Policy Brief: Electricity Services and COVID-19: Understanding the Role of Infrastructure Improvements and Institutional Innovations

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Sustainable electricity supply is a prerequisite for economic growth. Financial challenges, exacerbated by losses caused by electricity theft are a major obstacle for developing economies. This paper summarises findings for research in Karachi, Pakistan, on the role aerial bundled cables (ABCs) can play in reducing such losses.

Key messages and recommendations

- ABC installation led to (on average) decreases in monthly losses of about 8% and increases in monthly revenue of 5%..
- Upgradation to more pilfer-proof wiring also led to an increase in total customer numbers (an indicator of formalizing previously informal customers), billed units, bill payments and reduced the number of technical issues, as well as customer reported service complaints.
- Customers in areas with ABC wiring reported fewer blackouts, though there was no evidence of changes in the quality of electricity provision (voltage fluctuations and appliance damage).

Motivation and research questions: Access to reliable electricity is crucial for sustainable growth and prosperity, but in low to middle-income countries, fiscal challenges threaten to dampen economic growth. A major cause of fiscal problems is electricity theft, which is estimated to cost utilities worldwide $25 billion.

As part of our project, we analyse the effectiveness of Karachi Electric's (KE) institutional innovations and infrastructural upgrades in improving their bottom line. The timing of the interventions also allow us to study the effects of COVID-19 on KE's operations and determine whether its interventions allowed it to better weather the effects of the pandemic.

In this policy brief, we provide a summary of our main findings, namely that institutional and infrastructural improvements have the potential to reduce losses and increase revenue recovery, but they require customer trust and buy-in to succeed fully.

Figure 1: Illegal hooked connections or 'kundas'

Local Context and Background: KE is the sole provider of electricity in Karachi, Pakistan, a sprawling metropolis home to more than 20 million residents. KE's distribution network spans an area of 6500 km2, covering 2.5 million customers including residential, commercial, industrial, and agricultural consumers. Like other distribution companies in the country, KE faces high transmission and distribution losses, estimated by the National Power and Regulatory Authority to be 19.1% in 2019-20. Karachi's high settlement density and high percentage of informal settlements result in significant non-technical losses, largely caused by illegal wire hooking (kundas) onto nearby service cables.

To combat these losses, in 2019 KE embarked on a multi-pronged intervention (Project Sarbulandi - PS), which decentralised decision making to distribution offices (Integrated Business Centres- IBCs), providing them with increased resources to implement a range of intervention types, including, human capacity building, technical solutions, and community outreach. The project was initiated in the four highest loss IBCs in 2019, with another 2 IBCs joining later in 2020.

A major component of the project was upgrading supply lines at the Pole Mounted Transformer (PMT) level to Aerial Bundle Cabling (ABCs). Due to their intertwined cable design, ABCs are difficult to connect to using "kundas", making it physically harder to attach illegal lines to them. While ABC conversion pre-dates the project, it was a major component and also the most visible aspect of the project, and we therefore analyse its effects separately as well.

Data and Methodology: To analyse the effectiveness of the project, ABC conversions and study the effects of the COVID-19 pandemic, we leverage both qualitative and quantitative research tools. To analyse the (perceived) effectiveness of institutional interventions, we conducted stakeholder interviews with the heads of project IBCs (General Managers), while also conducting focus groups with customers in their IBCs. We augmented this with quantitative data, both administrative data provided by KE on losses, revenue recovery, ABC installation, billing, etc, as well as household level data of customer behaviour and perceptions collected through our own independent survey. We used these data to triangulate both the effects of KE's interventions and their ability to mitigate the negative effects of the COVID-19 pandemic.

Institutional innovations: Project Sarbulundi decentralised decision making to the IBCs and provided them with more resources for infrastructure upgrades, incentivising and hiring more staff, and engaging in customer outreach. Interviews with GMs in both project and non-project IBCs highlight that GMs perceive this increase in autonomy and resources to have overwhelmingly positive effects. They claim the increase in human resources and flexibility to schedule metering and invigilation tasks allowed them to better allocate these tasks to reduce incidences of theft while simultaneously increasing customer engagement and service quality. Similarly, resources to engage with customers allowed them to build trust with the community, which they believe, helped make their efforts to "win customers over" and also increase the number of formal customers. GMs perceive these efforts to have not just positive effects on internal morale, but also on losses and revenue recovery. Table 1 summaries GM perceptions of the impact of various PS interventions.

