Donor conditionality and public procurement: Causal evidence from Kenyan electrification

ⓡ Catherine D. Wolfram   Edward Miguel   Eric Hsu   Susanna B. Berkouwer

Date: September 1, 2022

Abstract

Multilateral organizations often impose conditions on procurement and construction procedures when financing public goods provision by low- and middle-income country governments. What do these do in practice? While this question has been fiercely debated by aid-receiving governments, multilateral organizations, and academics, it is difficult to answer causally due to the endogeneity of project choice and the relatively small sample size of projects funded via multilateral financing. To provide causal micro-evidence on this topic, we leverage an unusual feature of Kenya's nationwide electrification program: the quasi-random allocation of multilateral funding sources across nearby villages, with African Development Bank funded sites following turnkey contracting and World Bank sites following segregated contracting procedures and strengthened inspections. We collect detailed on-the-ground engineering assessments of conductors and poles, minute-by-minute household-level outage and voltage data, and household surveys on connection quality and usage, and analyze a rich set of procurement contracts and inspection reports. We find that segregated contracting delayed construction completion at the average site by 9.6 months relative to turnkey contracting, but these procedures improved on-the-ground construction quality by 0.6 standard deviations, indicating a trade-off between the different approaches. To disentangle the roles of two key dimensions of donor conditionality—contracting versus audits—we implement a randomized audits scheme mimicking the latter, and find that this improves household connectivity and electricity usage. In this context, streamlining contracting procedures that generate delays—such as contract segregation—while strengthening those that improve quality with minimal cost—such as ex post inspections—could improve project outcomes. Given the current regime, the net impacts of short-term delays and long-term grid resilience could reasonably be argued to favor either segregated or turnkey contracting procedures, depending on time preferences and technical assumptions.

JEL codes: D73, F35, H5, L94, O19

Authors are in ⓡCertified Random order. Wolfram: U.S. Treasury, on leave from Haas School of Business, University of California, Berkeley and NBER, cwolfram@berkeley.edu. Miguel: Department of Economics, University of California, Berkeley and NBER, emiguel@berkeley.edu. Hsu: MacMillan Center, Yale University, eric.hsu@yale.edu. Berkouwer: The Wharton School, University of Pennsylvania, sberkou@wharton.upenn.edu. We thank the Foreign, Commonwealth and Development Office (FCDO) and Analytics At Wharton for generous financial support. We thank Christopher Kilby, Ken Opalo, Giulia Zane, and seminar participants at Arizona State University, Carnegie Mellon/Pittsburgh University, FCDO, the Occasional Workshop, University of Pennsylvania, Stanford University, University of California at San Diego, University of Washington, and the Working Group in African Political Economy, for helpful comments and suggestions. We thank Kenya Power for generously sharing administrative LMCP data. Carolyne Nekesa, Jane Adungo, and Joseph Otieno superbly implemented field activities. We thank Oliver Kim, Nachiket Shah, Adam Streff, Matthew Suandi, Kamen Velichkov, Felipe Vial, Aidan Wang, and Katie Wright for excellent research assistance and nLine for their support deploying the GridWatch technology. A pre-analysis plan was registered with the AEA RCT Registry (ID 2389). This project had IRB approval in Kenya (Maseno MSU/DRPC/MUERC/27/13) and the U.S. (U.C. Berkeley CPHS 2016-11-9365).

1 Introduction

Between 2009 and 2019, multilateral agencies provided on average USD 32.9 billion per year in loans to low- and middle-income countries (LMICs), with a large share of this funding used to contract private sector companies to provide public goods.[1] Agencies often seek to improve accountability by conditioning such financing on the use of specific procedures when administering procurement auctions, evaluating and awarding contracts, and overseeing implementation. The nature of donor conditionality has changed substantially since its well-publicized use in the 1980s, but the question of its impacts continues to be widely debated by governments, multilateral agencies, and academics. Proponents argue it can improve policy and economic growth (Archibong, Coulibaly, and Okonjo-Iweala, 2021) and reduce corruption (World Bank 2016). Others question its effectiveness or criticize the scope for political interference.

Negative efficiency impacts of public procurement restrictions and contracting regulations have been documented outside multilateral context (Tadelis, 2012). In the context of donor conditionality however, this debate has suffered from a dearth of causal evidence (Easterly, 2019). The infrequent, endogenous, often politicized, and often bundled allocation of financing to countries and sectors complicates causal identification. In addition, much existing research focuses on the policy conditionality of the 1980s, whereas the primary form of conditionality today—applicable to billions of dollars of investments annually—is procedural conditionality, which aims to strengthen contracting procedures and enforce institutional processes. The specific conditions tend to vary across major funders, such as the two we focus on in this study—the World Bank (WB) and the African Development Bank (AfDB)—as well as among increasingly important Chinese lending agencies, which are seen as applying relatively little policy or procedural conditionality.

This paper exploits natural policy variation to generate some of the first causally identified evidence on the benefits and costs of procedural donor conditionality and its mechanisms. We do so in the context of the USD 600 million nationwide Last Mile Connectivity Project (LMCP), one of Kenya's largest public infrastructure construction projects, with work contracted out to dozens of private sector firms. The LMCP was launched in 2015 with the aim of connecting all Kenyan households to electricity by 2020. The Government of Kenya and Kenya Power (Kenya's electric utility) first jointly selected thousands of villages to be LMCP sites, where all unconnected households near an existing transformer—usually between 20 and 100—would be connected to the grid. The identification strategy leverages a useful program feature: LMCP sites were assigned to be funded either by the WB or the AfDB without obvious regard to factors that would impact the project outcomes this paper studies. Key program features—eligibility, pricing, and network specifications—were identical across all LMCP villages, as was Kenya Power's eventual ownership and operation of electricity networks.

Here we have a case where two multilateral organizations are funding sites within the same government program—often with different funders supporting literally neighboring villages— but

[1] Total loans minus principal and interest payments. Includes some country-year observations for which this is negative. Agencies include the World Bank, regional banks, and other multilateral and intergovernmental agencies.

with each funder imposing its own set of procedural conditions. For both funders, Kenya Power outsourced construction to private contractors selected through international competitive bidding in accordance with each funder's processes. However, WB processes and regulations applied to the USD 135 million disbursed for construction at the 4,200 sites funded by the WB, and AfDB processes and regulations applied to the USD 154 million disbursed for construction at the 5,320 sites funded by the AfDB.[2] The AfDB opted to use 'turn-key' contracting, with 10 contracts awarded in a single bidding round, whereas the WB opted for a more segregated contracting approach, awarding 29 contracts across three staggered bidding rounds.[3] In addition, the WB imposed more stringent pole certification requirements, and WB sites required an additional inspection before being handed off to Kenya Power for perpetual management. To disentangle the role of these two major components of conditionality—contracting and audits—we implement a randomized auditing intervention (with the support of partners at the WB, the AfDB, and Kenya Power) designed to mimic existing audit structures. A random subset of sites was randomized into the monitoring intervention: through in-person meetings, contractors were informed that key aspects of the completed construction at these sites would be measured and reported to the WB and AfDB.

A key contribution of the paper is the collection of detailed construction and power quality outcomes, building on a small but growing literature emphasizing the importance of detailed infrastructure measurement (see Olken (2007) for an early example of this approach). We manually track construction progress for 380 LMCP villages, and then collect three types of on-the-ground outcomes. First, we measure construction quality for key infrastructure such as transformers, poles, and wires. Second, we deploy state-of-the-art sensors to measure minute-by-minute household-level power outages and voltage quality. Third, we conduct socioeconomic surveys to understand household connection experiences and energy usage. We complement on-the-ground data collection with detailed analyses of LMCP procurement contracts, inspection reports, and infrastructure data. Finally, we conduct in-depth informational interviews with management-level staff to understand each funder's contracting, construction, and audit procedures.[4]

To identify the causal impacts of conditionality, we use the ad-hoc assignment of sites to funders, which the evidence indicates was largely arbitrary and we argue below can reasonably be thought of as quasi-random. Sites are spatially interspersed: 95% of WB sites in our sample are within 10km (6mi) of an AfDB site, and there are often different funders in literally neighboring villages within a constituency. The econometric analyses include constituency fixed effects to account for geographic or socioeconomic differences. We conduct a battery of baseline balance tests using geographic, satellite, and census data to quantify the extent of imbalance between WB and AfDB sites across a range of covariates: they appear balanced along many attributes, and any selection appears uncorrelated with the outcomes of interest.

[2]AfDB funded two tranches, Phases I and II: this paper focuses on Phase I, launched concurrently with the WB tranche.

[3]These numbers exclude metering and consulting contracts, which we discuss in more detail below.

[4]These included conversations with senior personnel at Kenya Power, the AfDB, the WB, and the Consultant charged with supervising construction. Appendix C provides an anonymized list of individuals.

The analysis generates several key findings. First, the staggered approach to contracting employed by the WB caused significant construction delays. On average, construction at WB-funded sites was completed 9.6 months later than construction at AfDB-funded sites. Six years after LMCP construction began, 17% fewer WB sites than AfDB sites had seen any construction, and there were fewer poles and customer connections per site at surveyed WB sites. Second, and in terms of potential benefits, the WB requirements improved on-the-ground construction quality of 0.6 standard deviations: 74% of WB sites had higher quality construction than the median AfDB site, which could have meaningful implications for pole longevity and long-term maintenance costs. The net benefit of improved longevity but delayed construction depend on time preferences: under even a modest range of assumptions, the net benefit could range anywhere from a USD 5.6mn net benefit at AfDB sites to a USD 2.8mn net benefit at WB sites. The estimates of WB conditionality on other outcomes such as household installation quality, cost, and energy usage are positive but modest in size and not generally statistically significant, and there are no differences in the electricity reliability and voltage quality experienced by households. Finally, the randomized audit treatment generated moderate improvements in household connectivity and energy usage at relatively low cost.

These results suggest that, at least in contexts with relatively strong domestic institutions such as Kenya (relative to many of its East African neighbors), enhancing ex post monitoring while streamlining ex ante contracting procedures could reduce delays while achieving similar improvements in quality. Under the existing regime, the features of different procedural conditions create nuanced differences in outcomes. In some contexts, this creates a trade-off between short-term expediency and long-term resilience. For policymakers or individuals with a higher discount rate or a shorter time horizon, or for projects with compounding benefits, expediency might increase net benefits. In other situations, or in situations where maintenance costs are expected to rise more quickly with poor quality, a delayed start might be worth the improved long-term outcomes. In democracies with short-term electoral incentives, this framework can also explain political preferences for donors with higher expediency. This sheds light on the rapid growth of more rapidly dispersed Chinese aid, which has been the subject of concerns about poor quality resulting from limited oversight (Dreher et al., 2021; Mihalyi et al., 2022; The Economist, 2017; The Africa Report, 2022). That said, these results have noteworthy limitations: conditionality may generate additional positive benefits in ways that we were unable to measure, for example by strengthening institutional capacity in the Kenyan public sector. Finally, in settings where funders have repeat contracts with contracting firms, even when these span industries or countries, enhanced ex post audits can improve construction quality at relatively low cost and with less delay.

This paper contributes to a longstanding debate about the effectiveness of donor conditionality, whose nature has changed significantly since the 1980s. As domestic institutions in LMICs improved—arguably in part as a result of policy conditionality—by the late 1990s policy conditionality was often regarded as excessively heavy-handed. The changes in conditionality were in part due to changes in leaedership at international financial institutions. James Wolfensohn, as President of the WB from 1995-2005, relaxed policy conditionality related to major structural adjustment reforms (such as privatization of state assets), focusing instead on the goal of poverty reduction and streamlining WB and International Monetary Fund (IMF) procedures. Starting in 2005, his successor Paul Wolfowitz emphasized the anti-corruption goals of conditionality, which continue to drive much of the procedural conditionality that remains important in WB projects today, including in our study setting. Research on procedural conditionality suggests it can cause politically-motivated delays and incur costs that exceed the benefits (Kersting and Kilby, 2016; Kilby, 2013). Concerns around political interference, which have also been raised for decades, remain relevant: Andersen, Johannesen, and Rijkers (2022) find that significant portions—roughly 5 to 10% on average—of WB financing are transferred to offshore financial havens (and probably to some politicians' private bank accounts) in the months after a tranche transfer. In evaluating on-the-ground construction of WB projects we relate to Moscona (2020) and Marx (2018).

The debate about the impacts of donor conditionality date back to the 'Washington Consensus' in the late 1980s (Rodrik, 2006; J. Williamson, 2009). Studying the more policy-focused conditionality of the 1980s, Mosley (1986), argued that the WB "made it clear that penalties would attach to any failure by the Kenyan Government to comply with the conditions" and that conditionality has "genuine cost for the recipient." Easterly (2002) argues that misaligned incentives have caused much WB conditionality to be ineffective in increasing economic growth. Importantly, African scholars have had a range of different perspectives in this debate. In her provocatively titled book *Dead Aid*, Moyo (2009) argues how aid conditionality can distort markets and be abused for political gain. Archibong, Coulibaly, and Okonjo-Iweala (2021) acknowledge that market-oriented reforms based on Washington Consensus may have lead to short-term frictions, but argue that conditionality may have boosted long-term economic growth by strengthening institutions.

The rise of Chinese lending to LMICs after roughly 2000 has also shifted the debate. The Chinese government states its approach is one of non-interference in local policy-making and politics (State Council, 2011). A lending model with reduced oversight can enable expediency, which can be preferred by politicians operating under relatively short time horizons. On the other hand, this reduced oversight has generated concerns about quality and resilience of construction (Dreher et al., 2021; The Economist, 2017). There is recent evidence that Chinese aid projects increase reports of local corruption substantially in African settings (Isaksson and Kotsadam, 2018; Malik et al., 2021; Ping, Wang, and Chang, 2022), perhaps in part due to the laxity of contracting conditions or auditing, or high levels of project leakage.

In evaluating private sector procurement regulations set by public agencies, we build on an extensive literature studying government contracting and public contract administration (Hart, Shleifer, and Vishny, 1997; Levin and Tadelis, 2010; Tadelis, 2012; O. Williamson, 1999), including a small but growing literature in the context of energy and electricity infrastructure in LMICs (Ryan, 2020, 2021). Independent monitoring has furthermore been shown to improve state performance in LMICs (Duflo et al., 2018; Ferraz and Finan, 2008; Finan, Olken, and Pande, 2017; Olken, 2007).

Finally, studying accountability in the context of rural electrification per se is important because mass government electrification programs in poor countries are widespread and ongoing.

Poor construction quality can harm reliability and voltage quality and undermine these programs' socioeconomic objectives. Blimpo and Cosgrove-Davies (2019) find that in some countries in Sub-Saharan Africa, most connected households "reported receiving electricity less than 50 percent of the time in 2014," and that this may undermine the economic growth that household connections were designed to generate. These outages could be due to generation capacity constraints, local network quality, or the electric utility's operational constraints. In rural Kenya, Lee, Miguel, and Wolfram (2020), find that transformer outages frequently last for more than four months, and may therefore contribute to the low uptake and impacts of household electricity. This may explain why Lee, Miguel, and Wolfram (2020) and Kassem, Zane, and Uzor (2022) find limited impacts in rural Kenya. In India, Burlig and Preonas (2021) find that improved electricity reliability increases the impacts of rural electrification in larger villages. To the extent that low quality infrastructure exacerbates poor power quality and slows economic growth, identifying opportunities to improve construction quality may lead to meaningful improvements in economic outcomes.

2 Kenya's Last Mile Connectivity Project

In February 2014, Kenya's Ministry of Energy and Petroleum (MoE) published the Draft National Energy Policy, establishing a list of policies and strategies to *"increase rural electrification connectivity to at least 40% by 2016 and 100% by 2020"* and to *"seek funding from development partners for specific programmes especially...in rural electrification projects."* (MoE 2014). In May 2015, Kenya's President Uhuru Kenyatta announced the launch of the LMCP, with a goal of connecting *"one million new customers to electricity each year"* (Kenya Presidency, 2015). The program would primarily target households living near existing transformers, who could be connected to the existing local electricity network at relatively low cost. In a press conference two weeks after President Kenyatta's announcement, Kenya Power's then- Managing Director Ben Chumo added that the program was designed to facilitate *"the government's objective of providing 70% households with electricity by 2017 and universal access by 2020"* (Kenya Power, 2015b).[5] While not quite reaching these ambitious targets, the program has generally been effective: nationwide household electricity access was reported to have increased from 25% in 2009 to approximately 70% in 2019 (KNBS 2009, 2019).

The LMCP's cost, totalling over USD 600 million, was financed through loans and guarantees from the AfDB and the WB, the European Investment Bank, and the Agence Française de Développement; a grant from the European Union; and funding from the Government of Kenya (GoK) (Kenya Power, 2016a). In Kenya Power's 2014-2015 annual report, they note that *"The KShs 4 Billion receivable from the GoK is part of a larger commitment by the GoK, to be financed partly through support from the World Bank and the African Development Bank to enhance universal access to electricity."* This paper focuses on transformer sites funded by the WB and by Phase I of the AfDB, which we refer to jointly as Phase I of the LMCP.

[5]This target date was later extended to 2022.

While the LMCP was financed through various channels, it was a single nationwide project implemented by Kenya Power under a single set of implementation specifications. As of 2019, there were around 60,000 transformers across Kenya, which convert high- and medium voltage power lines (33kV or 11kV respectively) down to low voltage lines (usually 0.415kV) that can be connected to households. Many rural transformers had been constructed between 2005 and 2013 as part of a nationwide push by Kenya's then- Rural Electrification Authority (REA)[6] to connect all public facilities—such as markets, schools, health centers, and water points—to electricity (REA 2008, Berkouwer, Lee, and Walker, 2018). Kenya Power and the GoK jointly selected which transformers would be included in the LMCP, targeting an equitable distribution of LMCP sites across Kenya's 47 counties.

The LMCP's objective was to connect all unconnected households located within 600 meters of the existing transformers selected for the program—usually between 20 and 100 households—by extending the low voltage network, a process referred to as 'maximization.'[7] Kenya Power developed a uniform set of LMCP procedures that were implemented homogeneously across all LMCP transformers. Eligible households benefit from a reduced electricity connection price, from USD 350 down to USD 150, and from the ability to pay in monthly instalments rather than upfront. The program was also touted as reducing the red tape frequently associated with new electricity connections: the long and laborious process of applying for electricity, which can take months and often requires significant paperwork, would be replaced by a system where Kenya Power contractors proactively visit households to initiate the connection process, with minimal effort for households.

The process of determining exactly how many and which transformers in each constituency would be maximized involved extensive back-and-forth written communications between Kenya Power and each constituency's Member of Parliament (MP) that factored in cost and human development considerations. This process yielded a single nationwide list of approximately 8,520 LMCP transformers for Phase I of the LMCP, with AfDB Phase I financing the maximization of 5,320 transformers and the WB financing the maximization of an additional 3,200 transformers (Kenya Power, 2016a, 2017).[8] LMCP transformers were assigned to be funded by either the WB or the AfDB in a seemingly arbitrary and ad hoc manner. Section 3 discusses this process in more detail.

2.1 Corruption concerns

There is widespread concern that political interference and corruption within Kenya Power could jeopardize the quality, cost-efficiency, timeliness, and equity of the construction process (ESI Africa, 2020; Kenya Power, 2018b, 2020; Lee, Miguel, and Wolfram, 2020; The Star, 2018; Wolfram et al., 2022). In 2019, for example, bidding collusion led to "the supply of substandard wooden poles

[6] Since renamed Rural Electrification and Renewable Energy Corporation (REREC).

[7] Households could choose not to get connected, but in practice this was rare. Statistics are not available nationwide, but Lee, Miguel, and Wolfram (2020) found that at most four percent of participants in a rural sample in western Kenya randomly selected to receive a free electricity connection chose not to receive one.

[8] The WB provided additional funding to install 1,000 new transformers. For comparability those projects are excluded from this paper's analyses.

for [USD 8 million]" (The Nation, 2021). Kenya Power's CEO Ken Tarus and his immediate predecessor Ben Chumo were arrested in July 2018 (Reuters, 2018) and—alongside several other senior Kenya Power officials—faced various charges relating to corrupt procurement practices that resulted in significant losses of public funds. As of mid-2022, the case is ongoing (The Nation, 2022). Tarus furthermore faced additional charges relating to "failure to comply with the law relating to management of public funds" (Business Daily, 2018).

These types of events are not unique to Kenya, and not unique to the electricity sector. The WB defines corruption as *"the abuse of public funds and/or office for private or political gain"* (WB 2015). The WB's extensive regulations designed to curtail these abuses—detailing the procurement, financial management, and disbursal of funds—apply well beyond Kenya and across a range of industries:

> "Borrowers using the Regulations spend billions each year procuring works, services, or goods from third-party suppliers, contractors and consultants. Procurements under these Regulations happen in over 170 countries across the globe [and] range from highly complex infrastructure, cutting edge consultancy, major pieces of plant/equipment, and high tech information technology."
>
> World Bank Procurement Regulations for Borrowers (2020)

Over the past 20 years international donors have increased their efforts to combat corruption at all levels while also moderating the complexity of complying with these regulations. These efforts have generated progress in streamlining and harmonizing procurement policies for donor-financed projects in recent years (WB 2014). The result is that WB and AfDB regulations have significant overlap that lower the costs of complying with both simultaneously.

One policy lever at the disposal of the WB and AfDB is the 'debarment' of a private contractor with egregious performance. This has happened several times to LMCP contractors (Kenya Power, 2018b; Spotlight East Africa, 2020), which we discuss in more detail in Subsection 2.3. Being debarred in this manner generally applies globally: under-performance in a sector in one country under a contract with one donor can lead to disqualification from contracts in other countries by other donors in different sectors. Independent monitoring in a sector that frequently provides large contracts across multiple countries can therefore be a meaningful economic threat for contractors.

