ACCELERATING SUCCESSFUL SMART GRID PILOTS

World Economic Forum
in partnership with Accenture

This World Economic Forum report was developed by the Forum's Energy Industry Partnership in collaboration with Accenture and with the input from a steering board of project champions and a task force of experts.

About the World Economic Forum

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About the Smart Grid project

The Smart Grid project is driven by the Energy and ICT Industry Partner Communities and supported by the resources Partner, Accenture. In 2009, the Forum began researching the opportunities and challenges surrounding smart grid, publishing a report entitled *Accelerating Smart Grid Investments*. Building on this report and a series of workshops, including a private session at the World Economic Forum Annual Meeting 2010 in Davos, the Forum launched the second phase of the smart grid project in June 2010.

In 2010, the Smart Grid project is bringing together key stakeholders across the smart grid value chain and combining research and dialogue to:

- Provide a platform for public and private stakeholders across the smart grid value chain to collect and share practical knowledge and insights on what it takes to create successful and larger smart grid pilot projects and move forward smart grid developments
- Fill the current knowledge gaps on what can be learned from existing pilot projects to define success criteria and a value case for future pilot projects and create recommendations to inform investment and policy-making as well as roadmaps of smart grid roll-out
- Explore ways of implementing the recommendations from the project, particularly the opportunity to catalyse concrete partnerships for action

This report is a key milestone in this effort.

About the Smart Grid Steering Board and Task Force

The project is guided by a steering board of project champions, and a project task force of experts. Steering Board and Task Force members contributed to building the report by providing insight and input throughout the research and publication process.

The views expressed in this publication do not necessarily reflect those of the World Economic Forum, Accenture, the Smart Grid Steering Board and Task Force members or the Industry Partner companies.

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Abstract

Over the last 12 months, the utility industry has witnessed progress on two fronts: the recognition by governments of the importance of fiscal stimulus in kick-starting the transition to the low-carbon economy and the centrality of smart grids as an enabler for a set of low-carbon technologies and solutions. As a result, there has been a substantial increase in the number of smart grid pilots being implemented, with industry estimates at around 90 pilots globally[1]. For this report, over 60 industry and policy/regulatory stakeholders were engaged to identify the factors that determine the success, or otherwise, of smart grid pilots.

The global analysis identified a number of issues across the pilot life cycle that are preventing pilots from reaching their full potential. Our report presents several recommendations for stakeholders: the crucial role of the regulator in incentivizing smart grid pilots by providing clarity over funding and stranded assets; the need for the utility to apply rigor to pilot scoping with a mixture of consumer-centric and grid-centric technologies and to develop compelling consumer value propositions and outreach programmes while understanding operating model and business model implications of smart technologies; and the need for cross-industry collaboration to form multidisciplinary consortia and to increase international knowledge exchange.

[1] World Economic Forum Smart Grid Project Task Force & Steering Board (July 2010)

Executive Summary

In the 12 months since the publication of the joint World Economic Forum and Accenture report, *Accelerating Smart Grid Investments*, and the presentation of the Forum's Smart Grid Task Force on Low-Carbon Prosperity recommendations to world leaders, there has been a significant increase in funding committed to smart grid pilots. Governments have begun to recognize the centrality of smart grids as an enabler for a set of low-carbon technologies, and are increasingly viewing smart grids as a strategic infrastructure investment that will enable their long-term economic prosperity and help them to achieve their carbon emission reduction targets. Over the last year, China alone has spent US$ 7.3 billion[2] on smart grid developments, while the US has directed US$ 4.5 billion of its fiscal stimulus package[3] to smart grid activities.

A "smart grid" is a digital, self-healing energy system that delivers electricity or gas from generation sources, including distributed renewable, to points of consumption. It is capable of optimizing power delivery and facilitating two-way communication across the grid, enabling end-user energy management, minimizing power disruptions and transporting only the required amount of power. The result is lower cost to the utility and the customer, more reliable power and reduced carbon emissions.

INDUSTRY DEVELOPMENTS

Over the last 12 months, we have seen significant growth in the number of projects being undertaken; the prevailing industry estimate is that 90 smart grid pilots are in progress today, with at least as many in the pipeline[4]. The pilots have been predominantly focused in North America, Australia and Europe; however, we are now seeing considerable activity in South America, South Africa, China, India, Japan and South Korea. The scope of these pilots shows the continued dominance of advanced meter reading (AMI – smart metering); however, we are beginning to see more smart grid projects that are focused on network optimization and dealing with the challenges of accommodating a broad spectrum of low-carbon technologies.

"Smart grid pilots are essential in helping utilities field-test technologies and develop their understanding of the business model implications for mainstream roll out. The utilities that succeed with smart grids will demonstrate three distinctive capabilities: the ability to lead collaborative networks, value propositions that engage consumers and innovation in using the breadth of new business data and information."

William D. Green, Chairman and Chief Executive Officer, Accenture

Over the last year, we have observed three broad trends within the smart grid industry:

- **The rise of smart grid as an industrial imperative** – Many governments are seeing smart grid and the broader low-carbon technology industry as critical to the evolution of their manufacturing and knowledge economy. In the East Asian economies, strategic investments are being made to develop intellectual property and manufacturing capabilities in this sector with a view to growing the export market globally.

- **The broadening of the smart grid concept to intelligent cities** – The debate has also notably shifted from being a discussion on pure "smart grids" and electricity infrastructure to include intelligent infrastructure, whereby the sensing and control capabilities inherent in the smart grid are applied to multiple physical infrastructure layers within the urban environment (e.g. water, waste, buildings, etc.).

- **The emergence of new entrants in the utility value chain** – We are beginning to see a new breed of industry participants, such as consumer products, telecoms and retail companies, explore their potential roles within the industry. We have not yet seen a significant disruption in the traditional business model; however, as the new entrants develop their understanding of the industry dynamics, we expect disruptive business models to emerge.

[2] "Smart Grid: China Leads Top Ten Countries in Smart Grid Federal Stimulus Investments, Zpryme Reports", Zpryme Research & Consulting press release, 27 January 2010, http://zpryme.com/news-room/smart-grid-china-leads-top-ten-countries-in-smart-grid-federal-stimulus-investments-zpryme-reports.html
[3] "Renewable Energy and Smart Grids Spurred by Economic Stimulus Act", EERE News, US Department of Energy, Energy Efficiency & Renewable Energy, 18 February 2009, http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=12244
[4] World Economic Forum Smart Grid Project Task Force & Steering Board (July 2010)

OPPORTUNITIES AND CHALLENGES

Our review of the first crop of pilots suggests that, while the industry has taken a significant step forward, there are clear opportunities to extract more insight and value from these investments. We see the following as the key challenges of today's smart grid pilots:

- The struggle to create strong smart grid business cases remains in environments where regulatory incentives have not evolved to reflect today's policy agenda
- Future legislation is uncertain and, in some cases, disaggregation of the utility value chain is increasing complexity; making it more difficult to align and allocate risk and reward
- Challenges remain around data privacy, cybersecurity, interoperability and standards
- There are examples of conflation of objectives, whereby new technologies and pricing structures are rolled out in parallel, making it difficult to understand cause and effect when customers react poorly to the change
- Pilots are encountering consumer engagement challenges, both in communicating effectively with the consumer and in delivering high-quality implementations in unpredictable field environments
- A number of smart metering pilots have struggled to convince the regulator and the consumer over the true benefit of their smart grid value propositions

In the context of the growing number of smart grid pilots, it is critical that we use this period of industry momentum to accelerate the technology development and develop the sustainable regulatory frameworks that will enable them to transition to the mainstream. By challenging the regulatory status quo at this stage, we will avoid the risk of becoming limited by the legacy frameworks to the "lowest common denominator" of smart grid.

Finally, for consumer-centric pilots it is critical that projects seek to engage and educate consumers at this point of inflection in order to generate buy-in and stimulate the necessary market demand. For smart grid to be economically and socially sustainable, customers will need to recognize the value that these technologies can provide and be willing to pay for the products and services on offer.

LESSONS LEARNED

Pilots serve a twofold purpose:

1. They provide a mechanism for utilities and their partners to innovate in a lowered risk environment and gather data proving the value of smart grid investments.
2. They help the utility to field-test new technologies and generate capabilities and insights that will support them in the successful full-scale roll-out of smart grids.

This year's publication is the output of a joint research effort between the World Economic Forum and Accenture with the input from the project Steering Board and Task Force members, who represent stakeholders from the entire smart grid value chain. It puts forward a number of recommendations to enable current and future pilots to reach their full potential. The research engaged utilities, vendors, communications companies, regulators, policy-makers and NGOs via workshops and one-on-one interviews. This study unearthed a number of "lessons learned" from the existing pilots, which we have broadly grouped into four sections:

1. Political and Regulatory Context

- **The right regulatory and policy framework for innovation and investment:** Regulators and policy-makers need to create the right environment for private sector investment in innovation and capital assets. In liberalized markets, this is further complicated by the disaggregated nature of the value chain. Regulators should pay close attention to the allocation of risk and reward across the value chain and develop regulatory frameworks that encourage investment and align incentives.
- **Drive for global standards:** Standards help provide market certainty and increase interoperability. However, if they are applied too early or are deemed too proprietary in nature, they can stifle innovation. Multiple regional standards are being developed with the consequent risk that we will see competing standards bodies. There is an opportunity to increase the level of international outreach and cooperation; increase the prevalence of open standards; and apply standards from other established industries, such as the Internet protocol and security standards, to help expedite their adoption.

2. Scoping Phase

Be clear about the test parameters and understand when customers will be engaged

- **Clarity and ambition in design:** It is essential that pilots invest in creating and documenting clear test parameters and hypotheses that they intend to prove, or disprove, through the implementation phase. We encourage utilities to trial holistic and ambitious smart grid pilots that demonstrate the value of the technologies within a broader system context. Designers should be mindful of the risk of conflating objectives and ensure that pilots are divided into sequential, yet iterative, phases examining technology, operating models and business models.
- **Grid vs consumer pilots' capabilities:** Most pilots will contain a mixture of consumer-facing and network-facing technologies. Consumer-facing pilots may confront additional challenges around consumer acceptance and behavioural change, where proactive consumer engagement programmes can play a critical role in securing the long-term success of a pilot. Each interaction with the customer can be critical to the longer-term success of the pilot.

Collaborate to develop commercial capability that trials new operating and business models

- **Successful commercial collaboration:** The creation of successful commercial consortia will become a point of competitive differentiation in the transition towards the low-carbon economy. Utilities will benefit from using pilots as a test bed to put in place the commercial and legal frameworks to bring these different capabilities together.

- **Experiment with new operating and business models:** Once technology is robust and interoperability is proven, there is an opportunity for pilots to help utilities understand what changes they will need to make to their operating and business models to maximize the value of new technologies.

Develop consumer insight

- **Segment consumers by behaviour:** In the planning stages we recommend that pilots undertake behavioural segmentation analysis, looking carefully at the three major groups: residential; small and medium enterprises; and commercial and industrial. By segmenting these customer groups, utilities and their partners can develop product and service offerings that meet the customer needs and create "pull" for smart grid offerings.

- **Target business customers:** Business customers are often more sensitive to price and open to innovative product and service offerings that help increase profitability. Furthermore, early adopters in the residential sector often take their cue from technologies that they are made aware of in the work environment.

3. Execution

- **Engage and educate consumers:** Consumer outreach programmes and ongoing product/service support are critical during pilots that directly impact the customer. Within these outreach programmes, utilities need to communicate messages in clear, common language; adopting new techniques, channels and incentive schemes to build trust and to explain the value proposition to consumers in their everyday lives.

- **Re-engineer in the field:** The most successful pilots encourage collective problem solving in the field, eliciting and responding to consumer feedback and ensuring the skills and flexibility are in place to successfully re-engineer improvements in technology and the business process. This is particularly important in consumer-facing pilots, where any lapse in performance has the potential for a long-term, detrimental impact on the consumer's perception of smart grid and their relationship with their energy provider.

4. Dissemination of the Lessons Learned

- **Share lessons from the field:** Today's knowledge exchange remains limited. The recent launch of the Department of Energy's beta version Smart Grid Information Clearinghouse[5] demonstrates the way forward; however, it remains focused on the US market. A larger, international data set with contextual data, such as customer demographics and network topology, may enable utilities to benchmark themselves more effectively and make stronger value cases.

- **Inform the regulatory/policy environment:** An opportunity exists for utilities to make the case for change in their own regulatory frameworks. Data and knowledge gleaned from the pilot programmes will provide empirical data that can be used to create policy and regulatory frameworks that align incentives and encourage private-sector investment.

Important Takeaways for All Stakeholders across Three Key Timescales

1. **Short term: Lay the foundations for success**

   a. **Policy-makers and Regulators –** Create the right conditions for innovation and certainty over funding and regulatory treatment while driving alignment on standards
   b. **Utilities and Partners –** Develop broad-based consortia, focus on creating a stable technology platform and engage consumers where they are likely to be personally affected

2. **Medium term: Reshape the agenda and roll-out proven technologies**

   a. **Policy-makers and Regulators –** Review the regulatory framework to align incentives and encourage private-sector investment
   b. **Utilities and Partners –** Use initial data to help shape the regulatory agenda; pilot changes to the operating model and processes; share data and use simulation to make the value case for roll-out of "proven" technologies

3. **Longer term: Change the model**

   a. **Policy-makers and Regulators –** Reward utility innovation and encourage participation of new entrants that may offer new business models
   b. **Utilities and Partners –** Position the value case for full-scale roll-out of technologies as the economics improve; innovate around the business model to offer customers greater value; and use behavioural segmentation data to target a greater proportion of customers with differentiated product and service offerings

[5] "Secretary Chu Announces More than $57 Million in Recovery Act Funding to Advance Smart Grid Development", Department of Energy press release, 20 July 2009, www.energy.gov/7670.htm

Structure of this Document

The following report is intended as a guide for policy-makers, regulators, utilities, vendors and other interested stakeholders, and provides pragmatic recommendations to accelerate the success of smart grid pilots and move the industry forward at pace.

The first section sets the context for the report and provides an introduction to smart grid and its benefits. This section explains three of the main industry trends of the past year and presents the case for focusing on the success of pilots.

The second section outlines some of the key challenges that we have encountered and focuses on potential actions that can be taken to make pilots more effective. It is organized into four sections:

1. Industry Context
2. Project Scoping
3. Project Execution
4. Exchange and Use of Project Learnings

Where possible, we have provided both data and case studies to demonstrate our findings. In the case of the major case studies, we have created separate call-out boxes to highlight the stories.

The third and final section describes some of the pivotal stakeholder dynamics that will influence the success of pilots, and provides specific recommendations for each of the key stakeholder groups.

1 The Current Smart Grid Landscape

1.1 Introduction of the Smart Grid Concept

The following section is organized into three key parts:

1. **Defining the smart grid and its benefits:** The smart grid is a complex technological solution to satisfy the present and future needs of the energy network and delivers benefits to all stakeholders within the utility value chain
2. **Smart grid industry trends:**
    - **Geographically differentiated smart grid development strategies** – There has been an emergence of multiple smart grid development strategies, driven by different regulatory regimes, legacy infrastructures and economic growth priorities.
    - **The broadening of the smart grid concept to intelligent cities** – The debate has notably shifted, particularly in Europe, from a discussion on pure smart grids and energy infrastructure to a broader conversation on intelligent infrastructure and intelligent cities.
    - **The emergence of new entrants in the utility value chain** – Non-utility companies are beginning to develop innovative smart grid capabilities and invest in joining pilot consortia. New entrants provide both competition and opportunity to the existing members of the utility value chain.
3. **The importance of getting pilots right now:** It is crucial to ensure that the public money being invested in smart grid pilots in the coming one to two years is spent appropriately and effectively to realize the true transformational value of smart grid.

WHAT IS A SMART GRID?

According to the International Energy Agency (IEA), approximately US$ 13 trillion of investment will be needed to upgrade electrical infrastructure worldwide by 2030[6].

Our energy networks were originally designed in an era of low-cost, plentiful energy that is no longer valid today. The power sector needs to continue to supply energy in an increasingly carbon-constrained world, and governments are facing growing energy security concerns. Globally, we are now at a point of inflection where clean energy will be at a premium, networks will need to be flexible to allow for the incorporation of new low-carbon technologies and customers will want increasing visibility and control of their energy consumption.

The technology innovations of the last 10 years and the increasing prevalence of ubiquitous communications networks (as an example, the number of mobile phone subscribers is expected to reach five billion this year[7]) present a unique opportunity to coalesce advancements in power engineering, IT and communications to our energy infrastructure and create a "smart grid" – an energy grid with embedded sensing, control and automation, supported by two-way communications.

This transition from an analogue to a digital infrastructure in the utility sector is akin to the industry transitions we experienced in the banking and telecommunications industries 10-15 years ago. A smart grid will allow for greater transparency, drive efficiency and reliability, greater access and choice to consumers; and provide the network flexibility required to support our transition to a low-carbon economy.

A "smart grid" is a digital, self-healing energy system that delivers electricity or gas from generation sources, including distributed renewable, to points of consumption. It is capable of optimizing power delivery and facilitating two-way communication across the grid, enabling end-user energy management, minimizing power disruptions and transporting only the required amount of power. The result is lower cost to the utility and the customer, more reliable power and reduced carbon emissions.