Table 1: Summary of intervention impacts

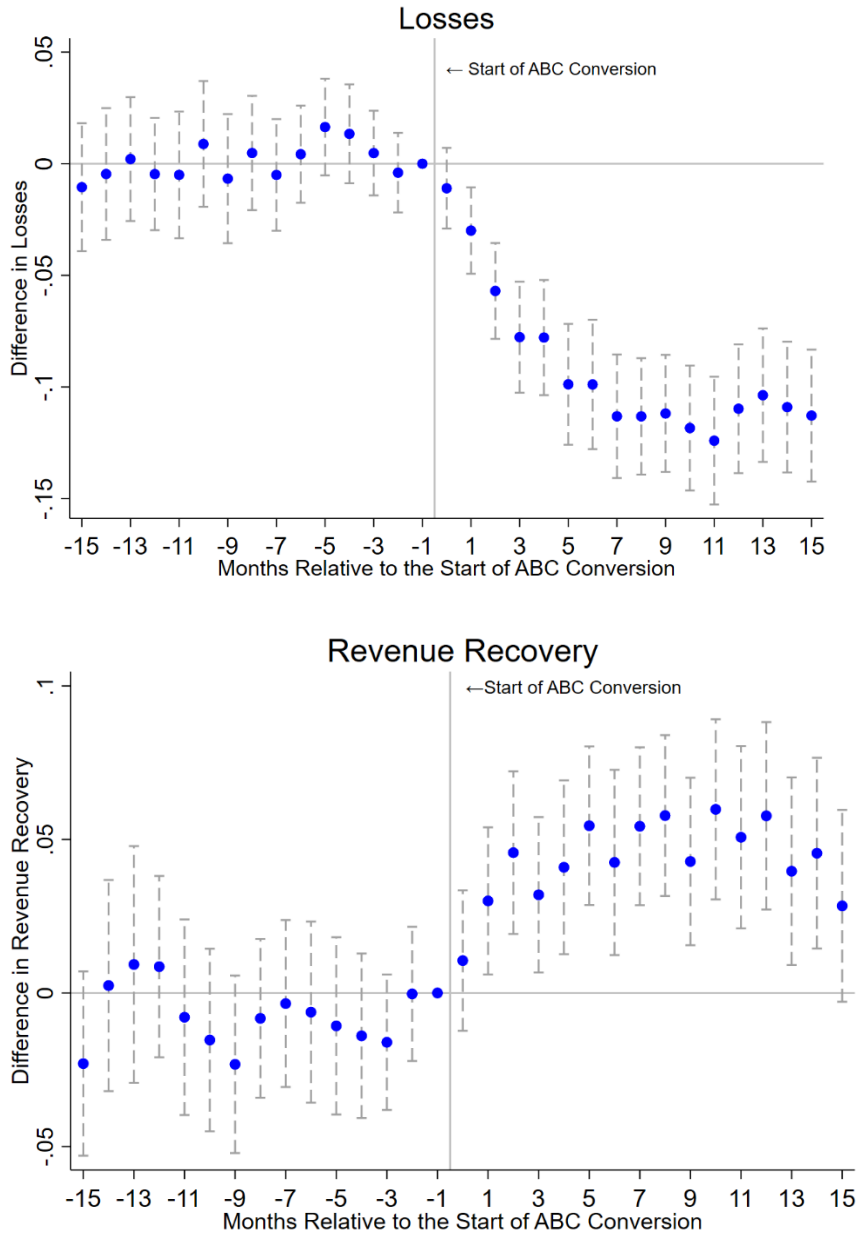
Intervention Type	Impact	Number of IBCs Cited
Infrastructure	Improved billing	3
	Improved bill collection	2
	Improving support	3
	Improving financials	3
	Changing patterns of theft	4
Staff incentives	Improving morale	4
	Improving KE end results	1
Customer engagement	Improved customer education	3
	Improved support for KE	3
	Improved accessibility of KE	3

While the reported increase in IBC level morale is positive, caveats to the above come from our focus group discussions with customers in PS IBCs. Discussions indicate that customers continue to distrust KE and in fact claim to be overbilled. Many report being unaware of the project or any of the customer engagement activities reported by IBCs. One exception was ABC installation, which seemed to be the most visible interventions for customers, though even here, customers view these infrastructure with suspicion and suspect these were used to overbill them. These findings suggest the need for both more thorough customer engagement, as well as the need to independently verify the effectiveness of such activities.

