Smart grid – smart customer policy needs

Grayson Heffner
International Energy Agency
9, rue de la Federation
Paris 75016
France
Grayson.heffner@iea.org

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Abstract

Smart grids will transform the traditional generator-network operator-customer hierarchy, allowing customers to respond to dynamic prices and network needs or deliver distributed generation. Smart meters also enable new functions – remote disconnection and dynamic pricing – which might disadvantage customers unable or unwilling to modify their consumption patterns. Recently, some smart grid deployments have been delayed out of concern for impacts on end-users, especially vulnerable groups such as low-income households and the handicapped. Consumer advocates have also increased their scrutiny of the costs, benefits, and social impacts of smart grid deployments, reflecting increased ambiguity about the value proposition of smart grids for energy consumers. This paper outlines the major policy issues which regulators, governments, and smart grid stakeholders should consider when developing smart grid deployments that are beneficial for energy consumers. Drawing from a recent IEA workshop on smart grid-smart customer policies, the paper lays out a logical framework useful in ensuring end-users can share in the benefits of smart grid deployments while avoiding adverse impacts. The paper also describes key policy research questions that will guide future IEA research on this topic.

Introduction

Smart grid and smart meter deployments will bring about fundamental changes in the relationship between energy providers and end-use customers. Large amounts of detailed customer-specific information will become available, and energy providers will gain new capability for controlling the conditions of service provided. These capabilities will require new policies to protect consumers from adverse impacts.

Policies are needed to control and regulate the creation and use of detailed data on customers, addressing issues such as ownership and control of customer usage data as well as privacy and data security. Social safety-net policies are also needed, especially for vulnerable groups such as low-income households, pensioners and the handicapped. These groups may be disadvantaged due to their consumption level or inability to change behaviour, or the added cost if financing smart grids may simply outweigh their opportunity to benefit. Finally, smart meters enable new functionalities, such as remote disconnection, dynamic pricing (see below) and instantaneous bill rendering, which affect the relationship between energy provider and customer. New consumer protection policies are needed to balance the new capabilities of energy providers which smart grid technologies enable.

In September 2010 the International Energy Agency (IEA) held a workshop on the regulatory, market and consumer policies needed to ensure that smart grid deployments are carried out with adequate consideration of the risks to and rewards for all stakeholders. This was one of several workshops bringing together energy providers, network operators, technology developers, regulators, customers and government policy makers to discuss smart grid technology and policy. The Smart Grid-Smart Customer Policies workshop allowed stakeholders to:

- gain perspective on key issues and barriers facing early deployment of smart grids;

- hear expert opinion on regulatory, consumer and market challenges to smart grids;
- discuss smart grid-smart customer policy priorities; and
- consider how to build consensus on the technology and policy ingredients needed for customer-friendly smart grid deployments.

Smart Grid-Smart Customer Policy Drivers

COMPLEXITY OF THE ELECTRICITY SYSTEM

Reliable and affordable electricity supply is essential for industry, commerce and daily living. The physical and market mechanisms that make up the electricity system must be capable of continuous operation, and of meeting and balancing ever-changing levels of demand and supply in a cost-effective way. The complexity of power system operations will only increase as the electricity system adapts to new demands for electric transportation and delivery of renewable energy and distributed generation. Smart grid technologies will be fundamental to creating electricity systems that can satisfy demand growth while providing additional functions and new services.

POWER SECTOR REFORM

The physical structure of the electricity system reflects both increased competition plus changes in asset ownership. Deregulation, privatisation, divestment, the introduction of wholesale markets and the creation of new operating entities are transforming the vertically integrated electricity industry. Taking its place are functionally unbundled entities with service offerings and business practices influenced by market forces as well as the physical demands of the electricity system.

