World Economic Forum White Paper Digital Transformation of Industries:

In collaboration with Accenture

Electricity Industry

January 2016

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1. Foreword

There is widespread recognition among leaders in most industries that the role of digital technology is rapidly shifting, from being a driver of marginal efficiency to an enabler of fundamental innovation and disruption.

Digitalization is the cause of large-scale and sweeping transformations across multiple aspects of business, providing unparalleled opportunities for value creation and capture, while also representing a major source of risk. Business leaders across all sectors are grappling with the strategic implications of these transformations for their organizations, industry ecosystems, and society. The economic and societal implications of digitalization are contested and raising serious questions about the wider impact of digital transformation.

While it is clear that digital technology will transform most industries, there are a number of challenges that need to be understood. These include factors such as the pace of changing customer expectations, cultural transformation, outdated regulation, and identifying and accessing the right skills – to name just a few. These challenges need to be addressed by industry and government leaders to unlock the substantial benefits digital offers society and industry.

Digital Transformation of Industries (DTI) is a project launched by the World Economic Forum in 2015 as part of the Future of the Internet Global Challenge Initiative. It is an ongoing initiative that serves as the focal point for new opportunities and themes arising from latest developments and trends from the digitalization of business and society. It supports the Forum's broader activity around the theme of the Fourth Industrial Revolution.

A key component of the DTI project in 2015 has been the quantification of the value at stake for both business and society over the next decade from the digital transformation of six industries. The 'compass' for these industry sectors is being set and it is imperative that all stakeholders collaborate to maximize benefits for both society and industry. Digitalization is one of the most fundamental drivers of transformation ever and, at the same time, a unique chance to shape our future. The World Economic Forum is committed to helping leaders understand these implications and supporting them on the journey to shape better opportunities for business and society.

In 2016, the DTI initiative will focus on the impact of digital transformation on an additional 10 industries, further deep-dives into industries from this year's project, as well as examine a number of cross-industry topics such as platform governance, societal impact, and policy and regulation.

The report was prepared in collaboration with Accenture, whom we would like to thank for their support. We would also like to thank the Steering Committee, the Working Group members, as well as the more than 200 experts from business, government and academia and over 100 industry partners who were involved in shaping the insights and recommendations of this project. We are confident that the findings will contribute to improving the state of the world through digital transformation, both for business and society.

Bruce Weinelt

Head of Digital Transformation

World Economic Forum

2. Executive Summary

The electricity sector is ripe for realizing value from rapid digital transformation; we estimate that there is $1.3 trillion of value to be captured globally, from 2016 to 2025.

By leveraging the building blocks of digitization, such as service platforms, smart devices, the 'cloud' and advanced analytics, companies in the industry have the opportunity to increase the asset life cycle of infrastructure, optimize electricity network flows and innovate with customer-centric products. New pools of value could also be tapped 'beyond the electron' by harnessing big data across sectors.

Five initiatives in particular, which range from managing the performance of assets, to real-time platforms, to integration of energy storage and customer solutions, can unlock respectively more than $100 billion over the next decade and must be prioritized for investment.

Yet, the maturity of digital initiatives in the industry varies: from projects using advanced analytics to optimize assets; and the widespread implementation of smart meters; to early moves by some utilities to manage and integrate distributed generation resources. Industry players agree on the need to make deeper customer engagement a priority and the pivotal role of digital technologies in making this a reality.

Energy technology providers are playing a key role in digitizing the industry, releasing a suite of smart turbines and panels, and sensors for commercial infrastructure. They are also developing connectivity platforms for industrial, commercial and retail customers. Established players and startups alike, are experimenting on the fringe of the industry. The burgeoning home energy market is a case in point, with more than 100 (non-utility) actors capturing value. With higher potential business value, smart industry and smart city markets are following suit in the business-to-business (B2B) and B2B-to-consumer spaces.

As the sector continues to adapt to the various transformations taking place, digitization must be a key priority, and indeed, can support development of new business models to respond to these industry shifts. Digital technologies have tremendous potential to contribute to growth in the sector and help deliver exceptional shareholder, customer and environmental value.

Four themes emerge for creating value:

1. **Asset life cycle management**: Technology solutions can enable real-time, remote-control or predictive maintenance to extend the life cycle or operating efficiency of the generation, transmission or distribution assets and infrastructure.
2. **Grid optimization and aggregation**: Grid optimization is possible through real-time load balancing, network controls and end-to-end connected markets, enabled by connected assets, machines, devices and advanced monitoring capability.
3. **Integrated customer services**: Innovative digitally enabled products and services relating to energy generation and energy management are bundled into an integrated customer service.
4. **Beyond the electron**: Hyper-personalized connected services beyond the electricity value chain, that adapt to the consumer. Electricity moves from being a commodity to becoming an experience.

No matter which shape the electricity company of the future takes, digital is likely to be a fundamental part of it. This report offers a series of pragmatic steps – both shorter-term, "no regret" capabilities and longer-term "bold plays" – that enterprises can take to digitally transform their operations and business model, and ultimately become a digital champion. This report also raises key questions for electricity leaders and policy makers to consider and address:

1. How do you reimagine the design of the energy system, given near-term digital and technological innovations which include predictive forecasting and energy storage? What infrastructure and systems are required to meet tomorrow's energy demand?
2. In economies transitioning to a lower carbon, more decentralized energy system, what incentives can be created by regulators and policymakers to optimize the electricity system and create a better functioning market?
3. What business- and operating-models are pre-requisites for energy companies to gain a greater share of the future industry profit pools beyond the electron – for instance, from connected home, smart car, buildings and cities, and industrial services?

3. Industry Context

This analysis of the electricity market covers utilities and energy equipment manufacturers, with a primary focus on those operating in countries of the Organization for Economic Co-operation and Development (OECD). The impact of digital transformation on electricity was considered across the value chain, from generation and transmission to distribution and consumption, and among residential and commercial/industrial customers. Market operations and trading were excluded from the value analysis.

a. Macro and industry trends

Growth in developed markets is slowing and becoming decoupled from demand.

Electricity consumption in the United States and Europe represents about 40% of global demand, but has been declining in both regions in recent years. In contrast, energy consumption in the rest of the world grew by 5.1% from 2007 to 2012, driven by a higher rate of economic growth in emerging economies. While the nature of this trend is uncertain in the longer term, in part due to the growth of decarbonized electrification and its potentially increased uses, such as in transport, it is clear that utilities must act now to decouple their revenue growth from future electricity demand in developed markets. With the potential of cleaner energy supply coming from renewable energy, and the surge in shale gas in North America, utilities are in a position where they must evolve their supply mix and innovate to protect their customer base.

Competitiveness for industrial consumers remains a challenge.

Global electricity price differentials are large, with industrial consumers in China, Japan, Brazil and Europe paying on average more than twice as much for electricity as their counterparts in the United States. Fair and predictable energy costs are essential to ensuring the competitiveness of domestic industries, particularly where energy accounts for a significant share of total production costs. Even with the collapse of oil prices, and taking into account China's lower labor costs and higher productivity, the country remains on par with the United States, which is driven by much cheaper electricity. Lower gas and electricity prices in the United States relative to Europe in 2014 illustrates this, as they totaled nearly $130 billion in estimated savings for the United States manufacturing industry.[1] In Europe, this is exacerbated by the impact of policy support costs on energy prices, which further impacts the competitiveness of industrial consumers.

The energy industry is under pressure to decarbonize.

More than 75% of global energy supply currently depends on nonrenewable sources such as coal, oil and natural gas, which contribute significantly to carbon dioxide (CO_2) emissions.[2] Global CO_2 emissions from energy have increased from 15,633 metric tons (Mt) in 1973 to 31,734 Mt in 2012; greenhouse-gas emissions from the energy sector represent two-thirds of the global total.[3] There is consensus on the need to reduce carbon emissions. For the first time, there is a legally binding and universal agreement on climate, with the aim of keeping global warming 'well below' 2°C, with countries striving for 1.5°C above pre-industrial levels.[4] Almost 200 countries took part in the 21st UN Conference of the Parties (COP21) in December 2015, with agreement that much greater emission reduction efforts are required. The onus will fall on utilities to look beyond conventional generation to more sustainable fuel sources.

Rapid technological development makes decentralization possible.

Digital technologies are increasingly being applied to energy infrastructure, with consumers and businesses adopting distributed generation and storage solutions. With the declining cost of renewable technologies, including batteries that are being scaled rapidly by companies such as Tesla Motors and Panasonic, and regulatory incentives, generation is being transformed. GE estimates that annual distributed power capacity additions will grow from 142 gigawatts (GW) in 2012, to 200GW in 2020, representing an average annual growth rate of 4.4 percent. When compared to an average annual growth rate in global electricity consumption of 3.3 percent, decentralized energy will grow at a rate that is almost 40 percent faster than demand.[5]

b. Technology and digital trends

The building blocks of the digital revolution

The advent of the cloud, social technology, big data and analytics are driving a number of technology trends that have immense potential for the electricity industry. Cloud computing is improving business agility, with an unparalleled time-to-market advantage. Big data is helping companies innovate, with the capability to analyze large quantities of both structured and unstructured data generating insights in real time. Mobile is enabling new business scenarios, while social channels are transforming the ability to connect with customers quickly, directly and cheaply. With the emergence of the Internet of Things, the volume of data that electricity companies can access – through the car, connected home, wearables and smart cities – will increase exponentially.[6]

Over the coming years, these technologies will combine to deliver a new layer of connected intelligence. It will revolutionize the ability of electricity companies to improve the efficiency of the electricity system and better meet their customers' diverse needs. However, three technology trends in particular are especially relevant to tomorrow's electricity provider: intelligent enterprise, platforms and mass personalization.

