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Cost Recovery and Financial Viability of the Power Sector in Developing Countries

A Literature Review

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Abstract

The financial viability of the power sector is a prerequisite for attracting the investment needed to ensure reliable energy supply, meet universal access targets, and hasten the clean energy transition. Adequate pricing of electricity to allow for cost recovery is also important to minimize the power sector's negative macroeconomic, fiscal, environmental, and social impacts. This paper takes stock of the empirical and conceptual literature on the financial viability and cost recovery of the power sector in developing countries. Time-series data across countries are relatively scarce, but comparing the findings from 21 studies suggests that under-recovery of costs remains pervasive despite decades of efforts by governments and development institutions. Large electricity subsidies continue to burden governments, especially in the Middle East, South Asia, Central Asia, and Sub-Saharan Africa. Reviews by the World Bank and International Monetary Fund on outcomes of their own engagement also conclude that progress on cost recovery in supported countries has been limited. Although the aggregated view obscures fluctuation within individual countries over time, the available evidence suggests that countries progressing toward cost recovery may find themselves backsliding within a few years. As for understanding the circumstances under which progress can be made, a handful of studies point toward a correlation between sector reforms and cost recovery, although few of the studies address obvious endogeneity problems. To provide more solid guidance for future efforts to improve cost recovery, more research is needed on: (i) the determinants and enabling conditions of progress on cost recovery; (ii) tariff reform sequencing; and (iii) institutional arrangements, policies, and regulations that enable countries to sustain cost recovery once it is reached.

This paper is a product of the Energy and Extractives Global Practice Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at jhuenteler@worldbank.org.

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Cost Recovery and Financial Viability of the Power Sector in Developing Countries: A Literature Review[1]

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Abbreviations and Acronyms

AC	Average cost
AICD	Africa Infrastructure Country Diagnostic
CAPEX	Capital expenditures
CPI	Consumer price index
ECA	Europe and Central Asia
ESMAP	Energy Sector Management and Assistance Program
GDP	Gross domestic product
GHG	Greenhouse Gases
GST	General sales tax
IEA	International Energy Agency
IEG	Independent Evaluation Group
IMF	International Monetary Fund
LRMC	Long-run marginal cost
MC	Marginal cost
OPEX	Operating expenditures
PSP	Private sector participation
QFD	Quasi-fiscal deficit
VAT	Value-added tax
WTP	Willingness to pay

1. Introduction

1. Financial viability of the power sector is a prerequisite for attracting the investment needed for universal access to affordable, reliable, and sustainable electricity and the transition towards clean energy (The World Bank and IEG, 2016, 2014a). However, chronic poor financial performance of electricity utilities is pervasive in the developing world—resulting from underpricing, excessive losses, and bill collection failure—and has for decades been a main driver of investment shortfalls, power shortages, poor quality of supply. Electricity subsidies needed to keep utilities afloat have long-term macroeconomic, fiscal, social ramifications, as they limit the fiscal resources available for other public services, including clean water, education, health and social protection (Komives et al., 2007; Saavalainen and ten Berge, 2006; Sdralevich et al., 2014). Underpricing of electricity also increases levels of pollution and other environmental impacts (Badiani et al., 2012; IEA et al., 2010; Monari, 2002; Rentschler and Bazilian, 2016).

2. Making electricity services financially viable and recovering the cost of service have long been core objectives of power sector reform[2] in developing countries (The World Bank, 1993a, 1993b). Public utilities' limited ability to finance expansion of capacity to meet growing demand was a main argument for power sector reform in the developing world in the 1990s, and raising tariffs to cost recovery levels has therefore been a *sine qua non* of the 'standard menu' for power sector reform (ESMAP, 1999). In some cases, tariff reforms were part of a homegrown reform program to improve macro-economic and service conditions. In many other countries, raising tariffs was a condition for assistance by the donors and multilateral institutions to reduce the fiscal burden from the power sector (The World Bank, 1996; Williams and Ghanadan, 2006).

3. Almost four decades have passed since Chile began its power sector reform efforts in the 1980s and three since the reform agenda swept through much of the rest of the developing world in the 1990s. Cost recovery and financial viability remain core objectives for institutions such as the World Bank in the power sector.[3] However, overall reform outcomes have often fallen short of expectations and many countries have chosen to adopt hybrid reform models different from the standard prescription (Besant-Jones, 2006; Jamasb et al., 2015). A renewed debate among policy makers and in the literature is emerging on the validity of the 'standard menu' of the 1990s and the need for a new, more empirically grounded reform paradigm (Jamasb et al., 2015; Vagliasindi and Besant-Jones, 2013; Williams and Ghanadan, 2006). As in the 1980s and 1990s, the financial performance of the power sector remains at the heart of this debate.

4. In parallel, especially in recent years, more advanced electricity markets, including in the OECD, have seen a renaissance of subsidies to the power sector as governments aim to stimulate the diffusion of new renewable energy technologies. Zero-marginal cost renewables and distributed energy are

[2] Power sector reform is understood here as institutional and policy measures aimed at advancing power sector commercialization, restructuring, regulation, privatization, tariff rebalancing, and liberalization.
[3] For example, a recent review found that between 2000 and 2015, the World Bank included sector financial conditions in at least 41 project loans in 25 different countries (total volume US$5,193mn) as well as 49 development policy loans covering 25 different countries (US$10,680mn) (The World Bank and IEG, 2016).

challenging the textbook model of power market reforms (IEA, 2016a). The IEA estimates that subsidies to wind and solar in the power sector reached around US$120 billion in 2015 (IEA, 2016b). As utility-scale solar and wind power make inroads into power sectors outside the OECD, policy makers are grappling with questions relating to their impact on sector financial performance and their treatment in electricity pricing.

5. This paper aims to inform these debates in policy and academic circles.[4] To this end, the paper takes stock of the conceptual and empirical evidence on cost recovery and financial viability of the power sector in the developing world, synthesizes the literature's findings, explores how the focus of the literature has evolved over the past decades, and identifies what gaps remain and which hypotheses are emerging on the most important reform issues. Given the focus on technical aspects of cost recovery of electricity tariffs and the financial viability of utility services, the political economy of cost recovery and tariff reforms as well as broader aspects of tariff regulation, while important for cost recovery, are beyond the scope of this paper and have been addressed elsewhere.

6. The paper is organized as follows. After introducing the terminology and definitions used (Section 2), the paper provides an overview of the literature that addresses cost recovery and synthesizes key developments over time in Section 3. The following three sections elaborate in more detail on specific themes of the literature: Impacts of under-recovery of cost on sector and country performance (Section 4); empirical evidence on current trends of cost recovery in the developing world (Section 5); and lessons learned from reform experience (Section 6). Each of these four sections summarizes key findings and recommendations and the gaps in the literature that call for further research. The last section summarizes the main conclusions (Section 7).

[4] For a synthesis of the World Bank's policy guidance on energy subsidy reform, see also the *Energy Subsidy Assessment Framework* (https://www.esmap.org/node/3043).

2. What Do We Mean by Cost Recovery and Financial Viability?

7. The paper focuses on technical aspects of cost recovery of electricity tariffs, the financial viability of electric utility services, and the fiscal sustainability of subsidies for electric utility services. These three concepts are closely related and sometimes used interchangeably: one can easily image a scenario where underpricing of electricity leads to poor financial viability of a publicly owned utility, which is only restored through a government subsidy. But conceptually the terms are not identical. For the sake of clarity, the following paragraphs lay down how these concepts are defined and how they relate to each other.

8. 'Cost recovery' is understood as an attribute of electricity tariffs and is fulfilled when the average electricity tariff aligns with the average cost of service, usually measured as the ratio between tariffs and costs (often expressed as a percentage).[5] For this paper, if not otherwise specified, tariffs refer to average tariffs across all consumers and costs are defined as 'full cost of service', including capital and associated operating cost of generation, transmission and distribution, and including the cost of financing new investments to sustain the service over time. However, a range of definitions are in use in academic and policy circles and, as explored later in this review, the literature uses many different approximations and measures for both tariffs and costs in empirical studies.

9. 'Financial viability' is understood as an attribute of utility companies[6] and is fulfilled when tariff revenues together with other sources of income are adequate to cover the cost of service. Cost recovery of tariffs is obviously a main determinant, but financial viability also depends on the adequacy of cash inflows and outflows (taking into account collection losses and availability of adequate financing) as well as the sustainability of the company's balance sheet (most importantly, if the company's debt and dues are under control). Therefore, while the two mutually reinforce each other and the literature sometimes uses them interchangeably, a utility can be financially viable even if cost recovery is below 100 percent, for example if tariffs are set below cost recovery level but reliable fiscal transfers are made to compensate. Further, analyses of financial viability in the literature often do not differentiate between revenues from electricity sales and revenue not related to the sale of electricity (e.g., government transfers); take input cost at financial value (e.g., fuels, capital, land or labor at subsidized prices); and count SOEs' contribution to the government's revenues—e.g., in the form of taxes, duties, and, for SOEs and any mandatory allocations from profits—as costs. When discussing the financial viability in sectors with multiple utility

[5] Conceptually, cost recovery can be viewed from the perspective of the power utility/sector, fiscal perspective or overall economic perspective. In each case, the full costs would be defined differently, and which perspective is appropriate depends on the research question. Further, depending on the purpose, cost recovery may include "full costs" with any inefficiencies (including excess losses) the power company/sector have or cost recovery assuming efficient operation of the company/sector. The latter approach is ideally that taken by the regulators so as not to pass inefficiencies to consumers. Importantly, full cost recovery of tariffs for the sector does not necessarily mean that all individual parts of the supply chain (generation, transmission and distribution) recover their costs, depending on how tariffs are set for the different services. Furthermore, some studies in the literature approximate tariffs with revenues and cost with actual cost incurred by the utilities, bringing the concept of 'cost recovery' closer to the common understanding of 'financial viability'.

[6] Financial viability is also an attribute of investment projects and in fact early World Bank studies of financial viability in the power sector were primarily interested in the ability of individual investments to make adequate returns. However, this view has evolved (see Sections 3 and 4) and now the primary unit of analysis in the literature is the utility. This is reflected in the term's usage in this paper.

companies, the term can apply to each company separately or as an aggregate of all companies in the sector.

10. While financial viability is sometimes reported in binary terms, the reality – particularly in the developing world – is that there is a continuum of degrees of financial viability (Trimble et al., 2016).[7] While it is indisputable that a utility unable to recover operating expenditures (OPEX) is not financially viable, the ambiguity arises with capital expenditures (CAPEX), which can be measured in different ways. Utilities may differ according to whether they are only able to recover the debt financing costs associated with their existing capital expenditures or the full cost of capital associated with current and planned future capital expenditures (see Table 1).

Table 1: The 'Ladder' of financial viability

Level of Financial Viability	Comment
Level 1: Utility does not cover existing OPEX.	Financially unviable, loss-making utility.
Level 2: Utility covers at least existing OPEX.	Utility dependent on government for capital investments.
Level 3: Utility covers existing OPEX plus concessional financing costs on existing assets.	Utility dependent on access to concessional financing.
Level 4: Utility covers existing OPEX and full CAPEX for existing assets.	CAPEX based on new replacement value of assets.
Level 5: Utility covering efficient OPEX and full CAPEX on existing and future assets.	Future assets based on a least-cost expansion plan.
Level 6: Utility covers efficient OPEX and full CAPEX on existing and future assets plus environmental externalities.	Definition of financial viability that may be used in high-income economies.

Source: Trimble et al. (2016)

11. 'Electricity subsidies' are understood as an attribute of the sector or the economy. Electricity subsidies can be defined as deliberate government policy actions targeting electricity services that (i) reduce the net cost of electricity or fuels purchased; (ii) reduce the cost of electricity production or service delivery; or (iii) increase the revenues retained by the electricity producer or service provider (adapted from Kojima, 2017). This means that electricity can be subsidized irrespective of whether or not the utility itself incurs a visible cash shortfall, and irrespective of whether or not any visible cash waterfall is covered by fiscal transfers from the budget (as opposed to commercial borrowing, deferred depreciation, etc.). However, empirically, in the absence of good ways to quantify many forms of implicit and indirect subsidies, most estimates referred to in this literature review of electricity subsidies either apply relatively simple methodologies comparing the full cost of service to tariffs or revenues (expressed as absolute amount or percentage of GDP) or focus on direct budget transfers to utility companies.

