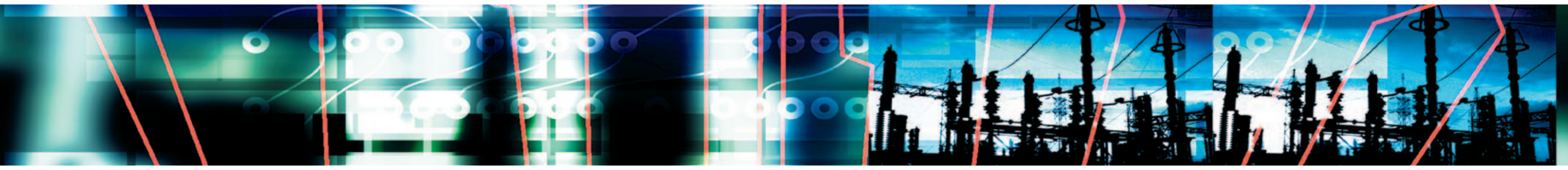
WORKSHOP REPORT

An IEA paper submitted to the Energy Efficiency Working Party



Smart Grid - Smart Customer Policy Needs

Grayson Heffner

April 2011

International Energy Agency

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This workshop report was prepared for the Smart Grid - Smart Customer Policy Needs Workshop held in September 2010 in Washington, DC. It was drafted by the IEA Energy Efficiency and Environment Division. This paper reflects the views of the International Energy Agency (IEA) Secretariat, but does not necessarily reflect those of individual IEA member countries. For further information, please contact the Energy Efficiency and Environment Division at: grayson.heffner@iea.org

International Energy Agency

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- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
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Introduction

The use of smart grids and smart meters will bring about a fundamental change in the relationship between customers and energy providers. Large amounts of detailed customer data will become available, and energy providers will be able to control the conditions of service to an unprecedented degree. These changes will require new policies to regulate the use of customer data and protect consumers from adverse impacts. Smart grids and smart meters will also create enormous economic benefits by empowering consumers to control their energy bills, improving how electricity markets operate, and deferring or reducing investments in costly peaking generation. Smart grids and smart meters will enable customers to deliver and benefit from lower electricity costs. Realising this potential, however, will require new policies that create and encourage smarter customers.

In September 2010, the International Energy Agency (IEA) held a workshop on the regulatory, market and consumer policies necessary to ensure that smart grids are deployed with adequate consideration of their risks and benefits to all stakeholders. This was one of several workshops that brought 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 a 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
- build consensus on the technology and policy ingredients needed for customer-friendly smart grid deployments.

Drawing on workshop discussions, the following paper lays out a logical framework to maximise the benefits and minimise the risks that smart grids pose for customers. The paper also describes key policy research questions that will guide future IEA research on this topic.

Drivers of Smart Grid-Smart Customer Policy

Complexity of the electricity system

Reliable and affordable electricity supply is essential for industry, commerce and daily living. The physical and market mechanisms of the electricity system must operate continuously, and meet constant changes of supply and demand in a cost-effective way. As the system adapts to new demands for renewable energy and distributed generation, the complexity of the system will increase. Smart grid technologies will be fundamental to creating systems capable of accommodating growth in electricity demand, and providing new services and functions.

Power sector reform

The physical structure of the electricity system reflects both increased competition and changes in asset ownership. In recent years the traditional, vertically-integrated industry has been transformed through deregulation, privatisation and divestment, together with the introduction of competitive wholesale and, in some cases, retail markets. The result has been services and business practices that are guided not only by physical demands of the system but by market forces.

Liberalisation has yielded many benefits – lower electricity prices, greater efficiency, increased interconnection, robust regional trade and heightened transparency. But the functional unbundling that results from liberalisation has also made it more difficult to undertake large-scale investment projects such as smart grids.

Lagging customer technology and awareness

Most electricity customers are unaware of their electricity use: how much they use, when they use it and how it is priced. Compared with other industries (telecommunications, travel, retail, for instance), electricity consumers lack the service options and pricing information necessary to make informed decisions. In the United States, for example, less than 10 % of electricity customers have advanced metering capability (Federal Energy Regulatory Commission, 2009).

