669	63.5	8,248
Republic of Cote d'Ivoire	25,716,554	2,233	68.5	9,137
Zimbabwe	14,645,473	2,346	46.8	8,729
Mozambique	30,366,043	2,814	29.7	16,240
Zambia	17,861,034	2,981	43.0	14,152
Kenya	52,573,967	3,155	69.7	11,731
Congo, Democratic Republic	86,790,568	3,190	19.1	10,199
Sudan	42,813,237	4,138	54.0	
Ethiopia	112,078,727	4,300	48.1	14,075
Ghana	30,417,858	5,382	83.5	16,885
Angola	31,825,299	6,156	45.6	15,074
Nigeria	200,963,603	11,681	55.4	30,521
South Africa	58,558,267	58,683	85.0	225,913

**Source: United Nations and World Bank Databases**

In accounting unbundling, the electricity sector remains vertically integrated but there is a reorganisation of accounts to ringfence the costs of each segment of the ESI, i.e., generation, transmission, distribution, and retail. Beyond these changes in book-keeping, there is no material change in sector organisation such as in ownership, management, or staffing. Legal unbundling typically follows functional/accounting unbundling and involves the separation of each segment of the ESI into separate legal entities with its own management and staff as well as accounts. Legally unbundled power utilities (companies) may have a similar ownership structure as it had prior, such as continuous public ownership but may remain connected via a holding company (Foster and Rana, 2020). Finally, and the strictest form, is ownership unbundling, for which accounting and legal unbundling are pre-requisites. This involves a

separation of ownership from management, often through the conversion of legally unbundled utilities into limited liability companies or corporations with distinct shareholders and a Board of Directors.

The main rationale for unbundling during reforms pertains to its implications for competition. Specifically, vertical unbundling is argued to facilitate non-discriminatory third-party access to electricity networks, an essential condition for private sector participation and competition. The logic is that a firm controlling the network and, at the same time, involved in the competitive segments of the ESI has the incentive to limit or deny access of other firms to the network through discriminatory access tactics such as pricing or “strategic” investments in grid augmentation.

Thus, vertical unbundling presents a structural remedy for anticompetitive practices as it differentiates interests in the competitive segments from those in the networks, subsequently removing the possibility and interest to discriminate. In addition, vertical unbundling has been indicated to enhance transparency and facilitate accountability as it allows easy identification of costs and (in)efficiencies. However, vertical unbundling on its own may not result in improved performance unless matched with proactive steps to address identified issues.

Once the sector has been fully unbundled vertically, it can be unbundled horizontally to create an adequate number of competing firms. This involves the breakdown of existing firms into smaller units to remove the dominance of any one firm. It is often at this point when reforms are curtailed in small electricity systems, as total demand can often be met with one or few firms and de-concentration creates suboptimal firm sizes. In several SSA sectors, these limitations are particularly pronounced as pre-reform generation portfolios are dominated by hydropower which are often non-dispatchable and fully amortized. This gives the incumbent generators a competitive advantage of generating electricity at lower cost and in most cases the privilege of priority dispatch. Under such conditions, horizontal unbundling would lead to sub-optimal outcomes, giving existing generators natural monopoly powers.

In the absence of horizontal unbundling and subsequently competition, however, arguments for vertical unbundling also weakens. This is because the separation of sector activities leads to loss of vertical economies, removes complementarities in technical coordination, and creates information asymmetry given the separation of sector management, ownership and regulation, and the concomitant separation of interests and incentives (Kaserman and Mayo, 1991; Nemoto

and Goto, 2004; Arocena and Oliveros, 2012; Gugler et al., 2017; Armstrong and Read, 2004; Nepal et al., 2018). In countries where payment discipline is lacking, sector financial challenges may also be amplified as debts are cascaded across the various unbundled segments of the ESI (Foster and Rana, 2020). Thus, given that third party access can be regulated or negotiated effectively, and transparency is not a sufficient condition for improved performance, the economic justification for vertical unbundling in small electricity systems tends to weaken especially when one considers the high transaction and economic costs involved. However, decisions to vertically unbundle are best made at the country-level based on a robust economic analysis that rightfully reflects the economic costs and benefits in each context.

