ENERGY CLOUD 4.0

CAPTURING BUSINESS VALUE THROUGH DISRUPTIVE ENERGY PLATFORMS

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MACKINNON LAWRENCE
Director, Navigant Research

JAN VRINS
Global Energy Practice Leader

CONTRIBUTORS:

KORNELIS BLOK
Director

JAN CIHLAR
Consultant

RICHELLE ELBERG
Associate Director

BRETT FELDMAN
Associate Director

DEREK JONES
Director

JOHN GARTNER
Director

STUART RAVENS
Associate Director

RICHARD SHANDROSS
Associate Director

NEIL STROTHER
Associate Director

CASEY TALON
Associate Director

ERIC WOODS
Associate Director

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ENERGY

ENERGY CLOUD 4.0

Capturing Business Value through Disruptive Energy Platforms

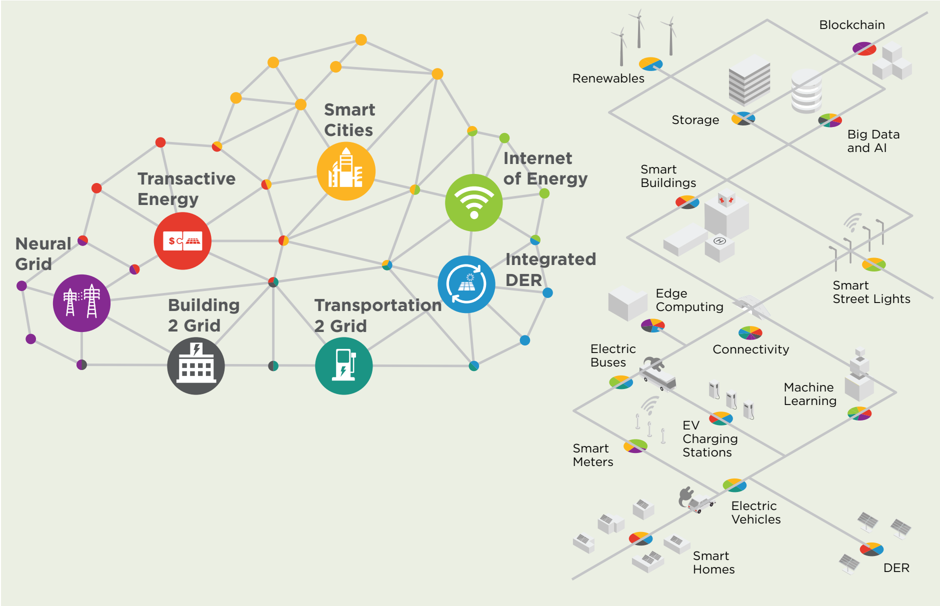
1 EXECUTIVE SUMMARY

1.1 Defining the Energy Cloud Transformation

The energy sector is in the midst of a major global transformation. During the next 5-15 years, Navigant expects massive disruption across the entire energy value chain that will affect a broad set of stakeholders. This transformation is primarily being fueled by multilateral efforts focused on decarbonizing the global economy to address climate change and a shift toward an increasingly clean, intelligent, mobile, and distributed energy ecosystem.

Linear value chains supporting one-way power flow from centralized generation to end customers will give way to a more sustainable, highly digitized, and dynamic energy system. Moving toward a multidirectional network of networks and away from a linear hub-and-spoke model, this system will support two-way energy flows in which customer choice (optionality), clean energy, innovation, and agility command a premium. At Navigant, we call this the **Energy Cloud**.

Figure 1.1 Navigant Energy Cloud 4.0: Network of Networks



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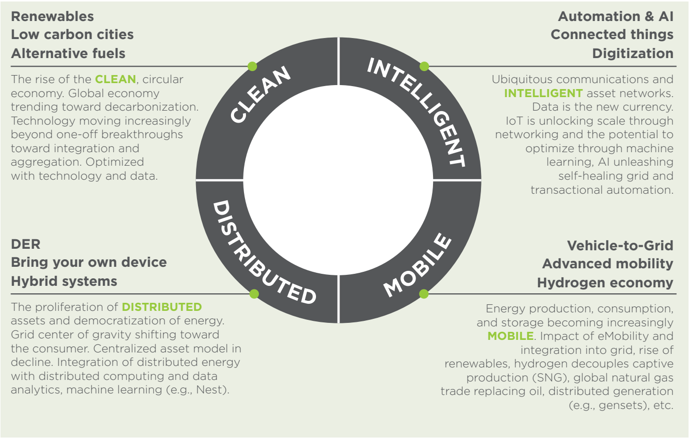
Multiple Energy Cloud trends and tipping points indicate that a transformation is already well underway. These trends are driving major energy paradigm shifts that can be categorized into four dimensions: clean energy, intelligent energy, mobile energy, and distributed energy (Figure 1.2).

Figure 1.2 The Clean, Intelligent, Mobile, and Distributed Grid

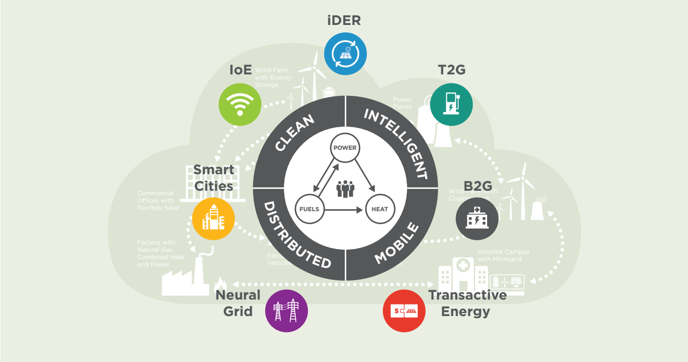


(Source: Navigant)

In the Energy Cloud, the epicenter of disruption will center on the customer as demand for cleaner, more flexible, and cheaper solutions reaches commercialization. For many emerging technologies, critical mass either has arrived or is on the immediate horizon. The combination of these innovative technologies, increased demand for new energy products and services, and viable business models will give rise to dynamic, customer-centric Energy Cloud platforms such as Building-to-Grid (B2G), Transportation-to-Grid (T2G), and Smart Cities (Figure 1.3). Unlocking value beyond the electron, Energy Cloud platforms will capture a growing share of revenue and power flow away from centralized energy production and bulk transmission.

Energy carriers will become increasingly interconnected. For example, excess renewable power can be converted to heat or hydrogen that can be transported and stored; hydrogen can be converted back into electricity and used directly as fuel for industries or transportation. Enabling greater integration across energy carriers (including electricity, liquid and gas fuels, and heat), the impact of the Energy Cloud transformation will be felt well beyond the power grid and the power industry. It will affect the way we live, work, and move around in our communities and cities, as well as the way we use materials, produce and move goods, and provide services.

Figure 1.3 The Energy Cloud Transformation



(Source: Navigant)

As demonstrated in other industries, platforms in the energy industry will be managed by network orchestrators that connect customers to a rich tapestry of products and services. Platforms across the energy industry are not mutually exclusive; instead, the meshing of underlying networks will enable a fully mature Energy Cloud ecosystem. It is no longer a question of if the Energy Cloud will mature, but rather, when—and more importantly, how.

1.2 Navigating the Transformation

Energy companies and utilities need to be more responsive to changing market pressures and increasingly agile in adopting innovative new business models. Although policy and regulatory reform is an important driver of transformation, customer choice and technology innovation are relentless instigators of disruption. These forces are critical in understanding the Energy Cloud transformation.

In the most extreme cases, traditional market structures will disintermediate and long-standing stakeholder relationships will rearrange in combination with new market entrants. Renewables and distributed energy resources (DER) are fundamentally changing the way we produce and use energy. Furthermore, the broad application of technology, data, artificial intelligence (AI), Internet of Things (IoT), and blockchain will unlock opportunities far beyond our purview today, further blurring the lines across traditional industries. Data is rapidly emerging as the most disruptive commodity in the 21^{st} century and an increasingly important opportunity for market differentiation among market actors.

Meanwhile, new value streams from energy and non-energy products, services, and platforms are emerging and have the potential to offset flat or declining load growth. Service-based and network orchestrator business models leveraging fast emerging Energy Cloud platforms have the potential to scale faster and yield greater profit margins than the traditional asset-focused and supply models that currently dominate the industry.

Changing customer demands, progressive policies and regulations, and technology innovation are expanding conventional benchmarks for customer service as well. Regulatory regimes ensure a minimum standard of safe, reliable, and affordable service, but evolving customer choice and individualized power products and services require incumbent stakeholders to meet an expanding list of new customer expectations:

- **Sustainability:** Clean and low carbon energy products and services.
- **Flexibility:** Dynamic, intelligent, and connected energy solutions and infrastructure.
- **Autonomy:** Local, distributed energy assets and democratized control over energy use.
- **Individualization:** Highly personalized energy products and services catering to an assortment of customers.

The Energy Cloud transformation is already having profound impacts across five core industry dimensions—customers, policy and regulation, technology, business models, and operations—which raise several critical strategic questions:

- How can energy companies and utilities maneuver to capitalize on emerging Energy Cloud platforms?
- Where will new profit centers emerge across the evolving value chain?
- What business models should energy companies and utilities pursue to sustain shareholder returns while serving shifting public interests?
- How can they drive changes to the traditional regulatory construct so that value is captured by service providers without penalizing nonparticipants?

In response, energy companies and utilities should embrace the following immediate priorities:

- Move rapidly to the energy system of the future (the time is now).
- Grasp market opportunities derived from increasing consumer demand for new energy products and services.
- Maximize the business benefits offered by Energy Cloud platforms and the digitization of the energy system.

Service-based and network orchestrator business models leveraging fast emerging Energy Cloud platforms have the potential to scale faster and yield greater profit margins than the traditional asset-focused and supply models that currently dominate the industry.

1.3 Building Sustainable Value

In **Section 2: Transformation** of this paper, we discuss the foundation for the Energy Cloud evolution and examine the potential industry impacts from three disruptive "what if?" scenarios. **Section 3: Opportunities** explores new sources of value creation through the emergence of dynamic, high growth platforms. **Section 4: Pathways to Success** offers an innovation blueprint for industry stakeholders, introduces two emerging business model frameworks, and provides a blueprint for navigating the Energy Cloud transformation. Finally, **Section 5: Conclusions and Recommendations** summarizes specific actions industry incumbents (energy companies and utilities) and disruptors can undertake to capitalize on the Energy Cloud transformation.