In addition to noting the benefits, it is worth recognizing the potential impact of delayed action. The increasing prevalence of renewables, distributed generation, electrified heating and electric vehicles (EVs) have the potential to put the stability of the energy system at risk. In 2009, for the second year in a row, both the US and Europe added more power capacity from renewable sources such as wind and solar than conventional sources like coal, gas and nuclear[8]; however a recent *MIT Technology Review* concluded, "without a radically expanded and smarter electrical grid, wind and solar will remain niche power sources."[9]

[6] "Power firms expecting global nuclear revival", Professional Engineering, 27 April 2005, via Factiva, ©2005, Institution of Mechanical Engineers
[7] "ITU sees 5 billion mobile subscriptions globally in 2010", International Telecommunication Union press release, February 15, 2010, www.itu.int/net/pressoffice/press_releases/2010/06.aspx
[8] "Reports detail global investment and other trends in green energy", Energy Weekly News, 30 July 2010, via Factiva, ©2010 Energy Weekly News via VerticalNews.com
[9] Talbot, David "Lifeline for Renewable Power", MIT Technology Review, January/February 2009

Even at relatively low penetration levels, these technologies could increase the risk of outages. This is particularly pertinent as the IEA has recommended that, in order to ramp-up the EV market share to 50% by 2050, the sales of EVs and plug-in hybrids need to reach at least five million globally by 2020. By acting now, decision-makers can avoid having the electricity infrastructure become a bottleneck to delivering a lower-carbon future.

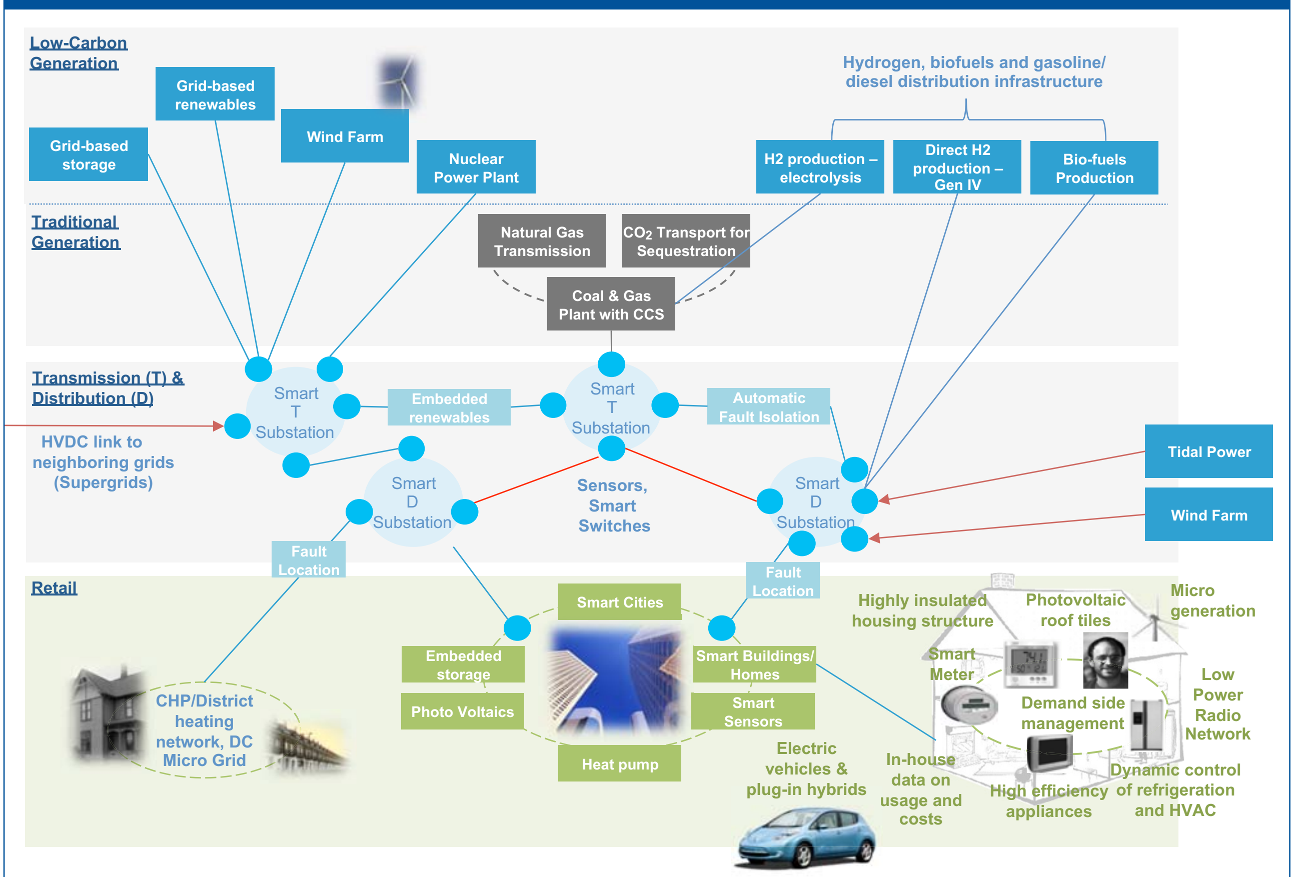
It is important, when defining smart grid, to understand the relative role of smart meters, as the two terms are sometimes, incorrectly, referred to synonymously. Smart meters are a subset of the broader suite of smart grid capabilities. They enable consumers to understand their energy consumption while reporting back operational and asset management data to the utility. This two-way flow of information enables consumers to become part of the broader smart energy system. It provides the opportunity to offer dynamic pricing and demand response, which are useful tools for managing load profiles and decreasing overall energy consumption.

THE KEY BENEFITS OF SMART GRID

The benefits of smart grid include:

- Delivering energy more efficiently and reliably
- Providing the capacity to integrate more renewable energy into existing networks
- Providing the ability to manage increasing numbers of electric vehicles

Figure 1: The Smart Grid Definition



- Enabling customers to have greater control of their energy
- Providing a considerable capacity to reduce global carbon emissions
- Stimulating an array of new business models in the energy sector

The end-to-end smart grid solution operates across the utility value chain, and the benefits realized are contingent on the stakeholders' perspective (see Table 1):

1.2 Recent Smart Grid Industry Trends

GLOBAL SMART GRID DEVELOPMENT STRATEGIES

Over the past 12 months, it has become increasing evident that different smart grid strategies are being developed globally. The drivers of this differentiation come from a variance in regulatory regimes, legacy infrastructures and economic growth priorities. Table 2 details the smart grid development strategies globally, reflecting a continued resonance of the "one size does not fit all" concept defined in the 2009 World Economic Forum *Accelerating Smart Grid Investments* report.

Perhaps most notable in these approaches to smart grid is the rise in the number of South Korean and Japanese consumer electronics companies investing in international smart grid pilot programmes, where fiscal stimulus and regulatory frameworks are sometimes more favourable than their domestic market. It is also an opportunity to showcase their high-tech product in North American and European markets supporting a long-term strategy to develop smart grid intellectual property for global export.

Table 1: Smart Grid Benefits by Stakeholder

Government and Regulators	Utilities
1. Opportunity for GDP uplift and green-collar job creation 2. Effective carbon abatement investment option 3. Security and reliability of energy supply improved 4. Creation of low-carbon regulatory frameworks accelerated 5. Spending efficiency increased by providing options to rationalize national infrastructure investments	1. Wider portfolio of generation options 2. Grid efficiency, reliability and understanding of power flows increased enabling operational/maintenance savings 3. Opportunity to transition from a commodity provider to a service provider 4. Creation of new revenue channels and ways to improve customer service 5. Opportunity to evolve the operating model and lower operating costs
Vendor	**Consumers**
1. Opportunity to collaborate with other participants in the value chain to gain market access 2. Opportunity to create new products and services to take to market e.g. further broadband business development for telecom operators 3. Ability to improve understanding of consumer behavior 4. Cost of delivery reduced through mass deployments 5. Opportunity for a machine-to-machine platform that can service multiple industries	1. Greater choice between energy providers, products and services 2. Greater transparency and control over energy consumption 3. Opportunity to see environmental benefits on a household/business basis 4. Access to clean technologies, such as electric vehicles and micro-generation 5. Provision of a more reliable service with potential energy bill and carbon savings

Table 2: Global Smart Grid Development Strategies

	Low-Carbon Agenda	Improving Consumer Experience	National Export Strategy	Fast Growth Infrastructure
Examples	UK, Germany, Australia	United States	South Korea, Japan, UAE, Singapore	China, India, Brazil, Kenya
Local Industry Drivers	Strong commitment to carbon pollution reduction Integrate with other initiatives – intelligent city, electric vehicles, renewables, transnational supergrid, broadband roll-out Facilitate competitive energy retail markets Empower and inform consumers	Improve supply reliability, quality, grid resilience and peak load reductions Diversify energy dependencies and secure energy supply Integrate with other initiatives – smart city, electric vehicles, renewables Empower and inform customers	Development of an industrial complex to export smart grid technologies and solutions globally Green economic growth agenda Integrate with other initiatives – intelligent city, electric vehicles, renewables, transnational supergrid, broadband rollout	Fast build out of infrastructure to keep pace with urbanization and economic growth rates Improvement in supply reliability, power quality and grid resilience Reduction of system losses, especially for long distance transmission, theft and long-term energy cost
Market Model	Liberalized market	Vertically-integrated	State-owned monopoly	State-owned monopoly
Regulatory Incentives for Smart Grid Pilots	Smart grid regulatory competition funds and standard development funds Innovation funding Mandated smart meter rollouts, renewables and energy efficiency targets, reliability incentives, feed-in tariffs 2010 smart grid investment[10]: - Germany US$ 397 million - Australia US$ 360 million - UK US$ 290 million	Fiscal stimulus packages including investment for up-skilling workforce Less money available for R&D Standard development NIST funding 2010 smart grid investment: - US US$ 7 billion	International knowledge sharing programmes, e.g. the Korea-Illinois Smart Grid Collaboration Program[11] National smart grid roadmaps Smart city new builds, e.g. Songdo, Masdar 2010 smart grid investment: - Japan US$ 849 million - S. Korea US$ 824 million	Global financial institution funding e.g. US$330 million World Bank grant to increase electricity access and green energy in Kenya[12] Power sector transformation roadmaps e.g. India Strong synergies with accelerated telecommunications growth 2010 Smart Grid investment: - Brazil US$ 204 million - China US$ 7.3 billion
IP Development Focus	• Integration of large-scale renewables and distributed generation • Open metering standards • Innovative product/service development	• Software and data architectures • Transmission and distribution solutions • Electric vehicles	• Transmission and distribution solutions • Storage technology • Electric vehicles	• Large-scale renewables • High voltage transmission networks
Smart Grid Maturity	Medium	Medium	Low-Medium	Low
Local Industry Challenges	Current market models do not incentivize all value chain players to invest in smart grid	Some examples of poor execution in early smart metering pilots have increased regulator's sensitivity	Domestic regulatory markets may not be strongly conducive limiting ability to develop innovation in a local context	Capital constraints in some developing countries and the scale of development required

[10] "Smart Grid: China Leads Top Ten Countries in Smart Grid Federal Stimulus Investments, Zpryme Reports", Zpryme Research & Consulting press release, January 2010, http://zpryme.com/news-room/smart-grid-china-leads-top-ten-countries-in-smart-grid-federal-stimulus-investments-zpryme-reports.html
[11] "BOMA/Chicago to Lead Commercial Smart Grid Pilot Program through Illinois-Korea Collaboration", Penton Insight, 27 July 2010, via Factiva, ©2010 Penton Business Media
[12] "World Bank Approves US$ 330 Million to Expand Electricity Access to Kenyans", World Bank press release, 27 May 2010, http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22595378~pagePK:64257043~piPK:437376~theSitePK:4607,00.html?cid=3001_2

THE BROADER SMART GRID CONCEPT

The smart grid concept is evolving. A few years ago, the majority of the industry concentrated upon the development of consumer-centric technologies, predominantly automated meter reading (AMR) and advanced metering infrastructure (AMI). At the time, much of the focus was for the utilities' benefit, using advanced communications to eliminate manual meter reading and to enable the provision of timelier interval data. Within the last two years, there has been growing policy and regulatory pressure for networks to deliver operational efficiencies and help manage security of supply while also supporting the transition to a low-carbon energy system.

In response, there has been a move towards a much broader smart grid concept, which includes the optimization of the utility supply chain from point of generation to consumption. In the last 12 months, we have seen the discussion expand further to a smart energy system, which also takes into account all the players, both traditional and new, in the utility value chain; the integration of non-energy devices (consumer fuel cells or mobile phone applications); and the new business operations and services created to support the requirements of long-term, end-to-end smart energy solutions.

The rise of the intelligent city
The smart energy system sits within the broader vision of intelligent infrastructure and intelligent cities. Smart grid trials inevitably need to be trialled in the context of dense urban archetypes. With the digitization of the energy network, there are clear economies of scale and scope for the sensor networks and data analytics to be applied to multiple infrastructure layers within urban environments, such as the water and waste networks, transport networks, etc.

This coincides with an increasing demand from cities for solutions to enable sustainable carbon reductions, operational savings and service quality improvements for residents and the businesses located within cities. The smart energy system operating within the context of an intelligent city environment presents a number of knock-on effects:

- **New funding channels** – Due to their scale, cities can offer additional channels from which to secure smart grid project funding, including public-private partnerships and potential future green bond markets that are able to finance sustainability projects in the public/private arena.

- **Optimal testing and innovation ecosystems** – The radial environment of the city provides an ideal testing ground, supporting the requirements of delivery for many smart grid projects such as Amsterdam Smart City. Cities provide scale as well as offering an ideal foundation of people and services with which to test the broader capabilities enabled by smart grid, e.g. electric vehicles and widespread distributed generation. Additionally, new city builds, for example in Songdo in South Korea, provide a unique opportunity for smart grid solutions to be tested away from the traditional retrofit environment, encouraging much-needed smart grid innovation.

- **Increases in complexity of interactions** – As the scope of the smart grid landscape widens, there will inevitably be an increasing number of stakeholder relationships to manage, including local governments, who will play a central role in any intelligent city smart grid consortium.

- **Alters the scope of security issues** – These above factors, in turn, alter the perimeter of security that value chain actors will need to secure with respect to data privacy and data security.

EMERGENCE OF NEW ENTRANTS

Traditionally, utilities concentrated on optimizing themselves as predominately commodity-focused businesses, fairly single-mindedly focused on the cost-efficient, reliable provision of energy. The new smart energy system will require a greater set of capabilities that will allow smart technologies to fulfil their true potential. The influx of consumer and network data from smart grid will require capabilities in data management, customer relationship management, analytics, etc.

"Information and Communications Technology (ICT) is an enabler to accelerate smart grid. The collaboration between energy and ICT industries will not only improve the efficiency of smart grid deployment, but also generate new opportunities for ICT. Mutual understanding and elimination of knowledge barriers are the prerequisite for this collaboration; ICT players should continue innovation to support smart grid. The synergy of the two industries will make a big difference in people's lives, and ultimately help to create a greener and smarter world around us."

Ken Hu, Board Member, Executive Vice-President and Chief Marketing Officer, Huawei Technologies, People's Republic of China

Telecommunications, network and consumer-centric companies have started entering the utility market, developing new and innovative smart grid capabilities and investing in joining pilot consortia. New entrants provide both competition and opportunity to the existing members of the value chain. In the competitive retail sector, there is the potential for specialist new entrants to offer new energy management products and services to consumers.

The integral role of communications in smart grid (the communications typically represent a significant contribution to the capex and opex) means that telecommunication and network companies will likely play a significantly increasing role in the smart grid value chain. Consequently, over time there is likely to be a disruptive effect as new and existing entrants compete for the new value pools emerging.

1.3 The Importance of Getting Pilots Right Now

ARE PILOTS FINDING SUCCESS?

There are approximately 90 smart grid pilots in implementation around the world today[13]. The vast majority of these pilots are focused on AMI. Geographically, we see a concentration of pilots in North America, Europe and Australia, although there is increasing activity within South America, South Africa and Asia. The smart grid industry is expected to continue to grow, with 77% of industry respondents to a recent Microsoft survey expecting their budgets for smart grid technologies to increase over the next two to three years[14].