Whether or not vertical unbundling is chosen, the predominant market structure that prevails in small electricity systems is the single buyer model. The single buyer model was first known to appear in developing countries in the 1990s following the initiation of reforms as Governments strived to relieve capacity shortages while conserving scarce public resources (Asantewaa et al., 2022). The liberalization of the sector allowed Independent Power Producers (IPPs) to generate electricity, which was then sold to sector utilities, often state-owned distribution companies in vertically unbundled electricity systems or the vertically integrated public corporation. These IPPs typically enter long-term Power Purchasing Agreement (PPAs) with an off-taker, which are typically utilities or the Government, to which they sell the power they generate.<sup>5</sup>

In the subsequent sections, we present the regulatory approaches used to incentivize cost efficiency in small electricity systems and the effectiveness of these mechanisms drawing on various case studies from SSA. As the largest cost components of electricity service delivery are generation and distribution costs (together accounting for about 90% of total electricity supply costs), these two segments are often the focus reforms and cost-reduction efforts and subsequently the focus of our discussion.

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<sup>5</sup> IPPs are not utilities but limited liability companies often privately-owned or publicly owned special purpose vehicles.

### 3. Generation Cost Efficiency in Liberalised Small Electricity Systems

In fully deregulated electricity systems, licensed generators produce electricity which they sell in a wholesale market to an offtake entity (often a distribution company) for onward resale to end-users through retail markets. It was posited that the establishment of competitive wholesale markets would incentivize cost control by shifting the risks of technology choices, construction costs and operational mismanagement from consumers to producers (Joskow, 1997, 1998a, 1998b; 2005, 2006, 2008; Jamasb et al., 2005, 2006; Philipps, 1971; Besant-Jones, 2006). Then retail competition will subsequently facilitate the transfer of these efficiency gains to consumers in the form of lower costs and or improved quality of service (Guasch, 2004; Demsetz, 1988; Bain, 1951, 2014; Armstrong et al., 1994). In such markets, prices are determined through auctions, where generators bid to supply the market demand. A generator offers a price at which they can supply a specific quantity of electricity, and if the bid is successful, it is said to “clear” the market. The cheapest generation resource will “clear” the market first, followed by the next cheapest option, and so forth until demand is met.<sup>6</sup> When supply fully matches demand, the market is “cleared,” and the price of the last successful bid resource (plus other market operation charges) becomes the wholesale price of power.

In small electricity systems where such markets do not exist, new generation capacity is often procured through contracts following a regulated planning process called Integrated Resource Planning (IRP). In this, utilities propose, and regulators consider long-term power generation needs based on the economics of different approaches, as well as operational and reliability trade-offs associated with different resource mixes. Based on these plans, new generation capacity is procured, ideally through a competitive process to force all potential generators to bid against one another publicly and transparently to reduce energy prices (Eberhard and Shkaratan, 2012). Once the winning bid is selected through this procurement process, a PPA is signed between the generator (IPP) and the offtake entity.

PPAs have a two-part pricing, a capacity charge, and a volume charge. Capacity charges ensure that investors recover the full capital costs of their investments and a return on the invested capital. It can be conceptualised as the amortised capex of a generation plant, i.e., the cost of constructing the power plant (including financial costs), a return on the investment, and the

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<sup>6</sup> This process is called economic dispatching, which ensures the successive dispatch of the generation source with the lowest "marginal" or operational costs to the point where all load is met or the generation source hits its capacity constraint, whichever comes first.

costs of maintaining the power plant to ensure its availability when needed. On the other hand, volume charges cover the operating costs of running a power plant and subsequently incurred only when the plant runs. Thus, in theory, while a capacity charge is incurred by virtue of capex sunk, volume charges are directly related to kilowatt hours produced. As PPAs are legally binding contracts, the opportunities for cost reduction are prior to contracting and often achieved through some policy and regulatory provisions.

Regulators are not party to the commercial relationship between generators and offtake utilities. However, they can influence these contracts through the pre-specification of cost criteria that would be considered in the rate setting. This may include guidelines about planning, procurement, and in some cases contract terms, which an off-taker must consider in its power purchases if it expects to fully recover its costs through tariffs.

However, in SSA, enforcing regulatory standards have proven to be challenging. System planning is weak, with new generation capacity often procured under extreme pressure. Many electricity systems do not have an up-to-date least-cost plans, and the few that do, they are not linked to procurement. Modelling inaccuracies are also common in these plans, especially pertaining to demand projections which often deviate significantly from actual demand in magnitude and in timing (Eberhard et al., 2016). This is largely because system planning is a technical exercise that require high technical capacity, something that is lacking in many small electricity systems in SSA, especially in countries affected by fragility, conflict, and violence (Nepal and Jamasb, 2012). Thus, it is not uncommon to have shortages kick in before new capacity is constructed. This has led to an increased popularity of mobile power plants (often called Emergency Power Plants - EPPs) in the region. In West Africa alone, all countries (except for Liberia, Togo, and Niger) have had some experience with EPPs in the last ten years, with EPPs accounting for an estimated 1527 MW of generation capacity (17% of total net installed generation capacity) as at the end of 2019.

