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Getting smart about smart meter analytics

Satisfying customers, enhancing operations, and running a better utility business.

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Introduction

Around the world, utilities are deploying vast networks of advanced metering infrastructure (AMI), commonly called as smart meters.

But are utilities truly getting the most value out of all that data and the investment they made?

The key to unlocking the full potential of smart meters and the smart grid is to analyze meter data to answer and to keep answering, continuously and in real time, key business and operations questions for utilities. For instance:

- Which specific customers offer the greatest potential to help control peak demand through our demand response programs or time of use rates?
- How can we make our load and peak demand forecasts as accurate as possible, in order to plan efficiently for power generation and to negotiate least costly contracts for wholesale market power?
- Which of our transformers are getting overloaded, and how can we shift load away from that equipment until we can install larger transformers or switch meters to transformers that are not at capacity?
- Can we exploit new techniques to save energy or reduce reactive power on a large scale, such as through initiating conservation voltage reduction programs?
- How can we justify to regulators that our programs are succeeding or warrant expansion?
- How can we move from a reactive to a proactive maintenance model and assign our limited field resources to the equipment with highest risk of failure?

AMI analytics software, such as application built on EnergyIP, can help utilities create custom dashboards and reports to continuously keep a close eye on all the important numbers. Robust analytics, applied thoughtfully, can help utilities spot opportunities, save money, work with regulators and partners, and most importantly keep the lights on.

- This paper explains how AMI analytics can be put to use to benefit your utility.

1. Understanding and engaging customers through AMI analytics

Once upon a time, most utilities segmented their customer base into just three broad groups: residential, commercial, and industrial.

Today, analyzing data from smart meters allows utilities to identify any number of market segments. This can be crucial to optimizing programs which directly involve customers. It also can help utilities get the greatest return on their investment in these programs, provide better rates to the customers and demonstrate program success to regulators.

In the big picture, understanding customers well also allows utilities to plan and operate their businesses more efficiently, effectively and profitably.

Better market segmentation, better programs

AMI analytics can enhance many aspects of how utilities conduct customer programs (energy efficiency, demand response, time-of-use rates), as well as the benefits these programs yield to customers and the utility:

- Program design:
  Determine the right mix of measures and incentives
- Identify participants:
  Target for outreach specific customers most likely to contribute value to, or benefit from utility programs.
- Help customers make informed choices:
  Online calculators can show individual customers, based on their actual energy data, whether they might save money or otherwise benefit from participating in a program or switching to a time-of-use rate.
- Evaluation and reporting:
  Are programs achieving their goals?

In fact, analytics can become the marketing engine behind any utility's consumer-oriented programs. That's already the case in many other industries that serve consumers, such as retail stores and online shopping.

Using analytics to target program marketing and outreach can offer significant improvements in program participation.

In the past, when utilities began offering a new program, sometimes they would simply list it on their website. In such cases, few consumers would find the information and even fewer would sign up. But now, utilities – especially those with smart meter data – can see which customers might be most valuable to (or reap the most benefit from) a new program. This makes direct outreach efforts more effective and more cost effective.

Such analysis can even be automated, so it can be conducted continuously.

Make customers part of the solution

In almost every utility's service territory there are some regions that are "transmission (or distribution) constrained." These places face capacity limits on transformers or other distribution assets, or load growth in that region is outpacing the utility's ability to serve it reliably.

In these areas, analytics can help utilities both better understand the problems and identify customers who can be part of the solution.

Examining the details of regional or local peak demand patterns can show which devices along the network start to get overloaded, at which times. This analysis can also identify the highest-use "downstream" customers during local peak hours. Those customers might warrant special outreach efforts to engage them in existing or new programs for demand response.

Similarly, for energy efficiency programs, analytics can help utilities identify customers whose usage patterns should be modified to improve the overall stability of the network.