Intelligent enterprise

Machines are becoming smarter, and software intelligence is being embedded into every aspect of a business, helping drive new levels of operational efficiency and innovation. This trend turns big data into smart data, enabling significant cost- and process efficiencies. For example, enterprises can shift to predictive maintenance by using analytics. The *Accenture Technology Vision 2015* report found that 64% of utilities estimate that the volume of data managed by their organization has grown by more than 50% over the past year. As machine-to-machine communication becomes more prevalent, the interaction of people, data and intelligent machines will have far-reaching impact on productivity and operations.[7]

Platforms

Leading companies are bringing together digital initiatives onto the same platform to create next-generation products and services. While factories were the platforms driving the Industrial Revolution, computer and communications platforms have driven the information and connectivity disruptions of the past 30 years. Now, digital platforms are the next wave of change. According to the Massachusetts Institute of Technology in the United States, 14 of the top 30 global brands by market capitalization in 2013 were platform-oriented companies that connect buyers, sellers and third parties in real time.[8] Airbnb, Uber, Apple, Amazon and eBay are standout examples. The platform revolution will offer an opportunity to develop an entire system for electricity and beyond, spanning the digital and physical worlds.

Mass personalization

The ‘Internet of Me’ is the personalization of applications, products and services. It is changing the way people and enterprises interact through technology, placing the end user at the center of every digital experience. Current examples include equipping employees with tablets and smartphones, and making changes to information technology infrastructure to facilitate a bring-your-own-device program. An environment in which every intelligent device provides a channel for engagement with a customer is approaching quickly, creating an opportunity for electricity companies that can move fastest.

c. Digital adoption in the electricity industry

The maturity of digital initiatives in the electricity industry is varied. From projects using advanced analytics to optimize assets; and the widespread implementation of smart meters; to early moves by some utilities to manage and integrate distributed generation resources. To illustrate, 43% of utilities are currently investing in digital technologies as part of their overall business strategy, indicating a mixed approach.[9]

Energy technology providers are playing a key role in enabling the digitization trend, releasing a suite of smart turbines and panels, and sensors for commercial infrastructure. There are several examples of leading connectivity platforms for industrial, commercial and retail customers, such as **Johnson Controls** Panoptix and **Honeywell’s** Intelligent

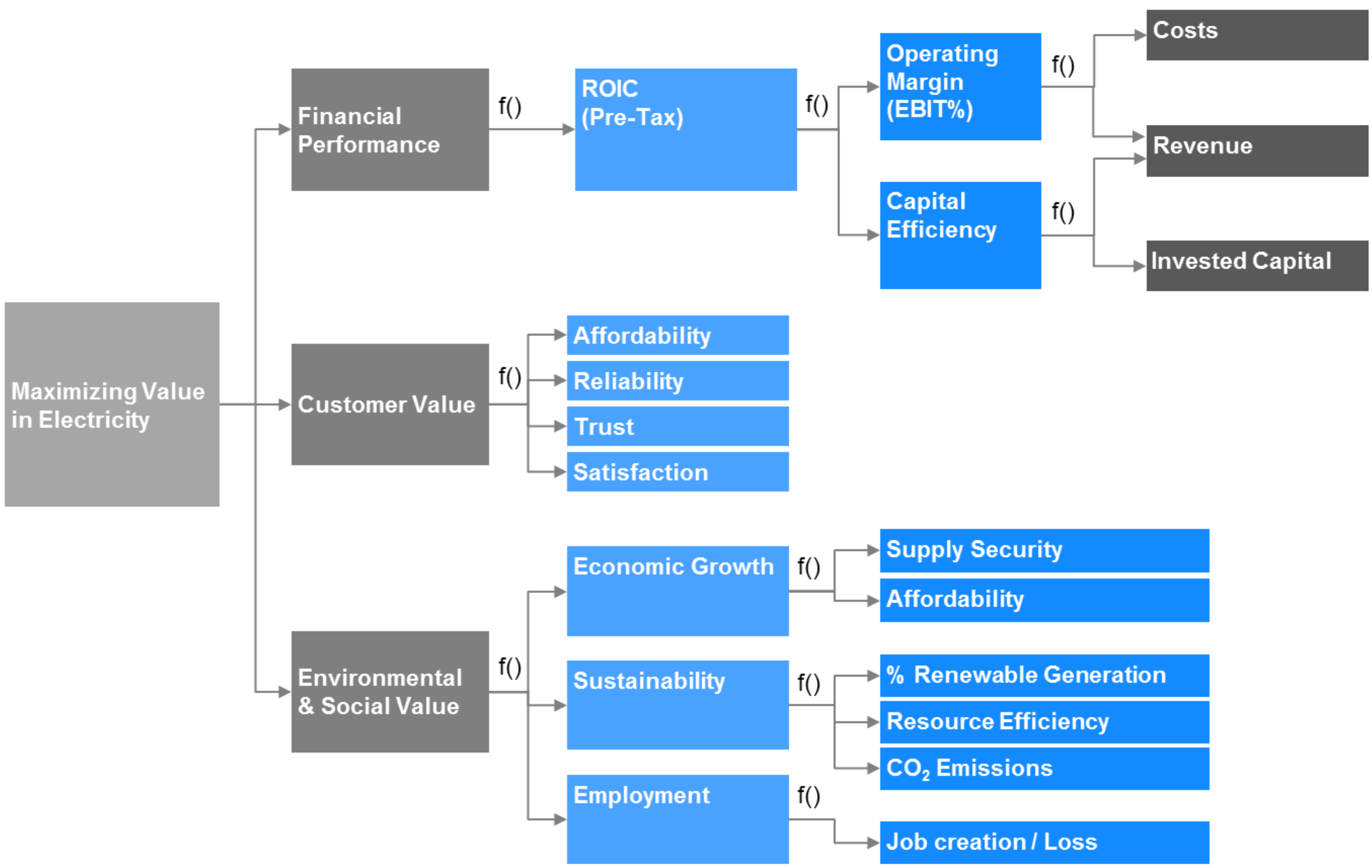
Buildings. Similarly, **GE** has recently launched Predix, a platform for industrial-scale analytics, which will connect machines, sensors, control systems and devices to capture and interpret data from manufacturing and production systems.

Equally, change is coming from non-industry actors, including both established players and startups. Such companies are emerging across the value chain, from **Bosch** and **Telenor** optimizing the grid, to **BT** and **Comcast** connecting the home. The head of strategy at Vattenfall sees increasing convergence between electric utilities and the home retail market, noting that "industry boundaries are blurring, creating an entire home service that better meets the need of the consumer." Kitchen appliances, thermostats, lights, locks, phones and televisions are becoming smarter and more interconnected. **Miele**, for instance, offers energy-efficient appliances connected to a home gateway that stores information on up-to-the-minute electricity rates, so that appliances can be started automatically at the most economical time[10]. In addition, a whole host of startups are entering the home hardware space, from **tado°** in thermostats to **Rainforest** or **2GIG** in home displays.[11] Energy utilities can develop partnerships with energy technology companies at the forefront of the industry's digitization.

d. Value creation and disruption in electricity

Digitization does not have to happen outside of organizational priorities and, indeed, can play an important role in forming a cohesive response to these industry shifts. Digital technologies have tremendous potential to move beyond stagnant growth and deliver exceptional shareholder, customer and environmental value. Value creation in the electricity market is a function of financial performance and customer, environmental and social value (Figure 1). Please refer to the appendix for an overview of the value at stake framework.

Figure 1: Maximizing value in electricity



Source: Accenture analysis for the Digital Transformation of Industries project

The traditional utility business model is being challenged, placing utilities under pressure to innovate.

Many integrated utilities have struggled to deliver shareholder returns amid regulatory changes, price volatility and demand fluctuations. Return on invested capital (ROIC) for the 25 largest integrated utilities declined from an average of 6.6% in 2009 to 4.1% in 2014. Most of the decline for these companies was driven by lower operating profits,[12] which fell by an annual rate of 5.2% over the five-year period.

Non-integrated players are capturing increasing value.

Despite this decline in profits for integrated utilities, profits for the industry as a whole increased at an annual rate of 2.7% from 2009 to 2014. This came predominantly from independent conventional power generation companies in Asia, particularly China, whose profits grew at an annual rate of 25%. The shift to renewable generation, coupled with slowing demand growth in developed markets, has meant that a larger share of industry profits is now captured by non-integrated electricity companies – particularly those engaged in renewable equipment manufacturing, generation and distribution. Based on analyst forecasts, non-integrated players have captured a larger share of the industry profit pool over the past five years, and this trend is expected to continue.