Customers connected to a smart grid can help deliver lower electricity costs. Around the world, pilot projects in smart metering show that time-differentiated pricing reduces peak demand by an average of 15%. With additional technology in the customer's home or business, these effects can double (Faruqui, 2010b). Such results show that more detailed and frequent information on customer electricity use, together with new service offerings, can yield significant efficiency improvements.

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

Protecting Smart Grid Consumers

Some recent smart-grid deployments have been delayed out of concern for end-users. Peak demand pricing may adversely affect vulnerable groups, such as low-income households, pensioners and the disabled. Smart grids may not benefit these customers, either because they consume more or less electricity than the average customer and are unable to change their consumption levels, or because the added cost of financing smart grids outweighs the advantages.

Smart grids have also come under scrutiny by consumer advocates anxious about higher electricity costs and social impacts. For example, customers may be affected by the capability of smart grids and smart meters to remotely disconnect or instantaneously render bills. These consumer protection issues should be addressed within the overall context of smart grid design and deployment planning; otherwise, some customers may be harmed.

Privacy, data ownership and security issues

Customer privacy, data ownership and security issues are leading concerns of consumer and privacy advocates. Since smart grid and smart meter deployments create large amounts of detailed information about customers, the collection, storage and use of this data requires regulation. Issues affecting regulatory policy include:

- Customer data ownership
- Access to and use of these data
- Privacy and security of customer data (*e.g.* against risk of surveillance or criminal activity)
- Sale or transfer of customer data

Customer acceptance and social safety nets

Utilities and technology companies promote the potential of smart grids and dynamic pricing to empower consumers and reduce utility bills. Consumer advocates, on the other hand, warn of rate increases and adverse consequences, especially for consumers unable to adjust their energy consumption patterns.

Finding the right balance in sharing smart grid costs, benefits and risks is the responsibility of regulators and legislators. Key policy issues include:

- Recovery of smart grid investment costs,
- Allocating shortfalls in smart grid benefits between utilities and consumers,
- Determining which service offerings, *e.g.*, dynamic pricing, should be optional or obligatory,
- Protecting vulnerable customers from the possibility of higher bills from dynamic pricing,
- Mitigating the risk of technology obsolescence of smart grids and smart meters,
- Balancing economic efficiency and social equity.

The development of smart metering and dynamic pricing technology has stirred debate over economic efficiency and social equity issues associated with energy pricing (Faruqui, 2010a). Many analysts and some regulators point out that there is nothing inviolable about the traditional flat rates charged by utilities; they are a century-old artefact of now-obsolete metering technology. Charging customers the same amount for electricity at all hours when production costs constantly change is not economically efficient, especially if cost-effective technology exists to reflect these variations. Some analysts argue that small customers pay more than their fair share for electricity, as users with large, temperature-sensitive loads create costly peak demand that burdens everyone. Smart metering and dynamic pricing could lead to more equitable pricing by removing transfers and subsidies that are now hidden in electricity rates (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 targeting urban areas (*e.g.* Chicago, Washington, DC), lower-income households signing up for time-varying rates demonstrated a strong ability to shift load in response to price signals (Summit Blue Consulting, 2006; PowerCents DC, 2010).

Some experts suggest that dynamic pricing be accompanied by a bill protection mechanism that guarantees no harm to the customer. Although such a policy would cause continued subsidies to risk-averse customers, it does have practical advantages as a transition mechanism. Bill protection as part of an "introductory offer" of dynamic pricing would be a distortion – but a temporary one quickly offset by higher enrolment and thus greater aggregate demand response. An alternative approach might be to let customers choose between economy and comfort by offering: a) dynamic pricing tariffs with a lower average rate for those able to shift load; and b) flat rates set at a level reflecting higher the costs of peak electricity use incurred by non-load-shifters.

Protection from abrupt service disruption

Energy providers generally deal with non-paying customers by manually disconnecting their service, with reconnection provided only upon settlement of arrears. At present, this process takes time and costs money – usually resulting in continuation of service while payment terms are sorted out. With the smart grid, disconnection can be done remotely and instantaneously. This has raised concerns among consumer advocates, who fear that utilities may abuse this new capability, thus eliminating an implicit customer protection. But remote disconnection/reconnection capability does have benefits: costly truck rolls are avoided, and these savings are passed on to consumers. Compared with high reconnection charges that customers currently pay, the charge for a remote reconnection should be negligible.