For instance, consider a utility that offers special electric vehicle (EV) rates. If a customer charges during the night hours, it is assumed that they plug in their cars, the moment they come home. This can cause additional consumption when the demand peak is already high. Analytics can help locate these customers after which, they might be offered incentives like better rates if they participate in the EV program wherein they are charged after e.g. 10 PM. Many utilities include commissioning as part of their energy efficiency programs, to verify that installed measures yield desired savings over time.

Often these utilities hire third-party contractors to conduct this commissioning. Analytics can help guide and inform this process, providing contractors and utility staff with data and context about a customer's energy use patterns since the measures were installed. Together with in-the-field inspections, this can provide a more accurate picture of how those measures are performing.

Evaluate customer program performance

Analytics make it possible to ask specific questions about how well your programs are performing and to get actionable answers, nearly in real time. For instance, are participants in a demand response program really curtailing or shifting enough load, to adequately manage local or system wide peaks?

In this way, utilities can borrow a page from the software industry's "agile development" process: rapidly prototyping, and iterating or adapting programs and outreach efforts in response to shortcomings and opportunities that become apparent via analytics.

For example, many utilities deploy a web portal or in-home displays which allow consumers to view and trend their energy use data, compare rate options, and generally figure out how they might use energy more wisely or save money. Analytics can, thus help utilities understand the effect of this access of information by consumers on their energy usage and energy-related choices. This means that utilities can now take the next step beyond simply knowing that X% of residential customers view their energy data, and overall these households reduce their consumption by Y%.

Therefore, a utility might analyze when and how often individual customers access their energy data, and correlate that with reduced or shifted demand in those households. If those customers also have smart thermostats, the utility might also be able to pinpoint specific actions taken, like changing a set point, or requesting a home energy audit. Such data could indicate whether a smart thermostat pilot program warrants expansion.

Revenue recovery

AMI analytics can help utilities improve the efficiency and the accuracy of billing. Specifically, examining where and when billing problems occur, can help utilities identify where the problem with meter readings may exist. Perhaps there are faults in some meters, or in a portion of the data network which relays meter data to the utility.

Similarly, analytics can also help spot likely instances of meter tampering or energy theft or even that a customer might be on the incorrect rate. For instance, a customer on a residential rate whose energy use is both, unusually high and tends to peak in the evening, may actually be a small restaurant, hence not a household rate, and thus might warrant a rate change.

This sort of advance analysis can reduce the amount and duration of field visits needed to investigate issues. Thus, every avoided truck roll or field inspection, represents operational savings.

Working with large customers

Analytics-supported market segmentation works not just for residential customers, but for com-mercial and industrial customers too. While retail competition is limited in the U.S. residential energy market, many U.S. utilities do face competition to serve commercial and industrial customers. Maintaining and attracting new C&I revenue is a high priority for many utilities.

Consequently, a utility might use analytics to aggregate all the loads for a single large customer across multiple sites, and use that to spot trends which might indicate increasing or decreasing load. These can be cues for the account representatives serving those large customers to reach out and see how things are going, and how the utility might help.

Of course, account reps have always done such outreach, but equipped with current data, they can now time their calls more effectively. Plus, sharing data analysis with the customers can help position the utility as a helpful partner in long-term business planning to reduce CO2 emissions, boost operations, and strategically approach complex tariffs – regardless of industry; not merely a vendor of energy.

Better business planning and rate cases

A considerable breakthrough offered by AMI analytics is that utilities can now support key business processes (such as rate design and load forecasting) by observing the data for the entire customer base rather than statistical samples. This data can be managed flexibly, allowing utilities to update forecasts daily if desired or determine the revenue effects of different rate designs.

Previously, such forecasts could only be based on "snapshot" data from statistical samples of the customer base. While that method is valid, analytics support more accurate and robust business processes.

When utilities prepare their rate cases for presentation to regulators, they must estimate the likely impact of new rates on different types of customers. In the past, this was done by describing hypothetical "example" customers. But now, with analytics, utilities can more confidently predict rate impacts for all customers and even list real examples in a rate case.