Non-traditional entrants in renewables are challenging incumbents.

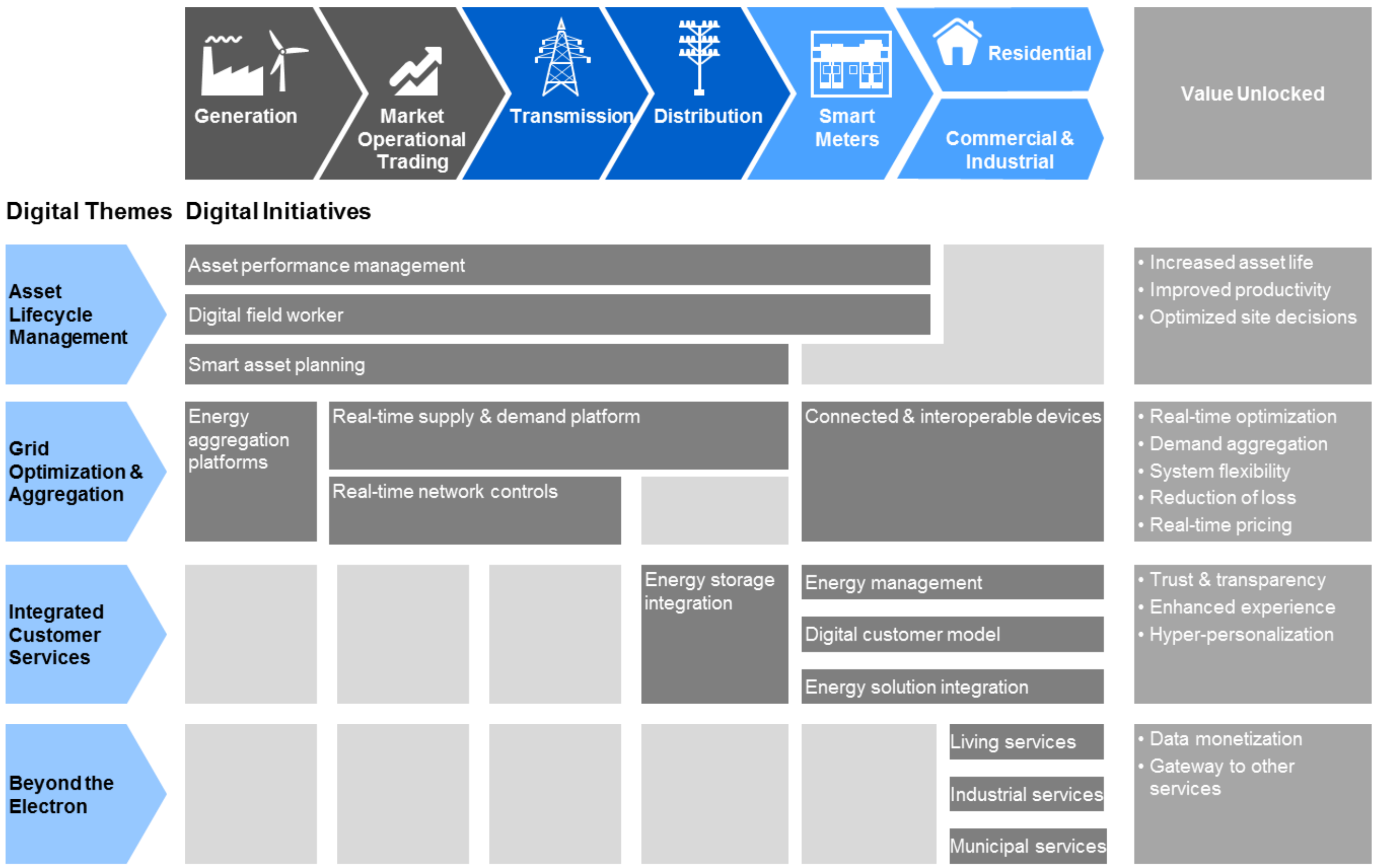
Investment in advanced renewable technologies is a significant source of innovation within the electricity industry and there are a host of new entrants. Solar received by far the largest amount of startup investment in renewables from 2012 to 2015, totaling $5.4 billion, with Sunrun and SolarCity among the major recipients. In addition, investment in wind power totaled $2.2 billion over the same time period, with Pattern Energy a major startup in wind power generation and transmission. Investment by both disrupters and incumbents into emerging technologies and the unbundling of services across the value chain will result in a major shift of value over the coming decade.

4. Future Horizons

Digital themes and initiatives

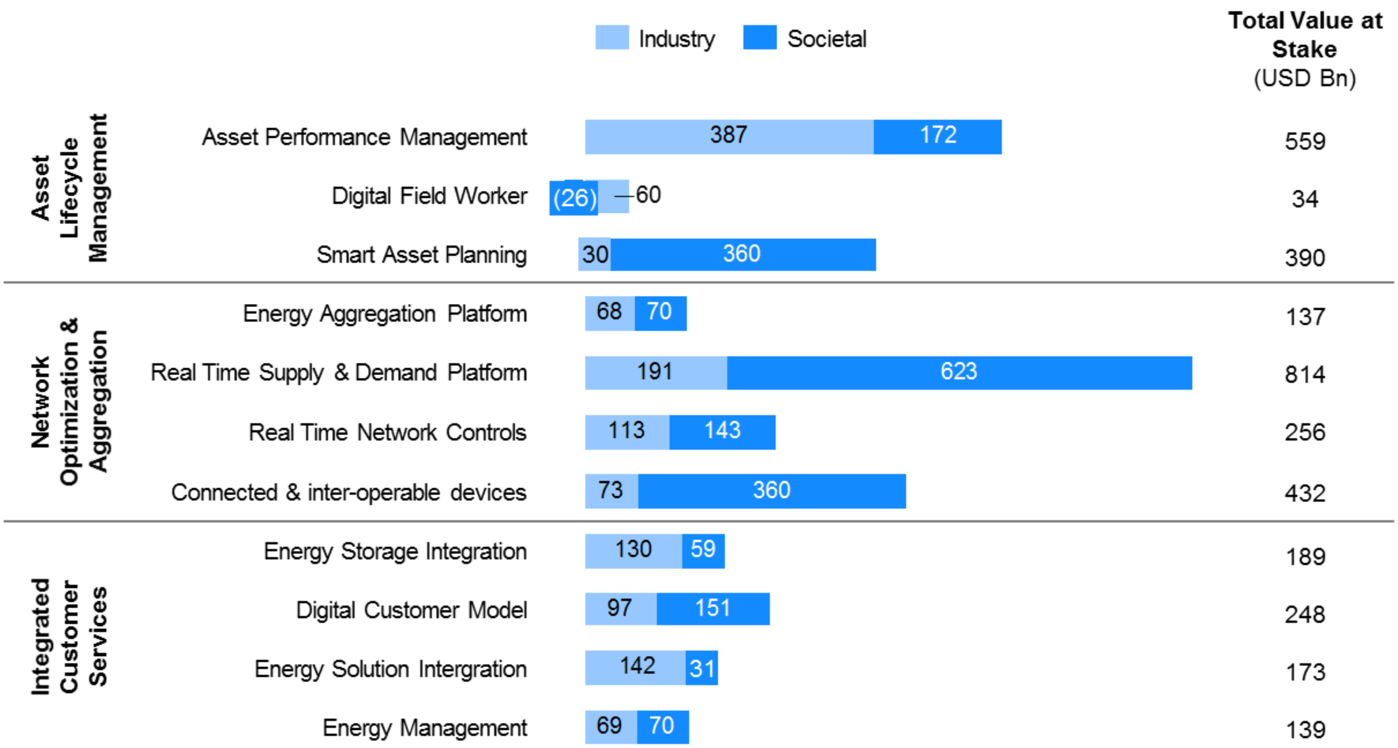
The four themes that have emerged are asset life cycle management, grid optimization and aggregation, integrated customer services, and beyond the electron. A number of digital initiatives can be pursued within each theme, each with our estimated 'value at stake' to enable prioritization. Figure 2 maps initiatives to the part of the electricity value chain that they relate to, from generation to consumption. Each initiative clearly illustrates, with current examples, how these digital themes are relevant to the electricity industry as it evolves over the next few years. Figure 3 summarizes the value at stake for each digital initiative.

Figure 2: Digital themes and initiatives



Source: Accenture research for the Digital Transformation of Industries project

Figure 3: Value at stake for digital initiatives



Source: Accenture research for the Digital Transformation of Industries project

a. Asset life cycle management

Asset life cycle management encompasses the technology solutions that enable real-time, remote control or predictive maintenance for extending the life cycle or operating efficiency of assets. Some utilities have projects underway and are deploying technologies such as smart sensors on generation and distribution assets. However, many assets still lack the capacity to collect and transmit data and are not connected to a central platform.[13] A marginal improvement in operating efficiency of generation, transformers or power lines will have an exponential effect once scaled across the industry.