Our review of the first wave of pilots suggests that, while the industry has taken a significant step forward, it still faces a number of challenges that prevent the pilots from reaching their full potential:

- The challenge of creating strong smart grid business cases remains in environments where regulatory incentives are not reflective of the current policy agenda
- Future legislation is uncertain and, in some cases, disaggregation of the utility value chain is increasing complexity, making it more difficult to align and allocate risk and reward
- Challenges remain around data privacy, security, interoperability and standards
- There are examples of conflation of objectives, whereby new technologies and pricing structures are rolled out in parallel and multiple variables lead to confusion over the pilot's results
- Pilots are encountering issues around consumer engagement, where questions remain over how compelling their value propositions are and the quality of the customer interaction in the field
- A number of smart metering pilots have found difficulty in convincing the regulator and the consumer over the true benefit of their value propositions (see Case Study 1)

[13] World Economic Forum Smart Grid Project Task Force & Steering Board (July 2010)
[14] "Smart Grid Revolution Becomes 'Disruptive' for Utilities Worldwide According to New Microsoft Survey", Microsoft press release, 10 March 2010, www.microsoft.com/presspass/press/2010/mar10/03-11smartgridpr.mspx

Case Study 1: Regulators Question US Smart Metering Pilots

In 2009, amid Pacific Gas and Electric's (PG&E) US$ 2.2 billion, 10-million smart meter deployment, a class action lawsuit was taken out against the company in Bakersfield, California, USA, over concerns of smart meters overcharging customers. The lawsuit is based on claims that individuals' average bills jumped from "about US$ 200 a month to about US$ 500 to US$ 600 a month" after they received a smart meter. In October 2010, the California Public Utilities Commission asked PG&E to obtain an independent third-party technical expert to test and validate meter and billing accuracy of smart meters currently being deployed in Bakersfield[15].

In June 2010, Baltimore Gas and Electric planned to roll out smart meters and time of use (TOU) tariffs were rejected by Maryland Public Service Commission (PSC). The PSC criticized BGE's proposal because it "contains no concrete, detailed customer education plans, includes no orbs or other in-home displays, and provides grossly inadequate messaging, in our view, to trigger the behaviour changes" it contemplates.

The commission also expressed predictable concerns that the TOU did not adequately protect the company's "most vulnerable customers, such as low-income households, elderly customers, customers with medical needs for electricity that cannot be shifted to off-peak hours or other customers who are stay-at-home." BGE filed an amended proposal, highlighting that BGE could lose US$ 200 million in federal stimulus grants to help pay for the effort if the proposal was not approved [16]. The PSC granted conditional approval to the amended proposal in August 2010.

Although the first wave of pilots has been broadly consumer-centric, whether by choice or mandate, with some receiving negative reactions from the public, others have produced good results; in particular, those pilots that have invested significant effort in consumer engagement activities or those that have erred towards grid-centric solutions. For example, in SmartGridCity in Boulder, Colorado, USA, the grid-centric smart grid solutions have produced a 90% reduction in reactive power outages and voltage complaints and up to a 5% reduction in power demands [17].

In conclusion, it seems that, although some pilots are on the right track and are going some way to producing the data/lessons required to reach scale deployment, the majority still face a number of barriers that are reducing their ability to achieve their full potential.

THE IMPORTANCE OF GETTING PILOTS RIGHT NOW

It is important to ensure that the public money being invested in smart grid pilots is spent appropriately and effectively to realize the true value of the investments being made. The availability of fiscal stimulus is likely to be temporary and it is therefore important that money be used to accelerate smart grid to a sustainable economic model. As it stands, only 8% of utilities believe they have a technology architecture that is adequate to support new smart grid business processes and new technologies[18].

There is a risk that without sufficient dialogue between industry, regulators and policy-makers, the full value of the smart grid will not be successfully articulated to key decision-makers. Duplication of testing parameters will also be more likely, resulting in wasted time, money and effort.

It is possible to see a situation where there is a roll-out of the lowest-common-denominator functionality of smart grid. Although we may get to this destination faster, by not building in the true network flexibility that is required to integrate the broader suite of low-carbon technologies, this may act as an overarching brake on the transition to a low-carbon economy.

In the worst case, if we fail to engage consumers appropriately at this early stage in the process, we may end up in a situation where the prevailing public view of smart grid is skewed by a small number of cases where poor execution has led to a broader perception that smart grid is not delivering value to the consumer.

[15] "'Smart meter' lawsuit prompts accelerated Calif. Probe", Greenwire, 24 November 2009, via Factiva, ©2009 E&E Publishing LLC9
[16] "BGE tries again on 'smart meter' technology: New proposal to regulators comes after June rejection by Maryland Public Service Commission", The Baltimore Sun, 13 July 2010, via Factiva, Distributed by McClatchy - Tribune Information Services
[17] Xcel set to start SmartGridCity in-home testing", Boulder County Business Report, 19 March 2010, via Factiva, ©2010 Boulder County Business Report. "Two Way Centralized Volt/VAR Control and Dynamic Voltage Optimization", Xcel Energy/Current Group joint presentation, DistribuTech, 2010
[18] Smart Grid Revolution Becomes 'Disruptive' for Utilities Worldwide According to New Microsoft Survey", Microsoft press release, 10 March 2010, www.microsoft.com/presspass/press/2010/mar10/03-11smartgridpr.mspx

2 Introducing the Smart Grid Pilot Framework

The piloting challenges identified during the research phase of this report were seen as very different depending on the stage of the pilot life cycle. Therefore, the report has been structured to reflect pilot challenges and potential solutions across each stage of pilot life cycle.

Figure 2 below presents the pilot life cycle in four broad categories and how they have been categorized within this report – sections 3.1 to 3.4 – and gives a graphical representation of how these categories all contribute to informing the mainstream roll-out of smart grid.

2.1 Industry Context

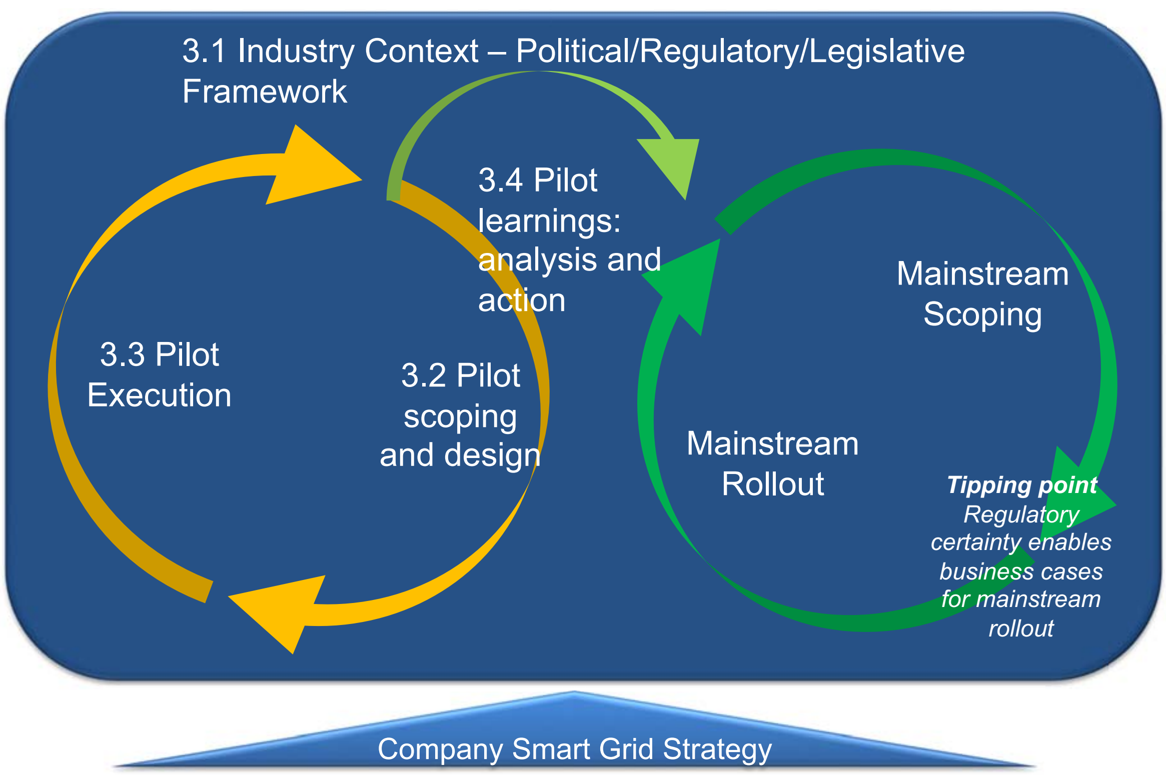
The last few years have seen a significant shift in priorities for energy policy-makers around the world. With the advent of concerns around climate change and the low-carbon agenda, the policy landscape has become more complex as politicians try to balance carbon targets, security of supply and consumer imperatives (e.g. energy cost, reliability and quality). While politicians reassess the policy frameworks and priorities that govern energy policy and wrestle with the legislative changes that are required at the national and transnational level, the industry and regulators remain in limbo.

The same change that is vexing the political establishment creates challenges for regulators that are required to translate policy ambitions into regulatory frameworks. The regulatory frameworks that currently exist are legacies of the policy priorities of the 1990s and, as such, are not tuned to the changing needs of the low-carbon economy.

The current patchwork of regulatory constructs reflects the diversity of political and economic imperatives. As such, it is impossible to provide blanket solutions to the question: "What needs to change to improve the environment for smart grid investments?" However, there are certain developments that we have observed that target known challenges and may provide a route forward for the next evolution of economic regulation.

At an industry level, we see a number of initiatives underway to organize the industry around the key challenges of standards, interoperability, data privacy and security. While some of these fall under the mandate of public policy and regulation, there is a broader self-regulating push from industry participants to create industry solutions to industry problems. In this section of the document, we highlight some of the initiatives that are underway and make recommendations for reinforcement.

Figure 2: Pilot and Mainstream Roll-out Life Cycle – Providing the Structure for Section 3



Several findings from the early pilots warrant consideration as they point to industry-wide developments that will be required to accelerate smart grid adoption:

- Create a clear political mandate – A clear political mandate to transition to a smart grid sets the foundation for investment and the parameters for regulation.
- Create a conducive regulatory environment – The regulatory environment must reflect the policy ambitions and create the right incentives for private sector participation and innovation across the value chain while protecting consumers and balancing broader policy objectives.
- Accelerate the roll-out of interoperability and standards – A number of initiatives have been underway to drive more rapidly towards standards that will improve interoperability and reduce the total cost of ownership of solutions. Where these standards exist, they should become embedded within the design of the pilot to keep costs down.
- Provide assurance on data privacy and security issues – Pilots should adopt emerging best practices in relation to data privacy and security. Breaches of data privacy and security can have a catastrophic impact on pilots. Protocols exist within the smart grid industry and in adjacent industries that can and should be applied as a matter of course.
- Adequate training and re-skilling opportunities – Existing pilots have demonstrated the need to critically assess the capabilities that are needed within the utility workforce to design, build and operate a smart grid. At an industry level, there is a need to build a pipeline of graduates and trainees that will be able to operate in this new mode while the existing workforce is re-skilled to adapt to the new environment.

2.1.1 Create a Clear Political Mandate for Action

Over the last few years, the energy policy landscape has transitioned to a position where low-carbon considerations are starting to find an equal footing with issues of security of supply, liberalization, price and reliability. The balance of priorities will differ by country or even by city/state, dependent on the local legacy and political agenda.

From the perspective of utilities and other industry participants, it is important that there is a clear strategic direction or mandate, as well as clarity over the outcomes that are valued and guidance on how to deal with the inevitable trade-offs inherent in investment decision-making, where capital is constrained. This point is manifest in the Eurelectric CEO Declaration[19] that calls on policy-makers to provide clear direction on a number of topics relating to the smart grid.

In some cases, there are hard targets that have been set and these should be clearly articulated to the industry and embedded within the regulatory contract. For instance, EU member states are committed to contributing to an overall 20% reduction in EU energy consumption and to have renewables contributing 20% of EU energy production by 2020[20]. These targets should relate to both the desired outputs from the network and the projected integration of low-carbon technologies.

By providing long-term signals on policy towards electric vehicles, electrification of heating, distributed generation and renewable generation, the industry will be able to understand the potential for discontinuities in their networks and design pilots that target the challenges they are likely to face.

It is important to note that policy interventions and targets can have significant and sometimes unexpected results for the utility companies. In the case of Germany, for example, the introduction of solar feed-in-tariffs had a rapid impact on investment in solar technologies and created challenges for the distribution network operators that had not anticipated the change. Consequently, a US$ 125 billion investment in solar has delivered only 0.25% of national energy requirements[21].

Simple statements of political commitment go a long way towards encouraging private sector action. Cross-party consensus on the importance of smart grids allows regulators to design frameworks with longevity. Hence, they encourage companies to invest with confidence that they will be able to recoup their investments if they deliver on the targets that have been agreed. In some cases, such as India and the United Kingdom[22], the government has developed clear transformation roadmaps for smart grid that give broad direction but are not prescriptive on timings and specific technologies.

[19] A Declaration by European Electricity Sector Chief Executives, Eurelectric, www.eurelectric.org/CEO/CEODeclaration.asp
[20] The EU climate and energy package, European Union, http://ec.europa.eu/environment/climat/climate_action.htm
[21] "A Green Retreat; Why the environment is no longer a surefire political winner", Newsweek International, 19 July 2010, via Factiva, ©2010 Newsweek Inc.
[22] "A Smart Grid Routemap", Electricity Networks Strategy Group (ENSG), February 2010, ©Crown copyright, www.ensg.gov.uk/assets/ensg_routemap_final.pdf

Case Study 2: Transformation Roadmap for the Power Sector – India[23]

Overview
In India, the Ministry of Power has set out a transformation roadmap for the power sector over the next 15 years that provides a clear direction for future investment and development for industry stakeholders.

Restructured Accelerated Power Development and Reforms Program (R-APDRP)
This programme incorporates Phase One and Two of the transformation roadmap. Initially, Phase One addresses concerns such as transmission and distribution losses, and lack of transparency and accountability. Phase Two, from year three to five, is expected to address issues around operational efficiency, customer service excellence and automated control.

Smart Grid Implementations
Phase 3 – the final phase of the roadmap running from years five to 15 – focuses on the development of a number of initiatives to support smart grid development, including the formation of a Smart Grid Task Force and smart grid piloting (including 50-75% funding grants from R-APDRP, with the balance being met by the respective state, distribution company or technology provider).

Finally, in some countries/states there are legislative barriers to implementing smart grids (e.g. the ability to execute remote connection and disconnection, or constraints to the ability to offer time of use tariffs). It is imperative that policy-makers and legislators collaborate with industry to understand where these barriers exist and work to legislate accordingly.

2.1.2 Create a Conducive Regulatory Environment

Most of the regulatory regimes that currently exist were created during the period preceding the emergence of the low-carbon agenda with the focus on universal, low-cost and reliable service. In some cases, we have seen regulators taking bold steps to redefine their role in light of the changing policy landscape (see Case Study 2).

Although many aspects of the regulatory frameworks are still valid, some actively discourage the changes that are needed to transition the network towards a smart grid. For instance, many regulatory frameworks still measure a utility's expected earnings based on the volume of electricity consumed despite mandating energy conservation. However, in those markets where regulators have factored in the cost of carbon or outages, such as in the United Kingdom or Australia, we have seen an increased focus on smart grid solutions.

The level of change that is needed requires innovation, research and development and the ability to form new partnerships that will transform the network from the analogue to the digital arena. Once policy-makers have delivered the mandate to change, regulators need to rapidly adapt the economic framework and industry structure to support the transition. For example, in California, a "decoupling" policy was introduced to ensure that utilities retain their expected earnings while energy efficiency programmes reduce energy sales. Under decoupling, California's per capita energy consumption has remained stable over the last 30 years, while it has surged by 50% in the rest of the country[24].

Align incentives across the value chain
In those countries where we have seen market liberalization and the consequent disaggregation of the value chain, additional regulatory challenges arise. In these cases, the incentives for generation, transmission, distribution and retail participants differ and are a function of the legal and economic frameworks that were put in place to encourage competition and market efficiency. With the introduction of smart technologies, the investment requirements, risk and reward distribution and incentives change.

Without regulatory intervention to actively understand the incentives, motives and risk/reward balance, the industry will, at best, proceed with a significant change in the distribution of profits across the value chain or will become paralysed by market participants that stand to lose out and obstruct the process in the interests of their shareholders.

[23] World Economic Forum Smart Grid Task Force Member, HCL Technologies; Distribution Overview, Ministry of Power, Government of India, www.powermin.nic.in/distribution/distribution_overview.htm.; "Union Power Minister Launches India Smart Grid Forum; Sam Pitroda to Chair Smart Grid Task Force", Press Information Bureau press release, Government of India, May 26, 2010, http://pib.nic.in/release/release.asp?relid=62128routemap_final.pdf
[24] "California PUC approves $3.1 billion for utility energy-efficiency programs", Gas Daily, 25 September 2009, via Factiva, ©McGraw-Hill Inc.

In many cases, it is the generation end of the value chain that is most at risk, as the assets are long lived and relatively inflexible in their operating modes. If smart technologies are introduced that fundamentally change the demand profile, the impact on the generation portfolio will be significant. This risk may prevent investors from investing in new capacity to replace existing, ageing or polluting plants. Regulators can address this through changes to the regulatory construct, but it requires active management and targeted intervention.

The same principles apply to allocation of risk and reward in relation to the smart grid investments themselves. The regulators should play close attention to how and where the risks are managed and how risk and reward are passed on to the consumer throughout the process.

Give "permission to fail" and create incentives to develop valuable intellectual property
Pilots are inherently risky activities: new technologies, operating models and business models are tried and tested and, as part of the learning process, some will fail. Utilities and their partners need to be given "permission to fail". Under many regulatory frameworks, this is entirely counter-cultural. For example, some utilities face the possibility of retroactive disallowance of their capital investments. This can act as a powerful barrier to innovation since the utility loses the capital invested.