Furthermore, analytics allows utilities to assure regulators that they can identify and reach out to customers who might be disproportionately adversely affected by a planned rate change.

For instance, a residential rate change might disproportionately increase bills for 5,000 out of a utility's 100,000 residential customers. In such a case, the utility could use AMI analytics to identify these customers and reach out to them to offer options to minimize this impact. Furthermore, the utilities can indentify how likely customers will fare.

Case Study

Konstant (NRGi): Data analytics leads to grid load predictions

When Danish grid operator, Konstant, began to analyze its smart meter data beyond just the billing operations, they discovered a treasure trove of digitalized information. With the right set of analytical tools, the data is helping them optimize operations, improve maintenance and predict the loads on their power grid. The Danish grid operator rolled out smart meters in eastern Jutland between 2010 and 2014 – far earlier than other utility providers. The 225,000 smart meters are exactly the same, which means that Konstant's data management system receives a uniform data stream.
It also means that both the meters and the management system can be updated easily.
Without visiting a single customer, the grid operator has equipped the smart meters with new functionalities several times already.

Every hour these smart meters send millions of data sets from houses, businesses and factories to the transmission system operator Energienet's nationwide data hub. Originally the data was used only to account for a customer's electricity usage and deliver correct bills, but Konstant started to take a closer look at how the data might be used to monitor the grid and predict future changes. In the past, the grid operator didn't really know much about what was happening in the low-voltage grid between its transformer stations. But when Konstant coupled the smart meter data of diverse loads from all three phases of its transformers with the geolocation data from our geographic information system, the grid operator knew how the stations were being used. Thus, Konstant can detect patterns in incoming error messages and use this knowledge to improve the management of the grid. Konstant receives many thousands of events on a daily basis, including numerous indications of over- and undervoltage.

And more data is brought in from the interruption statistics that the supervisory control and data acquisition system provides.

This well analyzed knowledge is worth real money: Just to know more about how one transformer station on Djursland or five kilometers off cable northeast of Aarhus are charged at different times, can save the grid operator huge amounts. This is especially true as more and more energy consumers are becoming producers as well.

The analysis of smart meter data helps Konstant prepare for upcoming challenges, but choosing the right data for analysis is the key. Konstant's smart meters deliver on average around 1.3 billion data sets per month, including data for consumption and production fluctuations over time, maximum and minimum voltage, power and reactive power. Much of the data contained in the meters isn't used immediately, but if the grid operator suddenly needed it due to a fault or an outage, it has it archived for 14 days. The data is also made available for asset management and new installations. The brain collecting and handling the huge amount of data is the Siemens EnergyIP Meter Data Management (MDM) application. Siemens, in close cooperation with external partners, is constantly expanding the system to make even more data accessible and useful. Konstant is starting to use the data to make predictions. Based on around five million weather-related data sets collected over a two-year period, they will estimate how the load and the voltage in parts of the main grid will develop if e.g. the sun shines tomorrow morning. Konstant's analytical programs are standards that come on top of the EnergyIP platform and its broad set of other applications.

The grid operator can draw a picture of his power grid and is able to make predictions. To keep up with this development and make the operation of the grid better and more cost-effective, direct access to data from the meters is crucial.

2. Operating more efficiently on the wholesale power market

The wholesale power market plays a huge role in any utility's overall financial picture. Utilities that can forecast their power needs with a high degree of accuracy tend to be able to negotiate more affordable long-term contracts for wholesale power purchases. They also tend to avoid far pricier last-minute power purchases on the spot market.

For regulated distribution utilities, this yields savings that can be passed on to customers as well as, in some cases, profits that can be passed on to shareholders.

AMI analytics supports more accurate forecasting of system load and peak demand, which in turn yields smarter procurement decisions. Analytics lets utilities evaluate how and when system peaks happen, and disaggregate system loads into meaningful customer and regional peaks. With such immediate and granular information, utilities can monitor how customer patterns in device and energy usage evolve over time.