According to the chief executive officer of AutoGrid, “data is cheap, clean and the only resource that is increasing. Machine-learning algorithms can do a great deal to improve efficiency and predictability”. The incentive is clear: the United States Department of Energy found that 75% of breakdowns are eliminated by energy companies that have implemented predictive maintenance.[14]

Operational recommendations can be generated in real time by using data captured from connected devices, plant equipment and sensors, and applying algorithms to this data. Plant managers can immediately identify actions that decrease production costs, and can predict and prevent unplanned downtime. Engineers can be more productive by making better-informed decisions; this can eventually lead to a smaller, more skilled workforce. As an example, real-time analytics help a business better understand the trade-off between asset life and revenue generation, as there may be times when it makes sense to work a machine harder, if a generator can take advantage of scarcity pricing.

Asset performance management

This digital initiative includes condition monitoring, predictive forecasting and reliability-center maintenance, all enabled by analytics and robotics.

Case study

Iberdrola deployed a technology to monitor and operate renewable generation facilities from a single dispatch center called CORE, located in Toledo (Spain). CORE centralizes the operation and control, in real time, of 7,000 megawatts (MW) of installed power from 220 wind farms, 70 mini-hydropower plants and more than 6,000 wind turbines, spread across nine countries.[15]

Information from sensors is fed to the central control center, which monitors in the region of 2 million operational signals. With improved insights into fault detection, events and breakdowns in turbines and control systems; the reactive and active power regulation; and the voltage in the connection point, both the quality of renewable energy and the management of the grid is improved. In addition, by taking preventive measures remotely, both operational risk and maintenance expenses are significantly reduced.

Digital value at stake

Asset performance management has the greatest value potential among all the digital initiatives, to the tune of $387 billion over the next 10 years. Utility firms across the value chain are likely to enjoy margin expansion from lower repair and maintenance costs, lower downtime of assets and fewer critical breakdowns. However, a significant portion of this is expected to accrue from the sale of smart sensors and hardware/software to enable predictive maintenance. Energy technology companies, such as ABB, Siemens, GE, JCI and Schneider Electric are already profiting from this initiative, with sales of sensors for commercial infrastructure and software services. Asset performance management is likely to have a positive impact on the environment, with reduced carbon emissions of 2.4 billion metric tons.

Digital field worker

The focus of this digital initiative is to use digital technology to improve field workers' performance and productivity by empowering them with data and tools to drive operational efficiencies. Electronic work packages can transform the end-to-end work cycle, from the planners and schedulers to those responsible for data entry and reporting.

Case study

Advances in mobile technology have led to a number of solution providers emerging to digitize field operations. **Avoka TransactField**, a field data collection system, moves slow paper processes to an application featuring audit and compliance processes that work both online and offline on any device. The solution was deployed by **Ausgrid**, a state-owned Australian electricity infrastructure company that owns, maintains and operates the electrical distribution network of 1.6 million customers in New South Wales. One of its tasks is to do site checks at the company's more than 250 power stations, as well as 500,000 power poles, 30,000 small distribution substations and almost 50,000 kilometers of below- and above-ground electricity cables in the region. Using the software, information can be gathered in remote locations, improving responsiveness and data quality. In 2014, 22,000 field workers in the energy industry were digitized by the Avoka system, with the company estimating that productivity had improved by an average 72%.[16]

Digital value at stake

This initiative is likely to result in significant productivity improvements for field workers and associated staff. We estimate that the technology could result in savings of five to eight hours of work per week across the value chain. However, gains in efficiency are likely to come with redundancy; we estimate this could reach 340,000 jobs by 2025. While these losses are more than addressed with jobs gained due to digital transformation, electricity providers must commit to reskilling. The value realization potential could be up to $60 billion, after investments in relevant infrastructure. Software and hardware service providers for this infrastructure could also enjoy significant and recurrent profit streams.

Smart asset planning

Smart asset planning covers the use of predictive analytics, machine learning and robotics to improve capital-project execution, including site and asset selection, installation and decommissioning.

Case study

The **US Department of Energy**'s SunShot initiative seeks to make solar cost-competitive with other forms of electricity by the end of the decade.[17] The initiative funds innovative projects by organizations, universities and national laboratories that drive down the cost of solar technology. As hardware costs continue to fall, a key part of the cost of deploying photovoltaic (PV) systems is in site selection. The SunShot program has made a number of mapping applications open-source to assist in siting decisions. **PVMapper** is an example of a geographical information system that takes into account site location, time zone, sun path and nearby weather station data, among other variables, to optimize the decisions on location and commissioning.[18] Since SunShot's launch in 2011, the average price per kilowatt-hour of a utility-scale PV project has dropped from approximately $0.21 to $0.11, of which some value can be apportioned to better siting. SunShot has achieved 70% of the program's goal after only three years of the 10-year timeline, demonstrating the initiative's impact.[19]

Digital value at stake

Smart asset planning offers the potential to better commission generation, transmission and distribution assets. Targeted investments can optimize capital expenditures, reduce costs and increase asset life and reliability. Interestingly, while smart asset planning offers the least value to industry of all of the digital initiatives, estimated at $30 billion, societal benefits are likely to be significant. Carbon emissions can be reduced by almost 6.3 billion metric tons, the highest among all initiatives, while we predict there could also be significant job creation.

Asset life cycle management: Summary

While good practices in asset life cycle management are evident today, electricity companies have a great opportunity to scale it up. The cumulative impact of companies investing in these initiatives across their operations would be significant. Asset life cycle management reduces operating costs and improves standard manual processes, with maintenance becoming predictive and intuitive. Improved information regarding grid investment and management leads to more informed decision making. Moreover, companies usually have low margins in generation, transmission and distribution, and so can improve their financial performance, albeit while accepting a typical two- to five-year payback for initiatives.

Great potential also exists to improve workforce safety in remote areas, with more automated maintenance and the tools to enhance operating efficiencies; drones, for example, could inspect remote pipelines. However, gains in efficiency come with the downside of redundancy in a number of traditional skilled jobs. Electricity providers have a social responsibility to give careful consideration to the reallocation and reskilling of the workforce.

Finally, improving operating efficiency has clear environmental value, with the opportunity to reduce carbon and the embodied water in electricity production. Renewables at high risk of wear and tear from the weather become more predictive and therefore more resilient, improving the capital life cycle and the overall business case. Supply security is improved, as algorithms are self-learning and can predict when alternative modes of supply need to be switched on, or when a plant is due to fail.

b. Grid optimization and aggregation

This theme epitomizes the shift of a utility toward a 'commitment to optimize', tackling inefficiencies and waste in the transmission and distribution grid through a number of digital initiatives. Optimization of the grid is made possible through real-time load balancing and network controls, enabled by connected devices and advanced monitoring capability.

Utilities will be able to receive the latest usage information from customers in real time, while customers will receive up-to-the-minute pricing signals and tariffs. As the director of group strategy at Centrica points out, "data is enabling the network to be cheaper, allowing less spare capacity on the system, offering much finer optimization and flexibility in meeting requirements". The impact of this theme is transformational: the system can start to dispatch the most economic, reliable and sustainable sources to meet demand, delivering higher efficiency.

An optimized grid moves beyond a smart grid deployment (new technology in an old management paradigm) by combining smart grid infrastructure with analytics and intelligent devices, linking the grid to the customer. While doing so, it also creates an efficient and well-functioning market, offering price signals that promote the right kind of behaviors by market participants. Besides driving greater value from existing smart meter investments, mobile devices and social media tools will improve communications with the customer. Along with better insight, this creates a dynamic customer interface, where utilities can offer genuine value to customers through add-on services, providing the data backbone of integrated customer services.

Insights for an optimized distribution grid can also be applied to the system operators. Because improved data would facilitate better understanding of supply and demand, digital technologies can use demand information to alleviate transmission congestion by dispatching distributed resources as opposed to tapping into distant resources through the transmission grid. An improved link between wholesale and retail prices can be established, enabling wholesale to factor more real-time information into price decisions. In sum, digital technology has the potential to improve the system's flexibility by establishing this feedback loop.

Energy aggregation platforms

In this digital initiative, the utility serves as an aggregator of locally generated power. Platforms for energy aggregation bring small-scale distributed-energy sources – renewables such as PV, wind, biomass, combined heat and power, or diesel – onto a single platform, enabling a cluster of generators to act as one large power plant. These platforms can both deliver electricity when it is required and store any surplus power, thereby balancing the grid.

Platform technology allows renewables to be more efficiently integrated into the grid, as their variability is managed from one central control room. A common example of such a platform is a virtual power plant; which integrates renewable energy sources while avoiding the common pitfalls of lack of scale and predictability. A virtual power plant allows for the system to be optimized based on region-specific grid needs and can provide more economically than delivered electricity. Investment decisions are made more efficiently, as they can be based on additional capacity required.