2.2 Procedural conditions

The implementation of the LMCP was segregated into contracts that domestic and international private sector contractors could bid on. The WB financed USD 135 million in contracts and the AfDB financed USD 154 million in contracts, through procedures that were similar in some respects. Each contract specified a portion of the construction process for all sites assigned to a specific funder, usually for a specific geographic cluster of Kenya's 47 counties, each consisting of several hundred transformers that were to be maximized. Both funders financed contracts with external consultants who were to oversee project implementation and manage the relationships with the remaining private contractors. Each funder also financed independent contracts for the procurement of meters with the same company, to facilitate integration with Kenya Power's operational systems.[9]

Still, differences in procurement guidelines, and in the ways donors interpret them, were meaningful. Compared to other development banks, WB policies have been described as more prescriptive, with some concerns that this inflexibility of such policies may make them more time-consuming without necessarily limiting fraud and improving outcomes (AfDB 2014, WB 2014). This is reflected in the fact that the WB opted to use a segregated contracting approach while the AfDB imposed a more hands-off contracting approach that the AfDB and the WB both refer to as 'turn-key', which "provides for full design, supply, erection and commissioning of the works by a single contractor at a fixed lump sum price" (AfDB 2018). The WB decision to use segregated contracts for the LMCP was made subjectively after internal discussions. The WB Procurement Regulations for Borrowers (2020) states that the "selection of contract types and arrangements takes into account the nature, risk, and complexity of the procurement, and VfM considerations". The AfDB Operations Procurement Manual (2018) similarly states that, "In complex cases, a 'turnkey' or 'design-and-build' approach may be more appropriate." Neither funder specifies a strict rule on how this decision is to be taken.

The 10 AfDB turn-key contracts corresponded to 10 geographical clusters of counties. Whichever contractor won a particular contract would be responsible for the entire construction process associated with the maximization of all transformers located in that contract's counties. This process included identifying all eligible unconnected households at each transformer site, developing engineering designs for an efficient extension of the low-voltage network to reach those households, procuring the materials required to complete those designs, and implementing construction using these materials. Each contractor therefore had full ownership over the entire construction process in a specific set of sites, allowing them to potentially leverage any associated synergies. Together with a single metering contract and a single consulting contract, Kenya Power awarded in total 12 LMCP contracts under the AfDB component.

Rather than providing turn-key contracts, the WB segregated contracts across construction phases. Eight contracts were first issued for contractors to complete designs for sets of sites, detailing the proposed local low-voltage networks and also specifying the materials required to complete the designed construction. Once the design contracts had been awarded and completed, a series of procurement contracts were issued to procure the relevant materials. The procurement of materials was separated into 15 separate contracts: six contracts for the supply of wooden poles, three for concrete poles, three for conductors, and three for cables. The WB then issued 6 contracts for the construction of the proposed designs using the procured materials, with each contract containing a geographically clustered set of sites. The WB component also included two metering contracts (one for the meters themselves and one for metering accessories such as boxes and circuit breakers) as

[9] The WB signed two contracts—one for the meters themselves and one for meter accessories—but they were with the same company and signed on the same day and thus constituted a single relationship.

well as four consulting contracts (one for inspections, one for procurement, and two for supervision). Kenya Power awarded a total of 35 contracts under the WB component.[10]

There are a number of ways in which the WB contracting structure for the LMCP creates additional work for the local implementing agency, in this case Kenya Power, relative to the AfDB structure. First, a larger absolute number of contracts to be signed will require more dedicated time by Kenya Power staff: when factoring in bid writing, bid elicitation, bid review, and actual contracting, the contracting process for any single stage can take months, and Kenya Power staff time availability was equal across the WB and AfDB components. Second, the staggered nature meant that the request for proposals for procurement contracts could not be published until the engineering designs are finalized, as this determines the procurement requirements, and construction cannot commence until the procurement contracts and activities are finalized. Third, while the 10 turn-key contracts were all identical in nature, the segregated design, procurement, and construction contracts all contained different language: these were thus more complicated for an individual Kenya Power manager to oversee.[11] Finally, these delays compound: a lag between the design phase and the construction phase means that the designs may be out of date by the time construction begins, requiring costly adjustments to the as-built designs or a change in the required materials. Similarly, a lag between procurement of materials and installation means that storage arrangements must be adjusted.

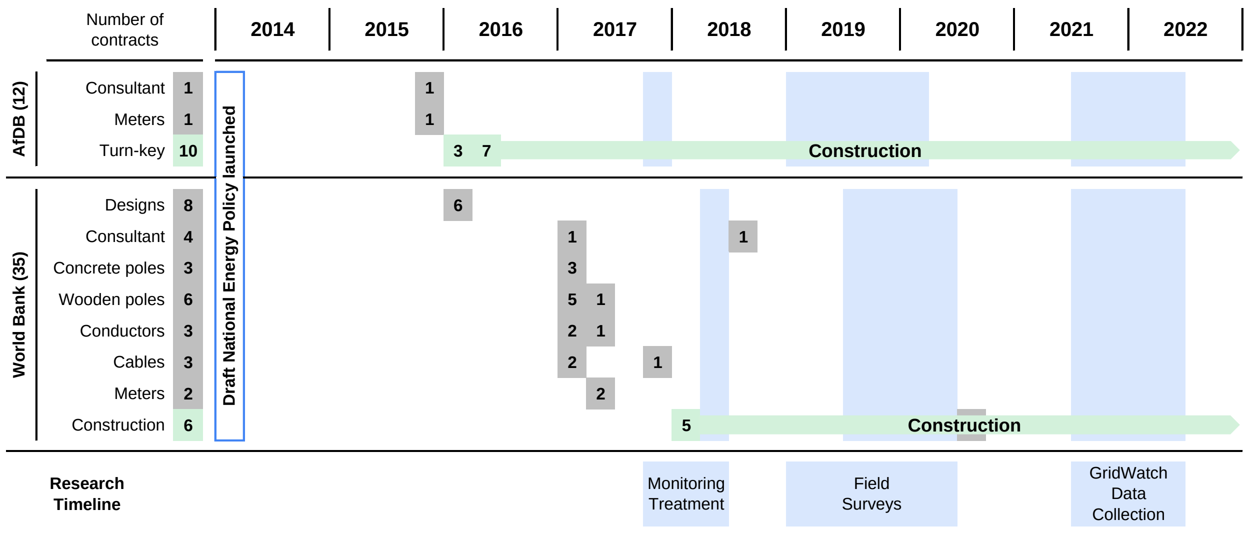
Importantly, these two separate contracting styles—turn-key versus segregated contracting—did not fundamentally affect the detailed set of technical project requirements, which were streamlined significantly in the past decade (WB 2014). Kenya Power is expected to strictly comply with the procedures set forth in each donor's international guidelines (see Subsection 2.5 for more detail).

Figure 1 compares the construction timeline for each lending institution. Initial funding approvals from the AfDB and WB were finalized at a similar time – the AfDB in November 2014, and the WB in March 2015. Project appraisal reports released in October 2014 for the AfDB and March 2015 for the WB indicate that contracts for both sets of activities were planned to be signed by early 2016 (The African Development Bank, 2014b; The World Bank Group, 2015). In December 2015, Kenya Power and the AfDB signed all 12 contracts needed to launch the LMCP (Kenya Power, 2015a). The WB initially followed a similar timeline, with design contracts signed by March 2016, however the contracting process proceeded more slowly after this. Materials contracts were signed starting in February 2017. In November 2017, the WB signed the final six contracts required to commence construction, a substantial delay relative to the project timeline at the time of approval (Kenya Power, 2017). Incidentally, right around the same time—in November 2017—the AfDB also

[10] A 16th procurement contract was signed for the procurement of transformers which were installed in a small number of villages, for a total of 36 contracts, but we exclude these from our analysis since the 'maximization' of existing transformers was the component that was most consistent across WB and AfDB and applied at most WB locations.

[11] Kenya Power employed one staff member to manage the WB contracting procedures and one staff member to manage the AfDB contracting procedures. The employees who held these positions were all certified electrical engineers with at least a bachelor's degree in electrical engineering. An anonymized list of individuals that our research team interviewed for the purposes of this research is included in Appendix C.

Figure 1: Dates of contract signing, construction, and research activities by multilateral



Timeline of the experimental components and the contracting process for the WB's 35 contracts and the AfDB's 12 contracts. Discussions with both parties started after the release of the Draft National Energy Policy in 2014. Each funder had independent contracts for meters and consulting. The AfDB used turn-key contracting, allowing construction to begin as soon as the remaining 10 contracts had been signed. The WB separated the remaining 29 contracts into three distinct tasks—design; the procurement of concrete poles, wooden poles, conductors, cables; and construction—causing significant delays in when construction could begin. AfDB sites that had been completed prior to the implementation of the monitoring treatment in late 2017 were excluded from randomization. Surveys were conducted after construction completion.

signed 15 additional turn-key contracts to begin maximization of an additional 5,200 sites as part of its *Phase II*.

2.3 Contractors

The contractors that bid on LMCP contracts are generally medium-to-large construction firms with an international track record of completed projects. Contractors that won the AfDB- and WB-funded LMCP contracts were a mix of Kenyan firms and international firms, with some joint ventures comprised of two or more firms. For both AfDB and WB, contractors were chosen via a competitive bidding process. In addition selection on the basis of bid amounts, bidders must satisfy certain requirements related to financial capacity, prior experience including with similarly sized jobs, and any record of sanctioning and litigation. The 12 AfDB contracts were awarded to 10 unique contractors, with two contractors winning two turn-key contracts each. The 35 WB contracts were awarded to 31 unique contractors with four contractors winning two contracts each.[12] All three contracts for meters and metering accessories were awarded to Shenzhen Clou Electronics Co. (China) for the purposes of harmonization with Kenya Power's management and billing systems. Other than Shenzhen, there was no overlap between AfDB and WB contractors.

[12] One contractor was awarded both meters contracts, one was awarded two cables contracts, one was awarded two wooden poles contracts, and one was awarded two construction contracts.

The winners of the 12 AfDB contracts had been selected from among a combined 110 bidders. Six of the 10 materials and works contracts winners were Kenyan while four were foreign (Capital Business 2015). The set of contractors awarded WB contracts also included a mix of Kenyan and International firms, with Kenyan firms primarily awarded bids for the supply of wooden and concrete poles.

There is no blanket provision preventing firms from submitting—or being awarded—bids with both donors simultaneously. Indeed, many of the AfDB contractors named above have in the past bid on—and in many cases been awarded—WB contracts. International procurement and construction bidding can be thought of as a repeated game among a small set of actors, and poor contract performance can have serious ramifications on long-term performance. As an example, in October 2018 the WB Sanctions Board imposed "a sanction of debarment" on the Indian company Angelique International for "fraudulent practices as defined in Paragraph 1.16(a)(ii) of the January 2011 Procurement Guidelines." (WB 2017; WB 2011). The WB appears to have stricter standards, leading to a higher frequency of sanctions against private contractors. We do not see this as a concern around selection bias from an identification perspective, but rather we view this as a mechanism through which conditionality may operate. We exploit the threat of debarment in our randomized audits treatment, discussed in Subsection 3.2.

2.4 Subcontractors

Many of the 40 companies that were awarded at least one LMCP contract hired subcontractors for components of the work they had been contracted for. For example, since AfDB contractors were responsible for the design, procurement, and construction of sites, it was standard for these contractors to subcontract some of these components out to smaller, often Kenyan, firms. Given the specialty nature of electricity networks, these smaller firms often already had well-established supplier relations with Kenya Power even prior to the start of the LMCP. As an example, public minutes from a pre-bid meeting for wooden pole procurement organized by Kenya Power in 2014 indicate that eight of the wooden pole supply companies that won WB contracts or AfDB subcontracts for the LMCP in 2016-2017 were already engaging with Kenya Power as early as 2014, well before the launch of the LMCP (Kenya Power, 2016b), and in many cases well before that (Business Daily, 2007).

Evaluating these pole suppliers reveals that there was significant overlap between winners of WB procurement contracts and subcontractors from which AfDB turnkey contractors procured materials. All three contractors that were awarded contracts for the procurement of concrete poles under WB contracts were also approved by Kenya Power to act as subcontractors to AfDB turnkey contractors.[13] Similarly, one of the WB contractors awarded a contract for the procurement of wooden poles was also approved by Kenya Power to act as a subcontractor for at least one AfDB

[13] As donors provide relatively little oversight into subcontracting (The African Development Bank, 2014a) we are unable to confirm how many poles were actually procured from these contractors, however the fact that they were explicitly listed in AfDB turnkey contracts suggests there is likely to have been significant overlap.

turnkey contractor. This degree of overlap suggests that while there were significant differences in the contracting structure, in many cases the manufacturing of concrete and wooden poles for AfDB- and WB-funded sites happened at the same facilities.

2.5 Quality assurance and oversight

The tender documentation for both the WB and the AfDB contained detailed specifications for the materials and installation procedures of poles, wiring, conductors, fuses, and meters. The quality assurance and oversight procedures can be broadly split into four mechanisms. Across all four mechanisms, the similarities generally outweigh the differences between the two donors. This harmonization facilitated lower cost compliance by Kenya Power staff responsible for implementation, however there remain important differences, as we discuss below.

First, when implementing the above-described contracting process, each donor had to provide a "no objection" approval at critical stages. The donors required these recurring reviews of the documentation and Kenya Power's proposed plans to ensure that they were in compliance with the detailed technical guidelines and requirements set forth by each funder. That said, anecdotally, the WB's "no objection" process was on average more involved, consisting of more steps, than that of the AfDB.

Second, each donor required a similar set of materials inspections processes. A team representing Kenya Power (including members from Kenya Power's LMCP management team, supply chain department, and operations & management department) would visit the factories of private contractors—located in India, China, Kenya, or elsewhere—prior to procurement to inspect the materials.[14] Both funders required detailed mechanical and chemical inspections of 10 poles out of each batch of 500 poles. The WB furthermore required every single pole that passed inspection be marked physically such that these can be easily verified upon arrival at Kenya Power storage facilities.

Third, each donor required the contracting of a 'consultant', led by a project manager who was responsible for project coordination, monitoring, and supervision for all contractors. Their oversight structures were similar: the WB's project manager managed 22 cluster and site supervisors across six offices nationwide, while the AfDB's project manager managed 19 cluster and site supervisors across four offices nationwide. The consultants' primary activities during the construction process included conducting site-level spot checks, collecting monthly progress reports from contractors, and hosting (at least) monthly meetings with Kenya Power and each respective contractor. Once construction at a particular site was complete, the consultant, the contractor, and Kenya Power would do a joint inspection and sign a "Joint Measurement Certificate" (JMC) to certify that a contractor completed construction at a site and that the site can be handed over to Kenya Power for activation.

The inspection procedures set by AfDB and WB consultants contained one notable difference. Prior to the joint inspection that would produce the JMC, the WB consultant often did an on-site

[14] A number of factory assessments between 2020-2022 had to be conducted via Zoom for public health reasons.

inspection together with the contractor (but without a Kenya Power representative) to produce an "Inspection Report" (IR). The IR would list any construction errors or oversights identified in the materials or installation. Comments from the IRs include, for example, "pole caps are poorly installed" and "the strut pole bolt is not secured with nut and washers." Many comments were accompanied by photographs of the issues in question. One of the goals of the IR was to provide the contractor with an opportunity to fix the error before the JMC inspection visit. The goal was to conduct an IR in advance of the JMC at every site, and it appears that this was largely adhered to, however in some cases (particularly in remote areas, where travel is costly) the JMC and the IR were conducted concurrently. Since the IR was not required at AfDB sites, it was common for a JMC to be issued even when no new meters had been installed yet.

Fourth, each funder engaged in direct monitoring. Kenya Power would combine and summarize the contractors' monthly summary progress reports and share these with funders. At least twice per year, each funder conducted a week-long 'supervision mission' consisting of meetings with senior Kenya Power and Ministry of Energy officials in Nairobi as well as 1-2 days of site visits in nearby regions. The information collected in each mission was recorded in a Supervision Mission Report, which was generally similar between the two donors.

2.6 Household involvement

A correctly installed electricity connection with a functioning meter is of little benefit to a household without power sockets or light switches. The final household connection is thus crucial. During LMCP, households were responsible for installing—or hiring a local handyman to install—internal wiring, defined as anything between the meter and the appliances a household consumes. The field surveys indicate that households who were connected prior to the LMCP spent on average USD 125 on internal wiring.

For most households, the internal wiring posed a significant financial and logistical barrier, on top of Kenya Power's connection fees. To address this issue, Kenya Power decided to provide low-income households who could not afford internal wiring with a 'ready board': an electrical panel that would satisfy the wiring requirements of a connection. In a May 2015 address, President Kenyatta described this policy as follows: *"The Ministry of Energy has also come up with designs that will enable households that do not have internal wiring in their houses to use electricity by providing a 'ready board'... [it] has switches, sockets and bulb holders and those who do not have wiring in their houses will be able to use electricity as soon as they are connected*" (Kenya Presidency, 2015).

Beneficiaries under the LMCP are connected via 'pre-paid' meters, meaning they must buy electricity credits in advance of using electricity. Once they consume their prepaid electricity, they lose access to electricity, and only regain access only after they buy more credits. Households usually prevent this by purchasing additional credits before their credits run out.

To recover the USD 150 connection fee, Kenya Power initially enrolled households into a payment plan consisting of 36 monthly installments of around USD 4 per month. The charge was automatically added to households' accounts on a monthly basis, and any electricity payments the household made were directed towards paying off this debt prior to being directed towards electricity credits. However, this generated a significant barrier for households: as an example, if a household runs out of electricity credit in January, and then does not consume any electricity in February or March, they would have to pay at least USD 16.01—4 months worth of connection fees—to be able to consume any electricity in April. The contribution was thus later capped at 50% of any topup amount (Kassem, Zane, and Uzor, 2022).

This barrier was not only a significant financial hurdle, but one that was unanticipated and poorly understood. According to Kenya Power, households should have been informed of the payment structure as part of the consent process, which was the very first step in the construction process, but it is unclear whether this consent process was regularly implemented in practice. To verify whether this process was correctly implemented, and to test whether donor conditionality and monitoring can improve adherence to these guidelines, the household survey (described in Subsection 4.2) measures respondent understanding of the aggregate costs of an electricity connection under the LMCP. 58% of households do not recall ever having been told that they would have to pay Kenya Power for the connection; 44% thought they would not have to pay.

The LMCP's objective was to connect all unconnected households to electricity, however, in practice connectivity was not universal. At the average site at least 7% of compounds were not connected to the grid, and at the 90th percentile site at least 25% of households were not connected.[15] The most common reason (given by 31% of respondents) is that they were not present or available during the days on which construction or sign-up were administered. Second, even though the LMCP program specifications indicate there were to be no upfront connection fees, 23% of respondents still report having been unable to pay, often because they were not able to afford the internal wiring required by Kenya Power to be connected: 16% of unconnected households report this to be the reason. This suggests that despite efforts to provide free readyboards to low-income households, the cost of household wiring remained a barrier that prevented some households from getting connected.

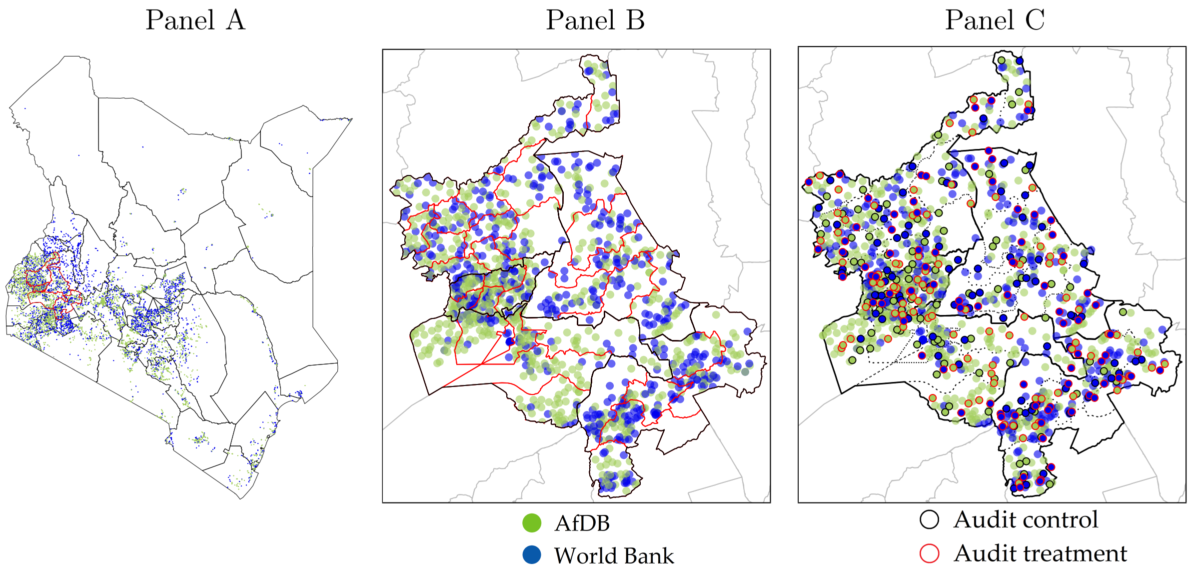
Households also report numerous instances of bribery. In our household survey data, 8% of households connected under LMCP had been explicitly asked for money by the contractor, with amounts generally ranging from USD 5 to USD 50. Tragically, a small number of households report having paid an individual claiming to be a contractor, only to never hear from them again. 5% of unconnected households report not wanting a connection, for example because they are simply not interested in having electricity or because they think electricity is unsafe (this is similar to the rate reported in Lee, Miguel, and Wolfram (2020)).