However, when an innovation is successful, the utility's return is capped at a rate of return: utilities earn the same return on investing in a piece of steel as a smart grid, despite the fact that it requires much more effort and risk. Utilities work tirelessly to manage down risk to protect shareholders' interests. Without clear innovation incentive mechanisms, it is difficult for utilities to take calculated risks without being constrained by the fear of failure.

Regulators have a critical role to play in creating innovation reward schemes that encourage utilities and their partners to develop new technology architectures, operating models and business models. In designing these schemes, it is critical that they offer upside to the innovators to allow them to benefit from the intellectual property that they are developing, while encouraging the best practices to be shared and adopted elsewhere.

For this scheme to work, both the regulator and the utility should have a stake in the risk and have the opportunity to achieve a return based on the level of risk that they are taking on. In some more extreme cases, regulators may go as far as to offer these incentives to non-utility consortia and grant leases to operate ring-fenced sections of the incumbent utilities network.

Case Study 3: Driving Innovation through Regulation – Ofgem[25]

Overview
The existing utilities regulatory landscape of Great Britain (GB) is a legacy of the processes of privatization and liberalization that started two decades ago. Controlled by the regulator – Ofgem – the GB utilities regulatory framework has evolved over the last 20 years through a series of five-year long price control reviews to address the most pressing needs of the industry over time.

Encouraging a shift in strategic priorities
Within the most recent price control review, Ofgem will publish a comparative carbon footprint performance league table for distribution network operators (DNOs). In addition, DNOs are being encouraged to ready themselves for a low-carbon future with Ofgem announcing a £500 million Low Carbon Network Fund (LCNF), which will provide up to 90% of the capital required to pilot and trial new low-carbon technologies.

Participants in the scheme will be allowed to benefit financially from the intellectual property that is generated in proportion to the risk capital they have put at stake. To reflect this transition in objectives towards a low-carbon future, Ofgem has separated its organization into two parts: one side continues to focus on regulation of the industry and the other on supporting the industry transition to a low-carbon future. This reflects a broader policy shift within GB energy policy.

Stimulating innovation
LCNF funding will be available to everyone including new market entrants or vendors. If new entrants or vendors present a compelling bid without a recognized DNO or energy supplier being involved in the consortium, Ofgem may require the incumbent DNO to lease a localized area of the network on which testing can take place. Furthermore, Ofgem has held back £100 million of the total fund to be awarded to participating consortia to recognize schemes that have brought particularly valuable learning and innovation to the industry.

Supporting the transition to the low-carbon economy
RPI-X@20 was a two-year project to establish a new GB regulatory framework with the objectives of: addressing the challenges of meeting new social and environmental objectives; aiding the transition to a low-carbon economy; and ensuring a secure energy supply. The

[25] Steve Smith, Managing Director of Markets and a Member of the Gas and Electricity Markets Authority, Ofgem (Interview June 2010)

new framework will establish a larger cross-network innovation fund, available for any value chain participant, to encourage investment in low carbon technologies. Other key changes in the new framework are:

- Create an outcome-based regulation that links opex and capex allowances to outcomes achieved on network reliability, safety, environmental targets, customer satisfaction and social objectives
- To encourage longer term investments and greater innovation in the way network services and access arrangements are designed and priced
- To encourage network companies to collaborate with third parties (in order to develop commercial business models that deliver low carbon, safe and secure energy services)
- To enable market testing of large new network infrastructure projects where there is substantial scope for innovation, allowing other companies to compete with the incumbent to build new infrastructure

Provide clarity on funding and how those funds will be treated in the regulatory contract
During the early stages of the American Recovery and Reinvestment Act programme in the United States, there were delays in the take-up of the funding offered as utilities sought to understand the future regulatory and tax accounting treatment of the investments. This is just one example of the impact resulting from any ambiguity on how investments will be treated in both the short and long term. Where there is a distinction between the funding agency and the regulator, it is critical that the two are aligned on treatment prior to the request for proposal process so there are minimal delays in the process.

A number of specific challenges have become evident during the early pilot funding programmes:

- Clarity on regulatory accounting treatment – this includes tax treatment, depreciation policy and the longer-term inclusion within the regulatory asset base
- Treatment of intellectual property – Consortia will need to understand how IP will be treated, especially clarity on the distinction between existing and "new" IP
- Technical policies – Regulators/policy-makers also need to be clear regarding:
  - Rules around feed-in tariffs and when one is on and off grid
  - Safety rules for integration of distributed sources and automatic switching
- Treatment of bid costs – Utilities may be dissuaded from bidding if they are not able to recover the costs of pulling together a proposal and the advisory costs that are often associated with bids
- Non-regulated funding sources for pilots – as competition funds will not fund all smart grid pilots, consortia often seek private-sector investment. However, many smart grid pilot business cases cannot generate a guaranteed return on investment for private sector businesses. In these cases, public-private partnerships may be required to carry some of the investment risk, e.g. having been unable to secure significant fiscal funding for their smart grid proposal, Los Alamos Laboratories and PNM collaborated with NEDO – Japan's New Energy and Industrial Technology Development Organization – for funding[26].

Case Study 4: Business Model Innovation in Energy Retail – Yello Strom[27]

Overview
Yello Strom was founded in 1999 and is a 100% subsidiary of Energie Baden-Württemberg (EnBW). Within the deregulated marketplace, German customers can switch between competing utilities which, in turn, leads to more focus on customer value propositions and innovation. Yello Strom currently has over 1.3 million residential customers and is considered an energy retail market pioneer.

Creating a winning business model
Yello Strom found that meters on the market only focused on creating energy efficiency from a utility perspective. They created the Yello Sparzähler - an online, user-friendly smart electricity meter that uses existing market standards. The meter provides access to an online monitoring tool and to the Yello website, where customers can find their personal overview of their consumption data and power bill. In addition, customers can connect for free to the Google Powermeter, another online tool for energy monitoring. Several North American utilities provide these capabilities too; however, unlike utilities that are rolling out meters for free (or at a small monthly charge), Yello Strom's business model depends on customers buying its products and therefore must have a strong customer value proposition.

Customers can either rent the device from US$ 5.60 to US$ 11.24 per month, dependent upon a customer's package of services and functions, or buy the device when purchasing a new house. Yello Strom believes that because people are consciously making the choice to invest in the Yello Sparzähler they will create a bigger impact in changing their energy consumption patterns.

Open platforms are critical to sustaining business model innovation
Yello Strom is also one of the only utilities basing its Smart Meter service around the consumer broadband connection, with the advantages of making data available faster to the consumer without having to build a network. Critically, it enables Yello Strom to easily add software upgrades and retail services to the Smart Meter creating the opportunity for further revenue sources and ensuring a high-quality, up-to-date product for the consumer.

[26] 19 companies picked to work on Japan-New Mexico smart grid projects", Associated Press Newswires, 17 June 2010, via Factiva, ©The Associated Press
[27] World Economic Forum Smart Grid Task Force Member, EnBW

Focus on open platforms for development
Regulators have a critical role to play in setting the technical ground rules and access rights to various components of the smart grid such as the meter, home area network (HAN) and wide area network (WAN). For example, regulators can encourage innovation with respect to domestic and small and medium-size enterprise (SME) product and service offerings, by ensuring that utilities and vendors use open platforms and provide third party access rights.

This approach is particularly important in competitive retail markets, where barriers to switching could quickly form if closed platforms prevent third party product and service offerings to be ported from one supplier to another. We would expect to see retailers driving towards providing hardware and service bundles on the HAN to increase stickiness, as consumers are less likely to switch if it means losing hardware.

2.1.3 Accelerate the Roll-out of Standards for Interoperability

Standards play a dual role within the industry:

- They enable interoperability, creating an open and fair smart grid architecture for multiple vendor environments
- They offer a degree of certainty in a maturing market that encourages utilities to invest with confidence, accelerating the development of smart grid

Over the last year, we have seen the industry take a significant step forward in the development of standards at both the national and regional levels. For example, the State Grid Corporation of China recently released standards to regulate smart grid technology and related equipment development for the implementation of its smart grid project[28]. In the US, the National Institute of Standards and Technology (NIST) facilitated an open forum to develop a Smart Grid Reference Architecture and identify 75 smart grid standards to be used to a greater extent.

In addition, 17 application areas have been recommended as priority areas and have been assigned priority action plans to address and resolve their development[29]. In Europe, through the OPEN meter project, the EU Commission aims to specify a set of open and public AMI standards, taking into account the real conditions of the utility networks to allow for full implementation. The resulting draft standards will be fed into the European and international standardization process[30]. These represent just a handful of the activities currently underway. Additional information on other work being done across the world can be found in a recent publication by the German Commission for Electrical, Electronic and Information Technologies of DIN (Deutsches Institut für Normung) and VDE (Verband der Electrotechnik, Electronik und Informationstechnik [31].

International outreach
Although a certain level of regional and international cooperation on standards has begun, there is a risk that a polarization of the standards debate could emerge from regional/national standards development, with competing standards bodies reflecting the industrial policy of their local market (especially where nations are placing strategic emphasis on clean technology as an engine for economic growth). Development and protection of IP may become a critical battleground in the next wave of economic development and trade. Therefore, international outreach projects by standards bodies will play an important role in managing the risks associated with smart grid standards developments globally.

Interoperability
Currently, the International Electrotechnical Commission (IEC) and Institute for Electrical and Electronics Engineers (IEEE) are standards bodies that are intimately engaged with NIST and other standards bodies in facilitating the development of internationally agreed standards for interoperability. Given the complex nature of smart grid, it is recognized that creating standards for interoperability at key interfaces will accelerate the smart grid industry more than the development of global, detailed technical specifications alone. In turn, this will ensure the creation of a platform for innovation for manufacturers and utilities.

Open protocols for competition
Recognizing the challenges of interoperability and future-proofing of pilot technology, Iberdrola – a Spanish-based international utility – plans to roll out a smart grid pilot is Castellón, Spain, in 2010 that uses open protocols in its metering, data and communications systems. The pilot will combine consumer and grid-centric technologies, increasing grid sensing and automation, and integrating renewable distributed generation, EVs and demand-side management services to an estimated 175,000 consumers[32]. Iberdrola's open model of development represents an economic-efficient solution to the challenge of smart grid transformation, as it will allow for competition among technology and software suppliers while maintaining operational synergies.

[28] "China to include smart electricity grid in five-year plan", Industry Updates, 2 July 2010, via Factiva, ©2010 China Daily Information Company
[29] "NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0", Office of the National Coordinator for Smart Grid Interoperability, National Institute of Standards and Technology, US Department of Commerce, January 2010, www.nist.gov/public_affairs/releases/upload/smartgrid_interoperability_final.pdf
[30] "Expert Group 3: Roles and Responsibilities of Actors involved in the Smart Grids Deployment", EU Commission Task Force for Smart Grids, 22 June 2010, http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/expert_group3.pdf
[31] "The German Roadmap E-Energy/Smart Grid", German Commission for Electrical, Electronic & Information Technologies of DIN and VDE, 2010, www.e-energy.de/documents/DKE_Roadmap_SmartGrid_230410_Engllish.pdf

Evolutionary process
Despite the intense focus on the standards debate in smart grid, it is still likely to take a number of years for the standards to evolve to a point at which they are at the level of maturity seen in telecommunications or financial services. Standards will need to coalesce on several levels: a common information model, data management, meter specification, substation automation, and security and communications protocols.

Potential for acceleration
However, it is possible that utilities and their partners can significantly accelerate pilots through judicious adoption of de facto and evolving standards. The main barriers to adoption seem to be a lack of awareness (currently, standards development organizations and suppliers do little to educate utilities about standards, their features, benefits and overall value) and an aversion to risk, due to a lack of clear best practices and regulatory guidelines for applying new standards.

Regulators can play a key role in moving the industry to use standards and platforms already adopted by other industries, like Internet protocol, as a way of opening the market and leveraging the economies of scale (and the security investment) associated with widely deployed technologies. For new standards, regulators will need to provide clarity over the treatment of assets should they become stranded as early-adopted standards evolve or become obsolete.

Importance of specifications during mandates
Meter specification is particularly topical as the standards may settle at a level that implies a level of functionality that is fit for purpose in mass scale, mandated roll-outs where functionality is predominantly driven by the need to reduce back-office processing costs. The minimum functionality can rapidly become the default standard and preclude future applications within the smart grid due to limited functionality or modular upgrade paths. As such, utilities and regulators need to think carefully about evolving functional requirements even when presented with seemingly de facto standards.

2.1.4 Provide Assurance on Data Privacy and Data Security Issues

The increased embedding of sensing and monitoring of data on a smart grid, including smart meters, raises a range of data privacy and security requirements. In terms of data security, concerns arise around confidentiality of data; the integrity of the grid when attacked by corrupted commands or information; the ability of third parties to control the grid; and the level of intelligence that utilities have to successfully respond to security threats, including acts of terrorism and manipulation of meter data[33].

Data privacy issues are inherently more complex, as consumers tend to be sensitive to the sharing of personal data by businesses and could prove to be a barrier to smart metering roll-outs and demand response mechanisms. In the UK, Consumer Focus is calling for an urgent review of smart metering policies with respect to data privacy, disconnection and sales and marketing practices. They have called for suppliers to halt the roll-out of time of use tariffs until sufficient protections are in place[34].

More significantly, we have seen a hiatus of the compulsory smart meter roll-out in the Netherlands as Dutch consumer and privacy organizations expressed concern that information relayed as frequently as every 15 minutes could allow employees of utility companies to see when properties are empty or when expensive new gadgets have been purchased[35]. Protection, accessibility and appropriate use of consumer data, as well as consumer awareness of data being collected and used by the vendor/utility is crucial to building trust and acceptance between the consumer/ regulator and new smart technologies.

[32] World Economic Forum Smart Grid Task Force Member, Iberdrola
[33] World Economic Forum Smart Grid Task Force Member, McAfee
[34] "Ground rules needed in smart meter roll-out, says Consumer Focus", Consumer Focus press release, 29 March 2010, www.consumerfocus.org.uk/news/ground-rules-needed-in-smart-meter-roll-out-says-consumer-focus
[35] "Security fears threaten smart meter plan", The Times, 14 January 2010, via Factiva, ©Times Newspapers Limited

There are a number of actions that should be considered when addressing smart grid data privacy and security issues:

- **Draw parallels from other industries** – Telecommunications and financial services serve as good case studies for how data privacy and cyber-security can be embedded within current systems and processes. By providing points of reference and simple comparators, consumers and government may be able to better place the smart grid into context.

- **Establish a secure smart grid reference model** – due to the small scope of the majority of pilots to date, building a robust reference architecture that reflects the true end-to-end capabilities of the smart grid will be difficult. Therefore, any reference model created will need to be broad in scope; built through the collaboration of industry players and standards bodies; and future-proofed to be able to facilitate the construction of smart grid pilots/deployments with standard design components that include:
  - The aforementioned security and privacy considerations within smart grid designs and supply chains
  - Situational awareness and command and control
  - The ability to switch from one provider to another at the consumer's discretion
  - The ability to allow continuous integration and innovation in a multi-vendor environment

- **Use standards and certifications to encourage rigor** – Through bodies such as NIST and European Grid Initiative (EGI), the industry is developing robust security and privacy standards and certifications that may become the de jure standards for cyber-security and data privacy. These standards should ensure that vendors are able to incorporate them into their technologies while still allowing for interoperability.

- **Linking funding availability with security compliance** – Given the level of funding that has been committed by governments in smart grid developments, compliance criteria could be clarified by the regulator to ensure that pilots incorporate the required data privacy and security standards into pilot scoping. A secure smart grid reference model may need to be developed through cross-industry collaboration with regulators and consumers to support such scoping activities.

2.1.5 Adequate Training and Re-skilling Opportunities

As the industry transitions from an analogue to a digital footing, the skills and competencies of the workforce will need to adapt. The new technology landscape will require changes across the industry from the re-skilling of field service engineers with communications and IT skills to the development of more advanced analytics skill sets within the asset management arena.

At the pilot level, it is important to assess the current competency gaps and explore methods for rapidly training the workforce. Near-term skill gaps can be addressed through the introduction of contractors from adjacent industries such as telecommunications.

In the longer run, there is a growing problem that needs to be addressed. During the next five to 10 years, many utilities will lose their current workforce to retirement. With the current rate of growth in the industry worldwide, there is a significant risk that the pace of roll-out will be constrained by the availability of trained personnel. There is a need to both adapt the training regimes of utility company employees to develop the right balance of skills while also working with government and academic institutions to ensure that an appropriate flow of graduates and trainees with relevant skills are flowing into the industry.

As we look around the industry, the US appears to be leading the way on training the future workforce of the utilities sector with US$ 100 million of ARRA funding being directed through the Department of Energy for smart grid workforce training and development[36]. Universities and colleges across the country are developing ARRA-funded training programmes as well as utilities, including Florida Power & Light, National Grid USA, Duke Energy, Edison, GE and Oncor[37].

2.2 Scoping

One of the critical determinants of the success of a smart grid pilot is a thorough and analytical scoping phase.

