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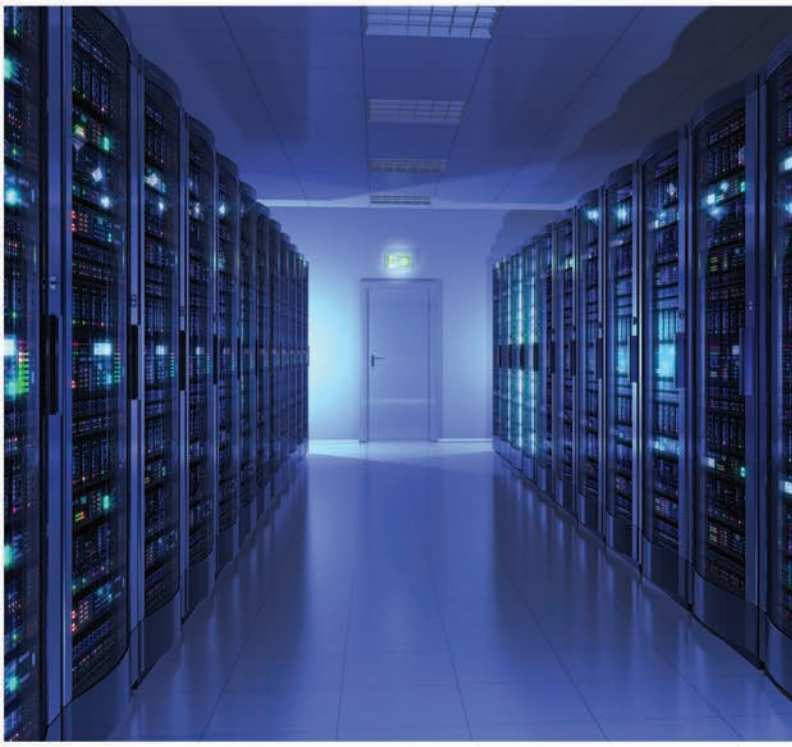
Optimized Network Utilities and Demand Response



The World of Demand Response

White Paper Series

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About the Authors

Mark Knight is Director of Consulting in CGI's utility solutions practice. A graduate of Imperial College, in London, Mark is also a former chairman and a current member of the GridWise Architecture Council (GWAC)—a group formed by the U.S. Department of Energy to promote interoperability in the country's electric power system.

With 20 years of experience in utilities and communications, **Ana Domingues** is CGI's global lead for these industries, and has extensive expertise in business development and consultancy. At CGI, Ana drives executive discussions on global strategy and investments, defines international offerings and supports senior executive engagements across Western Europe and the Americas. She holds master's degrees in engineering and business administration.

INTRODUCTION

In the first paper in this series, we looked at how demand response (DR) developed and how it offers great possibilities in the future by creating flexible ways to help balance the grid—both by decreasing and increasing loads in response to generation fluctuations. The type of benefits that demand response can provide includes:

- Bill savings earned by customers that adjust their electricity demand in response to signals
- Market-wide financial benefits driving production costs and prices down and lowering aggregate system capacity requirements
- Reliability benefits resulting from demand response lowering the likelihood and consequences of forced outages
- Increased levels of renewables through coordination of supply side and demand side resources
- Market performance benefits by mitigating suppliers' ability to exercise market power
- Enhanced customer satisfaction through participation

In these papers, we focus on those benefits, the drivers that face utilities and the need for change in utilities' operations in order to maintain or improve reliability. This is important because with "no grid" there would be no power and markets. Avoiding disruptions to electricity supply is perhaps one of the key objectives of an electric utility. The other key objectives are safety and economics, with the economic supply of power becoming increasingly important in a low-carbon world given that investment is driven by the capacity required to support peak demand, however brief those periods of demand. Using trends to guide strategy is not as easy as it might appear because there are always short-term issues to be addressed, and the way we look at change means that the problem often appears further in the future than it really is. Waiting for future problems to manifest themselves could lull the industry into being less agile than it needs to be, but being agile requires looking at the big picture.

Looking at the big picture is one of the things that a network utility needs to be doing continuously. Visualizing how the utility will look like as part of this energy transition through a holistic approach will help define a roadmap that balances the shorter and longer term benefits that can accrue for the ROI evaluation. This will help ensure that the value of technologies and systems deployed today are fit for the future needs and that their value can be efficiently exploited in both the shorter and longer terms. That means defining how to deploy smart grid related and other technologies with a whole-system perspective, while also looking at multiple value drivers and the way technologies and market players can interconnect and coordinate to optimize the realization of these benefits. One of the tools that will play a part in this future is demand response and this paper looks at how demand response fits within an Optimized Network Utility.

