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Can Utilities Realize the Benefits of Advanced Metering Infrastructure? Lessons from the World Bank's Portfolio

THE BOTTOM LINE

Advanced metering infrastructure (AMI) provides significant benefits to utilities around the world. Although it is entering the mainstream, technical concerns, policy challenges, capacity, and will in the Bank's client countries hinder wider adoption. Starting out with smaller AMI deployments aimed at addressing revenue constraints seems to offer the best chance of success at utilities supported by Bank-financed projects.

Varun Nangia is a consultant with the World Bank's Energy and Extractives Global Practice.

Samuel Oguah is an energy specialist in the same practice.

Kwawu Gaba is a lead energy specialist with the Energy and Extractives Global Practice and also leads the World Bank's Power Systems Global Solutions Group.

Why is this issue important?

Smart meters clearly benefit utilities and their customers, but implementation poses technical and organizational challenges

Advance metering infrastructure (AMI) refers to an integrated system of smart meters and enabling communication networks and data management systems that provide enhanced capabilities over traditional analog or digital meters. AMI-enabled smart metering evolved from previous one-way metering systems, such as traditional electromechanical metering and automated meter reading (AMR) systems. The key difference is the development of two-way communication between the meters and the utility (US Department of Energy 2015).[1]

In addition to preserving all of the features of previous systems (figure 1), an AMI deployment allows, at a minimum, remote meter reading, bidirectional communication, complex tariff systems, and utility control of energy supply (Uribe-Pérez and others 2016). In some AMI deployments, systems allow distributed power generation to be sold back to the grid and offer readings as often as every 15 minutes to an in-house unit or third-party developers. The readings encourage energy savings. In such systems, utilities can often monitor operational and performance issues, support advanced tariff systems (such as time-of-use pricing), and interact with large connected loads to move them to nonpeak times (European Commission 2012).

AMI significantly benefits all power system stakeholders. Utilities benefit from reduced commercial losses through tamper- and collusion-resistant equipment, quicker accounting for electricity sales, improved understanding of network performance, and rapid notification of outages. AMI also benefits customers. By allowing utilities to vary tariffs by time and demand, AMI can enable new billing models that help customers save money. Such models can also reduce peak load (and hence generation costs and total system emissions) and allow the utility to provide better customer service. In this regard, AMI is one of the quickest and most cost-effective ways to improve system performance and revenue collection.

While the case for AMI is easily made, implementation of an AMI system can be challenging. World Bank projects have run a gamut of challenges that have delayed projects significantly. These include capacity and governance issues, interoperability and compatibility concerns, and taxes and tolls. This brief draws up a list of potential problems and mitigating actions based on the experience of World Bank staff with AMI projects currently under implementation or recently closed. These hard-won lessons can hopefully smooth the way for future rollouts that meet the needs of client countries.

A typical AMI system includes smart meters in each household, data collector units at the neighborhood level, and a "metering data and services management system" (MDMS) on the utility's premises. Communication between individual components may involve wireless or wireline networks or a combination of the two.

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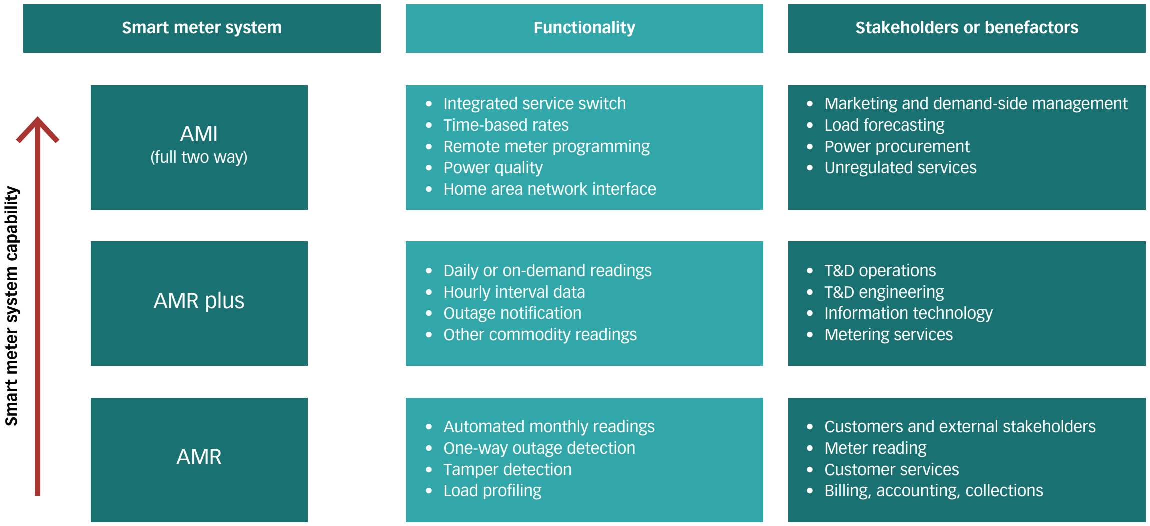
[1] World Bank experience in procuring AMR systems suggests that most currently commercially available AMR systems are actually AMI systems with the return communication function disabled. In one memorable case, the difference was simply the absence of a SIM card in otherwise identical hardware and software. In countries with a history of AMR installation, certain domestic manufacturers continue to produce AMR hardware in support of previous deployments, although expansions of such deployments are increasingly rare.