The effective scoping of these complex, multi-year programmes takes considerable skill and effort. Pilots require utilities to grapple with multiple new challenges simultaneously, implementing relatively immature technologies and trialling new operating and business models. They require unprecedented levels of cross-industry collaboration and challenge utilities to maintain a balance between their "business as usual" operations and the evolution of their "smart-enabled" operating model.

[36] "DOE Lays Out Nearly $100M for Smart Grid Training", Power Market Today, 12 April 2010, via Factiva, ©Intelligence Press Inc.
[37] Workforce Training for the Electric Power Sector, US Department of Energy, www.energy.gov/news/documents/04-08-2010_SG_Workforce_Selections.pdf

Pilots require utilities to measure and track delivery of specific outcomes, while within consumer-centric pilots there is the need to segment the consumer base to ensure that new energy management products and services are targeted towards the broad spectrum of customer segments and their specific needs. Moreover, timelines for the completion of pilot scoping may be compressed to account for funding competition time frames.

From the approximately 90 smart grid pilots in implementation today it is possible to extract a number of key lessons learned, which if integrated into pilot design, will help increase the chances of success:

- **Clarity of scope and design parameters** – It is essential that pilots invest in creating and documenting clear test parameters and hypotheses that they are intending to prove, or disprove. The scoping must also take account of the level of customer interaction and shape the pilot's approach accordingly.

- **Avoiding the conflation of objectives** – Defined phasing of the pilot's objectives will help simplify results and reduce risks. Ensuring technology is sufficiently bedded in before experimenting with operating and business model changes will be important to clarify cause and effect.

- **The opportunity to develop new operating and business models** – In some cases, utilities have become short-term investment focused and constrained in ambition by the existing regulatory framework. Leading pilots challenge themselves to push the boundaries of innovation, look at the required changes to their operating and business models and enable smart grid pilots to showcase the art of the possible.

- **Measure a broad set of outputs to inform future regulatory contracts** – The most progressive pilots are both estimating and measuring rigorous performance metrics to demonstrate their broader societal value – for example, their ability to deliver carbon emission reductions. This, in turn, helps them to inform future changes to the regulatory framework to make the environment more attractive to investors.

- **Build a multidisciplinary team and be clear on roles and design authority** – The scoping phase is an important window to establish the capabilities and governance for implementation. Pilots should ensure that they gain early alignment on the goals and objectives across the consortium members and senior management commitment. As the low-carbon energy industry develops, relationships and access to consortia will become a source of competitive advantage.

- **Developing the customer value proposition** – The most successful consumer-centric smart grid pilots invest in developing an appreciation of their consumer preferences and work hard to develop new products and services that are intrinsically compelling, increasing consumer stickiness and retention (in those markets where retail competition is mandated).

2.2.1 Clarity of Scope and Design Parameters

At the head of a successful pilot is the combination of a tightly defined and articulated scope, clear objectives and well-partitioned test parameters. In setting the scope, objectives and test parameters, the utility needs to look critically at its network legacy and what the regulator/policy-makers are asking it to achieve in terms of performance.

Ultimately, this may need to be done on a circuit-by-circuit basis; however, when scoping the pilot, it is critical to identify the full range of challenges and objectives that are likely to be set and the potential disruptions that they are likely to encounter in the coming years (e.g. the impact of electric vehicles, distributed generation). In each case, the blend of objectives will be different.

In some cases, this will be enshrined within a regulatory or funding tender. For example, Ofgem requested that pilots competing for Low Carbon Network Funding would need to demonstrate their intent to test network solutions – such as the improvement of grid efficiency or the integration of concentrated renewable, distributed generation or storage – that would support the move to a low-carbon economy[38].

"Research and development in the utility industry has long been hampered by the need for tried and true – 'prudent' investments. As a result of this dictum, true boundary-stretching R&D happens too infrequently. Even vendor development tends to focus on well-established, non-controversial areas, since it is easier and less risky to sell – 'enhancements' rather than new and radical tacks to traditional problems."

Xcel Energy [39]

A pilot's scope and objectives will need to reflect the utility's corporate strategy, incorporating where the company wants to compete in the future, instilling the key capabilities they need to build and not being afraid to deal in the unfamiliar. This may include the intention to help shape a future regulatory regime that is more in tune with the changing policy landscape.

With these objectives defined, the utility can develop a series of detailed hypotheses that lay out the expected-benefits case by design parameter. Clear definition and articulation

[38] Low Carbon Networks Fund Stakeholder Workshop, Ofgem, 30 March 2010, www.ofgem.gov.uk/Networks/ElecDist/lcnf/Documents1/Ofgem%20slides%20LCN%20workshop%2030%20March%202010.pdf
[39] Xcel Energy SmartGridCity™ Benefits Hypothesis Summary, Xcel Energy, July 2008, http://smartgridcity.xcelenergy.com/media/pdf/SmartGridCityHypothesisWhitePaper_July2008.pdf

of the project objectives and design parameters up front will enable clear metrics to be defined and then consistently tracked throughout the project life cycle. Once defined, it is important that the objectives and hypotheses are well communicated. If stakeholders can easily track cause and effect on a test-case by test-case basis, it will be easier to develop compelling value cases from the pilots to make the case for transition to full-scale roll-out.

"The significant societal benefits from a grid focused Smart Grid, including a 5% reduction in overall generation requirements through improved grid efficiency, are real and proven and don't require the participation of the customer. However, it is a difficult business case for a utility unless the incentives they receive for investing in such a solution offset the impact of the reduced sales to their overall corporate profits."

Thomas J. Casey, Chief Executive Officer, Current Group, USA

Pilots will need to ensure that they are using the available funds to make tangible steps towards implementing next-generation electricity infrastructure. In this regard, utilities should push their pilot scope to portray a broad spectrum of smart grid capabilities and low-carbon technologies. For example, the SmartGridCity pilot in Boulder, Colorado, USA, by Xcel Energy was one of the first pilots to test an impressive spectrum of both grid-side and consumer-focused hypotheses.

One of the most important aspects to determine early on in the scoping is the weighting of consumer-centric versus grid-centric technologies that are likely to be deployed in a single pilot. A clear separation is emerging between grid-centric pilot and customer-centric pilot activities. The challenges of scoping and management are quite different and require careful consideration. This distinction will become more apparent in liberalized rather than vertically integrated markets.

In grid-centric activities, technology integration and efficacy testing are central tenets:

- A clear separation of objectives and test parameters to reflect the prioritization of objectives under each smart grid archetype
- End-to-end testing of multiple configurations of hardware, software and communications
- A good understanding of sequencing of layers for capability enablement and benefit realization to allow for effective road mapping of capability releases (i.e. base communications, sensing and analytic software followed by capabilities like distributed renewables, PHEVs, etc.)

In consumer-centric activities it is critical to:

- Predict and test the behavioural segmentation of the customer base
- Layer in smart grid functionality over time (test roll-out timings and installation methods)
- Be focused on customer value rather than outcomes for the utility

Pilot designers should be aware that any pilot activities that involve touch points with the consumer will require careful consideration and significant effort to plan the engagement to help achieve the typical demand reductions that they forecast in their value cases. Utilities may also want to consider that, in regions where the regulators may have grown sensitive to consumer-facing technologies, there may still be considerable benefits available from optimizing the operation of the network, with a view to deploying a holistic back office and data model that can incorporate aspects such as smart metering data at a later stage.

2.2.2 Avoiding the Conflation of Objectives

The complexity of trialling ecosystems of new hardware, software and communications alongside new ways of working can lead to a conflation of objectives.

Without crisp separation, multiple variables may be changed simultaneously, making it difficult to distinguish between cause and effect. One of the most common examples is the roll-out of new pricing plans as customers are receiving smart meters for the first time. In these cases, it can be difficult to tell whether the pilot results are a function of the customer's reaction to the technology change, or the fact they are being charged differently for their energy consumption. Pilots that are testing multiple technologies and approaches need to be unambiguous on the variables that they are choosing to flex, and those they are intentionally keeping constant.

A single pilot that tests multiple hypotheses should clearly separate these by either:

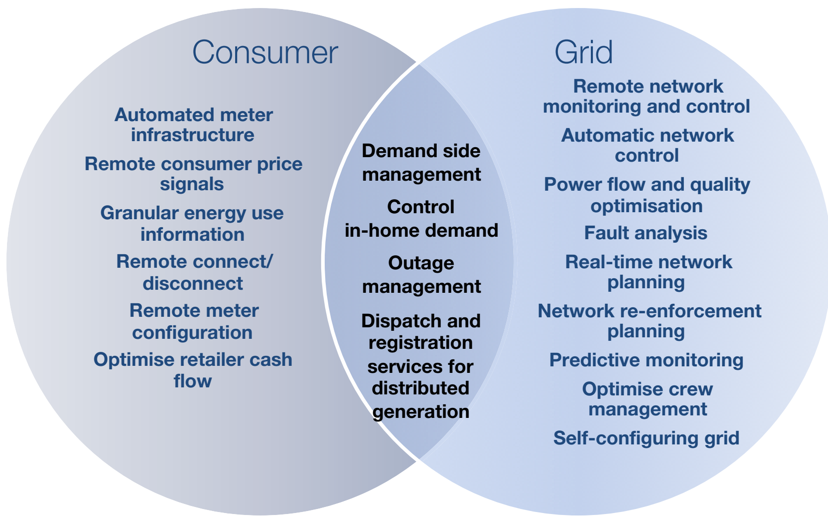
- Targeting different segments of the consumer base
- Drawing clear geographic delineations (e.g. e-energy project in Germany[40])
- Phasing the introduction of new variables overtime

The ability to layer in smart grid capability over time is often a critical component in successful pilot design (see Figure 4). Pilot designers should start with the foundational technologies (such as the communications backbone) that are required, and then prioritize and build out incremental capability (including sensing, control and automation) over time.

[40] E-Energy - Smart Grids made in Germany, Federal Ministry of Economics and Technology, www.e-energy.de/en

Figure 3: Consumer-centric versus Grid-centric Activities

Technical Capabilities



	Consumer	Grid
Business Enablers	• **Consumer education** • **Consumer outreach** • **Proactive media management** • **Consumer services in back office** • **Upskillingof the workforce** • **Revision of operating model** • **Innovative retail strategies (if implemented at this stage)**	• **Restructuring of the back office services and functions** • **Data management capability** • **Data visualisation and integration with system operations** • **Revision of operating model** • **Upskilling of the workforce**
Measures of Success	• Increased collection of interval data collection Reductions in total energy consumed • Reduction in peak loads • Increased consumer satisfaction • Reduction in occurrences of consumers switching to other suppliers • Improvement in retailer cash flow • Increased adoption rates of new energy efficiency technologies	• Increased operational efficiency • Increased grid efficiency • Increased voltage optimisation • Reduction in the frequency of outages • Reduction in the frequency and duration of maintenance/outage patrols • Decreased consumer complaints regarding outages • Increased optimisation of assets • Increased integration renewables and EVs

Through the incremental addition of new capabilities, utilities can better separate the relative costs and benefits over the lifetime of a pilot. Furthermore, it allows utilities to pick and choose capability builds on a modular basis to allow circuit-by-circuit customization to fit the needs of different smart grid archetypes. Utilities can grow their understanding of the operating model and business model implications of pilots as they develop (see Case Study 5).

One good example of this capability phasing is the GreenLys Project being led by ERDF and involving GDF SUEZ and GEG, among others. They are developing a smart grid pilot with over 1,000 customers in Lyon and Grenoble, France, which is planned to be conducted between 2010 and 2014.

The project will include two testing cycles with evolving sets of objectives over the two time frames:

- Winter 2011/2012: The pilot (over 500 customers) will remain both consumer- and grid-centric, evaluating the impact of renewables on the network (grid stability) and focusing on understanding the capabilities of smart metering associated to a demand response programme in existing residential homes

- Winter 2012/2013/2014: The pilot (over 500 customers in addition to the first phase) will extend into new residential homes (with low-energy consumption due to efficient insulation), where it will incorporate micro-renewables (combined heat and power and photovoltaics) and vehicle-to-grid technology through the roll-out of electric vehicles. In this phase, the project will explore advanced demand response management and aggregation activities to provide benefits to stakeholders (suppliers, producers, TSO and DSO) [41].

[41] World Economic Forum Smart Grid Task Force Member, GDF SUEZ

Case Study 5: Phased Delivery – EnergyAustralia

Overview

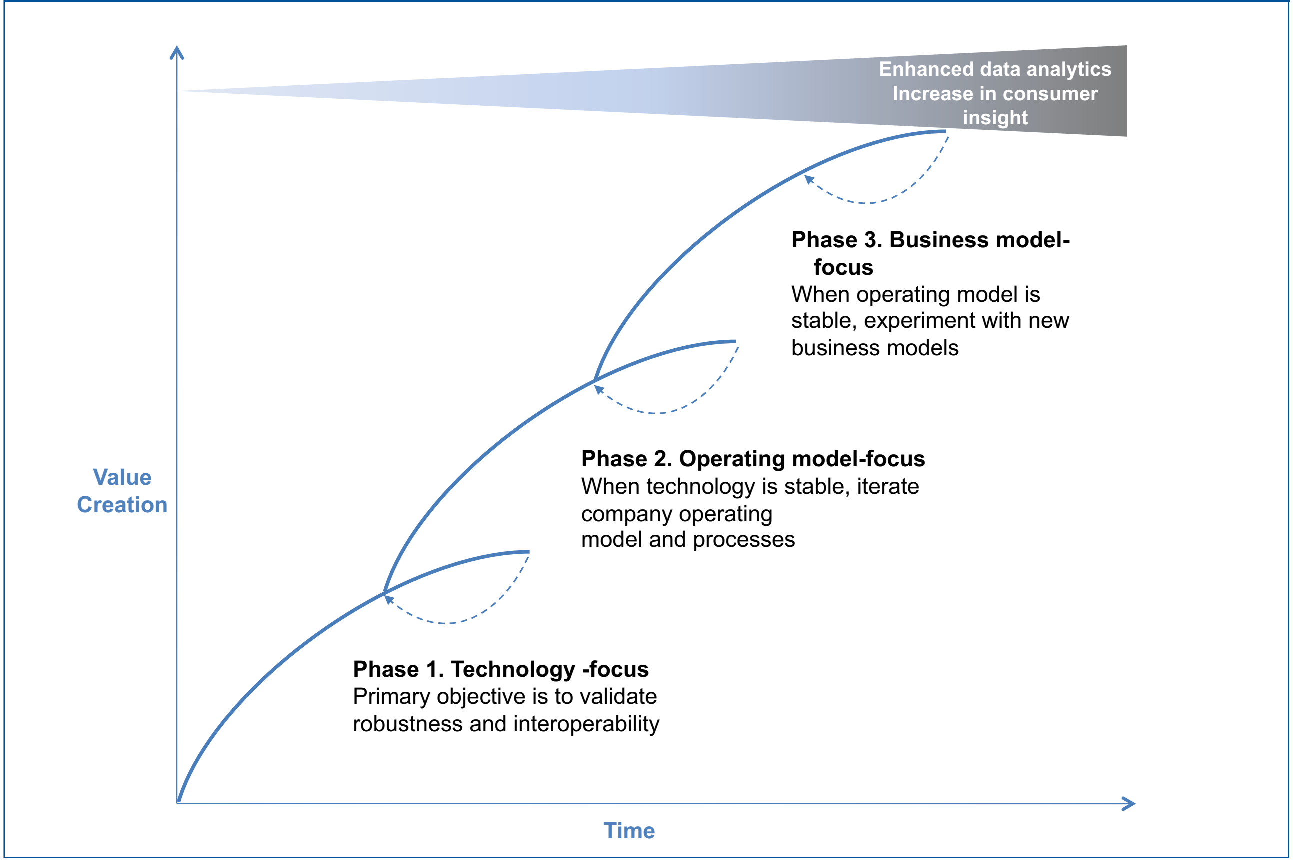
In 2006, EnergyAustralia began piloting AMI technologies in New South Wales, Australia, and has released the findings of each stage of the project publicly. To avoid any conflation of objectives and to establish all change management requirements for the technology, operating model and business processes and models, the pilot was split into three phases, and here we present lessons learned at each phase:

1. **Technology Trial (June 2006 to July 2008)** – To understand the level of technical development achieved in the market and the practicalities of installing the AMI solution

   Lessons learned:
   - A complex vendor environment is created as a large number of technologies from a combination of different vendors are procured for testing
   - AMI product trialled at the time required further development before the testing phase was complete
   - Laboratory testing may take longer than expected as technologies may not be as mature as envisaged
2. **Cutover (August 2008 to November 2009)** – To understand the issues for using half-hour, remotely read metering data delivered daily for billing and market settlement

   Lessons learned:
   - Early engagement is needed with retailers to create an effective roll-out process
   - Extensive process change is required to allow for the variation of timelines for installation and commissioning depending on technology and vendor
   - Back office processes and systems are required to be able to sort the large amounts of data being sent from the vendors
3. **Customer Research (December 2009 to December 2011)** – Having addressed technology and back office/field operational issues in phases one and two of the pilot, EnergyAustralia is now concentrating on testing new advanced metering infrastructure business models with consumers; they are specifically conducting research into the impacts of different pricing structures (including time of use tariffs) and consumer products across different consumer demographics

Figure 4: Pilot Phasing to Avoid Conflation of Objectives



2.2.3 The Opportunity to Develop New Operating and Business Models

Once technology is sufficiently robust and interoperability has been proven, there will also be an important role for pilots to help companies understand the changes they will need to make to their operating and business models in order to maximize the value of the new capabilities offered by smart grid technologies.