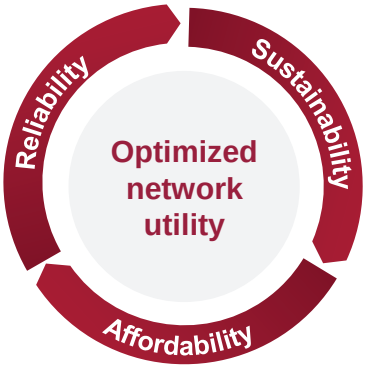
OPTIMIZED NETWORK UTILITIES

Taking a holistic view will allow utilities to exploit opportunities at a time of uncertainty. It will enable them to balance many different stakeholder expectations, while having the flexibility to alter tactics as opportunities and circumstances change. And it will enable them to achieve all of this while maintaining a clear strategy that will help them achieve their long-term objectives. At CGI, we call organizations that embrace, exhibit and act on these attitudes Optimized Network Utilities, or ONUs.

Today, the utility industries—providers of the basic commodities of energy and water—are facing a transition. To successfully manage the transition that is taking place, utility networks need to evolve. Since utilities operate many existing demand response programs, it makes sense to look at how utilities need to address the changes taking place. ONUs are in a unique position to bring grid operations closer to consumers' activities. That is, to drive the development renewables and customers, there needs to be a grid to provide connectivity and somebody to operate it. Rather than a "wait and see" approach, ONUs can drive innovation, collaboration and the sharing of data across the value chain to support the energy system transformation in an increasingly interconnected ecosystem. This is what Alliander, one of the biggest network operators in the Netherlands is doing, by partnering with CGI to develop an open smart grid platform that encourages open innovation, the emergence of new business models and the pursuit of the lowest (social) costs.

For CGI, the ONU is driven by the objectives of ensuring network reliability in an affordable and sustainable way, successfully exploiting the opportunities of future paradigm shifts guided by three fundamental mindsets:

- Embracing the bidirectional element of energy and information flows, assuming a leading role in an interconnected ecosystem
- Defining a journey of progressively rolling out technologies with a clear ROI while building knowledge and flexibility
- Aspiring to exploit 360º control and visibility by driving end-to-end business processes enabled by automation and integration of operational technology/information technology (OT/IT)



1 **Embraces the bidirectional flow of energy and information, assuming a leading role in an interconnected ecosystem**

2 **Defines a journey of progressively rolling out technologies with clear ROI while building knowledge and flexibility**

3 **Exploits 360º control and visibility by driving end-to-end business processes enabled by automation and integration of OT/IT**

DRIVERS FOR DECENTRALIZATION

Grids are moving from centralized to distributed networks. The rise of renewable energy and the emergence of the prosumer are having a major impact. In Australia alone, 20% of all homes have solar arrays installed and are connected to the grid, and expectations are that these numbers will continue to rise. As a result, network utilities will have to bring together disparate and often intermittent supplies of energy from a range of large and small sources and distribute them efficiently. Recognizing the significance of this period in the electricity sector's history, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia convened the Future Grid Forum in 2013 to develop and explore potential scenarios[1] for Australia's energy future and support the accompanying decision- making process.

CGI believes that the future grid will involve increased use of decentralized intelligent assets—advanced sensors and communications capabilities—working automatically to provide measurement and control at a much more local level[2]. The recently published Quadrennial Energy Report[3] by the U.S. Government lists six federal government actions to promote grid modernization and three of them mention controls and end-use technology integration. Also, in their last report on Worldwide Utilities 2015 predictions[4], IDC Energy Insights has stated that by 2018, 45% of new data traffic in utilities' control systems will originate from networked, non-utility owned distributed energy resources such as micro-generation, storage and electric vehicles.

These digitally connected and distributed intelligent assets will enable the two-way flow of energy and information, allowing utilities to efficiently manage increasing complexity. Setting aside who will be responsible for managing the distribution grid, this move into an "Internet of Things" environment will enable data from intelligent assets to be utilized increasingly in real or near real time across end-to-end business processes. The challenge for the entities managing the grid is to invest in distributed control networks with three valuable characteristics: scalability of the control system for real-time network communications, resilience of the logical control network, and complexity bounds[5].

The process will be a journey, its route set out by an ONU's broader vision of where it wants to be in the long term within its interconnected ecosystem. The ONU will also need to continually adjust its tactics to make the most of new efficiencies, technologies and ways of working, as well as sometimes having to balance seemingly conflicting expectations from different stakeholders.

ONUs are part of a wider CGI vision of smart utilities that we have been developing with clients over many years in innovative projects such as InovGrid with EDP in Portugal and the Low Carbon London program with UKPN in the UK. In this vision, we see "smart" as the creation of physical and commercial infrastructures that enable consumers to benefit from affordable, reliable and sustainable energy.

