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THE ROLE OF DEMAND MANAGEMENT IN THE UTILITY OF THE FUTURE

Dialogue Summary

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21st Century POWER PARTNERSHIP
Accelerating the transformation of power systems

Johnson Controls

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INTRODUCTION

Amid concerns about the environment, climate and constraints on infrastructure, there is increasing discussion about expanding the use of demand management and distributed generation technologies to deploy energy resources more efficiently. Recent energy and information technology advances have the potential to transform how consumers interact with the electricity grid and manage their energy use. Empowered consumers who participate more actively in meeting their energy needs may be disruptive to the way the grid operates, yet this can offer tremendous opportunities for consumers and utilities alike. Successful integration of these rapidly developing opportunities will require evolution in consumer solutions, training, technology, government policy, and the operational business models of energy providers.

On February 12, 2014, the Institute for Building Efficiency and the 21st Century Power Partnership hosted a group of experts from business, public sector labs, and non-government organizations (NGOs) to discuss the key questions facing demand management and how the utility of the future can adapt to capture the greatest benefits with the least negative disruption for consumers and utilities. Participants included:

Doug Arent – 21st Century Power Partnership/National Renewable Energy Laboratory

Barbara Bauman Tyran – Electric Power Research Institute (EPRI)

Morgan Bazilian – 21st Century Power Partnership/National Renewable Energy Laboratory

Shawn Bennett – Federal Energy Resource Commission (FERC)

Cameron Brooks – Tolerable Planet Enterprises

Reid Detchon – United Nations Foundation

Clark Gellings – Electric Power Research Institute (EPRI)

Katherine Hamilton – 38 North Solutions

Sila Kiliccote – Lawrence Berkeley National Lab Demand Response Research Center

Jennifer Layke – Institute for Building Efficiency, Johnson Controls

Clay Nesler – Johnson Controls

Alex Perera – World Resources Institute (WRI)

Graham Pugh – 21st Century Power Partnership/U.S. Department of Energy

Rich Quattrini – Johnson Controls

Thomas Simchak – Center for Clean Air Policy (CCAP)

Jon Sohn – McKenna Long

Zolaikha Strong – Copper Development Association

Shana Udvardy – Center for Clean Air Policy (CCAP)

The discussion identified key challenges and needed innovations in technology, policy, and business models on the path to the full realization of demand management's potential. It also addressed how technology, policy, and business model changes could be quite different in developing countries – with a significantly different starting point, history, and needs – relative to a more evolutionary change needed in the United States. This summary synthesizes key themes and issues to be addressed for the effective deployment and utilization of demand management programs and distributed energy systems.

Demand management programs and distributed energy systems help users reduce their energy costs, and potentially their overall energy consumption, while diversifying their energy sources. Where distributed energy systems use renewable resources and replace fossil-based central power generation, air-quality improvements can be realized. Perhaps less apparent is that demand response technologies and reduced consumption can also help the grid itself operate more efficiently. Demand-side actions and greater deployment of distributed energy may provide greater resilience to weather disruptions, allowing sites to maintain electrical power when the wider grid has failed. They also can provide flexibility to offset some of the challenges of variability that come with deployment of renewable energy.

Today, the value and costs of distributed technologies and demand management are not captured in utility rates or in the energy system. The business case for using distributed energy systems and demand management requires a more thorough analysis of the system benefits. Yet even as distributed resources and demand reduction can provide significant benefits, power plant maintenance and grid upgrades are critical infrastructure investments that provide system benefits for all users. The grid provides complementary benefits for those operating distributed generation systems, including backup and supplementary power and support in maintaining power quality on site. New models are needed to finance and retain these critical resources.

The Electric Power Research Institute (EPRI) shared with roundtable participants a new initiative outlined in an EPRI paper, "The Integrated Grid: Realizing the Full Value of Central and Distributed Resources."