Figure 1. Evolution of metering capabilities



Smart meter system	Functionality	Stakeholders or benefactors
AMI (full two way)	• Integrated service switch • Time-based rates • Remote meter programming • Power quality • Home area network interface	• Marketing and demand-side management • Load forecasting • Power procurement • Unregulated services
AMR plus	• Daily or on-demand readings • Hourly interval data • Outage notification • Other commodity readings	• T&D operations • T&D engineering • Information technology • Metering services
AMR	• Automated monthly readings • One-way outage detection • Tamper detection • Load profiling	• Customers and external stakeholders • Meter reading • Customer services • Billing, accounting, collections

AMI = advanced metering infrastructure; AMR = automated meter reading; T&D = transmission and distribution.

Source: Edison Electric Institute (2011).

> "Advanced metering infrastructure is particularly effective at enhancing revenue collection, a major concern of utilities in most of the World Bank's client countries."

A wide variety of network mediums has been deployed, including proprietary radio-frequency meshes; cellular, wi-fi and Bluetooth wireless networks; and DSL, optical fiber, and power line–based wired networks (Uribe-Pérez and others 2016).

What are the main advantages of AMI?

Enhanced revenue collection, real-time data exchange, and accommodation of generation from renewable sources are driving the adoption of smart meters

Research produced by the International Energy Agency indicates that although interest in smart grids is high within utilities in economies at all levels of development, the factors driving adoption are different in developed and emerging economies. In emerging economies, reliability, system efficiency, and assured revenue collection are the top drivers of smart grid adoption (IEA 2015a) (table 1). AMI deployments address all of these factors as a primary outcome of their installation.

AMI is particularly effective at enhancing revenue collection, a major concern of utilities in most of the World Bank's client countries (box 1). While disaggregated data on commercial and technical losses are difficult to find (aggregate data are usually available), a survey of utilities in Sub-Saharan Africa (Africa Infrastructure Knowledge Program 2011) showed significant potential for stemming commercial losses. At an average tariff of $0.05/KWh, losses of nearly 353 TWh amounted to some $17.6 billion over the six-year period in a dozen countries. Capturing even a third of that revenue through a revenue protection program (RPP) as described in box 1 would significantly improve the cash flow of many utilities.

In addition to helping with revenue collection, AMI provides other benefits immediately relevant to client countries. The two-way nature of AMI ensures that information can be proactively sent from

> “Advanced metering infrastructure facilitates integration of renewable-energy sources by permitting consumers to sell excess power back to the grid.”

