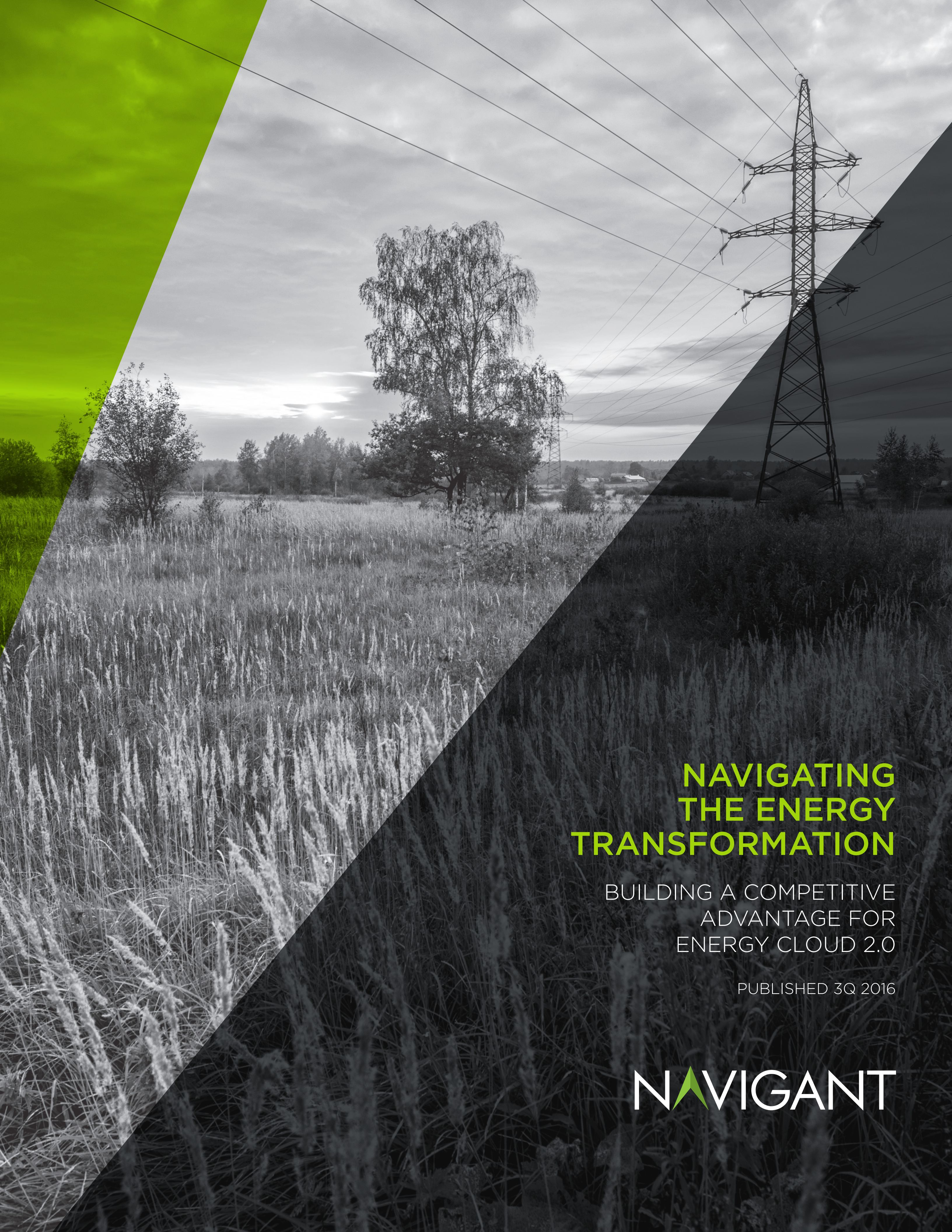

NAVIGATING THE ENERGY TRANSFORMATION

BUILDING A COMPETITIVE ADVANTAGE FOR ENERGY CLOUD 2.0

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SECTIONS

CHARTS & FIGURES

NAVIGATING THE ENERGY TRANSFORMATION

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SECTION 1. EXECUTIVE SUMMARY

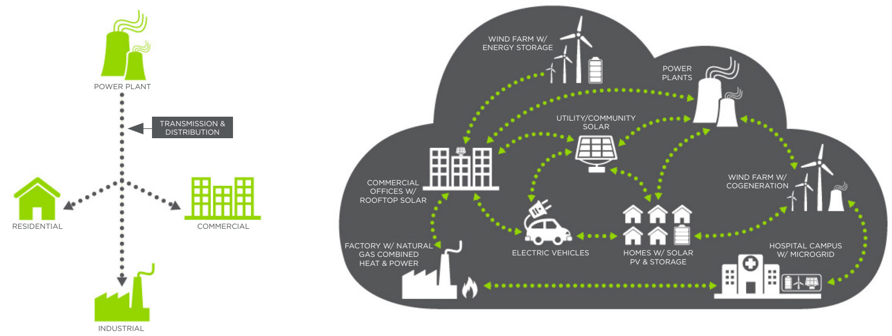
1.1 The Energy Cloud

In April 2015, Navigant Consulting, Inc. (Navigant) described a power sector embarking on a historic transformation in its white paper, *The Energy Cloud*. Such a transformation entails a shift away from a one-way power system relying principally upon large centralized generation plants and conventional transmission and distribution (T&D) infrastructure toward a highly networked ecosystem of two-way power flows and digitally enabled intelligent grid architecture. Part of this shift is the Energy Cloud, a dynamic energy ecosystem that leverages ubiquitous connectivity, intelligent sensors and devices, information and operations technology, and data-driven machine-learning functionality across the grid value chain. This ecosystem will be far more sophisticated than the legacy hub-and-spoke model in use today.

Depicted in Figure 1.1, the Energy Cloud will usher in widespread disruptive changes in the way energy is produced and consumed globally. As a result of these changes, an expanding percentage of market share across the emerging grid value chain will be up for grabs.

Figure 1.1 The Emerging Energy Cloud

TODAY: ONE-WAY POWER SYSTEM EMERGING: THE ENERGY CLOUD



Source: Navigant

- Large, centrally located generation facilities
- Designed for one-way energy flow
- Utility controlled
- Technologically inflexible
- Simple market structures and transactions
- Highly regulated (rate base) and pass through

- Distributed energy resources
- Multiple inputs and users, supporting two-way energy flows
- Digitalization of the electric-mechanical infrastructure: smart grid and
- behind the meter energy management systems
- Flexible, dynamic, and resilient
- Complex market structures and transactions
- Regulation changing rapidly around renewables, distributed generation (solar, microgrid, storage), net metering etc.

It is no longer a question of if these changes will occur. Rather, it is a question of when these changes will take place—and more importantly, how? Blending traditional assets, services, and interactions (e.g., utilities and their customers) and unlocking many new technologies, business models, and relationships (e.g., prosumer-to-utility, prosumer-to-consumer, consumer-to-service provider, etc.), the emerging Energy Cloud will continue to redefine market structures and traditional stakeholder relationships. Changing customer needs, evolving policy and regulation, and accelerating innovation around distributed energy resources (DER) and digital technology will drive the creation of more distributed transactions and dynamic business models. These developments will also spur a more democratized and sophisticated grid platform and a rapidly evolving ecosystem of incumbents and disruptors.

As the next installment in Navigant's Energy Cloud thought leadership series (see *The Energy Cloud*, published April 2015), this update details new developments and technologies that have emerged in the last 2 years. Focusing on emerging platforms for growth such as Internet of Things (IoT), smart cities, and transactive energy, it evaluates shifting value across the value chain and revenue implications for incumbent players and new market entrants. Finally, industry stakeholders, and particularly utilities, are provided a blueprint—the Energy Cloud Playbook—for proactively preparing and managing their organization to maneuver around the Energy Cloud disruption and position for long-term success.

1.2 Strategic Threats and Opportunities

Nearly $3 trillion has been invested globally in grid modernization efforts since 2000. According to the International Energy Agency, another $8 trillion will be required over the next 25 years to accommodate emerging areas like distributed intelligence and data analytics.

Nearly $3 trillion has been invested globally in grid modernization efforts since 2000. According to the International Energy Agency, another $8 trillion will be required over the next 25 years to accommodate emerging areas like distributed intelligence and data analytics. Meanwhile, as described by Marco Iansiti and Karim R. Lakhani in *Digital Ubiquity: How Connections, Sensors, and Data Are Revolutionizing Business*, "The grid ecosystem is moving rapidly away from a displacement and replacement paradigm to ubiquitous connectivity and technology recombination … Transactions will increasingly be digitized, new data will be generated and analyzed, and discrete objects, people, and activities will be more connected to the grid ecosystem than ever before."

With limited capital and, in many cases, facing divergent investment choices, utilities must decide which of the strategic pathways to follow. They must do so within a market increasingly defined by an expanding array of mass-produced technologies with ever shorter product lifecycles and targeted by new market entrants.

With an estimated $1.3 trillion in new annual industry revenue available globally by 2030, new entrants—manufacturers; technology companies (from startups to global powerhouses like Apple, Amazon, and Google); telecommunications and other data, content, and network providers; and even some oil & gas companies (like Total)—have the rare opportunity to disrupt a status quo nearly 150 years in the making.

This rapidly unfolding landscape will require new strategies and approaches to both current and emerging industry realities. History proves that the majority of business model innovations are introduced by market newcomers rapidly introducing new technologies that address emerging client needs, making today's utility industry more vulnerable to disruption than ever before.

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Meanwhile, Navigant forecasts that more consumers (residential and non-residential) will become prosumers, selling renewable energy back to the grid (either individually or aggregated) at the retail or wholesale level. Governments and regulators at all levels have a key role to play, as well. They will have to balance a wider set of imperatives supporting a safe, reliable, and affordable power grid and incorporate clean, distributed, and more intelligent energy. In doing so, they must ensure that this shifting landscape accommodates innovation while also adapting rules and procedures to better match the pace of change underway.

The biggest challenge will be balancing ongoing investments in the grid as the total volume (and with that, revenue) that flows through core, centralized components decreases over time. This includes mitigating the risk of stranded assets that may become obsolete or financially unsustainable, as well as their costs to incumbent utilities, customers, and society.

1.3 Energy Cloud Scenarios

No two markets are alike. Energy Cloud transformation will play out differently across regions, countries, and markets depending on specific realities. Electricity prices and tariff structures, existing policies and regulations, customer demands and choices, and market structure (unbundled versus integrated; competitive versus monopoly market landscapes) and viability, as well as acceptance of new technologies, will necessitate different levels of response.

Three Energy Cloud scenarios—conservative, moderate, and aggressive—outlined in this paper describe various degrees by which this industry transformation could occur. The goal is not to detail an exhaustive outline of each scenario, but rather, to provide a basis for a new strategic planning framework for the industry.

Of the scenarios outlined, the aggressive scenario is the most transformative and is the primary focus of this paper. Specifically, it details a mature Energy Cloud ecosystem in 2030:

- Utility-scale and distributed renewables account for 50%–100% of generation; DER uptake is widespread, accounting for a majority of new build capacity.
- Annual utility industry revenue reaches nearly $6 trillion, resulting in more than $50 trillion in cumulative revenue generated between 2016 and 2030. Digital innovations account for more than a fifth of total revenue generation by 2030.
- Revenue allocation across the electric value chain shifts significantly downstream toward the edge of the grid and beyond (customer side of the meter), where the current value allocation of generation and retail cost and revenue effectively swap. The cost and revenue of distribution and customer energy management (including beyond the meter) represent more than half of revenue allocation across the value chain.
- Grid boundaries will expand, integrating existing infrastructure with behind-the-meter building energy networks, community-scale nanogrid and microgrid infrastructure, and supergrids linking power networks that extend across geographic regions well beyond traditional state-nation boundaries.
- Today's smart grid gives way to a neural grid that is nearly autonomous and self-healing and leverages innovations in artificial intelligence (AI) and cyber-physical systems (e.g., IoT, self-driving EVs, and the smart grid). The application of blockchain technology gives rise to digitized electron exchanges and transactive energy.

1.4 A Blueprint for Navigating Complexity: The Energy Cloud Playbook

With the barrier for market entry for new and emerging players lowered by low-cost digital innovation and democratized energy, utility industry incumbents face a challenging path ahead. Although many have direct relationships with customers and ownership of infrastructure assets, challenges remain. Utilities in particular must prepare their organizations to be disruption ready. This includes challenging tried-and-true business models as well as rapidly shifting cultures to embrace agile innovation.

Specifically, stakeholders must remain flexible and responsive to shifting priorities. This new landscape will also require utilities and their oversight bodies to react more quickly, providing increased financial rewards commensurate with increased risk exposure. Existing strategic planning mechanisms currently in use, like integrated resource planning (IRP, with a planning horizon of 30 years or more) and strategic plans (with a 5-year horizon), are insufficient. To adequately understand and prepare for the threats and opportunities of the Energy Cloud and complement existing planning tools, Navigant recommends that stakeholders develop a 10- to 15-year strategic view, as well as a short-term (6- to 12-month) agile execution plan.

This paper offers a framework for approaching strategic planning within an industry facing historic transformation. The Energy Cloud Playbook outlines five steps industry participants should follow to prepare their organizations to maneuver around disruption and capture value in the Energy Cloud. Specifically, this means capitalizing on emerging innovation ecosystems ripe for new business models and revenue creation. Moving beyond siloed technologies, these platforms recombine technologies and services, offering industry participants fertile testing grounds for harnessing value in the Energy Cloud.

SECTION 2. THE ENERGY CLOUD 2.0

2.1 Disruptive Triggers

As observed across various industries, disruption is a prevailing and uncompromising theme of technological innovation in the 21st century. In his book, *The Fourth Industrial Revolution*, Klaus Schwab explains, "The acceleration of innovation and the velocity of disruption [facing the global economy] are hard to comprehend or anticipate … these drivers constitute a source of constant surprise, even for the best connected and most well-informed." While seemingly more insulated from competitor-led innovation, highly regulated industries like energy are no exception to the rule.