New distributed resources may strain the traditional grid in ways that must be accounted for in planning and in utility service models and rate structures. Compensating utilities for energy consumption alone is unlikely to suffice for ensuring financial viability under a new distributed energy system. In the emerging system, traditional energy load may be met through on-site energy resources, demand management, and shifting of demand profiles; information technology will enable a more networked ecosystem with utilities as a central, but no longer exclusive, player in energy services.

ADVANCING INNOVATIVE POLICIES, BUSINESS MODELS, AND TECHNOLOGIES

The Roundtable Dialogue focused on the three categories of policies, business models, and technologies. Key questions and technology advances were discussed and barriers to greater deployment of distributed energy systems and demand management were identified.

The discussions touched on a wide range of questions that face distributed energy and demand management and also contemplated a wider range of innovations and actions that could address those questions. A more inclusive list of items raised in the discussion is presented in the Appendix. A brief overview of key questions follows.

POLICIES

The majority of the key questions raised in discussions were policy related. They included:

- How can the co-benefits of demand management be captured? For example, how can the benefits of resilience and emissions reductions be accounted for in regulation and legislation?
- What operational and rule changes are needed to build these technologies into the operation of wholesale markets? How can the markets that currently operate on a wholesale basis be adapted to the distribution level?
- Who pays for grid modernization and the integration of demand management technologies? How can potential implementers find the financing they will need? Where utilities are investing in improvements, what will rate structures look like? With energy demand dropping and a need to modernize the electricity grid, how will rate structures need to be altered?

Policymakers and regulators will have important roles to play both in removing existing barriers that hamper deployment of demand management and in proactively encouraging greater deployment. The group's discussion identified numerous specific policy actions that could encourage these technologies (presented more fully in the Appendix). The government's role in standardization was noted in a number of instances – for example, in equipment energy efficiency standards and in building energy codes. Leveraging the tax code and allowing for innovative financing mechanisms would help consumers overcome capital costs to deployment. Meanwhile, recognition of demand management in existing regulatory structures, such as electricity capacity markets, can open new opportunities, while government action can ensure that other structures, like the Clean Air Act's New Source Review, do not shut them down.

Perhaps most important, regulators will have a major say in what utilities are and are not allowed to do in most states, particularly those with a regulated utility model. If utilities are to expand beyond their traditional roles as generators and grid operators, and are to remain financially viable with declining electricity sales and perhaps rising infrastructure costs, it will have to be with at least the acquiescence of state and federal regulators. Ideally, those regulators would actively encourage utilities to advance and adapt to the changing environment that demand management is bringing.

BUSINESS MODELS

The group raised a number of issues connected to business models, both of utilities and of companies seeking to deploy demand management technologies. In some instances, individual energy consumers may have "business models" of sorts for decision-making, even if they are not themselves businesses. Key questions included:

- How can utilities transition to a services-oriented business model? What will their rates look like and how will they make money with this model?
- What will the return on investment be for purchasers of demand management technologies? How and where will different rate structures be needed to compensate those who invest in demand management technologies that generate benefits beyond reduced energy consumption, and how can those benefits be quantified?
- How can the combined benefits of both central and distributed resources be quantified and made evident to stakeholders?

The advances identified for business models differ for utilities, technology developers and manufacturers, implementers, and commercial energy consumers. The business models utilities will need to generate revenue in the future formed a large part of the discussion, but the group also considered how to effectively plan and operate an existing power grid with new demands placed on it. Commercial energy consumers looking to deploy energy management will also have to adjust in some situations to benefit from the potential of demand management; they may have to integrate thinking about energy use more broadly in their operations. But these technologies will also have to be made more appealing to a broader range of consumers.

TECHNOLOGY

Few questions were explicitly technology-related, although technological issues were an undercurrent in many of the questions raised about the evolution of policies and business models. As technologies advance, policies and business models must keep pace to ensure optimal deployment. These advances included:

- Very specific needs for technology to address – for example, cost-effectively enabling demand response in developing countries' expanding stock of window unit air conditioners.
- Broader applications like planning for efficiency in total operations rather than just in equipment or systems.
- Ways to encourage greater deployment, like using military bases as early adopters to drive the market.