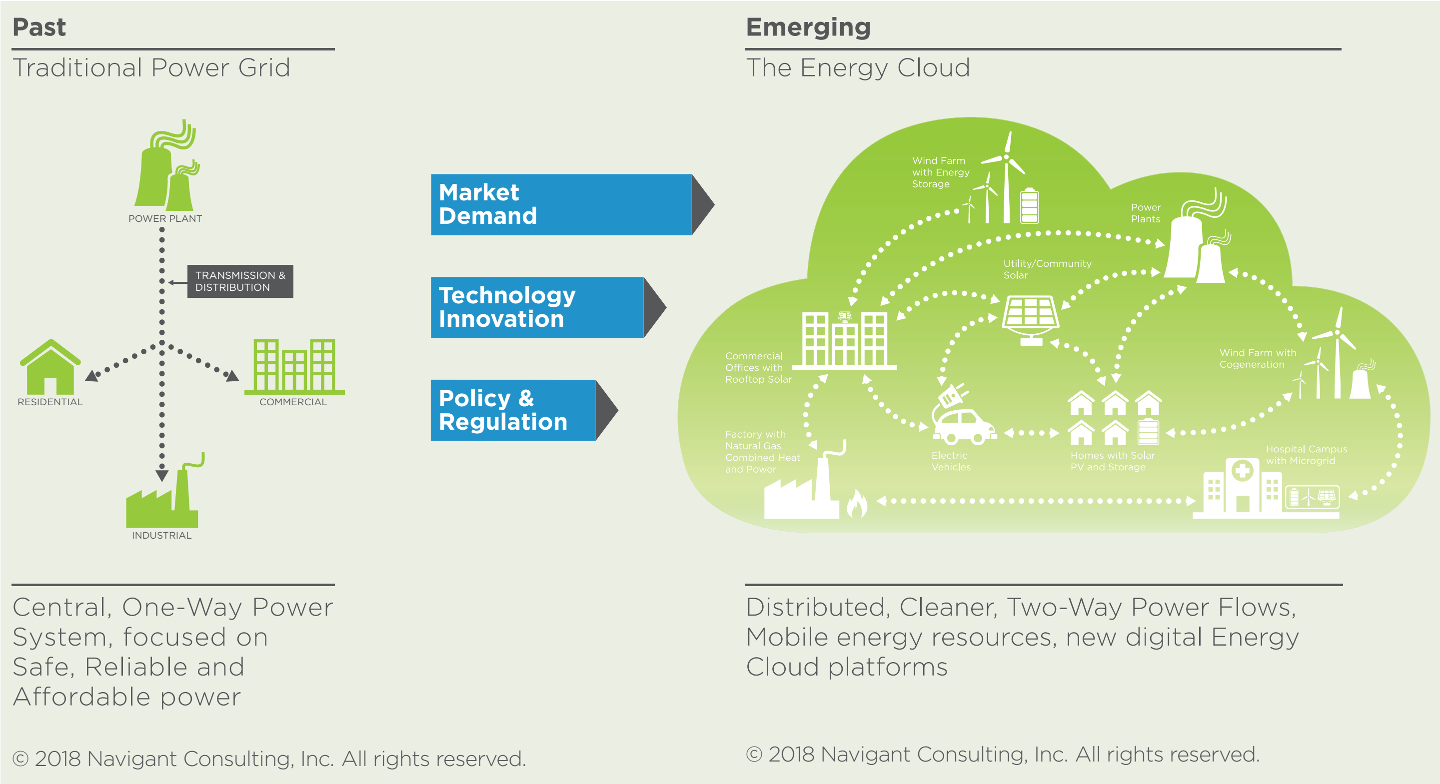
2 TRANSFORMATION

2.1 Sizing Up the Energy Transformation

The most salient aspect of technology is its power to disrupt. When combined with changing market demand (customer preferences) and evolving policies and regulations, the impact can result in dramatic industry shifts in which the status quo becomes not only untenable, but unrecognizable (see Figure 2.1).

Today's energy industry is merely in the first phase of transformation. A rapidly increasing share of renewable energy generation, wide-scale adoption of distributed energy resources (DER), decarbonization of the global economy, electrification of transportation, and digitization are reshaping the existing energy paradigm in profound ways. The resulting Energy Cloud ecosystem will support multiple value flows among networked actors. Although subsequent growth will mean more competition, it will also mean more opportunities for incumbents and third parties across multiple customer-centric platforms.

Figure 2.1 Grid to Cloud: The Energy Transformation



Although all markets are moving toward a clean, intelligent, mobile, and distributed energy ecosystem, the Energy Cloud transformation will evolve at different paces and along different trajectories depending on regional and local priorities. Energy prices and tariff structures, market structures (unbundled vs. integrated; competitive vs. monopoly market landscapes), and the cost and availability of new technologies will require different levels of response. While Navigant sees advantages in a more regional approach to policy and system design for the Energy Cloud transformation initially, best practices should be applied globally. In both Europe and North America, for example, there are lessons from early responses at the individual country, state, province, and local levels that can be leveraged in other markets.

In Europe, the Energy Transition (as it is called) is further along than in other regions due to Europe's precautionary, preventive, and rectifying energy policies, as well as customer demand for sustainable and decarbonized solutions. Although Navigant sees additional increases in large-scale renewables in Europe, significant disruption will come from an increasingly distributed energy system. DER is expected to grow 9 times faster than net new central station generation (including renewables) across the region in the next 10 years (664 GW vs. 72 GW). The threat to traditional energy markets, systems, and stakeholders is increasingly acute.[1]

1. Navigant Research, *Global DER Deployment Forecast Database*, 4Q 2017.

Europe should prepare the energy system to manage the increased capacity of intermittent renewables (and all its impacts). It should also ensure that DER are fully integrated into the system to maximize their value and optimize the cost of the total energy system. Europe will, together with China, lead the way on electrification of transportation, with countries and cities setting aggressive targets to replace combustion vehicles with electric drivetrains. Lastly, Europe could benefit from additional focus on energy efficiency and demand response (DR), which is receiving increased attention at the EU and individual country level.

North America has focused on the demand side of the energy system for many decades primarily through a federal appliance policy and standards program and many state-supported energy efficiency programs. In several parts of North America, the impacts of DER are well understood. Discussions about the value of DER and rules by which DER can be integrated into the system and used in the energy markets have been implemented in many states. The Federal Energy Regulatory Commission's (FERC's) announcement of an order to remove barriers to the participation of electric storage resources in the capacity, energy, and ancillary services markets operated by regional transmission organizations and independent system operators is a good example.[2] While North America has seen a recent surge in renewable deployments, it could learn from the progress that Europe has made with offshore wind. The region could also apply best practices from Europe around the electrification of transportation and heating. Finally, although at the federal level the US is in the process of rolling back policies aimed at decarbonizing the power sector, local and state initiatives and large corporations and industries are increasingly filling the void.

Organizations should be prepared for all potential Energy Cloud realities. This includes considering high disruption scenarios that threaten to put your organization out of business and, potentially, leveraging paradigm shifts to reinvent your business and capitalize on opportunities seemingly far-fetched today.

Other global regions are responding in unique ways as well. Asia Pacific and the Middle East are driving growing investment targeting innovative, sustainable solutions to address rapidly expanding electricity needs. In many cases, energy access issues allow for more experimentation at the customer level. China is poised to spearhead a DER and cleantech explosion across Asia Pacific during the next decade that will likely reverberate throughout the rest of the world as domestic expertise is exported abroad. According to a Navigant Research study, the DER market in China will reach $100 billion within the next 5 years, growing at a compound annual growth rate of 8.2% through 2030.[3] Unique market dynamics within China and across Asia Pacific provide additional potential models of response, though they are also still in the nascent stages of Energy Cloud maturity.

2.2 Energy Cloud Scenarios

While projecting the myriad of variables that will materialize in any market is fraught with uncertainty, successful innovators are those that look to the future and consider a range of possible scenarios. Organizations should be prepared for all potential Energy Cloud realities. This includes considering high disruption scenarios that threaten to put your organization out of business and, potentially, leveraging paradigm shifts to reinvent your business and capitalize on opportunities seemingly far-fetched today.

Three future scenarios—Base Case, DER Growth, and Energy Cloud—offer three visions of the future to 2030. These describe various degrees by which industry change may occur, from a more conservative outlook (Base Case) to aggressive transformation in which long-held industry assumptions are no longer applicable (Energy Cloud). The scenarios do not represent the full range of pathways, but rather, are illustrative of the continuum of realities that should inform strategic planning.

2.2.1 Base Case

Under the **Base Case** scenario, existing market structures remain mostly intact. In the US, for example, vertically integrated utilities shoulder the bulk of load and infrastructure development, managing centralized generation assets to deliver safe, affordable, and reliable power to mostly passive customers. Upgrades are made to the existing network and regulations generally protect this operational environment in support of market and financial stability. Two-thirds of industry value remains concentrated around centralized generation assets (including large-scale renewables), with the bulk of power flowing through the transmission and distribution (T&D) grid. T&D and the customer end of the value chain represent the remaining one-third of industry value. The bulk of new investments are concentrated on upgrading existing infrastructure, with recovery amortized over a 20- to 30-year period, recovered in full through electricity rate schedules. This scenario assumes only minimal disruption to the industry.

2.2.2 DER Growth

The **DER Growth** scenario describes a future in which DER adoption continues through 2030, forcing a shift in value downstream from centralized generation and transmission to distribution, energy delivery, and behind-the-meter (BTM) products and services. While centralized generation is maintained

2. Federal Energy Regulatory Commission New Release, "FERC Issues Final Rule on Electric Storage Participation in Regional Markets," February 15, 2018, www.ferc.gov/media/news-releases/2018/2018-1/02-15-18-E-1.asp#.WpQ8kXxG0kJ

3. Navigant Research, *Global DER Deployment Forecast Database*, 4Q 2017.

as a key source of bulk power production for the grid, including utility-scale renewables, fewer terawatt-hours ultimately flow through the bulk transmission infrastructure. Distributed generation (DG), distributed energy storage, microgrids, demand-side management programs (including DR and energy efficiency), and EVs shoulder much of the load. Dynamic T&D pricing keeps the grid financially sound and investable. In this scenario, a third of current value moves downstream from centralized generation assets to the customer level, which represents two-thirds of total value across the electricity supply chain. While energy companies and utilities see more competition from technology and DER solutions providers, revenue is recovered through familiar mechanisms (i.e., rate base and some dynamic rates varying by time and location). This scenario assumes a moderate disruption to the industry. Higher risk is mostly concentrated on organizations owning and operating centralized generation as well as T&D assets while operating under the traditional business model. Although associated revenue compared to the Base Case scenario will decrease significantly, new revenue streams associated with owning, operating, and optimizing DER assets will arise.