This is especially true when the confluence of three forces—regulatory and policy shifts, changing market demand, and technological innovation—undermine long-standing value chains. In particular, technologies that can slice through preexisting layers of regulatory processes and business models to directly connect customers to the goods and services they seek are gaining traction across global markets.

The digital disruption of media (Buzzfeed and Netflix), brick-and-mortar retail (Amazon and Etsy), travel accommodations (Airbnb and VRBO), and personal transportation (Uber and Lyft) are the latest examples of how such trends can upend seemingly stable industries and business models. The utility industry currently faces a perfect storm of all three forces described in Figure 2.1.

These forces may occur suddenly or arise gradually to expose long-standing inefficiencies within an industry, then spread quickly to displace incumbent solutions and disintermediate the traditional value chain. The digital disruption of media (Buzzfeed and Netflix), brick-and-mortar retail (Amazon and Etsy), travel accommodations (Airbnb and VRBO), and personal transportation (Uber and Lyft) are the latest examples of how such trends can upend seemingly stable industries and business models. The utility industry currently faces a perfect storm of all three forces described in Figure 2.1.

Figure 2.1 Disruptive Triggers in the Utility Industry

REGULATION & POLICY	• **Carbon mitigation:** Cap and trade, Clean Power Plan, EU Emissions Trading Scheme, COP21 • **Shifting utility regulatory models:** Incentive-based regulation (e.g., UK RIIO, NY REV) • **Flexibility:** Promotion of distribution system operators, support for energy storage, support for international interconnection • **Renewables promotion:** Renewable Portfolio Standards, Renewable Energy Directive • **DER adoption:** Net metering, feed-in tariffs, Solar Renewable Energy Credits
MARKET DEMAND	• **Control:** More customers demanding control over their electricity usage and spend, as well as when and what type of power they buy • **Choice:** More customers want the ability to purchase green power or self-generate and sell that power back to the grid • **Sustainability:** Marketplace differentiation and brand awareness • **Accessibility:** More options available to greater share of end-use customers
TECHNOLOGY INNOVATION	• **Affordability:** Declining cost of ownership for solar PV, energy storage, and other demand-side technologies • **Digitalization:** Lowering the barrier for entry for innovative solutions • **Networking and data analytics:** Harnessing distributed computing and data across the grid • **Integration:** Pairing of complementary disruptive technologies (e.g., solar + storage)

Source: Navigant

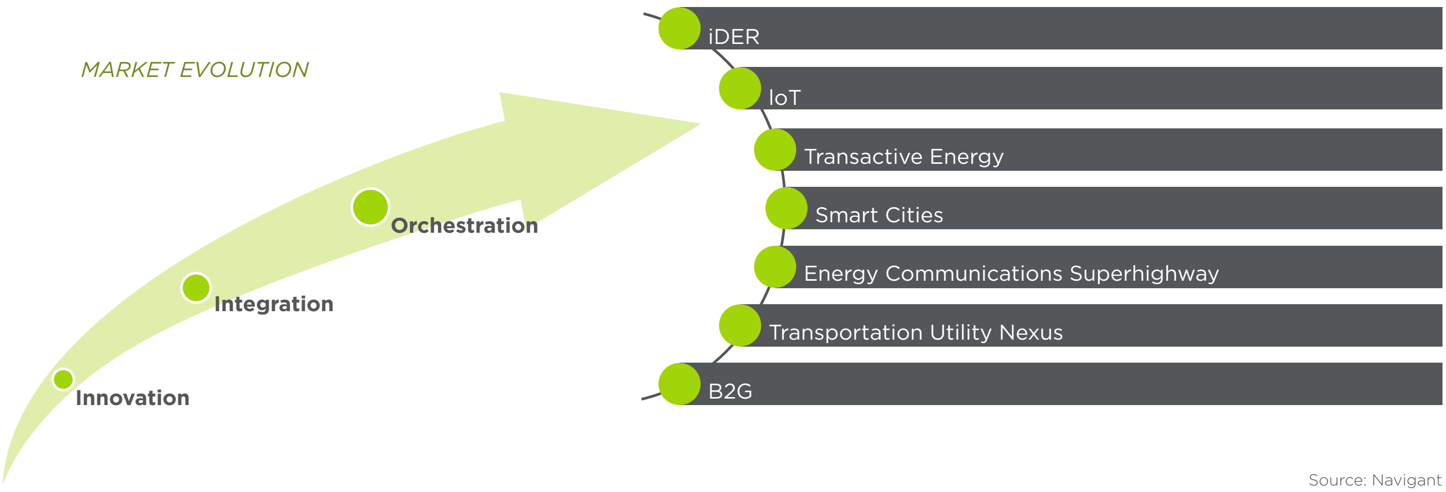
While the Energy Cloud is in its infancy today, these disruptive triggers suggest that the transformation facing the industry will be pervasive. Technology, services, and system design innovation will expand exponentially.

2.2 Next-Generation Energy Platforms

Specifically, utility industry innovation is currently moving beyond one-off, standalone technologies (e.g., renewables) and the pairing of these technologies (e.g., solar plus storage) toward the orchestration of complex ecosystems of technologies working in concert to deliver more flexible, responsive, and customer-centric services.

Supporting these ecosystems are technology platforms (examples of which are outlined in Figure 2.2) that sit at the confluence of regulation and policy, market demand, and innovation. These platforms are moving the industry beyond an exclusive focus on the transaction of energy to include the bundling of non-energy services. They share similar features as the Energy Cloud: they are composed of highly networked and distributed assets; leverage ubiquitous communications, IT, and data analytics; and operate as semi (or fully) autonomous and learning-enabled machines. Moreover, they are both highly dynamic and broadly integrated.

Figure 2.2 Energy Cloud 2.0 Platforms (Sampling)



Source: Navigant

While highly disruptive in their own right and, these platforms provide the utility industry fertile testing grounds for new products and services in the Energy Cloud. They are the building blocks of Energy Cloud 2.0—an ecosystem of platforms cutting across multiple industries, but still very much focused on the generation, supply, consumption, and the management of electricity. Building on digitization efforts across the utility industry, these platforms have the potential to deliver unique value to energy customers while enabling exponential growth opportunities for early movers within the industry.

Seven platforms emerging today are profiled in more detail in the following sections.

2.2.1 Integrated Distributed Energy Resources

The growth of distributed energy resources (DER) is increasingly viewed as one of the most disruptive trends affecting the utility industry today. From solar PV and energy storage to demand response (DR)-enabled thermostats and EVs, DER with capabilities that were previously only provided to electric grids from supply-side resources continue to multiply across the edge of the grid.

Multiple technological trends point to sustained growth across the DER technology landscape. Navigant Research estimates that global DER capacity is expected to grow almost 5 times faster than new central station generation over the next 5 years and generate $1.9 trillion in cumulative investment over the next decade. In the United States, total DER capacity is projected to more than double by 2023. The installed cost for solar PV in global markets, for example, is expected to fall below $1.50 per watt by 2024. The North American market for EV services and equipment is projected to grow to more than $4 billion by 2025.

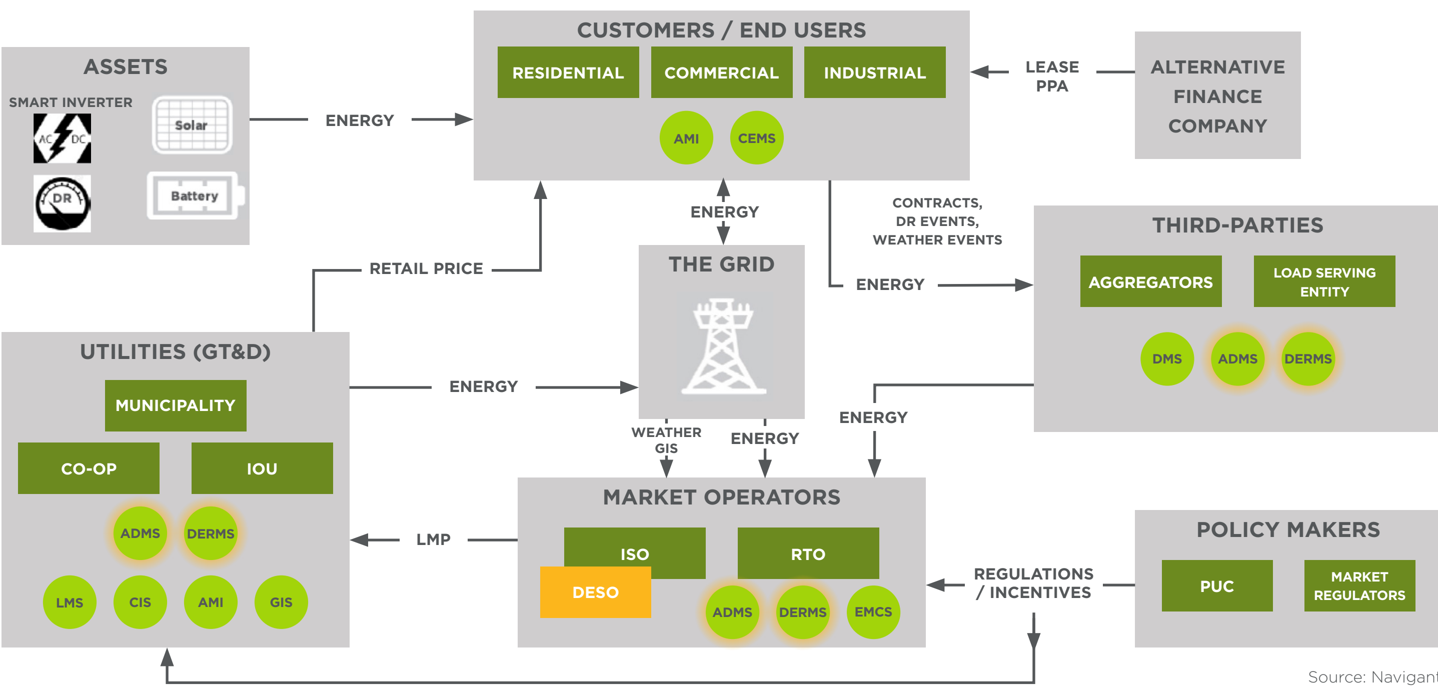
DER bring with them levels of variability and nuance never before seen by network operators. This tangible convergence of DER interconnections to networks ill-suited to integrate variable demand-side behaviors represents ground zero for the disruption of the global energy landscape caused by DER.

The concept of integrated DER (iDER)—describing a custom, portfolio-based, DER adoption approach at every level of energy markets—encourages customer choice and flexibility while addressing aggregation issues at the grid operator and utility level.

The concept of integrated DER (iDER)—describing a custom, portfolio-based, DER adoption approach at every level of energy markets—encourages customer choice and flexibility while addressing aggregation issues at the grid operator and utility level. From utility procurement departments to corporate building fleets to single-family homes, the valuation of DER portfolios offers tremendous opportunities to maximize both ROI and societal benefits. Market actors that seek to enable these platforms and aggregate iDER value streams from wholesale markets, energy procurement processes, prosumer power preferences, and regulatory incentive programs through portfolio-based approaches are poised to capture value across a more distributed grid landscape.

Navigant's iDER Maturity Model allows utility stakeholders to assess their organization's progress toward DER integration. The blueprint outlined in Figure 2.3 would score the highest ranking in Navigant's iDER Maturity Model.

Figure 2.3 Blueprint of a Fully Integrated DER System



Source: Navigant

An advanced ranking in Navigant's iDER Maturity Model describes markets in which utilities, customers, third parties, market operators, and regulators are working in conjunction with iDER processes for full integration across operations, energy markets, and IRP. These processes are supported by critical information, operations, and communications technology systems to ensure active, real-time, and large-scale iDER management. Evolving energy economics and increasing customer choice, supported by strong policies and mandates, drive DER penetration. Third-party aggregators and customers are incentivized to participate in the local energy markets, supported by transactive energy platforms and systems.

At the advanced iDER maturity level, utilities have augmented their role as a supplier of electricity and have assumed the role of a platform provider enabling prosumers to market their DER assets in an open market. This role is not only critical to fully maximize the benefits of DER, but will also be key to providing future value to the utilities' customers and shareholders.

2.2.2 Internet of Things

The rapid adoption of Internet-connected devices supports a new digital foundation for the energy industry. This emerging Internet of Things (IoT) landscape touches, or will touch, nearly all aspects of the grid value chain, not to mention the broader economy. IoT has the potential to become the connective tissue enabling the Energy Cloud, unlocking value across a wide variety of assets from traditional generation to DER, connected homes, intelligent buildings, the transportation grid, and smart cities.

In the residential sector alone, Navigant Research expects cumulative global revenue from IoT device shipments and services to total more than $815 billion from 2016 to 2026.

In front of the meter, demand for IoT connections is fueled by the need to optimize existing grid assets and to integrate DER assets like solar PV, EVs, and onsite storage. Regulatory pressure contributes to the adoption of IoT technologies as well, particularly among states like New York, Illinois, and California. Regulators in these states support IoT functionality as a key contributor in efforts to create a cleaner, more resilient, and affordable grid.

Behind the meter, connected devices are proliferating across connected homes, intelligent buildings, and the industrial Internet. In the residential sector alone, Navigant Research expects cumulative global revenue from IoT device shipments and services to total more than $815 billion from 2016 to 2026. Moreover, the number of IoT devices that will ship annually is expected to grow more than fivefold during the same forecast period.

The United States is expected to account for 91 million smart meters by 2020, along with 36 million smart communicating thermostats, and 183 million IoT residential devices.