So far, utilities typically have based forecasts on a small sample of their customer base, maybe just a few thousand people. Also, this sample data typically is used for quite some time after it has been collected. This yields relatively gross estimations of customer behavior, with minimal segmentation and a long lag in modeling updates.

With modern AMI analytics, utilities often can refine forecast models by projecting load and peak demand based on actual data for individual customers and dynamic groups, not static samples or top-down analysis which does not take generation at the end-user site into consideration. This can yield a more accurate and nuanced understanding of specific events, trends or situations.

On a typical day, enhanced load and peak demand forecasting might not make much difference. But on unusual days (where extreme weather, holidays or special events such as the Superbowl significantly alter energy consumption patterns), more accurate forecasts can help utilities avoid spending lots of extra money on the spot power market.

Risk management

In most utilities, decisions about wholesale power procurement and plant scheduling are made with the support of Energy Trading and Risk Management (ETRM) tools. Procurement and power scheduling staff examine demand forecasts, weather patterns, and the relative cost and reliability of various options to procure power or reduce demand. Then they determine the potential financial risks, in case any of those projections are significantly off-target. These teams then make power procurement plans and contingency plans attempting to avoid or minimize the biggest risks.

At many U.S. utilities, ETRM processes haven't yet realized the full benefits of meter data and analytics. The people involved in power procurement and plant scheduling may be aware of the potential that meter data holds, but they may lack the tools to integrate it effectively into their processes.

Consistent access to timely, comprehensive and reliable meter data increases certainty and thus reduces guesswork and risk in the wholesale power market. This, in turn, gives power schedulers the confidence to enter into longer-term (and thus lower-cost) wholesale power agreements.

Knowing the total consumption and how it fluctuates over time is pertinent for long-term planning, but in addition, it is important to know where in the network the consumption deviations will occur to route electricity appropriately or deploy new distributed resources at the correct location. This challenge can only be tackled by having an accurate network model. The meter to transformer connectivity model is crucial for planning, outage management and all grid applications that rely on an accurate connectivity model. Especially after storm-restoration efforts, when the network has to be brought back up quickly, not all new connections established between meter and transformer find their way into the utility system records. It is estimated that 5-20% of the meter to transformer data is incorrect in the utilities' system of record. Normally, costly field services are required to walk the lines to verify where the connectivity model is incorrect. With our array of analytics (Asset Topology Mapping), you can replace slow, manual and expensive field investigations methods with an automated system that analyses the connectivity model on a regular basis to identify errors. Correct transformer to meter data, will improve customer satisfaction, optimize the accuracy of other grid-application and enhance the safety of the low-voltage network.

Improving price signals and keeping customers motivated

Demand response programs are potentially a powerful tool for help avoid or minimize costly spot-market power purchases. Most demand response programs rely on customers to take action to shift load in response to price signals. Keeping customers motivated to act is crucial to program success.

When deploying smart metering and analytics, utilities should plan to use AMI data to continuously refine price signals (such as peak time rebates or time-of-use rates) with the goal of continuous improvement (which analytics also can trend). Never lose sight of the basic rationale for smart metering: reducing peak load and overall consumption. That's why utilities want to gather detailed energy usage data from customers in the first place.

Keeping demand response program participants motivated is another way that AMI analytics can help curb demand and avoid the highest prices on the wholesale power market. Hence, it helps to tell customers their collective efforts are making a positive difference as well as how they each benefit individually. On this front, AMI analytics can provide feedback to demand response program participants.

This can be done on the individual level: "Congratulations, you reduced your household's peak demand by 20% during yesterday's peak -- which could save up to $3 on your next energy bill!"

Similarly, aggregate figures on total shifted peak demand, can tap into the desire to contribute to the greater good: "Congratulations! Yesterday was a hot one, but together we met our target for controlling overall peak demand – which helps the environment and saves everyone money!"