2.2.3 Energy Cloud

The **Energy Cloud** scenario describes a world in which the Energy Cloud transformation is fully mature. The power supply is predominately clean and distributed. Digital transformation initiatives embrace applications for artificial intelligence (AI) and the Internet of Things (IoT) while blockchain-enabled retail trading networks are prevalent. Widespread electrification of transportation means that power supply and demand become increasingly mobile. Energy company and utility business models will transform from bulk asset and supply-based to individualized service- and network-based solutions more tuned to customers' shifting demands. Energy markets, especially retail, will be far more competitive, even without the adaptation of traditional, regulated constructs. Ubiquitous AI and communications infrastructure will transform smart grids into autonomous and self-healing networks that integrate clean, intelligent, mobile, and distributed energy while enhancing safety, reliability, and affordability. Network orchestrators, energy service providers (ESPs), and prosumers will emerge as active stakeholders, further pushing the grid's value to the edge.

2.3 Energy Cloud Inflection Points

Three megatrends outlined below have the potential to greatly accelerate the pace and scale of Energy Cloud transformation. Thus, they should be considered as part of strategic planning efforts.

2.3.1 Decarbonizing the Global Economy

According to the Paris Agreement, staying within planetary boundaries requires the average global temperature rise to stay well below 2°C or even 1.5°C compared to pre-industrial levels.[4] This ambitious climate goal necessitates scaled-up, real-world implementation across the entire global economy. The energy and transportation systems, which currently account for nearly half of global emissions (with buildings and industrial processes accounting for another quarter), are critical to delivering on these goals. Successful implementation requires balancing deep decarbonization progress within energy, transportation, and buildings markets with energy's foundational role in fueling economic growth.

Successful implementation requires balancing deep decarbonization progress within energy, transportation, and buildings markets with energy's foundational role in fueling economic growth.

As the energy sector undergoes the low carbon Energy Transition, new and shifting technologies and processes will present emerging opportunities and challenges for both supply and demand. For example, decarbonization requires not only reduced investments in fossil fuel generation, but also additional investments in emerging clean technologies. According to Bloomberg, zero carbon power generation will attract nearly $9 trillion in investment through 2040.[5] At this scale of investment, significant ripple effects would be felt across the grid (due to intermittency and load balancing) and beyond (e.g., water demand for geothermal and nuclear systems and forestry and agricultural impacts for the bio-economy).

The increasing convergence of action among stakeholders to decarbonize the energy system points to sustained investment in decarbonization initiatives. The most important levers to maximize impacts for stakeholders in the near term are the following:

- Scale up energy efficiency across sectors for all buildings and industries globally.
- Deploy renewable energy, which is already achieving strong growth in the power sector, at greater scale to produce clean power and fuels for industries, buildings (heating), and transportation. This includes greater electrification within the transportation and heating sectors.
- Expand bulk power storage capacity, including hydro and battery storage, by taking advantage of increasing round-trip efficiency and rapidly declining costs.

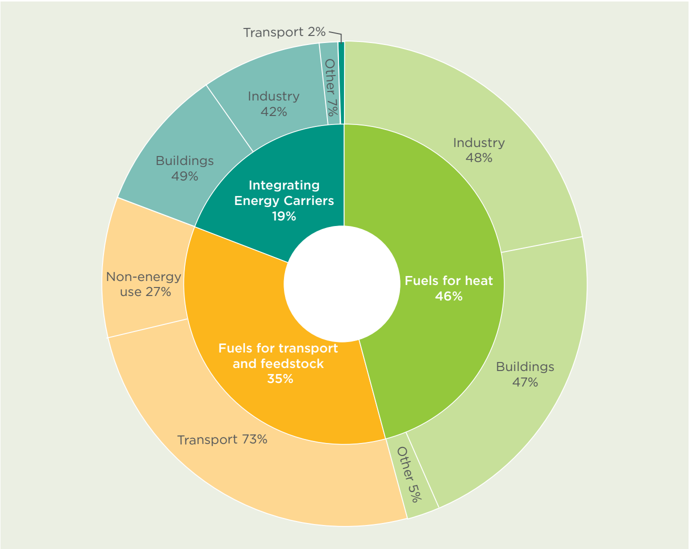
4. For more information, see: www.cop21paris.org.
5. Bloomberg New Energy Finance, *New Energy Outlook 2017*, 2017.

- Target reductions in energy inputs for extracting, producing, and shipping basic materials as part of more comprehensive sustainability targets.
- Move to business models and processes that embrace principles of circular economy, as significant energy inputs are needed to produce basic materials.

2.3.2 Integrating Energy Carriers: Moving beyond the Electron

In the Energy Cloud, the role of electricity will become more prominent and more central in the energy system. As shown in Figure 2.2, heat and fuels account for nearly 80% of total demand across the global energy system today. Led by buildings and the electrification of transportation, however, the share of electricity demand within the global energy system is expanding quickly.

Figure 2.2 Integrating Energy Carriers



(Source: IEA World Energy Balances 2017)

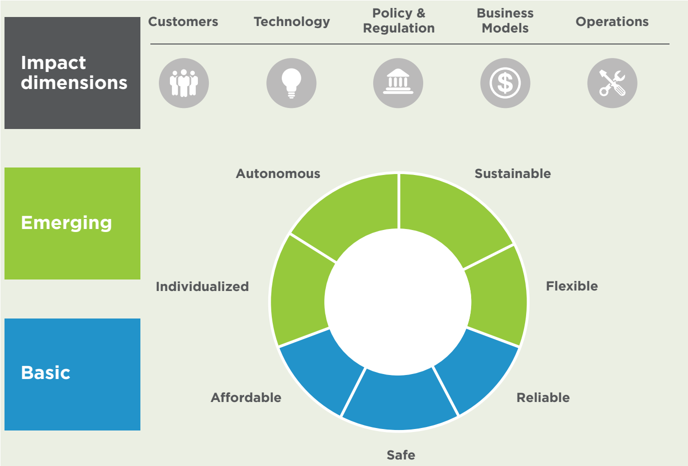
Transportation electrification, for example, will offset demand in the oil & gas industry while providing opportunities for incumbent energy companies and utilities to capture new load growth. The electrification of heating, especially in Europe, will reduce dependence on natural gas. At the same time, we see a more sophisticated arbitrage across energy systems and commodities whereby one energy form may be converted to another and vice versa.

As a result, residential, commercial, and industrial customers will have more choice across energy carriers and will select one or the other depending on spot prices. Interconnectedness across energy carriers will also lead to increased hedging across energy commodities. For example, industrial companies may choose to produce heat from electricity instead of natural gas when electricity prices drop below gas prices (as is already the case in periods of abundant supply of renewable electricity). Similarly, power-to-gas schemes in which electricity is converted to hydrogen and eventually to other fuels, like synthetic methane, will become more common.[6] Hydrogen can then be used for power generation, industry processing, heating, and transportation.

In the Energy Cloud, multi-fuel-based energy companies and utilities will take advantage of integration across energy carriers to access multiple end markets and high growth applications. As a result, we expect more power and gas utilities to consolidate their operations further and traditional oil & gas players to continue increasing their investments across the new energy ecosystem.

Facing emerging customer demands, decarbonization, and the proliferation of demand-side technologies, energy companies and utilities will need to rethink conventional value attributes of service. As the performance requirements move beyond safe, reliable, and affordable, for example, changes to their traditional business will be felt across multiple dimensions. Safe, reliable, and affordable is no longer a sufficient measure of customer service. In an increasingly competitive market, organizations will also need to ensure sustainability, flexibility, autonomy, and individualization in their solutions to set themselves apart from competition (Figure 2.3). Furthermore, with more suppliers competing for their business, customers will increasingly select their preferred supplier based on an expanding set of criteria such as trust (with their data), brand reputation, and convenience.

Figure 2.3 Value Differentiation of Products and Services in the Energy Cloud



(Source: Navigant)

6. Navigant Research, *Redefining Mobility Services in Cities*, 4Q 2017.

Market actors anticipating these changed customer service values should consider the following actions:

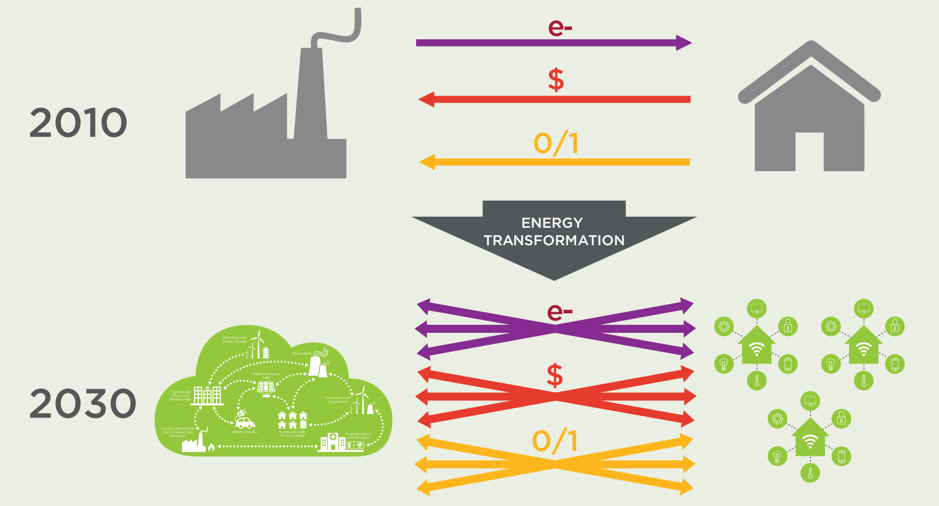
- Cater to shifting customer demands and offer specialized services to a more diverse and more concentrated mix of customer segments.
- Adapt to changing policies and regulations that will place a premium (and in some cases, require) an energy supply that is clean, distributed, and resilient and embraces transportation electrification.
- Integrate disruptive technologies that enable additional value attributes for customers and allow greater flexibility across energy carriers. Embrace principles of agility in piloting solutions and a willingness to rapidly scale even if it erodes demand for your core products.
- Develop and nurture strategic business partnerships that deliver compounding value to customers and leverage synergies across products and solutions.
- Invest in platform opportunities that optimize customer and system flexibility better than current control mechanisms and socialize the benefits across ecosystem stakeholders.