[7] The first step along the ladder is to achieve cost recovery levels 2 or 3 to be able to maintain day-to-day operations. However, given the substantial investments required to meet demand and reach universal access by 2030, and the limited availability of concessional foreign financing, utilities should progress toward levels 4 and 5 in a reasonably short time frame (Kojima and Trimble, 2016).

12. 'Hidden cost' and 'quasi-fiscal deficit' are measures of implicit financial losses of the power sector. The quasi-fiscal deficit is measured as the difference between the revenues that would be collected by a utility applying cost recovery tariffs and achieving best practice levels of commercial and operational efficiency, and the revenues collected by the existing utility. In general, power utilities in most developing countries are state-owned and can be considered quasi-fiscal entities. Typically, these utilities display poor financial performance in part because they channel a variety of transfers to consumers through underpricing, uncollected bills and other inefficiencies (e.g., excessive network losses, including theft). However, the total cost of such transfers is not reflected in the public budget because a large portion is 'hidden cost', i.e., implicit or involuntary (e.g., theft). The resulting financial gap in the public utility has been called in the literature quasi-fiscal deficit, typically expressed as percentage of GDP, or hidden cost, expressed in absolute terms.[8] The quasi-fiscal deficit can usefully be disaggregated to clarify how much is attributable to underpricing, under-collection or excessive distribution losses.

[8] According to the most common definition, QFD is the difference between the actual revenue charged and collected at regulated electricity prices and the revenue required to fully cover prudently incurred operating costs of service provision and capital depreciation: QFD (as % of GDP) = Cost of Underpricing of Electricity + Cost of Nonpayment of Bills + Cost of Excessive Technical Losses (Alleyne et al., 2013).

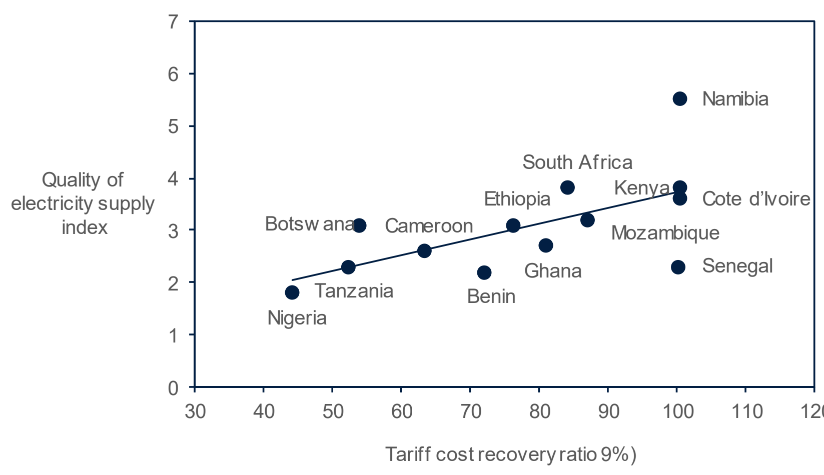
3. Why Do Cost Recovery and Financial Viability Matter?

13. Underpricing of electricity is popular with many governments and voters, because it has immediate and tangible impacts on end-consumers' disposable income. Reform experience across the globe demonstrates that, once introduced, underpricing is difficult for governments to remove. In a review of the World Bank's lending to the power sector, Covarrubias (1996) found that electricity tariff increases were the single most resisted conditionality linked to the institution's projects. In view of this limited popularity, much of the literature on cost recovery and financial viability has been devoted to establishing why these issues should matter to policy makers.

3.1. Impacts on Project and Sector Performance

14. The 'traditional' argument for cost-reflective electricity tariffs applied a relatively narrow definition of cost recovery and focused on the effects of underpricing on the financial viability of investment projects and utilities (Munasinghe, 1979; The World Bank, 1977). Conceptually, underpricing of electricity influences utility performance in three main ways. *First*, it limits the utility's ability to finance or attract investment to meet new demand and expand access. *Second*, it limits the utility's ability to maintain adequate O&M expenditures to extend the lifetime and increase performance of existing assets, eventually leading to poor quality of supply and non-compliance with service standards. *Third*, if not immediately covered by budget transfers or other forms of government support, underpricing can lead to the accumulation of short-term liabilities in the utilities' balance sheet, burdening it with escalating interest payments and other impacts, which will eventually require a government bailout (The World Bank and IEG, 2016). Historical examples of these impacts are provided in Box 1.

Figure 1: Tariff cost recovery and quality of electricity supply in Sub-Saharan Africa



Source: The World Bank /IEG (2016). Data are from WEF and Accenture (2012) and Briceño-Garmendia and Shkaratan (2011).
Note: Quality of electricity supply is a survey-based index that is part of the World Economic Forum's Energy Architecture Performance Index. The survey question used is "How would you assess the quality of the electricity in your country (lack of interruptions and lack of voltage fluctuations)?" The scale ranges from 1 = insufficient and suffers frequent interruptions to 7 = sufficient and reliable. Underlying data for the quality of electricity supply index are for 2012, and data for tariff cost recovery ratios are from the mid-2000s.

Box 1: Country experience on impacts of sustained lack of financial viability (The World Bank and IEG, 2016)

The **Dominican Republic** in the early 2000s, experienced a vicious cycle with poor financial viability leading to power blackouts that further undermined revenue collection and worsened financial viability. In 2002-2004, poor quality of service, permanent customer dissatisfaction and relatively high tariffs induced large-scale theft through illegal connections and nonpayment of bills by businesses and households. Cash collection fell to 48 percent of cost in 2004. As a result, generators were unable to pay for fuel purchases, leading to severe blackouts. From mid-2002 onwards, power cuts curtailed supplies by over 20 hours per day in large parts of the country, particularly in poor neighborhoods. In 2004, unmet electricity demand rose to 25 percent (The World Bank, 2005).

In **India**, despite considerable progress in other reform areas, including open access regulation and liberalization of generation, power sector finances have deteriorated sharply in the past decade. In conjunction with other factors, the poor financial situation brought the electricity sector to the brink of a supply crisis, with massive grid failures in July 2012 interrupting electricity supply in the northern half of the country for two consecutive days. Most of the state electric utilities have been caught in the “death spiral” of revenue gaps and service shortfalls reinforcing each other. Sector-wide financial losses stood at US$25 billion in 2011 (1.3 percent of GDP), more than twice (in real terms) than in 2003, and total debt stood at US$77 billion in 2011 (5 percent of GDP). Because they lose money on every unit of electricity sold, utilities are unable to procure enough supply to meet demand. The peak electricity deficit by 2014 was as high as 10.5 percent and the amount of unserved energy was 7.5 percent and consumers generally receive only unreliable service with frequent supply interruptions (Pargal and Banerjee 2014).

In **Bangladesh**, the electricity sector’s financial performance deteriorated significantly after 2008, largely due to tariffs significantly below cost recovery levels. Net losses of the national electricity utility (Bangladesh Power Development Board/BPDB) increased from US$146 million (18 percent of operating revenue) in FY2008 to US$640 million (30 percent) by FY2013 – a 4.5-fold jump in a half decade. Amid worsening sector finances, the electricity deficit (peak demand minus maximum generation) widened from 1,439 MW in FY2008 to 1,949 MW in FY2013. In 2012, load shedding was equivalent to 12 percent of total installed generation capacity despite the extremely rapid growth in expensive short-term rental generation capacity (The World Bank and IEG, 2014b).

In **Senegal**, a direct linkage could be observed in the 2000s between the electricity sector’s deepening financial crisis and rapidly growing electricity shortages in terms of undelivered energy. In tandem with the 14-fold increase in SENELEC’s financial losses between 2004 and 2010, the undelivered energy jumped 12.5-fold during the same period. The increasingly severe energy shortages were the result of delays in needed generation investments, poor operational efficiency and fuel supply difficulties faced by generators primarily as a result of SENELEC’s downward financial spiral (The World Bank and IEG, 2013a, 2013b).

15. Empirical studies have since provided ample evidence that these concerns are justified. Cost recovery and financial viability indices have been shown to correlate with indices of quality of electricity supply (The World Bank and IEG 2016; see also Figure 1); generation costs (Bella et al., 2015); distribution losses (Bella et al., 2015); and low scores in the ease of doing business (Alleyne et al., 2013). When reviewing its programs to expand electricity access, the World Bank identified the financial viability of

power utilities as one of the key drivers of performance towards universal electricity access, as most countries that had successfully transitioned to the high/universal access category also ensured the financial viability of power companies through the adoption of rational electricity tariffs and well-designed subsidy policy (The World Bank and IEG, 2014a).

16. Qualitative country experience suggests that the effect of poor utility financials on technical performance can be material and cause 'death spirals' of declining operational performance, service quality and willingness to pay causing declining financial performance, and vice-versa (see Box 1).

3.2. Macroeconomic, Social and Environmental Impacts

17. Over the last two to three decades, the literature has widened its conceptual focus in terms of effects considered, and has established that – beyond its detrimental effects on sector performance and service quality – the practice of subsidizing power can also have severe macroeconomic, distributional and environmental impacts (summarized in Table 2).

18. *First*, the literature is collecting an ever-larger body of evidence that electricity subsidies are a drain on fiscal resources and can distort the economy (e.g., Coady et al. 2015; Devarajan et al. 2014). As many countries that underprice electricity also face high fiscal deficits, electricity subsidies are credited with crowding out public spending on health, education and investment and possibly threatening sustainability of public debt. Subsidies encourage overconsumption because underpricing incentivizes inefficient and excessive use, as evidenced by the negative correlation between electricity tariffs and electricity use per US$ of GDP (IEA, 1999). Further, Devarajan et al. (2014) argue that—by skewing economic activity away from more labor-intensive sectors towards resource-intensive sectors—electricity subsidies also contribute to unemployment.

19. *Second*, it has been established that in most cases studied, the allocation of electricity subsidies is heavily skewed towards the rich, who consume more electricity than the poor (Arze del Granado et al., 2012; Komives et al., 2009, 2007, 2005; Laderchi et al., 2013; Mayer et al., 2015). That means electricity subsidies are not only inefficient in supporting the poor, but they also impose a much heavier burden on the public finances than more targeted social protection tools (e.g., Sdralevich et al., 2014). The case is obvious in countries with low coverage rates of electricity access, where electricity subsidies by design exclude most of the poorest households. However, even in high-coverage countries electricity subsidies rarely achieve a neutral, let alone a progressive distribution of benefits (Komives et al., 2007). This is because, due to their higher consumption, the rich benefit disproportionally from price subsidies for electricity, and most electricity subsidy schemes are designed to exclude very few households from subsidies.

20. *Third,* the literature has provided evidence that—by incentivizing overconsumption—underpricing of electricity also increases levels of pollution and other environmental impacts, such as groundwater over-extraction and greenhouse gas (GHG) emissions (Badiani et al., 2012; IEA et al., 2010; Monari, 2002; Rentschler and Bazilian, 2016). Underpricing removes incentives for investing in energy efficiency and renewable energy (Rentschler and Bazilian, 2016), which is why the IEA (2016a) identifies removing electricity subsidies as a key measure to mitigate climate change.

21. Because the macroeconomic, social and environmental impacts of electricity subsidies closely overlap with those relating to subsidies for petroleum and natural gas, the study of the fiscal, social and environmental impacts of electricity subsidies is increasingly merging with the broader literature on 'fossil fuel subsidies' or 'energy subsidies' (e.g., Kojima 2016), and electricity subsidies have become a central subject of debate in the global advocacy on climate change (e.g., IEA et al. 2010, 2011).

Table 2: Impacts of underpricing of power discussed and explored in the literature

Class of impact	Impacts attributed to underpricing of power (with sample references)
Sector performance	• Deteriorated quality of electricity supply (The World Bank and IEG, 2016) • Higher generation costs (Bella et al., 2015) • Higher distribution losses (Bella et al., 2015) • More cumbersome access to electricity for businesses (Alleyne et al., 2013) • More difficulties expanding energy access (The World Bank and IEG, 2014a)
Macroeconomic	• Higher electricity consumption per GDP (IEA, 1999) • Higher fiscal deficits (Ahmed et al., 2013) • Slower growth (Devarajan et al., 2014) • Higher unemployment (Devarajan et al., 2014)
Social	• Higher fiscal deficits (Araar and Verme, 2016) • The rich benefit disproportionally (Sdralevich et al., 2014)
Environmental	• Over-extraction of groundwater (Badiani et al., 2012; Monari, 2002) • Limited uptake of renewable energy (Bridl et al., 2014) • Higher pollutant emissions (Rentschler and Bazilian, 2016) • Higher GHG emissions (IEA et al., 2010)

3.3. Gaps in the Literature

22. Two gaps are apparent in the literature on the impacts of electricity underpricing. First, relatively little attention has been paid to the dynamic interplay between pricing reforms and performance. How long does it take for reform benefits to materialize? Is raising tariffs more palatable to the population when they are explicitly linked to service quality improvements? How close to cost recovery does a utility have to get to avoid the vicious cycle of deteriorating performance? *Second*, what characterizes cases of power sectors that have performed well over time in terms of performance despite persistent under recovery of costs, and what can be learned from these cases?