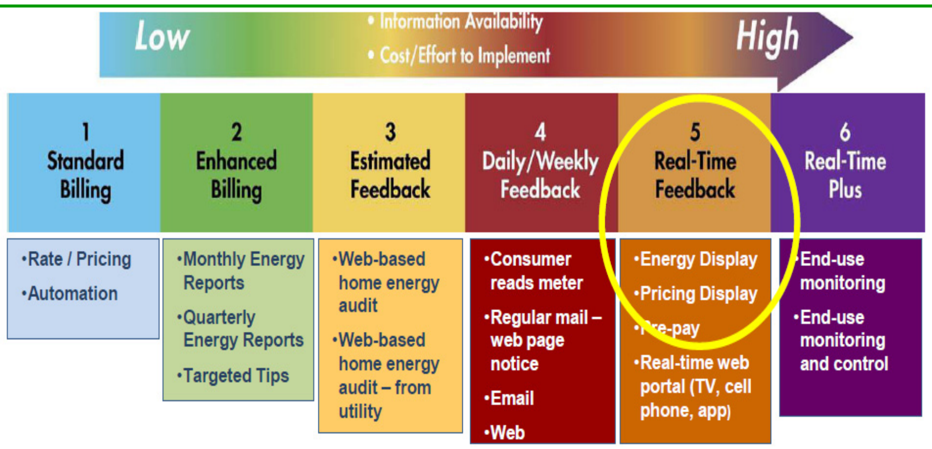
Consumer Feedback Policies

Progress in smart grid and smart metering technology has stimulated interest in the benefits of consumer feedback. Such feedback can be provided across a continuum (Figure 1), from monthly bill rendering to real-time display of consumption and prices. Any consumer feedback policy should begin by considering the likely benefits of such measures, and how this feedback can be provided 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;
- Changes in long-term infrastructure, 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).

A balanced and cost-effective consumer feedback policy should consider the information actually needed to make rational energy decisions together with the best form and medium to deliver it.

Figure 1: Energy feedback continuum



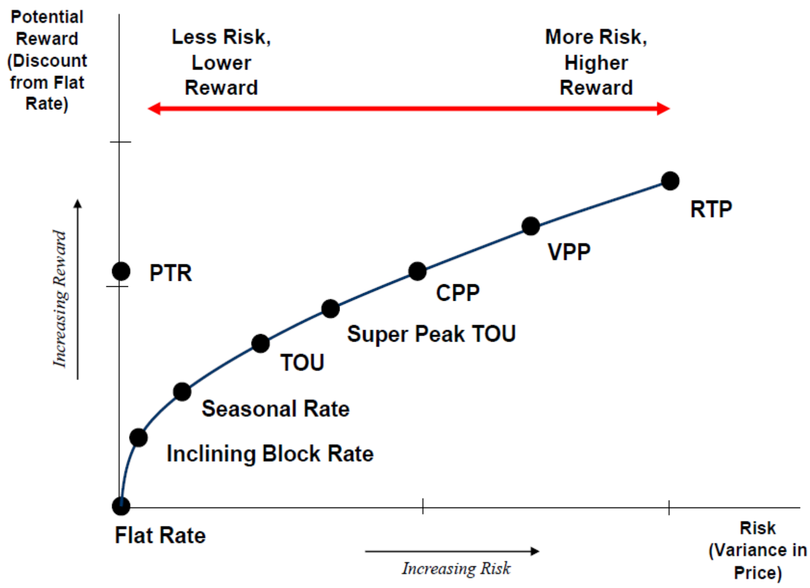
Source: Neenan, 2009

Much research has been undertaken to find effective consumer feedback solutions, and different views have emerged regarding how to induce and sustain desired behavioural changes. One school of thought holds that consumers only need to receive feedback for a relatively short period of time to learn how they can optimise their usage patterns. In this view, even a modest amount of feedback and education can prompt consumers to change their behaviour. An opposing view holds that only continuous and long-term feedback is effective. There is evidence supporting both hypotheses available from the widely divergent results of consumer feedback pilot projects. Variations in experimental design as well as weak methodology contribute to these differences. Changes in customers' behaviour or in infrastructure decisions remain hard to predict, reducing confidence in estimates of long-term smart grid benefits. Rigorous and methodical research and evaluation is necessary to determine how and how often feedback should be given, the interaction of consumer feedback and prices and the effect of enabling technologies. Differences in experimental framework must also be considered, including historical consumer feedback policies, variety in customer types and preferences, and the service options being piloted (Levy, 2010).