In addition, most new generation capacity in the region continues to be sourced directly despite extensive evidence that competitive procurement of new generation capacity tends to reduce the levelized cost of electricity generated by IPPs (Eberhard et al., 2017). This practice stems from initial engagements with IPPs during the earlier stages of reforms when SSA countries were indebted, and public utilities were insolvent (Eberhard et al., 2017). Earlier IPPs benefited from generous PPA terms in the forms of high prices, and investment risk mitigation mechanisms such as guarantees and escrow accounts to mitigate credible risks to investments

in the region at the time (Gratwick and Eberhard, 2011). Despite considerable improvement in the financial position of SSA utilities and Governments over the years, these risk perceptions continue to persist, with the Rate of Return (RoR) on IPP investments often significantly above actual risks. The World Bank estimates that the costs of power procured through IPPs in the region may represent a 40% mark-up over corresponding economic costs.

IPP transactions are often associated with strong and entrenched vested interests due to their high-value nature. These are often shrouded in formal and informal local content requirements which legitimizes the allocation of project shares to political elites with the ability to influence regulators and compel regulated firms to consider their interests (Albalade et al., 2015). These special interests often dominate procurement processes, even when these are done competitively. This may be in the forms of unclear and restrictive tendering procedures, discriminatory release of information, strategic selection of award criteria and predatory clauses (Auriol et al., 2016; Iossa and Martimort, 2015). Thus, competitive procurement must be done in an open and transparent manner to attract high quality bids.

Contracting terms can also be anti-competitive. For instance, “take-or-pay” clauses or volume risk shifting conditions in PPA contracts mandates a minimum purchase commitment.<sup>7</sup> This is often useful for developers in accessing debt financing on limited recourse terms but implies a lock-in of a certain market share over the duration of the PPA (often between 10 to 30 years). This implies that small electricity systems cannot take advantage of newer and cheaper generation technologies even if the cost savings from a switch is higher than the capacity cost of existing vintage plants. The opportunity cost for switching will now include the “take-or-pay” costs, and these are often prohibitive. This makes it challenging for small systems to fully participate in regional electricity markets, especially if IPPs had not been procured under the value-for-money conditions discussed earlier.

The Africa Infrastructure Country Diagnostic estimated that about sixteen SSA countries (mostly small systems) would benefit from reduced electricity prices by importing more than 50% of their power. This is largely because, while many small and fragile states are struggling with severe energy constraints, their neighbours are endowed with abundant gas, hydropower and solar resources that often exceed their domestic demand needs. For example, Mano River countries have surplus hydropower in the wet season but suffer power shortages in the dry

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<sup>7</sup> In some electricity systems, “take-or-pay” quantities imply no need for capacity charges as the capex associated with the production of the agreed take-or-pay” quantities are often covered in the agreed payments.

season, while Sahelian countries have the potential to generate excess solar energy during the day but would face shortfalls in the night. Countries stand to make savings ranging from \$0.01 to \$0.07 per kilowatt-hour (kWh), with the largest beneficiaries being smaller electricity systems. Regional electricity trade could also facilitate emission reduction by creating larger balancing areas to facilitate the integration of variable renewable energy resources while displacing domestic thermal generation with renewable energy (Chattopadhyay and Fernando, 2011, Singh et al., 2018). However, without a concerted effort to address the contractual rigidities of national PPA contracts, the participation of small systems in regional markets will be limited. This will make small electricity systems slow to respond to technological progress and decarbonise their electricity sectors.

In principle, regulators should be able to enforce these value-for-money criteria to ensure that small systems achieve cost-efficiency in generation. In practice, however, this can be challenging to enforce given the pervasive relevance of the electricity sector in all other aspects of the economy and the high economic and socio-political costs of its poor performance. The sector is thus of national and political interest and an implicit liability in most countries.<sup>8</sup> Subsequently, the burden of regulatory insubordination often falls on consumers, directly or indirectly, especially if utilities are state-owned.