Liberalisation has yielded many benefits – lower electricity prices, greater efficiency in planning and operating electricity system assets, increased interconnection and regional trade, and greater transparency. Yet the unbundling of operations and ownership has also made it more difficult to undertake large-scale investment programmes such as smart grid deployments. For example, functional unbundling makes it much more difficult to capture all of the benefits of smart grid deployments across generation, transmission, distribution and retail operations.

LAGGING CUSTOMER TECHNOLOGY AND AWARENESS

Most electricity end-use customers have little idea of how and when they use electricity and what price they pay. Compared to other industries (telecommunications, travel, retail), electricity consumers do not have the service options or pricing information necessary to make informed consumption decisions. In the United States for example, as of 2008, only 5 % of electricity customers had advanced metering capability (Federal Energy Regulatory Commission 2008).

Smart electricity customers can deliver significant benefits to grid operations, including reducing the costs of delivered electricity. Smart metering pilot projects conducted around the world have shown that time-differentiated pricing can reduce peak demands by an average of around 15 %; adding additional customer interface technology can more than double these impacts (Faruqui 2010b). This research shows a positive relationship between information and consumption behaviour, in which more detailed and more frequent information yielded greater efficiency improvements.

The contributions of smart customers account for a considerable share of the overall benefits claimed for smart grids. For example, the United Kingdom's national smart meter roll-out is expected to reduce domestic electricity consumption by 3 % and peak demands by another 5 %, generating almost half of the USD 22 billion annual estimated savings. Electricity providers in California and elsewhere estimate that demand response and energy efficiency benefits made possible by smart customers will be one-third to one-half of total smart grid benefits (Southern California Edison 2007; Baltimore Gas and Electric 2008). Achieving these benefits in practice will require large investments in new metering, communications, and customer interface technology.

Smart Grid Consumer Protection Policies

Smart grid and smart meter deployments will bring about fundamental changes in the relationship between energy provider and end-use customer. Large amounts of detailed customer-specific information will become available, and energy providers will gain a new medium for interacting with customers. New time-differentiated tariffs may adversely affect vulnerable groups, e.g., low-income households, pensioners and the handicapped, due to low consumption levels or an inability to change their consumption behaviour. New capabilities gained from smart metering, such as remote disconnection and quicker bill rendering, may need to be regulated. All of these consumer protection issues should be addressed within the overall context of smart grid design and deployment planning, otherwise there is a real potential for some customers to be harmed.

PRIVACY, DATA OWNERSHIP AND SECURITY ISSUES

Customer privacy, data ownership, and security issues are leading concerns of consumer and privacy advocates. Smart grid and smart meter deployments create large amounts of detailed customer-specific information, and regulatory policies are needed for how energy providers collect, store, and apply these data. Policy questions include:

- who owns customer data and how is access to and use of this data regulated?
- who guarantees privacy and security of customer data (e.g. against risk of surveillance or criminal activity)?
- will sale or transfer of customer data be allowed, and under what terms and to whose benefit? and
- in jurisdictions with retail choice, are measures needed to ensure that competing electricity providers have access to customer data on the same terms as the incumbent utility?

CUSTOMER ACCEPTANCE AND SOCIAL SAFETY NETS

Customer acceptance and social safety-net issues are also topics of vigorous discussion in the among smart grid stakeholders. This discussion is asymmetrical, with utilities and technology companies describing the potential of smart grids and dynamic pricing to empower consumers and reduce utility bills, while consumer advocates warn of rate increases and adverse consequences, especially for consumers unable to adjust their usage patterns.

As with most policy issues, the key is finding the right balance in the sharing of costs, benefits and risks. Responsibility for achieving this balance lies with regulators and legislators. Key policy questions for them include:

- How should smart grid investment costs be recovered?
- How should shortfalls in expected smart grid benefits be allocated between utilities and consumers?
- Should dynamic pricing and Time of Use (TOU) rate options be compulsory or voluntary?
- Should vulnerable customers be protected from the possibility of higher bills; if so, how?
- Should advanced technology investments such as smart grids, which carry the extra risk of technology obsolescence, be treated differently than other utility investments?
- Should some customer groups less able to participate in dynamic pricing be excused from bearing the extra costs of smart grids or being subject to new service conditions? If so, what can or should be done for these customers?

