IEA Experts' Group on R&D Priority Setting and Evaluation (EGRD)

Will a Smarter Grid Lead to Smarter End Users – or Vice Versa
Smart Grid Applications at End-User Points

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Hosted by the Research Council of Norway

Research, development, and deployment of innovative technologies are crucial to meeting future energy challenges. The capacity of countries to apply sound tools in developing effective national research and development (R&D) strategies and programs is becoming increasingly important. The Experts' Group on R&D Priority Setting and Evaluation (EGRD) was established by the IEA Committee on Energy Research and Technology (CERT) to promote development and refinement of analytical approaches to energy technology analysis, R&D priority setting, and assessment of benefits from R&D activities.

Senior experts engaged in national and international R&D efforts collaborate on topical issues through international workshops, information exchange, networking, and outreach. Nineteen countries and the European Commission participate in the current program of work. Results provide a global perspective on national R&D efforts that aim to support the CERT and feed into the IEA Secretariat's analysis.

This Executive Summary reflects key points that emerged from the discussions held at this workshop. The views expressed in this report do not represent those of the IEA or IEA policy nor do they represent consensus among the discussants.

The full workshop report, including detailed information on individual sessions and presentations, has been prepared by the U.S. Department of Energy's Office of Climate Change Policy and Technology in the Office of International Affairs, and may be consulted at http://www/ieadsm.org/egrd/.

To view the agenda and presentations for this workshop, see: https://www.iea.org/workshops/egrd-will-a-smarter-grid-lead-to-smarter-end-users---or-vice-versa.html

For further information about EGRD activities, see:
http://www.iea.org/aboutus/standinggroupsandcommittees/cert/egrd/

EXECUTIVE SUMMARY

The International Energy Agency (IEA) Experts' Group on R&D Priority Setting and Evaluation (EGRD) convened a workshop titled *Will a Smarter Grid Lead to Smarter End Users – or Vice Versa* to examine the potential benefits of smart grids for end-users and society at large, with the goal of identifying novel approaches and critical aspects for realising this potential as well as core R&D needs. The Research Council of Norway hosted the workshop, which took place 3-4 June 2015 in Oslo, Norway. A total of 45 participants included EGRD national experts; government representatives; research, development and demonstration (RD&D) decision makers; strategic planners; and program managers from industry. Speakers presented examples of end user-applications, consumer segmentation and engagement schemes, and a range of business models to illustrate emerging international best practices.

Several trends are driving grid modernization and can speed the transition to next-generation energy delivery (see Figure ES-1). These trends include adoption of low-carbon and market liberalisation policies, growing customer interest in autonomy, and the new possibilities presented by the information and communications technology (ICT) sector. The widespread adoption of ICT technologies is opening opportunities for increasing consumer involvement and hosting capacity for distributed and renewable generation.

Technology challenges are being resolved rapidly. For example, while the increasing share of variable renewables has created some problems due to fluctuations in wind and solar, data from the European Union show that in 2014, variable renewable share in member states grew to over 10% without causing operational difficulties.