2.3.3 Leveraging Data Analytics and AI

In the Energy Cloud, data is also expected to give rise to new value creation beyond the energy products and services. The rise of big data across the broader economy has been acutely disruptive, with data dubbed "the commodity of the 21st century" and "the oil of the digital era," according to the *Economist*.[7] Data changes the nature of competition. In a big data future, infrastructure scale and customers served will no longer determine success for energy companies and utilities. Leveraging data in the Energy Cloud means unlocking a trove of opportunities and greater precision in system balancing between increasingly dynamic local networks, Energy Cloud platforms, and more variable wholesale markets.

As Figure 2.4 illustrates, in a future transactive environment within the Energy Cloud, data will flow both to and from a customer, informing AI algorithms within smart contracts of the optimum time to store excess generation, sell it to the grid, participate in DR programs, charge or discharge batteries, etc. Data from a customer's premise feeds DER management platforms, informs market operators of consumption and production, and alerts potential customers of when and how much power the prosumer can export.

Figure 2.4 Changes in Value Flows in the Energy Cloud



(Source: Navigant)

7. "The World's Most Valuable Resource Is No Longer Oil, but Data," *Economist*, May 6, 2017.

Navigant expects the Energy Cloud to create more than $1 trillion in added value (the total of investment in new technologies and assets) to the power grid by 2030. With the uncertainty that surrounds ripple effects associated with technology adoption, this figure is likely a conservative estimate.

Digital savvy will be a competitive advantage in the Energy Cloud. New value will be enabled by the introduction of smart and connected DER as well as new digital products and services. The companies that win the lion's share of new revenue will be those that harness technology and data and extract their value most aggressively.

Data has changed the nature of competition in many ways: by freeing up capital through efficiency savings, creating new digital products and services, and selling more through an improved understanding of customers. Companies that aggregate vast quantities of data are rewarded with high valuations relative to peers. Tesla, which has delivered a fraction of the cars of industry incumbents in the last couple years and has yet to turn a profit, commands a higher stock price than its peers. This valuation is partly a reflection of the perceived value of data and the potential of tomorrow's transportation infrastructure as a platform. When combined, these factors greatly enhance the disruptive threat vehicle electrification poses to an industry organized around the internal combustion engine. The more data Tesla gathers from its self-driving cars, for example, the more it can transform them into self-driving machines. Even if Tesla does not survive as a profitable business, it will have cemented itself as an industry disruptor, which the market is valuing and rewarding today.

Market actors should consider the following in leveraging data analytics and AI:

- Begin with an investigation into how to use data to improve operational efficiency as you embark on your digital transformation. By analyzing massive datasets of operational data, companies are reporting efficiency savings of 20%-30%.
- Look well beyond efficiency savings to achieve digital maturity. Develop new products and services that have the power to disrupt at scale.
- Leverage customer-related data to better segment your customer base and target specific customer groups with tailored marketing campaigns.

2.4 Anticipating Energy Cloud Ripple Effects

The ripple effects that will be felt across the industry from an Energy Cloud scenario can be difficult to anticipate. We consider three "what ifs?" below to illustrate how the competitive landscape could shift unexpectedly and much sooner than

rates of traditional power industry growth suggest. While these ripple effects are not certainties, they remain within the realm of possibility, and therefore, critical to fully preparing for an Energy Cloud future:

1. What if widespread DER adoption causes a 50% reduction in the electricity flowing through the bulk transmission grid?
2. What if 75% of power and utility industry value shifts downstream to the customer?
3. What if energy companies and utilities lose 50% of retail market share to new market entrants?

2.4.1 DER Impact on Centralized Generation

The proliferation of DER will be among the most disruptive trends to the traditional energy industry for the foreseeable future. Most energy companies and utilities are already wrestling with revenue erosion due to energy efficiency, demand-side optimization, and solar PV. As deployments of DG and energy storage, plug-in EVs (PEVs), and microgrids gain further traction, the impact on incumbent revenue will become more pronounced.

According to Navigant Research estimates, new global DER capacity deployments—including DG, distributed energy storage, PEV charging load, microgrids, DR, and energy efficiency—are outpacing the deployment of new centralized generation capacity today.[8] In the next 2 decades, the same forecasts show that there will be at least 14,000 GW of cumulative installed DER capacity deployed globally, assuming all installed assets after 2017 remain in service or are replaced. This represents nearly 1.5 times more DER capacity installed than the US Energy Information Administration (EIA) projects for centralized generation over that same timeframe, assuming all capacity installed prior to 2017 is decommissioned.

Applying a modest capacity (production) factor of 20% for installed DER capacity, Navigant Research estimates installed DER capacity would produce nearly 43,000 TWh of power, more than enough to cover the EIA's nearly 39,000 TWh of expected electricity consumption. On paper, in other words, DER could obviate the need for centralized generation entirely by 2030.

DER also includes so-called negative generation—such as energy efficiency and DR—which has the effect of lowering overall electricity consumption by an estimated 18,000 TWh globally. PEVs, which store positive generation from the grid and DG assets for consumption at a later time (and may forgo charging if already full), are the most significant wild card in this exercise. Again, assuming a modest 20% capacity factor for these assets, they account for 24,500 TWh of DER capacity. This leaves roughly 6,000 TWh directly attributable to DG, or what we might characterize as positive generation, which represents 15% of power consumption relative to EIA estimates.

The proliferation of DER will be among the most disruptive trends to the traditional energy industry for the foreseeable future.

Combining both positive generation and demand reductions associated with DER, a 50% reduction in the volume of electricity passing through bulk transmission is entirely plausible (and likely a conservative projection). The ripple effects caused by a 50% reduction in demand for centralized generation would be broadly felt.

For example, less power passing through transmission infrastructure would obviate demand for infrastructure expansion and new investment in the existing bulk transmission paradigm. In many countries, the existing infrastructure for electricity T&D is aging. According to the International Energy Agency, investment in T&D grids over the 2012-2035 period is projected to be $7.2 trillion (40% of this investment to replace existing infrastructure and 60% to build new infrastructure). If industry stakeholders chose to forgo simply replacing and upgrading the existing bulk grid, a 50% reduction in transmitted electricity could translate into a reduction of roughly $3 trillion-$4 trillion in investment, affecting a significant source of revenue for infrastructure companies. This will differ by region, depending on existing grid needs and new infrastructure investments (smart grid and grid hardening) to support large-scale renewables (transmission) and DER integration (distribution).

Transmission companies (and energy company and utility transmission businesses) typically attract investors' attention because they produce a steady, reliable stream of income. Thus, any significant disruption to the location and attributes of the generation mix warrants further consideration.

2.4.2 Major Value Shift to the Customer

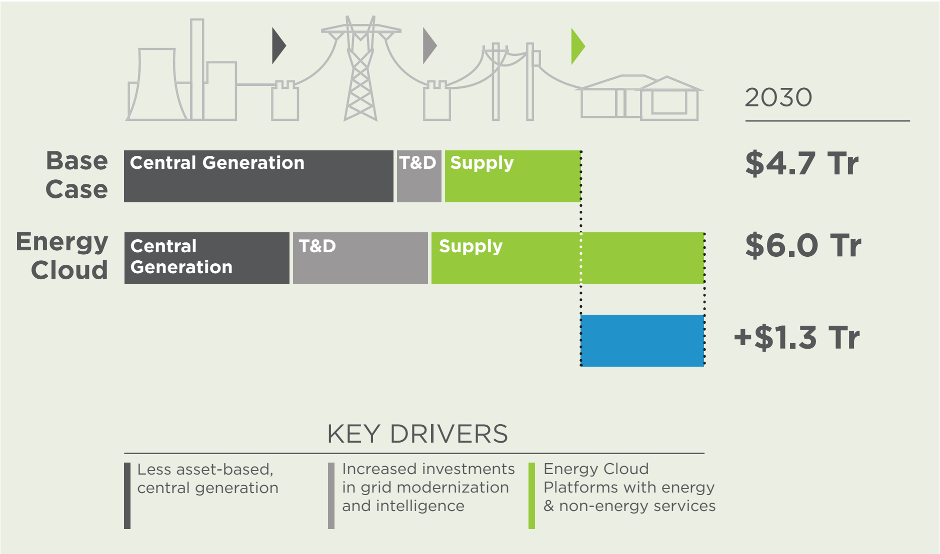
Combined with high bandwidth telecommunication infrastructure, data analytics, and machine learning, an estimated $2 trillion-$4 trillion in new industry value will be created under the DER Growth and Energy Cloud scenarios. The Energy Cloud scenario will add over $1 trillion in value by 2030 over the Base Case, which is likely a conservative estimate when considering both commodity energy sales as well as revenue associated with innovative energy and non-energy value-added products and services.

8. Navigant Research, *Global DER Deployment Forecast Database*, 4Q 2017.

With 75% of value shifting downstream, traditional gas, electric, and water utility customers sit at the heart of an emerging retail-centric ecosystem. Which firm they purchase from is often immaterial. Purchasing decisions will increasingly be driven by the additional value considerations outlined in Section 2.3.2.

As Figure 2.5 shows, the implications of industry value shifting downstream toward the customer are significant and affect virtually every aspect of the traditional power and utility industry. Specifically, by 2030, the relative value allocations of power generation and retail will swap. The cost and revenue of distribution and customer energy management (including beyond the meter) will represent more than two-thirds of revenue allocation across the value chain.

Figure 2.5 Value Shift Projections in the Energy Cloud



(Source: Navigant)

From demand-side management to solar PV to intelligent BTM 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. Declining costs of DER and consumer-enabling technologies—e.g., smart thermostats, building energy management systems, and machine learning heating and cooling systems—would point to an even greater deployment of technology and infrastructure at the edge of the grid.

The rise of onsite generation, energy storage, and net metering battles could result in a greater percentage of customers demanding the ability to self-generate and sell power back to the grid at reasonable compensation levels. Amazon, Whole Foods (now owned by Amazon), Google, Honda, Walmart, and other large energy buyers are establishing grid-independent (perhaps connected) sustainable energy solutions across their building portfolios. Led by Ikea and Apple, commercial and industrial (C&I) prosumers could eventually gain access to wholesale markets in order to sell overcapacity renewables.