Table 1. Drivers for the adoption of smart grids

Emerging economies	Developed economies
Reliability	System efficiency
System efficiency	Renewable power
Revenue collection and assurance	New products, services, markets
Renewable power	Customer choice and participation
Economic advantages	Reliability improvements
Generation adequacy	Asset utilization

Source: IEA (2015a).

the meter to the utility, allowing for quicker identification of, and response to, power outages, thereby increasing reliability. Smart meters can also report regularly on power quality, leading to greater awareness of system-reliability issues. Tariff mechanisms enabled by AMI can reduce peak loads by encouraging large loads to be displaced or deferred until off-peak hours, or by allowing customers to self-curtail power demand in response to tariff thresholds, all leading to a more efficient power grid. Because smart meters communicate usage daily (or even more frequently), they are more tamper-resistant and are able to provide precise figures on consumption, thereby reducing commercial losses from theft and collusion between customers and meter readers. Finally, AMI also facilitates integration of renewable-energy sources by permitting consumers to sell excess power back to the grid (IEA 2015b).

In the course of any AMI deployment, it is critical that a compatible MDMS should be selected. The MDMS must make the most of the volume of information supplied by the new infrastructure and take advantage of the full range of capabilities offered by smart metering. In addition, the MDMS must be reliable and able to scale up for service delivery once the AMI is deployed and meters are rolled out in large numbers.

What has been the Bank experience with AMI deployments?

The Bank has learned much from recent projects involving the installation of more than two million smart meters

Since FY2010, the Bank has supported 14 projects involving AMI, with substantial peaks in FY2012 and FY2015. Table 2 summarizes the location and approximate cost of the AMI components, which total about $420 million. Many newer programs have taken advantage of the RPP described in box 1. AMI accounts for about 18 percent of the total $2.34 billion lent by the World Bank for transmission and distribution system upgrades under the 14 projects, varying from a high of 83 percent in Uzbekistan to a low of 3 percent in Argentina.[2] In total, the projects involve the installation of approximately 2.27 million meters. Each meter costs approximately $240 to install, with World Bank financing accounting for about $178 of this total, although there is wide variation in both the installed cost and the share of World Bank financing.

Descriptions of several of the projects follow. Special attention is paid to sources of delay, with the hope that such problems can be avoided in future projects.

India: Haryana Power Sector Improvement Project (FY2010). The Haryana Power Sector Improvement Project set a target to install about 80,000 meters for high-use domestic and commercial customers—those with 10–15kV connections. Because the utility, Dakshin Haryana Bijili Vitran Nigam (DHBVN), was concerned about inconsistent standards and the costs of deploying AMI, it sought initially to reduce commercial losses using AMR meters. Eventually, however, the benefits of smart meters (demand response, time-of-day usage billing, and real-time monitoring to detect theft), as well as gradual reductions in cost and increasing standardization in the marketplace, convinced DHBVN to invest in an AMI deployment. As part of the process, the utility is planning a comprehensive

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[2] When support from other sources is counted, the projects have a value of approximately $3.17 billion.

Box 1. Smart meters protect revenue

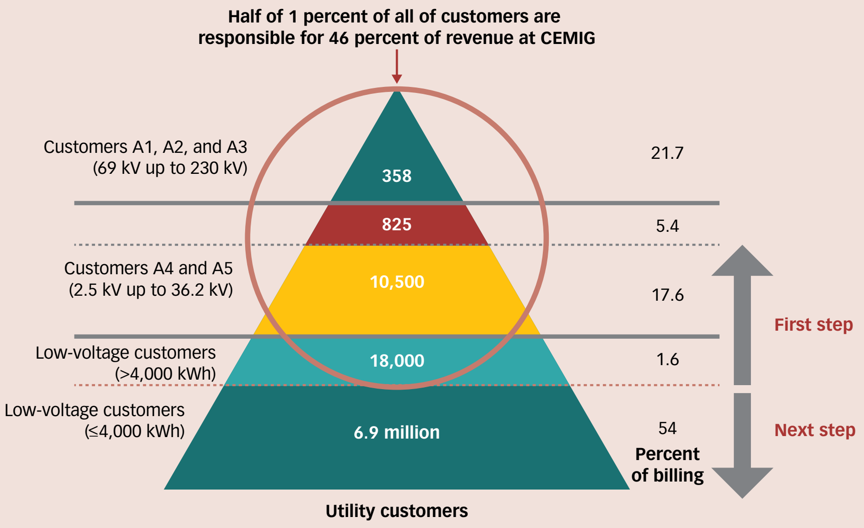
Growing numbers of World Bank projects involving advanced metering infrastructure (AMI) are using the model of the revenue protection program (RPP). According to World Bank Lead Energy Specialist Pedro Antmann, the RPP enhances the rationale for AMI deployments by linking them to a crucial driver in most utilities: revenue. Antmann's experience showed that in many utilities as few as 1–2 percent of the total customer base was responsible for as much as 50–60 percent of the utility's total revenue. The obvious conclusion: revenue protection should start with the largest customers.