Pricing Policies

A range of electricity pricing options are in use, from flat rates to real-time pricing. These 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 (Figure 2). The capability to deliver time-differentiated (*e.g.*, dynamic), as opposed to flat (*e.g.* static) pricing is a central feature of smart grids and smart metering. This new capability raises fundamental questions about the purpose of energy pricing. Under traditional rate regulation, pricing served mainly to ensure the collection of sufficient revenues to cover costs, plus a return on assets. With smart meters, it is possible to achieve multiple objectives: i) reflect the time-varying cost of energy; ii) provide consumer feedback; iii) deliver new service and pricing options; iv) eliminate cross-subsidies; and v) encourage energy efficiency (Faruqui, 2010).

Figure 2: Risk-Reward Relationship in Dynamic Pricing



Source: Faruqui, 2010b

Dynamic pricing policy issues for regulators

Key questions that regulators should consider before setting smart grid pricing policies include:

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

Strategies to ease the transition to dynamic pricing

Opposition to smart metering deployments by some consumer advocates makes it important to consider transitional strategies and policies. An effective transition strategy 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;
- offer some degree of initial bill protection, to be phased-out over time;
- consider two-part rate designs that offer bill stability while providing inducements for demand response;[1] and
- reimburse customers for the hedging premium in flat rates if they choose the dynamic pricing rate option.

Transition strategies are often predicated on "nudge" theory, *e.g.* encouraging consumers to make more rational choices by exposing them to alternatives (Thaler and Sunstein, 2009). For example, market research found that most customers who participated in a dynamic pricing pilot project in Baltimore choose to stay with the service option once the experiment concluded. This research also found that most customers exposed to dynamic pricing felt it should be made the standard rate for everyone (Faruqui, Hledick and Sergici, 2010). Such results suggest that most customers will prefer dynamic pricing options once they become familiar with them.

[1] A two-part rate design might include a flat rate for a baseline level of consumption with additional consumption priced dynamically.

Policies Encouraging Enabling Technologies

Pilot projects have shown that certain technologies enable smart customers to sustain new patterns of usage and thus continue to benefit from smart grids and smart metering. For this reason, it is important to develop policies that support development of these technologies. In fact considerable innovation is underway, and numerous new products have been tested. 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. Dozens of new enabling technologies are now available.

Policies and frameworks are needed to encourage new enabling technologies while ensuring today's smart grid technology does not become obsolete tomorrow. Key policy questions include:

- Is there an optimal mix of behavioural modification and automation technologies?
- What policies can governments adopt to encourage innovation without picking technology winners?
- How does the choice of a particular Information and Communications Technology (ICT), such as power line carriers or the Internet, affect the development of enabling technologies?

Governments, regulators and the private sector should consider establishing:

- policies and standards encouraging inter-operability and open architecture;
- national and international co-operation on setting and harmonising development standards;
- incentives to develop new technology;
- government procurement policies concerning technology; and
- consistency in price regulation, 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 helped the IEA to develop a smart grid roadmap together with a smart grid research programme covering technology, regulatory and consumer policies (IEA 2011). Some of these research areas are outlined below. The IEA intends to follow up the smart grid roadmapping 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 analyses of energy consumption are informed by a techno-economic model in which consumption is impeded or encouraged by technologies and economic conditions (IEA, 2010). According to this model, improving efficiency and reducing demand is achieved by informing consumers of the economic benefits of behaviour change. Consumers are regarded as logical decision makers who take rational steps once they know the cost of consumption. Unfortunately, this does not always appear to be the case (Parnell and Popovic Larsen, 2005).

Given the limitations of rational-economic theory, an effective consumer feedback policy should take into account best practices for conveying price signals to consumers, as well as non-economic motivations for behavioural change (*e.g.* cultural values, norms, beliefs, attitudes and practices). Designers of demonstration projects and policy makers need to consider lessons drawn from the social sciences in order to develop effective and sustainable systems of consumer feedback. The influence of culture and attitudes, for example, may limit the transferability of feedback designs among countries (Hargreaves, Nye and Burgess, 2010).