With 75% of industry value shifting downstream, the customer ecosystem will evolve into a far more dynamic marketplace, with a highly diverse asset mix, unpredictable load, and commanding an increasing percentage of the value pool. To stay competitive, energy companies and utilities will need to move beyond business models that cater to monolithic customer classes and embrace agile innovation strategies.

2.4.3 Loss of Retail Market Share

From airlines to financial services to, most recently, healthcare at the hands of Amazon, regulated industries are not immune to disruption. Energy is no different.

The Energy Cloud provides fertile ground for customer-centric, cash-rich, and digitally savvy companies to capitalize on emerging technology and customer ecosystems. With the potential encroach on the traditional utility enterprise's most valuable asset, its customers, these organizations are an emerging threat. Energy is ubiquitous and the industry is among the largest in the world, which makes it an attractive target for cash-strong and customer-centric disruptors across the broader economy.

Not surprisingly, customer engagement is expected to be among the most hotly contested aspects of the emerging Energy Cloud. Over 80% of respondents to Navigant's *State & Future of the Power Industry*[9] report believe that residential and commercial customers' demand for choice and control will change moderately (50%) or substantially (33%). This is typically an area where traditional power and utility companies struggle.

The challenge for energy companies and utilities will be to meet an exponentially growing set of customer choices and changing demands while continuing to serve their core customer base. While doing so, they will need to fend off competition targeting customer access from non-traditional players, as shown in Figure 2.6.

Figure 2.6 Retail Disruption in the Energy Cloud

(Source: Navigant)

9. Navigant Consulting, Inc., *State & Future of the Power Industry*, 2017.

There is significant value up for grabs in this emerging customer ecosystem. As such, the distribution and retail segments will be under constant threat of disruption. The foundation for customer trust and loyalty in the Energy Cloud is to create the kind of plug-and-play and dynamic platform environment that allows the customer the means to achieve their goals (i.e., cost savings, reliability, resiliency, and sustainability) while also remaining a customer of the energy company or utility.

Still, with access to capital, scale, and existing relationships with customers, energy companies and utilities are well equipped to take advantage of emerging opportunities across the Energy Cloud. Improving customer experience and engagement will continue to move from the fringe of business operations to the core. Investment is growing as they adapt to these evolving customer expectations and explore new technologies aimed at improving the customer experience.

Navigant cautions that energy companies and utilities have less than 5 years to reposition their companies or risk ceding significant market share to new market entrants already targeting opportunities focused on the energy customer. At stake is the highly valued customer relationship they enjoy currently. If they fail to recognize the threat posed by disruptors, incumbents' customer loyalty will be at risk.

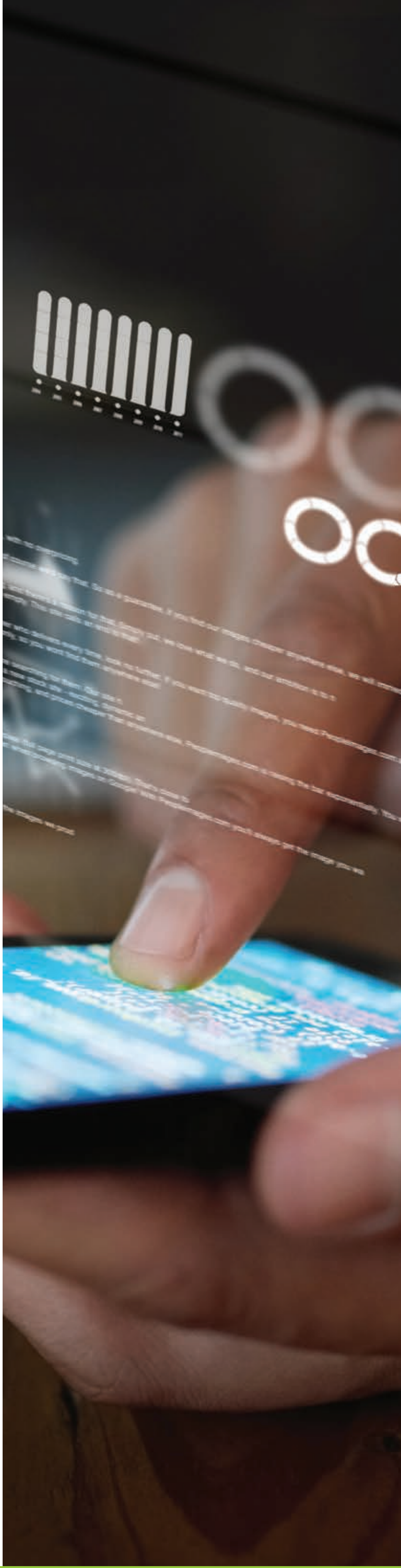
Disruptors include well-established companies as well as startups across many customer-centric industries: high tech, telecom, retail, heavy and consumer product manufacturing, security and internet providers, auto manufacturers, and others. Flush with cash and operating thriving R&D departments, oil & gas majors are among the most invested in new energy opportunities, especially across the clean and distributed energy landscape. But with less than 1% of revenue invested in emerging technologies across the power and utility industry, current initiatives are just the tip of the iceberg.

Figure 2.7 provides just a handful of examples of companies that are aggressively targeting Energy Cloud platform opportunities.

Figure 2.7 The Customer Battleground in the Energy Cloud

COMPANY	CORE BUSINESS	DESCRIPTION
amazon, Google, Apple	Tech	GAFAs (Google, Apple, Facebook, and Amazon) building customer ecosystems for a broad set of offerings in B2G, IoE, and T2G platforms.
T-Mobile, verizon, BT	Telecom	Telcos are increasingly active in IoE, T2G, B2G, Neural Grid, and Smart Cities platforms.
TOTAL, bp, Shell	Oil & Gas	Oil majors are making aggressive moves into retail commodity markets and active in iDER and T2G.
sonnen, SolarCity	DER	DER players pursuing large partnership networks to accelerate iDER scale-up.
TESLA, TOYOTA, Mercedes-Benz	Auto	Auto OEMs are focused on targeted expansion into T2G, iDER, B2G, and Smart Cities platforms.
Drift, current powered by GE	Energy Retail	Energy retail players offer algorithm-supported retail electricity focused on iDER, TE, and B2G platforms.

(Source: Navigant)



2.5 Beyond the Energy Cloud and Toward a Circular Economy

While it is difficult to predict the breadth, scale, and velocity of industry transformation or the timing of disruption, we can be certain that the combination of emerging technologies and blurring of industry boundaries mean that innovation and growth will be increasingly exponential for energy in the near future. The result is a market that will evolve well beyond our purview today.

Circularity approaches share many attributes of the Energy Cloud, like technological innovation, more distributed operations, and new business models.

As we think about a clean, intelligent, mobile, and distributed Energy Cloud future, we must do so in the context of long-term climate risk and scarcity of resources. Demand for raw resources is expected to continue increasing due to population growth and a global expansion of the middle class with greater means and demand for modern conveniences. A search for an industrial model that can decouple growth from natural resource consumption has generated interest in the circular economy.

The circular economy describes a practicable and scalable landscape of opportunities employing business models that are by design regenerative and as waste-free as possible. Strategies at the heart of the circular economy include reducing the input of virgin materials, employing more efficiency in the use of existing assets, and reducing the output of waste.

The central pillars of circular economy strategies include the following:

- Recovery and reuse
- Lifetime extension
- Sharing and service models
- Circular design
- Digital platforms

The management of energy inputs and production and the transformation of energy's role in fueling the global material system are critical factors in realizing a circular economy future. A substantial part of the global electricity and fuel use is associated with producing and transporting basic materials.[10] Since the development of circular economy will affect global material flows and supply chain logistics, energy company and utility business models will need to be prepared to adapt in kind.

Circularity approaches share many attributes of the Energy Cloud, like technological innovation, more distributed operations, and new business models. As illustrated below, the two concepts will become further intertwined in the future as the regulatory and policy system evolves:

- Energy use patterns will change, shifting from large-scale linear material production chains to circular and more distributed production chains. This shift in organization will require different service packages from the energy sector and will reduce reliance on centralized fossil fuel generation.
- Waste management programs will increasingly steer toward high grade recycling, with energy recovery in waste incinerators focused only on residual streams. Waste-to-energy, already in use today, will expand as a source of renewable power and fuel

10. Ecofys, A Navigant Company, *Implementing Circular Economy Globally Makes Paris Targets Achievable*, 2016.

as the economics and market demand for end-use products (e.g., waste-derived biojet fuel) expand.

- Material-related energy issues will become more important further down supply chains. For example, with increasing energy efficiency efforts, an increasing share of energy use in buildings will be embodied energy (e.g., for making cement and steel for construction). Demand-side management programs will also expand in scope to deal with these indirect energy requirements and how they can be reduced through circularity approaches.

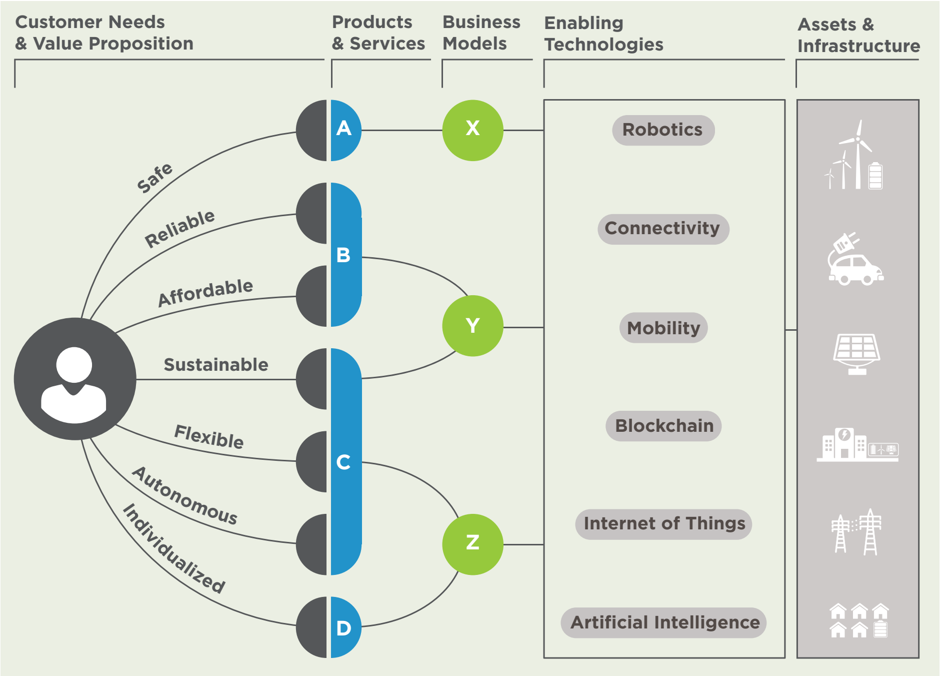
Circular economy has emerged as a powerful concept, generating greater attention from large corporations, industries, and governments. The production and consumption of resources needs to be balanced with the carrying capacity of the Earth. More importantly, circular approaches are becoming a strategic imperative and key differentiator, leading to lower costs of production, new business opportunities, and higher value-add.