BALANCING ECONOMIC EFFICIENCY AND SOCIAL EQUITY

The development of smart metering and dynamic pricing technology has created new discussions on economic efficiency and social equity issues associated with energy pricing (Faruqui 2010a). Many analysts and some regulators have pointed out that there is nothing sacrosanct about the traditional flat rates charged by utilities; they are an artefact of metering technology that has not changed in a century. Charging customers the same electricity price all hours of the year when the true cost of electricity constantly changes may not be good regulatory practice – if it is possible to cost-effectively deploy the technology to reflect these variations. Many customers pay more than their fair share for electricity, as users with big, temperature-sensitive loads create costly peak demand that is currently spread across all usage without regard for usage pattern. From this viewpoint, smart metering and dynamic pricing provide an opportunity to remove hidden rate subsidies that have up until now burdened some customers (Morgan 2010).

There is a commonly-held view that low-income customers will not or cannot respond to price signals as do other customers. However, in some pilot projects targeted on urban areas (*e.g.,* Chicago, Washington, DC) lower-income households have signed up for time-varying rates, and have demonstrated an ability to shift load in response to price signals (Summit Blue Consulting 2006; PowerCents DC 2010).

Some experts suggest that dynamic pricing should be accompanied by a bill protection mechanism that guarantees no harm to the customer. Although such a policy would extend the implicit subsidies between risk-averse customers and those who are willing to respond to price differentials, it does have practical advantages as a transition mechanism. Used in this way, bill protection as part of an "introductory offer" to dynamic pricing tariffs would be a temporary distortion quickly offset by higher enrolment levels and thus greater aggregate demand response. An alternative or even parallel approach might be to let customers choose between economy and comfort, by offering a dynamic pricing tariff with a lower average rate for load-shifters together with a flat rate incorporating a premium reflective of the higher peak electricity costs incurred by non-load-shifters.

PROTECTION FROM ABRUPT SERVICE DISRUPTION

The capability of smart grids to remotely disconnect and reconnect service is another issue of concern to consumer advocates. Until now, utilities have dealt with non-paying customers by manually disconnecting and reconnecting their service, at considerable cost and with some time delay. With the smart grid, this can be done remotely and instantaneously. This new capability is a double-edged sword for utilities, consumers and regulators. Even though most states already restrict when customers can be disconnected for non-payment, there is a potential for abuse by utilities. But remote disconnect also has a key benefit: it avoids a costly truck roll, with the savings passed on to consumers. Whereas a non-paying customer may face a USD 100 charge for the disconnect/reconnect procedure, the cost of remote reconnection would be negligible. Smart grids may also provide the ability to limit the loads of non-paying customers as a payment inducement.

Consumer Feedback Policies

The benefit of consumer feedback for energy customers is of increasing interest with advancements in smart grid and smart metering technology. This section briefly describes the policy issues associated with helping customers to understand and modify their energy usage patterns.

Consumer feedback can be provided across a continuum (see Figure 1), from monthly bill rendering to real-time display of consumption and prices. Any consumer feedback policy should begin with a consideration of the likely benefits of consumer feedback, and how to provide this feedback at a reasonable cost. Behavioural researchers have identified three principle modalities through which consumer feedback can modify energy consumption (Levy 2010):

- Short-run, low-cost behavioural change, such as turning off lights, unplugging electronics, or responding to peak demand pricing;
- Energy consumer adaptive behaviour based on increased awareness of consumption patterns, including near-term, medium-cost behaviours such as weather stripping, installing compact fluorescent lights (CFL), or purchasing a programmable thermostat; and
- Long-term infrastructure change, such as the purchase of high-efficiency appliances and equipment. Enabling such large investments usually takes time and may depend on access to other measures such as subsidies or incentives (Levy 2010).

