Alcatel·Lucent

STRATEGIC WHITE PAPER

Smart Metering – Enabling Greater Energy Efficiency

The electricity industry is one of the few industries where unconstrained demand is starting to be actively discouraged. The combination of rapidly increasing, more intense seasonal demand peaks with increasing pressure on infrastructure investment are causing the industry to look for ways of more intelligently managing demand. Smart metering is increasingly being seen as a tool through which regulators and network operators will be able to shape electricity demand patterns in the future. Smart metering will allow operators to educate and financially incentconsumers to be more aware of their energy usage. Ultimately it could allow a limited level of control over non-critical load, thereby increasing the reliability of supply and asset utilization efficiency.

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Introduction

The electricity industry is changing rapidly. The last decade has seen the rapid growth of distributed generation (mostly in the form of wind farms), demand peaks that are intensifying and increased pressure from stakeholders and regulators for asset efficiency. The result is that the electricity industry is one of the few sectors where unconstrained consumption is starting to be actively discouraged.

One of the tools being proposed to persuade users to be more conscious of their energy usage patterns is smart metering[1]. This new technology has already penetrated the factory and other large energy consumers. It is now finding its way into small enterprises and the home.

This paper explores the drivers that have brought about this change in attitude to the metering of user energy consumption, what smart metering is intended to achieve and the possible elements for an implementation.

Market environment

There are three primary influences on the operations of energy networks that are driving the need for smart metering. These are:

- The rapid growth in peak energy demand;
- The inherent inflexibility of the energy distribution infrastructure;
- The pressure from stakeholders and regulators for greater asset efficiency.

PEAK ENERGY DEMAND

Even in quite temperate climates, there has been a marked increase in peak energy demand. In London, UK, the summer peak is growing at 2.6% per annum against an average growth of 1.4% per annum. In hotter climates the effect is even more marked. One distribution system operator in Australia is quoted as saying that 30% of its infrastructure operates for 2% of the year.

This growth has been rapid. When the forward investment plans were being made even ten years ago, nobody would have foreseen growth of this magnitude. And the trend is for the peak to get taller and narrower, reflecting the sharp intensity of demand on the few hottest days of the year. In short, significant infrastructure investment is being demanded for an ever-decreasing portion of the year.

INFLEXIBLE INFRASTRUCTURE

By its very nature, electricity distribution networks are not readily configurable to rapidly changing demand patterns. Also the CAPEX required to implement such new infrastructure is significant. Finally, there can be popular resistance to the construction of new electricity infrastructure, which is considered a social nuisance. As such, network planners have to be reasonably certain of forward demand into the medium-term before committing to such a significant investment. Unfortunately, today such certainty does not exist.

[1] "Smart metering" is a term that can mean many things. It covers everything from simple remote meter reading to complex charging and control algorithms as applied to energy consumption. In this paper we use the term to cover the complete range of these activities, as will be discussed later in the paper.

ASSET OPTIMIZATION

The lack of certainty of forward demand forecasts coincides with an increased pressure from stakeholders and regulators for all energy companies to increase their asset utilization. So, the traditional response to increasing demand, namely to invest in new infrastructure, is no longer viewed favorably, unless the business case is cogent.

This forces the search for alternative mechanisms to address such peaks.

Smart metering as part of the drive for greater energy efficiency

One of the conclusions that governments, regulators and network operators have reached is that the consumer needs to become more energy efficient. To achieve this, the market seems to moving in three phases:

- Educating the consumer
- Incenting the consumer
- Managing the consumer

EDUCATING THE CONSUMER

The pressure is on for utilities to give more information to consumers on their energy consumption. The objective is to appeal to the consumer to be more aware of the nature of their consumption patterns and of the consequences. This education process takes two forms:

- A real-time display showing consumption of the previous period, highlighting peaks and troughs in consumption, and
- Detailed information on consumption and carbon footprint with comparisons against the previous period plotted against some norm for that type of customer.

The intent is that consumers will be influenced to reduce their peak consumption.

However, research to date suggests that this is only effective where the consumer is already interested in this information. Only this type of customer is susceptible to the messages of such data.

INCENTING THE CONSUMER

Consequently we already see movements towards the next steps: incenting the consumer to adapt their energy consumption. This requires a more sophisticated approach to tariffing than has been possible thus far.