4. How Has the Thinking on Cost Recovery and Financial Viability Evolved?

4.1. Paradigm Shifts in the Literature on Cost Recovery and Financial Viability (1960s-2010s)

23. This section briefly reviews the normative literature on cost recovery and financial viability, and its evolution over time. The literature has gone through a sequence of paradigm shifts that can be explained in view of the development of the broader sector reform policy prescriptions, economic context and reform experience. The main findings are summarized in Table 2. The table summarizes, in a stylized manner, the evolution of the main normative positions of the literature on various aspects relating to cost recovery and financial viability, ranging from the main objectives of tariff reform to views on aggregate electricity subsidies, cross-subsidies and connection subsidies.

24. The literature up until the 1980s adopted a largely technical perspective on the issue and was primarily motivated by the need to make projects viable and expand supply to meet growing demand, but did not explicitly take into account social equity considerations. It started to look in earnest at the pricing of utility services in the 1970s, at a time when the World Bank and borrower institutions were building technical capacity to work on the economics of public sector projects.[9] What emerged during the 1970s was a prescription to follow a two-step process. *First*, to determine the long-run marginal cost of supply (LRMC) that would need to be covered to expand the system, taking into account shadow prices for inputs such as fuels, labor and capital. *Second*, to adjust these for "non-efficiency" objectives, including cross-subsidies to account for affordability limitations, fiscal transfers and subsidies to promote the expansion of access (DeAnne and Alicbusan, 1989; Munasinghe, 1979; The World Bank, 1977). However, although many conducted LRMC studies, few countries adopted the concept in their tariffs (The World Bank, 1990).[10]

25. In the 1990s, the literature grew increasingly normative—informed by the broader power sector reform policy prescriptions and drawing heavily on the academic literature on the economics of infrastructure and network industries—and adopted a skeptical stance towards any form of subsidies (with the sole exception of connection subsidies; ESMAP, 1999; The World Bank, 1993a, 1993b). Attracting private sector investment and expanding fiscal space replaced expansion and social equity as dominant objectives. LMRC was still accepted as an efficient pricing principle, but regulated competition was touted as the ultimate state of reform and the main mechanism to achieve efficiency (The World Bank, 1994). Much emphasis was put on corporatization and commercialization[11] of sector operations—with implicit

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[9] A critical World Bank report in 1972 had raised a number of issues relating to power sector regulation in borrower countries, but the Bank in an internal report "stressed, as an obstacle to progress, the shortage of qualified people in the Bank and in institutions to work on these problems" (The World Bank, 1975, p. 10).

[10] The results of a survey in 1990 suggested that electricity tariffs in 1987 were not based on the marginal costs of supplying electricity in nearly 80 percent of developing countries, even though the marginal costs had been studied in most countries. Over 60 percent of developing countries had no intention of basing tariffs on marginal costs in the near future (The World Bank, 1990).

[11] ESMAP (1999) described the process as follows: This first step in the reform process has two parts: (1) the removal of the utility from the direct control that results from being, a part of a ministry and (2) the creation of an independent legal corporation with the goal of behaving like a commercial company (maximizing profits, for example). This step makes it more likely that costs can be reduced, efficiency improved, and tariffs raised towards covering costs (if necessary) so that the company becomes more attractive to potential purchasers."(p. 8)

subsidies replaced by explicit fiscal transfers—as intermediate step towards achieving cost recovery and financial viability (e.g., The World Bank, 1993a).

26. Since the 2000s, the literature’s normative view on cost recovery has become increasingly pragmatic and context-dependent, in three main ways. *First*, in a pragmatic evolution reflecting near complete absence of take-up of LMRC-based pricing, the literature has become less assertive in prescribing pricing principles (Bacon and Besant-Jones, 2002; Besant-Jones, 2006; Williams and Ghanadan, 2006) and accepting of the clear prevalence of average cost-based cost-of-service (rate-of-return) regulation in the developing world (Kury, 2016). In Sub-Saharan Africa in particular, research suggests that the recovery of average *operating* costs is the driving principle behind power pricing (Eberhard et al., 2008). *Second*, cross subsidies, and even overall underpricing, while viewed with skepticism with regard to their distributional effects, are evaluated in comparison to available alternatives for social protection, and their removal is recommended only with careful preparation and adequate compensation (e.g., The World Bank, 2010). *Third*, increasingly, reform recommendations explicitly take into account the political economy of reforms, recognizing that political constraints may prevent immediate and full adoption of cost recovery principles.

27. Notably, the literature’s focus on corporatization and commercialization, very prominent in the 1990s as stepping stones towards cost recovery, has almost vanished in recent decades. This may be because cost recovery is increasingly treated as a reform stream in itself, rather than being inextricably linked to other reform steps as part of a broader ‘standard model’ of reform (see below). Subsidies for connections to promote access are notably the only type of subsidies that are consistently considered justified throughout the literature (Barnes and Foley, 2004; Barnes and Halpern, 2000; Crousillat et al., 2010; The World Bank, 1994).

Table 3: Stylized overview of paradigms in the literature on cost recovery and financial viability, and their evolution over time

<table>
<tr><th>Time</th><th>Theoretical perspectives in cost recovery analyses</th><th>Main arguments for tariff reform</th><th>Paradigm for pricing</th><th>Normative view on aggregate underpricing</th><th>Normative view on cross-subsidies</th><th>Normative view on connection subsidies</th><th>Selected literature</th></tr>
<tr><td>1950-60s</td><td rowspan="2">Economics of public sector projects</td><td rowspan="3">Project/sector performance;
Financing capacity expansion;
Social equity</td><td>AC plus reasonable rate of return</td><td rowspan="2">Accommodating for select consumer groups to meet distributional objectives</td><td rowspan="3">Skeptical, but pragmatic</td><td rowspan="6">Accommodating</td><td>The World Bank (1972)</td></tr>
<tr><td>1970s</td><td>AC as a stepping stone towards LRMC</td><td>Anderson and Turvey (1974); The World Bank (1975, 1977)</td></tr>
<tr><td>1980s</td><td rowspan="2">Economics of utility sectors & reform</td><td>LRMC adjusted for non-efficiency objectives</td><td>Skeptical, but pragmatic</td><td>Munasinghe (1979, 1980); Munasinghe et al. (1989); DeAnne and Alicbusan (1989); The World Bank (1983)</td></tr>
<tr><td>1990s</td><td>Attracting private investment;
Fiscal space</td><td>LRMC as stepping stone towards competitive pricing</td><td>Very skeptical</td><td>Very skeptical</td><td>Adamantiades et al. (1995); The World Bank (1993a, 1993b, 1994, 1996); ESMAP (1999)</td></tr>
<tr><td>2000s</td><td rowspan="2">Economics of utility sectors & reform;
Macroeconomics;
Political economy;
Environmental economics</td><td rowspan="2">Sector performance;
Fiscal space; Social equity;
Environmental benefits</td><td>Pragmatic, recognizing prevalence of AC</td><td rowspan="2">Skeptical, but pragmatic, with differentiated view on levels of financial viability recovery (‘ladder’ model)</td><td>Skeptical, but pragmatic</td><td>Bacon and Besant-Jones (2002); Besant-Jones (2006); Williams and Ghanadan (2006)</td></tr>
<tr><td>2010s</td><td>Pragmatic, recognizing prevalence of AC and need for incremental reforms</td><td>Skeptical, but pragmatic</td><td>Williams and Ghanadan (2006); The World Bank (2010, 2013a); Jamasb, Nepal, and Timilsina (Jamasb et al., 2015); Kojima and Trimble (2016)</td></tr>
</table>

4.2. Cost Recovery and Financial Viability in the 1990s' Power Sector Reform Paradigm

28. Cost recovery was and remains closely linked to broader normative conceptions about power sector reform since the debate emerged in the 1980s, for both OECD and non-OECD countries. However, the stylized reform paradigms in OECD and non-OECD countries differed in two important ways that explain broader differences in the literature on power sector reform between the two clusters of countries.

29. The first difference relates to the relationship between cost recovery and reform. Among OECD countries, reform momentum emerged in the 1980s and 1990s even though the electricity supply industry in most of these countries worked well technically under vertically integrated, largely state-owned structures. Reform was motivated by the perception of (excessively) high prices, attributable to the cost-plus incentives of public utility regulation, and took place in the context of low demand growth. Financing new capacity, if at all, was a secondary motive. By contrast, in most non-OECD countries (with the exception of transition economies), *excessively low prices* made it unaffordable for the public sector to finance power sector expansion to meet rapid demand growth (Kessides, 2012). A comprehensive review by the World Bank in 1990 found that the average tariff level in the late 1980s in developing countries was just over half the average level in OECD countries (The World Bank, 1990). The resulting underinvestment was the main driver for reform, and reforms aimed to bring prices to cost recovery level so as to attract the additional financing needed for sector expansion (Williams and Ghanadan, 2006). This explains why many empirical studies on the impacts of power sector reform on pricing in OECD countries measure reform success in terms of tariff reductions (e.g., Erdogdu, 2011; Nagayama, 2007), and yield findings that are not immediately applicable to most non-OECD country experiences, where cost recovery or technical performance would be a better measures of success.

30. The second difference is that, in contrast to the OECD, pricing reforms in the developing world relied much more on regulated prices (by the government or independent regulators). In the OECD, the paradigm can be viewed as "competition where possible, regulation where not;" regulation was seen as a last resort, appropriate only where competition was unlikely to be applicable (Besant-Jones, 2006; Littlechild, 2005). Consequently, there is relatively little focus on different options for regulated tariffs in the literature. In the developing world, the reform paradigm envisioned a much more central and permanent role for independent regulators in setting prices in view of limited energy access and realism about speed of and practical limitations to full liberalization. Hence, the relatively strong focus on different options for regulated tariffs, including tariff structures[12] and cross-subsidies, in the literature on developing countries.

[12] The term tariff structure is used here to describe the composition of end-consumer prices (e.g., one aggregate service tariff compared to separate tariffs for generation, transmission and distribution) as well as the differentiation of end-consumer tariffs by consumer groups (do tariffs differ between groups and by how much?).

4.3. Gaps in the Literature

31. In view of the historical connection between cost recovery and the broader power sector reform program, the normative literature has relatively little detailed prescriptions for the synchronization between levels of cost recovery and reform steps. What level of cost recovery is 'necessary' and 'sufficient' in different stages of power sector reforms? Is it a condition before embarking on other reforms (e.g. how much progress the country needs to make before embarking on liberalization or introducing private sector participation)? What level of financial viability is 'adequate'? Can reforms entail successful outcomes without cost recovery? These and related questions would need in-depth, longitudinal case studies, as well as quantitative studies using panel data, too few of which have been done in a systematic fashion.

5. Have Cost Recovery and Financial Viability Improved Over Time?

5.1. Cost Recovery Levels in Developing Countries

32. Considerable efforts have been directed at measuring cost recovery and financial viability in the power sector in the descriptive empirical literature. An overview of major empirical studies is presented in Table 4. Classifications of these major studies according to the data coverage (geographical and temporal scope) and the applied definition of cost recovery are presented in Table 5 and Table 6, respectively. Detailed results from most recent studies are reproduced in annex II.