Case study

Next Kraftwerke, a plant operator and power trader founded in 2009, launched a virtual power plant covering 790MW of distributed generation capacity in Germany.[20] The company provides ancillary services for a number of Germany's transmission service operators, such as Amprion, EnBW Transportnetze, 50Hertz Transmission and TenneT.[21] Real-time market data, including electricity prices and weather forecasts, are captured and used to create an operational schedule, managed by a control room in Cologne. The central platform enables Next Kraftwerke to plan and optimize production while also improving monitoring and control. The plant operator is experiencing significant growth: in 2013, it aggregated 1GW of capacity from 2,400 installations and traded 2.5 terawatt-hours (TWh), mostly from biogas, biomass and combined heat and power plants, which was up from 400 installations and 1TWh in 2012.

Digital value at stake

Distributed energy resources are expected to grow from 10% to 20% of installed renewable capacity in the next 10 years. This would lead to reduced selling, general and administrative costs for small and dispersed energy sources by almost 10%, which would directly flow into profitability. However, a significant portion ($57 billion) of the total value realization of $68 billion is likely to flow to aggregator providers for these distributed resources. Societal benefits are also likely to be significant, with value accretion to customers to the tune of $42 billion, likely job creation and 392 million metric tons of reduced carbon emissions.

Real-time supply and demand platform

This digital initiative relates to the monitoring and communication of current load supply and demand, paired with a discriminatory pricing framework. This allows for a fundamental change in behaviors through tariffs, localized pricing signals and interconnectivity.

Disrupter **Reposit Power** in Australia enables consumers to sell electricity back onto the grid by placing bids back into the market, thereby turning residential properties into micro power plants.[22] Control is automated, so energy is sold to the grid when prices are high. Customers can feel confident they are receiving the best price for their excess electricity, and may reduce their usage to sell more back to the grid.

Case study

Alliander, a major energy distributor in the Netherlands, is currently piloting projects that match supply and demand at the local level in real time. Partnering with CGI, an IT solutions provider, Alliander is using its PowerMatcher software as the foundation for Realtime Energy eXchange (REX). An example at the municipal level includes smart controls for switching street lamps on and off at optimal times, leading to energy savings. This is expected to be rolled out to 800,000 streets across 14 municipalities.[23] At a household level, REX enables nonessential appliances to be run at times when supply is abundant and power prices are low – for example, overnight.

Response to demand is optimized by integrating consumer-owned technology with the management of the grid. In addition, by acting as an aggregator, the exchange allows surplus energy to be traded on the energy trade market. Alliander and CGI are also researching potential ways for REX to take advantage of the growing increase in electric car ownership in the Netherlands, for example by using the batteries of electric vehicles as a flexible storage solution for excess supply.[24]

Digital value at stake

Real-time supply and demand platform, potentially worth $191 billion for industry, offers more than three times the benefit to society. Customers are able to capture up to $559 billion of value from smart saving choices, with a higher incentive to postpone consumption during peak hours. Lower peak demand could result in lower carbon emissions **by** 1 billion metric tons. There is incentive for system operators to put in place the infrastructure that enables better monitoring and communication of current load supply and demand, to reduce wastage and improve margins.

Real-time network controls

The function of this digital initiative is to enable real-time adjustment to changing loads. Such adjustments can also be made to increases or decreases in generation and to failure conditions of the distribution system. It allows two-way communications and operational signals with the market.

Case study

An example of real-time network controls in action today can be found in Scandinavia. The **Nordic Power Market**, which includes Denmark, Sweden, Norway and Finland, enables electricity trading through aggregation at scale and across borders.[25] The Elspot market, which trades electricity for next-day delivery, covers 77% of total electricity consumption across the Nordic countries. To optimize the use of physical resources, electricity volumes are coordinated among the countries up to a day in advance. Communication triggers and control become vital. The transmission system operators publish data every minute on electricity production by generation type, net exchange and consumption per country.[26] This allows for generation and load to be balanced at any time, and a price to be provided for participants' power imbalances.[27] With large volumes traded daily, strong collaboration is required among system operators to determine the quantities that should be generated, sold and stored. If four nations can successfully coordinate their electricity supply and demand, what is preventing this approach being used more widely?

Digital value at stake

Real-time network controls is expected to be worth $113 billion in total value addition for the industry. Suppliers and advisors on smart-grid technology and services are expected to be worth $82 billion over the next ten years. Smart grid spending by some governments has been growing at 10% compound annual growth rate, so the value at stake could increase as more players enter the arena. Also included in the total value addition is potential for this initiative to reduce distribution losses by $32 billion, which amounts to a reduction in technical losses in the transmission and distribution network, by up to 50%. Reduced servicing costs from lower breakdowns would also lead to margin expansion.

Connected and interoperable devices

This digital initiative focuses on device-to-device connectivity and collecting and displaying energy consumption points for the utility. These can then be linked into the distribution network.

Case study

RWE embarked on a project in 2004 to create an open industry standard for industrial and commercial smart meters. A consortium was launched, including **EnBW Energie Baden-Württemberg, E.ON** and **Landis+Gyr**, and the Synchronous Modular Meter (SyM^2) metering standard was born. SyM^2 was one of the first meters based on the Internet Protocol, built with open modularity to allow for the introduction of new features and functions. Data quality was improved and costs were reduced for the partners involved; the industry came a step closer to interoperable devices connected to the network.[28]

In addition, the **PRIME Alliance** (where PRIME is PoweRline Intelligent Metering Evolution), established in 2009, aimed to develop an open, public and nonproprietary telecom solution to support progress toward the smart grid. A number of projects followed, including Iberdrola's deployment of 100,000 meters in 2010; and pilots by **Gas Natural Fenosa** (Spain); **EDP** (Portugal); **ENERGA-Operator** (Poland); **EDL** (Lebanon); and **Energex** (Australia). Today there are more than 10 million PRIME smart meters deployed in commercial rollouts and pilots, in more than 10 countries worldwide.[29]

Digital value at stake

Intelligent devices and sensors are required to reap the potential benefits from digital transformation. In this initiative, profits foregone from lower consumption would be offset by higher savings, for a combined value addition of $18 billion for the industry. Increased adoption of smart meters by residential and industrial customers could add a further $55 billion, for a total value addition of $73 billion for the industry. However, the main beneficiary is expected to be the end customer, who could potentially realize up to $290 billion of savings from lower peak consumption, over the next 10 years. Reduced need for peaking power plants could also reduce carbon emissions by up to 701 million metric tons.

Grid optimization and aggregation: Summary

Digital initiatives relating to this theme will start to build resilience into the system, improving availability and security of supply. Electricity may become more affordable for some customers, or at least price fluctuations will be levelled, if the value reclaimed from avoided wastage is passed onto customers. An additional upside is that utilities will be able to integrate renewables into their portfolio more seamlessly and at scale, playing their part in meeting challenging mandates on the reduction of emissions.

c. Integrated customer services

Electricity companies will move from being 'energy-centric' to 'customer-centric', using increasing volumes of customer data to better understand behavior. A tremendous opportunity exists to develop innovative digitally enabled products and services, bundled to provide an integrated customer service. Energy companies will start to play a bigger role in how consumers optimize the home, choose tariffs, manage consumption and payments, and embed self-generation.

Consumers are starting to expect choice, reliability and personalized service that extends beyond the meter. A growing number of blue-chip vendors, such as Apple, Google, Samsung and Verizon, are partnering with incumbent hardware and software providers to develop an integrated customer service. These players are well positioned to offer a seamless consumer experience across channels, and are challenging the traditional utility-customer model.[30]

Digitally engaged customers have higher potential value to utilities, as they are more likely to participate in energy-management programs and to trust – and be satisfied with – the service they receive. According to Iberdrola's group innovation director, "it is important to invest in integrated customer service offerings that may not have the economics now, but will increase customer segmentation and improve loyalty and experience".

Success in this market will be driven by the ability to provide customers with solutions that give them the flexibility to control, monitor and switch between different energy sources. For example, **Solar City**, which leases distributed assets without down payments, makes the adoption of solar straightforward and affordable. Accenture's New Energy Consumer research of 2015 found that, while only a handful of respondents (9%) had solar products in 2014, 55% were considering purchasing or signing up for solar in the next five years.[31] The sharing economy will boost the democratization of energy sources, with neighbors or local businesses connected on a platform to buy and sell power from each other, matching supply with demand on a micro scale.

Integrated customer services also relate to how energy technology companies are empowering businesses to self-generate, participate in demand response programs and take a data-driven approach to managing consumption. A number of energy technology players, such as **Silver Spring Networks, AutoGrid, Tendril, Opower** and **Hitachi**, to name a few, offer data management platforms that encompass these benefits. These companies are capturing value by running analytics on an increasing volume of smart meter data points to deliver energy management insights in real time. Some players, such as **Comverge**, **Enablon** and **C3 Energy**, also employ insights from behavioral science to encourage energy users, through interactive portals and personalized tips, to reduce their consumption and improve energy efficiency.[32]

Energy storage integration

Technology solutions that enable integrating energy storage devices into the grid, including those in a domestic setting, are the focus of this digital initiative.