The figure shows an example from Brazil's largest distribution company, CEMIG, where just 30,000 customers—half of 1 percent of the customer base—were responsible for 46 percent of total revenue.

Similar structures exist in many of the World Bank's client countries—where a handful of customers are responsible for a large share of the total revenue. Antmann refers to these as the "VIP customers." Ensuring that this revenue is protected is crucial to ensuring the long-term financial viability of the utility. It also allows the utility to offer additional services to VIP customers to keep them happy. Thus, the first step of an RPP is to roll out an AMI system to VIP customers, leaving comprehensive installation for later. Experience has shown that this approach has several benefits.

First, a typical utility has very limited resources for replacing meters. But installing new meters for 30,000–50,000 customers can be done with modest resources—typically a few million dollars. Yet the payback is enormous. Antmann cites the example of a deployment in the Dominican Republic that was repaid in seven months; most deployments, he notes, have paybacks of 18 months to two years.

Second, the AMI deployment does something that no other revenue measure can: it ensures the permanence of these revenues, barring intentional tampering, which is detectable. This fiscal stability can help the utility to move to a sustainable financial situation and engage in longer-term planning. Unlike field campaigns or random inspections, moreover, AMI deployments have negligible ongoing costs.



Third, Antmann notes that in most utilities gathering clear and unambiguous data on power usage improves transparency, accountability, and corporate governance. This is crucial to reducing the perception of corruption and to building trust between utilities and their largest customers. Internally, the deployment of an AMI system can improve morale by combining the interests of engineers with the business interests of the utility. Antmann also notes that an RPP is a decisive test of the utility's willingness to address its problems—objections can suggest collusion between large customers and senior utility management.

Finally, AMI deployments enable the utility to offer additional services and benefits to VIP customers. These include detection of outages and faults and assurance of electricity quality. Being able to respond to an outage preemptively, before the customer calls it in, builds goodwill toward the utility. Additionally, large customers can benefit from variable tariff schemes. Where there is a legal framework to enable net metering, a smart meter can create an extra revenue stream for some customers by allowing them to sell excess power back to the grid.

Before implementing an RPP, several questions must be answered.

- Does the utility know who its large customers are and what billing procedures are followed? Knowing the target customer base is the essential first step in rolling out an RPP. In some cases, large customers may need to be regularized.
- Does the utility have a commercial department that deals with the needs of large customers? Having a department that is able to address the unique needs of VIP customers is critical to building goodwill for the rollout. The department may also take the lead in defining a plan with the targeted customers that ensures that both parties will be happy with the changes.
- What data management/commercial management systems are installed? To ensure compatibility and interoperability with existing systems, a technical stocktaking must be done to explore how any new system will synchronize with the existing one. In rare cases where a relatively recent AMR rollout has occurred, it may be possible to upgrade the existing system, saving significant time.
- What local market conditions might affect price and procurement? Being aware of potential challenges up front and allocating time to address these challenges will help ensure a smooth rollout.
- What constitutes success? Having defined metrics that can be measured and effectively attributed to the project is key to building consensus for an expansion of an AMI rollout.

Antmann notes that most projects following the RPP model are still under implementation, but early results have shown promise. One utility saw its commercial losses drop from nearly 40 percent to the low teens. Antmann predicts that real results will appear in the next two years, as more deployments are completed.

Source: Antmann (2015).