For example, by moving to multiple time-of-day tariffs, which can vary by day of week and by season, the customer can be persuaded to adapt consumption to lower tariffs. Figures 1 and 2 shows a potential tariff plan for a summer weekday and a winter weekday, respectively. Weekends and public holidays could have different profiles depending on season. Equally between season profiles are also possible. This is the sort of profile adopted by various operators and retailers (for example, the Ontario Energy Board in Canada).

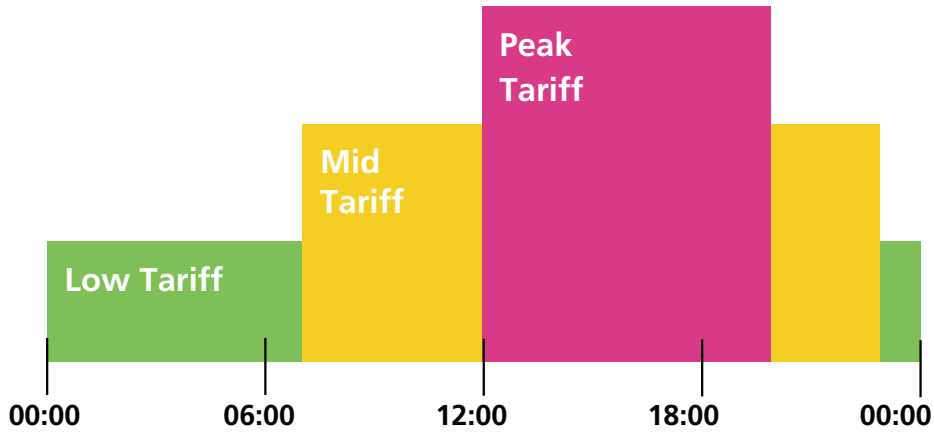

Figure 1: A possible summer weekday tariff structure

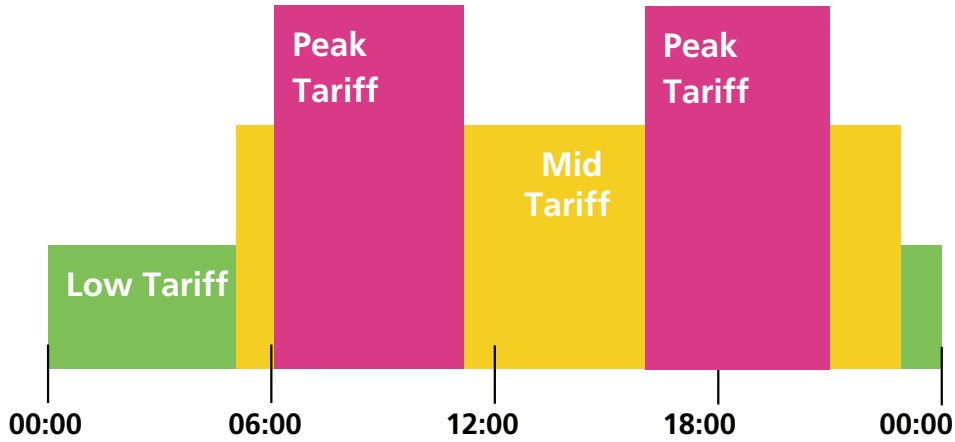

Figure 2: A possible winter weekday tariff structure

Another example might be tariffing by instantaneous demand. Figure 3 shows a possible tariff structure for a home. The curve represents the instant demand made by the home: a morning peak, then the cut in of the air-conditioning during the day, reaching a peak in the evening that combines the effect of all electrical appliances running simultaneously; this then tails off as external temperatures cool and the household settles to evening activities.