Operating models
From the first stage of scoping, it is necessary to strike the right balance between maintaining separation of the pilot from the core business to reduce disruption risk, while also allowing sufficient cross-fertilization and engagement with the entire workforce, in order to develop the skills and capabilities for future operating models (see section 2.3.2 for more detail).

Lessons from early pilots demonstrate three important recommendations for utilities:

- **Evaluate design release strategies** – Use the scoping phase as an opportunity to evaluate design different release strategies (capability-based versus circuit-based), examining the implications and relative costs/benefits of different implementation options
- **Consider asset management strategies** – Proactively integrate smart grid pilot planning and outcomes with asset management strategies so it is easier to develop asset roll-out strategies and minimize the risk of asset stranding. As a result, asset managers will be better placed during the transition to mainstream roll-out to simulate and optimize scaled smart grid programmes.
- **Understand the outsourcing options** – Explore outsourced business process outsourcing and application outsourcing solutions during piloting to understand their potential in supporting the transition to mainstream roll-out period to allow the business to focus on core competencies and/or to help stagger the pace of operating model change.

Business models
Over time, it is likely that companies will shift their focus away from smart grid technology and operations as they build the confidence and the insight needed to experiment with new business models. The focus on new revenue streams and routes to market will occur in both the consumer and grid-centric contexts.

If there is a collective desire to engage consumers in driving behavioural change, there will be a need to explore new business models that create a "net positive" experience for the consumer. This is particularly pertinent in deregulated retail environments, where there is a competitive dynamic to attract and retain consumers (see Case Study 4). In such activities, it will be important to collect and analyse long-term consumption and price sensitivity data to inform consumer engagement activities and product and service development. This may well include experimentation with different ownership and leasing models for low-carbon technologies such as electric vehicles and micro-generation.

We would also expect to see innovation around the product and service offerings that can be delivered over the home area network, allowing for greater automation and control and easing the transition for consumers who do not want to engage further with their energy consumption. In these cases, there may be a significant role for intervention by new market entrants to use their insight in creating and marketing innovative and attractive products and services directly to businesses and domestic consumers. As stated in section 2.1.1, regulators have the opportunity to level the playing field for traditional business models and the new value chain players in trialling new business models to ensure sufficient innovation in this space.

Creating a market value for demand response or grid optimization will be important in grid-centric pilots. Theoretically, "negawatts" can be aggregated and traded if the right market mechanisms are put in place. If this is to be the case, regulators may need legislative mandate to effect the change.

2.2.4 Measure a Broad Set of Outputs to Inform Future Regulatory Contracts

In many cases the pilots reflect the status quo with regard to the existing regulatory regime.

Privately owned utility companies frequently design pilots with objectives that reflect profit optimization priorities given the regulatory economic framework under which they are operating. The reality is that the current utility regulatory framework dates back to a period when the policy objectives were quite different and, therefore, do not reflect existing and future policy trade-offs; perhaps most importantly, there is a now an increasing need to balance low-carbon objectives alongside cost and security of supply.

To break this cycle, utilities need to avoid designing their pilots to solely satisfy the current regulatory objectives. They should work to gather sufficient quantitative and qualitative data to help build the case for rewarding the broader value case that smart grid delivers, not just to the utility shareholders or the customer base, but also to society more broadly.

Pilots should be designed to optimize and measure a broader set of societal benefits – e.g. carbon savings, job creation, etc. Some leading projects are starting to measure this broader suite of outcomes. They are also working to understand the true breadth of beneficiaries, and assign the value accordingly. For example, the West Virginia Smart Grid Implementation Project supported by NETL[42] is a broad-

[42] "Governor Touts West Virginia's Smart Grid Opportunities", State of West Virginia press release, 9 October 2009, www.wv.gov/news/governor/Pages/GovernorToutsWestVirginia%E2%80%99sSmartGridOpportunities.aspx

ranging smart grid implementation, from AMI through to demand response, advanced storage and wind generation. The project developed a cost/benefit analysis comparing the current and future electricity grid.

The project highlighted 13 benefits categories, organized into: reliability, economic, environmental, safety and security. Benefits were allocated as present day values in US dollars across four benefit groups: Consumer, Operational, West Virginia Society and US Society[43]

The next step would be for these pilots to put in place performance measurement systems that record their expected benefit against their actual benefits and, finally, to communicate the value case to policy-makers and regulators. This would provide regulators with the empirical basis to develop frameworks that encourage and reward utilities for the delivery of a broader set of societal outcomes (this is described in more detail in 2.4).

2.2.5 Build a Multidisciplinary Team and Be Clear on Roles and Design Authority

Smart grid pilots require access to a diverse set of skills and capabilities to be planned and executed effectively. The breadth of skill sets delivers fresh perspectives and helps the pilot to represent competing priorities.

Dependent on the scope of the pilots, there is likely to be the opportunity to develop multi-vendor consortia composed of parties providing funding, capabilities or other assets and resources. As the low-carbon energy industry develops, these relationships and access to consortia will become a source of competitive advantage. Early in the scoping stage, utilities will need to analyse the breadth of the capabilities required and determine how they are planning to meet any capability gaps.

The likely capabilities required in a smart grid vendor consortium include:

- Hardware and software providers to supply-side technologies
- Communications provider for a ubiquitous communications backbone
- A system integrator to integrate the new systems with the existing enterprise systems and enhance business decision-making
- A retailer to link pure network aspects to the consumer-facing technology and/or engage consumers (in the case of consumer-centric pilots)
- A regulatory expert to help navigate competition bids/ regulatory filings
- A marketing/communications agency to build consumer engagement and help bring about behavioural adaptation
- A municipal authority (e.g. mayor) to provide local market access and leadership

Table 3: West Virginia Smart Grid Implementation Project – Cost Benefits Analysis

Key Success Factors	Benefits	Annual Benefits ($M) (All Beneficiaries)
Reliability	Reduced Consumer Losses	$898
	Reduce Power Quality Events	$131
Economic	Reduce Price of Electricity	$399
	Job Creation	$215
	Consumer Sales of DER Resources	$175
	Increased Energy Sales as Exports	$7
	Reduced Transmission Congestion	$1
	Increased Transportation Fuels Business	$5
	Consumer Conservation	$20
	Operational Savings	$194
Environmental	Reduced Emissions	$7
Security	Reduced Blackout Probability & Dependence on Foreign Oil	$13
Safety	Reduced Hazard Exposure	$1

[43] West Virginia Smart Grid Implementation Plan, Revision 1, National Energy Technology Laboratory, US Department of Energy, 20 August 2009, www.netl.doe.gov/energy-analyses/pubs/WV_SGIP_Final_Report_rev1_complete.pdf

Selecting, negotiating and forming a winning consortium will require commercial and legal input. The governance of multi-vendor consortia will be a key determinant of the success of the pilot. It is important that vendors recognize that no one vendor has the entire solution and that they must work together to take the best parts of each of their solutions.

Some case studies suggest that municipal representatives within a consortium can significantly complicate decision-making, as multiple stakeholders require buy-in and political considerations have to be taken into account. It is therefore important that city officials allow freedom for rapid decision-making within the consortium.

Pilots should ensure that they gain early alignment across the consortium members on pilot goals and objectives and senior management commitment, combined with the willingness to collectively problem solve and openly share knowledge, especially around more sensitive areas of intellectual property.

There will be instances where a consortium has overlap in capabilities and when decisions need to be taken on which vendor's technology is selected. In these cases, it is important to designate a design authority to help distil the requirements and create a single decision-making body to manage competing agendas and manage trade-offs.

2.2.6 Developing the Customer Value Proposition

The roll-out of smart technologies provides an unprecedented opportunity for utilities to re-engage and increase the stickiness of their customer relationships by developing compelling product and service bundles that deliver a "net positive" experience for the consumer. The current crop of pilots tends to roll out fairly standardized technology/service offerings and may not fully recognize the diversity of needs and preferences.

To achieve the desired consumer-focused results, utilities and their partners need to-demonstrate a clear value proposition to their customers. In doing this, utilities will need to innovate to address two challenges:

- **The current low cost of energy** – Although this can be altered somewhat through dynamic peak pricing, it can be difficult to get consumer buy-in when savings are relatively small versus other categories of business/household expenditure

- **Unwillingness to adapt** – Consumers have demonstrated that they are somewhat reluctant to change their habits, preferring supply-side over demand-side solutions

The industry needs to tip this balance if it is to successfully integrate the end-user into the evolving smart energy system. This report recommends that those pilots with consumer touch points spend significant effort in forming an effective retail strategy by conducting sufficient consumer research and analysis to inform product and service development and multi-channel communication activities.

The result will be more effective engagement programmes and creation of more targeted product and service bundles that deliver tangible benefits to the consumer, allowing them to reduce their consumption and realize cost savings, and providing access to services that they perceive as having considerable valuable and are willing to pay for. It is only by generating this consumer pull that sustainable behavioural change will be delivered.

Retail strategy – understanding where the greatest value lies

Targeting the small and medium enterprise (SME) sector can be an excellent tactic for creating early buy-in. The SME sector typically has a greater real estate footprint, higher peak demand and discretionary load, and therefore offers a bigger potential payback per customer. Small commercial buildings – those with less than 200 kW of peak demand – make up 20-25% of peak electric demand in California[44].

Businesses also tend to be more price sensitive and earlier adopters of technology. Due to their typically higher energy costs, businesses have increased probability of generating savings from smart grid; giving greater potential for utility and business consumer to share the economic upside. Early adoption of technologies by SMEs has the knock-on effect of introducing technologies to domestic consumers while in the work environment. This seeds earlier adoption in the domestic market, as we saw with mobile phones and personal computers in the 1990s.

Segmentation analysis – understanding the consumer

Extensive consumer research prior to delivery is important in building an understanding of consumer needs and preferences. Customer focus groups and behavioural segmentation can help retailers to understand the local customer base and provide the project with the information to target those customers most likely to adopt and participate with pilot smart technology.

A recent global survey of over 9,000 energy consumers demonstrated clear and consistent behavioural segments with varying degrees of skepticism towards utility control over home appliances, level of environmental impact, and sensitivity to bill savings and amount of personal action required[45].

[44] Kiliccote, S., Piette, M.A., Dudley, J.H., "Open Automated Demand Response for Small Commercial Buildings", Lawrence Berkeley National Laboratory, July 2009, http://drrc.lbl.gov/pubs/lbnl-2195e.pdf

[45] Understanding Consumer Preferences to Energy Efficiency, Accenture, 2010, www.accenture.com/NR/rdonlyres/0E4EDD5C-15A5-45A6-936A-9F339C593BE3/0/Accenture_Utilities_Engaging_Consumers_Accenture_Perspective.pdf

Similar to Yello Strom (see Case Study 4), Xcel Energy recognized that smart consumer products should not follow a "one size fits all" approach. During their pilot in Boulder, the company mandated meters to only a portion of the population and allowed others to opt in[46]. Consumer segmentation will also have the secondary benefit of helping suppliers to provide tailored messaging and more effective marketing and engagement campaigns, described in more detail in section 2.3.1.

Product and service development

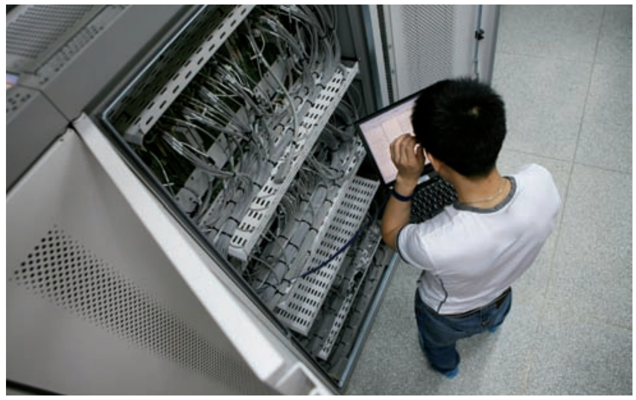
Consumer research suggests that consumers would like products and services that do not require them to interact heavily with their energy consumption[47]. They prefer user-friendly, self-sufficient devices that require limited intervention but allow them to retain control and save money, while not compromising their quality of service. An appreciation of the different ways each consumer segment would like to participate will become increasingly important (particularly in liberalized markets where consumer retention is a critical issue for suppliers).

The new entrants to the smart grid value chain are evidence of the current market gap to grow significant consumer pull in home energy management services. Firms such as IDEO, Best Buy, Google and Vodafone, with their wealth of background in developing compelling consumer-oriented products, are offering fresh perspectives. They see the benefit of generating consumer-centric smart technologies that have clear value to the consumer, either as stand-alone energy management devices or as a subset of a new offering. Those retailers that invest in innovative retail strategies and products/service development are more likely to be successful in this evolving value chain.

2.3 Execution

Despite a solid planning effort, it is likely that pilots will come across challenges in the field environment. These challenges could come in variety of forms:

- **Technical in nature** – Such as challenges with the seamless transfer and integration of data across the network
- **Process- or skills-related** – Such as issues with gaining access to the consumers' premises or shifts to back office processes
- **Linked to the local topography or geology** – The terrain can provide challenges when laying down fibre or cables and setting up wireless networks



It is critical for pilots to retain flexibility during the execution phase so they can adapt effectively in response to unexpected challenges. This can be difficult to maintain in a multi-vendor environment with multiple hand-offs and questions of accountability. To manage these challenges, pilots need to retain appropriate governance structures and project management capabilities throughout delivery.

Over recent years, many utilities have sought to drive down the frequency and length of interaction with customers to reduce the cost-to-serve. Consumer-centric pilots call for a different approach, presenting utilities and retailers with a unique opportunity to interact with customers and share the benefits of smart technologies. This interaction may be the first time that the customer has met someone from their utility and can set the tone for many years (positively or negatively). Any lapse in performance has the potential for a long-term detrimental impact on a consumer's relationship with the energy provider and his or her perceptions of smart grid. However, the opposite can also be true.

A number of activities should be considered when executing a pilot to ensure that it succeeds in delivering on its objectives:

- **Continual re-engineering in the field and back office** – Laboratory bench testing can only reveal so much; some technologies may not be fully mature and unexpected events may arise. The most successful pilots will see their consortia partners collectively solve problems in the field, eliciting and responding to consumer feedback and ensuring the skills and flexibility are in place to successfully re-engineer improvements into technology and business processes.
- **The challenge of consumer engagement** – for those consumer-centric pilots operating in an environment where scepticism remains over smart grid benefits, it is crucial to proactively engage the consumer and media to create a positive outlook and manage expectations. Consumer-centric pilots should consider customer

[46] "SmartGridCity ™ Update", Xcel Energy, 4 June 2009, http://ci.boulder.co.us/files/Environmental%20Affairs/EAB/2009-07-01_oea_smartgridcity_city_council_update_final.pdf
[47] World Economic Forum Smart Grid Steering Board Member, Duke Energy

outreach programmes and ongoing customer support. These outreach programmes need to communicate messages in clear, non-technical language, and adopt new techniques, channels and incentive schemes to build trust and generate consumer pull for future smart grid programmes.

- **Clear governance and PMO** – The execution phase is a dynamic environment, with various elements of the technology and business processes being challenged and revised on a regular basis. Such complexity requires a clear governance structure from the scoping stage onwards, with a commitment throughout the delivery phase and strong project management capable of ensuring alignment and communication between all consortium partners and workstreams.

2.3.1 Continual Re-engineering in the Field and Back Office

Adaptability when dealing with new technology
A number of pilots, including EnergyAustralia (see Case Study 5), have found that smart technologies may not be fully mature and suffer from a lack of interoperability. This problem is exacerbated when pilot consortia are using technologies from a high number of disparate vendors. In many cases, technology components have to be field re-engineered or upgraded to meet objectives and expectations.

Depending of the maturity of the technology, pre-installation lab testing is often required to ensure technologies are sufficiently robust and interoperable prior to field deployment. This is particularly pertinent for consumer-facing technologies where a lack of robustness in the technology (e.g. programmable thermostats that are consistently incorrect by several degrees) can have a long-term, detrimental impact on consumer perceptions of home energy management services.

However, laboratory testing has its limitations and problems often arise once out in the field. In these cases, there is clear value in the all consortium players collaborating to feed back lessons learned to configure technologies in situ and to avoid future quality issues.

For meter roll-outs, it is important to focus on the training of meter installation operatives, eliciting feedback on the customer experience and re-engineering improvements, especially in markets where the meter is located within the premises. Best practice is emerging around using the installation process as an opportunity to capture considerable data points about the final meter reading with a digital photograph to reassure customers over billing accuracy, and also identifying issues such as safety and security, such as identifying evidence of meter tampering.