3 OPPORTUNITIES

3.1 Energy Cloud Platforms Redefine Value Creation and Delivery

Dynamic, customer-centric platforms are emerging as the foundation of the Energy Cloud. These platforms consist of various combinations of customers, their individualized needs, energy and non-energy products and services that deliver value, viable business models, and enabling technologies that extend the functionality of physical assets, as illustrated in Figure 3.1. Platforms, and the service providers and orchestrators that connect value to the customer, sit at the confluence of highly disruptive innovation and enable multi-sided value exchange among energy and non-energy service providers as well as prosumers. Ultimately, platforms offer plug-and-play opportunities to tap into the expanding Energy Cloud ecosystem.

Figure 3.1 The Energy Cloud Platform Value Creation Model



(Source: Navigant)

Well-known platform companies today—such as Uber and Airbnb (crowdsourcing) and Facebook and Twitter (social)—leverage technology innovation and data to deploy highly disruptive products and services made increasingly valuable by a network of stakeholders. Stakeholders also create and realize value across the platform.

Similarly, Energy Cloud platforms facilitate connections among grid-edge actors (including customers and service providers). These connections are enabled and monetized through emerging, disruptive technologies. Examples like the smartphone and the internet demonstrate the dynamic potential of disruptive technology platforms built upon a combination of breakthrough innovations. Energy Cloud platforms also enable multi-sided value exchange around energy that can be extended and enhanced through a range of applications, data and analytics, and products and services.

Today's most profitable organizations are less a collection of resources and capabilities than a set of platforms. Value is increasingly created through the stickiness of a platform and integrated solutions rather than individual products. Actors may play one or several roles across platforms, but those actors that control or facilitate the platform have greater opportunities to scale their business rapidly. In turn, these actors are more likely to insulate themselves from competition (and disruption).

This shift mirrors observed impacts across the broader economy where emerging platforms are replacing linear value chains in which successive value is added to core raw materials before distribution to the end consumer. Platforms are allowing companies and customers greater access to alternative solutions that may compete on efficiency, price, customization, or any combination thereof. In this shifting landscape, volumetric sales—number of goods sold, units shipped, and kilowatt-hours—face unprecedented competition from nimble disruptors and solutions that can be scaled rapidly.

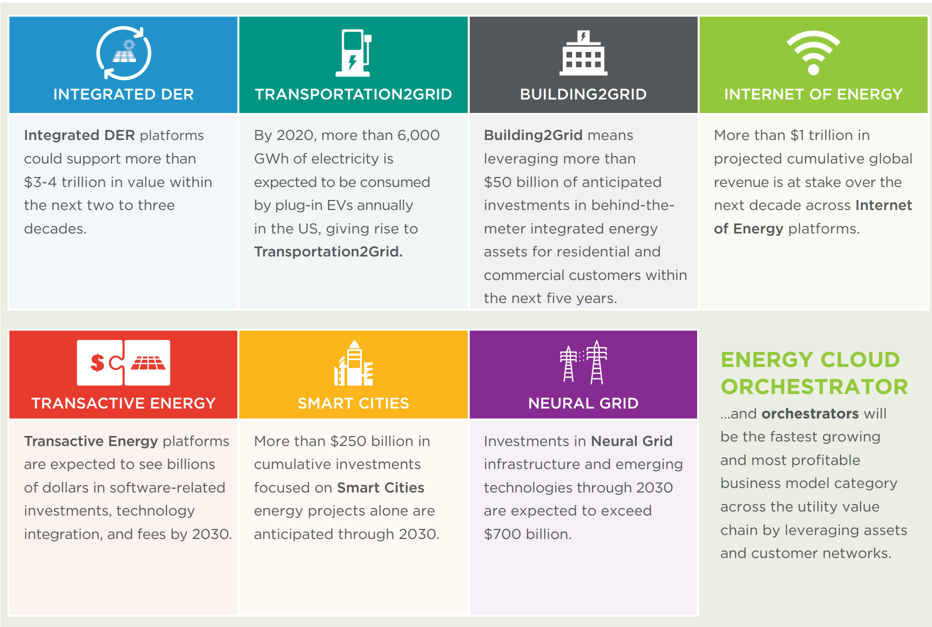
In the energy industry, the core infrastructure has evolved little beyond the traditional power, gas, and water grids through which commodity goods are traditionally distributed and sold. While a testament to the staying power of the grid, its scale is also a liability due to the cost of ongoing maintenance. Meanwhile, highly disruptive technologies are rewriting the rules for how value is created, quantified, and distributed. This is especially true where there is a tangible convergence of emerging technology, and more importantly, where combinations of those technologies spawn a rapid acceleration of product and solution innovation. These sudden explosions of innovation are upending traditional value exchanges across the power and utility industry as well as ancillary industries.

The nodes of disruptive innovation in the energy space (e.g., rooftop solar charging an EV and connected to a home energy monitoring system) are already attracting billions in investment. While business models focused on these nodes are still at nascent stages of development, such innovation-dense nodes are early examples of Energy Cloud platforms in which traditional industry boundaries will blur, linear commodity value chains will disintermediate, and product and service innovation will accelerate.

3.2 Capturing Value through Energy Cloud Platforms

Within the Energy Cloud, transactions are increasingly initiated within and delivered through one or more customer-centric platforms. Examples of these are: Integrated DER (iDER), Building-to-Grid (B2G), Transportation-to-Grid (T2G), the Internet of Energy (IoE), Transactive Energy (TE), Neural Grid, and Smart Cities.

Figure 3.2 Energy Cloud Platforms

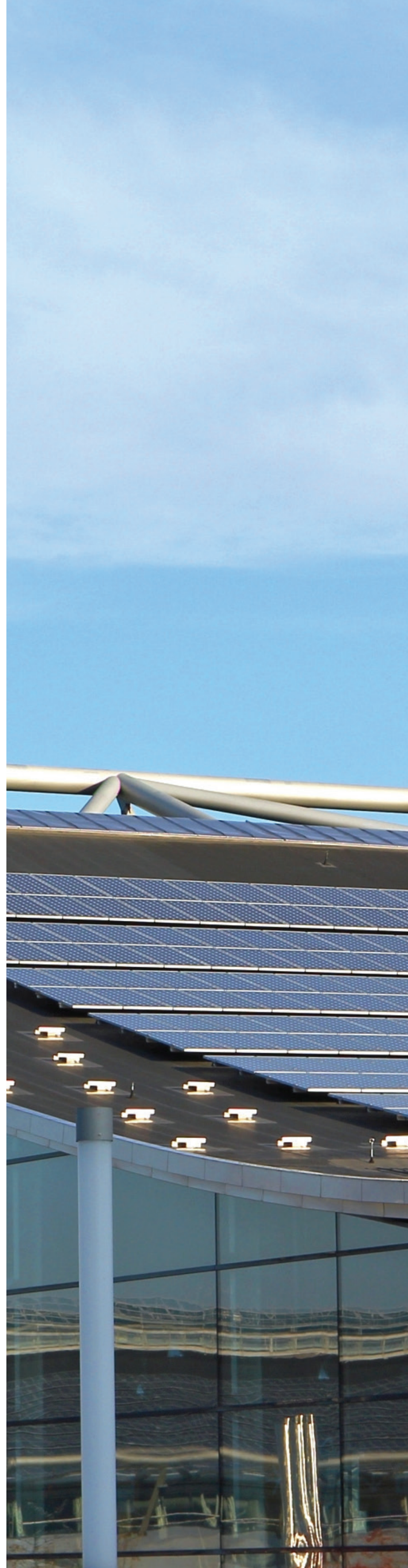


(Source: Navigant)

Each Energy Cloud platform is expected to generate billions in new investment in component technologies and infrastructure development by 2030, each representing high growth opportunities over the next decade. Within Energy Cloud platforms, when emerging technologies or products and services combine, second and third order effects such as new value streams emerge. These expand the potential for new value creation further.

More importantly, Energy Cloud platforms are not mutually exclusive. While each describes a node of technology innovation and value creation, they may overlap significantly. For example, EVs may deliver value across multiple platforms in the following ways:

- Deploy as part of a dynamic network of virtual power plants, or VPPs (iDER).
- Pair with solar and DR as a hybrid demand-side solution in a connected building (B2G).
- Operate as a mobile source of short duration generation and load in a parking lot (T2G).
- Connect to a ridesharing fleet (IoE).



- Initiate and close electricity transactions via software with a community energy network (TE).
- Respond automatically to an algorithm-initiated grid signal to provide automated grid ancillary services in response to an outage (Neural Grid).
- Dock in a charging station located downtown as part of a newly deployed electric transit network (Smart Cities).

Emerging technologies and assets across the Energy Cloud will coexist across multiple platforms. But, more critically, Energy Cloud maturity will be more fully realized and enhanced within each individual Energy Cloud platform.

Synergies across platforms (e.g., iDER and TE) will redefine market paradigms across the energy industry. We see a long-term convergence of platforms that further expands the Energy Cloud ecosystem.

Specific Energy Cloud platforms are described in more detail below.