Case study

The current utility business model will change with the ability to store electricity that is produced when it is not needed, and discharge it when it is, at scale. Through economies of scale and innovative manufacturing processes, lithium-ion battery prices are reducing, a trend that is set to continue. Players such as **Stem** have emerged to dramatically improve energy efficiency by combining big data, predictive software and batteries to learn customers' energy profile.[33] Stem's solution provides capacity to the grid when demand is peaking. With this approach, Stem has won an 85MW distributed storage contract with Southern California Edison to provide capacity to the grid in the West Los Angeles area.

Digital value at stake

Energy storage integration, worth a projected $130 billion for the industry, is significant because of the value at risk from migration due to new entrants, and the potential for pass-through margins from the sale of storage units to existing customers. Value migration in the industry, estimated at $67 billion, is driven by consumer renewables, especially solar, as PV penetration is forecast to increase 2% to 5% over the next 10 years. Penetration levels of solar units could rise significantly once grid-parity price is achieved, which is expected between 2018 and 2020. The value addition to the industry is expected to come from lower load on the grid ($6 billion), and value add to suppliers ($57 billion), with PV cells and other renewable technologies expected to gain significantly.

Energy solution integration

Branded solution integrators will provide new services that will help customers not only optimize energy production and use, but also allow for greater control and cost savings.

Case study

PowerShop is an integrated energy solution provider, offering consumers the ability to view, monitor and purchase electricity online, on mobile and via social media. Launched in 2009, the disrupter offers a differentiated, modern service by providing convenient, cost-effective and personalized access to energy packages at a range of price points. From their smartphones, customers can monitor home energy consumption and choose the source of their electricity, such as from alternative energy projects including wind, solar or landfill generation.[34]

Digital value at stake

Energy solution integration is expected to be worth $142 billion to industry, primarily from value migration to renewable sources of energy. There is significant value to be captured by developing plays in integrating renewable resources - for example installing, financing, running and maintaining energy assets such as distributed generation and electric vehicle charging stations. Disrupter companies currently building momentum include Stem, Solar City and PowerShop. Customers could also realize value of $27 billion from higher savings that these solutions provide, offsetting the higher unit cost of energy.

Energy management

This digital initiative will see prosumers provided with the energy-information displays and controls they need to manage generation, storage and flow.

Case study

E.ON is an integrated utility that differentiates through value-added services for its B2B customers. E.ON Connecting Energies provides an end-to-end service that integrates energy efficiency solutions, on-site generation and flexible solutions. On the supply side, electricity can be generated directly at the client's site, supported by a virtual power plant, with communication triggers back to the trading team to trade oversupply at optimum times. On the demand side, its energy management capabilities include online reporting of live energy usage, identifying and implementing energy conservation measures, and designing and installing larger capital investment projects.[35]

Digital value at stake

As electricity consumers increasingly turn to self-generated power, utilities have an opportunity to provide the necessary energy management tools to allow their customers to control and manage generation, storage and flow. At present, the increasing penetration of such systems is likely to migrate up to $16 billion in value away from traditional utilities, with total value to the industry likely to be worth around $69 billion. Utilities must act now if delivering on-site energy management is an attractive business model. Customers could realize up to $32 billion from lower costs and re-selling excess energy back to the grid. Carbon emissions are expected to reduce significantly (531 million metric tons) from higher adoption of renewables.

Digital customer model

Customers will increasingly interact with their electricity provider through multiple channels, including Web, mobile and social. The customer interaction model will be transformed through embedded customer analytics within services that accelerate digital migration and improve customer engagement.

Case study

To appeal to the UK rental market, **Centrica/British Gas** developed its "Me" app to allow users to predict bills and split payments with housemates.[36] In the future, add-on services may include the ability to compare the consumption of people residing on the same street, and integrate with remote temperature controls and smart meters. Utilities will be able to move from supplying a commodity to providing an experience, better meeting consumer needs and improving brand “stickiness”. Consumers will also be able to determine their electricity mix, reduce usage and drive efficiency.

Digital value at stake

Energy utilities stand to gain with lower customer acquisition and retention costs, through investing in digital channels that empower the consumer to manage their electricity consumption. Total value realization for industry could reach $97 billion, with higher savings offsetting the revenue lost from lower consumption. Consumers could save on their electricity bills, from closer monitoring of their consumption and billing patterns. The expected benefits total $139 billion. Lower carbon emissions (172 million metric tons) provide additional benefits to society.

Integrated customer services: Summary

With growth becoming decoupled from demand, more renewables being integrated and margins declining, integrated utilities are finding it increasingly difficult to grow revenue in developed countries. As it is impossible to differentiate on electrons, electricity companies have an opportunity to better segment their B2B or business-to-consumer (B2C) customers, resulting in a brand "stickiness" that has been nearly impossible to achieve to date. Add-on services present a new revenue stream that will help overcome the risk of a low-profit, low-growth market. A number of energy technology players have emerged that are partnering with utilities to offer a compelling suite of energy management services.

d. Beyond the electron

Customers are now starting to develop ‘liquid expectations’, with the belief that a high-quality service in one industry should be connected and translated to the next. Technology is propelling this expectation through sensor-rich objects, smarter devices, the decreasing cost of cloud computing and the increasingly seamless nature of connectivity. As noted by the senior vice president of strategy at Statkraft, “data-centric business models offer flexibility, improved margins and the ability to deliver new value to an existing customer base”.

Electricity companies can look beyond the electron by providing a hyper-personalized, connected service that adapts to the changing consumer, business and citizen. As the provision of electricity moves from being a commodity to becoming an experience, it will be managed not by a single utility but by cross-industry partners – the key differentiator of this theme from integrated customer services.

Living services

Living services describe the cross-industry digital services that can be offered to consumers by combining sensors, the cloud, connected smart devices and real-time analytics to deliver a new layer of integrated consumer experience.

Case study

In 2014, **Google** acquired **Nest**, a leading company in the connected home market, for $3.2 billion.[37] It signaled a move by Google toward developing a more integrated experience in the home. Nest and Google have continued this process by establishing a number of partnerships with lifestyle and home-product brands that extend far beyond the original Nest thermostat. Examples include LIFX's smart lightbulbs, primed to turn on at night to improve safety when a dwelling's occupants are out; Jawbone wristbands that use motion-sensing technology to turn the heating on when the wearer wakes; and Mercedes-Benz cars that communicate with the connected house to turn on the heating when the vehicle and its occupants are 30 minutes from home.[38]

The Nest thermostat and carbon monoxide detector continue to be popular, with 100,000 thermostats reportedly being sold a month, generating estimated annual revenues of $300 million.[39] Nest says that its thermostat pays for itself within two years, saving US customers 10 to 12% on their heating bills and around 15% on their cooling bills – a total of $131 to $145 per home, per year.[40]

Nest's core value proposition is based on the continually learning algorithms that collect and interpret data from the expanding network of devices.[41] Exploiting the growing infrastructure of sensors and connectivity will lead to a host of opportunities beyond the electron.

Industrial services

In this digital initiative, business customers will be offered a suite of engineering services, such as manufacturing and industrial processes, energy, power, data security, lighting and safety. All operate from a single platform and continually evolve, using insights from data analytics.

Case study

GE has recently launched Predix, a platform for industrial-scale analytics, which will connect machines, sensors, control systems and devices to capture and interpret data from manufacturing and production systems. Aimed at several different industries, its application includes the following examples: Digital Power Plant and Digital Wind Farm for electricity, Rail Connect 360 monitoring and diagnostics for transportation, cloud imaging for healthcare, and nondestructive testing remote collaboration for oil and gas utilities.[42] GE is encouraging innovation in the ecosystem, opening up the platform to third parties and developers for integrating new products and services.

Municipal services

A full integration of services for citizens is covered, such as providing those for transportation, emergencies, food, sanitation, waste management and electricity. Citizens will experience real-time interactions with service providers and receive tailored, individualized service.

Case study

Singapore is a smart city and currently active, with the government installing thousands of sensors across the city in 2015 to monitor metrics such as water levels, traffic congestion, crowds and air quality.[43] Across Singapore, connected heating, ventilation and air conditioning, and an abundance of sensors allow for monitoring consumer movement and behavior in real time. In addition, most government services are available on a single online platform. Launched in 2003, SingPass is a gateway to hundreds of e-services that provides convenience and a more individualized service.[44] Singapore continually ranks highly as one of the world's safest, healthiest and digitally secure cities, according to The Economist Intelligence Unit's Safe Cities Index 2015. Ultimately, improved data will lead to safer and more efficient living spaces and transport options in the city, boosting economic growth and improving its citizens' living standards.

Beyond the electron: Summary

Initiatives that play Beyond the Electron were more challenging to quantify, as they involved taking assumptions based on limited current penetration of services. Such initiatives are therefore excluded from the value at stake analysis. Nevertheless, big wins in customer value are expected for those that move quickly to market such services.

For energy utility and technology companies, even if offerings are foundational, those services will likely be appreciated by certain customers if they are clearly building blocks for the bigger picture. The early connected-home services from AT&T, Comcast and BT did not offer a complete, seamless experience, but created the platform upon which new layers of services and applications could be added. In the medium term, living, industrial and municipal services may become a necessary strategy to defend market share and, in the long term, a license to operate in the electricity market at all.