3 Research Design

To estimate the causal impact of conditionality on construction outcomes we exploit the quasi-random assignment of construction sites to two different international donors that implemented

[15] Enumerators only counted unconnected compounds that were within connection distance of the existing electricity network, so this may be an underestimate. Subsection 4.1 provides more details on surveying methodology.

Figure 2: Sites by funding source and audit treatment status



Panel A displays locations of the nationwide LMCP Phase I sites colored by funding source. Highlighted in red are the five counties where we conduct engineering and socioeconomic surveys (Kakamega, Kericho, Kisumu, Nandi, and Vihiga). Panel B focuses on this area and emphasizes constituency boundaries within the 5 counties, highlighting that the assignment of sites to funders does not appear to be geographically clustered in the study area. Panel C shows audit treatment and control sites circled in red and black respectively (see Subsection 3.2 for detail).

different contracting and oversight structures. To examine how ex-post audits affect project outcomes, we then implement a randomized audits scheme. This section describes both sources of variation in more detail in turn.

3.1 Quasi-random assignment of sites to international financing

The transformers selected to be maximized under the LMCP were assigned to be financed by either the WB or the AfDB. From June 2016 through July 2022 members of the research team held extensive private meetings with key Kenya Power personnel responsible for the LMCP. This included meetings with the General Manager for Connectivity (who was responsible for all of Kenya Power's activities connecting new households to power) and the two Project Managers who oversaw the nationwide implementation of the LMCP portions funded by the AfDB and WB, respectively, including all contracting, procurement, and construction activities. We read dozens of letters of correspondence between Kenya Power and individual Members of Parliament discussing and deciding which transformers would be included in each phase of the LMCP. Anecdotally, the pattern that we consistently observed was that assignment was ad hoc and did not follow any particular allocation rule. Given that the mandates were identical—to connect all households within 600 meters—Kenya Power and the GoK did not appear to see any strategic benefit in having a transformer be funded by one donor or the other.

Panel A of Figure 2 maps the nationwide distribution of sites, with each site colored according to the organization that financed it and oversaw its implementation. In line with explanations provided by the electric utility, there do not appear to be systematic differences in how funders were assigned to sites.

The causal identification strategy leverages this quasi-random allocation of each LMCP Phase I transformer site to a funder. Among Kenya's 290 constituencies, 210 contain at least one AfDB and one WB site.[16] Out of 8,520 nationwide LMCP Phase I sites, 1,139 are located in the five study counties: Kakamega, Kericho, Kisumu, Nandi, and Vihiga. Panel B of Figure 2 maps this subset of sites. The five study counties are made up of 36 constituencies, of which 35 have at least one WB site and at least one AfDB site, thus we restrict site selection to these constituencies and include constituency-level fixed effects in the primary outcomes regressions. 95% of WB sites among this sample are located within 10km of an AfDB site (and vice versa). Panel C presents the overlay of funding source and randomized audit treatment, discussed in Subsection 3.2.

To assess the scope for selection, we conduct several balance checks. Table 1 conducts balance checks at the ward level for the number of WB-funded LMCP sites by baseline socioeconomic characteristics (measured during the 2006 Household Budget Survey and 2009 Census data) conditional on the number of LMCP sites in each ward. The number of WB-funded sites in a ward is not correlated with the fraction of households with a high quality roof or electricity, the fraction of individuals with primary or secondary education, the fraction of residents who are 14 years or younger, and average consumption. There is a slight difference in the fraction of households with an electricity connection and the fraction of households with a solar panel, but these magnitudes are small (about 1 p.p. or less). To minimize the possibility that these baseline differences may cause bias, the main results that follow control for the 2009 fraction of households in the ward that have an electricity connection and the 2009 fraction with a solar panel.

It is possible that Kenya Power employees may have been aware that AfDB construction would proceed more quickly than WB construction and therefore assigned sites that were considered a priority to receive AfDB funding—while we have no evidence of this, possible reasons could include political expediency, economic growth expectations, or personal favor. To examine balance at the site level, Figure 3 compares trends in monthly Visible Infrared Imaging Radiometer Suite (VIIRS) nighttime radiance, or 'nightlights' (Elvidge et al., 2017). WB and AfDB sites have indistinguishable nighttime brightness levels and trends prior to the LMCP construction period. Columns (1) and (2) of Table A1 present a pooled balance test of pre-LMCP radiance levels confirming these were statistically indistinguishable.

Despite these similarities, there are modest differences between WB and AfDB sites. Most transformers had been connected as part of a push by REA between 2005 and 2013 to connect all public facilities nationwide to electricity. There appear to be some differences in the likelihood of transformers located near specific types of facilities to be assigned to one funder or the other. For example, 30 out of the 132 AfDB transformers we surveyed (23%) were located near a secondary school, whereas only 10 out of the 118 WB sites were (8%). We do not have a clear explanation

[16] A constituency is a relatively small geographic unit: the average population is approx. 185,000.

Table 1: Balance in 2009 census socioeconomic characteristics by number of LMCP sites per ward

	Number of LMCP Sites	...of which are WB-funded	N	Mean
Age 14 or Under	0.23*	-0.27	170	51.45
	(0.14)	(0.19)		
Consumption	-103.61**	66.92	170	3205.00
	(46.27)	(62.06)		
Primary Education	0.18	-0.29	170	61.08
	(0.18)	(0.25)		
Secondary Education	-0.34	0.46	170	20.04
	(0.26)	(0.35)		
Solar	0.07***	-0.08**	170	0.96
	(0.02)	(0.03)		
Electricity	-0.98**	1.01*	170	6.93
	(0.39)	(0.53)		
High-Quality Wall	-0.64	0.40	170	14.80
	(0.41)	(0.54)		
High-Quality Roof	-0.21	-0.12	170	83.13
	(0.43)	(0.57)		
Joint F-test		p-value = .08		

This table tests for correlations between the number of sites in a ward allocated to each funder and baseline characteristics among wards with at least 1 LMCP site. Row 1 shows these correlations for the percentage of individuals who are 14 years or younger. Row 2 shows consumption per capita in KSH. Rows 3 through 8 shows percentage of, in order: individuals who completed primary school education; individuals who completed secondary school education; households with solar; households with electricity; households with a high quality wall; and, households with a high quality roof. All regressions include constituency FE. Data source: 2006 Household Budget Survey and 2009 Census data. $^{*} \leq 0.10,^{**} \leq .05,^{***} \leq .01$.

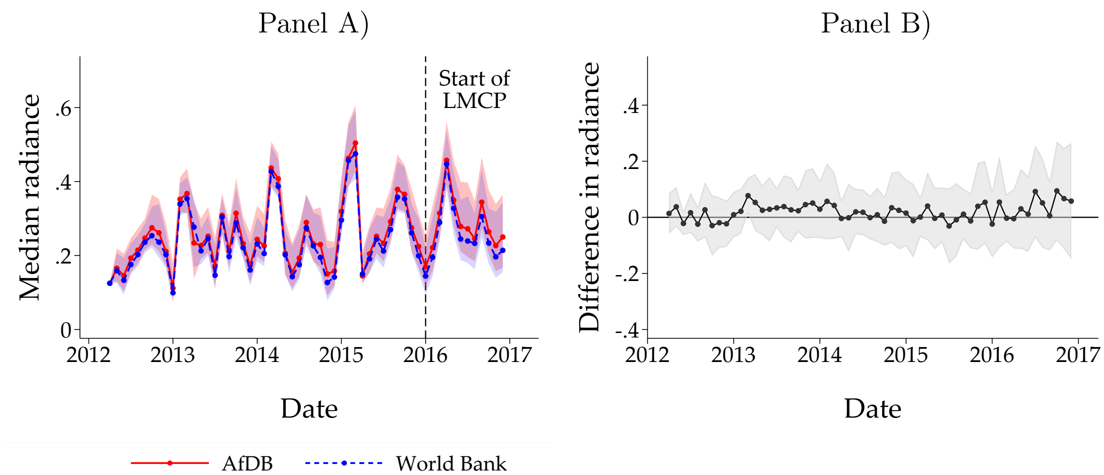
for this; nonetheless all regressions therefore control for these baseline characteristics. Table A2 quantifies these differences using field surveys and administrative data. The difference is largest for secondary schools. WB transformers are also slightly less likely to have a religious building nearby and slightly more likely to have a market center nearby, or no public facility at all.

There are also small differences in site geography across funding sources. Columns (3) and (4) of Table A1 indicate that WB-funded sites have a 13% higher average land gradient, indicating they were more likely to be located in hillier villages. Extensive robustness checks confirm that delays and construction quality are uncorrelated with land gradient and facility type, and that the results are constant across the entire support of land gradient and facility type. To minimize any remaining source of biases, all regressions control for land gradient and facility type. Subsection 5.5 discusses these robustness checks in more detail and shows that results are unchanged when controlling for baseline covariates that are imbalanced.

While contractors were allowed to bid on WB and AfDB contracts simultaneously, no firm won both a WB and an AfDB contract.[17] It is possible that donor conditions generate selection: firms with certain characteristics may be more likely to bid on WB or AfDB contracts, and this may cause

[17] This is with the exception of the metering contracts, which were intentionally contracted out to the same firm to reduce logistical hurdles for integration with Kenya Power's internal systems.

Figure 3: Site-level nighttime radiance by funding source



Panel A presents median monthly nighttime radiance from VIIRS between 2012-2017 per site-month, with bands showing the 25th to 75th percentile. Panel B confirms that radiance is statistically indistinguishable across World Bank and African Development Bank-funded sites (estimates include constituency FE). Table A1 confirms baseline balance using a pooled regression of these data.

differences in outcomes. Speculatively, firms with more streamlined operations may be more likely to submit for projects with more stringent requirements. Selection along this dimension would be a mechanism through which donor conditionality may operate to affect outcomes rather than a threat to identification.

3.2 Randomized Monitoring

To disentangle two key components of donor conditionality—ex ante contractual procedures and ex post inspections—we implement a randomized monitoring scheme designed to mimic the latter. In particular, we design a monitoring treatment that closely mirrors the WB's Inspection Reports (discussed in Subsection 2.5). Field officers hired by the research team visited each site to inspect crucial details of the electricity networks—such as line sag, LV wiring, and the presence of pole caps—at the conclusion of construction. To ensure relevance and accuracy, the research team developed these measurements and the field procedures for collecting them (described in Subsection 4.1) in collaboration with retired Kenyan electrical engineers.

Out of the 1,139 sites in the region, we select 380 sites for the randomized monitoring experiment.[18] We assign 190 to the treatment group and 190 to the control group. Assignment is stratified by site constituency and which multilateral the site is funded by.

The randomized monitoring is implemented jointly with the WB and the AfDB as follows. During in-person meetings set up for this purpose, members of the research team notify contractors that an independent, international team of engineers will audit a specific list of selected sites once

[18]This matches the sample size specified in the Pre-Analysis Plan submitted to the AEA RCT Registry (#2389, available here.)

construction is complete. During the meeting they provide formal, written notification that is signed by senior management at Kenya Power, the WB, and the AfDB (Figure A1). This notification also includes the specific set of sites within their contract region that were selected to be audited. In communications with WB officials (in both Washington D.C. and Nairobi), the WB indicated they would take contractor-level evidence of leakage (on both WB and AfDB funded projects) into account in future contracting. This setup can therefore be thought of as a repeated game environment. Contractors depend on their repeated relationship with international organizations such as the WB and the AfDB for future projects in many sectors—many also work in sectors outside electricity. This provides an incentive for contractors to implement high-quality infrastructure projects, or at least to be perceived as doing so, in order to win future contracts. To remind contractors of this incentive the notification states this explicitly.

Unbeknownst to the contractor, the list of sites that they are told will be audited is in fact a randomly selected subset of the full set of sites that are surveyed by our research team. Given the random selection, any difference in construction outcomes between the sites about which contractors are notified and the control sites can be attributed to contractors' response to the monitoring.

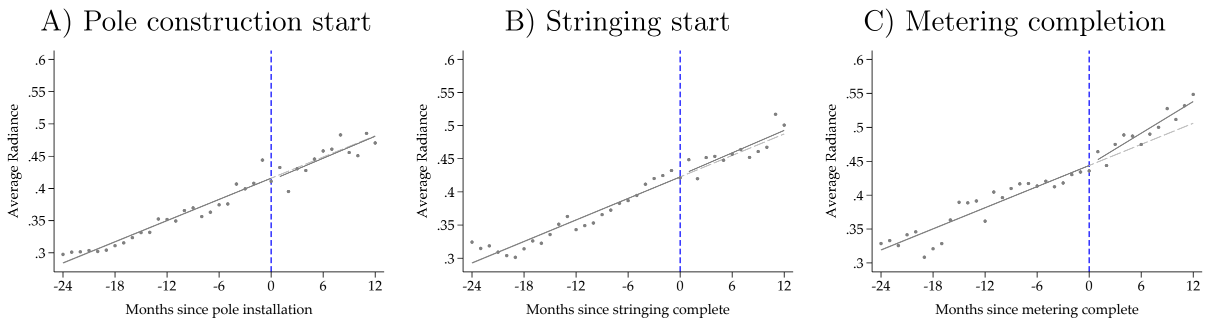
4 Data

We use rich nationwide administrative data on construction progress at thousands of construction sites provided by the electric utility to conduct sample selection. Of the 1,099 LMCP Phase I sites located in the five study counties, we randomly select 380 to be included in the randomization sample, stratifying on constituency and funder. We randomly assign 190 to the monitoring treatment group and 190 to the monitoring control group, stratifying by funder and by constituency.

Field managers employed by the research team conducted frequent, short, repeated assessments with village representatives—over the phone or in person—at all 380 sites to track construction progress at each site over time. This yields a panel dataset of construction progress at the site level. To verify the accuracy of these reports, Figure 4 plots event study graphs of nighttime radiance in the months before and after key construction stages. As expected, the start of construction or stringing does not affect nighttime radiance. On the other hand, in the 12 months after the completion of household metering, nighttime radiance increases sharply. This lends credence to the construction reports.

We conduct on-the-ground engineering assessments and socioeconomic surveys at all 250 sites where construction had made significant progress by the end of the main field activities in May 2021. Construction had still not been completed—and usually not even begun—in the remaining sites, limiting surveying activities there to short assessments of any initial planning activities (for example, whether a census of unconnected households had been taken and whether any materials had been delivered). To minimize differences caused by the construction delays, assessments and surveys are conducted between six and twelve months after construction is reported to have begun

Figure 4: Event study: nightlights after construction progress



Data on construction progress for the 135 AfDB sites and 121 WB sites located in the five study counties collected through phone surveys with local village representatives. As expected, nighttime radiance data (VIIRS) increases after metering completion (when the electricity connection is activated) but not earlier.

at a site.[19] Roughly half of the surveying sites are WB sites and half are AfDB sites. Figure 5 provides an overview of these elements in the context of the randomization and data collection.

4.1 Engineering assessments

The engineering measurements were developed in coordination with recently retired REA engineers who were very familiar with the technical specifications of Kenya's electricity grid. Field officers take detailed measurements on the quality of the materials and construction of the electricity network in each sample transformer community.

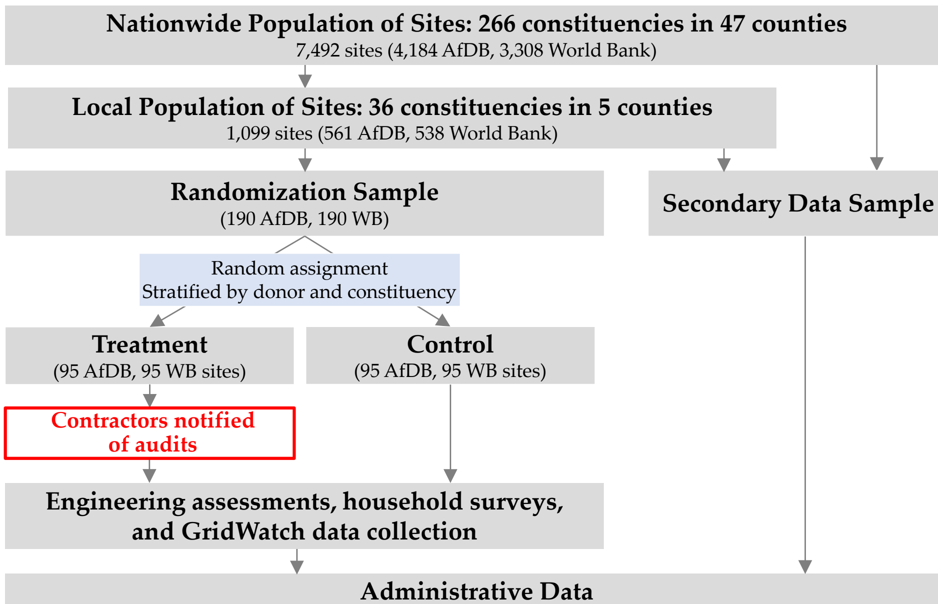
The engineering assessment consists of two parts. In the initial infrastructure census, field officers systematically record the locations of all poles in the low-voltage network, as well as their connectivity, up to 700 meters from the existing transformer. The 700 meter radius exceeds the government guideline of 600 meters, allowing us to test whether construction was completed beyond the eligible region, for example in order to earn informal side payments. They also document the number of poles in the low-voltage network that are further than 700 meters from the transformer and are within sight. Figure 6 displays network data recorded in this first part of the engineering assessment at an example site.

The field officers also record the number of drop-down cables connected to each pole (the connection between a home or business and the electricity pole), whether the drop-down cable connected a residential compound or a firm, as well as any unconnected compounds located near the pole. This provides a measure of the number of connected and unconnected firms and households across the entire site.

In cases where the local network was too large to complete in a single day, field officers selected a random subset of branches to assess, and then recorded all poles connected to every selected branch. At these sites, scaling the surveyed connections proportionally to the fraction of the grid that was surveyed yields an unbiased estimate of the total number of household connections at that site.

[19] Due to logistical constraints, in some cases surveys were conducted several months earlier or later.

Figure 5: Project design



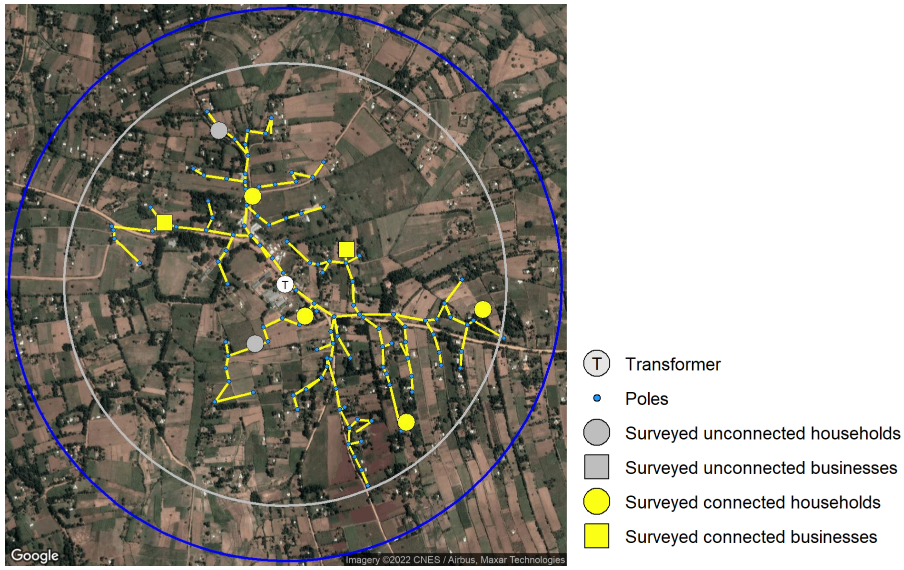
Sample selection and randomization. Contractor notification was implemented in 2017-2018 and assessments and surveys were done 2018-2021. Engineering assessments and household surveys were completed at the 250 sites where construction had been completed by the end of surveying activities in 2021. Additional tracking of construction progress at the remaining sites continued through 2022.

In the second part of the engineering assessment, the field officers record characteristics of every pole and the conductors (wiring) that connect them These measurements focus on outcomes that are most likely to affect the quality and longevity of the electricity grid. They include quality measurements of the pole itself, such as angle relative to the ground, whether it is wood or concrete, whether it is firmly placed in the ground, whether it has a pole cap, and whether it has any visible cracks. Pole measurements also include whether it has the appropriate grounding wires, stay wires, and struts. [20] Measurements taken of the conductors that connect the poles include whether it has appropriate ground clearance and clearance from other objects (such as trees, brush, or structures), and whether any electric lines cross. Measurements of the drop-down cables from the pole to the customer include the distance between the pole and the customer's structure, and whether the cable ends at a meter. Field officers also note down whether it appears to be an illegal connection, although this is quite rare in this rural setting, in contrast to some urban and peri-urban settings in Kenya and elsewhere. Finally, measurements of the central transformer at each site include whether the poles on which the transformer is mounted are leaning excessively, the number of missing or bypassed fuses, and whether the transformer has any other obvious defects.

Table A3 presents summary statistics on transformers, poles, and households surveyed at 250

[20] For a subset of poles, field officers also collect more detailed pole measurements, such as pole height, circumference at various points, and characteristics of each strut or stay that provides support for that pole. The rate at which poles were sampled for more detailed measurements varied by the size of each site. At smaller sites, field officers would conduct detailed measurements of every third or fourth pole, while at larger sites of 120 poles or more field officers would conduct detailed measurements of every sixth pole. The survey had been pre-programmed to automatically perform a calculation and provide instructions to the field officers at the end of the infrastructure censusing activity.