3. Saving money on field operations and asset management

Scheduling generation

When short-term and long-term load forecasts are less accurate, utilities tend to need to keep a larger reserve of generation capacity on hand, to meet customer needs and system reliability requirements. As the proportion of more intermittent renewable generation and customer-operated distributed generation continues to grow, utilities face new challenges in scheduling and coordinating generation.

AMI analytics not only supports forecasting of customer loads but also provides a platform for monitoring, analyzing and forecasting distributed generation and renewables.

It doesn't matter whether the source of distributed generation is a net-metered installation, a feed-in-tariff, or a conventional independent power producer (IPP).

By combining data from metered distributed generation and loads, utilities can enhance both the accuracy and granularity of forecasts. This is especially important in wholesale markets that are considering (or implementing) location-based marginal pricing methods.

In the bigger picture, when more utilities leverage AMI analytics to procure power, schedule generation, and manage demand, collectively they can help reduce (or at least slow the increase of) power prices yielding savings for utilities and customers alike.

AMI analytics can enhance virtually any aspect of a utility's business, including managing the operation, maintenance and life cycle of equipment used to generate and distribute power, as well as managing outages and other problems in the field.

For utilities that are just getting started with AMI analytics, finding ways to apply analytics that yield obvious and immediate savings can help demonstrate the value of this versatile tool. A few initial "easy wins" can foster support and consensus, including budgetary support for applying analytics more widely throughout a utility.

One of the fastest ways to realize demonstrable savings from analytics is to minimize the number and duration of truck rolls (sending out personnel in a truck to handle outage recovery or other field issues).

Analytics can track power outages that occur, and even help predict outages, by monitoring transformer overloading (or other patterns or problems) that can cause grid imbalances.

Analytics also can monitor momentary outages which are too brief for many customers to notice or report. These can indicate problems such as areas where tree branches need trimming. A study by the LBNL showed that momentary outages cost the US $52B where sustain outages are with $26B, half of that. So getting the upper hand on momentary outages can significantly reduce the maintenance budget of the utility and provide overall savings for the economy. Such a proactive approach can maintain or enhance system reliability, before reliability indicators dip.

Sometimes an individual customer (rather than several customers) will report a lone power outage. Before a repair representative is dispatched, the utility can "ping" that customer's smart meter to check whether it's still receiving power. If so, the cause is most likely a breaker or other electrical problem within the customer's building, and not a problem the utility could fix.

That's one way to avoid truck rolls and help customers solve power problems faster.

Whenever there's a wider power outage, utilities must deploy several trucks. Analytics based on the data from meters on both utility assets and customer premises can quickly reveal the likely location of failed utility equipment (blown transformers, downed power lines, etc.).

Once a repair is made, field personnel can ping downstream smart meters to confirm whether power has been restored without needing to drive around a neighborhood or telephone residents to confirm. And if "nested" outages remain, field teams can identify and address these quickly during the same truck roll.

Optimizing transformer load management

Transformers are the workhorse of any power distribution grid. They're built to last for years. However, local grid conditions have change over that time, with distributed energy resources our electric network that was designed for a one-directional flow has become bi-direction causing some transformers to be more severely overloaded or sometimes even begin to operate in reverse. This can shorten their useful life, or even ultimately causing outages, oil leaks or fires can be the consequences when they fail.

Transformer overloading occurs when demand for power downstream of a transformer frequently and for extensive duration approaches or exceeds the transformer's maximum capacity; with the global warming and extensive periods of hot weather, we see this happening more frequently. Over time, this damages the transformer, increasing the chances of failure.

Before smart meters, utilities only knew when their entire system was peaking. Of course, different parts of a grid (served by different substations and transformers) tend to peak at different times.