The potential for data analytics will be substantial. The United States is expected to account for 91 million smart meters by 2020, along with 36 million smart communicating thermostats, and 183 million IoT residential devices. Assuming 15-minute intervals, which may prove conservative, the estimated number of annual data points will approach 11 trillion among these categories alone. This stream of data will enable deeper analysis of the grid at an increasingly granular level. It will also facilitate the ability to act and react in realtime, thereby improving the efficiency of energy use.

Already, vendors are providing basic tools laying the foundation for a pervasive IoT platform, including devices like smart thermostats, connected lighting, and mobile apps. Utilities also have the opportunity to seize new IoT platform opportunities via certain actions:

- Becoming first movers in the IoT space before it matures and being willing to test new business models
- Leveraging their position for IoT managed services beyond standalone demand-side management (DSM) efforts
- Developing long-term IoT offerings for enhanced customer engagement and increased satisfaction

2.2.3 Transactive Energy

In transactive energy systems, economic- or market-based constructs are used to make decisions involving the generation, distribution, and consumption of power. Currently, transactions involving power are being made, but only in wholesale and over-the-counter markets. Similarly, DER are interconnected on some power grids on a for-pay basis, but they are limited to fixed arrangements for selling their power—and then only to the distribution utility.

Transactive energy platforms marry and expand upon these activities. Building on iDER and IoT networks, transactive energy enables power providers in the retail market to negotiate (transact) their exchanges of power and/or energy on a granular basis. Transactive energy platforms also expand a power provider's stable of potential customers to entities other than a single distribution utility.

A variety of benefits are expected from transactive energy:

- Much greater adoption of DER into the energy ecosystem
- More responsive and more effective harnessing of the DER (including demand and loads) to serve peak power, reliability, resilience, and stability objectives
- More choices and opportunities for energy prosumers
- Lower energy costs for customers
- New opportunities for services and products
- Deferral of large-scale generation investments in capacity-challenged locations
- Economic stimulation through the rise of new energy-related products with new marketplaces for trading them
- Establishment of community-level distributed energy markets

There are several types of transactive energy currently in development and demonstration. These may be characterized as grid-centric or bundled. Most common, grid-centric models are limited to exchanges of power and perhaps capacity, demand, load, or ancillary grid services. Bundled models put forth a vision of transactive energy involving value exchanges within and across the Energy Cloud, and they are sometimes referred to as transactive systems or transactional networks. These bundled models extend beyond the delivery of electric power to services (e.g., condition-based maintenance of monitored high power-consuming equipment), rights (e.g., priority EV charging rights or reserved backup power capacity), information (diagnostics, expert advice, etc.), financial products (e.g., futures contracts), and situational machine-to-machine decisions (e.g., deciding which rooftop heating, ventilation, and air conditioning [HVAC] unit should respond to a DR opportunity).

Challenges remain in realizing either type of transactive environment. As with any peer-to-peer network, threats from intentional harm, unintended consequences, fraud, and abuses of privacy are top of mind. One strategy for mitigating threats to transactive energy operating in the Energy Cloud includes blockchain. Gaining traction in the financial industry, blockchain is a digital ledger technology upon which bitcoin currency is based. The technology crowdshares the function of trust—used as the basis for value exchanges—by performing highly redundant, independent verifications of transmitted records. Blockchain has also gained attention as a potential distributed register for identifying devices across IoT ecosystems.

Several recent examples demonstrate ways in which blockchain has been deployed within emerging transactive energy platforms:

- In Europe, a project called Scanergy simulated a blockchain-based methodology for trading green energy within a Belgian neighborhood.
- A small but live transactive energy market using blockchain was recently launched in a neighborhood in Brooklyn, New York.

2.2.4 Smart Cities

According to Navigant Research, global smart city revenue is expected to grow from $36.8 billion in 2016 to $88.7 billion by 2025.

Amidst a global demographic shift from a majority rural population to predominately urban, population centers are the global epicenters of innovation and economic growth. Smart cities sit at the confluence of major disruption across multiple industries cutting across energy (e.g., smart grid), transportation (e.g., connected vehicles), integrated waste management (e.g., smart waste), and water provision (e.g., advanced water metering). The most ambitious of these so-called smart cities seek to integrate these services to improve service to residents and bolster efficiency across the system. According to Navigant Research, global smart city revenue is expected to grow from $36.8 billion in 2016 to $88.7 billion by 2025.

Combined with the center of gravity for the utility value stream shifting downstream from large-scale generation to the distribution grid, a significant proportion of energy-related investment is expected to be deployed in and around population centers. Innovations in community energy provision and energy management present significant revenue opportunities for new technology and service suppliers.

Smart cities and city authorities looking to seize the opportunities presented by the Energy Cloud are working with utilities and other stakeholders to examine their sources of energy and how efficiently they are used. At the same time, they are attempting to reduce both greenhouse gas (GHG) emissions and energy costs.

Specifically, these investments deliver a range of direct and indirect community benefits:

- Reduced GHG emissions
- Improved quality of life through lower heating/cooling bills and more comfortable, affordable homes
- Energy resilience in the face of catastrophic disasters
- Reduced operational costs for city managers, thus protecting vital services from budget cuts

One initiative that has had the most visible impact on energy consumption in cities and has helped lay the foundation for the Energy Cloud is the introduction of smart meters. Smart meter penetration in the United States now exceeds 50%. Along with distribution automation investments, this enables consumers to participate in a range of DSM programs and new pricing strategies. Smart meters are the basic building block of many city-focused smart grid programs, but smart grid investments have other advantages for cities as well. Distribution automation, for example, enables the grid to support new services such as demand management, EV charging, and distributed energy.

Intelligent grid infrastructure can also link into other services. For example, Barcelona, Spain and Nice, France have piloted systems that integrate utility networks and other city services, including street lighting controls, smart parking systems, and environmental monitoring.

Meanwhile, affordable and reliable energy remains one of the basic features of an economically robust city. Those cities that embrace the evolutionary shift toward the Energy Cloud are expected to remain centers of innovation, providing new jobs for their citizens and attracting new business investments. Energy providers are expected to be key partners as the management of a range of basic municipal infrastructure—power, transportation, water, and waste—becomes increasingly integrated.

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2.2.5 Energy (Communications) Superhighway

Electric utilities have long used communications to inform their operations centers and enable protective systems such as SCADA to make the grid safer and more reliable. Many of these connections were focused on high-voltage (HV) transmission networks and substations. Over the last decade, with the advent of smart grid technology, utilities have been prompted to invest in a wide array of networking technologies for a variety of purposes in both HV and distribution voltage systems: advanced metering infrastructure (AMI), distribution substation and feeder automation, and other monitoring and IT functions. Importantly, these networks have frequently been built and managed within operational silos. Even more importantly, they have been built only to handle the application for which they were conceived. This stage of development could be considered the first generation of smart grid communications.

If this first generation represents an incremental, application- and silo-driven strategy where competing interests within a utility must await management or rate-case approval for each project, the Energy (Communications) Superhighway represents a 180° turnabout. Ideally, a utility's Energy (Communications) Superhighway will be conceived of, planned for, procured, and managed over the course of a longer-term, companywide planning and funding process. It will be built to be future-proof and support not only the smart grid applications described above, but also many, many more—including those that have not yet been conceived. However, access to a ubiquitous, high bandwidth, low latency network—whether built or leased—will be needed.

Analogous to the Interstate Highway System built across America in the 1950s, the Energy (Communications) Superhighway describes a robust, ubiquitous communications network deployed nationally or across individual utility service territories. In a recent white paper, *Communications in the Energy Cloud*, Navigant Research outlines how a fully deployed system could be a catalyst for exponential economic growth from a vast array of new product and service providers within the Energy Cloud.

As evidence of the economic potential of platform infrastructure, according to a report published by the American Highway Users Alliance on the 40th anniversary of the system—now 20 years ago—the US Interstate Highway System had delivered $6 in economic productivity for every $1 in cost to build as of 1996. Employment in dining establishments increased at more than 7 times the rate of population growth between 1956 and 1996, while employment in lodging establishments grew at twice that rate. New businesses were spawned, such as long-haul trucking, while others, such as gas stations and convenience stores, enjoyed massive growth. The Interstate Highway System and its economic contribution have been frequently credited as a key underpinning to the healthy gross domestic product per capita in the United States.

Similarly, the development of communications platforms across utility networks have the potential to spawn new growth opportunities across the Energy Cloud. In order for utilities to adapt and thrive in the Energy Cloud and capitalize on yet realized service and revenue opportunities, access to a ubiquitous, high bandwidth, low latency network—whether built or leased—will be needed.

There are numerous technological paths by which a utility might get there, including both private and public options and both wired and wireless options:

- **Fiber-to-the-premises:** Create a fiber-to-the-premises network that not only provides an Energy (Communications) Superhighway backbone—enabling smart grid and a plethora of new energy-related offerings—but also supports broadband, video, and voice, commercially referred to as Triple Play services within the telecommunications industry.
- **Private licensed spectrum:** Utilities tend not to own their own spectrum—they simply cannot compete with major wireless carriers when it comes to buying large swaths of private spectrum—although some smart grid communications vendors may.
- **5G:** Fifth generation—or 5G—wireless technology is the next step in the evolution of wireless technologies. Its promise as the backbone of IoT is well marketed, but the practical reality is that it is not here yet. The 5G future may well fulfill a great many of the progressive (Energy Cloud-based) utility's needs related to its Energy (Communications) Superhighway vision—if the utility is willing to partner with public carriers.

Utility vision and investment in ubiquitous, high-speed broadband networks will be a prerequisite to ensure that evolving utility and power industry goals and service offering creation are not thwarted by inadequate connectivity—and not met by other service providers in the marketplace.

2.2.6 Building-to-Grid

Technology and people are transforming commercial buildings into economic assets and a dynamic platform for bundled services. Innovation in IT, automation, controls, and services pivot the facilities management paradigm from responsive strategies that combat occupant complaints and malfunctions to predictive operations that optimize spending and comfort. Technology and software innovation enable devices to deliver unprecedented visibility into system operations, algorithms to model energy use and predict system performance, and occupants to be engaged in facility use and strategies. Together, these innovations are the foundation of the intelligent building.

The keystone for building-to-grid (B2G) platforms is the transformation of intelligent building interfaces to enable seamless integration with the power grid. Where today's traditional commercial buildings represent a major center of energy demand, GHG emissions, and business cost centers, the B2G concept leverages this infrastructure as part of a broader DER portfolio within the Energy Cloud. Commercial buildings and facilities represent an estimated 30%–40% of energy demand and nearly $150 billion in annual electricity revenue in the United States. While greater control and flexibility over energy use continues to erode utility profit, the upshot of B2G is the potential to unlock two-way power flow and bundle non-energy-related services.

Commercial buildings and facilities represent an estimated 30%–40% of energy demand and nearly $150 billion in annual electricity revenue in the United States.

The B2G facility is optimized with integrated controls and automation over internal systems from lighting to HVAC to plug loads and people movers. It also supports energy assets such as rooftop solar, energy storage, or EV charging infrastructure while providing a digital conduit for greater coordination between energy suppliers, customers, and a range of non-energy services.

The proliferation of IoT in the commercial segment augments the B2G platform. Specifically, IoT complements the building automation and controls infrastructure as a data platform foundation. From a building owner perspective, acceptance and reliance on software and services to run their businesses sets the stage for corporate buy-in and acceptance of intelligent building solutions fundamental to the B2G concept.

The orchestration of integrated systems to balance energy supply and demand is where the B2G's potential comes into focus. Sophisticated data analytics translate the rich data generated by the intelligent building architecture into information and actions. The conditions within the facility automatically alter to reflect external or internal signals delivered through the integrated systems. Occupancy, weather, grid pressures, and system performance become news feeds for the B2G that direct either energy consumption or generation. The capacity to shift from a source of demand to supply in response to these feeds is core to B2G's potential value. By aggregating individually optimized intelligent buildings into fleets, such as a virtual power plant (VPP), these potential benefits could be further augmented.

2.2.7 Transportation-Utility Nexus

The clear benefits in reducing GHG emissions, improving urban air quality, and localizing the energy supply have led governments and regulatory agencies to view the electrification of transportation as inevitable. Fleets of electric cars, trucks, taxis, and buses will enable people and goods to be moved without direct emissions and will be integral to the launch of mobility as a service business models. Autonomous, connected, electric, and shared vehicles will coordinate with smart infrastructure to alleviate traffic congestion and reduce urban emissions, drawing workers back to densely populated centers.

Slowly, policymakers are developing programs to, for the first time, recognize the necessary coupling of two huge markets—transportation and power—through policies and incentives that have far-reaching implications for each. Within this transportation-utility nexus, advanced analytics will be used to coordinate the energy demand of powering the electrified transit fleets, delivery vehicles, and marine vessels with that of smarter city infrastructure to enable a holistic view of regional energy demands across the Energy Cloud.

EVs will be the single largest addition of energy demand to the grid in many nations of the developed world. By 2020, more than 4,000 GWh of electricity will be consumed by plug-in EVs annually in the United States. Two significant advantages of this new load for utilities are aggregation and dispatchability. New services are combining EVs with stationary storage and other DER offerings to optimize regional supply and demand. The smart charging of swarms of managed EVs will enable greater concentrations of rooftop solar, as charging is staggered outside of peak times and will be matched to distributed generation.

By 2020, more than 4,000 GWh of electricity will be consumed by plug-in EVs annually in the United States. Two significant advantages of this new load for utilities are aggregation and dispatchability.

Meanwhile, automakers, energy aggregators, and charging network operators are partnering with utilities to incorporate EVs, providing a platform for energy services, DR, and grid ancillary services. By 2019, more than 220 MW of EV load in North America is expected to be available for DR programs or load shifting during the day. Current projects in the United States are gathering the data for modeling these future services. For example, BMW and Pacific Gas and Electric are using a fleet of EVs in DR and Avista in Spokane, Washington will fluctuate power delivery to a network of charging stations based on local supply and demand.