Balanced and cost-effective consumer feedback policy can be developed by considering the information actually needed to make rational energy decisions together with the best form and medium to present this information.

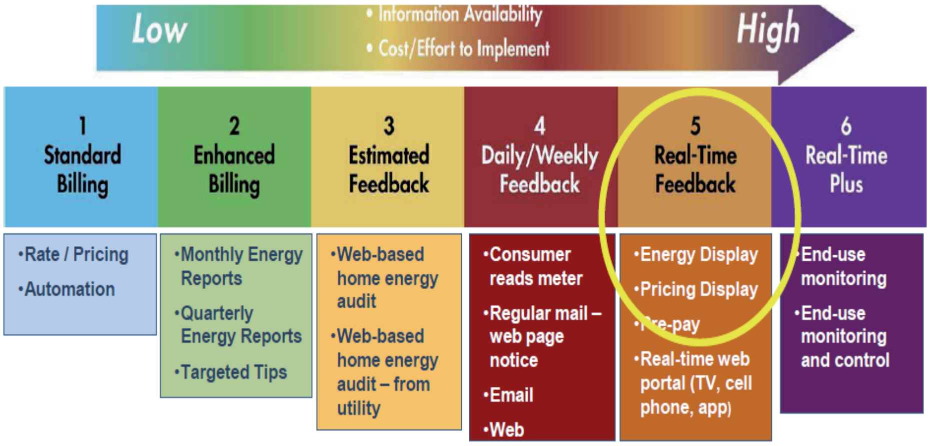

Figure 1. Continuum of Energy Feedback (Neenan, 2010).

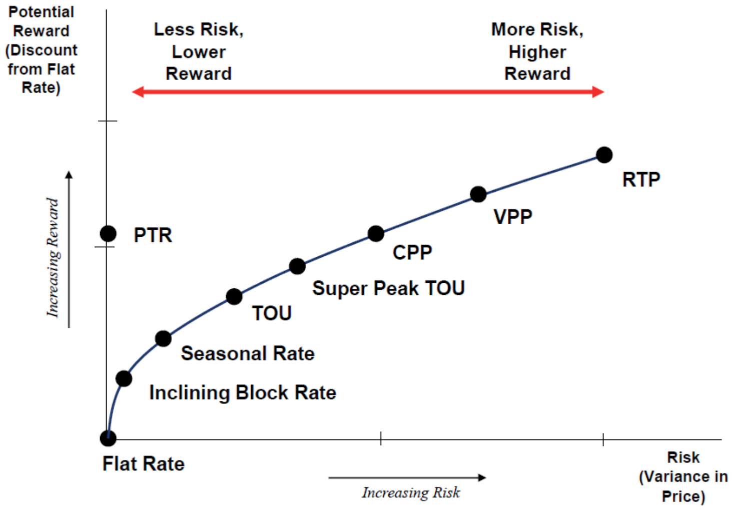

Figure 2. Risk–Reward Relationship in Dynamic Pricing (Faruqi 2010).

Much research has been undertaken to find effective consumer feedback solutions. However, this remains an unsettled area, and there are many different viewpoints on what is needed to induce sustainable behaviour change. One school of thought holds that consumers only need to receive feedback for a relatively short period of time to learn what they need to know in order to optimize their usage patterns. In response to even a little feedback and education, consumers may change their usage patterns and their investment behaviour as well. Another viewpoint holds that continuous and long-term feedback is needed both to reinforce learning regarding pricing and usage and sustain short-term behaviour changes. This viewpoint holds that the most-desirable behaviour changes, e.g., infrastructure investment behaviour, only be obtained from long-term or permanent programmes. Although there is evidence to support both these hypotheses, it certainly account for why consumer feedback pilot project results vary radically. The design of pilot projects also makes it difficult to discern adaptive and infrastructure changes, resulting in over-estimates or under-estimates of longer-term (e.g., years) results. More rigorous and methodical research and evaluation is needed to identify the optimal modality and frequency for delivering the feedback, as well as the interaction between consumer feedback and pricing, and the effect of enabling technologies (e.g. automation) on long-term results. Other issues that create variability in pilot project results include the prior history of consumer feedback policies, variety in customer types and preferences, and the specifics of the service options being piloted (Levy 2010).