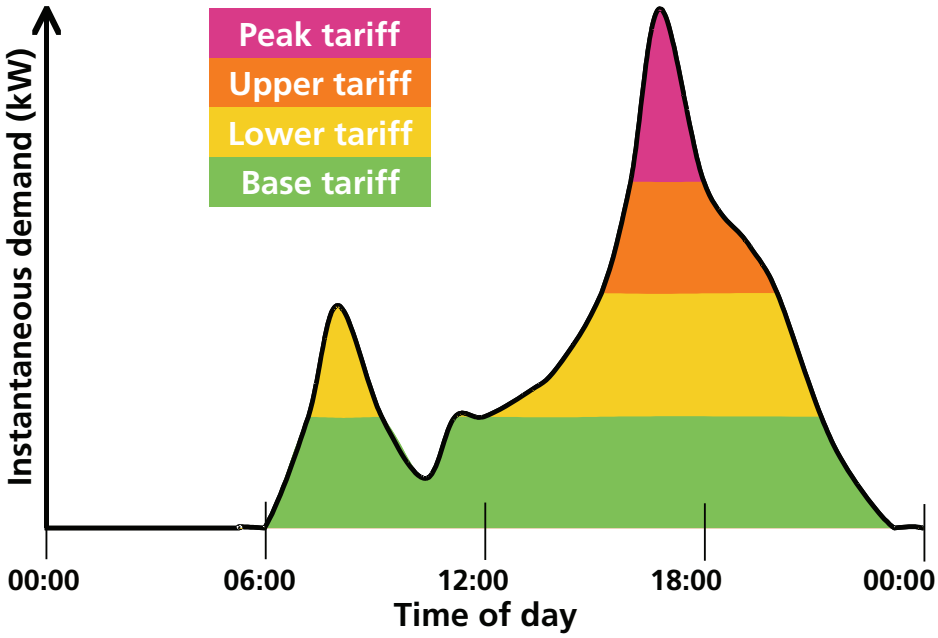

Figure 3: A tariff regime based on instantaneous consumption

The tariff regime shown is designed to encourage the smoothing of this demand. For example, by cutting the air-conditioning during the day when the house is unoccupied, or by moving some of the domestic tasks to later in the evening to benefit from lower costs.

This sort of structure also reflects far more accurately the charges incurred by the distribution and retail companies themselves for whom incremental power becomes increasingly more expensive. These are just two examples of what could be applied. It requires a change in measurement practice and it requires the types of technologies that have been long present in the cellular communications market: the real-time rating of consumption supporting more complex tariff regimes.

And just like the telecommunications market, this structure allows "special offers" to be created by energy suppliers (for example, a tariff holiday).

In short, this requires smart metering: the combination of a smart meter and an intelligent meter data management system.

CONTROLLING THE CONSUMER

In the long-term, we can envisage distributors or energy retailers wanting to be able to incent customers to allow them to control non-essential demand. For example, in exchange for a favorable tariff, the customer would allow the distributor to regulate their air-conditioning in order to shed load at times of excessive demand. The consequences of reducing air-conditioning across all the offices and homes of a big city by just 1 degree would result in a significant reduction of load: perhaps enough to avoid power outages that some are already suffering in peak weather.

This is not a dream. The technology is ready. Domestic appliance manufacturers are starting to implement standard remote control protocols that would enable this sort of control. All that is required is the political will and a rollout of enabled smart meters.

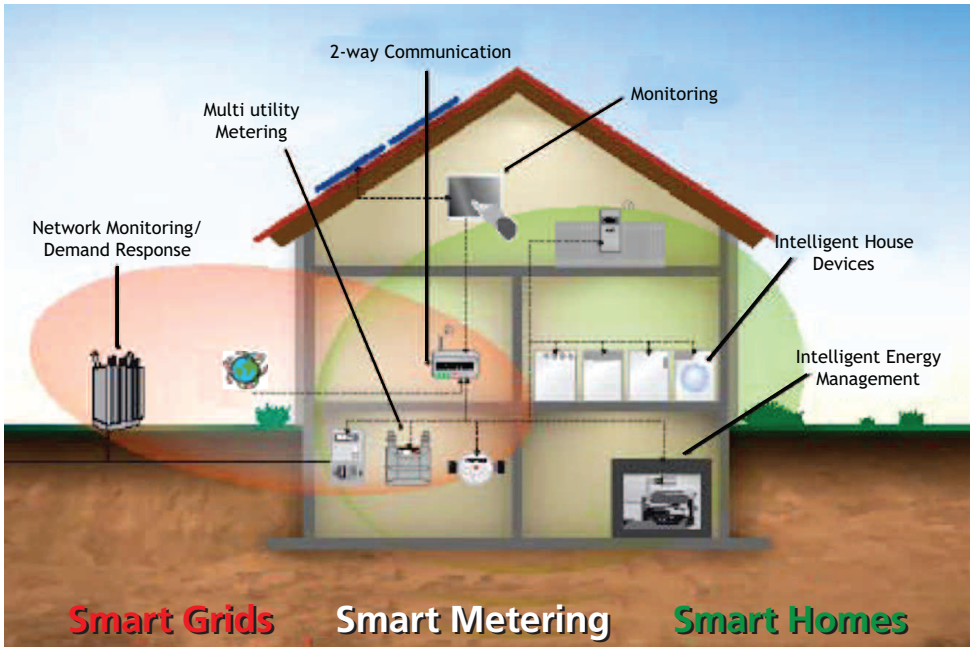

Figure 4: The smart home of the future (Source:Fraunhofer/ISE)

What smart metering can deliver

Smart metering has the capability to deliver the following features and benefits:

RECORDING USAGE DATA

Maintain data records of the usage within the meter at configured intervals for a set amount of time.