Figure 6: Infrastructure data collected (example site)



This map displays the construction data collected at an example site. Figure A2 presents additional examples of sites. The grey line denotes 600 meters and the blue line denotes 700 meters from the transformer ('T') at the center. The engineering surveys record the locations of poles, lines connecting poles, and infrastructure quality. At each site, between 4-9 connected and unconnected residential compounds and firms were randomly selected to participate in the socioeconomic survey (Subsection 4.2) and to receive temporary engineering technologies to measure power quality (Subsection 4.3): these are marked with yellow and gray circles and squares (random spatial noise has been added to their locations to preserve anonymity).

transformer sites. At around one quarter of transformers at least one fuse was missing or had been bypassed. We surveyed on average 87 poles per site, of which about a quarter had a large crack. 95 percent of surveyed households were connected in 2016 later, and the median year in which households were connected was 2019.

4.2 Household and firm survey data

After the infrastructure census had been completed, a random subset of the (connected and unconnected) residential compounds and firms that had been recorded at the end of drop cables were selected for more detailed socioeconomic surveys. The goal of the household and firm surveys was to understand household and community experiences with the construction process and electricity connections. For example, anecdotally, households are occasionally asked to contribute manual labor to construction for example by digging their own holes for distribution poles, even though this is strictly against Kenya Power policy. Higher quality construction and installation could also potentially reduce local power outages and increase power reliability, which could have tangible benefits for household well-being and firm productivity and profits, especially in the medium- to long-run. Finally, anecdotal evidence suggests that Kenya Power occasionally installs multiple meters within a single home compound, overstating the total number of households that are connected nationwide in order to exaggerate public perceptions of program progress. To disentangle this from compound residents' genuine preference for multiple meters (for example to leverage the lifeline tariff, or for independence between the households residing in the compound), the survey asks not just how many meters are at the compound, but also how many they had requested.

4.3 Power quality: outages and voltage

To measure household-level reliability and voltage quality we deploy the GridWatch technology (Klugman et al., 2021) with a subset of the households and firms that had participated in the socioeconomic surveying activity. GridWatch measures minute-by-minute power state and voltage at the household level, and can be installed by plugging a PowerWatch device (shown in Figure A3) into a power outlet. The device transmits data to the cloud in near real-time over the cellular network, and stores data locally to transmit later in the case of network failure. The central GridWatch server aggregates data to detect patterns in power outages and reduce noisy signals. For more information about the GridWatch deployment methodology see Klugman et al. (2019).

We aggregate these high-frequency measurements to the daily level. We code outages as hours of outage per site per day. Voltage quality is measured as the fraction of time voltage is within 10% of Kenya's nominal voltage of 230V (IEEE 2019).

We collect power outage and voltage quality across 150 sites for two months each, staggered between June 2021 and June 2022 by deploying four PowerWatch devices per site at a time. Since the staggered two-month GridWatch deployment rounds are overlapping, all regressions include day-of-sample fixed effects (in addition to constituency fixed effects) to control for power quality confounds such as weather and demand.

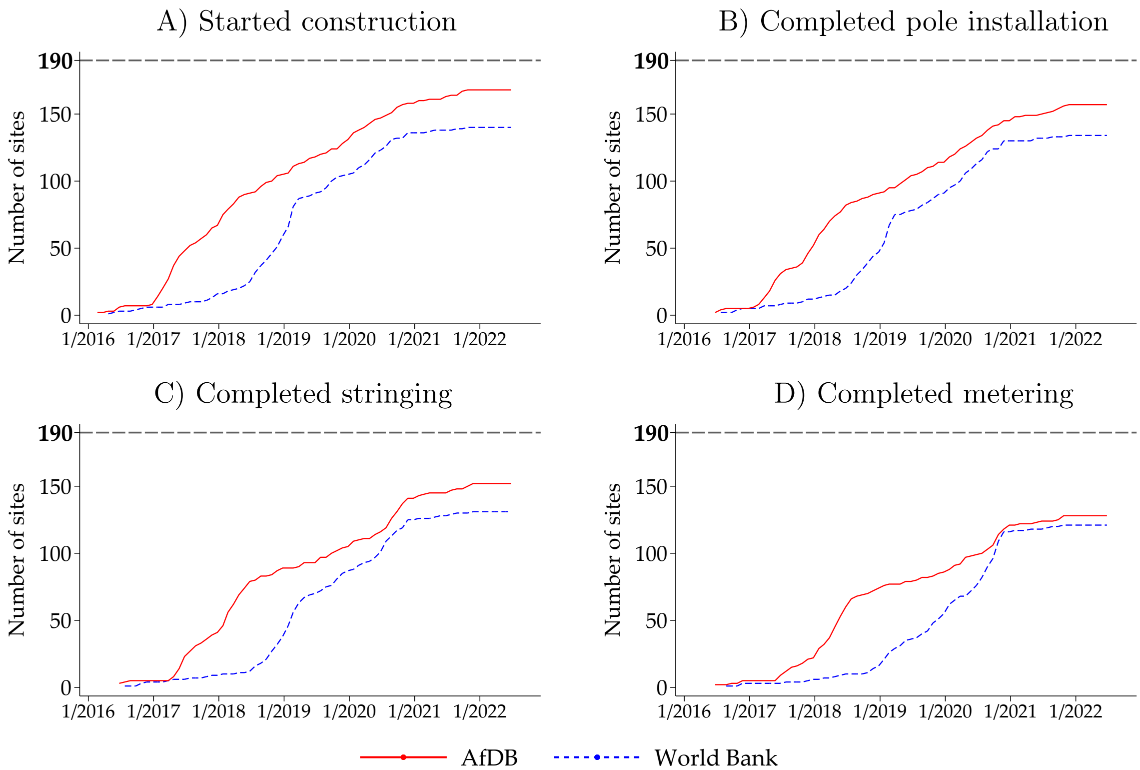
5 Results

Subsection 5.1 presents extensive margin results: how many sites saw construction, and among these sites, how much construction was completed? The next two subsections examine intensive margin results, defined as construction quality conditional on having a physical connection. Subsection 5.2 presents measurements of power outages and voltage quality collected using the GridWatch technology, and Subsection 5.3 presents results from the on-the-ground household and engineering assessments. Subsection 5.4 seeks to disentangle how two key features of conditionality in this context—contracting and auditing—contribute to these results. Subsection 5.5 quantifies correlations between funder, delays, and three potential sources of site selection bias—land gradient, facility type, and time since construction—and concludes that, while some correlations exist, these cannot explain our results.

5.1 Extensive margin results

Figure 7 demonstrates that construction progress at WB sites lagged significantly behind AfDB sites. Panel A demonstrates that this lag is driven by the initial delay in starting construction,

Figure 7: Construction progress by funding source



Data for 190 AfDB sites and 190 WB sites located in the five study counties collected through phone surveys with village representatives.

which resulted from the extensive ex ante contracting procedures. On average, construction at WB-funded sites started 7.6 months later than construction at AfDB-funded sites. This is in line with the timeline shown in Figure 1.

Panels B, C, and D of Figure 7 indicate that once construction started, WB construction progressed more rapidly in subsequent phases. By the end of pole installation and stringing completion, the average lag between WB and AfDB sites was reduced to 5.7 and 6.8 months, respectively. AfDB sites reached 50% metering completion in mid-2018,[21] and while metering at WB sites was delayed relative to AfDB sites, it proceeded rapidly starting in 2019 and eventually nearly caught up. By the end of tracking surveys in July 2022, six years after the start of construction, household metering had been completed at 67% of AfDB sites and at 64% of WB sites.

Among sites where construction had been completed, there was less construction at WB sites. The average number of customer connections at completed sites is 100 at AfDB sites and 84 at WB sites ($p = 0.08$). The average number of poles is 137 at AfDB sites and 123 at WB sites ($p = 0.05$). Table A4 presents these results in more detail. Regressions include constituency fixed effects and scale the field measurements to adjust for the fact that we only surveyed a subset of the grid at

[21] This timeline is in line with Kenya Power's own nationwide progress metrics, which reported that 49% of the AfDB Phase I household connections targeted had been achieved by mid-2018 (Kenya Power, 2018a).

more densely populated sites.[22]

Under the LMCP program specifications, only households located within 600 meters of the transformer were eligible for a connection, potentially with the goal of preventing poor voltage quality due to excessive distance. Column (5) of Table A4 show that the aggregate difference in number of connections between AfDB and WB is caused in part by less construction outside the 600 meter boundary at WB sites, suggesting stricter adherence to the official program requirements. This could be a result of increased safeguards against bribery, which might otherwise be used to induce construction beyond the guidelines, however the household survey data show similar rates of requests for informal side payments—approximately 8%—inside and outside the 600 meter boundary.

These delays and reduced construction at LMCP sites speak to the costs of the segregated contracting imposed by WB conditions. These are important to enumerate but inconclusive on their own from a policy perspective: the higher costs might be worth it if they lead to significant benefits. To examine this rigorously, the following sections examine power quality, construction quality, and household experiences.

5.2 Power quality

We collapse the minute-by-minute data collected by the GridWatch devices to 7,500 site-day power state and voltage observations. Panels A and B of Figure 8 present the hours of outage per day and fraction of time experiencing poor voltage quality, respectively, for WB and AfDB sites. Panels C and D estimates a separate coefficient for each day of the sample, as per the following equation:

$$y_{id} = \beta_0 + \sum_{n=1}^{365} \beta_n \gamma_{n=d} \mathrm{WB}_i + \gamma_d + \gamma_c + \epsilon_{id}, \tag{1}$$

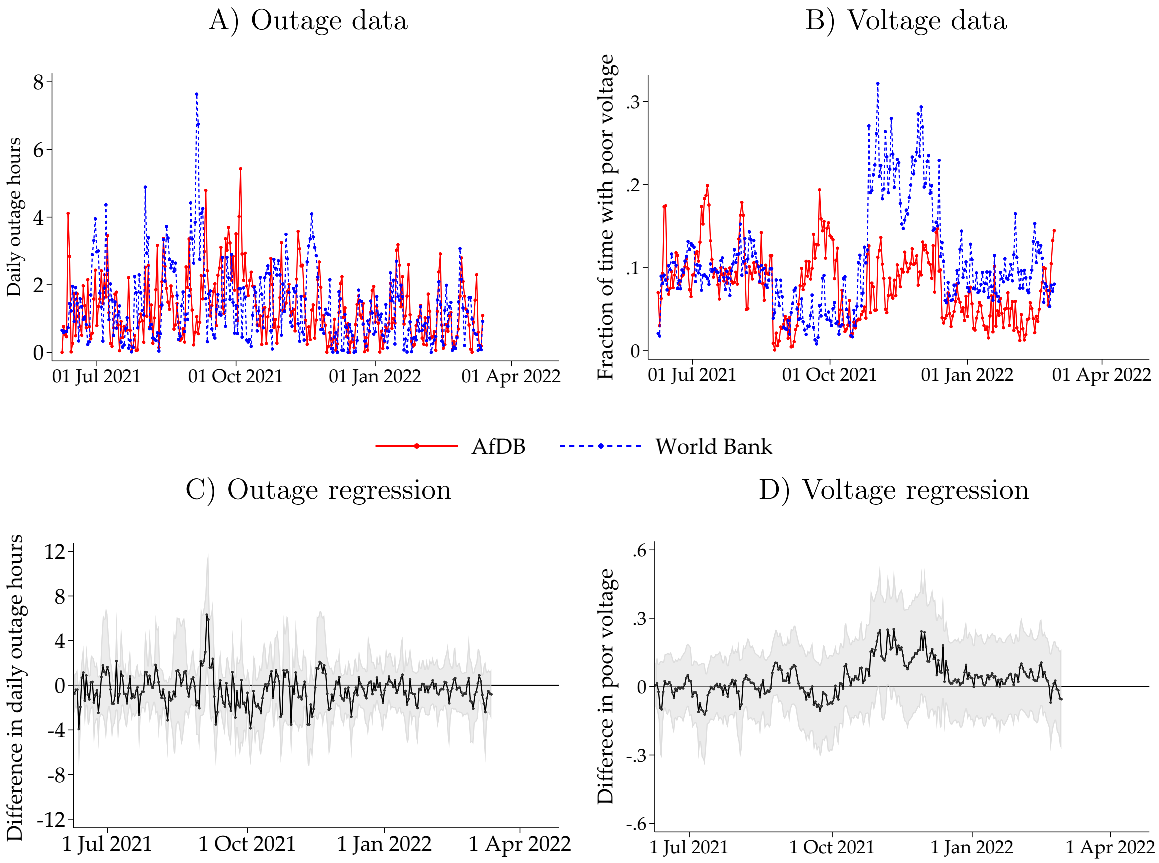
Where y_{id} is either hours of outage or fraction of time with poor voltage quality at site i on day d, WB_i is an indicator variable for whether site i is funded by the WB (as opposed to the AfDB), and γ_d and γ_c are day-of-sample and constituency fixed effects, respectively. Standard errors are clustered by site.

The estimates show no significant difference in power outages or in voltage quality between AfDB and WB sites. WB conditionality does not appear to have caused statistically or economically meaningful reductions in outages or improvements in voltage quality over the time period we study. Table A5 confirms that there are no significant differences in either outcome even when data are pooled.

Construction procedures and materials might affect power quality through two additional key engineering channels. First, voltage quality tends to worsen with distance from the central trans-

[22] This can be seen for example in the bottom right site shown in Figure A2, where we only surveyed the Southern half of the site. At sites that appeared too large to survey, we first recorded the number of distinct branches in the LV that started at the transformers, and then randomly pre-selected the number of branches that the field team is able to complete in the time that was allocated for the site. To obtain site-wide estimates, we scale the on-the-ground measurements according to the fraction of the grid that was surveyed.

Figure 8: Reliability and voltage quality by funding source



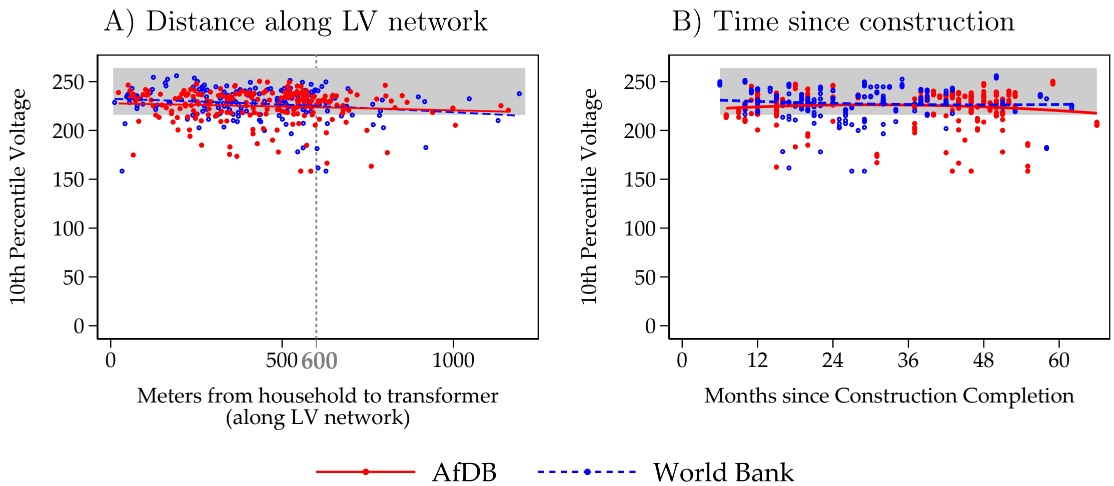
In panels A and C, outages are defined as hours of outage per day, averaged across sites. In panels B and D, poor voltage is defined as the fraction of time voltage is outside 230±10% per day, averaged across sites. In the voltage graphs, periods with power outages are set to missing in the voltage measurement data, but the results look similar when coding such periods as having $V = 0$.

former, both due to the distance traveled along the LV electricity wire as well as the consumption of electricity by meters connected more closely to the transformer (Jacome et al., 2019). Panel A of Figure 9 explores the correlation between 10th percentage of voltage quality and distance to the transformer along the LV network for WB sites and AfDB sites separately.[23] There appears no strong correlation along either dimension, and no difference between funders. In particular, there does not appear to be a significant or discontinuous decline after the 600 meters, the eligibility cutoff for a subsidized LMCP household connection, suggesting greater returns to scale might have been achieved under a higher distance eligibility cutoff.

Second, voltage quality could worsen with the passage of time, as infrastructure ages. Higher quality construction might make infrastructure more resilient and slow any associated decay. The time since construction varies across our sample since stringing was completed between June 2017 and January 2021, while GridWatch devices recorded data between June 2021 and June 2022. We

[23]The results look similar when using mean voltage. Using the 10th percentage of voltage quality is in line with engineering expectations around how resilience might affect voltage quality.

Figure 9: Voltage quality resilience to distance and infrastructure aging



10th percentile of hourly voltage readings with quadratic fit line. The gray area indicates Kenya's nominal voltage, 240 V, ±10% as per international utility guidelines. Panel A explores how a household's distance to the central transformer (as measured along the LV network) affects voltage quality. Panel B explores how the passage of time since the initial completion of construction affects voltage quality. Neither appear to strongly affect voltage quality. WB and AfDB exhibit similar trends.

surveyed the WB electricity networks when they were relatively newer. Associated biases, if any, would favor WB sites. Panel B of Figure 9 examines the correlation between voltage quality and time since construction. At both AfDB and WB sites, the grid appears resilient to aging, at least for the first five years after the completion of stringing. We discuss these robustness checks in more detail in Subsection 5.5.

Table A7 shows that distance along the LV network—expressed in terms of number of connections between the device and the transformer—worsens voltage quality. Donor conditionality does not appear to affect the resilience of voltage quality to the addition of customer connections along the LV network.

5.3 Engineering assessment and survey results

While WB conditionality does not appear to impact the quality of household electricity connections relative to AfDB procedures, it may still have improved construction quality outcomes in ways that did not translate to measurable medium-run changes in power quality. The primary outcomes are indices of the engineering measurements and socioeconomic outcome surveys described in Section 4. These indices are designed to estimate the impact of donor conditionality and independent monitoring—and their interaction—on engineering quality and socioeconomic well-being. All indices are standardized to have a mean of zero and a standard deviation of one. Outcomes 1–3, which measure construction quality, network configuration, and construction timing, are estimated

Table 2: Primary engineering and socioeconomic outcomes

	WB Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 1: Construction quality index	0.60***	-0.06	0.17	250
	(0.21)	(0.18)	(0.29)	
Outcome 2: Network size and configuration index	0.01	0.04	0.24	241
	(0.19)	(0.18)	(0.26)	
Outcome 3: Construction timing index	-0.90***	-0.29*	0.22	250
	(0.17)	(0.17)	(0.24)	
Outcome 4: Household installation quality index	0.05	0.23*	-0.21	944
	(0.12)	(0.12)	(0.17)	
Outcome 5: Household cost, experience, bribery index	0.13	0.11	-0.06	944
	(0.12)	(0.10)	(0.16)	
Outcome 6: Reliability and safety index	-0.11	-0.01	0.04	944
	(0.13)	(0.11)	(0.18)	
Outcome 7: Knowledge index	0.14	0.07	-0.07	944
	(0.10)	(0.10)	(0.14)	
Outcome 8: Electricity Usage index	0.12	0.28**	-0.17	944
	(0.13)	(0.13)	(0.17)	
Outcome 9: Household socioeconomic outcomes index	0.24*	0.20	-0.21	944
	(0.12)	(0.13)	(0.18)	
Outcome 10: Firm Performance Index	0.29	0.12	-0.23	373
	(0.19)	(0.17)	(0.28)	
Outcome 11: Political and Social Beliefs index	0.03	0.03	-0.02	944
	(0.08)	(0.09)	(0.12)	

Outcome variables are indices constructed from groups of variables standardized to have mean 0 and standard deviation 1. Each column presents results when the treatment variable is either: (1) WB funding source, or (2) the randomized audit treatment. In rows 1–3, observations are transformer sites; standard errors are shown in parentheses. For rows 4 through 8, observations are occupants of connected compounds. All regressions control for site land gradient and public facility type. Standard errors are clustered by transformer site and shown in parentheses. $^* \leq 0.10,^{**} \leq .05,^{***} \leq .01$. The sub-components for each index are presented in Table A8, Table A9, Table A10, Table A11, Table A12, Table A13, Table A14, Table A15, Table A16, Table A17, and Table A18.

at the site level using the following estimating equation:

$$y_i = \beta_0 + \beta_1 \text{WB}_i + \beta_2 \text{Treat}_i + \beta_3 \text{Treat}_i \cdot \text{WB}_i + \gamma_c + \epsilon_i \tag{2}$$

For site i, y_i is the outcome variable, and WB_i and Treat_i are indicator variables for whether site i is WB-funded and a randomized audit treatment site, respectively. β_1 and β_2 are the variables of interest for the primary treatment effects, while β_3 examines whether the additional WB inspections and the randomized audit treatment are substitutes or complements. γ_c are constituency fixed effects. Standard errors are clustered by site.