Pricing Policies

There are a range of electricity pricing options in use, from static (non-time differentiated) pricing to real-time pricing. These pricing options can be arrayed on a continuum according to the degree of exposure to price volatility (e.g., risk) and the potential rewards of price responsiveness (see Figure 2). The capacity to deliver time-differentiated (e.g., dynamic), as opposed to static, pricing is a central functionality of smart grids and smart metering. The advent of this new information and communications technology (ICT) and metering functionality raises fundamental questions about the purpose of energy pricing. Under traditional rate regulation and before smart meters were available, pricing served mainly to ensure that sufficient revenues were collected to cover costs plus a return on assets. With the availability of smart meters it is now possible to satisfy multiple objectives: (i) to be cost-reflective; (ii) to provide customers with feedback; (iii) to offer pricing options; (iv) to eliminate cross-subsidies; and (v) to encourage energy efficiency (Faruqui 2010).

DYNAMIC PRICING POLICY ISSUES FOR REGULATORS

Key questions that regulators should consider in deciding smart grid pricing policies include:

- Should dynamic pricing be the default service or an optional service?
- Are there better alternatives to dynamic pricing (such as peak time rebates or direct load control) that can yield equivalent demand response benefits but may be less controversial?
- How much time differentiation in prices is needed to deliver demand response benefits?
- What transitional policies are needed to help overcome customer inertia and risk aversion?

STRATEGIES TO EASE THE TRANSITION TO DYNAMIC PRICING

Transition strategies and policies are especially important considering opposition by some consumer advocates to smart metering deployments. An effective transition effort should:

- communicate the rationale and long-term goal to customers and provide the tools for them to respond;
- provide cost-reflective pricing and service options;
- provide some degree of initial bill protection, phased-out over time;
- consider two-part rate designs that promote bill stability while providing inducements for demand response;[1] and
- provide a mechanism for customers that take service on dynamic pricing rates to be reimbursed for the hedging premium that is embedded in flat rates.

Several of these transition strategies are predicated on "nudge" theory, e.g. how to encourage consumers to act rationally even if it means overcoming consumer inertia (Thaler and Sunstein, 2009). The applicability of nudge theory is supported by evidence from pilot projects in which the vast majority of participants prefer the dynamic pricing option once they are exposed to it. For example market research conducted as part of the 2008–2009 Baltimore Gas & Electric (BG&E) Smart Energy Pricing Pilot found that participating customers overwhelmingly supported dynamic pricing. Two thirds of the participants were "very satisfied" with the pilot program, and nine out of 10 participants stated they were either "very satisfied" or "satisfied". When asked if dynamic pricing rates should be made the standard offer rate, over 80 % of the pilot participants said yes (Faruqui, Hledick, and Sergici 2010).

Policies Encouraging Enabling Technologies

In addition to consumer feedback, consumer protection and pricing policies, there is also a need to encourage the development of enabling technologies. Pilot projects have shown that certain technologies enable smart customers to sustain their usage pattern changes, thus contributing to the continuity of benefit streams. There is a considerable innovation underway and numerous products have already been developed and piloted. These include in-premise customer displays, sometimes called smart energy monitors or "energy dashboards"; programmable and price-responsive end-use controls; and home or facility-wide automation networks. There is a wide array of research into both the behavioural aspects of how to present feedback on consumption and how to automate end-user response. As with any emerging field, the range of approaches is daunting and results are varied.