If the sector regulator disqualifies ineligible costs from tariffs, utilities seek external sources of financing such as short-term debt to cover this margin or accumulate payment arrears to subcontractors, i.e., generators, fuel suppliers, lenders, and other utilities. As both strategies are not sustainable, arrears and or debt often accumulate to financially unsustainable levels, and Governments are forced to intervene with various fiscal transfers and subsidies at the expense of other public services such as potable water, education, health, and social protection. These subsidies also interfere with consumption signalling, leading to higher consumption, pollution, and other externalities (Badiani et al., 2012; Monari, 2002; Rentschler and Bazilian, 2017; IMF, 2013a, 2014b).

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<sup>8</sup> Implicit liabilities represent moral obligations or burdens that, although not legally binding, are likely to be borne by governments because of public expectations or political pressures. *Contingent implicit liabilities* are not officially recognized until after a failure occurs. The triggering event, the value at risk, and the amount of the government outlay that could eventually be required are all uncertain.



A noteworthy case that encapsulates this is that of the electricity sector of Ghana. Between 2013 to 2016, there was an extensive load shedding in the country (dubbed “dumsor”)<sup>9</sup> that triggered an immoderate procurement of new generation capacity over and above demand needs and at high prices. While the actual details of contracts remain unknown, available public information indicates that the GoG contracted three EPPs and the Electricity Company of Ghana (ECG) signed 15 thermal and 17 renewable energy PPAs through an uncompetitive procurement process. The result was costly excess thermal generation capacity of about 1.5 GW in 2020 and a corresponding capacity charge of about US\$300 million annually (Ackah et al., 2021).

The sector regulator, in a strict execution of its mandate disallowed the costs of this excess generation capacity (referred to as idle generation capacity) in the tariff determination. These stranded costs, as well as other inefficiencies in the sector,<sup>10</sup> led to a fast accumulation of sector arrears as ECG struggled to cover the full cost of their power purchases. At the end of 2019, it was estimated that the accumulated stock of power sector arrears (legacy arrears) was about US\$2.3 billion, with an annual revenue-cost margin of about US\$1.3 billion, about 1.8% of GDP and about half of the annual GoG budget spending on social infrastructures. Subsequently, the Government launched the Energy Sector Recovery Program (ESRP) to serve as a roadmap to restore and sustain the financial viability of the energy sector (Ackah et al., 2021).

As part of the ESRP, the GoG passed the Energy Sector Levy Act in 2015 and the Energy Sector Levies Amendment Act in 2021<sup>11</sup> to clear the legacy arrears and the annual sector

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<sup>9</sup> The load shedding was due to due to inadequate generation capacity, unavailability of fuel for existing power plants. Reduced hydrogeneration due to droughts, gas supply interruption from the West African Gas Pipeline (WAGP) and high prices of imported liquid fuels created the need to ration power in Ghana.

<sup>10</sup> In addition to poor investment decisions, the distribution companies (the ECG and Northern Electricity Distribution Company) in Ghana are also inefficient, with low collection rates, high losses, and weak governance. Distribution system energy losses averaged between 26% and 28.5% for the two distribution companies respectively, in 2020. Of the energy billed to the end-user, these distribution companies were only able to collect 70% of revenues, leading to further cashflow constraints. The COVID19 further impacted the power sector as the GoG announced a 3-month COVID subsidy to the power sector including a 50% subsidy for all and 100% subsidy for all lifeline consumers while ECG and NedCo announced a non-disconnection policy for non-paying customers until December 2020, resulting in an even lower collection rates during the period.

<sup>11</sup> The Parliament of Ghana passed the Energy Sector Levies Amendment Act, 2021 (Act 1064) to amend the Energy Sector Levies Act, 2015 (Act 899). The new amendment imposes an Energy Sector Recovery Levy of 20 pesewas per litre on Petrol and Diesel and 18 pesewas per kilogram on Liquefied Petroleum Gas, and a Sanitation and Pollution Levy of 10 pesewas per litre on Petrol and Diesel to help pay the capacity charges in the energy sector as well as the fuel used by power plants to generate energy.

shortfall respectively. It also earmarked about 1% of GDP (around \$700 million) from the budget annually to support the programme until the sector is back in equilibrium. This was in addition to utilising about US\$1 billion from bond issuance in 2020 (Eurobond) to rationalize the costs of the expensive PPAs to lower IPP capacity charges. Since the launch of the ESRP, the GoG has been making annual fiscal transfers of over a billion dollars to the sector (Ministry of Finance, 2020).