33. Three major methodological trends can be observed in the descriptive empirical literature. *First*, while early studies relied either on financial statements or on comparisons between average unit revenues and estimates of LRMC (Munashinghe et al., 1989; The World Bank, 1990, 1972), the literature has developed an increasingly diverse set of methodologies to assess cost recovery and electricity subsidies (e.g., Briceño-Garmendia and Shkaratan, 2011b; Trimble et al., 2016; Vagliasindi and Besant-Jones, 2013), including methods that rely entirely on publicly available information (e.g., Coady et al., 2015). These approaches vary according to the scope[13] and level of cost recovery that is considered and their applicability depends on the nature of the policy question that is being addressed in any given analysis. Annex I presents a brief overview of the main empirical approaches (see also Kojima and Koplow 2015 for a review). *Second*, while early studies focused mainly on the adequacy of tariffs and revenues and their impact on the financial viability and fiscal burden of the power sector, newer studies also take into account the adequacy of costs when measuring so-called quasi-fiscal deficits (QFD) (e.g., Petri et al., 2002; Saavalainen and ten Berge, 2006; Trimble et al., 2016). Besides underpricing of electricity, QFD studies typically also take into account excessive losses, overstaffing and bill collection losses, allowing for more comprehensive discussions about solutions. *Third,* while early studies focused on cash cost and shadow prices for inputs, more recent studies also take into account externalities due to pollution or GHG (Coady et al., 2015).[14]

34. However, while much has changed in terms of empirical methodologies, relatively little progress appears to have been made on aggregate in terms of cost recovery in the power sector in developing countries since the late 1980s. Longitudinal data across countries are relatively scarce (see below for examples), but comparing the findings from 21 studies summarized in Table 4 over time suggests that under-recovery of costs remains pervasive despite decades of efforts by governments and development institutions.

35. Historical data suggest that power sectors in the developing world were financially relatively healthy in the 1950s, 1960s and 1970s (Munasinghe et al., 1989; The World Bank, 1972), before facing

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[13] Two approaches, 'price-gap' and QFD, were introduced to measure the implicit sector financial losses resulting from underpricing and a set of hidden costs such as under-collection, excessive grid losses and overstaffing. The main benefit of the price-gap technique is its relative simplicity. While it is more complex, the QFD method paints a more accurate picture on the underlying financial weakness of the power sector, including its main drivers. See annex I for more details.

[14] Notably, the more non-cash items are included in cost recovery analyses, the larger the potential differences between results for cost recovery and financial viability (which usually focus on items that appear in the utilities' financial statements).

difficulties from the 1980s onwards: Whereas in 1979 the average of tariff in developing countries was within half a US dollar cent per kilowatt-hour of the OECD average, by 1988 the gap had widened to almost US$ 0.04 per kilowatt-hour, and the developing country average had slipped to half the OECD average (The World Bank, 1990). In 1990, a major World Bank study of 60 developing countries found that by 1987, the weighted average level of tariffs in developing countries, at US$0.043/kWh in constant 1986 US$ terms, had fallen to only about 62 percent of the level required to cover the average incremental economic costs of the planned expansion of power systems during the 1990s. (Unweighted cost recovery levels were notably higher, at 92 percent.) The study concluded that 23 of 60 countries were recovering their LRMC (38 percent) and that conditions had deteriorated during the 1980s (The World Bank, 1990). Among the covered regions (Asia, developing Europe, Middle East & North Africa and Sub-Saharan Africa), Sub-Saharan Africa had the highest unweighted average cost recovery ratio (111 percent) and developing Europe the lowest (73 percent).

36. The situation appears to not have significantly improved since the late 1980s. The IEA (1999) studied China, the Russian Federation, India, Indonesia, the Islamic Republic of Iran, South Africa, the República Bolivariana de Venezuela and Kazakhstan in 1998 and found that the cost recovery ratio averaged 62.3 percent. Foster and Yepes (2006) studied 83 OECD and non-OECD countries worldwide in the period 1994-2002 and found that 15 percent of countries did not cover O&M costs while 59 percent did not cover total cost. Similar results have been found for India: Mayer, Banerjee, and Trimble (2015) found that, among 29 states, the average cost recovery was 68 percent in 2010 and 2 out of 29 states had effective tariffs above average cost. Recent global snapshots of energy subsidies (e.g., Coady et al., 2015; IEA, 2015) also suggest that electricity subsidies still represent a major fiscal burden, especially in the Middle East, South Asia, Central Asia and Africa. The results of a total of 21 relevant studies on the issue are summarized in Table 4.

37. Systematic reviews by the World Bank and the IMF of their own engagements also conclude that little progress has been made towards cost recovery and financial viability in supported power sectors. A recent World Bank/IEG study assessed the effectiveness of World Bank interventions during fiscal years 2000–15 in supporting client countries for improving the financial performance and long-term viability of their electricity sectors. The study concluded that sector outcomes from improved financial performance attributable to World Bank support were sustained in only few cases (including Brazil, Turkey, and Kazakhstan). The overall share of profitable utilities was found to have increased from 10 percent in 2000 to 35 percent in 2010, only to fall back to 25 percent in 2013, regarded as a “disappointing outcome”. A review by the IMF of its engagement in post-Soviet countries found that loan conditionality related to electricity sector subsidies “has yielded only limited progress in reducing the [sectors’] financial imbalances” (Saavalainen and ten Berge, 2006, p. 1).

38. Particularly concerning is the Sub-Saharan Africa region, where cost recovery remains elusive for many countries even as large investments are needed for universal electricity access and tariffs are already very high relative to household income in international comparison. Whereas in the 1980s the region had tariffs above long-run marginal cost and higher cost recovery levels than other regions, more recent studies paint a bleak picture. A major data collection effort completed in the mid-2000s for the Africa Infrastructure Country Diagnostic (AICD) Power Tariff Database (27 countries, 2004-2008)

suggested that less than a third of the sample countries had tariffs sufficient to recover the full cost of service, and that cost recovery levels had declined over the observation period. The study by Eberhard et al. (2008) using the AICD database to look at cost recovery in 21 Sub-Saharan African countries found that despite significant tariff increases over the period 2001-2005, cost recovery actually declined. Most recently, in 2016, a World Bank study of electric utilities in Sub-Saharan Africa found that only two of 39 utilities were recovering their full cost, and that the average cost recovery level of tariffs was 66 percent (Kojima and Trimble, 2016; Trimble et al., 2016). For the limited number of countries for which trend data were available, quasi-fiscal deficits improved or remained stable in several cases, and deteriorated in a few others. However, the stagnant trend appears not entirely driven by the inability to raise tariffs: Tariffs in Sub-Saharan Africa in particular are among the highest in the developing world but still not sufficient for cost recovery. For many countries in Sub-Saharan Africa, studies have identified huge cost savings potentials (Kojima and Trimble, 2016; Trimble et al., 2016), pointing towards the need to lower the cost of supply in order to come closer to cost recovery.

39. Further studies are summarized in Table 4. Overall, the data suggest that cost recovery declined in the 1980s from relatively sound levels and, since then, despite considerable reform efforts to break the vicious cycle of financial underperformance and poor service delivery (Kojima, 2016), the track record of improving cost recovery and financial viability of the power sector in developing countries is mixed at best.

40. However, the aggregated view obscures fluctuation within individual countries over time. Box 2 provides some detail on selected country experiences, with a focus on reasons for major changes in cost recovery over time. The World Bank/IEG study noted significant improvements followed by sharp reversals of financial performance in a number of developing countries including those to which the World Bank and other donors have provided considerable technical and financial support (The World Bank and IEG, 2016). Longitudinal case studies such as Vagliasindi and Besant-Jones (2013) show that countries that had reached important milestones of cost recovery and financial viability fell back into dependence on government support within a few years as tariffs did not track conditions outside the control of the utilities, such as droughts and the need to rely on expensive emergency power (in particular in SSA), inflation (e.g., India), exchange rate devaluations (e.g., Indonesia Argentina) or sudden changes in the availability of energy imports from neighboring countries (e.g., Botswana, Jordan).

41. As regards externalities, it has to be noted that while their measurement is gaining momentum, very little of these external effects have been internalized in the market price of electricity even in OECD countries. For example, a moderate carbon tax has been introduced to date only in a few countries.[15] A recent review by the IMF of global energy pricing practice also highlighted that consumption taxes for energy services, including electricity, are not taxed at levels comparable to other consumer goods (Coady et al., 2015).

5.2. Gaps in the Literature

[15] Among developing countries, only a few (India, South Africa and Costa Rica) have some form of limited carbon tax in place.

42. Two main gaps in the literature can be identified. *First*, while aggregate trends can be pieced together from the large number of studies on the subject, longitudinal or panel data on cost recovery of the type collected by The World Bank (1990) for the 1980s are still relatively scarce. The increasing standardization of methods to measure cost recovery levels, such as quasi-fiscal deficits and the price-gap approach, should make it easier for researchers to collect such data over time. *Second*, more explanatory research is needed on the enabling conditions for reform (e.g., is rate-of-return regulation generally yielding better cost recovery compared to "cost plus" or "price-cap" approaches? does differentiation of tariffs by consumer groups systematically affect overall cost-recovery levels? are cross-subsidies harmful to overall efforts to establish cost-recovery tariffs?). Such research would strongly benefit from better longitudinal or panel data on cost recovery, financial viability and electricity subsidies accompanied by qualitative information on tariff setting principles, tariff structures and the extent of cross-subsidies.

Table 4: Major studies of cost recovery and financial viability in the power sector in developing countries.

#	Study	Coverage	Time	Main KPIs	Main findings	Observed trends
1	The World Bank (1972)	Argentina, Brazil, Colombia, Ethiopia, Ghana, Malaysia, Mexico, Singapore	1955-1970	Rate of return on assets (based on utility financial statements)	All 10 analyzed utilities were profitable during the observation period, with return on assets mostly in the 8-9% range	Significant improvements in 1960s
2	Munasinghe, Gilling, and Mason (1989)	Recipient utilities of 123 World Bank power projects worldwide	1966-1984	Four financial ratios (based on utility financial statements)	Average rate of return for the period 1966-85 was 7.9	Distinct deterioration In the trend of utilities' financial ratios for the period 1973-1985
3	The World Bank (1990)	60 developing countries worldwide, comparison to OECD	1979-1988, with LRMC for 1990s	Comparison of existing tariffs to LMRC with shadow prices	Tariffs on (weighted) average sufficient to recover 62% of LRMC; average tariff level 55% of the average level in OECD countries	Real average tariffs constant in 1979-1983, then fell sharply until 1988
4	IEA (1999)	China, Russia, India, Indonesia, Iran, South Africa, Venezuela, Kazakhstan	1998	Price gap between tariffs and reference price (LRMC based on current fuel mix)	Cost recovery ratio ranged between 37% (Venezuela) and >100% (Indonesia); average: 62.3%	n.a.
5	Foster and Yepes (2006)	83 OECD and non-OECD countries worldwide	1994-2002	Average tariff compared to global benchmark values	15% of countries did not cover O&M costs, 59% did not cover total cost; strong correlation with income per capita	Slight real increase in tariffs in some regions but no significant trend across sample
6	Ebinger (2006)	20 countries in Eastern Europe and Central Asia	2000-2003	Disaggregated quasi-fiscal deficit: T&D Losses, collection losses, underpricing	QFD between 0.00% (Belarus) and 16.53% (Tajikistan) in 2003; mostly driven by underpricing (67%)	Decline in the QFD in 17 out of 20 countries between 2000 and 2003, by 48% (from $30B to $16B overall.
7	Saavalainen and ten Berge (2006)	8 countries in Eastern Europe and Central Asia	2002	Disaggregated quasi-fiscal deficit: T&D Losses, Collection losses, Underpricing	Cost recovery between 11.21% and 81.6%; QFD between 1.1% and 21.4% of GDP	n.a.
8	Eberhard et al. (2008)	21 Sub-Saharan African countries	2001–05	Average tariff revenues compared to average historical cost, LRMC	Despite comparatively high power prices only 57% of SSA countries recovered OPEXs; 36% recovered LRMC	Real tariffs almost doubled over the period 2001 to 2005, but cost recovery ratio declined