Battery storage and other storage technologies are commercially available but not generally cost-effective. In the absence of abundant and affordable storage, centralized energy resources delivered via the grid are needed to "firm" distributed energy resources.

UNIQUE INTERNATIONAL PATHS

The present situation in the U.S. and paths to an American "utility of the future" may not be directly applicable in other parts of the world, particularly in developing nations. The group heard a presentation about the Clean Energy Ministerial, a forum that promotes international engagement to promote a clean energy economy. In the presentation and subsequent discussion, group members acknowledged that new government policies and new utility business models in developing nations will need to account for local policy environments and business models, often different from those familiar in the U.S. While U.S. market participants seek to evolve technologies, policies, and business models, developing countries will often be crafting entire business models without the same historical basis. That means the processes to arrive at those blueprints, and then implement them, will necessarily be different.

Technological needs will differ. Developing countries may need cheaper solutions when infrastructure investment and capital budgets are much smaller in scale. Where no centralized electric grid exists at all, the technological solutions will have to be able to stand on their own and may have their own resiliency challenges when distant from support infrastructure.

Without legacy technologies and practices, developing countries may be able to partially leapfrog the systems present in developed countries. The often-cited example of mobile phone use in places where land lines are unavailable is just one example of technologies leapfrogging the progressions seen in developed countries. To cite an energy-specific example, without an extensive existing power grid based on centralized fossil generation, some developing nations may be in a position to deploy distributed generation in a microgrid arrangement and avoid some large-scale transmission infrastructure investments.

Innovation on U.S. and international grid systems may occur simultaneously, or may flow outward from developing countries – such as if highly technical emerging economies evolve their energy systems using distributed technology and management infrastructure solutions that could offer new models to the U.S. or other developed countries.

COMMUNICATION AND STAKEHOLDER ENGAGEMENT

Communication and outreach to stakeholders affected by these changes in the energy system will be an important part of any effort to advance integrated demand management – the desire for change is by no means universal, and these issues are not well understood. Customers, suppliers, technology companies, regulators and others need to understand the value and challenges that greater deployment of demand management will hold for them. Especially where there will be up-front capital costs or higher energy prices, the return on that investment needs to be apparent and understood by everyone involved.

A significant challenge will be to keep debates around these issues from becoming excessively polarizing. The changes needed to implement successful demand management programs and distributed energy resource systems have been identified as threats to the dominant utility business models of today[1] and are becoming increasingly politicized. Proactive engagement with a broad range of stakeholders may help mitigate antagonism and so may effective presentation of the range of benefits likely to accrue to all those stakeholders. This is likely to remain a significant challenge.

[1] Edison Electric Institute. *Disruptive Challenges: Financial Implications and Strategic Responses to a Changing Retail Electric Business.* January 2013.

Utilities in particular need to understand how to adapt their business models to allow for the more active roles their customers will play. Utilities are often locked into a system where they must defend their business models and the revenue structures that have worked for them for decades. State regulators and consumer advocates may be reluctant to risk modifying a historically successful model. More constructive ways of engagement need to be identified that can bring stakeholders together to collaboratively address the challenges to a modern grid and utility business models that facilitate demand management. Different regulatory structures in different states may require tailored plans and messaging – utilities will have varying ability to alter their own operations independent of regulators.

Given that most utilities are heavily regulated and nearly all have to answer to state regulators, regulators will need to be engaged on these issues. The regulators may not be familiar with the issues and technologies involved and so may defer to the status quo if no effort is made to engage and educate them. State utility commissions will need to understand these changes to properly govern utilities' transitions. Other government agencies, particularly state energy offices and, in many cases, air-quality regulators, will have to be a part of a holistic approach to modernizing the policies to foster changes in business models as new technologies are incorporated into power systems.

At a broader scale, the changes to traditional electric grid operation will require active involvement and buy-in from those who manage the grid and many of the standards for operation, namely the Federal Energy Regulatory Commissions (FERC), independent system operators and (ISOs) and regional transmission organizations (RTOs).