IEA research in this area has three objectives: i) collect and compare the results of advanced metering, real-time pricing and consumer feedback demonstrations; ii) identify technologies proven to induce sustainable behavioural changes among consumers; and iii) establish a "community of practice" throughout IEA member countries to estimate the benefits of changing consumer behaviour, and to better understand the cultural factors that may limit the transferability of feedback mechanism among countries.

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 communication 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 full potential of smart grids can only be realised by creating a seamless and automatic connection between the network and end-use devices, pre-programmed by the consumer. Research will compile and review the existing literature on processing and automation technologies, identifying best practices that enable home owners, building managers and business operators to automatically adjust their consumption according to price or other signals. The approach has already proven successful. In California, several energy providers collaborated on systems that curtail discretionary loads (*e.g.* lighting, elevators, HVAC) in both households and businesses whenever hourly prices exceed pre-set levels.

Consumer protection policy research

Smart grids require new forms of consumer protection. The IEA proposes collaborative research to identify the full range of consumer protection policies and good practices that can be recommended to IEA member countries. Issues to be addressed include:

- Data privacy, ownership, security and the risk of remote disconnection.
- Social safety nets for vulnerable consumers. Consumer advocates argue that customers who are unable to modify their consumption habits should be excused from bearing the extra costs of smart grids. Nor should they be subject to new tariffs, such as time-based pricing. Research will examine positive and negative impacts reported by low-income and other vulnerable customers who took part in pilot studies, as well as approaches that have been shown to work.

The results of this research will be used to create a suggested consumer protection template or regulatory road map for governments to consider when deploying smart grids.

Conclusions

Smart grids are a foundational investment that replaces physical infrastructure by the efficient use of information, providing 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. The benefits smart grids can deliver are:

Economic: controlled energy use by consumers, reduced cross-subsidies implicit in flat rates, improved market efficiency through price responsiveness, and less reliance on expensive peak generation;

Reliability: demand response prompted by real-time feedback on grid conditions; and

Environmental: fewer system losses, the ability to integrate distributed renewable energy and electric vehicles into the grid, and platforms to encourage long-term innovation in energy consumption.

Early results of smart grid pilot projects suggest large benefits from foundational investment in smart grids and smart pricing. Over time these developments will change consumer behaviour and ultimately the way society uses the energy grid.

The planning of power systems will evolve, as will the co-ordination of wholesale and retail electricity markets. Conventional approaches to system operations, planning and market arrangements (*e.g.* forward capacity markets) will be unnecessary if end-users become accustomed to dynamic prices. Wholesale markets would deliver lower electricity prices as more and more customers respond to dynamic retail pricing.

Smart grids will also change the power sector by creating new institutional arrangements that extend well beyond today's network of system operators, distributors/retailers and end-users. Opening the electricity system to third-party innovators, however, raises new questions about inter-operability, cyber security and consumer privacy, all of which will need to be addressed. New organisations and public-private partnerships, such as the Smart Grid Interoperability Panel (SGIP) and the Cyber Security Working Group, are exploring these issues and developing solutions (Centolella, 2010).

In all of this, consumer concerns are fundamental. Unless the consumer policy challenges described above are addressed, the full potential of smart grids will not be realised.

Ensuring value for the customer

Competition for customers is strong, especially in today's depressed economy. Smart grids compete for investment with other critical infrastructures such as 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 analyses of costs and benefits, and ensure that these are verifiable and transparent. Benefits should be credited against costs to reduce the overall smart grid price tag. Particular care should be taken that investments in advanced technologies such as smart grids are prudent, reasonable and free of risks such as technology obsolescence.

Rate designs that help customers save money

Smart grids should benefit both customers and energy providers. A range of service options is available to help customers manage their energy costs, including time-of-use rates, dynamic pricing, peak time rebates and load control. However, practical problems – poor customer participation, implementation delays and the novelty of smart grids and meters - have impeded market penetration. Customer-friendly rate designs that offer real chances to save are one way to accelerate smart grid deployments.

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 raising awareness (Office of the Ohio Consumers' Counsel, 2010; AARP, 2010). Regulators should require consumer education to be a part of any smart grid launch. Before placing customers on smart grids, utilities and regulators should introduce transitional aids such as "shadow bills" to show customers how much they can save. When appropriate, consumers should also be provided with information on energy efficiency, demand response, renewable energy and retail choice (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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