Today, AMI analytics can help identify which transformers experience overloading, to what degree, and when. Analytics also can spot patterns and trends in downstream loads being served by overloaded transformers. This makes it easier and more cost effective to implement a variety of solutions to minimize overloading and protect the utility's investment in that transformer.

For instance, on an overloaded transformer, a utility might split the load to redirect some of it to other transformers. Or they could opt to replace that transformer with a larger-capacity unit or even switch meters with highest consumption to a transformer that are under loaded. In this way, it enables the original transformer to work in its designed capacity boundary.

Another approach is to limit or shift peak demand on specific transformers by targeting and engaging customers who can have the most impact. Analytics can identify downstream customers who tend to contribute the most to peak demand for an at-risk transformer.

Customer demographic studies can help identify usage patterns and be strategically grouped. These grouped consumers could receive special outreach to participate in a utility's demand response programs or time-of-use rate. For larger commercial or industrial customers, their utility account representative might engage them in solution-oriented discussions.

In many urban or suburban areas, specific customers or neighborhoods can potentially be served power by more than one "feed." This gives utilities a localized option for managing overall system peak demand.

Analytics can identify regions of the grid which tend to place the most load on the overall system, especially during system peaks. Then, during peak hours, the utility might temporarily re-route the feed from which customers in that region receive power. This helps prevent circuit overloading.

So, in the hour before a peak is likely to occur, some customers, normally served by a stressed circuit, could be switched to a less-stressed circuit. This strategy has the advantage of not requiring customer notification or involvement which can help, because customers don't always appreciate being asked to take action to shift load, even when they're rewarded for doing so.

Capital portfolio planning

Analytics can play a key role in helping utilities get the "biggest bang for the buck" from the huge investments they must make. These costly decisions include:

- When to replace distribution transformers.
- Reduction of emergency truck roles by moving from a reactive to a proactive maintenance model.
- The appropriate capacity or size of new transformers.
- Generation capacity:
  Power plants, renewables, and distributed generation even long-term wholesale power market contracts.
- Tree-trimming schedules.

Prior to smart meters, most utilities did their capital portfolio and maintenance planning based on extensive studies of system wide summer and winter peaks. This meant they often had to plan for a large "safety net" in terms of extra system-wide capacity since they couldn't be sure of precisely which parts of the grid peaked, and when. Future growth could only be predicted for the entire system, not locally.

Today, analytics can help utilities be more efficient about their capital spend and more accountable to regulators when they make more conservative capital spending choices.

In the long term, one of the biggest ways this can pay off is, better planning for future power generation needs.

Smart meters and analytics make it easier to integrate a utility's own renewable energy resources (such as large wind farms) onto a power grid, since wind and solar energy tend to be intermittent and thus more complex to manage. Analytics also make it easier to reliably manage peak demand, plan storage, thus reducing the need to build conventional power plants which are intended mainly to deliver peaking capacity.

Distributed generation

Analytics can help distributed generation become a more viable and reliable part of a utility's overall resource portfolio. This usually includes smaller power plants (usually fueled by natural gas or propane and easier than large power plants to ramp up and down quickly by remote) which are operated by the utility itself. It can also involve distribution capacity owned and operated by large commercial, industrial, or institutional customers or by third-party providers.

During peak hours, if a utility needs more power than it can produce and if prices on the wholesale spot market are particularly high, distributed generation might be called upon to serve load more cost effectively.

Also, distributed generation located in less central regions of a power grid can help compensate for voltage variances or growing peak demand for customers who are near the "end of the line."

Often this is far more cost effective (and faster) than building a new utility substation to serve growing load, especially if new peaks or voltage problems occur infrequently.

In places that allow net metering (meaning customers can generate their own power and sell it to the grid, earning a credit from the local utility), large commercial and industrial customers who have their own generation capacity, might be engaged to voluntarily turn it on at times, when doing so would be most helpful. The utility might offer special programs or rates to provide additional incentive for this effort.