3.2.1 Integrated Distributed Energy Resources (iDER)

iDER refers to coordinated, aggregated DER resources and programs combined with networking and communications technology across a service territory. It includes a custom, portfolio-based DER adoption approach down to the feeder level that encourages customer choice and flexibility while solving for aggregation at the grid operator and utility level.

iDER is one of the most mature of the seven Energy Cloud platforms identified in this paper given the explosive growth of DER during the past decade and increasing focus on management software (e.g., DER management systems [DERMSs]). Bringing with them levels of variability and technological diversity, the proliferation of DER assets across the power grid is expected to continue unabated for the foreseeable future. In the US, DER deployments reached an estimated 30 GW in 2017, versus 19 GW for new central station generation.[11]

iDER describes a custom, portfolio-based, DER adoption approach at every level throughout energy markets. It encourages customer choice and flexibility while solving for aggregation at the grid operator and utility level. Market actors that seek to enable iDER platforms through portfolio-based solutions will position themselves at the center of an aggregation opportunity still mostly in the nascent stages of development. Opportunities include aggregating iDER value streams from wholesale markets, energy procurement processes, prosumer power preferences, and regulatory incentive programs.

Moving beyond strategies that focus on DER integration as yet another source of predictable load balancing (a.k.a. obedient generation), a fully mature iDER platform enables more dynamic optimization and innovation initiated at the edges of the network. As foundational DER technologies (e.g., solar PV, stationary storage, etc.) mesh with DER management tools, ubiquitous communication infrastructure, data analytics to fully optimize smart DER assets, and sophisticated machine learning capabilities, the payoff will be an expanding market of products and services that include opportunities like VPP orchestration, T&D deferral, and flexibility for renewables integration. Assuming an aggressive investment in iDER technologies and solutions, Navigant Research estimates iDER platforms could support more than $3 trillion-$4 trillion in value within the next 2-3 decades.

Bringing with them levels of variability and technological diversity, the proliferation of DER assets across the power grid is expected to continue unabated for the foreseeable future.

While energy companies and utilities are increasingly realizing that accommodating DER assets on their networks and, in some cases, exploring opportunities to capitalize on these assets are necessities, they largely remain laggards in ramping up a sophisticated digital infrastructure to unlock the full value of iDER. Third-party vendors, meanwhile, may possess innovative software, communication, analytics, and control solutions, but often lack the experience and scale to tap into the vast potential of distributed energy.

As a result, business partnerships remain common across the iDER landscape:

- Green Mountain Power and Tesla are focused on deploying and aggregating the operation of residential energy storage systems. They are working to expand this program to C&I customers and leverage their success with small-to-medium solar plus storage microgrids to drive reduced peak demand charges.
- Through Southern Company's PowerSecure subsidiary, C&I customers can get generator reliability solutions while also implementing new technologies and aggregation models where applicable. PowerSecure offers traditional gensets, fuel cells, solar PV, and now intelligent grid-interactive energy storage through a partnership with Advanced Microgrid Solutions.

11. Navigant Research, *Global DER Deployment Forecast Database*, 4Q 2017.

- Consolidated Edison is operationalizing many iDER business models in response to the New York Public Service Commission's Reforming the Energy Vision (REV) proceeding. Its Brooklyn Queens Demand Management program is procuring aggregated DER through a competitive auction process. It is also running a VPP for residential solar plus storage and testing innovative new BTM energy storage business models.

Key energy company and utility success factors include the following:

- Leverage opportunities for aggregation. iDER orchestration requires the DER market to mature beyond today's current disaggregated ecosystem to more sophisticated networks of assets, enabling technologies and market actors. This will take time, but once in place, the potential for exponential value creation through yet-to-be realized products and services will be significant.
- Manage the financial transaction of electricity across DER networks. Examples include enabling residential prosumers to market their DER assets into an open, competitive market. This role is not only critical to fully maximize the benefits of DER on the system, but will also be key to providing future value to energy company and utility customers and shareholders.
- Work with customers, third parties, market operators, and regulators in accordance with iDER processes for full integration across operations, energy markets, and integrated resource planning (IRP). These processes are supported by critical information, operations, and communications technology systems to ensure active, real-time, and large-scale iDER management.
- Increase the value of the network by promoting a deeper and wider network of third-party aggregators and customers participating in local iDER energy markets. These can be supported by TE platforms, the Neural Grid, and other related platforms to optimize the value of both assets and individual transactions.

3.2.2 Building-to-Grid (B2G)

B2G describes the nexus between connected building infrastructure and the grid. A typical B2G facility includes 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 PV, energy storage, and EV charging infrastructure.

Like the electrification of transportation, growing investments in building automation and connectivity are laying the foundation for an expanding B2G platform already evolving rapidly today. In the past, BTM energy company and utility strategies have generally focused on rebates for specific equipment upgrades and efficiency improvements as well as take-it-or-leave-it DR programs. Today, advanced metering infrastructure (AMI), connected living, and dynamic building functionality are transforming B2G into a lucrative opportunity to deliver energy and non-energy products and services to customers.

Navigant Research expects more than $50 billion to be invested in BTM integrated energy assets for residential and commercial building customers within the next 5 years.[12] More than half of global electric meters will be converted to smart AMI, and software is expected to account for at least half of the investment in intelligent buildings by 2020.

Energy companies and utilities can leverage smart connected homes and building solutions to deploy new strategies and channels for customer engagement. New value-added services can provide channels to support C&I customer participation in B2G. There are also bottom-line benefits to participation, including ancillary services and avoided T&D upgrades. B2G orchestration, meanwhile, creates new customer offerings, including advisory services, engineering, and technology implementation. Ongoing advisory services and technical capabilities for installation and commissioning of enabling technologies are two key areas of new revenue creation within the B2G platform.

Navigant Research expects more than $50 billion to be invested in BTM integrated energy assets for residential and commercial building customers within the next 5 years.

Energy companies, utilities, and competing stakeholders have the opportunity to aggregate a combination of single family, multifamily, and mixed use commercial buildings through the insights delivered via advanced analytics. Leveraging data streams related to weather, pricing, energy demand, and occupancy, the energy company or utility can send signals to each facility to automatically adjust equipment operations. The results can be characterized in three use cases:

- Energy efficiency and GHG emissions reductions can be achieved via reduced energy consumption during peak times to lower electricity generation from fossil fuel-fired peaker plants and continuously to deliver ongoing energy savings and GHG emissions reductions.
- Enhanced reliability, as the energy company or utility will have greater insight into energy loads across its portfolio. It will also have access to automation and controls to reduce consumption when the grid is threatened, manage DER assets as backup

12. Navigant Research, *Building-to-Grid Integration*, 3Q 2017.

during extreme events, and direct repairs and maintenance with more accuracy and insight for shorter downtime.

- Increasing customer satisfaction due to innovative technology solutions for the smart connected home and building. Deeper engagement will result from real-time analytics and insights to direct operational improvements that will drive cost savings and comfort. Another result will be engagement in broader sustainability initiatives that meet customer expectations and bolster brand image for businesses.

Key energy company and utility success factors include the following:

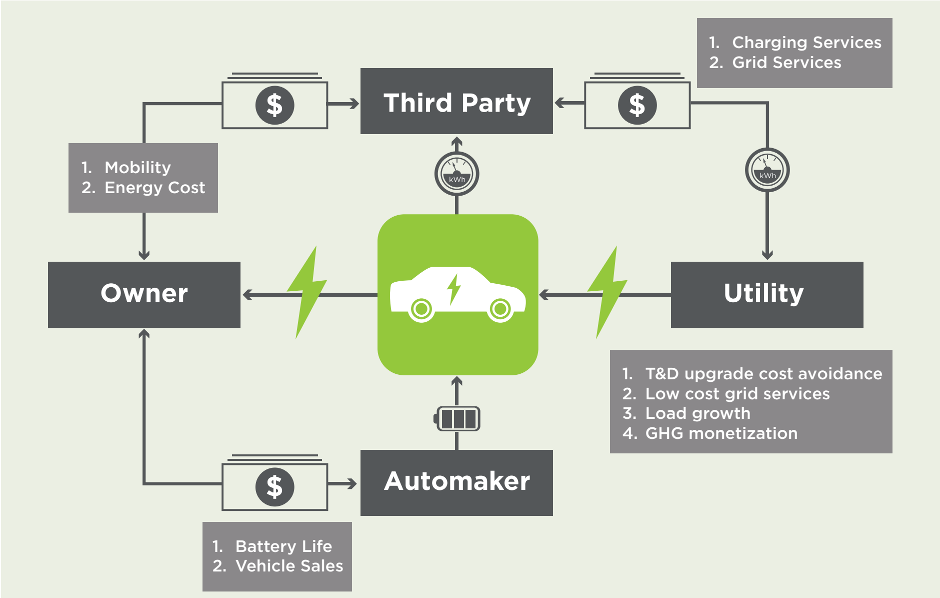
- Harness digital infrastructure, automation and controls, analytics, and DER as key enabling technologies. Homes and buildings with a complete technology stack offer dynamic load control and full integration into grid operations.
- Aggregate buildings through automation, remote control, and analytics. This approach would shift from the idea of the individual smart home and building into the smart block, neighborhood, or even region. The impacts of the coordination at this scale would be significant in terms of energy efficiency, resiliency, and GHG emissions reductions.

3.2.3 Transportation-to-Grid (T2G)

T2G describes the nexus between electrification of transportation (e.g., light duty vehicles, transit systems, commercial goods movement, and port operations) and the grid. Associated smart charging infrastructure, which adds a layer of locational flexibility (and unpredictability), potentially unlocks value and transformative business models across the distribution grid.

While EVs are a key aspect of the iDER story, the broader electrification of transportation trend represents a multidimensional growth opportunity for the power and utility industry. The consumer relationship with the automobile is changing from ownership of fixed capability vehicles to on demand mobility using the most appropriate resource for the task. The electrification of commercial fleets and transport systems is extending the T2G platform even further. Charging infrastructure will affect load patterns across urban and suburban areas while opening the door to multidirectional value flow, as shown in Figure 3.3.

Figure 3.3 EV Value Streams



(Source: Navigant)

Global EV adoption continues to accelerate, and an increasing number of automakers are scrambling to introduce new models catering to diverse tastes and price points. In early 2018, US auto manufacturer Ford announced plans to increase its investment in electrification to $11 billion by 2022. Most telling is a growing number of countries announcing commitments to ban the sale of petrol and diesel cars, including China, the UK, France, and India. These are the second, fifth, sixth, and seventh largest economies in the world, respectively. Norway has announced that it will require all new vehicles sold within the country to be zero emissions by 2025.

EVs will be the single largest addition of energy demand to the grid in many countries across the developed world. By 2020, more than 6,000 GWh of electricity will be consumed by PEVs annually in the US.