REMOTE INTERVAL METER READING

Interrogating the meter usage data at configured intervals ranging from 15 minutes to every three months.

REMOTE ONE-OFF METER READING

Interrogating the meter usage data on an ad-hoc basis.

REMOTE METER ACTIVATION, SUSPENSION, AND DEACTIVATION

The ability to configure a meter to be off (deactivated and not assigned to a customer account), to be on with a configured maximum capacity, and to be suspended (deactivated but remaining configured to a customer account).

CUSTOMER INFORMATION ON CURRENT AND HISTORIC CONSUMPTION

Providing a display unit (probably remotely from the meter itself). Equally this could be a web interface to the customers account.

METER DATA MANAGEMENT

Assembling and storing the data received from each customer, partitioning it by customer, by customer type, by geography, by retailer (if appropriate), etc.

Providing the statistics required to manage the service (for example, gross demand from a given geography by time over a given period, gross demand by customer type over a given period, etc.)

Formatting for transmission to the retailer (if appropriate), archive management.

FLEXIBLE TARIFFING AND RATING

Applying the tariff plan appropriate to that customer, customer type, retailer, etc. and creating the appropriate billing records for onward transmission to the customer.

REAL-TIME TARIFFING AND RATING

Applying the above in real-time. This is of great importance in the case of pre-paid metering.

CREDIT LIMIT CONTROL

Implementing a rules-based decision tree when credit expires or a credit limit is reached dependent upon customer, customer type, retailer, etc.

CAPACITY REGULATION

This can include the temporary reduction of power to a "social minimum" where credit becomes an issue or configuring the meter to suit the circumstances of the particular customer.

LOSS OF POWER NOTIFICATION

In the case of power outages, the meter can transmit a "last gasp" that alerts the distributor to a failure in the network.

REMOTE DEVICE READING AND CONTROL

In the longer term, there is the ability to register remote devices in the premises, to read their configuration and, upon suitable authority, to regulate them. The example, cited above, of raising the temperature of air-conditioning is a typical application. Others could be the activation of other devices (for example, washing machines, when the lowest tariff threshold is reached).

Other benefits

The implementation of smart metering has a number of other benefits:

- reduced reliance on physical visits to customer premises;
- reduced incidence of electricity theft;
- simplified implementation of pre-paid energy, removing any need for physical interaction with the domestic meter;
- Speedy identification of outages leading to more rapid service repair and restoration.

Looking at the overall business case, ENEL in Italy, implemented a program of 30 million automatic remote reading meters. ENEL has invested 2B? through the end of 2006 and has been reported as achieving 500M? savings per annum.

What needs to be implemented

Besides the meter themselves, there are four key elements that need to be considered:

- The access and backhaul
- The meter data management system
- The tariff management system
- Asset management system

These are represented in Figure 5.