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Table 2. IBRD/IDA-supported AMI projects, FY2010 to Q3 FY2016

FY	Project ID	Project name	Country	US$ millions
2010	P110051	Haryana Power System Improvement Project	India	34.27
2010	P114204	Eletrobras Distribution Rehabilitation	Brazil	94.00
2011	P114971	Energy Sector Strengthening Project	Paraguay	4.00
2012	P115464	Recovery and Reform of Electricity Sector	Cabo Verde	5.50
2012	P122141	Energy Loss Reduction (Additional Financing)	Tajikistan	5.00
2012	P122773	Advanced Electricity Metering Project	Uzbekistan	150.10
2015	P120014	Electricity Modernization Project	Kenya	40.00
2015	P133288	Renewable Energy	Argentina	5.70
2015	P133446	Electricity Supply Accountability	Kyrgyz Rep.	4.00
2015	P143689	Clean and Efficient Energy	Morocco	12.68
2015	P144029	Power Recovery Project	Albania	20.00
2015	P149599	Power Grid Improvement Project	Laos	19.00
2016	P147277	Distribution Grid Modernization and Loss Reduction	Dominican Rep.	22.95
2016	P153743	Electricity Access Expansion Project	Niger	4.00

Note: Amounts are estimated commitments based on reviews of project documents and interviews with team members. Actual expenditures may vary.

outreach to customers to tout the benefits of smart metering, including mobile consumption monitoring and notification of outages.

A significant delay in procurement occurred because of DHBVN’s concerns about interoperability. Although the current project involves a relatively small revenue-focused deployment, DHBVN ultimately hopes to deploy AMI universally for all three million of its customers. To ensure that it was not locked into products provided by a single vendor or system, DHBVN insisted that at least 20 percent of the meters be supplied by a second vendor. To enforce this rule, DHBVN attempted a multistage bidding process to narrow the field of potential bidders before opening the tender process, which caused a significant delay in procurement. To speed resolution, the project team worked with DHBVN to facilitate meetings between the utility and prospective bidders to help the utility understand what was technically feasible and commercially available, and what the long-term outlook was for compatibility and interoperability. This led DHBVN to adopt one of the fledgling standards for smart meter interoperability, resulting in a simpler procurement process that focused on making sure that bids met the technical standard and then choosing the qualifying bid with the lowest price.

Another problem arose in procurement. Bidders were concerned about several contract clauses that held all parties equally liable for problems during implementation. Since acquisition and installation of the smart meters represent 70–80 percent of the typical cost structure of an AMI deployment (the MDMS and data analytics make up the rest), meter manufacturers were concerned about the reliability of the connection with the MDMS at the back end, while back-end providers were concerned that an issue with the metering hardware would negatively affect them. Bidders were also concerned about how to establish a baseline performance standard, given all the moving parts.

Eventually, DHBVN issued a revised tender that addressed its own concerns as well as those of the potential bidders. The new single-stage, two-envelope approach allows DHBVN to score the bids on conformity with standards and other technical issues and then scales the score based on bid price to ensure that the lowest-cost, most full-featured bid is successful. DHBVN and the winning bidder will also work to establish a baseline performance standard within 30 days of completion of the deployment. This baseline will establish responsibility for failures and provide a comparator against which all parties can transparently evaluate future reliability issues.

Brazil: Eletrobras Distribution Rehabilitation (FY2010). The Eletrobras Distribution Rehabilitation Project sought to improve the commercial standing of six distribution companies located in Brazil's relatively poor northern and Amazonian provinces. Because of their poor fiscal health, these six companies were not privatized along with their peers in the rest of the country a generation ago. However, given shrinking subsidies and the financial situation of the six northern and Amazonian distribution companies, these remaining public distribution companies felt pressure to reduce losses quickly and to improve efficiencies. Another significant driver for the installation of smart meters and other automation was the remoteness of the region and the absence of large cities. Data to improve power planning are analyzed in Brasilia; infrastructure is required to relay detailed data back to Eletrobras headquarters.

The project encountered several country-specific challenges that were overcome through negotiation and accommodations in procurement. For example, the government first wanted national bidding rather than international competitive bidding. However, research by the project team showed that domestically manufactured meters had fewer features and were considerably more expensive than their international competitors.

An added challenge to international bidding was the complex two-stage process for certifying meters in Brazil. First, the meter type had to be approved by the National Institute of Metrology, Standardization, and Industrial Quality (INMETRO), the national standards regulator. Then, each meter had to be sent to a testing lab to verify conformity with the reference meter and stamped with the INMETRO logo. International bidders expressed concern over delays in having their meters approved, particularly since the domestic meter manufacturers have a controlling interest in the testing labs. To assuage this concern, clauses in the tender were added to prevent the winning bidder from incurring penalties traceable to certification delays. Additionally, during pre-bid workshops, the team encouraged international bidders to view selection for the AMI tender as a chance to establish a foothold in the market by becoming familiar with the import process.