#	Study	Coverage	Time	Main KPIs	Main findings	Observed trends
9	Briceño-Garmendia et al. (2008)	20 Sub-Saharan African countries	2006	Disaggregated quasi-fiscal deficit: T&D Losses, Collection losses, Underpricing	6 out of 20 countries recovered average historic costs; hidden costs of power mispricing amount to about 1% of GDP or 60% of total hidden costs	n.a.
10	Briceño-Garmendia and Shkaratan (2011)	27 Sub-Saharan African countries	2004-08 (latest available)	Average effective tariff and LRMC compared to OPEX (income statements) and CAPEX (LCOE benchmarks)	80% countries recovered OPEX; 30% also recovered CAPEX; 38% recovered LRMC	n.a.
11	Vagliasindi and Besant-Jones (2013)	19 developing countries worldwide + 3 Indian states	Late 1990s to late 2000s	Cost recovery index (average revenue divided by average supply cost)	Cost recovery index correlated with indices of competition and vertical unbundling	Tariffs increased over the period, but cost recovery fluctuated. See Box 2 below for details
12	Alleyne et al. (2013)	Large sample of Sub-Saharan African countries (unspecified)	2005-2009 (latest year available)	Disaggregated quasi-fiscal deficit: T&D Losses, Collection losses, Underpricing	Average tariffs were of 70% of cost. QFD was about 1.7 percent of 2009; half of which from underpricing	Average QFD constant at 1.7% of GDP between 2005-06 and 2009-10
13	Mayer, Banerjee, and Trimble (2015)	Residential electricity use in 29 states in India	2005, 2010	Average effective tariff (based on household surveys)	87% of residential consumption was subsidized in 2010; average cost recovery was 68%; 2 out of 29 states had effective tariffs > average cost	In real terms, the net cost of the average household subsidy in 2010 was 70 times larger than in 2005
14	Khurana and Banerjee (2013)	29 states in India	2003-2011	Comparison of average billed tariff was higher than AC	Cost recovery averaged 82% in 2003-2011; 7 states had tariffs below cost in 2003, 14 in 2011	Cost recovery fluctuated within a band of 76–85%; with a low point in 2010
15	Bella et al. (2015)	32 countries in Latin America	2011-13 (average)	Price-gap approach Pre-tax subsidies (% of GDP)	Electricity subsidies in LAC were almost as large as direct fuel subsidies, on average 0.8% of GDP in 2011–13	n.a.
16	IEA (2015)	40 non-OECD countries worldwide	2012-2014	Price gap approach (based on average cost of production)	All but four countries subsidize electricity (excl. renewable energy subsidies)	Decline in total subsidies by 10.4% in 2012-2014, 5 additional countries reached cost recovery
17	Trimble et al. (2016)	39 countries in Sub-Saharan Africa	2011-2015	Disaggregated quasi-fiscal deficit: Collection losses; T&D losses; over staffing; underpricing	Average cash collected 57% was of cost. 2 countries have a financially viable electricity sector; 19 countries cover OPEX; QFD average 1.5% of GDP	Most of the countries with low QFDs improved over past decade, while most of the countries with high QFDs remained high

#	Study	Coverage	Time	Main KPIs	Main findings	Observed trends
18	The World Bank and IEG (2016)	Utiliites in 40 developing countries worldwide	2003-2013	Utilities' profitability (based on utility financial statements)	10 out of 40 utilities were profitable; 2 out of 17 SSA utilities were profitable in 2000, 4 in 2013	Share of profitable utilities increased from 10% to 35% in 2010, then fell to 25% in 2013
19	Coady et al. (2015)	153 OECD and non-OECD economies worldwide	2013, 2015	Price-gap approach (reference price including consumption taxes; excl. renewable energy subsidies	79 out of 119 developing countries had electricity subsidies in 2015, compared to 1 out of 34 'advanced economies' (Taiwan, China)	Absolute decline of subsidies by 36.5%; numbers of countries with subsidies from 75% to 66%

Table 5: Classification of studies according to their data coverage (geographical and temporal scope)

		Geographical scope	
		Single country	Multiple countries
Temporal scope	Snapshot(s)	**Subsidy/Tariff reform study** • Dube (2003) • Trimble et al. (2011) • Ahmed et al. (2013) • Mayer et al. (2015) • Lin and Li (2012) • Malik and Al-Zubeidi (2006) • McDonald and Pape (2002) • Walker et al(2014)	**Cross-sectional study** • Munasinghe and Warford (1982) • IEA (1999) • WEC (2001) • Briceño-Garmendia et al. (2008) • Briceño-Garmendia and Shkaratan (2011) • Alleyne et al. (2013) • Coady et al. (2015) • Trimble et al. (2016) • Bella et al. (2015) • Chattopadhyay and Jha (2014) • Laderchi et al. (2013) • Petri et al. (2002) • Saavalainen and ten Berge (2006)
	Time series	**Longitudinal case study** • Mangwengwende (2002) • Komives et al. (2009) • Khurana and Banerjee (2013)	**Panel-data study** • The World Bank (1972) • Munasinghe et al. (1989) • The World Bank (1990) • Ebinger (2006) • Foster and Yepes (2006) • Eberhard et al. (2008) • Ajodhia et al. (2012) • Vagliasindi and Besant-Jones (2013) • IEA (2015) • The World Bank and IEG (2016)

Table 6: Classification of studies by applied definition of cost recovery

		Cost accounting		
		Cash cost	Shadow prices	Shadow prices & externalities
Cost coverage	OPEX	• Briceño-Garmendia et al. (2008)	• Trimble et al. (2016)	n.a.
	OPEX + CAPEX	• The World Bank (1972) • Munasinghe et al. (1989) • Briceño-Garmendia et al. (2008) • Vagliasindi and Besant-Jones (2013) • The World Bank and IEG (2016)	• Ebinger (2006) • Foster and Yepes (2006) • Trimble et al. (2016)	• Coady et al. (2015)
	LRMC	n.a.	• The World Bank (1990) • Eberhard et al. (2008) • Briceño-Garmendia and Shkaratan (2011)	n.a.

Box 2: Country-level trends in cost recovery and key drivers of fluctuation (Vagliasindi and Besant-Jones 2013)

A World Bank study assessed cost recovery for a number of developing countries over time during the 2000s (Vagliasindi and Besant-Jones 2013). Cost recovery was defined as the ratio of average revenue yield divided by the average operating expenditure for all electricity distribution companies as a group in a given country.

In **Argentina**, the cost recovery ratio for the power sector as a whole dropped sharply from a strong 2.5 2000 to 1.0 times in 2002, and hovered slightly above 1.0 thereafter. A significant proportion of total operational costs was linked to the U.S. dollar under concession agreements. The sharp drop in cost recovery in the early 2000s reflects the large devaluation of the Argentinian peso and the freezing of retail tariffs during the 2000-2002 economic crisis, illustrating the risk to cost recovery stemming from exchange rate fluctuations.

In **Brazil**, the power sector cost recovery index hovered around a value of 1.6 from 1999 to 2002, but increased to between 2.3 and 2.5 from 2003 to 2005. The government had responded to a major drought in 2001-2002 with large increases in tariffs. When hydropower availability recovered, tariffs remained high while costs plummeted. These high levels of cost recovery made the Brazilian power market attractive to private investors in generation capacity, which surged from 2002 onward compared to the much slower growth in new capacity in the previous years.

In **Chile**, the privatized electricity distributors maintained a healthy margin of revenues over operating costs that varied between 1.2 and 1.4 up to 2004 under the regulatory approach to tariff setting. However, this margin declined to under 20 percent from 2005 because of the additional generation costs due to the increased use of liquid petroleum fuels for power generation, illustrating the impacts that changes in the fuel mix can have on cost recovery levels.

In **South Africa**, Eskom's operating cost recovery ratio declined steadily from 1.53 in 1998 to 1.33 in 2003, then increased to 1.53 in 2005, but has since declined to 1.09 in 2008. This long-term decline—despite a doubling in average revenue yield (in nominal price terms) over the same period—can be traced to heavy investments in extending access to power supply to customers whose business was largely unprofitable for Eskom.

In **Zambia**, inflation and insufficient adjustments of the historically low electricity tariff resulted in deteriorating financial performance of the national utility ZESCO, as shown by the drop in cost recovery from about 1.3 in 2003 to about 1.0 in 2006-2007. This left the company without sufficient financial resources for major expansion in access to electricity or system supply capacity.

6. What Are the Challenges to Achievement of Cost Recovery and Financial Viability?

43. As discussed above, the literature is relatively unanimous in considering financial viability of electricity service providers as fundamental for the sustainability of affordable services to consumers, including low-income households. The literature also largely agrees on the scale of the problem and the urgent need for reform. However, there are considerable differences in the proposed approaches to achieving financial viability, ranging from designing appropriate tariffs through regulatory pressure for financial discipline to privatization (Besant-Jones, 2006). This section reviews the literature's conclusions relating to reform implementation, focusing on pricing principles, tariff structure, barriers to reform, reform sequencing, sustaining cost recovery and financial viability, and potential influences of new renewable and distributed energy on reform considerations.

6.1. Basis for Determining Pricing

44. The literature recognizes average cost (AC) pricing based on "revenue requirements" (also referred to as cost-of-service regulation) as the dominant regulatory practice in developing countries without competitive markets (Eberhard et al., 2008; Kury, 2016) and no longer takes a normative view on different pricing principles. In addition to pragmatic reasons, in particular the apparent preference of governments and regulators for AC pricing (see also Section 4.1), this is due to practical drawbacks of the conceptually superior pricing principles. *First*, real LRMC of electricity are so complex to determine that few countries have actually attempted to use it as a basis for tariff regulation.[16] *Second*, energy utilities under short-term MC-based pricing have struggled to finance long-term system expansion (the 'missing money problem') (Joskow, 2008). This may limit the applicability of MC-based pricing in markets with rapid demand growth, as is the case in much of the developing world.

45. The core principle of cost-of-service regulation is that revenues earned should equal prudently incurred actual costs of the electricity service provided plus a fair return. To determine the average rate necessary to provide adequate revenues (the "revenue requirement"), regulators divide the required revenues by forecasted power sales. In other words, they work backwards, dividing the revenue they want to achieve by the quantity they expect to sell to get the average price the utility needs. They later allocate the revenues into customer charges and inclining or declining quantity schedules, and adjust prices up and down to various customer classes. Setting electricity price equal to the AC reflects a compromise

[16] The literature review has not found any developing country where actual electricity pricing is based on shadow pricing of the resource costs in an integrated resource planning (IRP) context. The reasons are not entirely clear but the lack of necessary data, time and skilled labor resources, particularly in less developed country context, may generally preclude the analysis of a full economy-wide model when electricity-related pricing decisions are made. Political and social considerations might have also played a role, considering that setting electricity tariffs at the economically efficient levels (using shadow pricing) might have triggered politically and macro-economically unacceptable hikes. Notably, LRMC may be higher than current average cost, but not necessarily. Eberhard et al (2008) noted the likelihood that the observed (in mid-2000s) average total cost in the SSA power sector is higher than the average incremental cost of producing new power in the future. This is because past power development in SSA has been done using mostly small-scale and inefficient generation technologies, which could be superseded as countries become able to trade power across national frontiers, thereby harnessing larger scale and more efficient forms of generation.

between a desire for allocative efficiency—setting price near to MC—and the need for the utility (or sector as a whole) to break even.

6.2. Design of Tariff Structure

46. While electricity subsidies through generalized underpricing are likely to be regressive, better targeting may be achieved through a careful design of the tariff structure. Most developing countries are using some form of cross-subsidization between consumer groups or tariff blocks, with the aim to promote desirable social goals such as helping disadvantaged customers and providing positive externalities (including those associated with universal access to service) (Kessides, 2004).

47. Increasing block tariffs (IBTs) remain the most common tariff structure globally. However, although use of IBTs as a cross-subsidy mechanism is often justified on social grounds, the evidence suggests that they are rarely much more effective at targeting resources to the poor than a straightforward, subsidized, linear volumetric tariff would be. In general, quantity-based subsidies such as IBTs tend to perform better in country situations where a higher percentage of poor households are connected to the utility network. The most fundamental reason explaining the poor subsidy performance is that the access rate of poor households is typically much lower than the access rate of non-poor households. Another reason is that various common features of tariff structures often preclude smaller consumers from benefiting from such subsidies. High fixed charges, if applied, mean that households that consume very small quantities may face a much higher unit price than larger consumers despite the use of an IBT tariff structure. For example, in India—where the vast majority of states use an IBT structure—87 percent of subsidy payments go to above-the-poverty-line households, instead of to the poor, and over half of subsidy payments are directed to the richest two-fifths of households (Mayer et al., 2015).[17] A further issue that has been identified is that poor households often share connections so that they are able to split high up front connection charges, but this in turn raises their overall consumption level preventing them from benefiting from increasing block tariffs. This situation is quite prevalent in Africa (Kojima and Trimble, 2016).

48. The literature suggests that targeting performance can be considerably improved if first blocks are kept relatively small, and increasing block tariffs are replaced with volume differentiated ones, whereby the concessional first block tariff only applies to those households whose entire consumption falls within the first block (Komives et al., 2005; The World Bank, 2010). Subsidized connection charges were generally found to be a reasonably effective approach to reaching the poor (Komives et al., 2005).

[17] A major driver of these outcomes is inappropriate tariff design, in particular generous first blocks that have little to do with subsistence consumption and are applied to all customers. Few states have targeted concessional tariffs to households below-the-poverty-line. In most states, all households are eligible for a subsidy on at least a portion of their monthly electricity consumption. And, of course, a quarter of India's households without electricity (comprising a relatively larger share of the poor) are unable to take advantage of tariff subsidies (Mayer, Banerjee and Trimble 2015).