Infrastructure upgrades: Given the importance of infrastructural improvements as well as their visibility, as aforementioned, we also analyse the effects of ABC conversions separately. Utilising administrative data provided by KE, we are able to determine their effect on losses, revenue recovery, among other measures of service sustainability. Here we report some of our major results, though interested readers may consult the full report for more detailed analysis.

Figure 1 illustrates the effect of ABC installation on feeder level losses and revenue. Feeders were considered "treated" if at least one PMT on the feeder had been upgraded to ABC wiring. The figure illustrates that ABC installation had the desired effect of reducing losses and increasing revenue. The results are robust to different model specifications, and our estimates show that ABC installation led to (on average) decreases in monthly losses of about 8% and increases in monthly revenue of 5%[1].

Figure 1: Impact of ABCs on Losses and Revenue Recovery: Monthly Event Study.



Notes: Graphs report event study regression results. Data are at the feeder level. Regressions include IBC-by-month and feeder fixed effects. One month prior to the ABC installation (-1) is the reference group and normalized to 0. The ABC treatment is a binary variable that equals 1 when the PMT has any ABCs installed.

The positive effects of ABC installation carry beyond just losses and recovery. Upgradation to more pilfer-proof wiring also led to an increase in total customer numbers (an indicator of formalizing previously informal

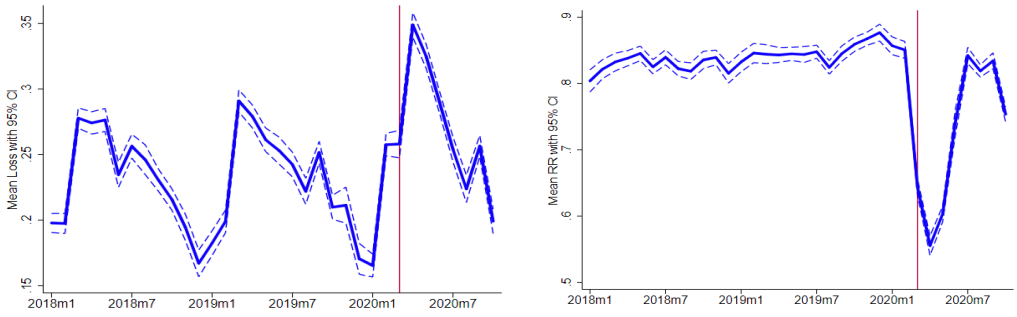
[1] For full report with detailed analysis and calculations, see: Ahmad, Husnain Fateh, Ayesha Ali, Robyn C. Meeks, Zhenxuan Wang, and Javed Younas. 2022. "The Economic and Environmental Effects of Electricity Infrastructure Improvements: Evidence from a Loss Reduction Technology in Pakistan"

customers), billed units, bill payments and reduced the number of technical issues, as well as customer reported service complaints.

Analysing customer survey data, which was conducted in PMTs both with and without ABC installations, we found evidence of ABC upgradation having a positive impact on customer perceptions of service as well. Customers in areas with ABC wiring reported fewer blackouts, though surprisingly we found no evidence of changes in the quality of electricity provision (voltage fluctuations and appliance damage).

The effects of COVID 19: In February 2020, the first cases of COVID-19 were identified in Karachi. Shortly afterwards, Karachi was put on lockdown from March 22 until May 9, during which time in-person operations were impacted and there were severe local economic effects. COVID-19 affected all of KE operations. As shown in Figure 2, there were negative effects on losses2 (e.g., unbilled consumption) and revenue recovery (i.e., payment of electricity billed).

Figure 2: Impact of COVID on Losses and Revenue Recovery.



Data suggest that IBCs that had implemented the PS project in Phase 1 saw improvements after the COVID-19 lockdown more quickly than other IBCs that are lined up to be in Phase 2 of the project, but have not yet implemented it (Table 2). These are in line with the perception of GMs (Table 3), though once again, focus groups suggest that this perception is not shared by customers, who described KE's attitude post COVID and PS to be one of continued indifference at best, and exploitative at worst.