"To ensure the integrity of the bidding process, extensive efforts—including ten separate revisions of the bidding documents—were made to ensure that the bidding process was conducted on a level playing field."

Pricing of the incoming meters was also a significant issue. Regulatory issues have kept the prices of domestic meters extremely high. In preparing the bidding documents, Brazilian auditors wanted to compare the cost of the international meters after the high import tariff had been applied so as to make the domestic meters appear more competitive. To ensure the integrity of the bidding process, extensive efforts—including ten separate revisions of the bidding documents—were made to ensure that the bidding process was conducted on a level playing field. A final twist came on the eve of the contract signing. Eletrobras thought the winning bidder was going to pay the expensive road-user fees for transporting the meters from the port of São Paolo to the rural north, while the bidder thought that the fees were to be paid by Eletrobras. The team worked intensively to find a way to ensure that the amount was paid from Bank project funds to ensure the lowest cost to the end consumer and the success of the project.

Despite these difficulties, the project has had some notable co-benefits. The winning bidder, a joint venture between Siemens, Itron, and Brazil-based Telemont Telecommunications Engineering, committed to draw heavily on local labor to install the meters, promoting employment in a relatively poor part of Brazil. Additionally, through the efforts of the team, a recycling and waste management system was established for the meters that were being replaced by the new smart meters, with the objective of recycling almost all of the materials in the old meters and so greatly reducing the waste generated by the replacement program. At the end of March 2016, the main MDMS data center in Brasilia was brought online, with a small portion of the meters sending live data.

Tajikistan: Energy Loss Reduction Additional Financing (FY2010). The Energy Loss Reduction Project planned to install a comprehensive advanced metering system in Dushanbe to stem losses approaching 20 percent. The implementing utility, Burki Tajik (BT), chose to push for universal metering, rather than following a revenue-first approach. This proved to be challenging. BT had limited internal capacity, which made the procurement process extremely difficult. The project financed a procurement specialist to help the utility prepare bid documents, engage in bid evaluation, and negotiate contracts. BT procured 215,000 meters, including some 5,000 spares. About 172,000 of these were installed before the project closed. A major concern was the shortage of contractors with experience installing the meters, which BT rectified by having its own staff do some of the installation work.

In addition to the smart metering portion of the project, which was financed by the World Bank, BT set out to procure a remote metering and commercial management system under a separate grant provided by the Swiss government. While the installation of the meters is substantially complete, the complexity of the SAP-based MDMS overwhelmed the selected vendor, and the cost exceeded the financing available from the Swiss grant. The World Bank remains engaged in an effort to support BT in completing these metering systems, but in the interim has advised the utility on how best to utilize its existing billing systems. It is noteworthy that, despite the challenges in the rollout of MDMS, losses fell modestly and electricity sales exceeded the end-of-project target by about 15 percent, thanks in part to the newly effective metering.

Uzbekistan: Advanced Electricity Metering Project (FY2012). The Advanced Electricity Metering Project (AEMP) was designed to install AMI in Tashkent City and two neighboring oblasts. Driven by the need to replace traditional electromechanical meters installed between 1960 and 1990, meters that have rarely been calibrated and are past their useful life, the AEMP sought to replace about 1.2 million meters for low-voltage residential and institutional customers. Unusually, the project separated the hardware acquisition and installation into two separate contracts—the Metering Infrastructure Project, worth about $150 million, and an energy data management package worth $18 million. This contract structure raises concerns about compatibility in the near future.

However, the project has run into difficulties with procurement of the meters: at the request of the government, the standard bidding process was replaced by a two-stage process to narrow the list of qualified bidders, leading to significant delays. In addition, cost concerns from the government caused several months of delay in approving the metering package. This obstacle was only recently overcome, and the tender has now been issued to the prequalified bidders. The second portion, the energy data management package, is nearing the end of the prequalification stage. Notably, the project did not follow an RPP-like model but instead attempted a universal rollout, which may have challenged the institutional capacity of the utility.

> "The utility chose to push for universal metering, rather than following a revenue-first approach. This proved to be challenging."