Technology providers (manufacturers, vendors and implementers) will have a very important role to play in communicating the broader benefits of demand management. This involvement cannot be limited to the specific benefits of their own products. Given the integrated nature of these technologies and practices, messaging will need to be collaborative and demonstrate the greater benefits of integrated approaches to upgrading energy systems.

CONCLUSION

Realizing the full range of benefits of distributed energy systems and demand management will require a range of approaches that the 21st Century Power Partnership and the Institute for Building Efficiency are committed to investigating, so that these transformative energy strategies can be developed and applied. This Roundtable Dialogue launches a new effort by the Institute to link to efforts underway that review new policies, spotlight new business models, connect distributed energy technologies and energy demand management, and advance transformative energy strategies.

The supply and demand side changes discussed in the Roundtable have the potential to be significantly disruptive to the traditional structure of the electricity system, and will change how it is operated and financed. Coordinated planning and implementation will be needed with the existing electricity grid, and utilities, to ensure a continued supply of cost-effective, reliable electricity. Simultaneous design of demand- and supply-side systems can avoid sub-optimal results, but this must happen across the power system, not just at a project-by-project level. Collaboration among stakeholders will be critical to reducing conflict. The adoption of demand management and distributed energy systems will require an understanding and recognition of the benefits each sector can hope to enjoy and the responsibilities each sector must accept.

APPENDIX: MATRIX OF KEY QUESTIONS AND SOLUTIONS

This matrix presents the wide range of emerging and mature technologies that influence the development of demand management and the energy system of the future. It is not an exhaustive list but is indicative of many key technology, systems, and integration issues and solutions that were discussed at the Roundtable Dialogue. This list is presented for discussion only. Inclusion in this list is not an endorsement of any item by the Institute for Building Efficiency or the 21st Century Power Partnership.

	Policies	Business Models	Technologies
Energy Efficiency	• Address the disincentive to upgrade industrial and utility equipment created by the Clean Air Act's New Source Review. • Phase out refrigerants that are extremely potent greenhouse gases. • Advance building codes and equipment energy efficiency standards, requiring greater efficiency, but also advanced capabilities that could support integrated energy management.	• Allow performance contracting periods to run longer and incorporate more innovative approaches to energy efficiency. • Make sure that buildings and process equipment undergo ongoing commissioning and re-commissioning to ensure persistence of energy savings. • Encourage businesses to pursue ISO 50001 for energy management.	• Enable data-driven efficiency projects and foster behavioral change with information systems and energy-aware buildings. • Plan for efficiency in total operations, not just in discrete systems and components. • Develop and deploy advanced lighting technologies. • Integrate communications and build in management capabilities to create an "internet of things," allowing greater control, integration, and feedback from appliances and equipment.[i] • Specifically target load growth from air conditioners, particularly in the developing world.[ii]

(continued)

[i] For example, high-power USB could offer addressability and allow for the much more advanced control of appliances and equipment along with the wiring for their power needs.

[ii] There is a real need for demand management capability in air conditioners in addition to energy efficiency in new units – even window units. In India, conservative estimates suggest that window unit air conditioner power consumption could reach 239 TWh in 2030.

	Policies	Business Models	Technologies
Demand Response	• Enable "bring your own" customer-supplied equipment with demand response capabilities, like the Nest thermostat, instead of relying on proprietary systems and custom-designed integration. • Make equipment customer-friendly. • Align rate structures and programs with the true need of the grid along while also ensuring customers or installed technology is able to achieve payback by taking action against them. • Enable more competition in states without retail utility choice, as the aggregation of demand response projects does not work as well within vertically integrated utility model states. • Make dynamic pricing more readily available to a wider range of consumers to create a value for demand response capabilities.	• Ensure benefits of demand response are apparent and understood by all actors in the demand response process (utilities, aggregators, end-users). • Legitimize demand response in the eyes of grid operators to create recognition that it is as an effective way to manage certain grid needs. • Get grid operators and utilities to understand true customer capabilities and design programs around what customers can do first as opposed to requiring customers to act just like generators. • Employ demand response in consort with renewable energy technologies to help balance intermittency. • Likewise, integrate energy efficiency and demand response into the same value chains to create greater value than either one on its own.	• Integrate capabilities like Open-ADR 2.0 for enhanced capabilities including day-ahead and hourly response periods. • Equip all new load consuming technology with the ability to shift or limit load in response to event or price signals. • Integrate communications and build in management capabilities to create an "internet of things," allowing greater control, integration, and feedback from appliances and equipment.[iii] • Specifically target load growth from air conditioners, particularly in the developing world.[iv]