Outcomes 4–11 are estimated at the respondent level with an econometric specification similar to Equation 2. Table 2 shows the results. Two key results stand out. First, construction quality (outcome 1) is on average 0.6 standard deviations higher at WB sites. An analysis of the sub-components (Table A8) shows that this is primarily driven by increased presence of pole caps, struts, and stays on poles at WB sites. These features may be important: engineering research suggests that capped poles generally experience inner-pole moisture levels between 8–20% whereas uncapped poles experience levels between 30–80%, well above the threshold of 28–30% "considered necessary for fungal attack," over the 10 years after construction (UPRC 2018). While these features may have limited impacts on power quality over the five years we observe, they can reasonably be expected to increase the lifetime of the poles over the long-term.

Second, the WB ex ante contracting requirements caused a delay of 0.9 standard deviations, in line with the results presented in Figure 1 and Figure 7. Separating these delays by construction stage indicates that this is driven by delays to the start of construction, and not by delays during the construction process itself (Table A10).

While the difference in the aggregate network size and configuration index is not significant (Outcome 2; detail provided in Table A9), Columns (5) and (6) of Table A4 suggest the lower extensive margin construction at WB sites is driven in part by lower construction in the area between 600-700 meters from the transformer. At AfDB sites, we see more frequent construction outside of the 600m boundary. This is in line with Kassem, Zane, and Uzor (2022), who find that almost 30% of LMCP households are located beyond 600m of the transformer. The fact that this occurs less at WB sites indicates more stringent adherence to official LMCP rules, which could be viewed as a positive attribute, however it does result in fewer connections per site.

For Outcome 4 measuring household installation quality (Table A11) we replicate the index omitting the question asking the respondent whether they have a readyboard, since it is not obvious whether the presence of a readyboard is a positive or negative component. Its presence simultaneously indicates Kenya Power provisions and a lack of household preparedness (see Subsection 2.6 for more detail). Outcomes 5, 6, and 7 show little difference in household experiences. As an example, 41% of AfDB respondents and 43% of WB respondents reported having been told that they would have to pay Kenya Power for their electricity connection prior to construction, though this difference is not statistically significant. More detail is provided in Table A12, Table A13, and Table A14.

The private contractor awarded lots 3 and 5 of the WB construction contracts[24] experienced unusual financial circumstances and this may have interfered with the timeliness and quality of their construction. We therefore repeat the analysis from Table 2 excluding these contracts, and then only keeping a balanced panel of counties. This does not affect results—if anything, the WB performed worse on the remaining sample (the reduced sample size causes these estimates to be noisier, so we refrain from over-interpreting this pattern other than to say that it appears unlikely that this unusual circumstance is driving the results).

5.4 Disentangling ex ante contracting and ex post auditing

The WB procedural conditions include two features that distinguish it from the AfDB procedures: staggered ex ante contracting procedures and an additional round of post-construction inspections. To disentangle the role of these two channels, Table 2 indicates that the randomized audit treatment

[24] A single consortium won both of these contracts.

increased household installation quality (Outcome 4), household electricity usage (Outcome 8) and household socioeconomic outcomes (Outcome 9). An investigation of the index sub-components (shown in Table A15 and Table A16) shows that these results are driven primarily by higher likelihood of having a working meter, and increased use of lighting, appliances, and purchases of electricity tokens at treatment sites. In addition, the audit treatment increased the number of poles constructed at AfDB sites but not at WB sites (Columns (2) and (4) of Table A4). This is consistent with the fact that AfDB contractors were able to change site designs and thus increase construction at treatment sites, whereas WB construction contractors were constrained by the site designs that had already been finalized by a separate contractor.

These benefits came at the cost of a small delay caused by the audit treatment (Outcome 3; Table 2), however this delay is much smaller in magnitude than the delay caused by WB contracting, is statistically significant only at the 10% level. Furthermore, in the aggregate these delays generally do not persist beyond the initial stages (Figure A4).

We find no difference in firm performance (Outcome 10; Table A17) or political and social beliefs (Outcome 11; Table A18) along any dimension. Finally, we find no significant interactions between the WB conditions and the randomized audit treatment, suggesting that the audit treatment effect does not vary by whether a site was funded by the AfDB or the WB.

5.5 Robustness

Subsection 3.1 discussed the mechanism through which villages were arbitrarily assigned to a multilateral development bank for funding. While assignment is largely uncorrelated with observable characteristics, three notable differences stand out. This section explores the extent to which such selection may drive the results above.

First, WB-funded sites have a 13% higher average land gradient. It is plausible that hilliness slows construction and that this difference explains the WB delays. Table 3 therefore examines the correlation between land gradient, funder assignment, and construction delays as measured by time to stringing completion.[25] Land gradient is uncorrelated with construction delays, both unconditionally and conditional on funder. The primary delays caused by WB conditionality estimated in Columns (1) and (2) persist in a stable manner when controlling for land gradient in Columns (3) and (5). Differences in land gradient therefore apparently cannot explain the delay at WB sites.

Furthermore, Figure 10 demonstrates that the lag between WB and AfDB is approximately constant across the entire land gradient support. The difference in land gradient is therefore unlikely to explain the results.

Second, WB sites are significantly less likely to be located near a secondary school or religious building, and more likely to be located near a market center or no public facility at all (Table A2). Columns (4) and (5) of Table 3 confirm that the gap in timing between WB and AfDB sites persists when controlling for facility type. There is no correlation between facility type and delay.

[25] This is our preferred outcome because it captures significant construction process, but has a higher sample size than the subset of sites where metering was completed.

Table 3: Impact of gradient and facility type on months to stringing completion

	(1)	(2)	(3)	(4)	(5)
World Bank (=1)	6.8***	9.9***	9.5***	9.5***	8.7***
	(2.1)	(2.2)	(2.3)	(2.3)	(2.5)
Land gradient			0.6		0.4
			(0.6)		(0.7)
Health center				-0.3	1.1
				(5.4)	(5.7)
Secondary school				-0.4	-1.3
				(3.3)	(3.4)
Primary school				1.8	2.6
				(2.4)	(2.6)
Market center				1.1	1.9
				(2.7)	(2.9)
Religious building				-3.9	-4.0
				(2.9)	(3.0)
Other				2.7	4.9
				(5.8)	(6.3)
Observations	246	246	229	226	211
Constituency FE	No	Yes	Yes	Yes	Yes

Stringing was completed at WB sites on average 6.8 months later than at AfDB sites. Controlling for land gradient and facility type does not affect these estimates meaningfully, and land gradient and facility type appear largely uncorrelated with time to stringing completion. Table A19 displays the same for months to metering completion. $^{*} \leq 0.10, ^{**} \leq .05, ^{***} \leq .01$.

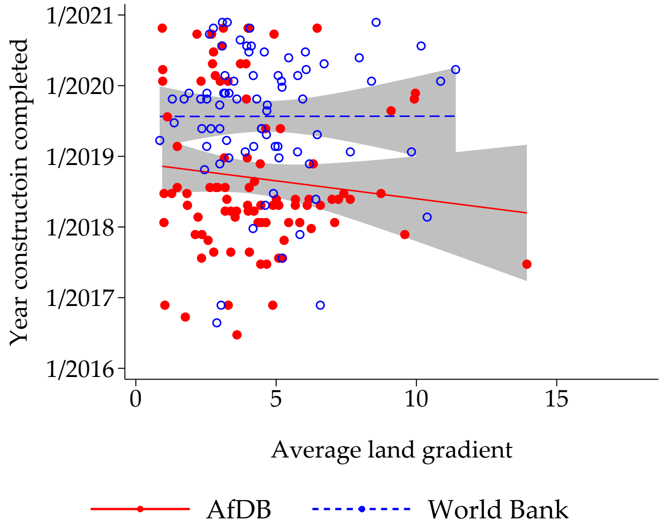
Furthermore, the gap in timing between WB and AfDB sites is not significantly different across facility types (Table A6). All results in Table 2 control for facility type, which do not qualitatively affect the results. Evaluated together, these analyses make it unlikely that baseline differences in land gradient or facility type contribute meaningfully to the results.

Third, the GridWatch devices recorded data between June 2021 and June 2022, even though stringing at most AfDB sites was completed between 2017 and 2019 and stringing at most WB sites was completed between 2018 and 2020. Thus, the GridWatch data measured WB sites when they were on average newer than the AfDB sites surveyed at the same time. If the aging of the grid negatively affects reliability and voltage quality, then this bias would favor WB in the results. Figure 9 confirms that voltage quality is constant over time, and that the lack of difference in voltage quality between the WB and the AfDB persists even among sites where the time since stringing completion was approximately equal.

6 Policy cost effectiveness

The WB's more onerous contracting and inspection requirements improved construction quality, but at the cost of significant delays. Subsection 6.1 first investigates each donor's program costs, in aggregate and by component. Subsection 6.2 then investigates the trade-off between short-term construction expediency and long-term infrastructure resilience, and examines whether this trade-

Figure 10: Construction delays and land gradient



Average land gradient is calculated for each site over the 600 meter radius around its transformer. Land gradient is uncorrelated with construction delays, both unconditionally and conditional on funder. The lag between WB and AfDB is approximately constant across the entire land gradient support. Data source: Shuttle Radar Topography Mission (SRTM) Global Digital Elevation Model. Gradient is measured in degrees from 0 (perfectly flat) to 90 degrees (perfectly vertical) (Dinkelman, 2011).

off is necessary: could improvements in long-term construction quality be achieved without any associated delays?

6.1 Cost analysis

Why did the WB not opt to use turn-key contracting, given its less onerous requirements and given that the WB and AfDB contracting guidelines are nearly identical on paper in specifying that turn-key or staggered contracting are both acceptable? One argument is that pooling the procurement of major materials nationwide generates cost savings.

To investigate this, we analyze nationwide contract amounts, including those covering consulting, design, goods, construction, and turn-key activities, across the AfDB's 5,320 sites and the WB's 4,200 sites.[26] 1,000 of the WB sites included the construction of a new transformer: these sites are excluded from our surveying sample, and we exclude the USD 1.96mn contract awarded for the procurement of 1,000 new transformers from these calculations. That said, we are unable to distinguish other potential costs associated with transformer construction, such as the cost of labor for transformer construction from labor for household connections. Given these differences, the costs seem comparable in aggregate. The average cost was thus USD 28,938.06 per AfDB site and

[26]The AfDB and World Bank's contracting methodology prevents a site-by-site analysis: contract amounts aggregate costs for design, procurement, and construction across hundreds of sites, usually spanning several counties, such that even Kenya Power lacks the detailed information about contractor activities that would enable them to dis-aggregate costs.

USD 31,679.38 per WB site.[27]

The national targets announced by Kenya Power would have required an average of 59 new household connections at each AfDB site and 74 new household connections at each WB site (Kenya Power, 2016a). Using these numbers, the average cost per connection would have been USD 519.58 at AfDB sites and USD 421.89 at WB sites. However, in the 250 surveyed sites, our survey team identified on average 72 new LMCP household connections at AfDB sites and 62 at WB sites. Using these numbers, the average cost per connection would have been USD 401.92 at AfDB sites and USD 510.96 at WB sites. Finally, assuming a uniform 80 households per site would yield a construction cost of approximately USD 361.73 per household connection at AfDB sites and USD 395.99 at WB sites.

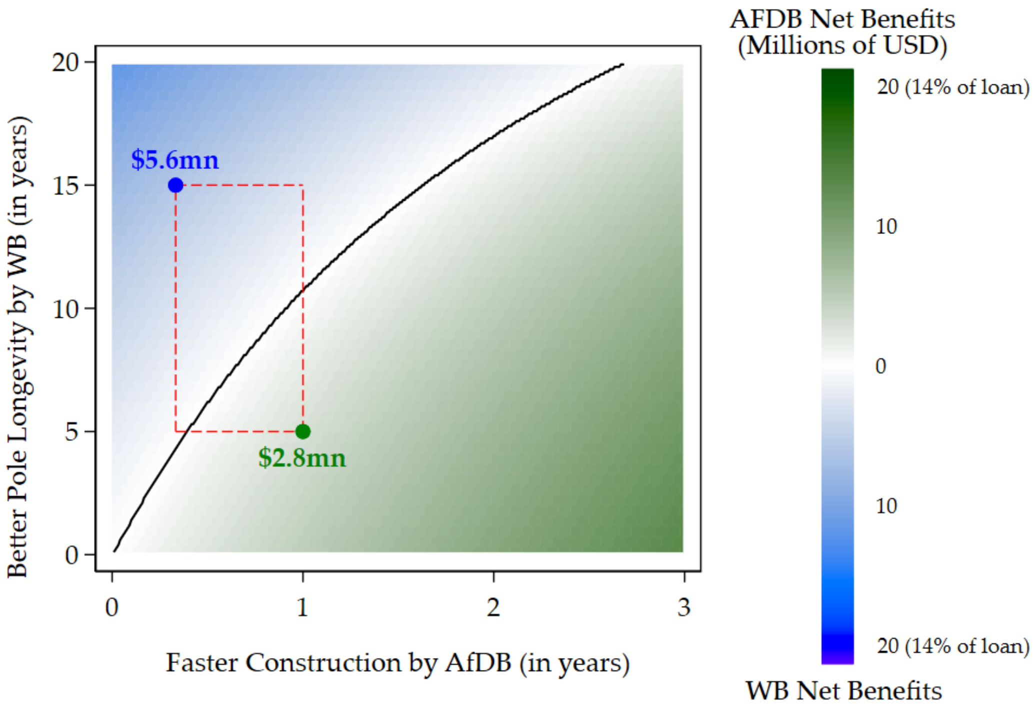
In any case, all of these estimates are significantly lower than the USD 739 average total cost per connection that Lee, Miguel, and Wolfram (2020) estimate under a 100% electrification scenario in a similar area in rural Kenya. The difference can be reasonably attributed to implementation efficiencies derived from the nationwide coordination of design, procurement, and construction activities.

The WB contracting structure may still generate cost savings for the procurement of specific goods. We explore the case of wooden and concrete poles, which are generally homogeneous which allows straightforward comparisons across contracts. The WB contracts indicate that Kenya Power procured 199,119 wooden poles and 44,701 concrete poles for use at WB sites, at an average cost of USD 98.60 per wooden pole and USD 198.75 per concrete pole. The AfDB contracts indicate that Kenya Power procured 159,604 wooden poles and 159,198 concrete poles for use at AfDB sites, at an average cost of USD 158.73 per wooden pole and USD 239.78 per concrete pole. The WB contracts thus do appear to have a cheaper per-unit cost. However, given that the aggregate cost per site across all contracts is almost identical, the amounts listed in individual AfDB turn-key contract categories may not perfectly reflect the procurement on the ground: anecdotally, contractors may shift costs onto goods since these invoices are paid earlier in the construction process than labor. Since this does not affect aggregate cost, we prefer the analysis using aggregate contract amounts.

Finally, there may be disparities between the contract amounts and the actual built amounts. For example, according to the procurement contracts, 18% of WB poles and 50% of contracted AfDB poles were concrete—however, according to our on-the-ground surveys, only 3% of poles at WB sites and 25% of poles at AfDB sites were concrete. However, we cannot distinguish pre-existing poles from poles that were newly constructed during LMCP, so if pre-existing poles were disproportionately wood poles then this could explain this discrepancy. For these reasons, we refrain from over-interpreting this result.

[27] Kenya Power awarded USD 153.95mn in contracts for construction at 5,320 sites. Excluding the transformer procurement contract, Kenya Power awarded USD 133.05mn in contracts for construction at 4,200 sites.

Figure 11: Costs versus benefits of different contracting approaches



This graph illustrates expected net benefits from adopting either the African Development Bank procedures or World Bank procedures. The horizontal axis represents the gains in construction speed from adopting more expedient contracting procedures of the type employed by the African Development Bank for work for the Last Mile Connectivity Project. The vertical exist represents the magnitude of potential quality gains from adopting contracting procedures of the type employed by the World Bank. Quality gains are assumed to accrue to the expected service life of poles, and the probability of pole failure is assumed constant in every year following construction. Households are assumed to value an electricity connection at $147 on average (following Lee, Miguel, and Wolfram, 2020). Households are assumed to have annual discount rates of 10%. The planner is assumed to have a time horizon of 40 years and an annual discount rate of 10%. The red box illustrates a region between 4 to 12 months faster construction (consistent with data on construction progress from the five-county study area) and between 5 to 15 years improved service life for poles (consistent with the discussion in Muthike and Ali, 2021). Figure A5 presents variations on these assumptions over 5-year and 40-year time horizons, lower discount rates, as well as assuming $293 household valuation elicited by Lee, Miguel, and Wolfram (2020) using stated preference methods.

6.2 Cost-benefit analysis

To evaluate the potential costs and benefits of different contracting methodologies, we focus on potential gains and losses in construction speed and construction quality. The data show that on average AfDB sites reached construction milestones six to ten months faster than WB sites. Depending on the discount rate, allowing benefits to be realized earlier will increase their net present value. However, as shown in Table A8, WB sites tended score higher in the construction quality index, with differences driven largely by aspects of pole and pole installation quality. This will likely reduce long-term repair and replacement costs for Kenya Power. [28]

[28] While the procurement cost per pole was different for AfDB and WB contracts during the LMCP, we assume a uniform replacement cost of USD 100 for this calculation as Kenya Power, not the multilateral donor, is responsible for long-term maintenance and repair and would thus procure these items independently.

In Figure 11 we estimate the costs and benefits of different contracting approaches under different assumptions. Household valuation of rural electrification is assumed to be $147, following estimates from Lee, Miguel, and Wolfram (2020). This valuation is expected to be context dependent, of course, and we would expect that higher valuation relative to replacement cost would lead an expedient approach to be more worthwhile. Annualized discount rates are assumed to be 0.1 for both households and the planner. We assume that households discount delayed provision of electricity services, and planners discount future maintenance costs.[29] The range of the vertical axis corresponds to roughly a 20 to 40 year average service life for a pole, which depends on pole quality and is consistent with the discussion in Muthike and Ali (2021). Some alternative assumptions are explored further in Table A20.

Figure 11 illustrates how net benefits to adopting AfDB style procedures increase as the speed of construction increases relative to the counterfactual under WB style policies. On the other hand, the higher the gain in quality, the greater the net benefits of WB style policies. Using plausible estimates of the gains in construction speed and in quality of poles, we find that the overall net benefits of either set of policies are ambiguous. The red box illustrates a region between 4 to 12 months faster construction and between 5 to 15 years improved service life for poles that appear to be consistent with the data and with Muthike and Ali (2021).

While the assumptions that are made in this exercise are particular to mass electrification in Kenya, the calculations in Table A20 are intended to illustrate the trade-offs that may influence the contracting approaches best suited to large-scale development projects more generally. If the planner discounts future costs and benefits more severely, or if a more stringent contracting approach is likely to produce greater delays, then a more expedient approach may be more worthwhile. Conversely, if a more expedient approach is expected to be associated with a greater decline in quality–perhaps because quality is more difficult to monitor and enforce through other mechanisms in a particular context– then a more stringent approach may be better suited.

Given the detail of the Inspection Reports (IRs) (discussed in more detail in Subsection 2.5), in particular with regards to the correct installation of visible materials such as pole caps, struts, and stays it appears likely that these played a big role in improving construction quality and therefore pole longevity. Given that the IRs were implemented after construction, they are unlikely to have contributed significantly to delays in connectivity. We do not have cost estimates of the IRs per se, however these costs could pay for themselves in reduced long-term repair and maintenance expenditures. For comparison, the research team budgeted approximately $125,000 for data collection at 380 sites, or about $329 per site (approximately 1% of the average per-site LMCP expenditures), however these data include household and firm surveys and their level of detail far exceeded the intensity of monitoring through the IRs.

These results come with important caveats. These back-of-the-envelope calculations do not

[29] For this exercise, we assume about half of total replacement costs is for materials alone, which is roughly consistent with contract amounts in the WB Phase I construction. Poles are assumed to have a constant probability of failure in any given year. The total number of poles is assumed to approximate the intended total number of new connections, which is consistent with survey data from the five counties study area.

consider any additional staff time incurred by the World Bank, Kenya Power, and other government agencies due to increased paperwork and processing necessary to implement the World Bank's contracting procedures. We also do not consider any potential spillover benefits such as increased knowledge of oversight mechanisms within Kenyan government agencies. We also do not consider possible degradation of electricity service quality over time due to lower quality construction. Perhaps most importantly, we do not observe leakage. It is possible that WB contracting requirements meaningfully reduce leakage of funds that were recently observed, for example, by Andersen, Johannesen, and Rijkers (2022). We cannot observe or rule out differences in funds leakage, but to the extent that this would have reduced the availability of funds for intended construction, this does not appear to have affected construction outcomes.

7 Conclusion

This research evaluates the impact of differences in donor conditionality set by multilateral organizations when financing government infrastructure investments outsourced to private sector contractors. We study this topic in the context of the Last Mile Connectivity Project (LMCP), one of Kenya's largest public infrastructure construction projects. The roughly USD 600 million cost of the program is financed in large part by international donors, including in particular the WB and the AfDB. We exploit quasi-random variation in the assignment of specific communities designated for inclusion in the LMCP to be funded by either the WB or the AfDB. Contractors who win bids issued by the WB are required to comply with the WB's relatively more stringent conditions. Our measurements include high-frequency household-level outage and voltage data, on-the-ground engineering measurements of the local electricity network, and household and firm socioeconomic surveys inquiring about the connection experience, knowledge, and electricity usage. In addition to primary data collection, we analyze LMCP procurement contracts, inspection reports, and infrastructure data, and we conduct informational interviews with dozens of senior personnel at Kenya Power, the AfDB, and the WB.

We find that the WB's requirements cause significant delays in implementation, with households at WB sites receiving their electricity connections on average 9.6 months later than households in sites that are funded by the AfDB. We can rule out that the conditions causing these delays generated statistically or economically meaningful improvements in power outages or voltage quality in the short term. However, we find a 0.6 standard deviation improvement in construction quality at WB site, driven by increased presence of pole caps, stays, and struts, which were key components examined during the WB's additional inspection round. The estimates on several other key outcomes—such as household installation quality, cost, and electricity usage—are positive but generally modest in size and not statistically significant, although improvements may emerge in the longer run.