Kenya: Electricity Modernization Project (FY2015). The power distribution utility, Kenya Power and Lighting Company (KPLC), will deploy about 45,000 meters as part of an RPP covering some 4,300 high- and medium-voltage customers and 40,000 large low-voltage customers. Although making up only 2 percent of KPLC's customers, these large users represent 72 percent of the total revenues of the utility. The effect of the deployment will be to cut commercial losses in half. Procurement for this component of the project has begun and will likely conclude in six to nine months.

Argentina: Renewable Energy Project (FY2015). A pilot remote metering scheme is under development to measure the precise usage of households in order to monitor and evaluate the use of solar home systems, wind systems, and small photovoltaic systems in individual homes, isolated public facilities, and micro-grids in remote communities. A significant challenge for this deployment is the volume of data to be collected and the remoteness of the installations. The project is in an early phase of implementation, and procurement is expected to begin later this year.

Kyrgyz Republic: Electricity Supply Accountability (FY2015). The Electricity Supply Accountability Project sought to broaden a previous series of rollouts financed by KfW Development Bank. Under the project, an additional 30,000 meters will complement the 110,000 previously procured. Even though the meters cover only 140,000 of Severelectro's 510,000 customers, they represent more than half of the utility's total consumption and revenue stream.

Two bidders emerged from the procurement process—a company that had provided the previously procured meters and the company that had been serving as an installer for the existing rollout. The latter firm, Hexing, was selected. Hexing's meters, which use the same standard as the previous meters, required new software to interface with the existing MDMS. The company committed to provide this software as part of their bid, illustrating one approach to solving possible interoperability and compatibility issues.

Albania: Power Recovery Project (FY2015). The Power Recovery Project seeks to reduce the public obligation to guarantee supply at regulated rates by moving medium-voltage commercial customers to the wholesale market. This move, which follows a similar shift of high-voltage customers in 2011, will put Albania at the forefront of EU energy-market reforms. To support the move of medium-voltage commercial customers to the wholesale market, the project will supply meters for these customers, enable metering at the feeders serving them, and build out a supporting MDMS. The project is at an early stage of implementation; the procurement process is about to begin.

> "Moving medium-voltage commercial customers to the wholesale market will put Albania at the forefront of EU energy-market reforms."

What have we learned from our engagements?

Most of what seem like country-specific issues fall into two categories

As the case summaries show, some of the Bank's experience with AMI deployments have been challenging (table 3). Several projects took many months to achieve their initial implementation (as was the case in Kenya and Kyrgyz Republic), but significant delays in projects occurred even after they were well into implementation. Once under active implementation, a few projects took as long as two years to proceed to procurement (as was the case in Brazil and India). The project in Uzbekistan is approaching four years of delay. Implementation can also be incomplete, as in Tajikistan, where the meters were procured and installed but the MDMS was not completed, leaving a system only partially enabled and unable to achieve all the goals set out for it.

Overall, the picture appears to be one of country-specific issues that delay implementation. But two larger overall issues emerge.

The first is the motivation behind the installation of the AMI system. In countries where AMI has been used to improve revenue collection as a prelude to universal metering, rollouts have been more successful. The two-stage process builds a guaranteed revenue stream from the largest customers, improving the ability of the utility to execute a wider rollout and allowing it to become more comfortable with the technology's capabilities and limitations. Projects that

Table 3. Drivers and challenges in IBRD/IDA-supported AMI projects since FY2010

	India	Brazil	Tajikistan	Uzbekistan	Kyrgyz Rep.	Kenya	Argentina	Albania	Morocco	Lao PDR	Dominican Rep.	Niger
Drivers												
Commercial losses, especially theft	X	X	X	X	X	X		X		X	X	X
Technical losses	X	X		X		X				X	X	
Remoteness		X					X					
Reliability / efficiency	X		X		X			X	X	X		X
Renewable power							X		X			
Challenges												
Institutional capacity			X	X								
Regulatory issues	X	X		X								
Procurement (interest, cost, taxation)	X	X	X	X								
Technical (interoperability, compatibility)	X		X	X	X							

The projects in Kenya, Argentina, Albania, Morocco, Lao PDR, Dominican Rep., and Niger are not yet under implementation.

follow a revenue-focused model also tend to execute faster. This process also seems to enhance corporate governance at the utility.