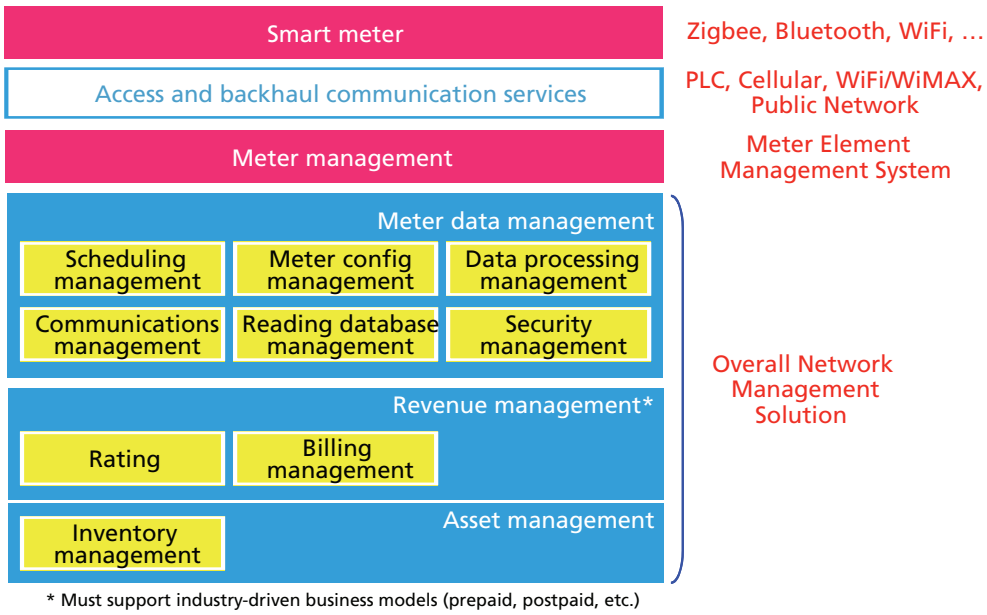

Figure 5. The elements of a smart metering implementation

There is no single ***access and backhaul solution***, since the implementation will be dependent on a number of factors: population density, existing communications infrastructure, any U-telco activity or aspirations, etc. Often there is a mix of solutions, for example, wireless in urban areas with power line communications (BPL) in rural areas. Other types of access/backhaul network technologies that can be used include GSM/GPRS, WiMax, meshed WiFi networks, use of existing broadband (DSL) connections, 870MHz unlicensed radio, Zigbee. Some of these communication mechanisms can allow only for one-way communication, but most of them are already prepared for two-way communication, which will ultimately enable the utility company not only to measure consumption but also to actively influence/control consumption.

The ***meter data management system*** is at the heart of the smart metering operation. The activities it undertakes are:

- Managing the collection of the metering data;
- Organizing the data by customer, by customer type, by geography, by retailer or any other criteria that is relevant;
- Ensuring the consistency and integrity of the data received and ensure its safekeeping;
- Managing the customer profile: the status of the customer, the meter rating, the tariff profile and any scheduled activities;
- Managing the configuration of the meter.

The ***tariff management system*** is another key element of any implementation since it is this system that enables the charging flexibility required to encourage consumers to change their energy consumption habits.

This is very similar in many respects to the charging engines developed for cellular mobile applications in the telecommunications market. The key elements are:

- The ability to handle multiple tariff options for the same class of customer;
- The ability to handle multiple account classes (for example, based on an individually contracted consumption profile) and account associations (for example, to link multiple meters into a single account for such things as holiday homes or support for aging parents);
- The ability to rate and calculate credit in real-time;
- The ability to react in real-time to credit anomalies (such as the expiration of pre-paid credit) according to rules set for that class of customer;
- The ability to allow retailers and individual consumers to interrogate on-line their own accounts securely.

The final element is the ***asset management system*** that allows the operator to keep track of all the different assets involved and their interconnection to form the smart metering network.

Alcatel-Lucent's skills lie in the design and integration of turnkey solutions pulling together these three elements and integrating with the customer premises meter.

Conclusion

Smart metering is seen as a key tool in the fight to flex customers' energy demand profile. With the rapidly rising demand for energy, the tendency to sharp peaks of demand and the inflexibility of the underlying energy infrastructure, smart metering can offer utilities the means to influence customers' consumption. By using a flexible meter data management system that allows utilities to implement flexible tariffs, the consumer can be incented to spread or reduce their demand profile.

At the heart of the smart metering solution is the meter data management system. This is the engine that will allow utilities to accurately measure, tariff and bill customers. Ultimately, it will allow utilities to control demand as and when this becomes acceptable.

About the Author

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Peter's career has taken him into a wide variety of experiences in the communications market working variously for vendors, managed services providers and a UTelco.

After a period with Nortel (equipment vendor) and then Racal Data Networks (managed services operator), in 1993 Peter joined National Grid's UTelco operation: Energis. Here he was initially responsible for the definition and deployment of the services infrastructure and subsequently for regulatory affairs and interconnect services.

In 1997 Peter moved to Alcatel and contributed directly to the successful development of the network applications business and then the outsourcing and managed services business, with several significant wins under his belt.

Peter's current role is as Vice President for Utilities within Alcatel-Lucent's Services Business Group, leading the company's approach to this market segment.

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