#### **4. Distribution Cost Efficiency in Liberalised Small Systems**

As mentioned earlier, the distribution segment accounts for about 25-30% of the cost of electricity supply on average. Distribution inefficiencies are often in the forms of poor operational performance and inadequate investments which lead to high technical and commercial losses, low collection rates and poor service quality. In fully deregulated sectors, distribution efficiency is typically incentivised through Private Sector Participation (PSP) and incentive regulation.

PSP experience in SSA has been limited over the years, with countries experimenting with various models thought to be best suited for various sector challenges. The longest lasting PSP arrangements in SSA till date have been in Nigeria, Gabon, Cote d'Ivoire, Kenya and Uganda. Generally, PSP in SSA involve contracts of whole utilities (distribution utilities or vertically integrated utilities) through concessions, Management Service Contracts (MSCs) or affermage contracts, among others, with the goal of improving operational and commercial performance such as reducing energy losses (Aggregate Technical, Commercial and Collection losses – ATCC losses), improving corporate governance and in some isolated instances reducing prices and service quality. In most cases, the responsibility of power purchasing is left to the Government or utility.

A PSP success story in SSA is the Société d'Énergie et d'Eau du Gabon SEEG<sup>12</sup> concession in 1997, one of the earliest PSP experiences in SSA. Despite SEEG being one of the better performing utilities in the region, the Government believed there was further scope for efficiency improvements. The concession was heavily focused on operational performance, i.e., improving collections (especially of public sector bills which had reached about US\$100

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<sup>12</sup> SEEG was a multisectoral utility which supplied both electricity and water.

million) and reducing technical and commercial losses estimated at 17% at the time (World Bank, 1998). The concession had a strong political ownership, as evident in two key steps taken by the Government prior to the agreement, i.e., increasing electricity tariffs to cost reflective levels, and reducing the staff numbers at SEEG. Once this housekeeping had been completed, a competitive procurement for a 20-year concessionaire was launched aimed at improving service quality, expanding coverage at affordable rates, and ending the fiscal burden of the sector on Government (World Bank, 1998). However, the selection of the Concessionaire was based on a single bidding criterion, i.e., proposed percentage reduction in tariffs.

A consortium comprising the French Compagnie Générale des Eaux (currently Veolia AMI, France) and the Electricity Supply Board International (ESBI) of Ireland was selected, with a winning proposal of 17.5% reduction in tariffs. The Concessionaire had to invest a minimum of \$135 million in rehabilitation (60% in water). It also informally committed to investing another \$130 million in the sector over the concession period to increase network density and expand service. The Concession consortium also acquired 51% of SEEG and made an Initial Public Offering (IPO) for the remaining 44% of the company's shares in addition to an exclusive offer of 5% to SEEG employees.

Within five years of the concession contract, more Gabonese gained access to electricity at no cost to the government and customer satisfaction with service delivery increased (World Bank, 1998). Financial performance of SEEG also improved, with dividends rising from the contractually guaranteed 6.5% of the share price in the first year of operations to 20% in 2000. Five years into the concession, 80% of the contractually required investments had already been made. The Government also began to pay its bills consistently after initial irregularities during the first two years of the contract.

The case of Gabon is evidently a reform success story in SSA with lessons for other small electricity systems. However, to place these lessons into better context, it is important to note that Gabon is one of the most affluent countries in SSA, an energy-rich upper middle-income country with abundant petroleum and renewable energy resources including hydropower. This made it easy for the Government to retain the responsibility of ensuring adequate generation capacity at low prices and implement pertinent but politically challenging reform steps such as

increasing tariffs and reducing the overemployment of SEEG.<sup>13</sup> Another important observation in the Gabon concession is the large investments in the networks secured in the contract. Generally, improvements in network efficiency and operational performance require major investments in network reinforcement and revenue protection programs. Without such investments, it can be challenging for most PSP models to achieve desired operational outcomes beyond improvements in revenue collection. Subsequently, PSP models like MSCs which does not include obligations to make capital investments are generally ineffective in reducing technical and commercial losses although they can be useful in improving collections. However, as collection losses are often presented as part of energy losses, improvements in collection can create an impression of an improvement in energy losses.