The second issue is interoperability and compatibility between systems from different vendors and between generations from each vendor. To some extent, these concerns have been mitigated by the finalization and adoption of standards such as the Device Language Message Specification, which create common methods for meters to exchange capabilities and data with each other and with back-end systems such as the MDMS (DLMS Consortium 2016). However, vendors remain concerned about reputational risk from projects that suffer from integration difficulties. Following the RPP model described in box 1 can further mitigate these risks by giving all stakeholders confidence in the outcome of a larger deployment through participation in a pilot project that builds experience and addresses interoperability concerns.

The choice of MDMSs also plays a critical role in addressing this issue. Selecting a technology-agnostic MDMS helps resolve several critical issues: (i) interoperability and compatibility between smart meters from different vendors; (ii) integration with legacy metering systems; and (iii) support for diverse protocol standards and communication media (power line communication, radio frequency meshes, point-to-point connections, and so on). While technology-agnostic MDMSs are a relatively new development, they are extremely scalable, permitting a utility to extend the AMI solution to a more comprehensive base of customers.

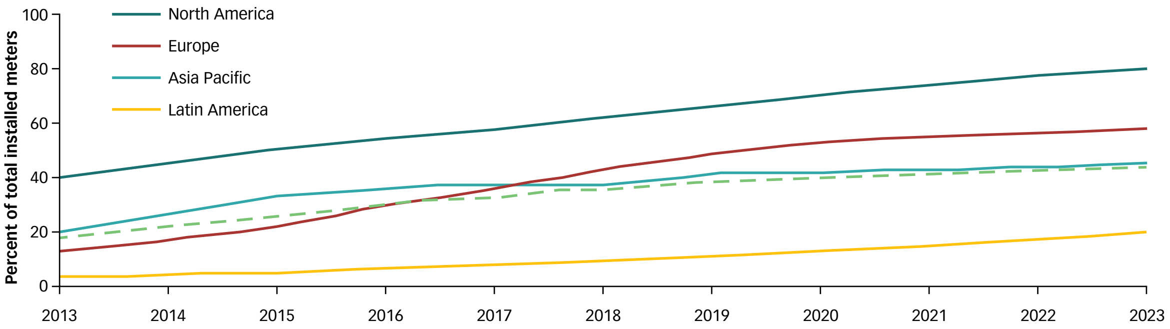
What is next for AMI deployments?

By starting with revenue protection, utilities can scale up to wider installations

Data from the International Energy Agency show that the number of smart meters is likely to increase significantly over the next decade and reach approximately half of the total installed meter base by 2023 (figure 2). While the penetration rate is expected to be highest in North America and Europe, approaching 80 percent and 60 percent respectively, installations in East Asia and the Pacific and in Latin America and the Caribbean are also expected to increase significantly (IEA 2015a).

However, these installations will not be fully successful in developing countries unless the challenges that existing projects have encountered are addressed. The lessons learned from existing World Bank projects—focusing on revenue as described in box 1 and addressing interoperability and compatibility concerns—can play a significant role in driving successful deployments in emerging economies.

Figure 2. Penetration of smart meters, by world region



Source: IEA (2015a).

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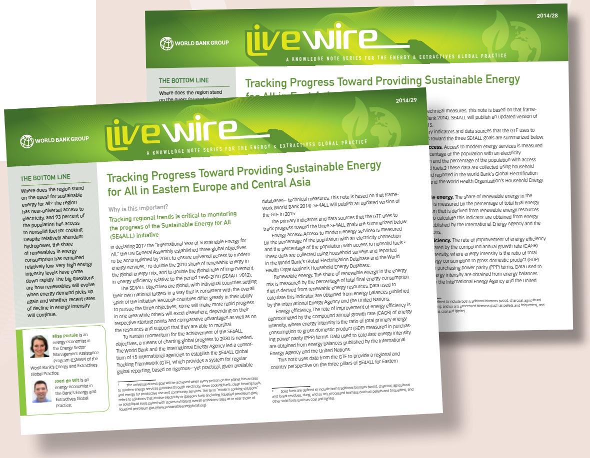

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