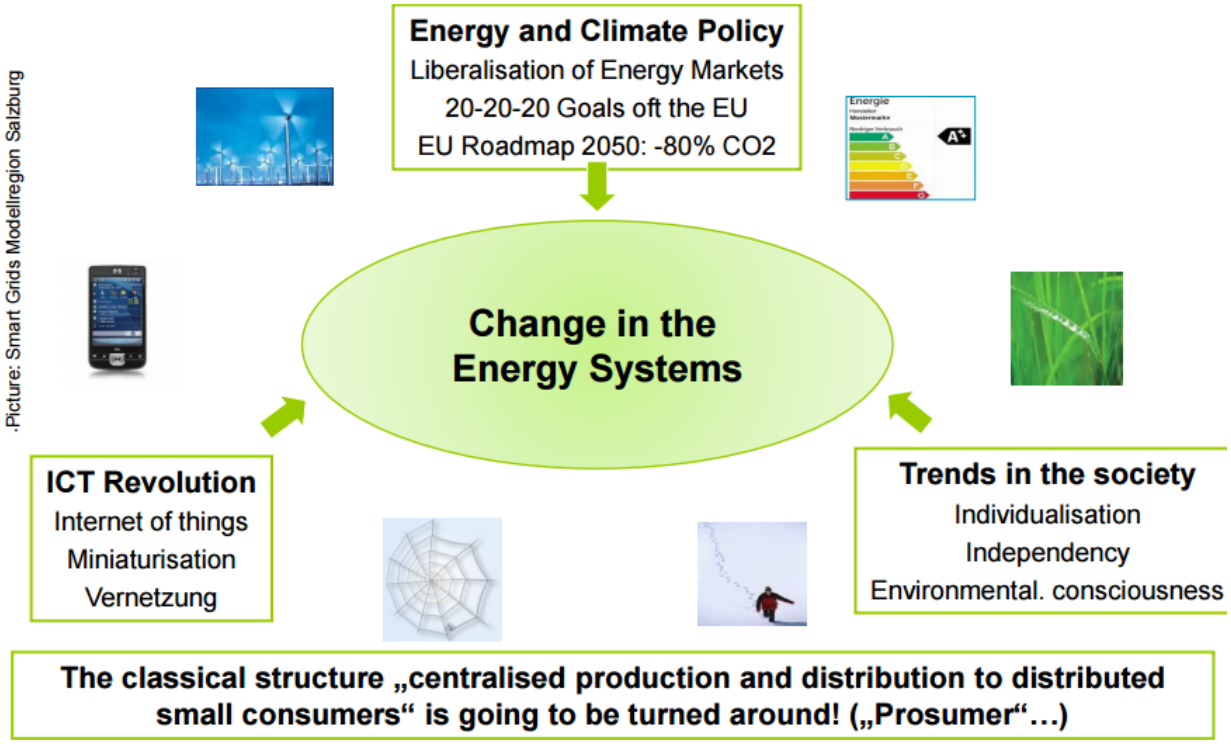

Figure ES-1. Drivers of change in modern energy systems.

Simultaneously, however, are slow-to-change practices that are holding back progress. Non-technical challenges include regulations and incentives based on traditional electricity grids and customers who are resistant to change. In particular, electricity has traditionally flowed unilaterally from large-scale generators to end-users. Moreover, demand for electricity has been traditionally inflexible and unresponsive to changes in the electricity system, a challenge which is exacerbated with an increasing variability of generation. With the growing digitalization of energy systems, the increase of information from end-consumption and the advent of distributed generation, the role of end-users in energy systems is set to fundamentally change. In this workshop, participants examined best practices, advanced technological developments, and challenges surrounding end-user adoption of new technologies. The primary focus was developments in ICT and how smart grids and customer-facing technologies can help and encourage end users to understand, control, and modify their energy consumption patterns. The group discussed projects that have studied whether new technology influences human behavior and how to encourage consumer adoption and behavior modification.

End-User Benefits and Consumer Engagement

Many countries are in the midst of massive smart meter rollouts, which presents opportunities for a wide range of benefits, such as customer empowerment through energy usage information. Several smart grid projects have indicated that smart meters must be paired with customer-facing products and/or services so that customers can become full participants in realizing smart grid benefits. These products/services would be more impactful if they are made available to all customers. If only the most interested customers avail themselves of these services, energy savings will be limited—not only because of fewer participants but also because benefits have already been captured by those customers who are already interested in energy efficiency (i.e., these customers are the first adopters and would have already explored and implemented solutions).

Motivated customers are the exception rather than the rule. Few customers perceive energy itself as a product; instead, it is the means to an end—transport, heating, washing, cooking, entertainment. As a result, it is left largely up to decision-makers in these sectors to determine how smart technologies can benefit consumers and society. Services that combine customer-focused benefits with energy efficiency will best optimize the smart grid's potential. Companies that build energy efficiency technology directly into products without involving the consumer in complex decision making will be more successful than products that rely on motivated users.

Similarly, consumers surprise economists by not always focusing on cost savings or the most cost-efficient choices. Incentives based solely on economic benefits often have limited long-term effects on consumer behavior. Customers often make quality-based rational judgments ("qualculations"), and their decisions can be heavily influenced by moral, social, and political issues.

Customer confidence in the proven performance and longevity of new technologies is also important. Earlier products—especially those focused on energy efficiency—have had disappointing performance and quickly disappeared from the market. In addition, experts have presented issues with products that were marketed as environmentally friendly but have not been fully evaluated in terms of their lifecycles. Customers are reluctant to invest in technology if they are uncertain as to how well it will perform or how long it will remain relevant. Customers also need confidence in after-markets, knowing that suppliers will provide repairs, warrantees, and other follow-up.