The issue from a smart grid-smart customer policy perspective is how to encourage needed innovation within an overall framework of industry standards that ensures technology used in today's smart grid deployments is not obsolete or otherwise stranded tomorrow.

Key enabling technology policy questions include the following:

- Is there an optimal mix of behavioural modification and automation technologies?
- What policies can governments adopt to encourage innovation without picking technology winners?
- What is the impact of information and communications technology (ICT) choices (e.g. power line carrier vs. internet) on enabling technology development?

From the point of view of technology developers, key policy needs include:

- policies and standards encouraging inter-operability and open architecture;
- national and international co-operation on standards development and harmonisation, such as for metres and ICT protocols;
- incentives for new technology development;
- technology procurement policies by governments; and
- consistent price regulation practices, especially as regards dynamic pricing.

Research Needs

A key objective of the September 2010 workshop was to identify and formulate the IEA's research programme on smart grid-smart customer policy needs. The workshop discussions allowed the IEA to develop a preliminary programme of smart grid research covering technology, regulatory and consumer policies. Some of these research areas are briefly outlined below. The IEA intends to follow up the smart grid road-mapping effort with collaborative research efforts in each of these areas, in partnership with governments, regulators, industry, consumer advocates and other smart grid stakeholders.

CONSUMER FEEDBACK AND BEHAVIOUR

Most current approaches to energy consumption analysis are informed by a techno-economic model in which consumption is impeded or encouraged by technologies and economic conditions (IEA, 2010, chapter 16). This theory assumes that efficiency improvements and demand reductions are achieved by providing information to the consumers about the rational economic benefits of saving energy. Consumers are assumed to be logical decision makers who take steps in order to alter their behaviour in a rational manner when faced with information about energy consumption and cost. Unfortunately, this does not appear to always be the case (Parnell and Popovic Larsen, 2005).

Given these limitations to rational-economic theory, an effective consumer feedback policy should take into account best-practice methods for conveying price signals to consumers, as well as non-economic motivations for behavioural change including cultural values, norms, beliefs, attitudes, practices, etc. Demonstration project designers and policy makers need to consider these lessons from social science in order to develop effective and sustainable consumer feedback systems. For example, the influence of culture and attitudes on designing

1. A two-part rate design might include a non-time-differentiated, e.g., average price, for a baseline level of consumption with any increment priced at time-differentiated levels.

consumer feedback policies may or may not limit the transferability of feedback designs among countries (Hargreaves, Nye and Burgess 2010).

IEA research in this area will have three objectives: (i) identify lessons for policy makers from social science research on consumer feedback by collecting and comparing the results of advanced metering, real-time pricing and consumer feedback demonstration; (ii) outline technologies proven to mobilise sustainable behavioural changes on the part of energy consumers; and (iii) establish a community of practice throughout IEA member countries to develop standard methods and analytic tools for estimating the benefits of consumer behavioural change (e.g. demand response and energy efficiency) of smart grids.

DYNAMIC PRICING POLICIES

Smart grid deployments assume significant benefits from customer behavioural changes, in response to time-based price signals, end-use load control, and other smart grid-based service options. However, many utilities and regulators are encountering opposition from consumers as they implement these new pricing and service options. This research effort will create a community of practitioners focused on understanding the trade-offs involved in establishing effective and acceptable pricing and service options, and the transition strategies needed to implement them without arousing adverse customer reaction. The research will examine the complexity of the time-differentiated pricing needed to induce behaviour-changing effects, as well as whether alternatives to dynamic pricing (such as peak time rebates or direct load control) can yield equivalent benefits. The research will also identify transitional strategies proven effective in overcoming customer inertia and aversion to dynamic pricing and other new service options. Promising transition strategies include consumer communications schemes, shadow pricing, bill protection mechanisms, explicit hedging premiums for flat rates, and two-part rate designs (Faruqui 2010b).