2.3 Harnessing Emerging Energy Platforms

Utility industry players are in a unique position to embrace innovative business models across the Energy Cloud by embracing business models that leverage digital connectivity and harness the interconnected energy platforms described above. In Navigant's article, "From Grid to Cloud: A Network of Networks in Search of an Orchestrator," a new emerging business model in the utility industry is discussed: the network orchestrator. Different than the asset builder, service provider, and technology creator, the network orchestrator has proven to be the most profitable and scalable.

Table 2.1 Toward a New Business Model

PLAYERS	ADVANTAGES	CHALLENGES
ASSET BUILDERS **Traditional utilities (vertically integrated, independent power producer, municipalities)**	• Existing relationships with customers • Insights into demand and supply across the grid • Deep understanding of how to integrate DER solutions into the grid • Understanding of the value streams from DER	• Developing networks of partners up and down the supply chain • Changing the focus/culture of the utility organization to one that is innovative, entrepreneurial, and customer-focused • Adopting new enabling technologies
SERVICE PROVIDERS **Deregulated utilities, competitive markets, retailers**	• Experience developing products and services for customers • Experience developing partnerships • Existing relationships with customers	• Developing insight into demand and supply across the grid • Developing understating of the value streams from DER • Expanding the network of partners • Adopting new enabling technologies
TECHNOLOGY CREATORS **SolarCity, Tesla, Schneider Electric, others**	• Experience developing products and services for customers • Experience developing partnerships • Existing relationships with customers (across multiple geographies)	• Developing insight into demand and supply across the grid • Expanding the suite of products and services provided to customers, including third-party products and services • Developing understating of the value streams from DER • Adopting new enabling technologies
NETWORK ORCHESTRATOR **New—unknown**	• Not constrained by legacy business models, technologies, or organization culture	• Developing insight into demand and supply across the grid • Developing understating of the value streams from DER • Developing a network of partners • Developing or adopting enabling technologies

Source: Navigant

Including high-growth ventures like Uber, Airbnb, and Spotify, network orchestrator business models can achieve higher valuations relative to their revenue, faster growth, and larger profit margins. By creating platforms that participants use to interact or transact across the network, these companies may sell products, build relationships, share advice, give reviews, collaborate, and more. Network orchestrators will capture significant value in the Energy Cloud by tapping existing and new grid networks and specifically tailoring electricity supply and demand services for a customer, utility, or grid operator.

To date, network orchestrators have not operated at scale within the utility industry— physical things do not scale quickly, easily, or cost-effectively. However, the emergence of the Energy Cloud means that anyone anywhere can sell energy services into an open market, typically on a forward-looking basis.

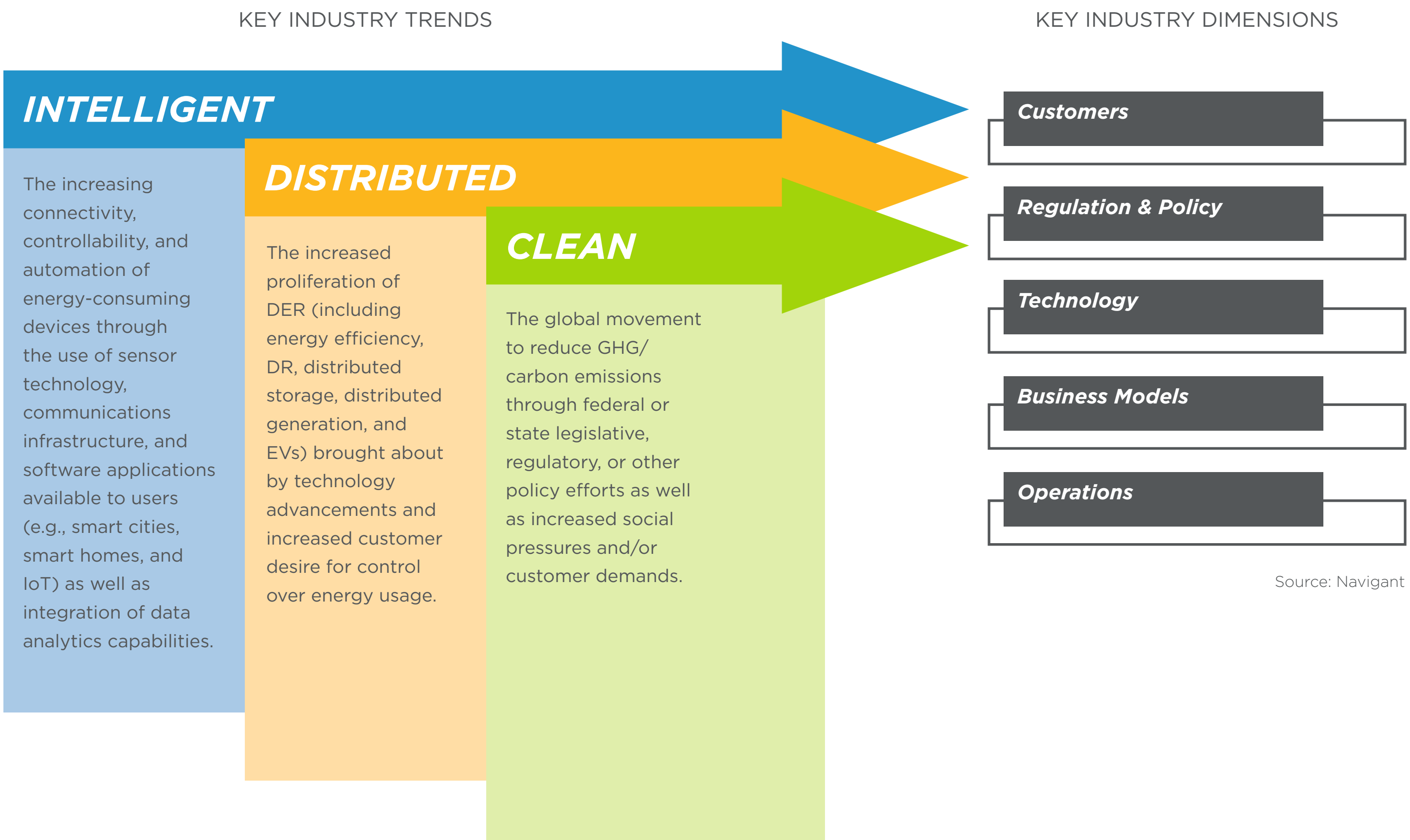
As proven many times over, network orchestrators are adept industry disruptors. Funding, investors, customers, and talent will continue to flow toward companies proving capable of capitalizing on digital networks and platforms. As connected devices, DER, intelligent buildings, and prosumers proliferate across the edge of the grid, it is only a matter of time before an innovator leveraging ubiquitous digital connectivity, data aggregation, and information exchange establishes itself within the industry. Energy Cloud 2.0 platforms are primed for such disruption.

SECTION 3. INDUSTRY TRANSFORMATION

3.1 Clean, Distributed, and Intelligent Energy

The emergence of Energy Cloud 2.0 platforms reflects an accelerating transition toward cleaner, more distributed, and intelligent energy (Figure 3.1). Describing broad paradigm shifts affecting how power is generated and consumed within the Energy Cloud—e.g., solar PV to distributed storage to digitization—these trends are also cutting deeper into multiple industry dimensions: customers, regulation and policy, technology, business models, and operations.

Figure 3.1 Energy Cloud Transformation



While not all clean energy is distributed (e.g., utility-scale solar and wind energy) and not all distributed energy is clean (e.g., diesel-fueled generator sets), among these trends, intelligent energy (or digital transformation) has the potential to be all encompassing, permeating all corners of the grid.

The impacts of clean, distributed, and intelligent energy across specific industry dimensions are discussed in more detail in the following sections.

3.1.1 Customers

From DSM to solar PV to smart behind-the-meter devices, energy customers have shown growing interest in controlling their electricity usage and spend, as well as when and what type of power they buy. The rise of onsite generation, storage, and net metering battles points to a growing percentage of customers demanding the ability to self-generate and sell power back to the grid.

The rise of onsite generation, storage, and net metering battles points to a growing percentage of customers demanding the ability to self-generate and sell power back to the grid.

Customer engagement is expected to be among the most hotly contested aspects of the Energy Cloud. Over 80% of respondents to Navigant's *State & Future of the Power Industry* report jointly published with *Public Utilities Fortnightly* believe that residential and commercial customers' demand for choice and control has the potential to change moderately (50%) or substantially (33%). Amazon, Google, Honda, Walmart, Whole Foods, and other large energy buyers, for example, have increased their focus on sustainable energy solutions across their building portfolios. This, in turn, is forcing new power-purchase agreements with incumbent utilities in order to minimize their risk of losing significant load. The next evolution is underway, with some (e.g., Ikea and Apple) requesting access to wholesale markets, selling overcapacity renewables.

The availability of intelligent data provided through the digital grid will drive behavior changes among all customer groups. Navigant analysis shows that increased awareness of energy use can add 1.5%-2% energy savings (measured through large populations of participant and nonparticipants via comparisons of metered data). Higher levels of energy savings may be achieved when differing levels of feedback (i.e., more real-time) are employed.

For utilities in particular, the challenge will be to meet an exponentially growing set of customer choices and changing demands while continuing to serve their core customer base. Creating trust and loyalty in the Energy Cloud will require a plug-and-play and dynamic platform environment that allows customers the means to achieve their goals (e.g., cost savings, reliability, resilience, and sustainability) while remaining a client of the utility.

3.1.2 Regulation and Policy

Regulatory and policy trends affecting the utility industry point to broadening support for clean, distributed, and intelligent energy. The impact of the United Nations Climate Change Conference (COP21), for example, is expected to be significant in driving clean energy adoption. Although there is a Supreme Court hold on the Environmental Protection Agency's Clean Power Plan, state governments, cities, and utilities in the United States are taking actions now to be compliant by rolling out widespread initiatives related to renewables, energy efficiency, DR, and DER. Meanwhile, sustainability objectives among global industry stakeholders are more closely aligned than ever before.

Rapid price declines of innovative solutions and increasing customer adoption of these solutions (e.g., solar PV), coupled with ambitious policy initiatives, have exposed limitations in current regulatory models, further accelerating market restructuring efforts. On one hand, some regulatory regimes seek to protect incumbent utilities by restricting market competition within a given market. On the other, progressive regulations seek to liberalize market rules to enable innovation toward a cleaner, open, and more efficient system. This approach includes creating room for new market entrants, DER, and new energy management products and services.

Policy initiatives are increasingly accepting of regional energy approaches (e.g., energy agreement among Canada-United States-Mexico, Europe's Energy Union, etc.) Simultaneously, local regulation and policy initiatives are driving ambitious carbon reduction and renewables targets. In emerging smart cities, for example, these efforts outpace global, regional, country, and state policies, forcing utilities serving progressive population centers and commercial and industrial customers to adapt innovative business models, products, and services in spite of more restrictive regulatory regimes.

In spite of continuing changes to regulatory and policy regimes, nearly 50% of respondents to Navigant's *State & Future of the Power Industry* survey identified the current regulatory environment as the greatest legacy challenge facing the industry over the next decade. To fully realize the benefits of emerging opportunities across the Energy Cloud, existing regulatory frameworks will need to continue to evolve. This includes providing financial incentives for regulated utilities to make infrastructure and programmatic investments. They must encourage innovation and experimentation in electricity pricing models to incentivize end users to make intelligent energy choices. Meanwhile, industry participants will need to make the difficult choice between influencing or even moving ahead of regulatory change to capitalize on clean, distributed, and intelligent energy opportunities or wait until a clearer (supported and more predictable) path can be identified.

In spite of continuing changes to regulatory and policy regimes, nearly 50% of respondents to Navigant's State & Future of the Power Industry survey identified the current regulatory environment as the greatest legacy challenge facing the industry over the next decade.