If you think of this in a system such as an electricity grid, where demand and supply must be balanced in real time, we must either move the demand curve to match the supply curve or move the supply curve to match the demand curve. If we do this successfully, the lights stay "on". By providing the ability for loads to communicate, the intelligence and communications that are becoming a part of almost every electrical appliance provide the opportunity for demand response to play a vital role by decreasing or increasing the load as required. CGI supports all new approaches that drive customer participation and give them the power to control the way they consume and produce energy. For example, a solution that supports clusters of customers to trade their surplus or shortage of energy in existing energy markets. Alternatively, a solution that allows utilities to provide dynamic price-based services to customers to help them manage their home energy consumption/ production. In both of these examples, collaboration and data sharing among different market players is pivotal if the flexibility within the system is to be fully exploited.

But as the supply and demand curves become less deterministic, we can't be certain where either curve will be[6] at any point in time. When it comes to keeping the lights on, that's a big problem because the current system was not designed to deal with this level of uncertainty. We will see the need to increase the levels of automation utilizing more real-time information and local processing. It will not be about just increasing the automation of networks, but also about changing the way consumers are engaged, as we start seeing prices that better reflect the condition of the grid. This is an essential move to avoid losing the wider benefits of a more intelligent power system that is truly integrated with consumers. These changes all necessitate new approaches to how electric power is managed and delivered, and to the economic and business models involved.

[1] CSIRO. Accessed January 29, 2016. http://www.csiro.au/en/Research/EF/Areas/Electricity-grids-and-systems/Economic-modelling/Future-Grid-Forum.

[2] CGI, Utilities. Accessed January 29, 2016. http://www.cgi.com/en/utilities.

[3] Office of Energy Policy and Systems Analysis. *Quadrennial Energy Review: Energy Transmission, Storage, and Distribution Infrastructure*. Report. Washington, D.C., 2015.

[4] IDC FutureScape. *IDC FutureScape: Worldwide Utilities 2015 Predictions*. Report no. EISC04W. 2014.

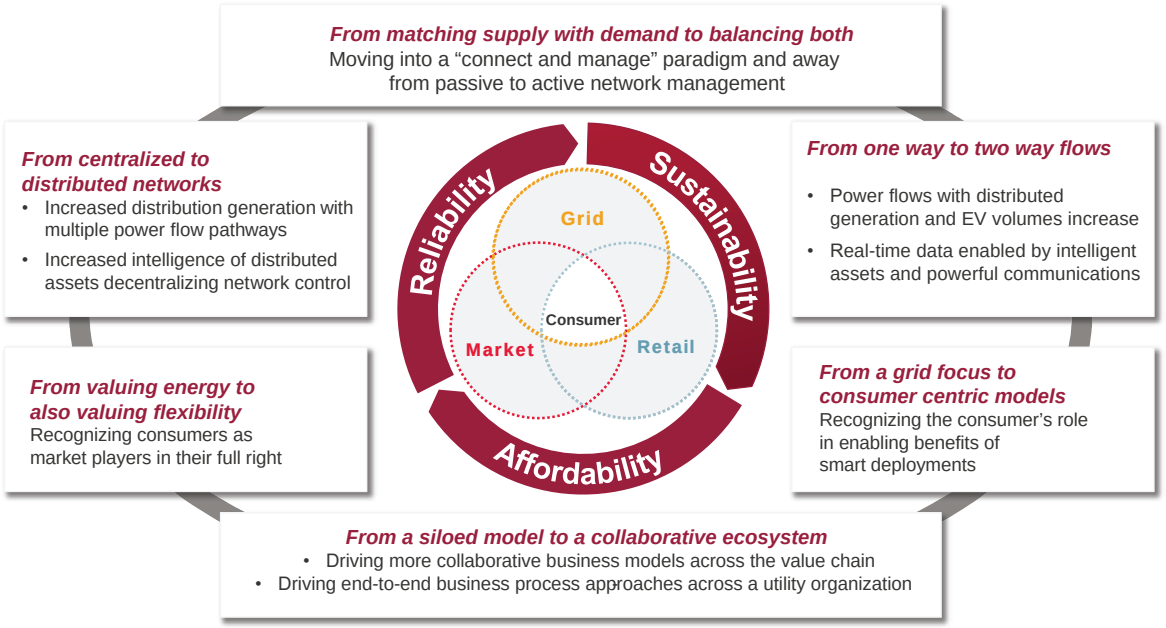
[5] J. Taft, and P. De Martini. *Scalability, Resilience, and Complexity Management in Laminar Control of Ultra-Large Scale Systems*. Technical paper. Cisco, 2012.

[6] Mark Knight. "Transactive Energy Builds Resilience." *EnergyBiz*, September/October 2014.

A PARADIGM SHIFT

An ONU drives change by anticipating events rather than following them. Paradigm shifts can quickly reach a tipping point, and an ONU recognizes that responses need to be planned early, with long-term objectives. How a network utility responds to these paradigm shifts will be driven by whether it has a holistic view of its role across the supply chain. ONUs have such a view and are proactively working towards long-term goals.