Operations re-engineering
The execution phase presents a valuable opportunity to iterate roll-out design through continuous monitoring and improvement of operating models and business processes. As pilots increase in scale and maturity, we see an increase in focus on understanding the changes between the current utility business and the "smart-enabled" business. By implementing a continuous improvement process and measuring the cost of poor quality, the utility and its partners can reduce the marginal cost of installation, which can then translate into lower capital and operating costs when it comes to defining the business case for mainstream roll-out.

Although pilots present an opportunity to develop skills and capabilities for the future in a controlled environment, it can be very challenging to do this while sustaining high performance in the day-to-day running of the business. The following activities are recommended to help the business to understand and prepare for the breadth and depth of business change required:

- **Process mapping of changes** – Map the business process change from across all relevant lines of business with a focus on maximizing value from new data flows.

- **Mapping of new system requirements** – Understand the new system requirements for the influx of data and use this to create a technology roadmap.

- **Capability and competency gap analysis** – Understand the new skills requirements and use this to inform a roadmap for transition.

- **Organizational change management activities** – Help the business absorb the change by providing regular communications, skills-based learning, etc.

Lessons learned from previous pilots suggest that key areas of focus for monitoring and improvement are:

- Problem resolution processes within customer service centres

- Data exchange and management processes between vendors and back office functions

- Outage management processes

2.3.2 The Challenge of Consumer Engagement

Consumer-centric pilots require utilities to shift priorities from purely cost control to a broader focus on user-friendliness, consumer-centricity and added value. To realize the demand reduction benefits, utility companies will need to develop more targeted consumer engagement activities that inform and educate those consumers.

Proactive engagement programmes
It is important to pre-empt and actively manage the customer and the media to counter negative perceptions and mistrust of smart grid. The Smart Grid Demonstration Project Partnership has been observing discussions on existing fora to gain a baseline reading of public sentiment towards smart grid. They discovered that a common perception among consumers was that businesses are being "greedy" and "evil" and that smart technologies will deliver cost increases.

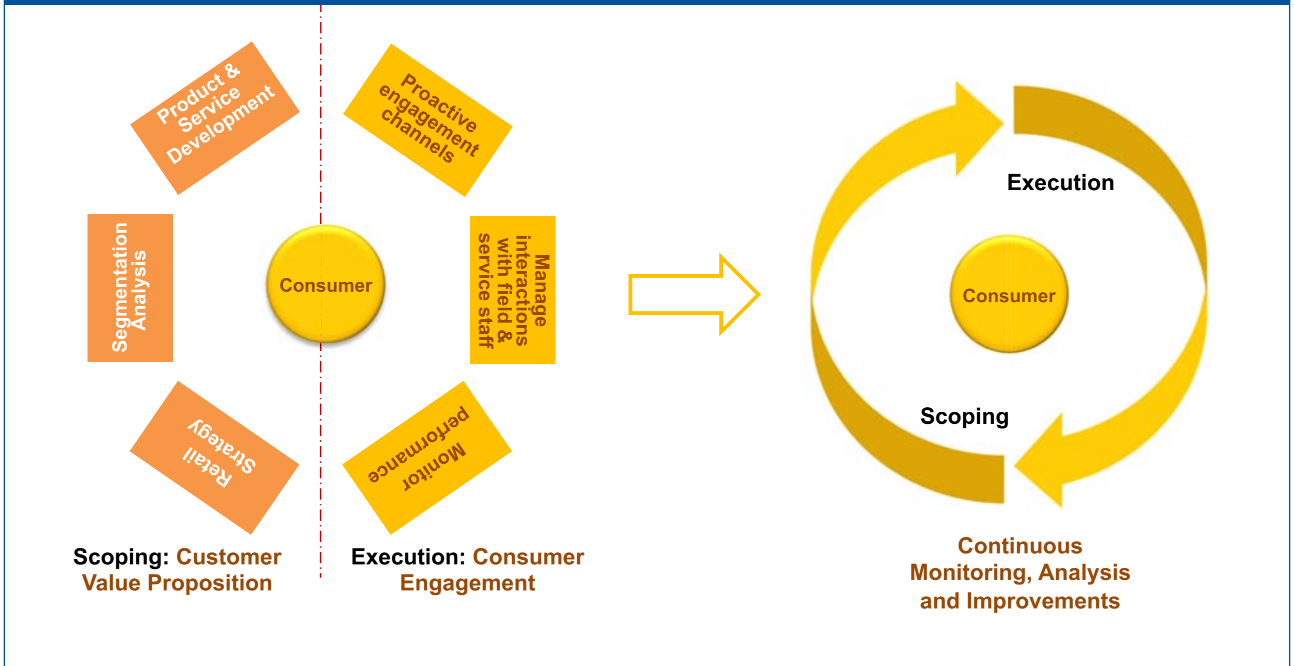
Language was a key factor – by labelling the grid as "smart", it suggested to the consumer that electricity travels like data, provoking suspicion and alarm about what information may be passed along by the smart meter[48]. An effective set of marketing and outreach activities is integral to the success of consumer-centric pilots to counter such consumer perceptions and to build trust and understanding between the consumer, the utility/consortia and smart technologies.

- **Targeting the right consumers with the right message**
  Consumer research and analysis in the scoping phase (see Figure 5) will indicate the consumers' needs and preferences towards their energy consumption and enable better messaging and communication with different consumers.

  Consumer expectations are likely to be raised with respect to the new capabilities that smart meters and other in-home energy management systems can deliver. Companies need to be careful not to overstate their potential, but should communicate a clear and practical message to each consumer segment to create an understanding of the technologies' capabilities and the level of consumer interaction required to enable these capabilities to realize future financial and carbon savings (see Case Study 6).

- **Multi-channel management**
  Pilots should use multiple channels of communication to reach their consumer base. Proactively supplying the media with positive local use cases can be key to demonstrating that the change will directly benefit consumers. Consumers are likely to be more receptive to messages that are communicated via local and trusted media, such as town newspapers and neighbourhood champions.

Figure 5: Know Your Customer: Generating Insight through Pilot Scoping and Execution Phases



[48] "Blowback Attack: The Smart Grid's Greatest Danger?", SmartGridNews.com, 9 Feb 2010, www.smartgridnews.com/artman/publish/Business_Planning_News/Blowback-Attack-The-Smart-Grid-s-Greatest-Danger-1875.html

Focus groups and community-based programmes can provide accessible fora for consumers to voice concerns and contribute ideas to improve the delivery of the programme. In Ontario, Toronto Hydro visited different neighbourhoods and festivals around the city to educate consumers and promote a “culture of conservation” among the general public[49].

Toronto Hydro also chose a neighbourhood of selected homes to showcase the overall effectiveness of smart technologies and energy efficiency measures in the community. Establishing smart micro-communities where residents can view their personal consumption against the community average or another micro-community can also create an element of competition and peer pressure to drive efficiencies and carbon savings. Altruism has also been found to be a powerful driver of energy efficient behaviour.

The use of social media has proven successful for some companies in increasing interaction between the utility and consumers. For example, Duke Energy launched a Twitter site that allows consumers to communicate with the company and receive regular updates. This has proven particularly popular during times of emergency, e.g. power outages[50].

Finally, international exhibitions, which showcase the art of the possible using high-tech multimedia formats, can be very valuable for raising public awareness and acceptance levels for smart grid technologies (see Case Study 6).

Training the workforce interacting with the consumer

Consumer-centric pilots mean that the workforce, from field engineers to marketing personnel and customer service operators, will be interacting with the consumer more frequently regarding novel topics and technologies. In the US, Duke Energy conducted a home energy management pilot with approximately 100 residential consumers in North Carolina. During the pilot, call centre agents received an average of five to eight calls per customer per month during the pilot. Analysis of the data received from the calls indicated that the technology being used required significantly more education of the consumer to enable them to effectively use the technology during the pilot[51].

Staff from multiple departments will need to be sufficiently educated on these new topics and on how to best engage with the consumer in different environments to ensure that any interaction with the consumer remains a positive experience.

Case Study 6: Engaging the Consumer – State Grid Corporation of China

State Grid Corporation of China (SGCC) is running demonstration projects at the Shanghai World Expo 2010 with the SGCC Pavilion. The integrated pilots include nine sub-projects covering each element of the electricity value chain:

- Smart Substation
- Distribution Automation
- Fault Restoration Management System
- Power Quality Monitoring
- Customer Energy Usage Collection System
- Energy Storage System
- Renewable Energy Integration
- Smart Building/Home
- EV Charging/Discharging Station Operation

For the Shanghai World Expo 2010, SGCC has invested in a significant showcase: a 4,000-square-metre pavilion named “Magic Box” to help test and explain the integration of their diverse smart grid technology projects and provide the opportunity for people to experience smart grid technologies. On the underground level, a MengZi 110 energy saving and smart substation has been built and showcased on site. The substation employs several cutting edge technologies, including a dry type amorphous alloy power transformer, optical cyber CT, electronic PT, ice storage and ground heat pump air conditioner, and captive solar power generation. It is an excellent example of smart substations realizing smart monitoring, digital power metering, fault recording, a relay protection network and automatic trip, based on the GOOSE protocol.

In the SGCC Pavilion, visitors can see the smart grid control centre technology, smart grid transmission, IT platforms and visualization displays. Visitors can operate the smart interactive portal to see the how the smart communities and smart homes of the future will improve people’s lives, facilitate the interaction of the customer with the power grid, increase convenience levels and improve the economy of electricity consumption. Specific installations include:

- A televisual display of the smart community and smart home capabilities, PLC installation and live feed of information from the demonstration smart home

- The energy usage platform, which enables understanding of consumption patterns of each home and control of each smart home’s appliance to facilitate smart load control to drive improved safety, efficiency and energy saving benefits

- The two-way interactive display shows energy saving benefits of optimized energy usage decisions such as reduced CO_2 emissions and energy bill reduction

This “Magic Box”, which is helping consumers to engage with smart grid technologies and understand the technologies’ valuable role in enabling modern living, has received over 2.6 million visitors.

[49] “Toronto Hydro rolls out the green carpet - public event”, Toronto Hydro press release, 22 June 2010, http://micro.newswire.ca/release.cgi?rkey=1806237601&view=46250-2&Start=10&htm=0.
[50] “Duke Energy uses Twitter to update on power outages”, Charlotte Observer, 16 June 2010, via Factiva, ©The Charlotte Observer.

Monitoring retail performance
The retail environment is constantly evolving. In other industries with liberalized markets, where consumer retention is a key issue, companies are constantly improving on and innovating their existing product/service base and marketing activities to ensure high customer satisfaction. To remain competitive in the new smart era and against new entrants to the value chain, suppliers will need retail strategies that reflect the latest consumer needs and preferences. To do this, continuous performance monitoring, data gathering and analysis will have to take place to inform future retail strategies.

2.3.3 Clear Governance and Programme Management

Companies will realize the full benefit of smart grid pilots if they ensure that a strong and adaptable governance process, with clear roles and responsibilities, is agreed across all consortium members early in the planning stage. For example, it is important to determine who between the utility or third party installation team (if used) will take ownership for problem resolution after meter installations.

The main challenge of deployment is the ability to maintain a clear governance structure while continual improvements to processes and workflows are being integrated into the pilot. Strong project management and communication between the multiple workstreams across the whole consortium is a critical factor in ensuring alignment of objectives and programme deliverables in such a complex working environment. The project management function can also facilitate the communication of lessons learned and process and workflow changes.

Effective risk and issues management and benefits tracking should be conducted throughout the delivery process. It is important to do this is at the process and workflow level to provide data on the cost of poor quality and process efficiency for unit costing. Stakeholder expectations should always be set accordingly to mitigate confusion over potential disruptions or phasing of benefits.

2.4 Exchange and Use of Pilot Learnings

Although there are a number of pilots that have been initiated globally, there are still relatively few that have completed the entire piloting process, including post-pilot analysis and review. Even the early pilots such as the SmartGridCity in Boulder, Colorado, USA, have only been collecting data for a year and, as such, are offering early indications on performance. However, those early results have already delivered significant insight into the performance benefits and challenges posed by smart grid implementations. Such information and insight is already influencing the design and build of the next wave of pilots.

There are significant benefits to data capture and knowledge exchange at an industry level, as it promises faster, cheaper and more effective pilots that will expedite the transition towards full-scale roll-out. However, there are a number of challenges to be overcome to enable this exchange, as commercial interests and concerns over intellectual property leakage elicit caution within the utility and vendor community.

In some cases where pilots have been funded through fiscal stimulus or regulatory incentives, there may be a set of prerequisites to make data and knowledge public. However, this is usually limited to a national or regional level and is rarely systematized. In the US, we have seen increased coordination with respect to both the funding allocation decision-making approach and the creation of a central clearinghouse[52] for smart grid data.

This increased level of coordination is a step in the right direction, but could be taken further by serving as a clearinghouse, not only for post-pilot data, but also for planned pilot test parameters, to ensure that pilots minimize overlap or repeat test protocols in the knowledge that they are being tested elsewhere.

In the sections below, we explore the opportunities for improvement from two perspectives:

- How to improve the **exchange** of data, information and knowledge relating to pilot design and execution
- How to **structure and use** the data, information and knowledge to develop better pilots and transition more rapidly to full-scale roll-out

[51] World Economic Forum Smart Grid Steering Board Member, Duke Energy
[52] Smart Grid Information Clearinghouse, www.sgiclearinghouse.org

2.4.1 Knowledge Exchange around Pilot Design and Execution

The systematic collection of pilot data at a national and transnational level could act as a catalyst in the development of reference architectures and data sets for the development of value cases for the transition from pilots to full-scale roll-out. From analysis of pilots to date, a number of steps have been identified that could be taken to develop a framework for knowledge exchange.

Sharing pilot design parameters

Most industry knowledge sharing on smart grid pilots is limited to conference presentations and high-level information posted on company websites. In some cases, there is knowledge exchange at a national or even a transnational level (e.g. in April 2010, the US Gridwise Alliance and Japanese Smart Community Alliance formed a partnership to share learning and drive forward internationally recognized standards and interoperability[53]). However, these exchanges are not typically systematized in a way that enables utilities to benchmark their test parameters.

As a consequence, we see common test protocols repeated in multiple pilots. This is not in itself a bad thing, as the outcomes may differ depending on the local conditions. However, if the people responsible for shaping the scope parameters had access to a repository that allowed them to know what had been tested, they would be able to make informed decisions about whether or not to repeat the test.

A new programme financed by the European Commission has tried to solve such problems in designing the ADDRESS Project (Active Distribution network with full integration of Demand and distributed energy RESources), which, during 2011, will test smart grid solutions. They will be validated in three complementary sites with different geographical and demographic characteristics and different infrastructure mixes. Sites will be selected in Spain, Italy and France to meet these diversity requirements and to provide a representative realization of the ADDRESS architecture[54].

Still, there is an urgent need to reduce the time and resources wasted in trialling similar test parameters in parallel conditions. As discussed in section 1.3, fiscal stimulus is likely to be short-lived and pilots need to capitalize on the funding currently available to ensure that smart grid pilots are providing lessons learned across the range of technologies and archetypes and are building upon each other's experiences to create a solid foundation for longer-term, sustainable smart grid models. In many cases (but not all), simulation (see section 2.4.2) could also replace physical trials.

Developing common metrics, normalization and benchmarks

Given the diverse nature of smart grid trials, it is not feasible to expect that a completely common set of metrics could be put in place. However, if there is a broader ambition from both funders and regulators to drive towards common platforms for sharing data from pilots, then there are steps that could be taken to align basic measures of performance. The process of collection and categorization of metrics has already been started by the US Department of Energy (DoE), initially through their work with Gridwise/KEMA/OMB to create the funding allocation scorecard and more recently through the Smart Grid Clearinghouse (see Case Study 7).

The World Economic Forum and its Partners welcome this development, as suggested in the Low-Carbon Task Force recommendations, and call for the approach to be broadened to other regions and even at a global level. The broader the network of participants, the more valuable this pool of data will be, but only if the data is contextualized with clear definitions of the original test protocols and normalization data.

For the data mentioned in the sections above to be useful for benchmarking and simulation, it is imperative that contextual data is provided to enable normalization and statistical analysis of the raw data. With additional data in such areas as customer demographics, network topology and climatic conditions, the appropriate normalization can provide comparable benchmarks. We would expect academic institutions to play an important part in managing the data sets that are being submitted to data clearinghouses and advise companies on the protocols for collection and submission.

Case Study 7: Smart Grid Information Clearinghouse – Global Online Portal [55]

Virginia Tech Advanced Research Institute in the United States recently released a beta version of its Smart Grid Information Clearinghouse (SGIC). They received US$ 1.3 million from the DoE last year to develop the site and plan to launch it formally later this year.

The SGIC website is intended for a wide audience: consumers, utilities, vendors, researchers and policy-makers. It offers an extensive searchable database, including project maps, lessons learned, cost-benefit analyses, value cases and performance data at the national and international levels. Encouraging open collaboration, the SGIC website is asking users to help shape the final version of the site by posting comments and suggestions for improvements.