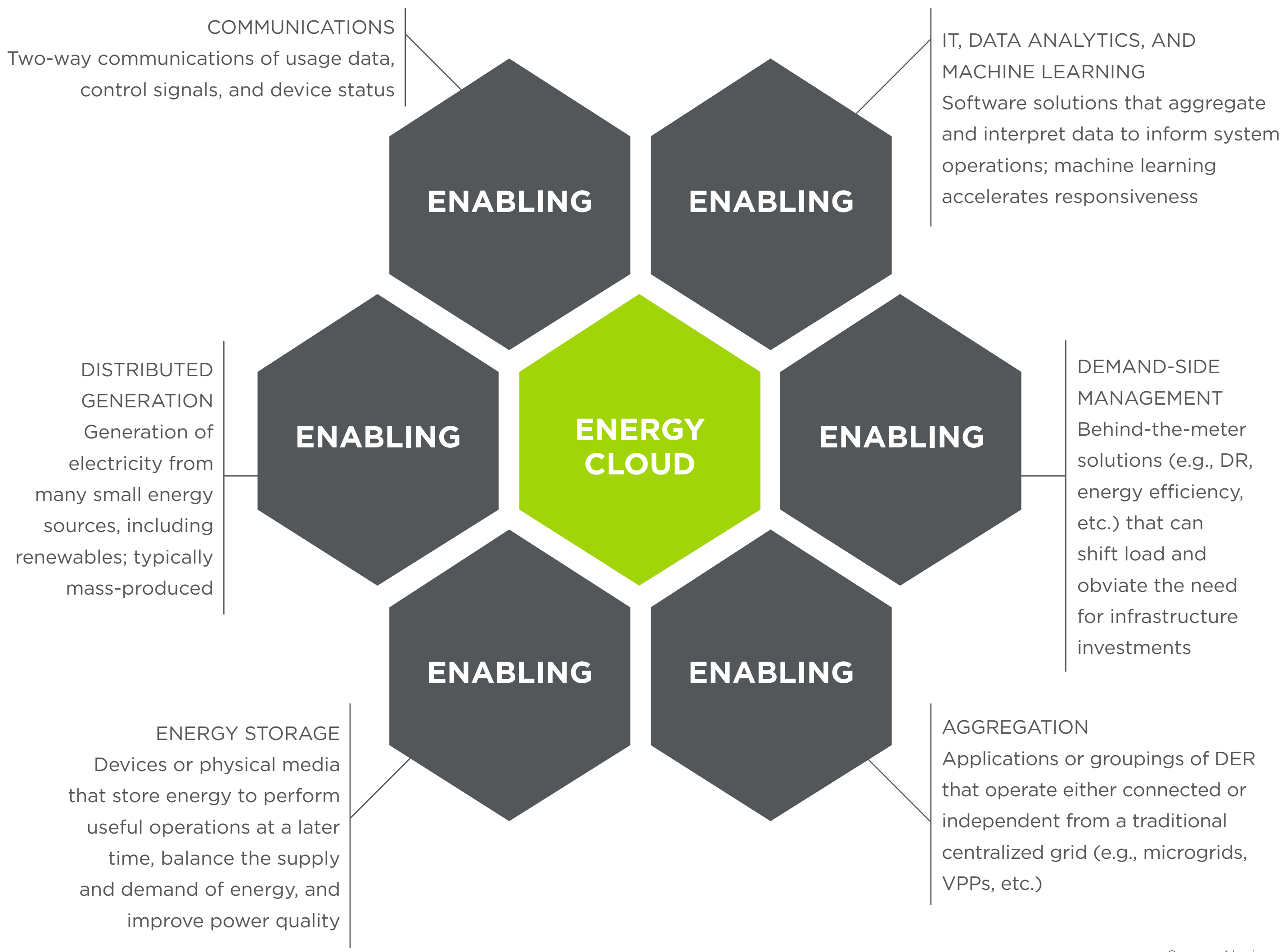
3.1.3 Technology

The volume of technological innovation and adoption across the utility industry today is staggering. The International Energy Agency forecast in its *Medium-Term Renewable Energy Market Report 2015* that by 2020, the amount of global electricity generation coming from renewable energy will be higher than the combined electricity demand of China, India, and Brazil today. According to Navigant Research, 2 TW of cumulative global DER capacity is expected to be deployed over the next decade, compared to 1 TW of cumulative centralized capacity.

The prolific rise of renewables, DER, smart sensors and devices, and behind-the-meter devices like smart thermostats are core components of an emerging clean, distributed, and intelligent grid infrastructure. DSM—supported by communications infrastructure, sound evaluation, measurement, and verification protocols, and data analytics—is contributing to a well-documented decoupling of economic and population growth on one hand and energy demand and revenue on the other. These trends point to the deepening impact of technology innovation within the utility industry.

At the confluence of technology innovation lies dynamic networks that combine standalone technologies to create new products, services, and value (e.g., Energy Cloud 2.0 platforms). This entails moving beyond siloed technology investment and incentive programs (e.g., solar PV) modeled on build, own, and operated centralized generation strategies to hyper-integration (e.g., solar plus storage plus energy management plus DR) and, finally, platform orchestration (e.g., iDER), as illustrated in Figure 3.2.

Figure 3.2 The Energy Cloud Innovation Ecosystem



Source: Navigant

While integrated technology platforms will accelerate the shift toward the Energy Cloud, they also require a sufficient level of adoption for their benefits to be fully realized. This ongoing tension will dictate the pace and scale of Energy Cloud transformation across various markets.

3.1.4 Business Models

Facing tectonic shifts across the industry, one certainty emerges: yesterday's utility-based electricity, volume, and rate base approach will not sustain organizational success in a more dynamic grid landscape. These shifts have intensified efforts to develop new business models better aligned with emerging market realities.

Utilities are increasingly partnering with vendors to adapt products and services. Emerging platforms like IoT offer exciting new channels that simultaneously deliver grid benefits like load control, improve customer satisfaction, and unlock new revenue streams. Many new business models in the Energy Cloud are expected to reflect the anything as a service model that is gaining steam across the broader economy in which underused physical products and assets are transformed into services. IT-enabled transactive energy systems that can track usage and bill for services is what makes these models possible.

For unregulated and non-utilities, the opportunities to leverage innovative business models are multiplying. Energy as a service models, for example, take a more menu-based approach to meeting the shifting demands of energy customers, offering a range of potential products and services to cater to an expanding array of customer preferences.

While there is no one-size-fits-all business model appropriate for all situations and markets, a wait-and-see approach risks missing the boat on major opportunities in a market that is becoming more open, competitive, and innovative. Digital transformation means that both the customer value proposition and earning revenue from selling electricity will shift considerably. Pay-for-performance contracts, for example, move away from generating revenue from turning the meter to a mutually profitable long-term partnership between the utility and customer. For utilities planning for a transition to DER, there are multiple pathways under consideration, as shown in Table 3.1.

Table 3.1 DER Business Models

MODEL	SELECTION RATIONALE
Integrate, develop, and own DER	Utility has DER integration experience and has no difficulty with designing, integrating, and controlling inhouse resources
Develop and own DER	Utility has the in-house capability to handle permitting, site selection, financing, and interconnection
Purchase a turnkey solution	Due to DER-specific knowledge, it may be more economical to have a third party handle the project development and site preparation tasks
Contract services	Due to the regulatory environment, utility contracts services from third parties; financed in various forms

Source: Navigant

3.1.5 Operations

Two-way power flows, large volumes of renewables generation, high penetration of DER, increased number of sensors, smart devices, and data, and a broader set of energy management solutions to meet customer demands will necessitate an overhaul of utility operations. The challenge will be to coordinate a more complex ecosystem and emerging energy platforms in a way that improves current grid functionality and creates new value while maintaining a safe, reliable, and affordable grid. As these issues are sorted out, the benchmarks for successful grid operations will increasingly move beyond safe, reliable, and affordable to embrace clean, distributed, and intelligent energy as well.

DER will need to be integrated into utility operations at several levels, including long-term IRP, mid-term energy markets as new resources, and the day-to-day grid operations (load balancing and dispatching based on pricing signals). Poor integration will lead to inefficiencies, wasted capacity, or even worse, poor long-term investment decisions and stranded assets. At the same time, operations must account for greater regionalization of energy issues and power flows increasingly crossing national boundaries. This requires stakeholders to continually calibrate operations between changing local demand (i.e., cities and companies setting their own carbon reduction and renewables targets) with an expansion of the grid ecosystem.

As energy becomes increasingly democratized, utility incumbents and new market entrants will need to personalize products and services much more so than today. This includes focusing on increased market segmentation analysis to better target and customize product and service offerings. From low-income customers that want reliable and affordable power to tech-savvy, environmentally conscious residential customers to commercial and industrial customers that want onsite generation, energy storage, and DR, the value of electricity is evolving and preferences are becoming more specific. The opportunities to strengthen the utility-customer relationship with these energy services will also lead toward customized and configured financing and retail pricing options.

Meanwhile, the utility industry is collecting more data more quickly and accurately—and at a higher level of resolution than ever before. Challenges associated with this include integrating data across different utility departments with specific objectives and ensuring accessibility to the data. With the investments made in meters, sensors, and infrastructure, it is imperative to produce value from these investments, and that comes when data streams are shared and used in a variety of applications within the utility.

3.2 Global Shifts

Whether the march of clean, distributed, and intelligent energy is characterized as a gradual evolution or wholescale transformation, the Energy Cloud can be observed across global markets today. These shifts are disparately felt. Specifically, the Energy Cloud's characteristics vary based on local market conditions: unbundled versus integrated and competitive versus monopolistic markets, developed versus emerging economy, and fossil fuel-rich versus renewables dependent state.

Generally speaking, the impact of the Energy Cloud will be felt in several ways:

- **Industry boundaries will expand:** An increasing number of utilities are operating at a more global scale (e.g., AES, Centrica, Enel, EDF, E.ON, Engie, and National Grid, just to name a few).
- **Barriers to entry will be lowered or eliminated:** Stakeholders across tech, telecom, cable, home security, retailers, and heavy manufacturing industries and sectors are targeting direct engagement opportunities with utility customers, offering products and services to offer products and manage consumption behind the meter.
- **Markets will become increasingly competitive and segmented:** Utilities face the difficult choice of protecting their core business of generation, T&D, and supply or moving into new areas of DER and other beyond-the-meter opportunities that offer greater value long term.
- **New distribution channels and services will be created:** Tesla/SolarCity, Apple, Edison International, General Electric, and other industry players are creating bundled energy service products and platforms to meet changing customer demand and choice.
- **Prices for electricity will fall:** In Germany, the United Kingdom, and the United States, the oversupply of renewables has resulted in periods in which the wholesale price of power has dipped into negative territory. With increased interconnection, more energy storage, DR, and transactive energy platforms, these savings will be extended across time, markets, and geographies.
- **Pricing mechanisms will become more complex and diverse:** Dynamic pricing programs are proliferating, with some jurisdictions beginning to pair data and behavioral analytics.
- **New products and services will proliferate:** The rise of DER and behind-the-meter energy management systems are allowing utilities and non-utility stakeholders to package bundled solutions (e.g., energy services) with emerging business models (e.g., microgrid as a service) as well as leading to non-regulated opportunities.

Several global examples below illustrate differences in how the Energy Cloud is evolving across diverse markets.

3.2.1 Europe: Full Speed Ahead

Europe, and more specifically the European Union (EU), has been at the vanguard of electricity market reform over the past decade. Focused primarily on decarbonizing the grid by transforming itself through member states into a global renewables leader, the region has been at the forefront of testing Energy Cloud reform through policies that mitigate carbon emissions, expand the role of distributed generation, and promote smart grid initiatives. Ambitious in its effort to standardize reform across unique markets, with the major exception of the United Kingdom's Brexit referendum result, regulatory and policy momentum have shown no sign of slowing down.

The market today is almost unrecognizable from 5 years ago. Going forward, the share of electricity produced from renewables across Europe is expected to double by 2030. Given the intermittency of renewables and capacity imbalances across member states, the need for a more dynamic network (i.e., the Energy Cloud) is quickly moving from nice-to-have to outright necessity. Coupled with the EU's commitment to delivering on

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a new deal for customers, policymakers are focused on setting the conditions for a reliable and affordable energy supply for all EU citizens and businesses while continuing to support efforts to make the region a world leader in renewable energy.

In some member states (e.g., Denmark and Germany), more than 50% of renewable energy capacity is community-owned. In other regions with strong cooperative tradition, promising initiatives continue to emerge. In the Italian Alps, for example, over 77 existing energy cooperatives produce renewable electricity for 80,000 citizens in 110 small municipalities. In Germany, the rising trend of energy cooperatives has been growing rapidly within the past decade, with approximately 170 municipalities regaining ownership of power generation and distribution facilities since 2007.

Market changes and reforms are not without their challenges. Squeezed by the explosive growth of renewables and low wholesale energy prices, Europe's utilities are being forced to reinvent themselves—and adapt to unrelenting technological innovation. Share prices have been in steep decline, a potential canary in the Energy Cloud coal mine. Some European utilities have retrenched, focusing on cutting costs and divesting assets. Others have divested legacy generation business and are developing new DER businesses (e.g., Engie, Centrica, and most recently, RWE's expected initial public offering in October 2016 under the name Innogy). Others are focused on expanding internationally while diversifying into new, more profitable markets. With the power generation business in steep decline, one strategy is shared by all: a focus on offering a portfolio of energy services. In most cases, this entails substantial bets on energy efficiency. European utilities are further along than those in other regions in terms of facing disruption, and their experience will provide important lessons for global markets.

The challenge across EU member states is how best to strike the balance between centralized market administration and market liberalization promoting unfettered competition across the grid edge. Different strategies are emerging, and many questions remain to be worked out with respect to the degree of integration and interconnection versus member state autonomy (e.g., the Brexit debate). The EU's handling of these issues will provide an early test case for managing transition to the Energy Cloud.

3.2.2 Competing Visions: California versus New York

While there may be no cohesive national energy plan at the federal level in the United States, several individual states have embraced market reform in an effort to embrace clean, distributed, and intelligent energy. California and New York are two states at the vanguard of these efforts; however, their approaches to increasing reliability, reducing system emissions, and empowering customers differ substantially.

California intends to keep the regulated utilities at the center of grid management and planning. Doubling down on efforts to move beyond natural gas and increase the share of clean energy, each of the investor-owned utilities across the state are required to submit Distribution Resource Plans to identify optimal locations for the deployment of distributed resources. The utilities are responsible for managing their systems and procuring resources where they have the highest value. All activities are expected to continue to flow through the utilities.

New York, which is the home of the free market and capitalism, is attempting to take a more market-based approach more in line with market reform strategies introduced in Europe. Even so, it may look similar to the California model once implemented. The New York Public Service Commission (PSC) initiated the Reforming the Energy Vision (REV) docket in 2014. The center of REV is the Distributed System Platform (DSP), which is an entity designed to act like a grid smartphone with third parties able to leverage the platform by developing smart grid applications and selling their services to willing customers. While this concept represents a significant shift toward an Energy Cloud future, the PSC has designated the utilities as the DSP for the foreseeable future, so the evolution to full market liberalization will be likely slower than initially conceived.

Initiatives in California and New York offer differing visions, but will offer early lessons for other jurisdictions following suit. Massachusetts, Minnesota, and Washington, DC, for example, have begun more incremental grid modernization proceedings, and they will strongly rely on best practices from the California and New York experiences.

3.2.3 The Emerging Frontiers: Mexico, Canada, and Japan

Three markets—Mexico, Canada, and Japan—represent the next frontier of clean, distributed, and intelligent energy transformation. Like Europe, California, and New York, all have the potential to emerge as pioneers in an Energy Cloud future.