6.3. Concerns About Impacts on Affordability and Inflation

49. Tariff increases are the most resisted conditionality associated with World Bank lending in the power sector (Covarrubias, 1996). Concerns of governments and the public often relate to affordability and inflationary effects, specifically the impact of tariff reforms on poverty. However, as laid out below, the literature does not provide evidence for widespread affordability constraints. Therefore, targeted measures to support the poor, including installing individual meters and subsidizing installation, encouraging prepaid metering so as to avoid disconnection and reconnection charges, reformulating lifeline blocks and rates as appropriate, and stamping out corruption to eliminate bribe-taking, are better suited than universal underpricing to address affordability concerns (Kojima et al., 2016).

50. Affordability of electricity is understood here as acceptable share of total household expenditures spent on electricity. Since there is no objective measure for judging whether a particular household is spending too much on, or consuming too little of, electricity service (Komives et al., 2005), the literature has developed a number of rules of thumb for affordability, based on evidence of actual household behavior. These rules of thumb used in the literature include (i) having enough income to pay for all energy needs no more than 5 percent of household income in tropical zones (where electricity, if available, is the main energy expenditure) and 10 percent in temperate zones (where electricity and heating expenditures are equally significant (e.g., Banerjee et al., 2008); and (ii) having enough income to pay no more than 5 percent for subsistence consumption. The definition of subsistence consumption is context-specific, but has sometimes been defined in the range of 30 kWh per month (Kojima et al., 2016; The World Bank/ESMAP/SREP, 2017) and 50 kWh per month (Briceño-Garmendia and Shkaratan, 2011a).

51. Surveys show that affordability varies across regions and countries. An empirical study of 27 countries in Sub-Saharan Africa analyzed household spending on electricity by quintile using data from the mid-2000s (Briceño-Garmendia and Shkaratan, 2011a). It found that the share of total household expenditure allocated to electricity was below 3 percent in most countries, and that the share was relatively stable across expenditure quintiles. The authors concluded that average effective tariffs were affordable for 87 percent of households that currently have access to electricity, and fully cost-reflective tariffs would have been affordable for 72 percent of this population.[18] Data collected by Kojima et al. (2016), shown in Table 7, also suggest that actual average household expenditure in most countries remains below the 5 percent threshold even for poor households with access to electricity (which on average spend 3.6 percent of household budgets on electricity), but the data suggest that affordability varies significantly between countries in Sub-Saharan Africa.

52. The generally positive picture on affordability notwithstanding, Briceño-Garmendia and Shkaratan (2011) do find that many poor households in Sub-Saharan Africa without access to electricity would have problems affording electricity at current rates, let alone the full cost of service. Kojima et al. (2016) find that in Sub-Saharan Africa affordability challenges are aggravated by (i) a lack of lifeline rates enabling the poor to use grid electricity in many countries; (ii) the sharing of meters by several

[18] The affordability threshold for subsistence level power consumption (50 kWh per month) was assumed to be 5 percent of the total household budget.

households—denying them access to lifeline rates where they exist; (iii) high connection costs in many countries; and (iv) demands from utility staff for bribes in some countries. As a result, they find that grid electricity even at the subsistence level is out of reach for the poor in half the studied countries and even more so once connection charges are considered. However, rather than through universal underpricing, such constraints are better addressed through policies and subsidies targeted at the poor.

Table 7: Share of total household expenditures spent on electricity (Kojima et al., 2016)

	All households			Poor			Household head	
Country	Urban	Rural	Total	Urban	Rural	Total	Female	Male
Angola	4.0	2.9	4.0	5.6	4.2	5.5	3.1	4.2
Botswana	6.2	7.6	6.5	9.5	11.1	9.8	6.8	6.2
Burkina Faso	4.6	4.1	4.5	6.2	3.3	5.2	4.6	4.5
Cote d'Ivoire	2.5	2.4	2.5	3.1	3.0	3.1	2.5	2.5
Ethiopia	2.8	1.3	2.2	4.6	2.4	3.7	2.8	2.0
Ghana	2.6	2.0	2.4	3.1	2.4	2.7	2.5	2.4
Madagascar	4.4	4.1	4.3	4.1	3.7	3.9	4.6	4.3
Malawi	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.3
Mali	2.9	1.4	2.2	2.4	1.2	1.4	2.6	2.2
Mozambique	3.7	4.0	3.7	6.1	7.5	6.4	4.2	3.6
Niger	3.4	2.4	3.2	2.8	1.9	2.2	3.6	3.1
Nigeria	2.6	2.3	2.5	3.1	2.7	2.9	2.8	2.4
Rwanda	1.4	1.6	1.5	2.3	3.3	2.9	1.6	1.4
São Tomé and Príncipe	2.0	1.9	2.0	2.3	2.1	2.2	1.9	2.1
Senegal	3.7	3.6	3.7	3.7	3.5	3.6	3.7	3.7
Sierra Leone	4.5	9.1	4.6	4.9	13.2	5.2	4.5	4.6
South Africa	5.3	5.2	5.3	7.3	6.0	6.6	5.5	5.1
Swaziland	9.5	9.1	9.3	13.9	10.9	11.9	9.7	9.0
Tanzania	3.0	3.3	3.1	1.9	5.8	3.1	3.4	2.9
Togo	3.1	3.1	3.1	3.6	3.3	3.5	3.1	3.1
Uganda	2.4	1.9	2.4	—	3.6	3.6	2.6	2.3
Zambia	5.4	6.3	5.5	8.3	5.4	7.8	5.7	5.4
Median	3.3	3.0	3.1	3.7	3.4	3.6	3.3	3.1

Source: World Bank staff calculations using household survey data.
Note: Only households with positive expenditures on electricity are analyzed. In Ghana, South Africa, Uganda, and Zambia, freely provided electricity is excluded.
— = No households with positive cash expenditures on electricity.

53. Regarding consumers' willingness to pay (WTP),[19] studies find that consumers are willing to pay *significantly more* than existing—typically below cost recovery—tariffs if they will be provided with improved electricity service; and WTP is positively correlated with income, implying that better-off families' show higher WTP than poorer ones. Box 3 summarizes the empirical evidence for WTP for selected countries.

[19] WTP is generally understood in the literature as the maximum price at which a household would still be willing to use the electricity service, and, as such, it provides a measure of affordability that avoids making possibly arbitrary value judgments about how much households should be spending on electricity.

Box 3: Empirical evidence for WTP for selected countries

In **Ghana,** where the quality of electricity service is poor, a recent study found that households are prepared to pay on the average about US$0.27 per kWh, or about 150 percent of tariffs at the time of the study. Since the mid-1990s, steps have been taken to progressively increase tariffs, but they are still well below cost recovery. The study therefore recommends that – based on strong WTP and positive income/WTP correlation – the government implement a more aggressive tariff adjustment schedule (Twerefou, 2014).

In **Tajikistan,** despite periodic increases, electricity tariffs remain among the lowest in the world, far below cost recovery levels. Power supply is highly unreliable with rampant blackouts, particularly during winter. The power sector has been in a permanent deep financial crisis, which resulted in a large quasi-fiscal deficit estimated recently at US$180 million or 2.2 percent of GDP. Subsidies resulting from below cost electricity are regressive and benefit industry and richer households more than the poorest groups. The weighted average estimated WTP by consumers is US$0.07 per kWh, about three times the average tariff in 2013. Based on this finding, in the interest of ensuring financial viability of the power sector, the main international donors advised the government to undertake a more aggressive tariff restructuring along with much-improved collection rates. The minimal objective is to ensure the national utility's ability to cover O&M expenses and debt servicing from its cash flow on a yearly basis (The World Bank, 2014).

In **Vietnam,** retail tariffs are about 20 percent below cost recovery and they are the lowest in the region (The World Bank and IEG, 2014c). Power shortages are a relatively regular occurrence; though reliability metrics are particularly poor in rural areas. Electricity prices are implicitly subsidized through subsidized coal. Surveys show high WTP for electricity service and especially for connections (The World Bank, 2011). At 1.8 percent in 2013, the share of electricity in the total household expenditure of the poor is low (The World Bank, 2013b). Given unreliable power supply, reliability is a bigger problem for foreign investors in the country than the prospect of higher tariffs, as demonstrated by a recent enterprise survey. These companies are prepared to accept higher tariffs as a key means of enhancing the currently inadequate functioning of the electricity sector (Garg et al., 2015).

In **India**, survey results show that electricity supplies are generally poor, and households consider good quality, uninterrupted service delivery a top priority. About 60 percent of the households who do not use electricity identify access to electricity as their most important need. A recent WTP survey in the state of Madhya Pradesh showed that households that use electricity are willing to pay nearly 20 percent more for improved electricity service. At 0.34, the survey also found a positive income elasticity of WTP, implying that a 1 percent rise in household income results in a 0.34 percent increase in WTP. The policy relevance of this result is that given strong economic and household income growth in the state, the WTP for electricity will significantly increase in the future, allowing a more rapid transition to cost recovery tariffs (Gunatilake et al., 2012).

54. Besides affordability, inflationary effects of tariff increases are an often-voiced concern, but the literature presents relatively little supporting empirical evidence. Cross-country experience suggests that the pass-through of electricity price increases to headline inflation is very small given the marginal weight

of electricity in the consumer price index (CPI), as shown below (Table 8). For example, if electricity tariffs were increased 10 percent, CPI will increase 0.04 percent in Kuwait and 0.3 percent in Peru and Mexico (IMF 2015).

Table 8: Marginal weight of electricity in the consumer price index (CPI)

Country	Year	Electricity % of CPI
Bahrain	2006	1.27
Kuwait	2009	0.35
Saudi Arabia	2010	1.59
Brazil	2006	4.08
Korea, Rep.	2010	2.05
Malaysia	2010	2.88
Mexico	2010	2.81
Kuwait	2007	0.35
Poland	2005	4.42
Peru	2009	2.95

55. Potentially more significant are the indirect effects, given that electricity is a key input into the production of most goods and services in the economy. These indirect effects can be gauged only with general equilibrium models. Recent work on the impact of energy price increases in the Middle East confirms that the indirect effects of electricity price increases on consumer welfare via general price increases are indeed higher than the direct effects, but overall inflationary effects are still modest (Verme, 2016). In the three countries for which indirect effects were estimated—Morocco, Tunisia and Jordan—indirect inflationary effects of electricity tariff reforms were 37-41 percent of total inflationary effects (see Table 9). That means, including indirect effects in estimates of the inflationary impacts of electricity tariff reforms increased these estimates by 59-69 percent. For diesel, including indirect effects increases estimates of inflationary effects of price reforms by 335-809 percent.

Table 9: Relative weight of indirect inflationary effects for different fuels, as indicated by the shares of indirect effects over total effects

Country	Morocco	Tunisia	Jordan
Electricity	37	41	41
Gasoline	88	51	14
Diesel	88	89	77
Liquefied petroleum gas	n.a.	14	n.a.

56. The reviewed literature suggests that for the majority of the population in many countries, the main political barrier to tariff reform is not affordability or inflationary concerns, but the political economy

of electricity subsidies (Inchauste and Victor, 2017; Kojima et al., 2014; Lee and Usman, 2017; Tongia, 2003; Victor and Heller, 2007). This strengthens the case for institutional reforms that depoliticize electricity pricing, such as the introduction of automatic pricing mechanisms (see section 6.5).[20]

6.4. Linkages to Structural Power Sector Reform

57. Rigorous explanatory research on the institutional determinants and prerequisites of cost recovery and financial viability is still limited. The few recent exceptions build on large databases, which provide panel data sets of sector outcomes and reform indicators. These studies provide evidence that sector reform is conducive to cost recovery and financial viability, as detailed below.

58. An empirical study (Vagliasindi and Besant-Jones, 2013) covering 19 developing countries and 3 Indian states found that cost-recovery was on average higher in systems with vertical unbundling, more competition in the distribution sector, an autonomous regulator[21] and a higher share of private sector participation. In a regression analysis using the average tariff as dependent variable, too, private sector participation and the introduction of an autonomous regulator were found to have a significantly positive impact, indicating a stronger commitment to make tariffs more cost reflective under these conditions.

59. An empirical study covering the power sector of a number of SSA countries for the mid-2000s found no measurable improvement from privatization in terms of cost recovery or transmission and distribution losses (Eberhard et al., 2008).