[iii] For example, high-power USB could offer addressability and allow for the much more advanced control of appliances and equipment along with the wiring for their power needs.

[iv] There is a real need for demand management capability in air conditioners in addition to energy efficiency in new units – even window units. In India, conservative estimates suggest window unit air conditioner power consumption could reach 239 TWh in 2030.

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	Policies	Business Models	Technologies
Distributed Generation	• Ensure that interconnection, standby and other fees are set at levels that recognize the ancillary and external benefits of these technologies so as not to discourage deployment. • Advance standards for equipment like inverters and transformers to ensure that they can handle new, more complex needs placed on the distribution grid by customer-side generation. • Develop business case studies on net metering of distributed generation resources or tariffs, like "value of solar,"[v] to identify system-wide benefits/costs as well as benefits/costs to customers with and without distributed generation resources. • Update wires laws, which currently prohibit private electricity distribution in most cases and in most states, to expand revenue opportunities for exported generation.	• Involve a greater range of businesses in the distributed generation space – not just facility owners, but financers leasing or owning equipment, energy service companies (ESCOs), and third-party companies focused on providing on-site services. • Expand build-own-operate services available to customers interested in the benefits of distributed generation but without the capacity (operational or financial) to build or operate it themselves. • Where allowed or where regulators act to allow it, engage traditional utilities on implementation and management options for distributed generation services.	• Develop and deploy better inverters at lower cost and higher performance to manage the more complex demands of an integrated grid. • Expand use of direct current at the customer and distribution scales to mitigate inverter losses. • Develop universal transformers, rather than custom-designed equipment, to ease deployment of advanced equipment built to the standards needed to incorporate these technologies while also improving ease of repair. • Develop and deploy plug-and-play thermal appliances to take advantage of thermal energy storage, combined heat and power, and solar thermal energy sources.

[v] Minnesota's "value of solar" tariff seeks to account for the various costs and benefits of distributed solar photovoltaic power, particularly the impacts of greenhouse gas emissions.

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	Policies	Business Models	Technologies
Energy Storage	• Include energy storage capacity in energy portfolio standards, or in stand-alone energy storage standards, that require utilities to integrate certain quantities of storage capacity within their service territories or a state generally.[vi] • Equitably manage the value of stored energy in rate-making and billing systems, recognizing the value of storage for peak periods while encouraging charging during off-peak hours.	• Deploy energy storage capabilities at all scales, from bulk storage operating at a wholesale level much as a utility-scale generator would, to incorporation with the distribution network to meet localized needs, to on site in homes and businesses.	• Develop and deploy dispatchable thermal storage – including ice and hot water made during off-peak periods to supply thermal needs during peaks –as well as kinetic energy storage. • Enable plugged-in electric vehicles to provide ancillary services for the distribution network.[vii] • Repurpose old electric vehicle batteries to provide lower-cost grid-connected storage while reducing waste. • Use building mass as thermal energy storage, such as to cool building mass overnight to reduce electrical cooling needs during hot days.

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[vi] See, for example, California's energy storage mandate, AB 2514, which directs the state's investor-owned utilities to develop 1,325 MW of electric and thermal storage capacity into the state's grid by 2020.

[vii] Electric vehicle batteries can provide ancillary services to the grid, like voltage control, that reduce the need for some generation assets and provide value to utilities, car owners, and all those on the local distribution grid. Communications technologies and equipment standards will need to be more fully developed to allow it.