More efficient maintenance

Of course, analytics can help utilities plan the optimum schedule for conducting routine field maintenance. For instance, transformers which get overloaded more often might be checked more often. Also, power lines in areas especially prone to momentary outages might be checked for tree limbs that have grown too close for safety. This insight can influence routes and schedules for tree-trimming teams, and reduce bigger outages, unplanned truck roles when the next big storm hits.

All of these efforts ultimately save utilities money, through efficiency (getting the maximum benefit for every dollar spent on truck rolls, reducing emergency truck-roles), extending the useful life of capital equipment, and minimizing or preventing outages and equipment failure.

Analytics also can help demonstrate within a utility, or to regulators, or to shareholders the bottom-line value of these savings. This can help justify the investment in smart meters and analytics, and support further uses of these technologies to benefit everyone.

4. Monitoring and maintaining smart meter performance

One of the many beneficial ways utilities can make use of AMI analytics is to keep an eye on the AMI systems themselves, by tracking key performance indicators (KPIs) for:

- The pace and quality of installation efforts
- How well and reliably the smart meters and network devices are functioning
- Smart meter data quality
- Installation, meter reads, and other work performed under service level agreements
- Problems that develop with meters over time
- Voltage reads within the nominal Voltage band
- Measuring momentary outages over time
- Verifying meter to transformer connection after AMI deployment

Analytics, such as EnergyIP by Siemens, can help utilities define KPIs that make the most sense for an AMI deployment and network, and track them via a dashboard-like interface.

Smart meter data quality and availability

Utilities need to stay abreast of whether their AMI system is delivering accurate and timely data. Many utilities configure AMI systems to retrieve data at least one or more times daily. This data generally includes at least hourly interval measurements, along with various register values and event logs.

Therefore, a typical KPI a utility might track via analytics is the percentage of meters reporting in each data acquisition window, such as a day. Ideally this should be very close to 100%, but in practice is most often in the 97%-99% range.

Another KPI is data accuracy and completeness. That is, was the entire interval values delivered for the specified time period? Also, how many values failed a validation test?

Once a utility begins computing and reporting a particular KPI, it should also trend that KPI over time. If a KPI varies widely at some times, this may indicate that the system operator is having process control problems.

Analytics can help investigate problems further through follow-up questions such as:

- Is there a pattern in the times, locations or meter equipment involved?
- Over the long term, is there a general trend toward improvement or decline in the KPIs?

In general, any KPI should have upper and lower control limit values, guidelines within which the operator should feel comfortable that things are working as planned. Additionally, the operator can consider setting goals to improve operations by tightening these limits, reducing variability, or aiming to achieve more optimal values over time.

Selecting the right KPIs, setting control limits, and targeting improvements are all ways that analytics can help reduce AMI operating costs.

Smart meter deployment

One benefit of having a robust AMI analytics package in place before field installation of smart meters begins is to track the progress and performance of smart meter deployment. This can be a big job, especially in major deployments where several thousand meters may be installed and activated daily.

At high rates of installation, it's vital to catch issues before they become problems. For example, sometimes a meter is installed, but its communications aren't working or the meter is configured incorrectly. If daily installations aren't validated for correct communications and configurations, a utility might have to conduct thousands of costly field visits to correct these failures. Also, if it takes a few days more to verify these processes, then in the meantime tens of thousands more meters might installed before the problem is detected.

Many utilities handle their own smart meter installations; others hire third-party installers. In either case, analytics can track how well specific installation teams are performing, both in terms of installation rates and work quality.

During deployment, analytics can track field operation-related KPIs such as:

- Overall progress toward completion:
  The percentage of meters and data concentrators installed so far. Is the deployment running on schedule?
- The time between when a meter gets installed, and when it's been confirmed that the meter is functioning properly (called provisioning or commissioning).
- Pace of installation:
  The number of meters installed per day, per installer group, and by type of installation (such as indoor, outdoor, three-phase transformer-rated or self-contained single phase).

