

Technology's Role in Eradicating Poverty: The Importance of Advanced Metering Infrastructure in Karachi

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The purpose of this paper is to explore the research question: What is the potential for smart metering to curb major electricity losses due to theft in Karachi, Pakistan and further, how would the improvements that smart meters make aid greater Pakistan's ability to deliver reliable electricity to rapidly urbanizing populations?

The aim of this research question is to give the United Nations Department of Social and Economic Affairs empirical data and analysis of technologies that can combat rampant electricity theft in rapidly urbanizing emerging economies. Understanding the roles that these technologies play is critical to increasing transparent access to electricity for all, which is a prerequisite to the first Millennium Development Goal of eradicating poverty. I chose to focus on the city of Karachi, Pakistan for a few reasons, most notably that Karachi is an example of a successfully privatized, vertically integrated public electric utility. K-Electric's progressive attitude and investments in generation has enabled Karachi to become the only city in Pakistan that does not have sustained blackouts due to inadequate generation capacity.

This research question has a few implied sub questions related to the implementation of smart meters:

- Have smart meters been widely implemented thus far and have they been effective?
- How does the need for smart meters differ between high and middle-income countries?
- Are smart meters enough of a solution to service delivery problems, or are the savings in electricity that they generate still insufficient to serve Pakistan's growing need?

Current Trends in Non-Technical Loss (NTL) in Karachi

K-Electric, under the management of the Abraaj group is incorporating Advanced Metering Infrastructure (AMI), Aerial Bundled Cable (ABC) and innovative payment measures in order to increase collections and decrease electricity theft. Soon after their purchase of the majority of shares in KE in 2008, Abraaj began increasing metering activity and planning the incorporation of smart meters, which are slated to be installed in the first quarter of 2015.

This was in addition to other investments like increased generation and renovation of transmission lines to decrease transmission losses. As their pilot of this technology moves forward, other utilities can observe their best practices and successes.

K- Electric splits their electricity billing zones into 28 "Integrated Business Centers" (IBCs) within 4 regions of the city. These IBCs have a mix of different types of customers, who each pay different tariffs on electricity. Neighborhood size can be as small as 5km² to as large as 1000+ km².

Trends in Population Growth

K-Electric estimates that their average customers across the city of 20 million have increased by an average of 4.19% between 2010-2014, with a regional break-down featured below. These regions represent mixes of IBCs with different levels of affluence and population density. IBCs with "High Loss" are most concentrated in Region I, in Western

Karachi, and closely followed by Region IV, in North Central Karachi, though overall losses are highest in Region IV. These close levels of losses are particularly noteworthy given their vast differences in population density and industrial penetration. Region IV has significantly less penetration of industrial activity as compared to Region I, but its area is one-eighth the size with almost ten times the population density. In contrast, Region I encompasses the west and northwest region of the city, with larger land composition and low density of customers.

The differences in these two scenarios are important to note – high levels of theft cannot be attributed to one customer group or one

locality within the city. At the same time, smart meters make much more sense to deploy in areas with lower population density because fewer analog meters will have to be replaced with smart meters. Levels of losses are similar, but because different customer segments pay different tariffs, revenue recovery may differ based on where the greatest losses are occurring. AMI can help K-Electric achieve a level of granularity to see in real time where losses are occurring, and from there, to calculate returns on investment per customer segment, as well as per IBC. This means that AMI can aid in both system collections recovery on a much more precise level.

Region	Area Covered	Average customer base (FY13)	Population Density (Customers/Km2)	Percentage Of Zones with High Loss	Electricity Loss* (FY13)
I	10,276	547,411	53.27	57.14%	29.00%
II	130	596,441	4588.01	0.00%	18.80%
III	1,675	635,846	379.61	50.00%	27.60%
IV	1,277	607,735	475.91	42.86%	31.20%

**K-Electric FY2013 Annual Report*

Data courtesy of K-Electric, obtained March 2014

Karachi Smart Metering Pilot

K-Electric’s plan for smart metering contains multiple objectives, which speaks to the effectiveness and multi-use nature of the technology. Shortly after the Abraaj Group took a stake in KE, they began exploration into advanced metering to monitor energy flows from generation stations, through transmission, and into distribution. Once this initial monitoring was in place, they explored consumer mapping their feeder system in order to increase their ground visibility of theft and inefficiencies. K-Electric is now moving into trials with two-way Advanced Metering Infrastructure so that the utility’s service can determine and improve upon technical and commercial losses, and also monitor and improve network health parameters. This will also help them to respond more quickly to discrepancies between power consumption and

payment. The latest step in this initiative will be the installation of two-way smart meters in a few testing areas of Karachi.

With the deployment of this technology, data will be gathered by the meters every fifteen minutes and sent over General Packet Radio Service (GPRS).

At this point in time, K-Electric has created a multi-million dollar budget to complete this pilot project in certain pockets of Karachi with high distribution losses of electricity. This process begins with what K-Electric calls “ring-fencing” of a few testing areas where losses are high and install 6-8,000 smart meters in these neighborhoods. In addition, those areas with more common incidences of electricity theft through “hooking” will be installed with Aerial Bundled Cable (ABC), which insulates live overhead wires to prevent this hooking.

The most pressing challenge is cost, as these meters are not manufactured within Pakistan -- domestically produced alternatives are still in nascent stages of development. Until costs come down, K-Electric can only justify using smart meters in areas where theft levels are high, so that the higher recouped loss results in a higher return on investment (ROI). Incidentally, in many of these areas customers may not be educated about what a smart meter is and why it must replace current meters. Rule of law is also a problem in Karachi and depending on trends of violence in this pilot area may post a safety concern for K. Electric's employees. Without proper communication, smart meters can create paranoia and tension among customers who believe the new meters will charge them more. These top down approaches must be accompanied by lateral engagement with customers about why these meters are not only more beneficial, but much more technically advanced.

Conclusions

Smart meters and smart grid integration are in pilot stages in Karachi, which as Pakistan's largest city will be a good demonstration site for the rest of the country. Implementation of smart grid technologies in the US has been much higher, with McKinsey estimating the market opportunity in the United States for AMI to be between USD \$3 and \$4 billion¹. The question of whether smart meters and other smart grid investments alone will curb theft – additional data collection techniques like GIS mapping of the city will also aid in giving K-Electric a ground-level view of how their customers consume power, but AMI is also only a means to eliminating tendencies to steal power. K-Electric must continue to strengthen relationships with

consumers and understand motivations for theft.

As the Millennium Development Goals are set to expire this year, the United Nations must explore and include the improvement and expansion of grid infrastructure to its Post-2015 Sustainable Development Agenda in order to ensure that access can be obtained by all sectors, and also that countries can build industrial sectors sustainably. Countries like Pakistan, which have high levels of urbanization and non-technical loss, are ripe for innovation and disruption. UN DESA can encourage this innovation process, which adds necessary improvements to critical infrastructure.

¹ Booth, A, Demidroven, N & Tai, H. (Summer 2010). The smart grid opportunity for solutions providers. Retrieved fr: https://www.mckinsey.com/~media/mckinsey/dotcom/client_service/EPNG/PDFs/McK%20on%20smart%20grids/MoSG_SolutionProviders_VF.ashx.