60. A more recent large-scale study (Andrés et al., 2013) of 250 private and state-owned utilities found that, in Latin America, private sector participation, the existence of a regulatory agency (especially immediately after its creation), and good regulatory governance (measured using a composite index) had a significantly positive effect on cost recovery (Andrés et al., 2013). The study also found that, on average, distribution utilities with private ownership outperformed public utilities, with clear improvements in labor productivity, distribution losses, the quality of service (frequency and duration of interruptions) and tariffs after the change of ownership.

61. While these studies provide valuable insights, only limited conclusions can be drawn about reform sequencing, as none of the reviewed studies addresses concerns about endogeneity and reverse causality. This means that—in those cases where significant effects were found—it is still unclear if cost recovery enabled reforms, or vice versa. More research into these issues is needed.

6.5. Sustaining Cost Recovery and Financial Viability

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[20] As noted above, a detailed review of the literature on the political economy of tariff reform is beyond the scope of this paper, but is dealt with in detail in a separate literature review produced under the same project by the World Bank's Energy & Extractives Global Practice (Lee and Usman, 2017).
[21] In the sample with autonomous regulator, the cost-recovery index is 115.6 vs. 76.3 for the countries with no autonomous regulator.

62. Large cost fluctuations are common in many power sectors, especially in those relying on tradable fuels such as oil. Exchange rates and general inflation may introduce further cost fluctuations outside the control of the sector. Countries with regulated tariffs have adopted different mechanisms to pass through the fuel cost variability to rate payers on a regular basis, including regular tariff reviews and some form of automatic adjustment, or a combination of the two.

63. Fuel cost pass-through mechanisms for electricity are adopted by a large number of OECD countries and subnational jurisdictions with some form of cost-plus or fixed-rate-of-return regulation for electric utilities, including in the United States, the Republic of Korea and Japan.[22] Fuel cost pass-through mechanisms come under different names, including “fuel surcharge”; “fuel and power purchase cost adjustment”; “fuel cost adjustment”, “fuel adjustment charges”; “fuel adjustment clause” or “power cost adjustment”. The different names notwithstanding, the mechanisms all share the same functionality: to pass through hard-to-control changes in power generation or purchasing cost—in order to mitigate financial risks for the utilities and to encourage price-responses in consumption—by adding one or more adjustable components to consumer electricity bills. These adjustments usually provide for price decreases as well as price increases. Notably, the fuel cost adjustment is a process that is completely separate from the normal tariff review (which often happens annually or quarterly), and the base tariff remains the same during the tariff period. Ideally, these adjustment mechanisms are limited to factors outside the control of the sector (see Table 10).

64. Remarkably, despite their widespread adoption, the academic literature has had relatively little so say about automatic tariff adjustment mechanisms in the last 30 years. A significant body of literature had emerged when they were first introduced in the United States in the 1970s and 1980s (Baron and De Bondt, 1981; Michaels, 1994), but since then no major conceptual or empirical review has been published.

Table 10: Factors within and outside sector control in automatic tariff adjustments

	Factors within control of sector	Factors outside control of sector
Main factors	• Transmission and distribution losses • CAPEX per unit of energy delivered • Dispatching and conversion efficiency	• Changes in fuel cost, including purchasing prices, taxes, fees, etc. • Inflation • Currency devaluation

[22] Examples of utilities with such adjustment charges include DEWA (UAE), the Tennessee Valley Authority (TVA), USA; Duke Energy, USA; TEPCO, Japan; KEPCO, Korea; EGAT, Thailand; LESCO, Pakistan; and many more.

6.6. Adaptation to New Renewables and Distributed Energy

65. There is evidence from OECD countries that technological change in the form of zero marginal cost renewables and distributed energy may require new market mechanisms or regulatory frameworks to sustain cost recovery and financial viability.

66. Two factors in particular merit further attention. *First*, especially in recent years, more advanced electricity markets, including in the OECD, have seen a renaissance of subsidies in the power sector as governments aim to stimulate the diffusion of new renewable energy technologies. The IEA estimates that subsidies to wind and solar in the power sector reached around US$120bn in 2015, driven up by the gap between relatively high (fixed) costs of supply and falling prices on the spot market as average marginal cost declines (IEA, 2016b). So far, few developing countries seem to face a similar situation, but this may change with growing procurement of renewable capacity under fixed-price power purchasing agreements. *Second*, the distributed nature of some new renewable energy technologies, especially solar PV, may require new tariff structures in countries with large cross-subsidies between consumer groups. Net metering policies in particular, which allow consumers to 'net out' surplus electricity production fed into the grid from their electricity bills, appear to pose a problem for the recovery of distribution investments (Eid et al., 2014), because large-scale penetration would limit the ability of distribution companies to recover fixed costs through volumetric charges, as is common practice today. New pricing models for distribution are being explored in OECD countries to address these issues, including higher fixed charges and time-of-use tariffs, but experiments are still at an early stage.

6.7. Gaps in the Literature

67. The pattern emerging from the reviewed literature is that, for the majority of the population in most countries, inflationary concerns and affordability are not the main political barriers to tariff reform. However, further research is needed in the following three areas to confirm this hypothesis. *First*, with regard to inflationary impacts of electricity tariff reforms, most findings in the literature are from *ex-ante* simulations, rather than actual ex-post reform evaluations. Especially in markets with poor institutions, actual pass through of energy prices to consumers may differ substantially from modeling results. *Second*, rigorous research on willingness-to-pay, too, is still relatively scant, especially in countries with low levels of access that are aiming to significantly expand connections. *Third*, in a related point, relatively little research has been done on the affordability of connection charges and appropriate government policies to overcome the tension between the affordability of connections and the financial viability of utilities.

68. The review highlighted that while we have a relatively deep understanding of the technical aspects of tariff design, we still do not know much about how these are linked to the broader determinants and prerequisites of cost recovery and financial viability, and the conditions under which cost recovery and financial viability can be sustained. Broadly, more explanatory research is needed on issues such as reform sequencing and the relationship between cost recovery and other power sector reforms, as well as the institutional, political, and technical mechanisms that have proven effective for sustaining cost recovery and financial viability once it is reached. The latter include the regulatory practice of automatic tariff adjustment mechanisms, which have been approved in many countries, but the implementation and

effectiveness of which has not yet been systematically explored. Lastly, we still know relatively little about how new renewable and distributed energy affect or may affect regulatory practice in developing countries.

7. Conclusions

69. Financial viability of the power sector is a prerequisite for attracting the investment needed to ensure reliable supply as well as achieve universal electricity access and the transition towards clean energy. Adequate pricing of electricity to allow for cost recovery is also important to minimize the power sector's negative macroeconomic, fiscal, environmental, and social impacts. To this end, the paper takes stock of the conceptual and empirical evidence on cost recovery and financial viability of the power sector in the developing world, synthesizes the literature's findings, explores how the focus of the literature has evolved over the past decades, and identifies what gaps remain and which hypotheses are emerging on the most important reform issues. The key conclusions and literature gaps emerging from the review are as follows.

70. *First*, while cost-reflective pricing of power was traditionally motivated by concerns about sector performance and the ability to finance expansion, over the last two to three decades the literature has established that the common practice of subsidizing power can also have severe macroeconomic, social and environmental impacts. Because these concerns closely overlap with those relating to subsidies for petroleum and natural gas, the study of the macroeconomic, social and environmental impacts of electricity subsidies is increasingly merging with the broader literature on energy subsidies, and electricity subsidies have become a central subject of debate in the global advocacy on climate change.

71. *Second,* despite the increasing awareness of the broad negative impacts of electricity subsidies, the limited evidence available suggests that the aggregate level of cost recovery and financial viability in developing countries has hardly improved between the late 1980s and the early 2010s. Large electricity subsidies remain ubiquitous; although their magnitude varies significantly across regions, being especially large in the Middle East, Central Asia, South Asia and Africa. This is true even if narrow measures of cost recovery and electricity subsidies based on utilities' financial break-even are used, leaving aside the accounting for shadow prices and externalities recommended by regulatory theory and reflected in more recent measurements of electricity subsidies. However, the stagnant trend appears not entirely driven by the inability to raise tariffs: Tariffs in Sub-Saharan Africa in particular are among the highest in the developing world but still not sufficient for cost recovery, pointing towards the need to lower the cost of supply.

72. *Third*, the aggregated view obscures fluctuation within individual countries over time. Longitudinal case studies show that some of the countries that had reached important milestones of cost recovery and financial viability fell back into dependence on government support within a few years as tariffs did not track conditions outside the control of the utilities, such as droughts and the need to rely on expensive emergency power (in particular in SSA), inflation (e.g., India), exchange rate devaluations (e.g., Indonesia Argentina) or sudden changes in the availability of energy imports from neighboring countries (e.g., Botswana, Jordan). The aggregate trends also mask considerable cross-subsidies between

consumer groups. Increasing-block tariffs are the most commonly used tariff structure. Prices in the highest blocks are, in many cases, significantly above the cost of supply, and in some countries the largest consumers pay more than consumers in most OECD countries (e.g., Jordan).

73. *Fourth*, the normative literature on cost recovery and financial viability has evolved over time—with mounting evidence of the political and implementation challenges to tariff reform—to become increasingly empirical and pragmatic. Arguments for tariff reform are increasingly made based on empirical evidence about the negative impacts of electricity subsidies, rather than based on economic theory. The political economy of reforms is explicitly taken into account in technical analyses and advisory. Cross-subsidies, if designed appropriately, are seen as part of the distribution (and political) equation.

74. *Fifth*, reflecting the increasingly pragmatic nature of the literature, the dominant paradigm of recommended pricing principles evolved from long-run marginal cost in the 1980s and competitive pricing in the 1990s to a more pragmatic view based on average cost-based price regulation in recent years. This is in line with the considerable evidence that shows that revenue adequacy has become the driving principle behind power pricing practices. Shadow prices and environmental externalities, although prescribed by theory to reach economic efficiency, rarely feature in tariff recommendations or regulatory practice; neither are consumption taxes at levels comparable to other consumer goods.

75. *Sixth,* the reviewed literature suggests that, for the majority of the population in most countries, inflationary concerns and affordability are not the main political barriers to tariff reform. Even though more ex-post analyses are needed on these issues (see Section 6.7), this strengthens the case for institutional reforms that depoliticize electricity pricing, such as the introduction of automatic pricing mechanism. However, the generally positive picture on affordability notwithstanding, the literature points out that many poor households in Sub-Saharan Africa without access to electricity would have problems affording electricity at current rates, let alone the full cost of service, and that affordability challenges are aggravated by (i) a lack of lifeline rates enabling the poor to use grid electricity in many countries; (ii) the sharing of meters by several households—denying them access to lifeline rates where they exist; (iii) high connection costs in many countries; and (iv) demands from utility staff for bribes in some countries. However, such constraints are better addressed through policies and subsidies targeted at the poor, rather than through universal underpricing that benefits all customers and has substantial financial impacts.

76. *Seventh*, the limited empirical literature on the impact of power sector reforms on utility finances finds correlations between independent regulators, vertical unbundling, competition, and private sector participation on the one side and tariffs and cost recovery on the other. However, the exact mechanisms that explain these relationships remain under-researched. Further, the literature has so far only insufficiently addressed endogeneity issues, which suggests that only limited conclusions can be drawn about the direction of causality.

77. *Eighth*, the recent diffusion of new renewable and distributed energy in power markets is posing new challenges for regulators and policy makers concerned with cost recovery and financial viability. The distributed nature of some new renewable energy technologies, especially distributed, on-grid solar PV,

means that large-scale penetration would limit the ability of distribution companies to recover fixed costs through volumetric charges, as is common practice today, because many consumers would rely on the grid only as a backup power source. Few developing countries appear to face these problems immediately, but any new policy prescriptions on cost recovery and financial viability reforms would have to address them in order to be appropriate in the long term.

78. The review highlights a number of important gaps in the literature that lend themselves to further research. Most importantly, rigorous explanatory research on the factors that facilitate progress on cost recovery, as well as the performance impacts of achieving financial viability is still limited. Such research is critical to inform reform programs and reform sequencing. In-depth, longitudinal studies of country experiences with tariff reforms and cost recovery and financial viability are also comparatively rare, and more are needed to be able to speak with greater confidence about the extent to which cost recovery has improved over time. Such qualitative research could answer some of the more complex questions on reform: Which tariff structures, regulatory practices or institutional set-ups are most conducive to achieving and sustaining cost recovery and financial viability? What are some of the institutional, political, and technical mechanisms that have proven effective in de-politicizing the tariff revisions? What are the pros and cons of various automatic tariff adjustment mechanisms, for instance, those where fuel costs are passed through to consumers or those linked to inflation? Lastly, further research is needed into the impact of new renewable and distributed energy on electricity pricing in developing countries.