To investigate the difference between two key components of donor conditionality—contracting requirements and audits—we implement a randomized audit treatment where contractors are informed of a subset of sites that are selected for monitoring. The randomized audit treatment generates a 0.2 standard deviation improvement in household installation quality and a 0.3 standard deviation improvement in electricity usage, while causing significantly fewer delays than the WB approach. This suggests some benefits can be captured from this much less burdensome component of donor conditionality.

These analyses generate several tangible policy recommendations. First, and holding constant the two funders' contracting procedures, we identify a trade-off between short-term expediency and long-term grid resilience. Weighing the short-term benefits of earlier access to electricity with the long-term benefit of lower maintenance and upgrading expenditures implies that the social planner's time preferences will affect the relative net benefits. Under even a modest range of assumptions, our estimates can rationalize anywhere from a USD 5.6mn net benefit at AfDB sites to a USD 2.8mn net benefit at WB sites. Second, more streamlined upfront contracting with more rigorous auditing could prevent significant delays without necessarily compromising construction quality. This is likely especially the case when target contractors participate in a repeated game where poor construction performance could threaten a contractor's future contracting opportunities.

Several important limitations are worth noting. First, WB conditionality could generate substantial benefits that are unobservable to our research team, such as improved institutional capacity or accounting practices in Kenya public sector organizations. Second, the latest we inspect a site is five years after construction. While we see no correlation between construction quality and time since construction over this period, it is possible that construction quality worsens over time, and that the stringent WB contracting procedures will improve grid resilience against such depreciation over a longer time horizon. Finally, Kenya is a relatively high-capacity state in East Africa, and its internal regulatory system may be sufficiently rigorous so as not to benefit meaningfully from additional WB requirements. It is possible that our results would not hold in a lower-capacity state. Additional research is needed to understand these dimensions and potential impacts of donor conditionality over time and in other settings.

References

Andersen, J. J., Johannesen, N., & Rijkers, B. (2022). Elite capture of foreign aid: Evidence from offshore bank accounts. *Journal of Political Economy*, *130*(2), 388–425. https://doi.org/10.1086/717455

Archibong, B., Coulibaly, B., & Okonjo-Iweala, N. (2021). Washington Consensus reforms and lessons for economic performance in Sub-Saharan Africa. *Journal of Economic Perspectives*, *35*(3), 133–56.

Berkouwer, S., Lee, K., & Walker, M. (2018). Secondary School Electrification in Western Kenya [AidData Working Paper 57].

Blimpo, M. P., & Cosgrove-Davies, M. (2019). Electricity access in Sub-Saharan Africa: Uptake, reliability, and complementary factors for economic impact. *Africa Development Forum;. Washington, DC: World Bank.*

Burlig, F., & Preonas, L. (2021). Out of the darkness and into the light? development effects of rural electrification [Working Paper].

Business Daily. (2007, December 12). *Kenya: KPLC Allows Tree Farmers to Supply Untreated Poles*. Retrieved August 24, 2022, from https://allafrica.com/stories/200712121237.html

Business Daily. (2018, October 2). *DCI raid led to arrests at Kenya Power, says official*. Retrieved August 4, 2022, from https://www.businessdailyafrica.com/bd/news/dci-raid-led-to-arrests-at-kenya-power-says-official-2221694

Cappellazzi, J., & Konkler, M. (2018). *38th Annual Report 2018* (tech. rep.).

Dinkelman, T. (2011). The effects of rural electrification on employment: New evidence from South Africa. *American Economic Review*, *101*(7), 3078–3108.

Dreher, A., Fuchs, A., Parks, B., Strange, A., & Tierney, M. J. (2021). Aid, China, and growth: Evidence from a new global development finance dataset. *American Economic Journal: Economic Policy*, *13*(2), 135–74.

Duflo, E., Greenstone, M., Pande, R., & Ryan, N. (2018). The value of regulatory discretion: Estimates from environmental inspections in India. *Econometrica*, *86*(6), 2123–2160.

Easterly, W. (2002). *The Elusive Quest for Growth: Economists' Adventures and Misadventures in the Tropics* (Vol. 1). The MIT Press.

Easterly, W. (2019). In search of reforms for growth: New stylized facts on policy and growth outcomes [NBER Working Paper 26318]. *National Bureau of Economic research.*

Elvidge, C. D., Baugh, K., Zhizhin, M., Hsu, F. C., & Ghosh, T. (2017). VIIRS night-time lights. *International Journal of Remote Sensing*, *38*(21), 5860–5879.

ESI Africa. (2020, February 24). *Kenya Power contests High Court ruling over its tender cancellation* [News Article]. Retrieved January 29, 2021, from https://www.esi-africa.com/industry-sectors/finance-and-policy/kenya-power-contests-high-court-ruling-over-its-tender-cancellation/

Ferraz, C., & Finan, F. (2008). Exposing corrupt politicians: The effects of Brazil's publicly released audits on electoral outcomes. *The Quarterly journal of economics*, *123*(2), 703–745.

Finan, F., Olken, B. A., & Pande, R. (2017). The personnel economics of the developing state, In *Handbook of economic field experiments*. Elsevier.

Hart, O., Shleifer, A., & Vishny, R. W. (1997). The Proper Scope of Government: Theory and an Application to Prisons*. *The Quarterly Journal of Economics*, *112*(4), https://academic.oup.com/qje/article-pdf/112/4/1127/5393947/112-4-1127.pdf, 1127–1161. https://doi.org/10.1162/003355300555448

IEEE recommended practice for monitoring electric power quality. (2019). *IEEE Std 1159-2019 (Revision of IEEE Std 1159-2009)*, 1–98.

Isaksson, A.-S., & Kotsadam, A. (2018). Chinese aid and local corruption. *Journal of Public Economics*, *159*, 146–159.

Jacome, V., Klugman, N., Wolfram, C., Grunfeld, B., Callaway, D., & Ray, I. (2019). Power quality and modern energy for all. *Proceedings of the National Academy of Sciences*, *116*(33), 16308–16313.

Kangethe, K. (2015). *AfDB to finance sh15bn electrification project* [Capital Business]. Retrieved February 8, 2022, from https://www.capitalfm.co.ke/business/2015/12/afdb-to-finance-sh15bn-electrification-project/

Kassem, D., Zane, G., & Uzor, E. (2022). Revisiting the last mile: The development effects of a mass electrification program in Kenya [Working paper].

Kenya National Bureau of Statistics. (2009). Kenya population and housing census.

Kenya National Bureau of Statistics. (2019). Kenya population and housing census.

Kenya Power. (2015a, December 10). *KPLC awards contracts for implementation of the Last Mile Project* [Press Release]. Retrieved January 29, 2021, from https://www.kplc.co.ke/content/item/1226/kplc-awards-contracts-for-implementation-of-the-last-mile-project

Kenya Power. (2015b, June 9). *Notes by Dr. Ben Chumo, Kenya Power Managing Director and Chief Executive Officer, During the Press Conference on Implementation of the Last Mile Project* [Press Conference]. Retrieved January 29, 2021, from https://kplc.co.ke/img/full/2nPEsH9Dge4K_Notes%20-%20MD%20-%20Press%20Conference.pdf

Kenya Power. (2016a, September 16). *Last Mile Connectivity Program Q & A*. https://www.kplc.co.ke/content/item/1694/last-mile-connectivity-program-q---a

Kenya Power. (2016b, September 16). *Minutes of pre-bid meeting for tender NO KP1/9AA-2/PT/20/14-15 - supply of treated powr distribution wooden poles held on 16/10/2014 at the Stima Plaza basement floor*. %7Bhttps://kplc.co.ke/img/full/2Gwl66r7xFCG_MINUTES%5C%20OF%5C%20PRE_BID%5C%20MEETING%5C%20FOR%5C%20%5C%20SUPPLY%5C%20OF%5C%20TREATED%5C%20POWER%5C%20DISTRIBUTION%5C%20WOODEN%5C%20POLES(LOCAL%5C%20MANUFACTURERS%5C%20ONLY).pdf%7D

Kenya Power. (2017, November 8). *Kenya Power signs contracts for implementation of the Last Mile Connectivity Project* [Press Release]. Retrieved January 29, 2021, from https://www.kplc.co.ke/content/item/2272/kenya-power-signs-contracts-for-implementation-of-the-last-mile-connectivity-project

Kenya Power. (2018a). Annual report and financial statements for the year ended 30th june 2018.

Kenya Power. (2018b, May 24). *Kenya Power to blacklist contractors for shoddy work* [Press Release]. Retrieved January 29, 2021, from https://www.kplc.co.ke/content/item/2513/kenya-power-to-blacklist-contractors-for-shoddy-work

Kenya Power. (2020, March 18). *Kenya Power staff and several other suspects arrested over various crimes undermining quality power supply* [Press Release]. Retrieved March 10, 2021, from https://www.kplc.co.ke/content/item/3484/kenya-power-staff-and-several-other-suspects-arrested-over-various-crimes-undermining-quality-power-supply

Kenya Presidency. (2015, May 27). *Cost Of Installing Electricity Drops To Ksh15,000 With Option Of Instalments*. https://www.president.go.ke/2015/05/27/cost-of-installing-electricity-drops-to-ksh15000-with-option-of-instalments/

Kersting, E., & Kilby, C. (2016). With a little help from my friends: Global electioneering and world bank lending. *Journal of Development Economics*, *121*.

Kilby, C. (2013). The political economy of project preparation: An empirical analysis of world bank projects. *Journal of Development Economics*, *105*, 211–225.

Klugman, N., Adkins, J., Paszkiewicz, E., Podolsky, M., Taneja, J., & Dutta, P. (2021, April 2). *Watching the grid: Utility-independent measurements of electricity reliability in Accra, Ghana* (Conference Presentation, to appear) [IPSN Conference Presentation, to appear].

Klugman, N., Wolfram, C., Taneja, J., Dutta, P., Adkins, J., Berkouwer, S., Abrokwah, K., Bobashev, I., Pannuto, P., Podolsky, M., Suseno, A., & Thatte, R. (2019). Hardware, apps, and surveys at scale: Insights from measuring grid reliability in Accra, Ghana, In *Proceedings of the conference on computing & sustainable societies - COMPASS '19*. the Conference, Accra, Ghana, ACM Press.

Lee, K., Miguel, E., & Wolfram, C. (2020). Experimental evidence on the economics of rural electrification. *Journal of Political Economy*, *128*(4).

Levin, J., & Tadelis, S. (2010). Contracting for government services: Theory and evidence from u.s. cities. *The Journal of Industrial Economics*, *58*(3), 507–541.

Malik, A. A., Parks, B., Russell, B., Lin, J. J., Walsh, K., Solomon, K., Zhang, S., Elston, T.-B., & Goodman, S. (2021). *Banking on the Belt and Road: Insights from a new global dataset of 13,427 Chinese development projects* (tech. rep.). AidData at William Mary. Williamsburg, VA.

Marx, B. (2018). Elections as incentives: Project completion and visibility in African politics [Working paper].

Mihalyi, D., Hwang, J., Rivetti, D., & Cust, J. (2022). Resource-backed loans in Sub-Saharan Africa [Policy Research Working Paper 9923]. *World Bank Group*.

Ministry of Energy and Petroleum, Republic of Kenya. (2014). *Draft National Energy Policy* (tech. rep.).

Moscona, J. (2020). The management of aid and conflict in Africa. *Working Paper*.

Mosley, P. (1986). Book reviews. *Theory, Culture & Society*, *3*(3), 192–194.

Moyo, D. (2009). *Dead aid: Why aid is not working and how there is a better way for Africa*. Farrar, Straus; Giroux.

Muthike, G., & Ali, G. (2021). Concrete vs wooden poles: Effects of the shift to concrete poles on tree growers.

Olken, B. A. (2007). Monitoring corruption: Evidence from a field experiment in Indonesia. *Journal of Political Economy*, *115*(2), 200–249.

Ping, S.-N., Wang, Y.-T., & Chang, W.-Y. (2022). The effects of China's development projects on political accountability. *British Journal of Political Science*, *52*(1), 65–84.

Reuters. (2018, July 16). *Kenya Power's CEO charged in court over economic crime*. Retrieved March 10, 2021, from https://www.reuters.com/article/us-kenya-corruption/kenya-powers-ceo-charged-in-court-over-economic-crime-idUSKBN1K60WG

Rodrik, D. (2006). Goodbye Washington Consensus, hello Washington confusion? a review of the world bank's economic growth in the 1990s: Learning from a decade of reform. *Journal of Economic Literature*, *44*(4), 973–987.

Rural Electrification Authority. (2008). Strategic plan 2008-2012.

Ryan, N. (2020). Contract enforcement and productive efficiency: Evidence from the bidding and renegotiation of power contracts in India. *Econometrica*, *88*(2), 383–424.

Ryan, N. (2021). *Holding up green energy* (Working Paper No. 29154). National Bureau of Economic Research.

Silva, C. (2022). *Angola (re)model: How angola's honeymoon with China came to an end*.

Spotlight East Africa. (2020, May 7). *AfDB blacklists another Chinese Kenya Power contractor over fraud*. Retrieved March 10, 2021, from https://www.spotlighteastafrica.com/post/afdb-blacklists-another-chinese-kenya-power-contractor-over-fraud

State Council. (2011). *White Paper on China's Foreign Aid* (tech. rep.). Xinhua/Information Office of the State Council, People's Republic of China.

Tadelis, S. (2012). Public procurement design: Lessons from the private sector [Selected Papers, European Association for Research in Industrial Economics 38th Annual Conference, Stockholm, Sweden, September 1-3, 2011]. *International Journal of Industrial Organization*, *30*(3), 297–302.

The African Development Bank. (2014a). Comprehensive review of the afdb's procurement policies and procedures – summary of literature on harmonization in public procurement.

The African Development Bank. (2014b). Last mile connectivity project, project appraisal report.

The African Development Bank. (2018a). Operations procurement manual, part a, volume 1: General considerations.

The African Development Bank. (2018b). Operations procurement manual, part a, volume 2: Specialized procurement.

The Nation. (2021, December 9). *Rural electricity firm bought substandard poles for Sh800m*. Retrieved January 17, 2022, from https://nation.africa/kenya/business/rural-electricity-firm-bought-substandard-poles-for-sh800m-3646434

The Nation. (2022, August 3). *Kenya Power graft scam: State barred from introducing new charges*. https://nation.africa/kenya/business/kenya-power-graft-scam-state-barred-from-introducing-new-charges-3901214

The Star. (2018, December 18). *State lost Sh201m in Kenya Power scandal*. Retrieved March 10, 2021, from https://www.the-star.co.ke/news/2018-12-18-state-lost-sh201m-in-kenya-power-scandal/

The World Bank. (2015). Proposed guarantee in an amount equivalent to US$200 million to the republic of Kenya for an electricity modernization project.

The World Bank. (2017). Issuance of sanctions board decision no. 102. https://www.worldbank.org/en/about/unit/sanctions-system/sanctions-board/brief/issuance-of-sanctions-board-decision-no-102

The World Bank Group. (2011). Procurement of goods, works, and non-consulting services under IBRD loans and IDA credits & grants by World Bank borrowers.

The World Bank Group. (2014). The world bank and public procurement—an independent evaluation.

The World Bank Group. (2015). International development association project appraisal document on a proposed credit in the amount of SDR 172.6 million (US$250 million equivalent) proposed strategic climate fund-scaling-up renewable energy program grant in the amount of US$7.5 million and a proposed guarantee in an amount equivalent to US$200 million to the republic of Kenya for an electricity modernization project.

The World Bank Group. (2016). Guidelines on preventing and combating fraud and corruption in projects financed by IBRD loans and IDA credits and grants [LEGVP5.09-DIR.117].

The World Bank Group. (2020). Procurement regulations for IPF borrowers [Fourth Edition]. https://thedocs.worldbank.org/en/doc/178331533065871195-0290022020/original/ProcurementRegulations.pdf

A thousand golden stars: China goes to Africa. (2017). https://www.economist.com/middle-east-and-africa/2017/07/20/china-goes-to-africa

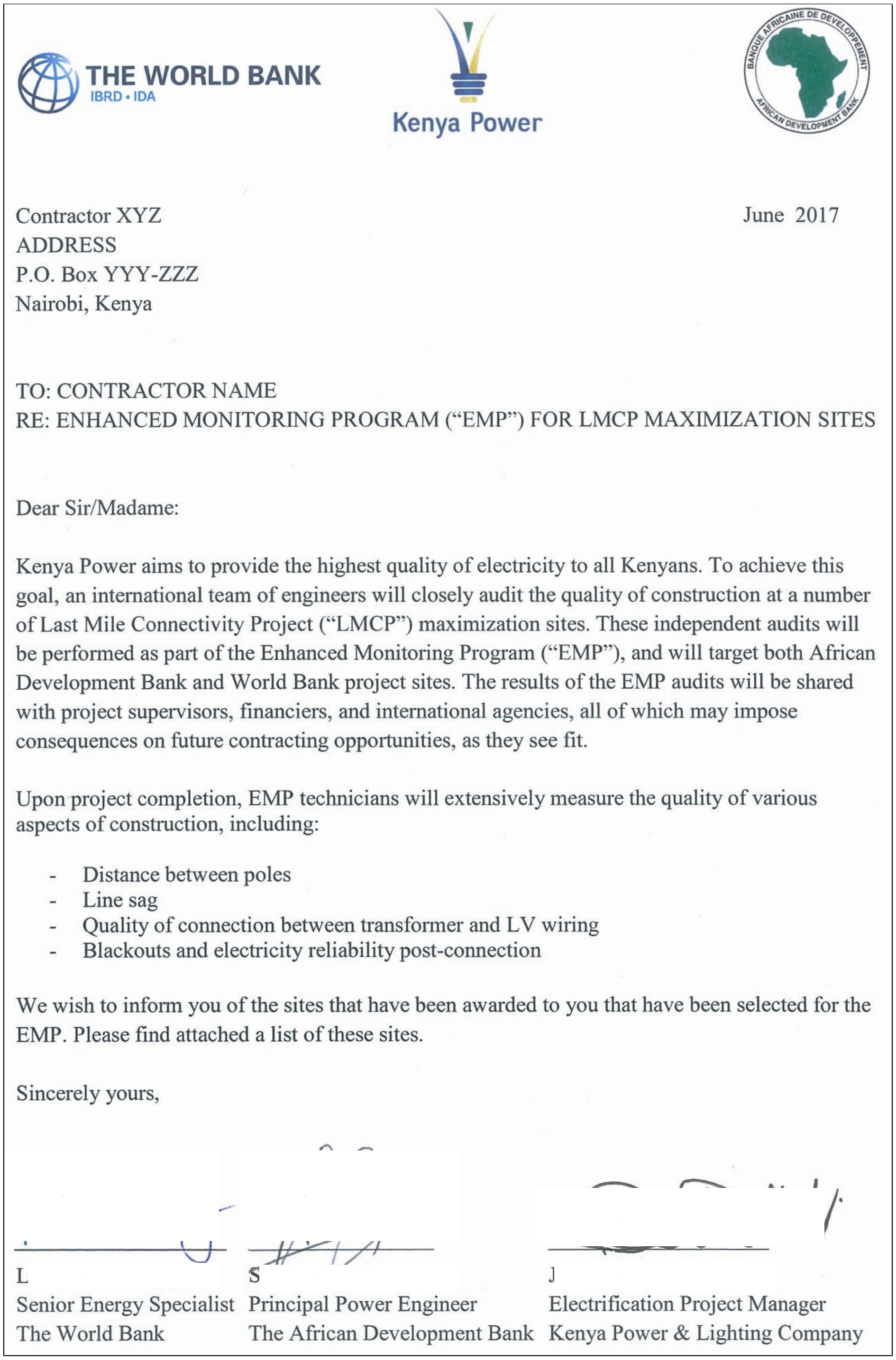
Williamson, J. (2009). A short history of the Washington Consensus preface. *Law and Business Review of the Americas*, *15*, 7.

Williamson, O. (1999). Public and private bureaucracies: a transaction cost economics perspectives. *The Journal of Law, Economics, and Organization*, *15*(1), 306–342.

Wolfram, C. D., Hsu, E., Berkouwer, S. B., Kim, O. W., Vial, F., & Miguel, E. (2022). Decomposing Political Favoritism in Kenyan Mass Electrification [Working Paper].

A Appendix Figures

Figure A1: Monitoring Intervention



THE WORLD BANK
IBRD • IDA

Kenya Power

BANQUE AFRICAINE DE DEVELOPPEMENT
AFRICAN DEVELOPMENT BANK

Contractor XYZ
ADDRESS
P.O. Box YYY-ZZZ
Nairobi, Kenya

June 2017

TO: CONTRACTOR NAME
RE: ENHANCED MONITORING PROGRAM ("EMP") FOR LMCP MAXIMIZATION SITES

Dear Sir/Madame:

Kenya Power aims to provide the highest quality of electricity to all Kenyans. To achieve this goal, an international team of engineers will closely audit the quality of construction at a number of Last Mile Connectivity Project ("LMCP") maximization sites. These independent audits will be performed as part of the Enhanced Monitoring Program ("EMP"), and will target both African Development Bank and World Bank project sites. The results of the EMP audits will be shared with project supervisors, financiers, and international agencies, all of which may impose consequences on future contracting opportunities, as they see fit.