Although there is reason to further motivate customers to adopt new technologies and behaviors, workshop participants discussed the experiences from several long-term demonstration projects and noted that significant change has already taken place. Some of these shifts are customer-based. For example, customers are often willing to pay a little extra for “green” energy, and they will consider energy efficiency when shopping for new appliances or homes. Changes may be gradual and go unnoticed in the middle of a transformation, but comparing present-day technologies and associated behaviors with those of ten years ago leaves no doubt that new technologies (including smart grid and smart technologies) are transforming electricity delivery at all levels. How energy is generated, delivered, purchased, and used are all in flux.

New Business Models and Opportunities

Understanding customer perspectives is helpful when considering new business opportunities and business models. There are several examples of new, "smart" energy efficient products and services that focus on consumer benefits. For example, a Norwegian energy company has combined energy delivery and ICT to provide new services for smart homes, safety and security, and communications (see Figure ES-2).

Figure ES-2. Functionality potentially enabled through a home energy control system.

Experiences from the telecom sector shows that new business models can lower the barriers for investing in new technology. If the customer can buy a service instead of having to invest in technology and expensive equipment, much of the risk stays with the suppliers. Such models could open markets much more quickly than models that require each customer to investigate all options and risks before investing. An example in the United States shows a new business model that encourages adoption of renewable energy: some companies install their own solar panels on rooftops and rent the rooftop space from the customer. In this case, both the technological and the financial risk stay with the

professional partner. New business models are also needed to encourage storage adoption and flexibility. Although big coalitions of companies have demonstrated a willingness to invest in smart grids in many countries, it still is unclear which stakeholders should pay—and how much they are willing to pay—for flexibility and grid safety.

Consumers wants and needs, and the relative importance of these, will vary from region to region and within consumer groups. Business models will need to adjust to each market in order to succeed. In one project, three different consumer groups were identified: older people who were most interested in cost savings, younger people who were most interested in the technology, and environmentalists who were most interested in the impact related to climate change.

Another important motivation is consumers' wish to be self-sufficient or independent. This drive can pave the way for wide-scale adoption of distributed energy resources, solar photovoltaics paired with electric vehicle charging, and other combinations. Business models should also consider—and leverage, when possible—the creative potential of the end user.

Similarly, different sectors have varying service needs and capabilities that merit investigation. For example, the transport sector combines with energy delivery systems to create new opportunities—and new challenges. Studies of electric vehicles and power systems provide an interesting integrated approach. For example, electric vehicle systems may add significantly to peak load while also providing new possibilities for storage.

New payment models can also be used to benefit both the company and the customer. Time-based electricity rates can encourage customers to reduce energy usage during peak usage periods, for example. One project is experimenting with a flat rate for connection to the grid with restrictions on energy usage. In most such new models, there is a role for aggregators in the system.

Standards and Regulations

Interoperability presents a major challenge to smart grid application. Codes and standards are needed to establish open networks and support wide-scale, cost-effective smart grid implementation. Universal standards will also lower barriers for competitors to enter the marketplace. Particular challenges are faced by projects implementing direct current, both at high and low voltage. Governments and standards organizations can play an important role in developing such standards.

Similarly, effective smart grid implementation would benefit from regulations and policies that encourage all players to adopt next-generation systems and techniques. Incentives throughout the lifecycle should be considered. For example, in the buildings sector, those who design and construct buildings do not ultimately pay the electricity bills for those structures, making energy efficiency less important than other aspects in the planning process. Good standards and certifying regimes can help ensure that both smart grid application and implementation is prioritized.

Conclusion

While global resources are appropriately focused on smart grids as a solution to many challenges presented by aging electricity delivery infrastructure and the growth in variable renewable and distributed power, it is important to bear in mind that "smart grid" is not a single solution but rather a portfolio of tools, techniques, technologies and business models. A broad range of factors—from technical to societal—must work hand in hand to optimise smart grid implementation and benefits. The

various aspects are interwoven, mandating a holistic approach to achieving the optimal results from advanced systems.

Customer participation is essential to a successful new energy economy; the importance of the customer's role in this larger picture cannot be overemphasized. Consumers participate in reducing demand, adopt technologies and techniques that result in energy efficiency, and enable flexibility—key to a successful next-generation system—through demand response, small-scale storage, and distributed generation.

Many consumers are ready to invest in new technologies and participate in new business models, but the stage must be set. New behaviours cannot be expected without new contexts. The energy economy is undergoing a transformation that opens the door wide for new products—and, indeed, demands that energy providers master new technologies and provide new business models and services to survive in the new era.

A supportive policy portfolio is also essential in establishing the contexts and incentives that drive innovation. And continued international and multidisciplinary cooperation is an important factor in successful smart grid implementation.