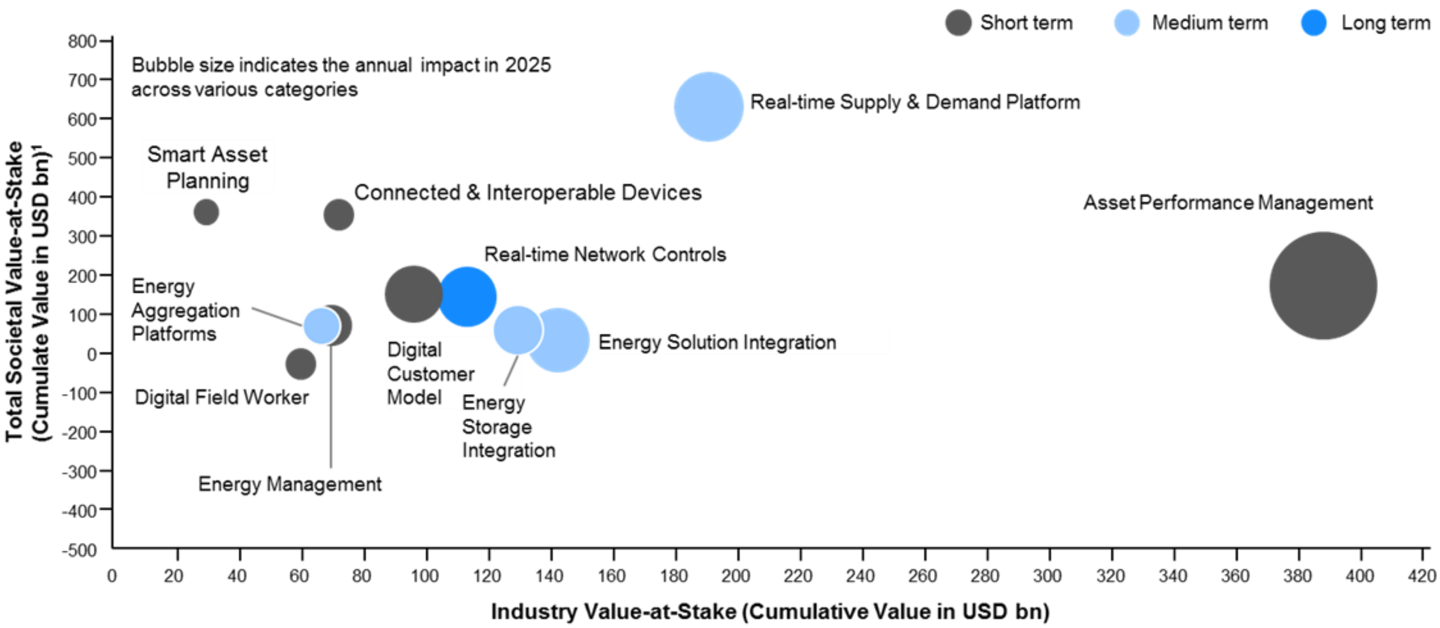
Developing an ecosystem of partnerships will be a critical success factor for electricity companies in beyond the electron initiatives. Development of a seamless, cross-industry customer experience is only possible if electricity companies are prepared to be collaborative with peers and competitors, including sharing data, ideas and resources.

Services that move beyond the electron, particularly when scaled to the city, will have a meaningful impact on consumers' quality of life. Improved use of data and interoperable services will make transport options more intuitive, healthcare more tailored and the environment safer and more comfortable. In addition, municipal services have unexpected environmental benefits, not least of which is the ability to track carbon emissions across every stage of a service, spanning many traditional industries. Projects can be better measured and involve participants across the value chain – a very real barrier at present.

e. Digital initiatives: Value at stake

There is immense opportunity for the electricity industry to unlock new value from digital initiatives. We estimate that from 2016 to 2025, there is $1.3 trillion of value to be captured globally. Of the 11 initiatives included in our analysis, five are worth at least $100 billion over the next 10 years and should be prioritized for investment (see figure 4). Value creation for both industry and society has become a win-win and electricity players have an important role to play in translating the $2 trillion opportunity into tangible benefit. Our estimates of the societal benefits are modest and include just three factors: value creation for customers (worth $986 billion); reduction in carbon emissions ($754 billion); and net job creation ($271 billion). Please refer to the appendix for an overview of the value at stake framework.

Figure 4: Digital transformation of the electricity industry – potential benefit to industry and society



Source: Accenture research for the Digital Transformation of Industries project

Asset performance management provides the highest value addition to the industry at $387 billion, of which $276 billion is expected to accrue from the sale of smart sensors and software advisory. Energy technology companies are already profiting from this initiative, with sales of sensors for commercial infrastructure and software services.

Real-time supply and demand platforms provide the largest societal benefits in addition to significant industry benefits – customers can expect to capture up to $559 billion of value from postponing consumption during peak demand periods.

Connected and interoperable devices are likely to contribute more than 5% of the cumulative industry profits over the next 10 years. Customers can expect to realize up to $290 billion of savings from lower peak consumption, from 2016 to 2025. However the impact could be significantly higher if adoption rates increase further.

Finally, initiatives that increase the penetration of renewable energy sources, such as energy storage integration, are also likely to provide significant value potential – but higher tariffs compared to traditional fuel-based resources are likely to keep adoption rates depressed over the next four to five years, after which grid parity is expected.

Building a sustainable energy system

Digital initiatives offer immense opportunity to decarbonize the energy system, with the potential to realize an estimated 15.8 billion metric tons of net avoided CO_2 emissions (see figure 5). When viewed as a product of the social cost of carbon emissions and inflation forecasts, this could translate into a staggering $454 billion value for society over the next 10 years. If smart asset planning and management, and energy storage integration were universal, we estimate that up to 8.8 billion metric tons of CO_2 emissions could be saved by 2025, creating $418 billion of new value for the economy.

Figure 5: Value to society through emission reduction and customer value

		Industry	Societal	Total Value at Stake (USD Bn)	Jobs created (# K)	Emissions Reduced (Mn Tonnes)
Asset Lifecycle Management	Asset Performance Management	387	172	559	596	2,385
	Digital Field Worker	60	(26)	34	-342	0
	Smart Asset Planning	30	360	390	925	6,334
Network Optimization & Aggregation	Energy Aggregation Platform	68	70	137	103	392
	Real Time Supply & Demand Platform	191	623	814	180	1,031
	Real Time Network Controls	113	143	256	14	1,794
	Connected & inter-operable devices	73	360	432	352	701
Integrated Customer Services	Energy Storage Integration	130	59	189	1,080	2,456
	Digital Customer Model	97	151	248	40	172
	Energy Solution Intergration	142	31	173	14	54
	Energy Management	69	70	139	196	531

Source: Accenture research for the Digital Transformation of Industries project

Implications on employment and skills

Current estimates of global job losses due to digitization range as high as 2 billion by 2030, but there is considerable variation in these projections (see Societal Implications narrative). Our analysis points to significant opportunity in the electricity sector for digitization to create jobs. Digital initiatives will create up to 3.45 million new jobs between 2016 and 2025 - translating to 10.7% job growth in the electricity industry. Job creation potential is highest in the consumer renewables sector, with energy storage integration creating up to 1.07 million new jobs. New jobs in smart asset planning (925,000 new jobs) and asset performance management (596,000) more than address job loss from automation or more efficient technologies. A significant problem that utilities are facing is an ageing workforce, with a weak pipeline of new talent and a potential productivity gap as new employees are recruited and trained. Digital initiatives go some way in ensuring that experience is captured as the workforce retires, with significant productivity gains expected.

5. Recommendations

a. Business models for a digital industry

Four business models become clear from this analysis of the digital themes emerging from the electricity industry. The potential models or new platforms for growth – asset life cycle managers, distribution platform optimizers, energy solution integrators and "beyond the electron" experience providers – span the value chain, from generation to the end customer. "Beyond the electron" providers move past the traditional industry boundaries to find new areas for creating value. Enterprises will need to decide which of these growth platforms to plan for and invest in, based on a review of existing capabilities and infrastructure, and coupled with an understanding of how digital fits into their overall corporate strategy.

Asset life cycle managers

Electricity firms must build a low-carbon supply portfolio, leveraging digital technologies to optimize both central and distributed generation sources. Successful players will achieve scale by balancing a broad array of generation assets on a digital platform that is low carbon, cost-efficient and safe. Asset life cycle optimization is vital for cutting costs and improving processes. Targeted investment in smart sensors, hardware and software for predictive maintenance, should be integrated into decision-making processes across verticals and operations. Growth will come from expanding to a broader range of assets, penetrating new markets and using real-time analytics to manage assets more effectively.[45]

Distribution platform optimizers

Utilities will become empowered to serve as energy clearing houses and address consumer demand with optimal sources of supply. Utilities will have an opportunity to create an optimized grid with interoperable standards, but this will only be possible through a long-term commitment to partner with both peers and competitors. Engaging with regulators will be essential to redesign the market, so that it becomes a performance-based model for distribution that works for all of its participants. Early successes are likely to play a role in establishing industry-leading standards; in the long run, they will separate winners from losers. To make this concept a reality, data must be integrated seamlessly in operations, with a bespoke customer platform at the front end. Electricity companies will need to accept that payback for investments in optimizing the grid will only materialize in the long term. Finally, success is dependent on a change of culture among both employees and customers, which will require careful planning and measurement.