Upon project completion, EMP technicians will extensively measure the quality of various aspects of construction, including:

- Distance between poles
- Line sag
- Quality of connection between transformer and LV wiring
- Blackouts and electricity reliability post-connection

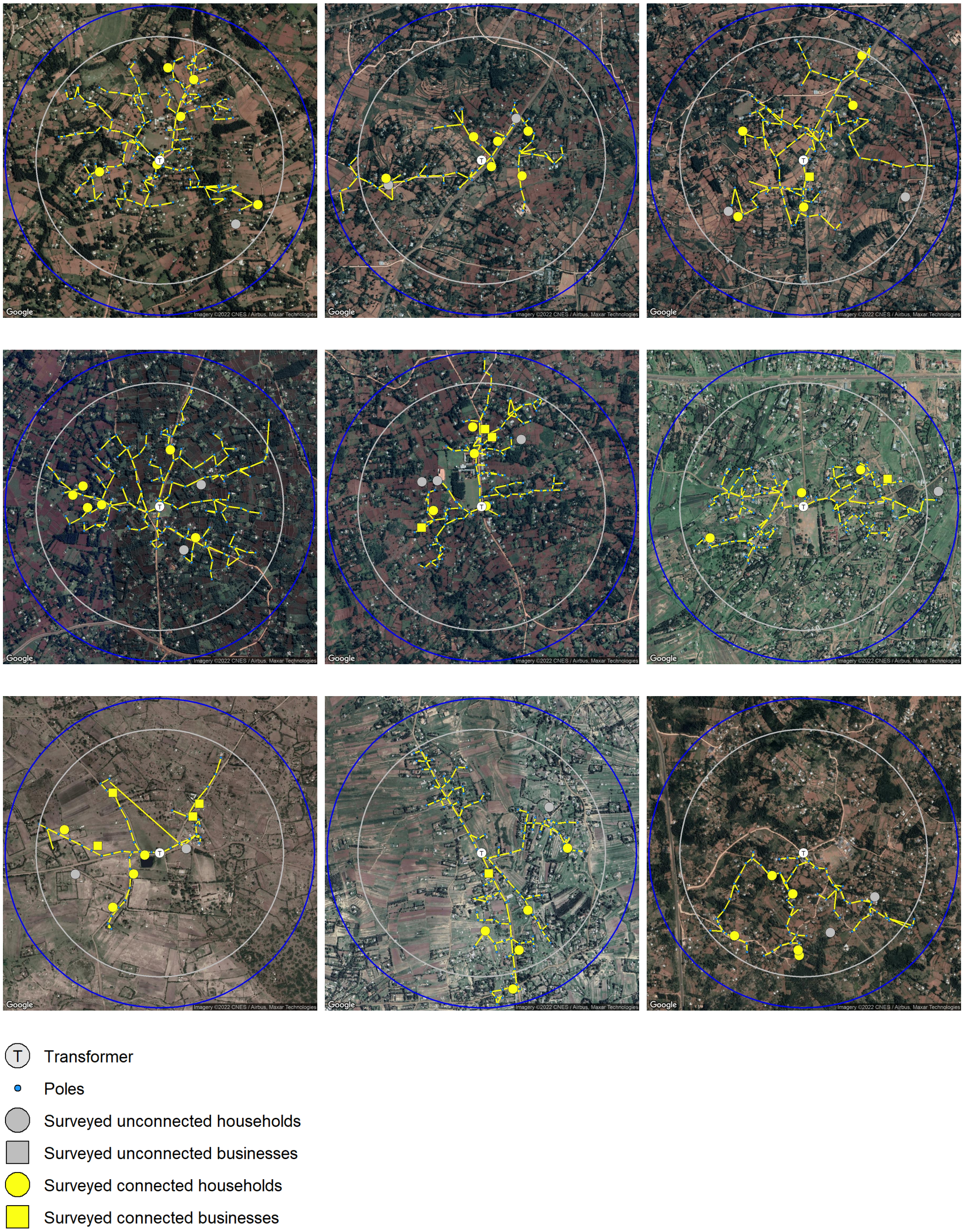
We wish to inform you of the sites that have been awarded to you that have been selected for the EMP. Please find attached a list of these sites.

Sincerely yours,

L	S	J
Senior Energy Specialist	Principal Power Engineer	Electrification Project Manager
The World Bank	The African Development Bank	Kenya Power & Lighting Company

This figure displays the monitoring intervention sent to contractors. Each contractor's name, contact information, and site details were entered individually. The names and positions of the relevant representatives from Kenya Power, the World Bank, and the AfDB were entered, and the letter was signed by these parties. The letters were then hand-delivered to management at the relevant contractors by members of our research team to ensure receipt, together with the list of treatment sites referenced in the letter.

Figure A2: Engineering data collected (additional example sites)

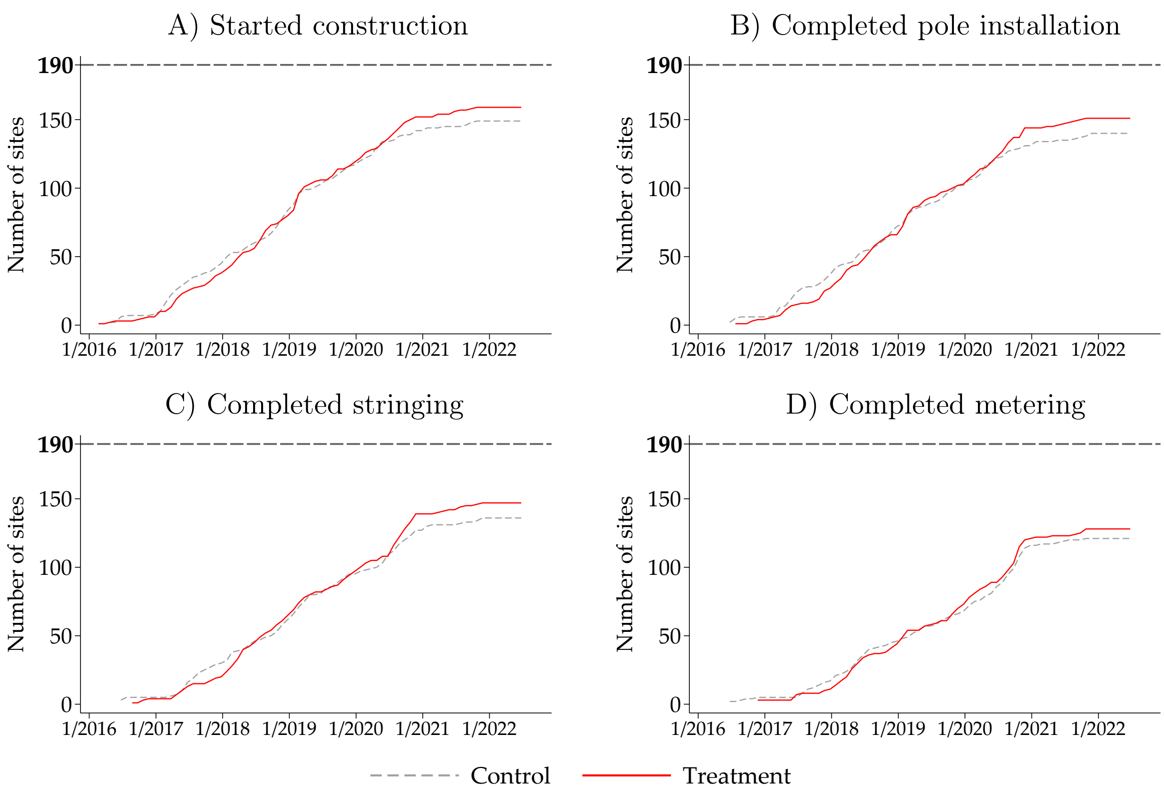


These maps displays the construction data collected at example sites. The grey line denotes 600 meters and the blue line denotes 700 meters from the transformer ('T') at the center. Section 4.1 provides additional information on data collection. To preserve anonymity random spatial noise has been added to household and business locations.

Figure A3: A PowerWatch device

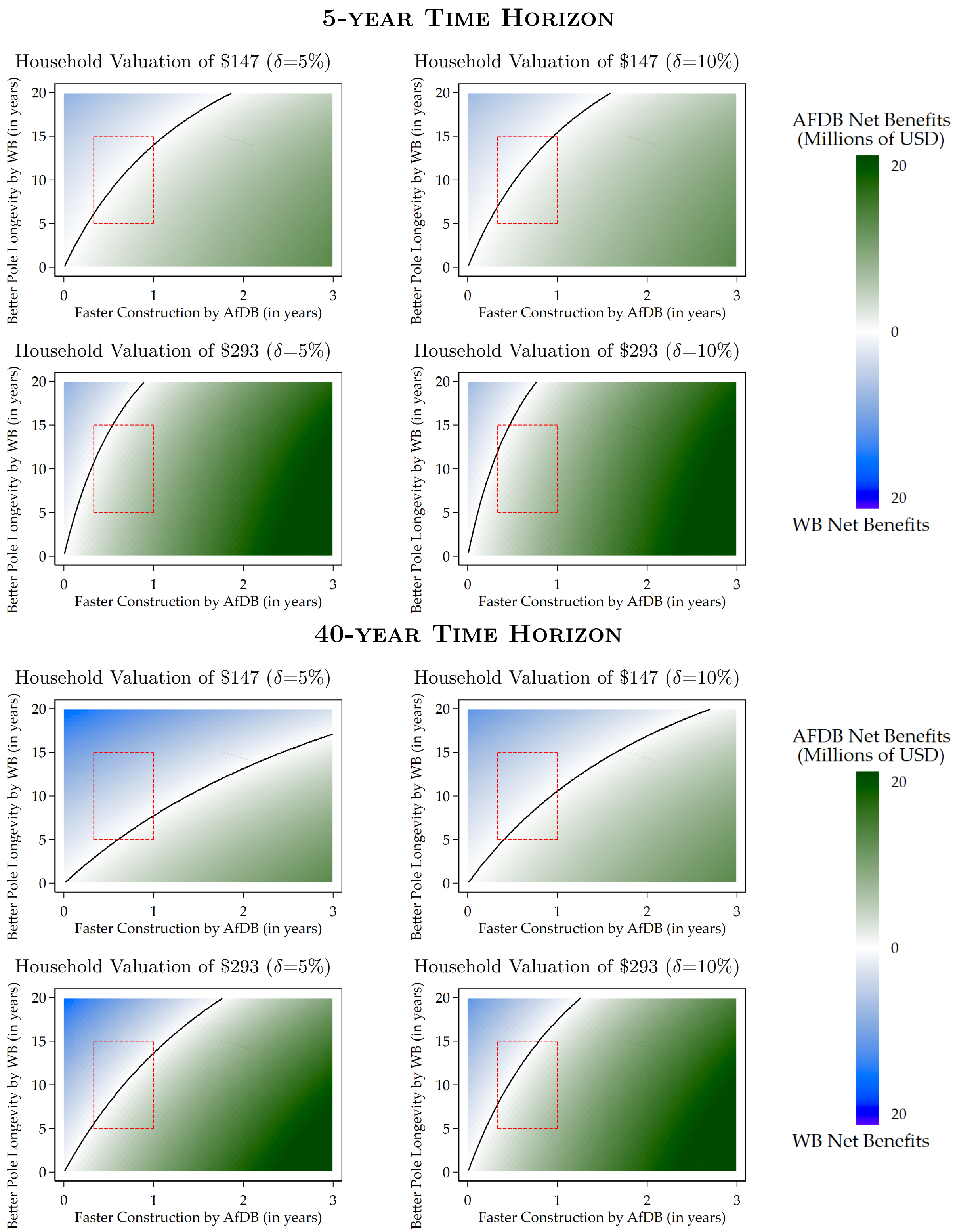
A PowerWatch device, part of nLine's GridWatch technologies used to measure household-level power outages and voltage.

Figure A4: Construction progress by audit treatment status



Data for 190 control sites and 190 treatment sites located in the five study counties collected through phone surveys with village representatives.

Figure A5: Costs versus benefits on various assumptions



Expected net benefits from adopting either AfDB procedures or WB procedures. The black line indicates similar expected net benefits for AfDB and WB procedures. δ=10, 5% refers to the planner's annual discount rate. Households are assumed to have an annual discount rate of 10%. Figure 11 presents results for our preferred specification. Lee, Miguel, and Wolfram (2020) find a household valuation of $147 when using revealed preference and $293 when using stated preference.

B Appendix Tables

Table A1: Geographic balance of World Bank and African Development Bank sites

	VIIRS Radiance		Land Gradient	
	(1)	(2)	(3)	(4)
World Bank (=1)	-0.006	-0.027	0.989***	0.573**
	(0.065)	(0.065)	(0.309)	(0.239)
Observations	51446	51446	347	347
Month FE	No	Yes	No	No
Constituency FE	No	Yes	No	Yes
Control Mean	.41	.41	4.36	4.36

Columns (1) and (2) estimate monthly average site-level nighttime radiance measured using VIIRS averaged across the 600 meter radius. Standard errors are clustered by site. Columns (3) and (4) estimate average site-level land gradient recorded using 90-meter Shuttle Radar Topography Mission (SRTM) Global Digital Elevation Model, a measure of site mountainousness.$^{*} \leq 0.10$,$^{**} \leq .05$,$^{***} \leq .01$.

Table A2: Transformer facility type

Panel A) Sample field data

	N	AfDB Mean (SD)	WB (SE)
Health center	250	0.05	-0.00
		(0.22)	(0.03)
School	250	0.50	-0.13*
		(0.50)	(0.07)
Market center	250	0.17	0.09*
		(0.38)	(0.05)
Religious building	250	0.20	-0.10*
		(0.40)	(0.05)
Other	250	0.08	-0.03
		(0.28)	(0.04)
None	250	0.27	0.12*
		(0.44)	(0.06)

Panel B) Sample administrative data

	N	AfDB Mean (SD)	WB (SE)
Health center	378	0.06	-0.03
		(0.24)	(0.02)
School	378	0.09	0.18***
		(0.29)	(0.04)
Market center	378	0.13	0.03
		(0.33)	(0.04)
Religious building	378	0.05	-0.03
		(0.22)	(0.02)
Other	378	0.09	0.03
		(0.29)	(0.03)
None	378	0.08	0.29***
		(0.27)	(0.04)

Panel C) Nationwide administrative data

	N	AfDB Mean (SD)	WB (SE)
Health center	7396	0.03	-0.02***
		(0.18)	(0.00)
School	7396	0.05	-0.01**
		(0.23)	(0.01)
Market center	7396	0.16	0.01
		(0.37)	(0.01)
Religious building	7396	0.02	0.00
		(0.13)	(0.00)
Other	7396	0.38	0.22***
		(0.49)	(0.01)
None	7396	0.00	0.00
		(0.00)	(.)

Most transformers were constructed between 2005-2015 through a nationwide program by Kenya's Rural Electrification Authority to connect public facilities to electricity. We test whether transformers connected to certain types of facilities were more or less likely to be assigned to WB or AfDB funding. Total shares can exceed 1 because some transformers are located near multiple public facilities. We test this separately using field data collected during our surveys, administrative data for our entire sample, and nationwide administrative data. All regressions include constituency FE.

Table A3: Summary statistics

	Mean	SD	25^{th}	50^{th}	75^{th}	N
Transformer missing fuse	0.23	0.42	0	0	0	250
Number of transformer lines	3.13	0.99	3	3	4	250
Number of poles	84.64	35.78	57	80	106	242
Number of leaning poles (<85deg)	1.72	2.60	0	1	3	242
Number of cracked poles	20.76	17.98	7	15	29	242
Number of stays	54.63	24.71	36	52	70	242
Households surveyed	3.78	1.63	3	4	5	250
Connected households surveyed	3.15	1.64	2	3	4	250
Year households connected	2018.89	1.13	2018	2019	2020	184

Summary statistics for surveying sites.

Table A4: Poles and customer connections per site

	Panel A) Poles					
	(1)	(2)	(3)	(4)	(5)	(6)
World Bank (=1)	-15.0*	0.9	-12.3	2.4	-2.7***	-1.5
	(8.0)	(11.2)	(7.7)	(10.7)	(0.9)	(1.2)
Treatment (=1)	9.4	24.5**	9.4	23.4**	-0.1	1.1
	(7.7)	(10.8)	(7.4)	(10.3)	(0.8)	(1.2)
World Bank X Treatment		-31.2**		-28.8*		-2.4
		(15.5)		(14.9)		(1.7)
Observations	242	242	242	242	242	242
600 M Boundary	All	All	Inside	Inside	Outside	Outside
Control Mean	82.91	82.91	79.66	79.66	3.25	3.25

	Panel B) Customer connections					
	(1)	(2)	(3)	(4)	(5)	(6)
World Bank (=1)	-13.0	-8.5	-12.0	-7.8	-1.7**	-0.9
	(8.0)	(11.3)	(7.9)	(11.1)	(0.7)	(1.0)
Treatment (=1)	5.7	9.9	5.1	9.1	-0.1	0.7
	(7.7)	(10.9)	(7.6)	(10.7)	(0.7)	(1.0)
World Bank X Treatment		-8.7		-8.4		-1.6
		(15.6)		(15.4)		(1.4)
Observations	242	242	242	242	242	242
600 M Boundary	All	All	Inside	Inside	Outside	Outside
Control Mean	60.14	60.14	57.63	57.63	2.52	2.52

Panel A studies the number of poles and Panel B studies the number of customer connections. Counts account for the fact that the grid was often too large to be fully covered by field officers, and instead only a randomly selected subset was surveyed: at 93% of sites we surveyed at least 50% of the network. The mean and median portion surveyed were both two-thirds. All regressions include constituency FE. Standard errors shown in parentheses. $^{*} \leq 0.10,^{**} \leq .05,^{***} \leq .01$.

Table A5: Donor and audit impacts on outages and voltage

	Outage			Voltage		
	(1)	(2)	(3)	(4)	(5)	(6)
World Bank (=1)	0.280*		0.076	0.018		-0.004
	(0.159)		(0.184)	(0.018)		(0.027)
Treatment (=1)		-0.056	-0.269		-0.014	-0.037
		(0.140)	(0.212)		(0.024)	(0.030)
World Bank (=1)			0.426			0.046
× Treatment (=1)			(0.351)			(0.046)
Observations	7203	7203	7203	6829	6829	6829
Control Mean	1.24	1.18	1.18	.1	.09	.1

Columns (1)-(3) display hours of outage per day. Columns (4)-(6) display the fraction of time electricity is supplied with no or bad voltage (defined as being outside ±10% of nominal voltage, 230V. Power quality is measured using GridWatch technology. $^{*} \leq 0.10$, $^{**} \leq .05$, $^{***} \leq .01$.

Table A6: Heterogeneity in WB delay by facility type

	Time to stringing completion (months)				
	(1)	(2)	(3)	(4)	(5)
World Bank (=1)	18.5	5.2	8.8*	-6.0	-3.0
	(13.5)	(6.9)	(5.0)	(5.3)	(14.6)
Observations	9	64	53	17	21
Control Mean	41.5	53.16	50.52	43.1	54.36
Sample	Health centers	Schools	Market centers	Religious buildings	Others

While there are small differences between funder type in the facility type associated with each transformer (Table A2) this does not drive heterogeneity in the impact of WB conditionality on construction delays when compared with AfDB sites.

Table A7: Resilience of voltage to distance from transformer

	(1)	(2)	(3)
Distance Along Wire	-0.000	-0.000	-0.000
	(0.003)	(0.003)	(0.003)
Customer Connections	-0.490***	-0.490***	-0.615***
	(0.160)	(0.163)	(0.230)
World Bank		0.043	-0.788
		(1.305)	(2.741)
World Bank=1 × Distance Along Wire			-0.002
			(0.008)
World Bank=1 × Customer Connections			0.261
			(0.347)
Constant	237.937***	237.918***	238.452***
	(1.345)	(1.459)	(1.507)
Observations	377314	377314	377314
Control Mean	235.69	235.69	235.69

Standard errors are clustered by respondent and shown in parentheses. $^{*} \leq 0.10$, $^{**} \leq .05$, $^{***} \leq .01$.

Table A8: Construction quality

	AfDB Mean	World Bank Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 1: Construction quality index	0.00	0.60***	-0.06	0.17	250
	[1.00]	(0.21)	(0.18)	(0.29)	
∗ Transformer does not have bypassed fuse	0.40	-0.15*	-0.08	0.02	250
	[0.49]	(0.08)	(0.08)	(0.12)	
Pole does not have a crack ≥1cm	0.73	0.06*	-0.00	-0.00	20282
	[0.44]	(0.03)	(0.03)	(0.05)	
Pole leaning at ≥85 degrees	0.97	0.01**	0.00	0.01	20483
	[0.16]	(0.00)	(0.00)	(0.01)	
Line has ≥0.5m horiz clearance	0.93	-0.03***	-0.02*	0.03**	19068
	[0.25]	(0.01)	(0.01)	(0.01)	
Pole has cap	0.28	0.33***	0.06	-0.02	17377
	[0.45]	(0.04)	(0.04)	(0.06)	
Stay/strut properly installed	0.92	0.01	0.01	-0.01	3083
	[0.28]	(0.02)	(0.02)	(0.02)	
Stay/strut installed when required	0.78	0.17***	0.01	-0.00	9482
	[0.41]	(0.04)	(0.04)	(0.05)	
Insulator properly installed	0.99	-0.03**	-0.01	0.01	2971
	[0.10]	(0.01)	(0.01)	(0.01)	
Insulator installed when required	0.98	0.01*	0.01	-0.02**	2996
	[0.13]	(0.01)	(0.01)	(0.01)	
Pole has grounding wire	0.34	0.03**	-0.03*	0.03	20483
	[0.47]	(0.01)	(0.01)	(0.02)	

The construction quality index (shown here in row 1) is a standardized average of sub-components shown in the remaining rows. Transformer bypassed fuse is measured once at each site. All other outcomes are measured for all poles measured in the engineering assessment survey (described in Section 4.1). For each pole-level outcome, the sample is limited to poles for which that outcome can be assessed. Standard errors are clustered by site. $^{*} \leq 0.10, ^{**} \leq .05, ^{***} \leq .01$.