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Annex I: Empirical Approaches to Evaluate Cost Recovery

Direct Measures of Utility Financial Performance

79. The simplest method for evaluating cost recovery is to rely on utilities' financial statements (e.g., Escay 1990; The World Bank and IEG 2016). This approach has the benefit that the data are often readily available, especially to a financier such as the World Bank. However, it also has obvious limitations, as it tends to ignore indirect subsidies and 'hidden cost' (e.g., in the form of subsidized fuel or labor); results cannot be easily compared across countries as many utilities rely on country-specific accounting standards; and issues such as cross-debts between public-sector entities and (explicit or implicit) government bailouts can obscure the view on the utilities' financial viability.

Price-Gap Approach

80. A common approach to measuring implicit sector subsidies (stemming in part from underpricing) is based on the price gap between the observed prices and a reference cost recovery price where costs are reasonably and prudently incurred, including a normal return to capital across the sector value chain (Clements et al., 2013). The reference prices are often estimated using the economic opportunity costs or shadow prices for inputs of the power sector (such as labor, capital and fuel) instead of purely financial costs to represent the true economic opportunity costs of those resources. The basic formula for calculating price gaps is straightforward):

Price gap = Reference Price—End-User Price

81. The price gap is often presumed to be the proxy for the aggregate distortionary impact of the existing set of policies on observed prices within a given country.

82. The primary benefit of the price-gap method is its relative simplicity compared with other implicit subsidy estimation methods. This simplicity is particularly important in countries that lack the capability or will to provide accurate information on electricity-related government policies. Also, the ability to quantify significant pricing distortions quickly across countries is important even if the results are not perfect. Establishing pricing benchmarks is, however, a challenge when evaluating a commodity like electricity for which there is no representative world price. Price-gap evaluations have generally used LRMC estimates as a proxy, assuming that the alternative supply would come via new construction rather than imports. However, pegging the cost of new capacity in advance is never easy for capital projects in the power sector in view of the number of assumptions involved about the future. Furthermore, price-gap measures are often seen as a lower band estimate of the implicit subsidies because they tend to underestimate the magnitude of the subsidy problem (Koplow, 2009).

Quasi-fiscal Deficit

83. In general, power utilities in most developing countries are state-owned and can be considered quasi-fiscal entities. Typically, these utilities display poor financial performance in part because they channel a variety of transfers to consumers through underpricing, uncollected bills and other inefficiencies (e.g., excessive network losses, including theft). However, the total cost of such transfers is not reflected

in the public budget because a large portion is implicit or involuntary (e.g., theft). The resulting financial gap in the public utility has been called in the literature quasi-fiscal deficit (QFD) or implicit financial loss. According to the most common definition, QFD is the difference between the actual revenue charged and collected at regulated electricity prices and the revenue required to fully cover prudently incurred operating costs of service provision and capital depreciation (Alleyne/Hussain 2013)[23]:

QFD = Cost of Underpricing of Electricity + Cost of Nonpayment of Bills + Cost of Excessive Line Losses

Measurement of Externalities

84. In the past two decades, more attention has been paid to the estimation and inclusion of the production externalities in the social (or external) cost of electricity. In the global literature, there is no disputing the propriety or desirability of including externalities, when it is feasible. When prices do not adequately reflect them (as usual), the monetary value assigned to the typically adverse effect (or damages) is not "visible" in the sense that government and other decision makers, such as electricity utility managers, may not recognize the full costs of their actions. When market failures like this occurs, there may be a case for government intervention in the form of regulations, taxes, fees, tradable permits or other instruments to motivate such recognition. Typically, environmental impacts are considered production externalities. Among the electricity production externalities, the most intricate challenge is the control of CO2 emissions (IPCC, 2014). The most immediate means to address the issue of the external costs of fossil fuel generation are through carbon taxes or emissions trading.

[23] In the literature, there are relatively minor variations of this generally accepted QFD formula. For example, Briceño-Garmendia et al. (2008) and Kojima and Trimble (2016) introduced overstaffing as an additional "hidden cost" item.

Annex II: Recent Data on Cost Recovery Levels in Developing Countries

Table 11: Financial Performance of the Leading Electricity Utilities in Selected Developing Countries

Region	Sample size	Of which Utilities that were profitable		
		2000	2010	2013
Sub-Saharan-Africa	17	2	6	4
East Asia and Pacific	6	0	3	3
Eastern Europe and Central Asia	5	0	2	1
South Asia	6	1	1	1
Latin America & Caribbean	5	1	2	1
Middle-East and North Africa	1	0	0	0
Total	40	4	14	10
Share of profitable utilities (%)		10%	35%	25%

Note: Where financial performance data were unavailable for the electricity sector as a whole, the national utility or equivalent was used as a proxy. In most cases, the after-tax net income was used as the indicator of financial performance.
Source: The World Bank /IEG (2016).

Table 12: India: State-level Cost-Recovery of Residential Tariffs in 2010.

State	Cost recovery level
Himachal Pradesh	< 25%
Tamil Nadu, Mizoram, Jharkhand, Kerala	25-50%
Bihar, Nagaland, Tripura, Andhra Pradesh. West Bengal, Delhi, Rajasthan, Haryana, Manipur	51-75%
Goa, Uttar Pradesh, Assam. Meghalaya, Karnataka, Madhya Pradesh, Gujarat, Orissa, Uttarakhand, Maharashtra, Chhattisgarh, Punjab, Sikkim	76-100%

Note: Average effective tariff is a household's total monthly electricity expenditure divided by its electricity consumption. The cost recovery index was obtained by dividing the average effective tariff by the average supply cost.
Source: Based on Mayer et al (2015) and The World Bank/IEG (2016).

Table 13: Cost Recovery ratios in Sub-Saharan African Countries in 2014 (constant 2014 US$ per kWh billed).

Country	Tariff	OPEX	CAPEX	Total cost	OPEX recovery	Total cost recovery
Benin	$0.22	$0.21	$0.06	$0.27	1.04	0.81
Botswana*	$0.07	$0.13	$0.09	$0.22	0.54	0.32
Burkina Faso	$0.23	$0.23	$0.12	$0.35	1.00	0.67
Burundi	$0.10	$0.09	$0.09	$0.18	1.11	0.56
Cameroon	$0.12	$0.11	$0.07	$0.18	1.09	0.67
Cabo Verde	$0.42	$0.39	$0.11	$0.50	1.08	0.84
Central African Republic	$0.12	$0.10	$0.08	$0.18	1.20	0.67
Comoros	$0.21	$0.48	$0.11	$0.59	0.44	0.36
Congo, Rep.	$0.12	$0.06	$0.11	$0.17	2.00	1.09
Côte d'Ivoire	$0.13	$0.16	$0.07	$0.23	0.81	0.57
Ethiopia*	$0.04	$0.02	$0.16	$0.18	2.00	0.22

Country	Tariff	OPEX	CAPEX	Total cost	OPEX recovery	Total cost recovery
Gabon*	$0.21	$0.18	$0.07	$0.25	1.17	0.84
Gambia, The	$0.22	$0.33	$0.10	$0.43	0.67	0.51
Ghana	$0.11	$0.10	$0.05	$0.15	1.10	0.73
Guinea	$0.11	$0.22	$0.13	$0.35	0.50	0.31
Kenya	$0.15	$0.12	$0.11	$0.23	1.25	0.65
Lesotho*	$0.06	$0.02	$0.08	$0.10	3.00	0.60
Liberia	$0.50	$0.54	$0.12	$0.66	0.93	0.76
Madagascar	$0.16	$0.23	$0.08	$0.31	0.70	0.51
Malawi	$0.10	$0.07	$0.11	$0.18	1.43	0.56
Mali	$0.21	$0.27	$0.07	$0.34	0.78	0.62
Mauritania	$0.22	$0.26	$0.09	$0.35	0.85	0.63
Mauritius*	$0.19	$0.16	$0.07	$0.22	1.19	0.86
Mozambique	$0.08	$0.06	$0.06	$0.13	1.33	0.61
Niger	$0.17	$0.15	$0.05	$0.20	1.13	0.85
Nigeria	$0.09	$0.13	$0.07	$0.20	0.69	0.45
Rwanda	$0.21	$0.31	$0.11	$0.42	0.67	0.50
São Tomé and Princípe	$0.23	$0.43	$0.09	$0.52	0.53	0.44
Senegal	$0.24	$0.31	$0.08	$0.39	0.77	0.61
Seychelles*	$0.32	$0.26	$0.09	$0.35	1.23	0.91
Sierra Leone	$0.33	$0.34	$0.20	$0.54	0.97	0.61
South Africa	$0.06	$0.06	$0.08	$0.14	1.00	0.43
Sudan	$0.04	$0.06	$0.10	$0.15	0.67	0.27
Swaziland*	$0.11	$0.12	$0.07	$0.18	0.92	0.61
Tanzania	$0.13	$0.18	$0.08	$0.26	0.72	0.50
Togo	$0.28	$0.29	$0.05	$0.34	0.97	0.82
Uganda	$0.17	$0.13	$0.05	$0.18	1.31	0.94
Zambia	$0.05	$0.04	$0.04	$0.08	1.25	0.63
Zimbabwe	$0.09	$0.08	$0.09	$0.17	1.13	0.53
Median	**$0.15**	**$0.16**	**$0.08**	**$0.23**	**0.93**	**0.65**

Note: The cost recovery ratios in the last two columns were calculated by the author by dividing OPEX and CAPEX values, respectively, by the tariff.
Source: Trimble et al. (2016).

Table 14: Sub-Saharan Africa: Breakdown of Hidden Costs, 2014 (% of current GDP).

Country	Bill collection	T&D Losses	Over-staffing	Underpricing	Total hidden costs
Benin	0.11	0.27	0.26	-0.29	0.36
Botswana	0.05	0.00	0.24	3.09	3.38
Burkina Faso	0.06	0.23	0.23	0.54	1.06
Burundi	0.37	0.21	0.06	0.20	0.85
Cameroon	0.08	0.43	0.23	0.11	0.85
Cabo Verde	0.52	1.37	0.00	-0.37	1.52
Central African Republic	0.08	0.22	0.16	-0.17	0.30
Comoros	1.21	1.45	0.30	0.71	3.67
Congo, Rep.	0.12	0.39	0.14	-0.10	0.54
Côte d'Ivoire	0.65	0.48	0.17	0.89	2.18
Ethiopia	0.25	0.36	0.05	1.16	1.82
Gabon	0.02	0.32	0.26	-0.18	0.42
Gambia, The	1.78	1.52	1.11	1.19	5.59
Ghana	0.10	0.31	0.19	-0.05	0.54
Guinea	0.65	0.39	0.13	0.92	2.08
Kenya	0.02	0.20	0.15	0.49	0.86
Lesotho	0.39	0.00	n/a	0.41	0.80
Liberia	0.06	0.21	0.08	-0.01	0.34
Madagascar	0.84	0.71	0.16	0.37	2.08
Malawi	0.35	0.95	0.36	1.54	3.21
Mali	0.04	0.47	0.19	0.67	1.37
Mauritania	0.61	0.55	0.24	0.58	1.98
Mauritius	0.04	0.00	0.41	0.18	0.63
Mozambique	0.05	0.27	0.34	0.26	0.92
Niger	0.21	0.16	0.21	-0.05	0.53
Nigeria	0.16	0.21	n/a	0.10	0.47
Rwanda	0.09	0.34	0.16	0.45	1.04
São Tomé and Príncipe	1.88	2.68	0.60	0.68	5.83
Senegal	0.37	0.53	0.38	1.30	2.58
Seychelles	0.07	0.20	0.29	-0.04	0.53
Sierra Leone	0.21	0.46	0.09	0.08	0.84
South Africa	0.17	0.00	0.47	4.12	4.76
Sudan	0.00	0.10	n/a	1.33	1.43

Country	Bill collection	T&D Losses	Over-staffing	Underpricing	Total hidden costs
Swaziland	0.04	0.04	0.41	0.93	1.42
Tanzania	0.08	0.33	0.08	1.22	1.71
Togo	0.56	1.19	0.30	-0.33	1.72
Uganda	0.01	0.17	0.08	-0.19	0.08
Zambia	0.14	0.12	0.62	0.99	1.87
Zimbabwe	1.35	0.62	0.75	3.20	5.92
Median	**$0**	**0.32**	**0.21**	**0.45**	**1.37**

Source: Trimble et al. (2016)