BEST PRACTICES IN AUTOMATED DEMAND RESPONSE

Many analysts believe that the smart grid's full potential can only be realised by creating a seamless and automatic interconnection between the network and end-use devices, preprogrammed by the consumer. This research will compile and review the existing literature on processing and automation technologies that enable home owners, building managers and business operators to programme end-uses to automatically adjust consumption and demand according to price or other signals. The potential for automated end-user demand and efficiency response are considerable and already proven. In California, several energy providers have collaborated to configure energy management systems suitable for both households and businesses that can curtail discretionary loads (e.g. lighting, elevators, HVAC) whenever hourly prices exceed pre-set levels. This research will collect and codify best practice from smart grid and smart metering pilot projects on automated demand response and energy efficiency.

CONSUMER PROTECTION POLICY RESEARCH

Smart grid deployment requires new consumer protections that address privacy, ownership and security issues associated with customer energy information, social safety nets for vulnerable customers, and susceptibility to remote disconnection functions made possible by smart grids. The IEA proposes research to identify the full range of consumer protection policies, identify good practice and make recommendations to governments on smart grid-related consumer protection issues. The research effort will take a collaborative approach to identify good practice and workable policies for the following issues:

- How should customer data privacy, ownership and security issues be handled? This research will seek to identify pressing issues and emerging good practice in IEA member countries on customer energy data.
- Social safety net policy requirements. This research will seek to identify good practice on smart grid social safety nets. Consumer advocates are concerned that some customer groups unable to modify their consumption behaviour should be excused from bearing the extra costs of smart grids or being subject to new tariffs, such as time-based pricing. This research will examine the evidence that social safety nets are needed, as well as the approaches that have been shown to work. The work will also seek to compile a body of evidence on low-income and other vulnerable customers participating in pilot projects and how they have been affected positively or negatively by characteristics of the programmes

Conclusions

Smart grids should be considered as a foundational investment that substitutes efficient use of information for physical infrastructure, at considerable cost savings to consumers. Smart grids will play an important role in addressing many of the fundamental challenges and uncertainties (globalisation, ageing infrastructure, energy security, climate change) facing the energy sector in years to come. Smart grids are expected to deliver:

- Economic benefits, by empowering consumers to control their energy bills, reducing regressive cross-subsidies implicit in flat rates, improving market efficiency by enabling price responsiveness, and deferring or reducing investments in unnecessary peaking generation;
- Reliability benefits, by enabling demand response and through real-time feedback on the distribution system, and
- Environmental benefits, through reduced system losses, mobilisation of demand response for ancillary services provision, integration of distributed renewable energy and electric vehicles, and the creation of a platform for ongoing innovation in how energy is consumed.

Early results of smart grid pilot projects provide a glimpse of the large potential benefits from foundational investment in smart grids and the development of smart pricing. Over time, these developments will have a transformative effect on energy consumer behaviour and interactions with the energy grid (Figure 3).

This transformative effect will change how power system planning is done, as well as how wholesale and retail electricity markets are co-ordinated. The conventional approach to system operations and planning, which is built on an assumption of inelastic demand, yields planning models and market arrangements (e.g., forward capacity markets) that would not be nec-