To make that happen, the conventional grid infrastructure needs to evolve towards a multi-directional digital network to manage intermittent supply and demand in real time. Market processes need to be reliable and secure, reducing barriers and costs of entry to the market and allowing retail markets to operate seamlessly across the physical grid. At the center of this is the consumer. A consumer-centric retail market will bring end users the ultimate benefits of smart utilities, putting consumer needs first and enabling their inclusion in the energy markets through new products and services, while balancing supply and demand.



EXPERIENCE THE COMMITMENT

CGI has been a major partner to the utilities sector worldwide for more than a quarter of a century, and was recognized as one of only three leaders in the IDC MarketScape: Worldwide IT Professional Services for Utility Smart Grid 2014 Vendor Assessment[7]. CGI was also recognized for best-of-breed utilities information technology and operational technology (IT-OT) integration services by Ovum in 2015[8] and we help to build the business case for a smart strategy that fits individual needs and market circumstances. CGI supports identifying new markets and models and re-engineering organization processes and has a proven track record in delivering systems that cover a wide range of operational areas—from managing customer interactions to managing the assets required to deliver energy to controlling and operating the grid. We design and deliver solutions that integrate smart distribution network technologies with existing business systems and our services allow our clients to scale and align their investments with future strategies and financial returns.

Our unique combination of systems integration skills and development of intellectual property (IP) based solutions enables CGI to provide our utilities clients with effective and innovative business solutions through end-to-end processes and market requirements. Also unique to CGI is our combined knowledge and experience of the OT and IT worlds, demonstrated by our own IP and also by our systems integration track record. IT and OT convergence will be pivotal to the success of an ONU as the new energy system evolves and utilities will need strategic partners with the unique combination of skills that CGI brings to the table.

In short, we not only have a future vision for utilities, we are already delivering on it. This includes working with the GridWise Architecture Council to explore and develop concepts such as Transactive Energy Systems.

DR AS A TOOL FOR TRANSACTIVE ENERGY SYSTEMS

Improving the management of increasing variability and complexity most efficiently, while maintaining system balance, stability, supply security and reliability is a huge undertaking—but one with equally huge benefits. Transactive energy is a concept that focuses on using decentralized control techniques that enhance grid reliability by complementing the present centralized systems. Transactive energy applies distributed control and communication techniques to increasingly complex grid operations as the electric grid and the Internet of Things collide.

In order to provide for both market agents and operational control (i.e., transactive energy capability) in an environment that supports new grid capabilities, it is clear that current grid control architecture must evolve in line with changing requirements. Such an evolution leads to a more distributed kind of control, especially at the distribution level. This is a paradigm change that requires faster operation, human supervision instead of human-in-the-loop operation, and control coordination that spans multiple levels of the power grid hierarchy that addresses these emerging complexities.

To successfully manage the transition that is taking place, utility networks need to evolve. The irony is that a tool, such as demand response, designed for a “load following” industry with central generation and control will evolve to be the perfect solution to help stabilize an industry that will be “supply following” with renewable generation, distributed control and intelligent customer loads. The time to start developing these solutions is today.

Thus the demand response market will continue to grow and is the perfect tool to help integrate and offset the intermittency introduced by renewable generation. It is one approach we expect to see ONU’s s adopting as a part of their digital transformations and in Europe, it is estimated that the DR market will grow at a compound annual growth rate of 36.3% between 2014 and 2019[9]. As the industry moves from a “load following” paradigm to a “supply following” paradigm, we will have a transition period of over a decade where the industry cannot afford to sit and wait for change to happen. We explore the topic of Transactive Energy Systems in a separate paper.

[7] IDC MarketScape. *IDC MarketScape: Worldwide IT Professional Services for Utility Smart Grid 2014 Vendor Assessment*. Report no. EI246402. 2014.

[8] Ovum. *Ovum Decision Matrix: Selecting an IT-OT Integration Partner, 2014–15*. Report. 2014.

[9] Europe Demand Response Management System (DRMS) Market. Accessed January 29, 2016. http://www.micromarketmonitor.com/market/europe-demand-response-management-system-7768963972.html.

Founded in 1976, CGI is one of the largest IT and business process services providers in the world. We combine innovative services and solutions with a disciplined delivery approach that has resulted in an industry-leading track record of delivering 95% of projects on time and within budget. Our global reach, combined with our proximity model of serving clients from 400 locations worldwide, provides the scale and immediacy required to rapidly respond to client needs. Our business consulting, systems integration and managed services help clients leverage current investments while adopting technology and business strategies that achieve top and bottom line results. As a demonstration of our commitment, our client satisfaction score consistently measures 9 out of 10.

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