A case-study that illustrates this is the Liberian electricity sector. Liberia is a small country in West Africa affected by fragility, conflict, and violence. By the end of the fourteen-year civil war in 2003, most of the Liberia's electricity sector infrastructures including the Mount Coffee hydropower Plant (the main generation source) and the transmission and distribution networks had been destroyed or looted. The Liberia Electricity Corporation (LEC), which was the vertically integrated national utility also ceased operation during the crisis, leaving the sector non-functioning. Following a peace treaty and a successful election in 2006, donor resources were mobilized to implement the Emergency Power Programs (2006-2012) which resulted in the installation of about 22MW of diesel generation, the reconstruction of some basic T&D infrastructures in parts of the capital (Monrovia), and the reestablishment of LEC operations to cater to the immediate needs of the country. The country has made modest progress since, with an installed generation capacity of 126 MW following the rehabilitation of the 88 MW Mount Coffee hydropower plant. However, investments in the network have lagged generation, making the current network capacity incapable of supporting access expansion to the 93% of the population without grid access.

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<sup>13</sup> However, it is noteworthy that in 2018, SEEG's concession was terminated on allegations of deteriorated quality of service and complaints from consumers. As noted by the Gabonese minister of energy, "In the interest of preserving continuity and quality in the public provision of drinking water and electric energy, the Gabonese state has proceeded exceptionally to the temporary requisition of the company," Veolia had been accused of expropriating profits to shareholders in France at the expense of the necessary investments in the sector leading to a surge in energy losses from 12% in 2012 to 22.6% in 2018. They were accused of environmental breaches with respect to the delivery of their services. The termination of the contract made international headlines given the way the requisition of assets was done, described by Veolia as "brute force".

The Government of Liberia initiated reforms with the objective of increasing access to affordable, reliable, and sustainable energy in the country. It has since enacted an electricity law and established a sector regulator which became operational in 2020. LEC has, however, been under a Management Service Contract since the end of the war because the civil war did not only destroy physical assets but also the human resources of the country.<sup>14</sup> These MSCs have nonetheless faced major challenges, with the current MSC struggling to address the high commercial losses in the sector. A major reason being that, since the rehabilitation of the Mount Coffee hydropower plant, demand for electricity connections increased sharply but LEC was unable to meet this new demand due to the constraints in the network and lack of funds. This resulted in a surge in illegal connections and subsequently in technical and commercial losses which reached a staggering 63% by the end of 2020 (of which 15% is technical) from about 35% in December 2017. The Millennium Challenge Corporation notes the presence of a thriving cartel responsible for both petty and grand electricity theft (Mathematica, 2020).<sup>15</sup>

The high system losses, small customer base, and the relatively high general and administrative expenses of LEC have left the utility in a precarious financial position despite the high electricity tariffs of US\$38.5/kWh and low generation costs from hydropower. With the high prices and the lack of revenue-protection mechanisms, existing customers including large consumers have begun to by-pass meters, initiating a vicious cycle of high prices and high losses putting LEC on the brink of financial collapse.

In the case of Liberia, the financial viability of the sector and by implication the prospects to reduce prices hinge on the ability to reduce commercial losses. This requires large investments in access expansion, network reinforcement and densification to regularize illegal connections. However due to a lack of effective business models for private investments in the networks, grid access expansion and network reinforcements projects are typically publicly financed in most SSA countries (Asantewaa et al., 2022; Jamasb and Marantes, 2011). Under such situations, the importance of a country's wealth becomes an important determinant of improved performance even if PSP is chosen as a management option as this determines the level of investments a government can make as well as the incentive to pilfer power.

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<sup>14</sup> There was a two-year period during which there was an interim local management team while arrangements were being made to procure another MSC.

<sup>15</sup> See Smith (2004) for a comparative analysis of electricity theft.

In cases where distribution utilities remain under state management and or ownership, debt financing is typically used for such network investments. However, access to debt financing is limited for several utilities of small systems and for those with access to such resources, the cost of capital can be very high given the poor financial position of several utilities. In most cases, equity injections by Governments (as the sole or majority shareholder of the utility) are used to finance these capital expenditures. Subsequently, the capital dependency of SSA utilities on Governments remains high despite the liberalisation of the sector.