Three markets—Mexico, Canada, and Japan—represent the next frontier of clean, distributed, and intelligent energy transformation.

On January 26, 2016, for the first time in Mexico's history, electricity could be sold between private parties without the state acting as an intermediary. This is the result of 3 years of legislative and regulatory proceedings, including a constitutional reform in December 2013 that eliminated the state's monopoly of the energy sector, opened access to T&D systems to private power producers, and created an independent operator to run a wholesale market.

With the goals of reducing the price of electricity, promoting competitiveness, and growth, the reform has two prongs. The first is Mexico's liberalized market, which will be managed by a new independent entity (CENACE). This includes the short-term wholesale electricity market. The second is the introduction of a Clean Energy Certificate (CEL) market—an electricity generation credit that certifies that it was produced using clean energy sources such as wind, solar, biomass, geothermal, and hydro. CELs will be traded by large consumers and residential suppliers to prove that a percentage of their electricity comes from clean sources.

While Mexico's reform efforts seem to be paying off thus far, there are still challenges ahead. At the end of October 2015, there was only one supplier registered for both the wholesale and regulated market; not surprisingly, it was CFE. At the moment, Mexico lacks the soft infrastructure needed to successfully run a market. There are few experienced power traders, a lack of experience with electricity consumption patterns, price discovery that occurs without any historical reference, and contracts that have yet to be optimized or tested in court.

Still, Mexico seems to be laying the groundwork to attract investment in innovative products and services. Most recently, the country joined the United States and Canada in pledging to produce 50% of its power by 2025 from hydropower, wind, solar, and nuclear plants, carbon capture and storage, and energy efficiency measures. Given the relative size of the industry within Mexico and the magnitude of the reforms, the opportunity for energy providers, service firms, and technology companies is significant. For its part, the country aims to invest $146 billion by 2029, with most of that going toward generation with natural gas and renewables, developing gas pipeline infrastructure, and strengthening the distribution system.

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Like Mexico, Canada sits atop a trove of clean energy potential from coast to coast, but has yet to cash in on its potential as a global leader in the trade of renewable products and services. While other major economies, including Germany, China, and the United States, have tapped into a global renewables market expected to eclipse $1 trillion in trade by 2020, Canada's share remains less than 1% of this global total. A recently signed trilateral energy and climate plan among Canada, the United States, and Mexico signals a commitment under Prime Minister Justin Trudeau's government to capitalize on the country's potential as an exporter of clean energy technology as well as to strengthen clean, distributed, and intelligent energy innovation domestically. Along with the United States, Mexico's and Canada's commitments could propel North America forward as an Energy Cloud pioneer globally.

Japan, meanwhile, has launched its own ambitious effort to liberalize power markets and tap into the transactive potential of the Energy Cloud. Its recent market reform removes power utilities' monopoly over electricity across the country. An estimated 260 companies are now selling electricity in Japan's $70 billion (and growing) retail market, putting customers in the driver's seat in choosing their power supply.

Under these market changes, Japanese consumers are able to buy electricity from suppliers ranging from telecoms conglomerate Softbank and trading firm Marubeni to travel agency H.I.S. and a Hokkaido-based supermarket cooperative that has branched out into solar parks. Companies such as railway operator Tokyu Corp. and Mitsubishi, which is joining forces with Japan's second-biggest convenience store chain operator, Lawson, are linking power sales to Internet and cable TV services. As an example of expanding beyond the provision of energy, they are also offering point programs and even free recipes, which are services popular among cooking buffs in Japan. Taking this model a step further, the Virtual Power Plant Experimental Project initiative launched by 14 Japanese companies subsidized by the government aims at establishing a VPP that bundles end-use devices scattered across the power grid (i.e., IoT).

3.3 The Energy Cloud: Tomorrow

For those able to weather disruption at the hands of clean, distributed, and intelligent energy trends, the Energy Cloud will give rise to many new opportunities. By sitting on the sidelines during this transformation, industry incumbents risk ceding trillions in new revenue to both non-utility players and new industry entrants.

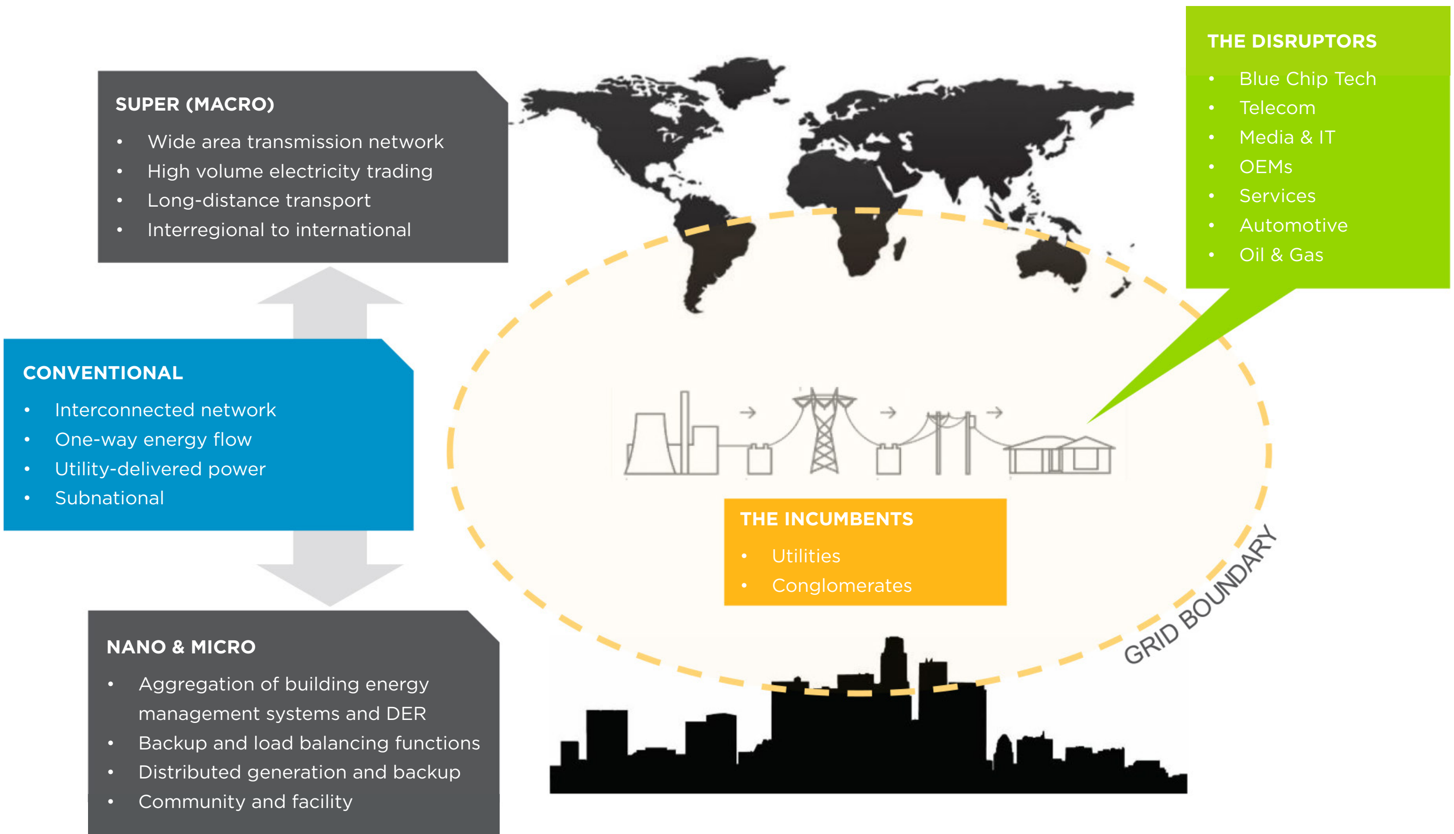
Currently, many of the most powerful and consumer-savvy companies in the world are lining up to put the traditional electric utility out of business. Google (and parent Alphabet), Apple, Amazon, Oracle, and Microsoft are already staking out positions across the energy value chain. In many cases, these companies are targeting opportunities to source renewable energy as well as leverage strong relationships with consumers in, around, and behind the meter by offering innovative solutions for smart homes, IoT, and other digitally enabled platforms.

Telecommunications companies like Verizon, Ericsson, and others are well-positioned to connect customers across the expanding Internet of Energy ecosystem. Their experience navigating massive disruption in their own industry will be an advantage. Security firms, oil & gas companies, and other diverse players are leveraging domain expertise to capitalize on opportunities across the energy value chain as well, including investing in renewables, storage, building energy management solutions, combined heat and power, and microgrid as a service offerings.

3.3.1 Industry Convergence Meets Boundary Expansion

As competition intensifies and the Energy Cloud matures, traditional grid boundaries are expected to expand (Figure 3.3). This will include digitally linking networks of hardware, software, and stakeholders at the built environment and community levels (nano and micro), as well as linking power networks that extend across geographic regions and beyond traditional nation-state boundaries (super).

Figure 3.3 Industry Convergence Meets Grid Boundary Expansion



Source: Navigant

Although the Energy Cloud will be associated with a significant shift toward DER and democratized power, traditional grid assets—baseload generation, poles and wires, and distribution architecture—will still have a key role to play in this future grid, but less prominent than what is seen today. The emergence of the Energy Cloud means that centralized generation's real and locational value will shift.

Across Europe in particular, dispersed DER are often aggregated as VPPs. Composed of distributed solar PV, wind turbines, backup generator sets, micro-combined heat and power, and DR collectively managed by a central control entity, these intelligent assets are beginning to field test next-generation energy management systems that combine robust data models to bridge energy resources on the one hand and energy markets on the other. VPPs demonstrate the potential of the Energy Cloud to simultaneously deliver value to a range of stakeholders, including energy consumers (e.g., lower costs and new revenue streams), utilities (e.g., avoidance of capital investments in grid infrastructure or peaking power plants), and transmission grid operators (e.g., regulation ancillary services such as spinning reserves).

At the other end of the spectrum, supergrids link grid networks and assets across national boundaries. These include domestic interconnection (e.g., the Atlantic Interconnection) as well as international interconnection (e.g., the Asian Supergrid) systems that utilize technologies that transmit electricity at high voltages across great distances more efficiently. Such technologies also integrate dispersed renewables into the power supply. When international interconnection is combined with economic market coupling using power exchanges, electricity becomes a tradable commodity that can be both imported or exported.

Asia and Europe are two of the most likely locations for the world's first international supergrids to take root. Most recently, a memorandum of understanding among China, Japan, South Korea, and Russia committed to feasibility studies for the development of an Asian Supergrid that could allow for the optimization of electricity, including power sourced from renewables, across the Northeast region of the continent. Other proposals are listed in Table 3.2.

Table 3.2 Global Supergrid Proposals

PROJECT	LOCATION
Desertec	Mediterranean, Germany
Medgrid	North Africa, Europe
China's Supergrid	China
Gobitec	China, Japan, South Korea, Russia
SE Asian Supergrid	Australia, Indonesia, Philippines, Malaysia, China
Asia Supergrid	China, Japan, Korea, Mongolia, and Russia
Nordic Grid	Northern Europe, Mainland Europe, Russia
North Sea Offshore Grid	Northern and Baltic Sea, Europe, Russia
IceLink	Iceland, United Kingdom, Mainland Europe
Brazilian Supergrid	Brazil
Atlantic Wind Connection	Eastern United States

Source: Navigant

3.3.2 The Energy Cloud Operating System

The smart grid evolution unfolding today will lay the foundation for an Energy Cloud operating system that integrates nanogrid, microgrid, and supergrid boundary distributions. This operating system will integrate ubiquitous digital connectivity, distributed networks, and sophisticated analytics into a fully self-organized network, propelled by data and distributed transactions across the grid. While kilowatt-hours were the operational currency of utilities in the 20th century, one could argue that data will be the operational currency within the Energy Cloud.

Utilities today are just scratching at the surface when it comes to harnessing data. The past decade has seen a rapid proliferation of smart devices across the entire network, from centralized power plants and wind farms all the way to the consumers of electricity in homes and businesses. Used widely in other industries, these distributed devices leverage computer-based remote control and automation, made possible by two-way communications technologies and computer processing.

Sophisticated data analytics will lay the foundation for a fully autonomous, self-healing grid integrating the full capabilities of AI and cyber-physical systems (e.g., IoT, self-driving EVs, and the smart grid). An Energy Cloud ecosystem fully leveraging these innovations into a neural operating system would render today's grid operations mostly obsolete.

This future state entails flipping the current command and control utility model on its head. While a radical concept, the proliferation of DER, digitization across the grid ecosystem, and rise of social networks are a potential harbinger of this future state. There is ample precedent for the operation of such a network delivering significant benefits, including improved safety, reliability, and sustainability. Self-organization among lower-level components—in this case, individual customers, things, and infrastructure—can mimic biological systems like ant colonies and bee colonies that collectively behave in the interest of the entire population. In *Self-Organizing Systems*, Scott Camazine describes selforganization as, "Physical and biological systems in which pattern and structure at the global level arises solely from interactions among the lower-level components of the system. The rules specifying interactions among the system's components are executed using only local information, without reference to the global pattern."

Although profoundly destabilizing to the industry, this bottom-up structure has the potential to deliver safer, more reliable, affordable, and cleaner power by optimizing resources across the network in real-time while eliminating many of the inefficiencies associated with human-machine intervention or long-distance transport of electricity. Again, the proliferation of data across the grid and harnessing of these streams into actionable intelligence is a crucial prerequisite to a fully operational neural grid.