	Policies	Business Models	Technologies
Microgrids	• Include microgrid development in disaster resiliency planning, including "energy assurance planning." • Include microgrid development in planning for greater penetration of other demand management technologies, particularly demand response and distributed generation. • Update wires laws to allow bilateral sale of electricity between facilities within a microgrid. • Leverage Department of Defense procurement and deployment to drive development of microgrids on military bases, providing proof-of-concept and driving the market.	• In areas without access to the broader electrical grid, for example in developing countries, deploy stand-alone microgrids based on distributed generation that are designed to be connected to a broader grid in the future when that infrastructure becomes available.	• Encourage deployment of inverter-based rather than synchronous microgrids to ensure that the microgrid can keep operating when the wider grid is down. More generally, explore microgrid designs that allow independent operation and "black start" capability.

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	Policies	Business Models	Technologies
Smart Buildings	• Expand Energy Service Performance Contracting providing renewables, building systems such as safety, fire, building equipment, demand response functionality, and cyber security. • Review and update demand response participation from buildings: AutoDR, capacity bidding. • Update rates/tariffs to reflect dynamic pricing models/opportunities.	• Address the communications gap on smart building issues in order to brand this approach and market it. • Owners contract for, or hire in-house management of energy information management system and/or enterprise integration of building/facilities performance. • Networked operations centers/energy services/demand response provision	• Deploy smart building technologies such as wireless sensors, and smart meters which can provide real time information on building performance. • Improve integration of "Smart" equipment such as lighting occupancy sensors/ballasts/controllers, HVAC controls and sensors • Upgrade ICT systems and integrate buildings systems (fire, safety, energy) • Operationalize integrated controls and access fault detection and diagnostics capabilities. • Utilize automated controls systems for demand response program participation.

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	Policies	Business Models	Technologies
Cross-Cutting	· Expand availability of innovative financing models like green banks, property assessed clean energy (PACE) financing, and on-bill financing. Explore new models to widen access to capital and create opportunities for investors. · Leverage the tax system to incentivize demand management projects, including investment credits, production credits, and master-limited partnerships (MLPs), and perhaps new innovative structures. · Allow carbon emissions reductions attributable to these projects to be credited under EPA power plant carbon emissions regulations, creating an incentive for utilities to support projects and potentially an additional revenue stream for projects. · Open capacity markets more to demand management beyond the PJM and ISO-New England service territories and increase its use in the territories of these two ISOs. Also, allow greater use of smaller-scale projects and bring markets to the distribution level. · Standardize and simplify permitting to reduce overhead costs and uncertainty.[viii]	· Open up additional capital for demand management projects with third-party financing mechanisms, including ESCOs, lease agreements, and new innovative structures. · In utilities' integrated resource plans (IRPs), take a holistic view of both the traditional generation and transmission systems and the integration of new demand management resources, as consumers' demand profiles may significantly differ from those seen in traditional utility planning models. · Address businesses' demands for short payback periods for capital projects, often as short as two years or even less, to recognize longer-term energy savings. · Broaden understanding of value streams in order to market these technologies.	· Improve efforts to commercialize national laboratory and university-developed technological advances.

[viii] For example, IEEE and FERC interconnection procedures.

About 21CPP

The 21st Century Power Partnership is a multilateral effort of the Clean Energy Ministerial that aims to accelerate power system transformation.

The Power Partnership serves as a platform for public-private collaboration to advance integrated policy, regulatory, financial, and technical solutions for the large-scale deployment of renewable energy in combination with deep energy efficiency and smart grid solutions. The 21CPP is unique in its emphasis on promoting systems perspective solutions on power sector transformation challenges and opportunities.

http://www.21stcenturypower.org

21st Century POWER PARTNERSHIP
Accelerating the transformation of power systems

The Institute for Building Efficiency is an initiative of Johnson Controls providing information and analysis of technologies, policies, and practices for efficient, high performance buildings and smart energy systems around the world. The Institute leverages the company's 125 years of global experience providing energy efficient solutions for buildings to support and complement the efforts of nonprofit organizations and industry associations. The Institute focuses on practical solutions that are innovative, cost-effective and scalable.

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