Energy solution integrators

This business model will provide a range of customer services that optimize energy production and use, allow for greater control and deliver cost savings. The energy management market landscape is highly fragmented with multiple actors, from energy utilities, facilities management, building and industrial, to IT or pure-play energy services, and there is value to be created through a brokerage model, that simplifies energy provision for the end user. Success in this market will be driven by the ability to provide customers with solutions that have the flexibility to control, monitor and switch between different energy sources. Digitally engaged customers have a higher potential value to utilities, as they are more likely to both take part in energy management programs and be satisfied with the service they receive. In this way, an integrated solution helps to close the "trust gap" between utilities and customers. Exploring partnerships with niche technology companies will leapfrog the requirement to develop a new product and will allow companies to focus instead on the integrated platforms that will support wide-scale adoption.

Beyond the electron providers

Electricity companies will move beyond traditional industry boundaries and become lifestyle brands by providing innovative cross-industry services. Success will depend on inter- and intra-industry partnerships, as industries and experiences come together. Electricity companies will need to decide whether to position themselves as a platform in their own right, or to partner with a platform in the sector for delivering niche services to customers. Services will need to be offered in markets where electricity players have not traditionally ventured. Big data management will fundamentally underpin this growth, as both customer and contextual data will need to be collected, analyzed and acted upon to create

living services that can be continually tuned and tweaked to benefit the consumer. Significant investment in developing data management and analytic capabilities will become vital, as will bringing in cross-industry experience.[46]

b. How to become a digital champion

Building a digital business is about speed, agility, scale and responsiveness. By installing a formal communication channel between business lines and new innovations, initiatives can be scaled up quickly with the support of an accessible, 'digitally capable' team.

Priority digital capabilities that form the building blocks for these four business models have been identified. In light of that, a number of no regret capabilities exist – tactical, shorter-term investments that industry players should start planning for today. In parallel, a bold play balances with the longer-term strategic decisions that will revolutionize a company's strategy.

No regret capabilities: Shaping internal capability to become a digital champion

Develop a digital strategy and roadmap: Digital should be made a priority in the organization. Consideration should be given to which of the four business models the organization wants to operate in and where its capabilities fit best, before the strategy is put into action – with pace. The digital strategy must support the overall corporate strategy to ensure that digital is fully integrated into core business. The value at stake analysis offers guidance on the relative value in pursuing each digital initiative.

Capture, understand and leverage data: Enterprises will need to move beyond using data just to create operational efficiencies, and instead understand how to monetize and use data to create new customer experiences. In a study by the Harvard Business Review on digital transformation, 52% of respondents cited big data as enabling faster generation of insights in their organization. Indeed, developing a robust data management capability is a prerequisite for all four themes and vital to operating in the new digital landscape. Electricity companies must consider how to manage data end to end, from digitizing generation assets to capturing and leveraging customer usage data.

Build and maintain a high-quotient digital team: Leaders will need to ensure teams are unconstrained by orthodoxies, such as "energy demand will increase forever" or "renewables are expensive". Ways to achieve this include creating an open channel for ideas or using technology to crowdsource ideas from more junior employees. Most utility chief executive officers (CEOs) are not digital natives, so developing the capability of the firm by creating more fluid, multidisciplinary teams is vital and will enable a shift away from one-way feedback mechanisms. Some companies are creating a chief digital or data officer; while the approach will vary, there must be clear accountability for the delivery of the digital agenda.

Build a digital talent strategy: Hiring in and upskilling existing staff will develop digital skills in-house, and offering individualized, flexible working models will attract the highest-caliber people. Lack of talent is often the missing piece in the puzzle of how to translate better insight into tangible strategy. Companies should have a clear plan to address any shortage of skills, for example in data analysis, creative marketing or programming.

Launch and communicate a change program: The conservative nature of the electricity industry, due to the high cost and long life span of assets, paired with the vital importance of a secure and reliable system, must be countered with innovative, fast-moving digital initiatives. To start this shift, embarking on a change management effort, supported by internal communications, is vital.

Bold plays: Internally and externally oriented activities

Accelerate the pace of digital innovation: Leaders should experiment more and learn to 'self-disrupt', with organizations instilling a culture of making mistakes to learn quickly; in other words: don't perfect it, but build it fast. This requires a significant culture shift, from the CEO to the coder. As seen particularly in utilities, creative thinking should not be the sole responsibility of an 'innovation team', but a mindset that, encouraged by rewards and recognition, runs through the entire business.

Design a delightful customer experience: Customers' expectations now transcend industry boundaries, with the belief that a high-quality service in one industry should be connected and translated to the next. It will be necessary to

move away from a commoditized, rate-payer utility model; thus, every digital initiative should have the end-customer experience at its core.

Partner and invest in the electricity ecosystem: Developing cross-industry partnerships will be imperative and should transcend all growth platforms. Business as usual in the new electricity ecosystem will look very different: partnering with peers and competitors to offer valuable customer services, improving and optimizing the grid, developing digital capabilities fast and playing beyond the electron will become core business activities for energy utility and technology companies.

Engage regulators around market redesign: Electricity players must establish a positive dialog with regulators to ensure that the industry and market are redesigned so that they work for all participants, and achieve the essential objectives of decarbonization, decentralization and digitization. In particular, the regulation pertaining to the grid ‘edge’ is rapidly evolving; the implications of distributed energy resources and their integration into the market is likely to shape and affect the digital regulation outcomes. Equally, the evolution of discussions relating to grid defection have a big role to play in how ‘connected’ and ‘effective’ the future system can be, with a more disconnected system potentially less optimal than a fully connected and optimized system.

Form an industry consortium to address concerns around interoperability, data privacy and cybersecurity: electricity players must collaborate to address risks and barriers in transforming the industry. With consortiums formed for the Industrial Internet, such as the Industrial Internet Consortium (IIC), the AllSeen Alliance and Open Interconnect Consortium (OIC),[47] there are test cases to learn and build upon.

Leadership and policymaker discussion topics

- How do you reimagine the design of the energy system, given near-term digital and technological innovations which include predictive forecasting and energy storage? What infrastructure and systems are required to meet tomorrow’s energy demand?
- In economies transitioning to a lower carbon, more decentralized energy system, what incentives can be created by regulators and policymakers to optimize the electricity system and create a better functioning market?
- What business- and operating-models are pre-requisites for energy companies to gain a greater share of the future industry profit pools beyond the electron – for instance, from connected home, smart car, buildings and cities, and industrial services?

6. Acknowledgements

The World Economic Forum would like to acknowledge and extend its sincere gratitude to a broad community of contributors across energy utility and energy technology companies, through their participation in the Working Group, workshop and interviews.

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7. Appendix

Value at stake methodology overview

Value at stake is a framework designed for assessing the impact of digital transformation initiatives on the industry, customers, society and the environment. It provides a differentiated and evidence-based understanding of the extent of impact that digital transformation will have on the electricity industry, and where potential value creation opportunities exist. It provides likely value estimates of global industry operating profits that are at stake, from 2016 to 2025, and the contribution that digital transformation can make to customers, society and the environment in that time frame.

For the 2015 value at stake analysis, an extrapolation approach was used to project our OECD findings to a global level. This multiplier is based on the ratio of the projected OECD and global electricity revenues. These revenue numbers have been calculated using the projected electricity consumption data from Energy Data and the projected electricity prices from Statista.

Industry value

Value at stake for the industry comprises two elements. First, the potential impact on the industry's operating profits that will be generated because of the digital initiatives (value addition). Second, operating profits that will shift between different industry players (value migration).

This analysis of the electricity market covers utilities and energy equipment manufacturers. The impact of digital transformation on electricity was considered across the value chain, from generation and transmission to distribution and consumption, and among residential and commercial/industrial customers. Market operations and trading were excluded from the value analysis.

Value to society

Value at stake for society includes three elements: customers, society and the environment. Each element is measured as follows:

1. Value impact for customers: the potential gain to customers (both B2B and B2C) in the form of cost and time savings, discounts and ability to earn additional profits (for B2B only).
2. Value impact for society: the impact (both financial and non-financial) of digital initiatives on productivity gains and jobs.
3. Value impact on the environment: the estimated impact of the digital initiatives on increasing or reducing CO_2 emissions.

Approach

The value at stake has been calculated using a top-down approach involving two key steps:

1. Identification of the total addressable market and the adoption/penetration rates over the next 10 years for each digital initiative based on secondary research, industry reports, existing use cases and interviews with subject and industry experts.
2. Creation of a value tree to represent the different industry and society value categories mentioned above.
3. Testing, revision and validation of assumptions and results with Accenture experts, DTI working group members and select industry partners of the World Economic Forum.

8. Endnotes

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