SECTION 4. THE ENERGY CLOUD PLAYBOOK

4.1 The New SAIDI

While not all strategic pathways to navigate the Energy Cloud transformation will be appropriate (or even successful) for all players across all markets, those that acknowledge the complexity of the challenge ahead will already have an advantage. Facing unprecedented industry transformation, including an increasingly competitive business environment, the proliferation of mass-produced technologies with ever shorter lifecycles, and widespread digitization, utilities must rethink many of the assumptions that have anchored strategic planning to date. For non-utility stakeholders, navigating the Energy Cloud will require maintaining a firm grasp of regulatory change and industry trends as well as leveraging technology innovation to deliver innovative services.

Remaining competitive begins with a commitment to playing both defense and offense. This entails industry participants being proactive in an evolving market. Figure 4.1 outlines a framework for approaching strategic planning within an industry facing historic transformation, outlining five steps industry participants should follow to prepare their organizations to maneuver around disruption and capture value in the Energy Cloud.

Figure 4.1 The Energy Cloud Playbook (the New SAIDI*)

STAGE	ACTION
1	Sponsor a cross-functional team that will spearhead a strategy with a view toward a robust, integrated Energy Cloud plan.
2	Assess how the Energy Cloud is evolving across markets in which the utility operates or has targeted for expansion.
3	Identify inefficiencies in the organization's current value chain and business models.
4	Develop more efficient and cost-effective solutions.
5	Innovate relentlessly across the organization.

*SAIDI is typically an abbreviation for System Average Interruption Duration Index.
Source: Navigant

4.1.1 Sponsor a Team

The ability to collaborate and develop innovative solutions drawing from cross-disciplinary expertise will be a key differentiator among those organizations that prove to be most adept at navigating Energy Cloud transformation. Accordingly, executive leadership should embrace the challenges and opportunities of the Energy Cloud as part of their organization's strategic planning. This starts by assigning a cross-functional team to assess the need to hone their understanding of the likely business environment in which they operate today—as well as 5, 10, and even 25 years into the future. Drawing from various disciplines and perspectives across the organization will help it move past siloed thinking and lay the foundation for more holistic planning.

4.1.2 Assess the Market

Markets evolve at different rates and along diverse pathways. The same is true for the Energy Cloud's evolution across different regions, countries, and states. In order to assess the current market in which stakeholders operate, evaluating the intersection of clean, distributed, and intelligent energy trends across industry dimensions allows for an assessment of 15 potential tipping points (Figure 4.2).

Figure 4.2 The Energy Cloud Matrix (Illustrative)

DIMENSION	CLEAN	DISTRIBUTED	INTELLIGENT
Customers	• Rise of Community • Choice Aggregation • Carbon free energy • Sustainability	• Self-generation/storage • Security/reliability • Cost savings	• Accessibility/control • Transactive energy • Digital communication
Regulation and Policy	• Clean Power Plan (US) • 20-20-20 (EU) • Paris Accord	• Self-generation incentives • Net energy metering • Feed-in tariffs	• Grid modernization • Standardization • Smart meter targets
Business Models	• Utility-scale renewables • Green pricing • Community aggregation	• DER build, own, and operate • Energy services • Microgrid as a service	• Network Orchestrator • Variable rate design • Smart grid as a service
Technology	• Utility-scale renewables • Distributed renewables • Intelligent devices	• DER • Volt/VAR • Microgrids	• IT/data analytics • Advanced metering • infrastructure • Blockchain
Operations	• Renewables integration • Transmission upgrades • Load balancing	• Aggregation • Two-way power flow • Asset management	• IT/OT convergence • Customer engagement • Cybersecurity

Source: Navigant

While anticipating the scale and velocity—not to mention the likelihood—of disruption can be challenging, Energy Cloud maturity transformation can be assessed within a market by asking specific questions related to intersections across the Energy Cloud Matrix:

- **Clean—Customers:** What are the prevailing views of customers within a particular jurisdiction around the value of renewables?
- **Distributed—Regulation and Policy:** How are DER solutions incentivized under the regulations and policies within a particular jurisdiction?
- **Intelligent—Technology:** What machine-learning innovations have the potential to affect the utility industry?

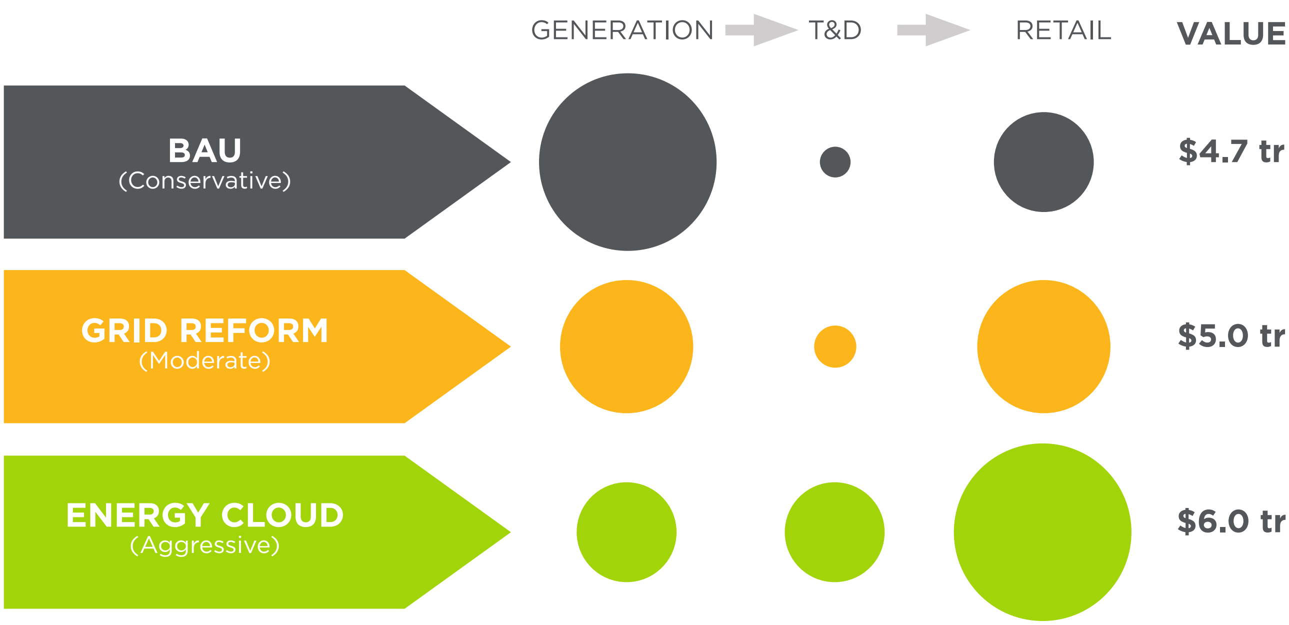
This analysis yields a textured view of Energy Cloud transformation within markets in which industry stakeholders are currently operating or plan to target through expansion or acquisition.

Once current market conditions are assessed, a scenario analysis can help identify future pathways of Energy Cloud evolution in order to guide strategic planning efforts. Ranging from conservative to aggressive transformation, Energy Cloud scenarios (Figure 4.3) paint three varying degrees of industry evolution. By identifying the scenario(s) most appropriate for their core or target market(s) today and in the future, utilities can evaluate strategic priorities to best position for long-term success:

- **Conservative:** This scenario describes a future grid with minimal penetration of clean, distributed, and intelligent energy (a minimum of tipping points triggered in the Energy Cloud matrix). The Energy Cloud does not materialize in a substantial way and many of the trends described today have little to moderate impact on grid development.

- **Moderate:** This scenario describes an emerging Energy Cloud with moderate penetration of clean, distributed, and intelligent energy disrupting traditional value streams. Digital transformation is expected to be minimal to moderate.
- **Aggressive:** This scenario describes a mature Energy Cloud in which widespread convergence of clean, distributed, and intelligent energy occurs across all five industry dimensions (customers, regulation and policy, technology, business models, and operations). Under an aggressive scenario, a majority of tipping points across the Energy Cloud matrix would be triggered.

Figure 4.3
Energy Cloud Scenario Revenue Generation (Est.) by Value Chain Segment, World Markets: 2030



Source: Navigant

Under the moderate and aggressive scenarios, new industry value (and revenue) will be created through investment in new infrastructure, products, and services across the value chain. This includes revenue streams that do not exist today or are the result of augmenting existing services, likely built upon emerging technology platforms described in Section 2.2: iDER, IoT, smart cities, transactive energy, etc. These investments are expected to have a measurable impact on all phases of the value chain under both the moderate and aggressive scenarios, resulting in a shift of industry value downstream toward the retail segment.

Each scenario is described in more detail below. However, the primary focus of this section is on the specific, transformative changes under an aggressive (Energy Cloud) scenario.

4.1.2.1 Conservative Scenario (Business as Usual)

Under a conservative scenario, industry revenue generation is expected to reach at least $4.7 trillion by 2030, growing at a compound annual growth rate (CAGR) of 5% between 2016 and 2030. Revenue allocation across the electric value chain remains mostly similar to existing percentages (e.g., generation accounts for nearly two-thirds of cost and revenue recovery).

Traditional forms of baseload generation tend to lead in markets reflecting a conservative scenario, with natural gas replacing some coal and moderate uptake of utility-scale renewables and DER penetration. Smart grid digitization efforts are expected to permeate nearly all phases of grid operations; however, the focus is primarily on improving utility efficiency. Furthermore, a lack of standardization and harmonization of rules for operation impedes efforts to capitalize on IT and data analytics innovation. Minimum investments in digital innovation occur. Incumbent utilities are expected to control a sizeable percentage of the value chain within these markets and successfully overcome threats to market share from third-party market entrants.

4.1.2.2 Moderate Scenario (Grid Reform)

Under a moderate scenario, industry revenue generation is expected to reach nearly $5 trillion by 2030, growing at a CAGR of 5.6% between 2016 and 2030. Revenue allocation across the electric value chain shifts downstream on a limited basis. Generation and retail account for roughly an equal share of cost and revenue recovery, with a conservative level of additional revenue attributed to digitally enabled products and services.

Coal is likely to be phased out aggressively, with utility-scale solar, wind, natural gas, and nuclear filling much of the baseload void. Adding to the mix, DER uptake is expected to be strong with greater synchronization of technologies integrated into the grid. Grid operations are more integrated, supporting individualized products and services, and are enhanced by advanced controls (including behind the meter) and analytics. A lack of harmonization of standards and protocols prevent autonomous grid operation; however, isolated progress is made territory-to-territory. Investments in digital innovation are minimal, but they affect all phases of the value chain. Utilities are likely to become moderately more specialized under this scenario, focusing predominately on infrastructure, services, and/or grid operations.

4.1.2.3 Aggressive Scenario (Energy Cloud)[1]

Under an aggressive scenario, industry revenue generation is expected to reach nearly $6 trillion by 2030, growing at a CAGR of nearly 6.6% between 2016 and 2030. Revenue allocation across the electric value chain shifts significantly downstream toward the customer, where the current value allocation of generation and retail cost and revenue effectively swap (i.e., customer acquisition costs and revenue represents more than 50% of total revenue generation). In fact, the traditional energy value chain begins to disintermediate to a great extent, enabling new market entrants at all levels. Digitally enabled clean, distributed, and intelligent innovations are expected to drive $1 trillion–$1.5 trillion in additional industry revenue above the BAU scenario through the creation of new products and services.

Utility-scale and distributed renewables account for 50%–100% of new generation. DER uptake is accelerated, driven in part by robust market demand and prosumer engagement. Grid operations are fully integrated and autonomous, and grid devices and networks are self-organizing and self-healing. Investments in digital innovation accelerate, affecting all phases of the value chain. Utilities may own traditional assets like poles and wires, but this infrastructure largely serves as a loss leader for more valuable services like enabling and facilitating transactions between and among market actors across the platforms (i.e., transactive energy).

CASE STUDY

The Wait-and-See Utility

One example utility in a state representative of business-as-usual (BAU) scenario stayed the course on generation assets and dragged its feet on AMI investments. However, disappointing load growth trajectory and federal regulations targeting fossil generation of late have begun undermining long-standing assumptions, causing management to reevaluate priorities. This includes surveying DER opportunities and contemplating shifting investments toward distribution assets and services. The question remains whether these efforts will be too little, too late.

CASE STUDY

The Proactive Utility

A utility operating in what many would characterize as a grid reform state with aggressive renewable and distributed policies has taken an Energy Cloud mindset. Anticipating a more networked grid, it has begun developing new services—integrating EV charging with DR, offering bring-your-own-device programs to customers, etc.—to serve an integrated, plug-and-play electricity system that it believes will enhance the value of individual assets across the network. With the goal of shifting away from the ratepayer model, this utility is taking steps to provide customers maximum flexibility and choice in how they use energy in order to maximize value across the network. To accomplish this, this utility has proactively built collaborative partnerships with technology providers.

4.1.3 Identify Inefficiencies

As described above, the aggressive scenario will be the most disruptive to the traditional utility value chain. While regulation can provide protection from disruptive trends, it can also stifle innovation, which will be a challenge particularly for utilities going forward. The obligation to serve—i.e., provide safe, affordable, and reliable power—and earn an acceptable rate of

1. As there are no markets indicative of the aggressive scenario today, no case studies are provided.

ROIs provides stability for an industry deeply dependent on access to credit; however, it also can promote a culture of risk avoidance. In such an environment, inherent inefficiencies can be built up and insulated over time, leaving aspects of the value chain particularly vulnerable to disruptive threats.

Anticipating disruption starts with evaluating inefficiencies across the utility value chain. Do customers feel they pay too much for services, and would they opt for a third-party solution? Are distribution assets fully optimized and could the organization save money by investing in data analytics? With the goal of prioritizing investments that shore up weaker or underperforming areas of the business while also positioning for new growth, a focus on inefficiencies is an effective way for industry stakeholders to play both defense and offense as the Energy Cloud matures.