An aspect of reforms that could be used to leverage private investments into the distribution and retail segments of SSA electricity systems is yardstick competition in distribution, which has interestingly not been pursued by several SSA electricity systems. Rather the focus has been on the ownership structure. Yardstick competition was the product of arguments that franchised monopolies (whether private or public) under cost-of service regulation have very little incentive to minimise costs especially as regulators are unlikely to know what the appropriate cost levels should be to justify any claims of inefficiency (Shleifer, 1985). Cost benchmarks or caps often used in PSP contracts in SSA for instance are static, with no clear economic rationale for how this standard was determined. Thus, an alternative regulatory form was necessary to incentivise cost control, prevent waste, and promote cost-reducing innovation.<sup>16</sup> Yardstick competition was subsequently proposed referring to the simultaneous regulation of homogenous firms with the rewards of a given firm dependent on its standing vis-à-vis a shadow firm, constructed from averaging the choices of other firms in the group (Shleifer, 1985). Firms in this virtual market are subsequently forced to compete with shadow firms as the regulator uses the cost of comparable firms to infer attainable cost levels (Shleifer, 1985).

Yardstick competition has been proven to not only be valid amongst homogenous firms facing identical demand conditions and price rules but also expected to outperform cost-of-service regulation even if heterogeneities are not accurately and completely accounted for (see Jamasb and Pollitt, 2001, 2003; Shleifer, 1985, 2020). What has not been discussed adequately is the viability of yardstick regulation in liberalised electricity systems without markets as incentive regulation in general and yardstick regulation in particular have generally been presented in the context of fully deregulated electricity sectors. The literature remains very simple and

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<sup>16</sup> Yardstick competition was originally used for a regulatory scheme in which private investor-owned firms are compared to public utilities.

unassertive on whether the rules of yardstick competition can be utilised and or modified to achieve a socially optimal allocation in alternative organizational structures such as vertically integrated sector structures. Mizuno and Okamura (1995) examined the effectiveness of yardstick competition under vertical structures in public utilities focusing on the relationship between its effectiveness and cost complementarities in the technologies of the constituent sectors of the industry. They concluded that yardstick rules can implement the first-best allocation if public-utility industries are vertically integrated. Thus, yardstick competition provides a superior regulatory alternative to cost-of-service regulation in small electricity systems in SSA as inefficiencies of a monopoly is not due to public or private ownership, but rather, due to lack of competition (Kuosmanen and Johnson, 2020). It also promises to be a more politically attractive reform as it does not require the transfer of sector assets to a single private operator, a move that often raises major security concerns in SSA countries.

In small electricity systems, discussions on the prospects of yardstick competition are avoided altogether with efforts to improve distribution and retail efficiency often focused on incentive regulation by arbitrarily set regulatory standards or contractual benchmarks for single PSP franchises. Arguably, this is a very limited use of incentive regulation especially as there is no practical hindrance to yardstick regulation in these contexts given the evidence a much lower MES in the distribution segment (Yatchew, 2000; Giles and Wyatt, 1993; Salvanes and Tjotta, 1998).<sup>17</sup> In fact, larger utilities have been found to exhibit constant or decreasing returns while utilities that deliver additional services (such as water and sewage) had lower costs, indicating the presence of economies of scope (Yatchew, 2000; Giles and Wyatt, 1993; Filippini, 1996, 1997).

There is thus a theoretical and empirical case for yardstick competition in liberalised small electricity systems, especially in SSA where benchmarks are often poorly designed and can incentivise regulatory games (Jamasp et al., 2003, 2004). It is important that regulators disallow inefficient cost choices by firms from influencing the price and transfer payment that a firm receives (Shleifer, 1985). Kuosmanen and Nguyen (2018) noted a spill over of the Averch-Johnson effect to the modern price cap and revenue cap regimes if the regulator defines the cap

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<sup>17</sup> Yatchew (2000) estimated that the MES in Ontario is achieved by utilities with about 20,000 customers with utilities which also participated in the delivery of other municipal services having costs that are 7 to 10% lower, suggesting the presence of economies of scope. Giles and Wyatt (1993) found output between 300-3500 GWh to be consistent with MES. Salvanes and Tjotta (1994) found the optimal size comprising utilities serving about 20,000 customers, independent of the level of GWh sold. Also see Salvanes and Tjotta (1998).

based on the observed capital input of the monopoly. In that case, a monopoly could increase the cap through its own investment decisions, creating an incentive to gold-plate. Thus, in several instances, these caps are at best superficial given the incentives and constraints faced by the regulated monopoly. Even if the regulator applies a stringent rate of return constraint to eliminate monopoly profit, the outcome will still fall short from the competitive market equilibrium. Kuosmanen and Johnson (2020) proposes conditional yardstick competition to address these issues of gold plating. This involves distinguishing between fixed and variable costs in the setting of benchmarking standards by treating capital as a fixed input, and local monopolies compete against the variable cost.