Table A9: Network size and configuration

	AfDB Mean	World Bank Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 2: Network size and configuration index	-0.00	0.01	0.04	0.24	241
	[1.00]	(0.19)	(0.18)	(0.26)	
Deviation in Pole Count (relative to design)	69.90	1.59	3.02	4.04	194
	[63.48]	(12.55)	(12.71)	(18.33)	
Deviation in Drop Cables (relative to design)	38.98	3.25	-3.44	0.89	176
	[25.93]	(6.88)	(5.35)	(9.90)	
Fraction of compounds at site, within 100m of LV line, electrified	0.89	-0.02	-0.01	0.05	241
	[0.13]	(0.02)	(0.02)	(0.04)	
Fraction of poles ≤600m from transformer	0.94	0.02	0.00	0.01	241
	[0.08]	(0.01)	(0.01)	(0.02)	

The network size and configuration index (shown here in row 1) is a standardized average of sub-components shown in the remaining rows. All outcomes are measured at the site level. Compound data is collected in the household and firm survey data (described in Section 4.2). Pole data is collected in the engineering assessment survey (described in Section 4.1). $^{*} \leq 0.10, ^{**} \leq .05, ^{***} \leq .01$.

Table A10: Construction timing

	AfDB Mean	World Bank Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 3: Construction timing index	0.00	-0.90***	-0.29*	0.22	250
	[1.00]	(0.17)	(0.17)	(0.24)	
LMCP construction start date (months since Jan 2015)	37.22	10.18***	4.00**	-2.34	250
	[11.38]	(1.90)	(1.93)	(2.68)	
Pole erection completion date (months since Jan 2015)	45.20	9.90***	3.52	-1.67	249
	[15.17]	(2.67)	(2.59)	(3.66)	
Stringing completion date (months since Jan 2015)	46.91	9.47***	2.70	-1.37	247
	[15.48]	(2.76)	(2.56)	(3.67)	
Metering completion date (months since Jan 2015)	47.73	15.67***	4.71*	-5.95*	226
	[14.56]	(2.48)	(2.65)	(3.37)	
months between construction start and pole erection complete	7.83	-0.06	-0.32	0.50	249
	[10.19]	(1.81)	(1.52)	(2.27)	
months between pole erection complete and stringing complete	1.90	-0.73	-0.53	0.05	246
	[4.41]	(0.80)	(0.68)	(0.96)	
months between stringing complete and metering complete	0.95	6.25***	0.37	-2.38	224
	[8.04]	(1.53)	(1.47)	(1.83)	

The construction timing index (shown here in row 1) is a standardized average of sub-components shown in the remaining rows. All outcomes are measured at the site level and collected via surveys with village representatives (described in section 4).$^{*} \leq 0.10,^{**} \leq .05,^{***} \leq .01$.

Table A11: Household installation quality

	AfDB Mean	World Bank Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 4: Household installation quality index	-0.00	0.05	0.23*	-0.21	944
	[1.01]	(0.12)	(0.12)	(0.17)	
Outcome 4 (omitting readyboard question)	-0.01	0.15	0.23*	-0.26	944
	[1.00]	(0.12)	(0.12)	(0.17)	
Electricity has flowed to this household (=1)	0.81	0.05	0.08	-0.04	944
	[0.39]	(0.06)	(0.05)	(0.07)	
Household has ≥1 meter (=1)	0.86	0.09**	0.08*	-0.06	944
	[0.35]	(0.04)	(0.04)	(0.05)	
Household has meter that has worked (=1)	0.77	0.06	0.11**	-0.03	943
	[0.42]	(0.06)	(0.05)	(0.07)	
Household has a readyboard (=1)	0.26	-0.14***	0.02	0.06	944
	[0.44]	(0.04)	(0.05)	(0.07)	
(-) Number of unrequested meters (of hhs w/ meter)	0.51	-0.04	0.09	0.01	713
	[0.50]	(0.07)	(0.06)	(0.09)	
(-) Weeks from paperwork to receiving meter (of hhs w/ meter)	13.64	4.32	-2.09	3.67	884
	[25.10]	(2.95)	(2.47)	(3.53)	
(-) Weeks from meter to receiving electricity (of hhs with elec)	2.43	-0.26	-0.82*	1.75**	761
	[4.12]	(0.44)	(0.46)	(0.72)	

The household installation quality index (shown here in rows 1 and 2) is a standardized average of sub-components shown in the remaining rows. Row 2 omits the readyboard question as it is the presence or absence of a readyboard is not strictly an indication of quality. All outcomes are measured at the household level and collected in the household and firm survey data (described in Section 4.2). For outcomes marked with a (-), a higher value indicates a lower quality. For all other outcomes, a higher value indicates higher quality. $^{*} \leq 0.10,^{**} \leq .05,^{***} \leq .01$.

Table A12: Household cost, experience, and bribery

	AfDB Mean	World Bank Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 5: Household cost, experience, bribery index	0.02	0.13	0.11	-0.06	944
	[0.99]	(0.12)	(0.10)	(0.16)	
Days given to fulfill paperwork reqs (of LMCP hh)	42.29	21.09	3.16	-2.86	828
	[79.87]	(14.35)	(11.70)	(18.91)	
Did not require own wiring before connection (=1)	0.77	-0.03	0.01	-0.05	855
	[0.42]	(0.05)	(0.05)	(0.07)	
(-) KSH spent on wiring (of hh that did wiring) (w)	7774.45	-925.05	-741.25	1386.49	708
	[6779.96]	(718.32)	(739.09)	(1020.36)	
(-) Up-front connection payment (Ksh) (w)	6684.48	-694.60	-685.49	1274.35	925
	[9104.41]	(844.78)	(923.51)	(1265.46)	
Connected by KPLC/REA (=1)	0.98	0.01	0.01	-0.00	837
	[0.13]	(0.02)	(0.01)	(0.02)	
Was not asked for bribe (=1)	0.91	0.02	-0.01	-0.01	944
	[0.29]	(0.03)	(0.03)	(0.04)	
Didn't do unpaid manual labor for connection (=1)	0.96	-0.02	0.00	0.04	929
	[0.19]	(0.02)	(0.02)	(0.03)	
(-) Amount paid so far in installments (Ksh) (w)	2698.65	-24.92	-48.46	-405.60	878
	[4531.45]	(521.88)	(504.09)	(717.62)	
Satisfaction with electricity installation (1-5 scale)	4.21	-0.02	0.08	-0.04	944
	[1.07]	(0.13)	(0.13)	(0.17)	
(-) Hours in past month with very low voltage	1.57	2.85	-1.80	2.87	602
	[6.61]	(1.86)	(1.67)	(2.35)	
(-) Repair costs for devices damaged b/c electricity (Ksh)	31.19	-9.37	-67.32**	23.05	604
	[206.11]	(32.01)	(33.07)	(40.34)	

The household cost, experience, and bribery index (shown here in row 1) is a standardized average of sub-components shown in the remaining rows. All outcomes are measured at the household or firm level and collected in the household and firm survey data (described in Section 4.2). For outcomes marked with a (-), a higher value indicates a lower quality. For all other outcomes, a higher value indicates higher quality. $^{*} \leq 0.10,^{**} \leq .05,^{***} \leq .01$.

Table A13: Household and firm reliability and safety

	AfDB Mean	World Bank Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 6: Reliability and safety index	0.01	-0.11	-0.01	0.04	944
	[0.99]	(0.13)	(0.11)	(0.18)	
Had power in past 7 days (=1) (of electrified hh)	0.88	0.06	0.11***	-0.13**	787
	[0.32]	(0.04)	(0.03)	(0.05)	
No regular blackouts (=1) (of electrified hh)	0.58	-0.11**	-0.05	0.08	787
	[0.49]	(0.06)	(0.06)	(0.08)	
No blackout in past 7 days (=1) (of hh w/ power last 7 days)	0.40	0.01	0.07	-0.07	703
	[0.49]	(0.07)	(0.07)	(0.10)	
(-) Hours power not working in past 7 days (of hh w/ power last 7 days)	7.12	1.74	0.56	-3.42	700
	[15.04]	(1.91)	(1.86)	(2.51)	
No blackouts ≥30 days in past year (=1) (of electrified hh)	0.95	-0.06	-0.02	0.02	787
	[0.23]	(0.04)	(0.03)	(0.05)	
No injury fr/ electricity in past year (=1) (of electrified hh)	0.99	0.00	-0.01	-0.01	787
	[0.10]	(0.01)	(0.01)	(0.01)	
No damage fr/ electricity in past year (=1) (of electrified hh)	0.99	-0.01	-0.02**	0.02*	787
	[0.09]	(0.01)	(0.01)	(0.01)	

The household reliability and safety index (shown here in row 1) is a standardized average of sub-components shown in the remaining rows. All outcomes are measured at the household or firm level and collected in the household and firm survey data (described in Section 4.2). For outcomes marked with a (-), a higher value indicates a lower quality. For all other outcomes, a higher value indicates higher quality. $^{*} \leq 0.10,^{**} \leq .05,^{***} \leq .01$.

Table A14: Knowledge

	AfDB Mean	World Bank Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 7: Knowledge index	0.01	0.13	0.06	-0.07	944
	[1.01]	(0.09)	(0.10)	(0.14)	
Told correct total cost of connection (=1) (of hh w/ drop cable)	0.29	0.05	0.02	-0.00	930
	[0.46]	(0.06)	(0.06)	(0.09)	
Correctly told to pay monthly (=1) (of hh told of connxn cost)	0.05	-0.05***	0.00	0.02	930
	[0.22]	(0.02)	(0.02)	(0.02)	
Knows how much still owed for connection (=1)	0.43	0.16***	0.02	-0.09	944
	[0.50]	(0.06)	(0.06)	(0.09)	
Knows 20th token costs same as 1st (=1) (of hh who have topped up)	0.76	0.02	-0.01	-0.01	707
	[0.43]	(0.06)	(0.06)	(0.09)	
knows_1st_token	0.94	0.01	0.02	-0.02	707
	[0.23]	(0.03)	(0.03)	(0.04)	
knows_20th_token	1.00	0.00	0.00	0.00	669
	[0.00]	(.)	(.)	(.)	

The knowledge index (shown here in row 1) is a standardized average of sub-components shown in the remaining rows. All outcomes are measured at the household or firm level and collected in the household and firm survey data (described in Section 4.2). $^{*} \leq 0.10,^{**} \leq .05,^{***} \leq .01$.

Table A15: Electricity Usage

	AfDB Mean	World Bank Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 8: Electricity Usage index	-0.01	0.11	0.28**	-0.17	944
	[1.00]	(0.12)	(0.12)	(0.17)	
Electricity is main source of lighting (=1)	0.73	0.06	0.13**	-0.10	944
	[0.44]	(0.06)	(0.05)	(0.08)	
Electricity is main source of cooking (=1)	0.00	0.00	0.00	0.00	944
	[0.00]	(.)	(.)	(.)	
Household has topped up (=1) (of hh w/ prepaid meter)	0.86	0.02	0.11**	-0.03	836
	[0.35]	(0.05)	(0.05)	(0.06)	
Electricity spending past month (Ksh) (of hh w/ meter) (w)	183.13	-9.93	11.54	-11.89	893
	[241.18]	(24.36)	(25.43)	(33.44)	
Hours of lighting used at night in past week	2.78	0.10	0.40	-0.11	848
	[2.74]	(0.29)	(0.30)	(0.38)	
Hours of lighting used in morning in past week	4.66	0.63	0.32	1.18	652
	[5.69]	(0.77)	(0.70)	(1.06)	
Number of appliances that use the grid	1.90	0.31*	0.32**	-0.25	938
	[1.51]	(0.17)	(0.16)	(0.23)	
Number of households in this compound connected	1.13	0.01	0.03	-0.02	944
	[0.67]	(0.04)	(0.06)	(0.07)	

The electricity usage index (shown here in row 1) is a standardized average of sub-components shown in the remaining rows. All outcomes are measured at the household or firm level and collected in the household and firm survey data (described in Section 4.2). $^{*} \leq 0.10,^{**} \leq .05,^{***} \leq .01$.

Table A16: Household Socioeconomic Outcomes

	AfDB Mean	World Bank Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 9: Household socioeconomic outcomes index	-0.02	0.24*	0.20	-0.21	944
	[0.99]	(0.12)	(0.12)	(0.18)	
Connection allowed pursuing employment, business (1-5) (of connected hh)	2.54	0.27*	0.16	0.17	787
	[1.19]	(0.15)	(0.15)	(0.20)	
Connection affected earnings (1-5) (of connected hh)	3.25	0.15*	0.01	0.08	787
	[0.78]	(0.09)	(0.09)	(0.13)	
Connection permitted changing hours worked (1-5) (of connected hh)	3.65	0.05	0.04	0.02	787
	[0.86]	(0.12)	(0.11)	(0.16)	
Connection affected amount of food consumed (1-5) (of connected hh)	3.10	0.14**	0.08	-0.05	787
	[0.45]	(0.05)	(0.06)	(0.08)	
Connection affected health (1-5) (of connected hh)	3.59	-0.08	-0.05	0.12	787
	[0.86]	(0.11)	(0.11)	(0.15)	
Connection affected children's education (1-5) (of connected hh w/ children)	4.32	0.33***	0.19*	-0.23*	691
	[0.85]	(0.09)	(0.10)	(0.13)	
Connection affected knowledge about news (1-5) (of connected hh)	4.15	0.14	0.10	-0.09	787
	[0.97]	(0.10)	(0.10)	(0.14)	
Connection permited changing kerosene spending (1-5) (of connected hh)	1.51	-0.03	0.07	-0.01	787
	[0.99]	(0.10)	(0.10)	(0.14)	
Connection changed phone charging freq. (1-5) (of connected hh)	3.11	0.57***	0.36**	-0.49*	787
	[1.49]	(0.18)	(0.17)	(0.25)	
(-) Kerosene spending, last week (Ksh) (w)	30.02	-15.21**	-8.91	24.43***	940
	[62.30]	(6.04)	(5.80)	(9.09)	
Owns home (=1)	0.99	0.00	0.00	-0.01	944
	[0.10]	(0.01)	(0.01)	(0.02)	
Number of rooms in primary residence	3.54	-0.19	0.08	-0.13	944
	[1.66]	(0.15)	(0.14)	(0.19)	
High-quality floors (=1)	0.38	0.04	-0.02	-0.09	944
	[0.48]	(0.05)	(0.05)	(0.07)	
High-quality roof (=1)	1.00	-0.01*	0.01	-0.00	944
	[0.06]	(0.01)	(0.01)	(0.01)	
High-quality walls (=1)	0.21	0.01	0.06	-0.06	944
	[0.41]	(0.04)	(0.04)	(0.06)	
Buildings in compound (of compounds with hh)	2.94	-0.15	-0.18	0.17	747
	[1.56]	(0.15)	(0.20)	(0.24)	
Electrified buildings in compound (of compounds with hh)	1.64	-0.04	0.14	-0.13	747
	[1.31]	(0.10)	(0.16)	(0.17)	

The household socioeconomic outcomes index (shown here in row 1) is a standardized average of sub-components shown in the remaining rows. All outcomes are measured at the household or firm level and collected in the household and firm survey data (described in Section 4.2). For outcomes marked with a (-), a higher value indicates a lower quality. For all other outcomes, a higher value indicates higher quality. Due to ambiguity in the wording for one of the survey questions, a pre-specified outcome ("connection affected security") was removed from this table. The wording of the survey question allowed the respondent to interpret the question two different ways. $^{*} \leq 0.10, ^{**} \leq .05, ^{***} \leq .01$.

Table A17: Firm Performance

	AfDB Mean	World Bank Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 10: Firm Performance Index	-0.00	0.29	0.12	-0.23	373
	[1.00]	(0.19)	(0.17)	(0.28)	
Firm uses electricity (=1)	0.64	0.20**	0.11	-0.09	339
	[0.48]	(0.08)	(0.08)	(0.11)	
Firm planning to buy electrical equipment in next year (=1)	0.42	0.13	0.06	-0.17	339
	[0.49]	(0.10)	(0.08)	(0.14)	
Firm uses elec beyond lighting and cell charge (=1) (of those that use elec)	0.36	-0.08	-0.19**	0.19*	344
	[0.48]	(0.09)	(0.07)	(0.11)	
Number of appliances owned by Firm	1.23	0.24	0.03	-0.16	344
	[1.13]	(0.24)	(0.20)	(0.32)	
Firm household has high quality roof (=1)	0.89	0.07	0.03	-0.11	306
	[0.31]	(0.06)	(0.06)	(0.08)	
Firm household has high quality walls (=1)	0.49	-0.04	0.11	-0.06	306
	[0.50]	(0.12)	(0.10)	(0.15)	

The firm performance index (shown here in row 1) is a standardized average of sub-components shown in the remaining rows. All outcomes are measured at the firm level and collected in the household and firm survey data (described in Section 4.2). $^{*} \leq 0.10,^{**} \leq .05,^{***} \leq .01$.

Table A18: Household Political and Social Beliefs

	AfDB Mean	World Bank Effect Estimate	Audit Treatment Estimate	Interaction Estimate	N
Outcome 11: Political and Social Beliefs index	0.00	0.03	0.03	-0.02	944
	[0.99]	(0.08)	(0.09)	(0.11)	
HH electrification in top 2 most-important govt policies (=1)	0.21	0.00	-0.01	-0.01	944
	[0.41]	(0.04)	(0.04)	(0.05)	
Thinks govt doing good job providing electricity (=1)	0.98	0.00	-0.01	0.00	944
	[0.14]	(0.01)	(0.01)	(0.02)	
Voted in August 2017 election (=1)	1.15	0.07	0.48	-0.13	944
	[4.42]	(0.20)	(0.35)	(0.39)	

The household political and social beliefs index (shown here in row 1) is a standardized average of sub-components shown in the remaining rows. All outcomes are measured at the household or firm level and collected in the household and firm survey data (described in Section 4.2). $^{*} \leq 0.10,^{**} \leq .05,^{***} \leq .01$.

Table A19: Impact of gradient and facility type on months to metering completion

	(1)	(2)	(3)	(4)	(5)
World Bank (=1)	9.6***	12.4***	11.7***	13.2***	12.2***
	(1.8)	(1.8)	(1.9)	(1.9)	(2.0)
Land gradient			1.0*		0.8
			(0.5)		(0.6)
Health center				3.7	5.3
				(4.5)	(4.6)
Secondary school				0.9	0.4
				(2.7)	(2.7)
Primary school				1.3	1.6
				(2.0)	(2.1)
Market center				-2.0	-1.1
				(2.2)	(2.3)
Religious building				1.4	1.3
				(2.4)	(2.5)
Other				3.8	6.5
				(4.7)	(5.1)
Observations	248	248	231	227	212
Constituency FE	No	Yes	Yes	Yes	Yes

Metering was completed at WB sites on average 9.6 months later than at AfDB sites. Controlling for land gradient and facility type does not affect these estimates meaningfully, and land gradient and facility type appear largely uncorrelated with time to stringing completion. Table 3 displays the same for months to stringing completion. $^{*} \leq 0.10,^{**} \leq .05,^{***} \leq .01$.

Table A20: Costs vs benefits of different contracting approaches

	(1)	(2)	(3)	(4)	(5)
Annual discount rate	0.05	0.05	0.05	0.15	0.15
Quality difference	Larger	Larger	Smaller	Smaller	Smaller
Delay	8 months	18 months	18 months	18 months	18 months
Planner's time horizon	40 years	40 years	40 years	40 years	5 years
Timeliness benefits	1.6	3.4	3.4	10	10
Quality costs	15.7	15.7	6.2	3.2	2.1
AfDB procedures net benefit	-14.1	-12.3	-2.8	6.8	7.8

Smaller quality difference is assumed to be a 40-year vs 30-year difference in average lifespan of a pole. Larger quality difference is assumed to be a 40-year vs 20-year difference in average lifespan of a pole. The probability of pole failure is assumed to be constant in any given year, and expected future maintenance costs are discounted according to the annualized discount rate specified in row 1. Net benefit of AfDB is the estimated net benefit of AfDB procedures as compared to WB procedures.

C List of individuals engaged in qualitative informational interviews

Qualitative research included detailed in-person (or in Zoom, where required due to Covid-19) conversations with key leadership personnel at Kenya Power, WB, AfDB, and the Consultant charged with supervising construction. A full list of individuals engaged is provided in Appendix X. Individuals are listed in approximate order of seniority. An asterix (*) indicates that a single position was held by different individuals at different points in time.

- World Bank employees:
  - Practice manager, Global energy and extractives practice, Africa region
  - Senior energy specialist, Kenya country team
  - Energy finance specialist, Kenya country team
- AfDB employees:
  - Principal power engineer*
  - Principal power engineer*
- Kenya Power employees:
  - General manager of connectivity
  - General manager of infrastructure development
  - LMCP Contract Project Manager (AfDB Phase I)
  - LMCP Project Leader (AfDB Phase I)
  - LMCP Contract Project Manager (World Bank)
  - LMCP Project Leader (World Bank)
  - LMCP Project Leader for (AfDB Phase II)
- Project Management Consultant employees:
  - Senior Manager