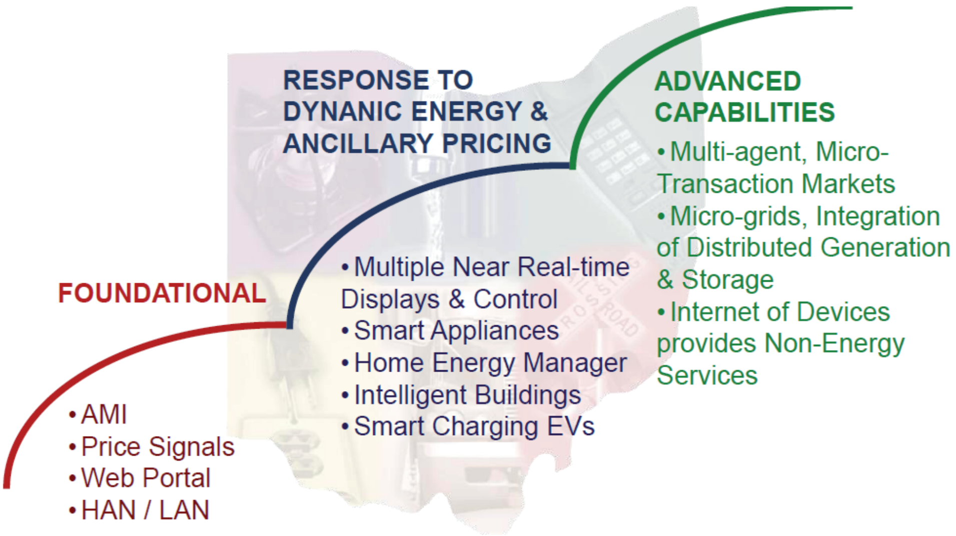

Figure 3. Smart Customer Technology Road Map (Centolella, 2010).

essary if end-users were exposed to dynamic prices. Enabling end-users to respond to price volatility will make it possible to reform wholesale markets, by integrating price responsive demand based on dynamic retail pricing. Smart grids will also change the institutional map of the power sector, creating new institutional arrangements extending well beyond today's network of system operators, distributors/retailers and end-users. Opening the electricity system to third-party innovation will, however, require addressing new issues such as inter-operability, cyber-security and consumer privacy. New organisations and public-private partnerships such as the Smart Grid Interoperability Panel (SGIP) and the Cyber Security Working Group are taking on these issues and developing solutions (Centolella, 2010).

Realizing the potential of smart grids cannot happen without addressing the consumer policy challenges described above. Consumer concerns and policies to address them must be a fundamental part of smart grid planning and deployment.

ENSURING VALUE FOR THE CUSTOMER

Competition for customer dollars is strong, especially in today's depressed economy. Energy utilities must consider that smart grid investments are competing with other the infrastructure investment priorities of other services providers, e.g, telecommunications and water. In states such as Ohio, where one in seven customers live in poverty, smart grids and smart metering may simply be unaffordable for hard-pressed consumers. Regulators should hold utilities to account, requiring careful analysis of costs and benefits, and ensuring that these are verifiable and transparent. Benefits should be netted-out against costs to reduce the overall smart grid price tag for consumers. Regulators should take particular care that investment in advanced technologies such as smart grids are prudent, reasonable and minimise risks such as technology obsolescence.

RATE DESIGNS THAT HELP CUSTOMERS SAVE MONEY

The bottom line of customers as well as energy providers should benefit from smart grid deployments. A range of options is available to help customers manage their energy costs, including time-of-use rates, dynamic pricing tariffs (e.g. critical peak and real time pricing), peak time rebates and load control. However, practical problems (including low customer participation rates, long time delays in implementation and concerns about utility control over loads) have impeded market penetration. Customer-friendly rate designs should be a key element of any smart grid investment.

NEED FOR CONSUMER EDUCATION

Consistent messaging at state and national levels is needed to increase consumer awareness and explain the benefits and changes associated with smart grids. Energy utilities, regulators and consumer advocates all play a role in building awareness (Office of the Ohio Consumers' Counsel, 2010; AARP et al., 2010). Regulators should require a consumer education programme as part of any smart grid launch. Utilities and regulators should build in other transitional aid such as "shadow bills", which allow utilities to demonstrate the potential for customer bill savings before customers are placed on smart grid rates. Customer education should also provide information on energy efficiency, demand response, renewable energy and retail choice as appropriate (Migden 2010).

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Acronyms

BG&E	Baltimore Gas and Electric
CPP	Critical peak pricing
PTR	Peak time rebates
ICT	Information and communications technology
TOU	Time-of-use
RTP	Real-time pricing
VPP	Variable peak pricing

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