An important caveat for yardstick regulation to work is for the regulator to be committed to enforcing its regulatory prerogatives to the point of bankruptcy of inefficient and imprudent firms to effectively enforce cost reduction standards. Shleifer (1985) recognizes the risk of collusive manipulation by regulated firms as a potential limitation of yardstick competition. However, this can be effectively managed as the number of competing firms increase given the impracticality to coordinate and implement collusive agreements in high numbers and the private incentives to deviate from such an agreement (Shleifer, 1985). In addition, the regulator would be armed with a justifiable basis to mete out penalties for such collusive practices.

## **5. Conclusion and Policy Recommendations**

This study examined electricity sector reforms in the context of small electricity systems. We presented the key challenges that emerge in liberalized electricity systems without markets and its implications for costs. We assessed the various regulatory tools and privatization arrangements that replace competition and incentive regulation in liberalized small systems, and how these have impacted costs and electricity prices. The analysis offers five main policy considerations for reforming small electricity systems relating to sector structure, procurement of generation capacity, incentive regulation, regional integration, and information sharing.

**Sector Structure.** We recommend continuous vertical integration of small electricity systems especially as many common problems in these systems are not differential to unbundling. Indeed, unbundling of small systems can create new problems relating to system coordination and information asymmetry between sector actors. Transaction costs to unbundle can be high, as new infrastructures and institutions will be required to support and manage new sector



structures. While full vertical unbundling may not be necessary, accounting unbundling may be useful, especially if complemented by policy and regulatory actions that facilitate accountability and good corporate governance of utilities. Accounting unbundling can also help to identify and address inefficiencies in the sector. Such unbundling could include a clear delineation of boundaries between the Government in its various roles, as the representative of public sector interests, as the shareholder of the utility, or others, to avoid grey lines that breeds and nurtures inefficiencies.

**Procurement of New Generation Resources.** Focus should be placed on promoting value-for-money in the procurement of new generation capacity. While transparent competitive procurement based on an up-to-date Integrated Resource Planning can ensure this, full Government support is required to enforce these procurement standards. Government as majority shareholders of utilities in most small systems can require this. Also, while the generation segments of small systems may not be competitive, they can be contestable. This is especially the case with the emergence of new technologies in mobile power plants. Powerships for coastal countries and containerised solutions for landlocked countries are revolutionising how IPPs will be procured in the coming decades. With no sunk costs involved in their development, mobile power plants do not need and should not require long term take-or pay contracts or capacity payments. While their cost per kilowatt is high in several countries, these costs have been reducing significantly in recent years with new players such as Karpower. As more players come into the market, prices are expected to fall further. Small systems should thus seriously consider developing procurement frameworks for mobile power plants to garner all contestable opportunities for lower prices.

**Yardstick competition.** Yardstick regulation remains a viable regulatory tool in small electricity systems. For several SSA countries, this model of private sector participation could be more attractive than traditional privatisation models as it does not require a permanent transfer of assets to a single private company. This model will also facilitate regulation by providing multiple sources of information for benchmarking. It would be an effective way to increase investments in the distribution and retail segments, i.e., network extension and densification in low access areas, network reinforcement to reduce losses and revenue protection programs to reduce commercial losses. However, these models require investments in boundary metering, smart metering, and other ICT ancillary infrastructures for real time

information transmission to facilitate effective and credible competition which can be publicly financed or included in the design of such contracts.

**Regional Power Pools.** Regional power markets offer opportunities for small electricity systems to neutralise the scale limitations of their autarkic demand. However, full participation in these markets would require collective efforts at the regional level to remove the contractual rigidities of long-term “take-or-pay” contracts in the short and medium term. This could be achieved with contract for differences to cover price differences between the prices of PPA contracts and prevailing pool prices, financed by Governments of small systems as a transition strategy to facilitate a deeper participation in regional power markets.

**Information Sharing.** Small electricity systems can benefit from peer-to-peer knowledge and resource sharing and should consider forming a coalition to serve as a platform for such information exchanges. Such a platform could be used to share information on costs of service delivery, generation costs opportunities and distribution performance standards. Such a platform would be a transparent, authoritative, and institutional source of information in the design of procurement standards and regulatory benchmarks. Over time, this coalition could also consider investing in shared infrastructures such as mobile generation facilities to provide access to cheaper generation resources during periods of unanticipated shortages.

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