Often third-party installers get paid according to such metrics, which make these figures valuable not just to engineering teams but to utility accounting departments.

Deployment benchmarks should be tracked and trended across the entire service territory, and by region. Utilities should also focus on the performance of specific subcontractors, types of meters, or other variables (such as weather) which might reveal patterns that can help improve performance and reduce costs.

It's always simpler and less costly to address meter problems early in a deployment. Sending teams out a second time to repair or replace meters already in the field is a considerable expense.

For instance, if analytics reveal that a specific model or production lot of a meter appears more prone to technical or communication problems, the utility might switch to deploying another type or batch, until the problematic model can receive further testing, or the utility can confer with field teams about possible installation issues.

Ongoing meter maintenance and management

Smart meters, and the data networks they use, can experience a variety of problems like firmware or memory errors, battery problems, low or intermittent radio signal, etc. Sometimes these issues are transient, but sometimes they can lead to a persistent, recurring or hard failure.

Typically, a utility can expect 0.5-1% of installed smart meters to fail per year. That's not a small number so efforts to spot problems early can pay off substantially.

Spotting meter problems early on, can help resolve the problem before a device fails entirely, or before the quality of data for a customer account is substantially compromised by gaps or inaccuracies.

EnergyIP spots possible meter or communication problems (single events, or trending over time) and automatically generates field orders to repair malfunctioning devices. Utilities can track an important KPI around this: The percentage of devices experiencing problems per month. Utilities can also drill down further into this benchmark to investigate possible correlations by type of meter technology, device model, installation team and date, and so on.

For instance, if several meters installed in a certain two-week period from a particular vendor are starting to show a common problem, this signals that the utility might want to revisit its internal training procedures, or perhaps its service level agreements. It also indicates that this group of meters may likely have additional issues. So, perhaps proactive replacement could avoid the more costly process of replacing meters after failure.

Analytics can help track another important KPI: The average time between when a field order is issued and the meter problem is solved. The shorter this time, the more money the utility saves and the more satisfied the customer is likely to remain. Further granularity on this metric could examine the work of specific repair teams, meter problems in certain neighborhoods, and so on.

Tracking and trending meter problems can provide early warning of possible large-scale failures, as well as advice for what meter installation or repair teams might watch for or do differently. This is crucial because most utilities do not routinely conduct field inspections of smart meters unless there is a problem.

Conclusion: Start where you are with AMI analytics

Whether your utility is just planning its first smart meter rollout, or whether you've already been using smart meters for years, it's always a good time to do more with analytics to improve your business and operations.

Ideally, the best way to get started with AMI analytics is to budget and plan for analytics to be set up and configured before the first smart meter gets installed on a customer's property. This measure can easily pay for itself in avoided field visits to fix meter problems, or replacement of problematic models, after the initial installation is done. It's always cheaper and easier to prevent problems (or at least, spot and address them early) than to go back and redo a great deal of hard work.

But if you're already deploying or using smart meters, it's still a great time to make broader use of analytics. Make a list of all your key questions for your business and operations, anything that might help you operate more efficiently, plan for future needs, explore new opportunities, or work more effectively with regulators. Then, consider how analyzing smart meter data might help you answer these questions.

At Siemens, we often guide utilities through exactly this sort of brainstorming. We also help utilities configure our analytics software to provide timely, useful answers to pressing questions.

And if AMI analytics is already yielding considerable value to your business and operations, what new benefits might emerge if more utility departments get involved? What might your billing and accounts receivable departments are able to achieve with access to analytics data? Or your environmental compliance department? Or your rate design teams? Or your field-investigation team?

An investment in analytics for utilities will continue to pay off for years to come. It can spur staff collaboration, reassure personnel and customers alike that their efforts are paying off, and give everyone in your business more confidence in their decisions and predictions.

Learn more about what AMI analytics can do for your utility: siemens.com/energyip-analytics

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