[53] Korea Smart Grid Institute, www.smartgrid.or.kr/eng
[54] ADDRESS Project, www.addressfp7.org
[55] "Secretary Chu Announces More than $57 Million in Recovery Act Funding to Advance Smart Grid Development", Department of Energy press release, 20 July 2009, www.energy.gov/7670.htm

Sharing lessons from the field

The collection and dissemination of this information and knowledge is often more challenging, yet can be incredibly valuable to the utilities and their partners as they seek to change operating models and business processes and models to drive the most value from the new technologies.

At the project level, there are knowledge management protocols that can be put in place to capture best practice. As companies shift mode within the pilots from a primary interest in driving technology stability to an interest in operating model and process optimization, the focus should shift towards measurements of process efficiency and the cost of poor quality. Some use methodologies such as Lean Six Sigma and WorkOuts™ to drive improvements in process efficiency and quality. The same methodologies can be applied to customer-facing processes with a focus on customer metrics.

While this exercise is likely to be the source of competitive advantage for industry consortia, there are examples where this best practice is shared across the industry. We are already seeing reference architectures and capability maturity models emerging. The example of including digital photos of the meter at the time of installation demonstrates where knowledge has been shared on an informal basis and has now become an integral part of the lexicon of how companies see best practices emerging on meter installation.

Going forward, we would like to see more systematized capture of operating best practice in capability maturity models and reference architectures. This could be performed by either academic institutions (within the ADDRESS Project, the Università degli Studi di Cassino is leading the workstream focusing on dissemination and exploitation of the results) or national/transnational entities such as the DoE or the EU.

2.4.2 Using Data to Maximize Smart Grid Pilot Potential

DEVELOP PILOT/ROLL-OUT SIMULATIONS

As we see the emergence of more systematic data collection, normalization and sharing, it will be possible for utilities and their partners to develop simulation models that will allow companies to accelerate scoping and design activities; better understand customer behavioural segmentation; and plan for full-scale roll-out of smart grid technologies. A recent study by Brattle Group[56] recommends that simulation will be needed to extrapolate project results for larger-scale deployment.

Interestingly, a joint PNNL/NETL programme intends to build tools that enable stakeholders to model smart grid technologies and strategies, creating a mechanism to link such simulations to business case assessments and dividing smart grid benefits into three fundamental categories – Utilities, Consumer and Society[57].

However, the quality of such simulations will be driven by the quality, breadth and depth of the data sets that they are able to access. With effective normalization and contextual data, the project teams should be able to create accurate simulations of network effects and customer dynamics, as long as their own data sets are robust.

The use of simulation should, in turn, drive down the cost of pilots and roll-out as tighter test protocols can be set, avoiding the need to replicate tests and allowing asset managers, work managers and retail strategists to tailor their programmes for local conditions. Functional analytics on data sets including power quality, system performance, asset health and utilization, customer behaviour and electrical device states can all help the utility to take the results of their pilots completed on a handful of circuits to predict the effects of a territory-wide roll-out.

We are already seeing some use of simulation in the design and roll-out of smart grid pilots. At EnBW, simulation was used to match representative customers' behaviour (in one area) with a grid (in another area) that was less robust with regard to customer choices and decentralized generation than the grid in the first area. By doing so, they were able to simulate critical grid situations and the possible effects on customer behaviour (response to price and grid signals) in those situations[58].

BEHAVIOURAL ECONOMICS

We have observed an increasing focus on the use of more advanced analytical techniques for customer behavioural segmentation, especially in those markets where competitive retail markets exist. The use of techniques pioneered in behavioural economics can play an important role in understanding and simulating how different consumer segments may respond to choices and incentives to change their behaviour.

While this is still an emerging science, it raises some interesting opportunities and challenges for policy-makers, regulators and utilities that are seeking to change consumer behaviour by tailoring product and service bundles to consumer behavioural segments and providing "nudges" to deliver outcomes that are mutually beneficial for the consumer and the broader community.

[56] "Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects", Brattle Group/EPRI, January 2010
[57] Pullins, S., "Smart Grid: Enabling the 21st Century Economy", National Energy Technology Laboratory, presented to the Governor's Energy Summit West Virginia, December 2008, www.netl.doe.gov/moderngrid/docs/SG-Enabling%20the%2021st%20Century%20Economy_Pullins_2008_12_02.pdf
[58] World Economic Forum Smart Grid Task Force Member, EnBW

This field requires extensive data on consumer behaviour on a number of dimensions that are not always collected as a matter of course. Furthermore, it requires a set of analytical skills and a focus on data privacy and security that is a step above the norm. However, where these factors are taken into account and the data is systematically collected and analysed, the level of insight into behavioural patterns and how they can be accounted for in the design of both products and services can lead to more rapid and sustained adoption.

This is still an emerging field and, as such, we would only expect those in competitive retail markets and innovative early adopters to explore the field in detail. It is an area where we expect to see increasing research from the academic community and investment from government, regulators and the private sector.

COMMUNICATION TO REGULATORS AND THE DRIVE FOR MAINSTREAM ADOPTION

The communication of findings from the pilot closes the life cycle of the project and prepares both internal and external stakeholders for the next phase of development: full-scale roll-out. From an external perspective, it is important that the key findings are collated and communicated in a way that drives the change that is required at the regulatory and policy levels. The data collected and analysis conducted during the pilot will inform the value case that is put forward to regulators to justify the investments that will be required. Where the case is still marginal, it should be clear what changes would be required to the capital and operating costs or the benefits that can be driven to make the case positive.

"Smart grids represent a rare opportunity to achieve a two-fold global good: protecting the environment and fostering social and economic progress. In emerging economies, economic growth and the resulting social benefits require abundant energy. But smart grids, with their potential to offer green, accessible and affordable power, won't spring up on their own. Their development will require collaboration among governments, which can provide leadership; the ICT and energy sectors, which can provide advanced information and other technologies; and consumers, who will need to be educated about their benefits."

Vineet Nayar, Chief Executive Officer, HCL Technologies, India

Over time, we would expect the capital and operating costs to fall as the technology matures, implementation risks are mitigated and manufacturing volumes increase. If the value case includes positive externalities that are not financially manifest in the current regulatory regime, this treatment can also be reconsidered if the outcomes are deemed to be in the public interest by policy-makers. Therefore, the value case is something that should be kept under constant review and should inform the release strategy for smart grid capabilities.

From an internal perspective, it is important that the findings of the pilot are communicated to employees to demonstrate where lessons have been learned and operating practices have been improved. Where immediate next steps are planned, these should be clearly communicated to demonstrate early "wins".

In some cases, there will be clear examples of capabilities that can be rolled out more broadly without the need for further regulatory intervention. In these instances, capital investment plans should be amended and steps should be taken to ensure that anything that is rolled out is both interoperable and forward compatible to ensure that options for future development remain open.

In section 1.2, we referred to a number of regional strategies that we see emerging around the world. We would expect to see a more rapid transition towards full-scale roll-out in developing economies, where new capacity is being built to accommodate economic growth and there is an ability to drive economies of scope and scale between electricity and telecommunications infrastructure roll-out. While we see areas where specific smart grid technologies such as AMI will be rolled out in a retrofit environment, it is in the new build arena that we are most likely to see large-scale roll-out of a fully-functioning smart grid.

3 Conclusions for Stakeholders

The following section develops a stakeholder-specific perspective on the challenges and opportunities posed by smart grid pilots:

- The first section identifies and describes the most important relationships that we believe will help progress the industry
- The second section takes each of the key stakeholder groups in turn and defines clear recommendations
- The final section provides a concluding set of actions over the short, medium and long term that, if taken, should speed the transition towards mainstream roll-out of smart grid

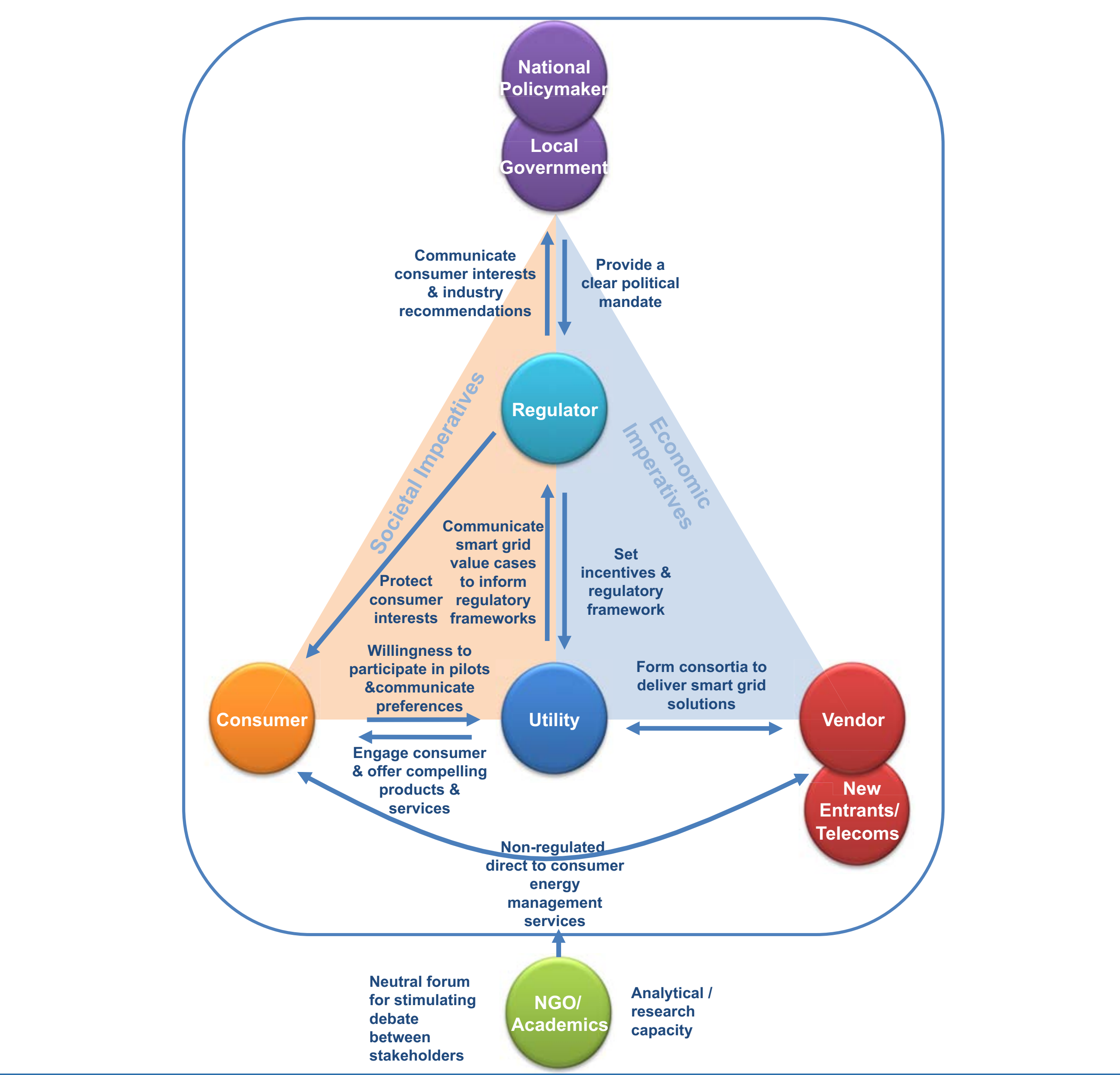
STAKEHOLDER DYNAMICS

No individual stakeholder group will accelerate the smart grid industry. A variety of stakeholders will need to collaborate. This cross-industry interplay will catalyse smart grid pilots and support the transition to mainstream roll-out.

This research effort has identified three of the most pivotal stakeholder relationships:

- **Policy-maker – Regulator: Realigning regulation with policy**: The relationship between policy-makers and regulators is critical as it sets the tone for the overall industry dynamic. Clear policy statements and targets help regulators and the broader industry frame the

Figure 6: Smart Grid Stakeholder Ecosystem



market rules and regulatory frameworks that govern the industry. Strong political consensus on direction and priorities provides the backdrop for the economic frameworks that, in turn, provide the stability for private-sector investment.

- **Utility – Vendor: The changing balance of power**: We see a shift in the balance of power in the traditional utility-vendor relationship through the formation of commercial consortia. Perhaps most interestingly, the introduction of telecoms companies as relatively new entrants to this vendor segment has the potential to bring about a positive industry disruption – their ability to cooperate with the utilities, or potentially bypass them, will stimulate healthy competition. The future success of the industry is heavily contingent on the ability of these consortia to form constructive partnerships.

- **Utility – Consumer: The advent of a closer interaction**: We see a heightened interaction between utilities and their customers through consumer-centric pilots such as smart metering, demand response programmes, EV pilots and smart buildings/smart home implementations. The success, or otherwise, of this relationship will be determined by the utilities' ability to develop compelling product and service bundles that meet the developing needs and expectations of the customer. These needs will vary by behavioural segment; however, if smart grid is to reach its full potential, utilities must develop a proximity to the consumer that enables them to develop pull for their products and services.

STAKEHOLDER RECOMMENDATIONS

Each stakeholder group will have a specific set of recommendations that they can take away from this report. In the section below we have identified a number of these by stakeholder group.

Policy-makers

- Reflect the new considerations of security of supply, increasing reliability requirements and climate change at all levels of the policy framework while focusing on achieving these goals at the lowest cost possible
- Provide clarity on the long-term policy direction enabling the private sector to justify pilot investments to shareholders
- Support international knowledge exchange, consumer education and the development of national and regional standards
- Promote national or regional cities as hubs for low-carbon infrastructure investment

Regulators

- Provide funding allocations to stimulate innovation (R&D and field pilots) and ensure that utilities have "permission to fail" but incentives to succeed
- Provide unambiguous guidance on the way pilot funding and pilot-related assets will be treated within the regulatory contract
- Align incentives across the value chain to ensure that the right incentives are in place for investment; provide guidance on how utilities should deal with asset-stranding risk
- Re-evaluate the policy objectives they are operating under and make steps towards outcome-based regulation that rewards delivery against a broad set of policy objectives
- Maintain a proactive and collaborative dialogue with industry to ensure that new frameworks are robust and fit for purpose

Utilities

- Participate in pilots, using the opportunity to build new skills and capabilities for the future
- Form cross-industry partnerships to reduce risk and gain access to new capabilities and perspectives
- Apply the effort, skills and discipline to the design phase to ensure clarity of objectives
- Make a logical separation between objectives relating to proving the technology, evolving the operating model and processes and testing new business models; all are important but, by piloting them in parallel, it can be difficult to separate cause and effect
- Be aware of the risks associated with consumer-facing pilot activities and engage consumers accordingly
- Where regulators are concerned about the potential consumer impacts of smart metering, consider progressing with grid-centric pilots
- Segment the customer base by need and behavioural markers and develop retail strategies and outreach programmes that target each segment
- Disseminate the qualitative lessons learned and anonymized quantitative data sets to reduce duplication of efforts and accelerate the industry's path to mainstream roll-out

NGOs and Academic Institutions

- Convene fora that promote cross-industry knowledge exchange and collaboration

- Become involved with technology R&D and analytical efforts that push forward the collective industry expertise

- Drive consumer education activities and operate as a trusted adviser for energy efficiency guidance

Vendors

- Evolve the relationship with the utility, moving out of the traditional contractor relationship into a collaborative partnering with shared risks and rewards

- Focus on articulating the value of smart grid, moving the debate beyond one centred on avoidance of the negative (blackouts, emissions, higher rates) to one that engages policy-makers and the public by describing the potential for exciting new energy applications with lifestyle benefits and enhanced opportunities for energy security

- Bring cross-industry lessons (especially from banking and telecommunications) to educate the successful transition from analogue to digital

- Drive business model innovation that disrupts the status quo and challenges the energy industry to develop compelling products and services

Consumers

- Regardless of sector – residential, SME, or commercial and industrial – make needs and preferences explicit to the utilities

- Consumers are encouraged to "vote with their feet", ensuring that where the regulatory regime allows, they switch to the energy provider that offers the most compelling products and services – driving retail innovation

- Recognize the stage we are in and appreciate that this represents a period of transition for the energy industry, where new technologies and business practices, while potentially not "right the first time", represent a step to a cleaner, more efficient and reliable energy system

SUMMARY RECOMMENDATIONS

A sense of urgency and a culture of action are required to move this technology from a niche activity to a mainstream technology. We advise the following three next steps:

1. **Short-term: Lay the foundations for success**

   a. **Policy-makers and Regulators –** Create the right conditions for innovation and certainty over funding and regulatory treatment while driving alignment on standards
   b. **Utilities and Partners –** Develop broad-based consortia, focus on creating a stable technology platform and engage consumers where they are likely to be personally affected

2. **Medium-term: Reshape the agenda and roll-out proven technologies**

   a. Policy-makers and Regulators – Review the regulatory framework to align incentives and encourage private sector investment
   b. Utilities and Partners – Use initial data to help shape the regulatory agenda; pilot changes to the operating model and processes; share data and use simulation to make the value case for roll-out of proven technologies

3. **Longer-term: Change the model**

   a. Policy-makers and Regulators – Reward utility innovation and encourage participation of new entrants that may offer new business models
   b. Utilities and Partners – Position the value case for full-scale roll-out of technologies as the economics improve; innovate around the business model to offer customers greater value; and use behavioural segmentation data to target a greater proportion of customers with differentiated product and service offerings

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