Table 2: Average IBC Losses and Revenue Recovery, by Sarbulandi Phase 1 and 2[3]

	Pre- Sarbulandi		Post- Sarbulandi	
	Nov 2018-Feb 2019	Mar 2019-Oct 2019	Nov 2019-Feb 2020	Mar 2020-Oct 2020
Panel A: Losses				
Phase 1	0.17	0.30	0.14	0.28
Phase 2	0.19	0.33	0.18	0.39
Panel B: Revenue Recovery				
Phase 1	0.88	0.85	1.02	0.75
Phase 2	0.76	0.76	0.80	0.70

Notes: Phase 1 are those that had implemented PS before the COVID-19 pandemic. Phase 2 are those IBCs that will implement PS, but not until a later time.

[2] Note losses are often seasonal (hence the saw-tooth nature of the losses graph in figure 2), but the spike in losses here at the onset of COVID lockdowns can be clearly seen to be larger than previous seasonal variations.
[3] When interpreted by season to account for seasonality, so for example, in terms of losses and comparing March – October seasons, Phase 1 losses decreased from 0.30 pre-Sarbulandi and 0.28 post-Sarbulandi, while phase 2 losses actually increased over the same period form 0.33 to 0.39.

Table 3: Impact of COVID-19 and effect of Project Sarbulandi

Topic	Impact	# IBCs Cited
COVID-19	Changes in Operations	6
	Changes in Load Shedding	4
	Changes in Community Engagement	2
	Financial Impact on KE	8
Mitigating Effect of Project Sarbulandi	Mitigating effect	4
	Because of Community Engagement	2
	Because of ABCs	2

Disentangling the effect of COVID from ABC installation is difficult, as while COVID disrupted operations, the pause was temporary and ABC installations continued. Table 4 presents preliminary analysis that suggests ABC installation offered some resilience to the COVID-19 shock in the realm of losses, but revenue recovery still took a hit. The former is explained by the fact that losses, especially those due to kundas, continued to be prevented by ABC wiring. On the other hand, revenue recovery was a function of customers' ability to pay their bills, which understandably took a hit as the pandemic led to an increase in the economic hardship of KE customers.

Table 4: The Resilience of ABC Impact to COVID

	All IBCs		High-Loss IBCs	
	Loss	RR	Loss	RR
	(1)	(2)	(3)	(4)
ABC	-0.081***	0.055***	-0.084***	0.056***
	(0.009)	(0.009)	(0.009)	(0.009)
ABC x COVID	-0.007	-0.025*	-0.013	-0.032**
	(0.011)	(0.014)	(0.012)	(0.015)
Outcome Mean	0.260	0.792	0.324	0.701
Observations	47,575	37,353	13,919	11,721
Feeder FE	Yes	Yes	Yes	Yes
IBC-Month FE	Yes	Yes	Yes	Yes

Notes: * p <0.1, ** p<0.05, ***p<0.01

Concluding remarks: Sustainable electricity supply is a prerequisite for economic growth. Financial challenges, exacerbated by losses are a major obstacle for developing economies. There is then space for good policy interventions to have major impact, and we find encouraging evidence of this in our analysis of KE's recent institutional and infrastructural interventions. We find that institutional interventions increase internal morale and lead to increased efforts to roll out infrastructural upgrades, which in turn have quantifiable effects on losses and revenue recovery, among other positive effects.

Customer trust and engagement however remain important aspects that must also be considered and evaluated independently. A pre-existing lack of trust in a utility can make consumers view upgrades as a negative change, and decrease trust in utility billing, which can theoretically have negative impacts on revenue recovery in the long run. This is troubling, as infrastructure improvements seem to have helped KE in mitigating some of the negative effects of the COVID pandemic, in particular those relating to non-technical losses.

Papers providing basis for brief:

Ahmad, Husnain Fateh, Ayesha Ali, Robyn C. Meeks, Victoria Plutshack, Zhenxuan Wang, and Javed Younas. 2021. "Breaking the culture of non-payment: A qualitative analysis of utility intervention Project Sarbulandi in Karachi Electric, Pakistan." Working Paper.

Ahmad, Husnain Fateh, Ayesha Ali, Robyn C. Meeks, Zhenxuan Wang, and Javed Younas. 2022. "The Economic and Environmental Effects of Electricity Infrastructure Improvements: Evidence from a Loss Reduction Technology in Pakistan." Working Paper.

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Citations:

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[ii] Depuru, S.S.S.R., Wang, L., Devabhaktuni, V., 2011. Electricity theft: Overview, issues, prevention and a smart meter-based approach to control theft. Energy Policy 39, 1007–1015. https://doi.org/10.1016/j.enpol.2010.11.037

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