The following examples illustrate how once stable incumbent solutions and revenue models exposed to disruptive triggers like regulatory and policy shifts, changing market demand, and accelerating technological innovation have succumbed to disruptive alternatives:

- Coal power disrupted by utility-scale renewables (wind/solar) and natural gas due to carbon mitigation regulations, market demand for clean energy and (more recently) cost.
- Centralized generation disrupted by DER due to supportive policies and incentives distributed generation, market demand for behind-the-meter products, technological innovation, and the cost decline of DER technologies.
- Demand growth (i.e., revenue growth) disrupted by DSM due to supportive policies and incentives for energy efficiency and DR, energy efficiency standards, increased customer awareness of programs, and technological innovation (e.g., LEDs).

Some have characterized the eroding profitability of utilities due to these disruptive forces as a death spiral. This is the doomsday scenario for industry incumbents. Of particular concern, disruption itself can feel abstract at the start, and then arrive suddenly—leaving incumbents grasping for market relevance.

Defending against disruptive innovation requires identifying those processes or services that can be replaced by, or outsourced to, more cost-effective digitally enabled alternatives. For stakeholders looking to establish or grow market share within the power industry, these opportunities could very well provide a beachhead for additional services. Despite vulnerabilities across the value chain, nearly every industry depends on power and the opportunities to build value and thrive within the Energy Cloud are significant.

Despite vulnerabilities across the value chain, nearly every industry depends on power and the opportunities to build value and thrive within the Energy Cloud are significant.

4.1.4 Develop More Competitive Solutions

Since value is shifting significantly downstream, it is critical to develop more efficient and cost-effective solutions to optimize the current business. At the same time, stakeholders must create investment space for new business models, products, services, and technologies.

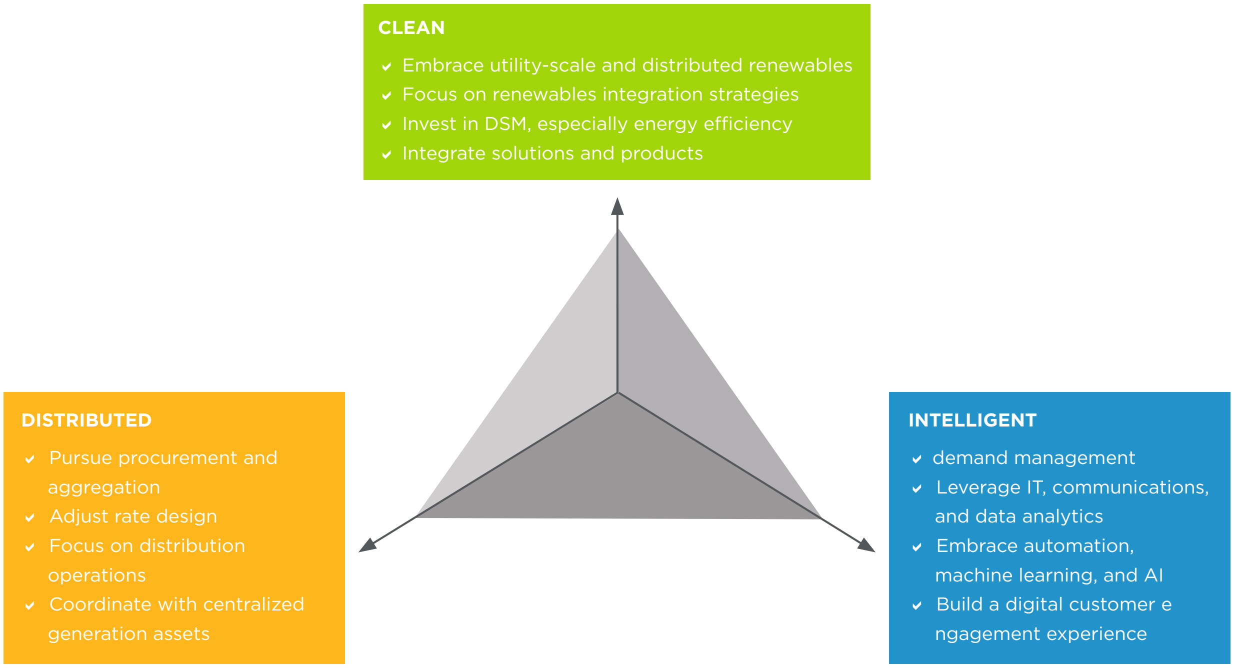
With some exceptions, utilities have generally not been granted much flexibility to assume significant risk when investing in emerging technologies. As with any such investment, the risk-reward calculus is important. For physical assets, there is considerable value in being the second mover or follower. But in the era of the Energy Cloud, where digital platforms have the potential to scale rapidly, latecomers could risk missing the opportunity to build a strategic advantage across a rapidly evolving market.

Remaining competitive will mean embracing a clean, distributed, and intelligent energy future. Maximizing all three dimensions will help meet demands from energy consumers, for whom reliability, affordability, and sustainability are increasingly priority issues. This starts with balancing the need for strategies specific to individual trends—clean, distributed, and intelligent—as well as an understanding of the intersections and dependencies across all three.

For example, to maximize potential return, stakeholder responses should approach distributed renewables with an eye toward the multidimensional implications of clean energy and customer-sited generation. The integration of advanced sensors, IT, and data analytics should also be considered to optimize the performance of the asset and its financial viability.

Examples of specific attributes of a holistic clean, distributed, and intelligent approach are outlined in Figure 4.4.

Figure 4.4 The Clean, Distributed, and Intelligent Utility



Source: Navigant

Embracing this triad will position stakeholders for long-term success in the Energy Cloud. Increasingly, energy and services in the power sector are expected to value clean, distributed, and intelligent as differentiators in the marketplace.

For utilities deepening their investment in emerging solutions, opportunities abound. With solutions proliferating across the value stream, utilities can protect upstream value while also creating new value downstream, especially on the customer side of the meter. DER presents a golden opportunity for utilities and non-utilities to develop and capitalize on new solutions. The blueprint presented in Figure 4.5 provides a tactical approach for utilities to capture new value in this space.

4.1.5 Innovate Relentlessly

Finally, the Energy Cloud Playbook calls for strategic planning to embrace an agile mindset. Focused on two objectives—accelerating the time to market readiness and reliably producing high-quality results—agile innovation is designed to be highly iterative, enabling rapid adaptation to unfamiliar and turbulent environments. Similarly, and perhaps most challenging for utilities, strategic planning must embrace the ability to fail fast, early, and often to keep pace with the rate of technology change. Many initiatives are bound to fail, or even worse, return just enough to sustain interest and tie up resources for several years before finally flaming out.

While the pursuit of new business models remains vitally important in this shifting landscape—whether regulated or not—the utility opportunity lies more in the ability to continuously shape and prune DER portfolios, embrace the rise of the digital prosumer, and capitalize aggressively on platform opportunities for bundled solutions. To do so effectively, utilities must begin transforming their operations and business models today by simultaneously pursuing risk mitigation capabilities and making bold bets on potentially high-growth product offerings.

Sitting on the precipice of profound industry change, utilities that embrace holistic planning while remaining flexible are likely to be the most successful at preserving and growing revenue as the Energy Cloud matures.

4.2 Conclusions and Recommendations

It is now widely acknowledged that unprecedented transformation within the power industry is underway. From clean, distributed, and intelligent energy transformation to emerging technology platforms, the opportunities for new growth are presenting themselves today. In this fast evolving Energy Cloud, stakeholders must move quickly and be prepared to navigate an increasingly multivariable landscape.

Many of these opportunities are not yet known. Note that when the power grid first emerged in the 1870s, it took 20 years for

Figure 4.5 iDER and the Energy Cloud Playbook

Source: Navigant

factories to move from powering their shop floors to realizing productivity gains by optimizing their machinery to take maximum advantage of access to electric power. Once these changes were integrated into the fabric of the factory operations, productivity gains grew exponentially. In other words, it can take time to fully realize the full scope of opportunities enabled by innovation. While intelligent energy is gaining traction today, opportunities for exponential growth built upon DER or industry digitization efforts, for example, have yet to be fully exploited.

Positioning for sustained growth in the Energy Cloud will necessitate a lane shift among industry participants. For some, this shift will be the result of strategic planning efforts. For others, a shift will be forced by industry evolution due to fluctuating regulation and policy, market demand, and technology innovation.

The following takeaways will define organizational success in the Energy Cloud:

- **Remain proactive in pursuing new business models, services, and offerings** regardless of challenges and many unknowns. There are no silver bullet business models that can reap outsized rewards for all players in all market. However, embracing change and targeting opportunities across an increasingly clean, distributed, and intelligent energy landscape will enable stakeholders to position for competitive advantage.
- **Ensure network facilitation is the long-term focus of every strategy** to maximize potential revenue returns in the Energy Cloud. One-off technologies will not sustain growth in the Energy Cloud; instead, stakeholders must be prepared to integrate networks of assets, customers, strategic partners, and enabling technologies to deliver augmented value.
- **Build a culture of agile innovation and flexibility.** In the evolving Energy Cloud ecosystem, there will be numerous technology paths for industry participants to pursue, many of which lay beyond stakeholders' collective purview today. Currently, many utilities are evaluating and making initial investments in network orchestrator roles, including areas like VPPs, building energy management systems, microgrids, energy storage, and others. But these areas are just the beginning in an environment where the pace of innovation continues to accelerate.

SECTION 5. SCOPE OF STUDY

Navigant has prepared this white paper as the next installment in its Energy Cloud thought leadership series (see *The Energy Cloud*, published April 2015). The focus of this paper is to provide current and interested stakeholders at all levels of the electrical grid—including utilities, regulators, technology suppliers, service providers, investors, and policymakers—with an overview of the opportunities and challenges offered by the shift toward clean, distributed, and intelligent energy. Examples of significant market and technology developments, an overview of industry transformation, and a blueprint to guide strategic planning efforts are provided. Note that the report does not aim to offer exhaustive assessments of industry transformation. Such analyses are discussed in more detail in Navigant Research's in-depth market and technology reports.

SOURCES AND METHODOLOGY

Navigant Research's industry analysts utilize a variety of research sources in preparing Research Reports. The key component of Navigant Research's analysis is primary research gained from phone and in-person interviews with industry leaders including executives, engineers, and marketing professionals. Analysts are diligent in ensuring that they speak with representatives from every part of the value chain, including but not limited to technology companies, utilities and other service providers, industry associations, government agencies, and the investment community.

Additional analysis includes secondary research conducted by Navigant Research's analysts and its staff of research assistants. Where applicable, all secondary research sources are appropriately cited within this report.

These primary and secondary research sources, combined with the analyst's industry expertise, are synthesized into the qualitative and quantitative analysis presented in Navigant Research's reports. Great care is taken in making sure that all analysis is well-supported by facts, but where the facts are unknown and assumptions must be made, analysts document their assumptions and are prepared to explain their methodology, both within the body of a report and in direct conversations with clients.

Navigant Research is a market research group whose goal is to present an objective, unbiased view of market opportunities within its coverage areas. Navigant Research is not beholden to any special interests and is thus able to offer clear, actionable advice to help clients succeed in the industry, unfettered by technology hype, political agendas, or emotional factors that are inherent in cleantech markets.

NOTES

CAGR refers to compound average annual growth rate, using the formula:

CAGR = (End Year Value ÷ Start Year Value)(1/steps) – 1.

CAGRs presented in the tables are for the entire timeframe in the title. Where data for fewer years are given, the CAGR is for the range presented. Where relevant, CAGRs for shorter timeframes may be given as well.

Figures are based on the best estimates available at the time of calculation. Annual revenues, shipments, and sales are based on end-of-year figures unless otherwise noted. All values are expressed in year 2016 US dollars unless otherwise noted. Percentages may not add up to 100 due to rounding.

SECTION 6. ACRONYM & ABBREVIATION LIST

5G ... Fifth Generation
AI ... Artificial Intelligence
AMI ... Advanced Metering Infrastructure
B2G ... Building-to-Grid
BAU ... Business as Usual
CAGR ... Compound Annual Growth Rate
CEL ... Clean Energy Certificate
CO2 ... Carbon Dioxide
COP21 ... 21st Session of the Conference of the Parties
DER ... Distributed Energy Resources
DR ... Demand Response
DSM ... Demand-Side Management
DSP ... Distributed System Platform
EU ... European Union
EV ... Electric Vehicle
GHG ... Greenhouse Gas
GW ... Gigawatt
GWh ... Gigawatt-Hour
HV ... High Voltage
HVAC ... Heating, Ventilation, and Air Conditioning
iDER ... Integrated Distributed Energy Resources
IoT ... Internet of Things
IT ... Information Technology
LED ... Light-Emitting Diode
MW ... Megawatt
PSC ... Public Service Commission
PV ... Photovoltaics
REV ... Reforming the Energy Vision
ROI ... Return on Investment
SAIDI ... System Average Interruption Duration Index
SCADA ... Supervisory Control and Data Acquisition
T&D ... Transmission and Distribution
TV ... Television
TW ... Terawatt
US ... United States
VPP ... Virtual Power Plant
VRBO ... Vacation Rentals by Owner

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SECTION 8. TABLE OF CHARTS & FIGURES

Note: Editing of this report was closed on August 12, 2016.

ABOUT NAVIGANT

Navigant Consulting, Inc. (NYSE: NCI) is a specialized, global professional services firm that helps clients take control of their future. Navigant's professionals apply deep industry knowledge, substantive technical expertise, and an enterprising approach to help clients build, manage and/or protect their business interests. With a focus on markets and clients facing transformational change and significant regulatory or legal pressures, the Firm primarily serves clients in the healthcare, energy and financial services industries. Across a range of advisory, consulting, outsourcing, and technology/analytics services, Navigant's practitioners bring sharp insight that pinpoints opportunities and delivers powerful results. More information about Navigant can be found at navigant.com.

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