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. Automated, 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, further adding to the T2G value pool. As shown by recent investments among oil majors like Shell, the electrification of transportation is initiating a large-scale shift in investment across the energy landscape away from the oil & gas segment to the power and utility industry.

The implications for energy companies and utilities are significant. EVs will be the single largest addition of energy demand to the grid in many countries across the developed world. By 2020, more than 6,000 GWh of electricity will be consumed by PEVs annually in the US.[13]

Figure 3.4 Evolution of Vehicle-to-Grid Integration

Generation 1	Generation 2	Generation 3	Generation 4
Technologies: • Bi-directional inverters on vehicle • Systems aggregation software **Services:** • Market integration • Ancillary services • Customer incentive ($5 per day) **Example Execution:** • University of Delaware/Grid on Wheels	**Technologies:** • Bi-directional charging stations • Wind energy • Participant communication interface **Services:** • Renewables integration • Real-time data **Example Execution:** • Fiat-Chrysler V2G Demo	**Technologies:** • Solar PV • Stationary storage • Microgrid/nanogrid **Services:** • Outage islanding • Demand response wholesale market sales • Demand charge reduction **Example Execution:** • EVGo/UC San Diego • PG&E EPIC 2.03b	**Technologies:** • Solar forecasting (proactive planned resource response) **Services:** • Cloud control optimized solar forecasting • Cloud control optimized resource aggregation beyond site conditions **Example Execution:** • Nissan/Nuwe-US

(Source: Navigant)

Two significant advantages of this new load for energy companies and utilities are aggregation and dispatchability. Nearing commercialization, shared autonomous electric vehicles (SAEVs) are increasingly regarded as a significant accelerant to changes in how cities are planned. Navigant Research expects SAEVs to represent 21% of global vehicles in automated mobility fleets within the next couple of decades.[14]

13. Navigant Research, *Market Data: Global Fuels Consumption*, 4Q 2016.
14. Navigant Research, *Transportation Forecast: Light Duty Vehicles*, 2Q 2017.

Meanwhile, policymakers are developing regulatory frameworks and incentives that recognize the necessary coupling of two massive markets in power and transportation through policies and incentives that have far-reaching implications for each. For example, advanced analytics and smart charging infrastructure 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.

The T2G platform will combine managed resources to support regional grid operations. It will also enable greater optimization of energy consumption, reduce the cost of electricity for all ratepayers, and create a more sustainable environment for urban mobility.

Key energy company and utility success factors include the following:

- Cultivate relationships with new partners, including automakers, transit system planners and operators, shipping and port operators, and emerging ESPs to realize growth in the T2G platform.
- Accelerate the commercialization of vehicle-to-grid (V2G) integration demonstrations and pilots into tangible business models for energy services, DR, and grid ancillary services.
- Facilitate platform expansion by streamlining energy delivery payment mechanisms to platform actors and standardizing key components and communication protocols across vehicle and charging infrastructure.

3.2.4 Internet of Energy (IoE)

An important building block in the Energy Cloud, IoE leverages sensors, telecommunication infrastructure, and machine learning to provide a digital foundation for the energy industry that touches, or will touch, nearly all aspects of energy generation, transmission, distribution, and consumption. IoE is an enabling opportunity for other Energy Cloud platforms.

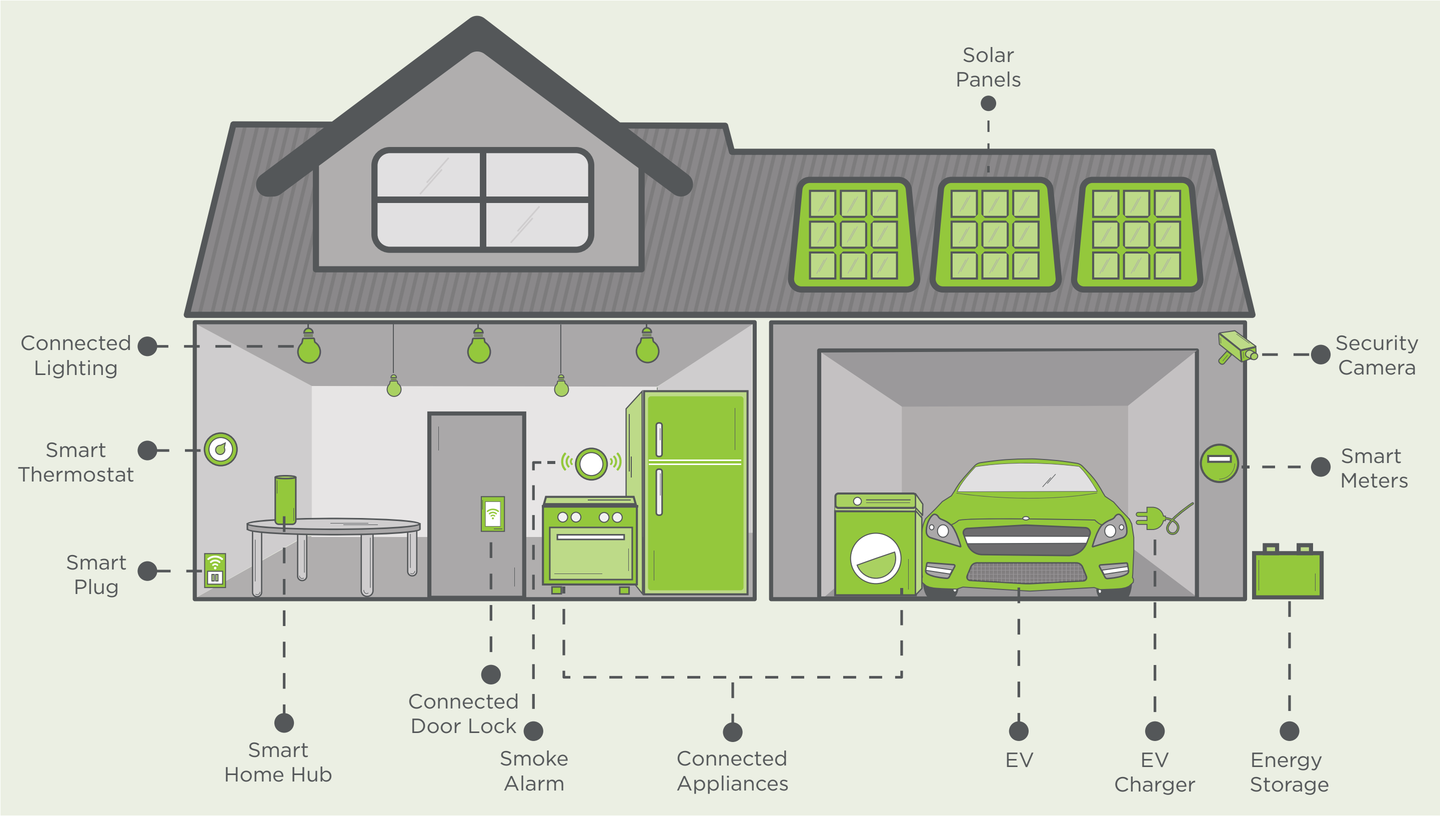
Within the Energy Cloud, IoE provides a digital foundation for transforming the traditional energy business by connecting old and new assets and harnessing increasing volumes of data. On the utility side of the meter, the change from IoE is already underway in the form of smart meters and investments in distribution automation as well as new communications networks. The proliferation of connected consumer and occupant-oriented technologies is expected to present new aggregation opportunities behind the meter.

Navigant Research estimates that more than $1 trillion in cumulative global revenue is at stake through 2030 from investment in connected industrial devices.[15] Tapping into this opportunity will require deeper predictive insights, effective management over the plethora of connected assets, and engaging customers with valuable new services.

15. Navigant Research, *Industrial Internet of Things*, 4Q 2017.

As depicted in Figure 3.5, behind the meter, new products that help customers improve management of lighting, HVAC systems, physical security, and overall comfort can deliver both energy savings and lifestyle services to the traditional energy customer. Energy companies and utilities may enable access to smart IoE devices such as thermostats via rebates or leasing models or partner with technology providers that can provide the devices directly. In competitive retail markets, energy companies and utilities can reduce churn across their client base by leveraging insightful data that drives energy efficiency while enhancing comfort in homes and commercial buildings. Furthermore, by harnessing BTM assets like smart appliances at granular levels, new value-added predictive maintenance and monitoring services will dovetail with DR functionality that benefits both the customer and the energy provider.

Figure 3.5 IoE Connected Home



(Source: Navigant)

On the customer side of the meter, IoE technologies will further optimize the grid by integrating with distributed assets like solar PV, EVs, and onsite storage. A sound IoE strategy leads to enhanced grid efficiencies and lower operational costs. The two-way flow of data from IoE sensors will further enhance asset management, lowering capital expenses through more accurate predictive maintenance. In addition, gleaning insights from IoE big data will streamline customer service and billing processes, thus driving costs down even further.

Energy companies and utilities have demonstrated a penchant for IoE already, having deployed tens of millions of smart meters over the last decade, and many have gained operational efficiencies from those deployments. While the industry is still in the nascent stages of embracing IoE opportunities, several use cases demonstrate its potential:

- Alpiq: This leading Swiss provider of electricity and energy services is undergoing a major transformation by leveraging IoE technologies. The company seeks to become a digital innovator and market leader. To do so, it is harnessing its digital assets across the company and consolidating these into an IoE platform that supports smart applications for enhanced grid management, energy trading, and demand-side management.
- Sacramento Municipal Utility District (SMUD): This major US municipal utility has long been at the forefront of IoE technologies, having tested or deployed many types—from smart meters to rooftop solar PV, to the latest energy management tools and storage products. SMUD has recently partnered with two technology providers, NEC Corp. and SpaceTime Insight, to deliver smart energy solutions to

Japanese electric utilities and others in the Asia Pacific region. This is part of a broad strategy to monetize its expertise and invest in the future energy grid.

- CLP Power (Hong Kong): This Chinese utility is leveraging key internal IoE assets, namely its AMI platform of smart meters, to help customers reduce energy consumption and adopt greener lifestyles through better informed energy choices. The utility's effort coincides with the city's overall goal of transforming Hong Kong into a smarter city.

Key energy company and utility success factors include the following:

- Make a long-term commitment to IoE. This is not a one-time, one-off decision. Instead, it is one step on a journey of digital transformation that can be both risky and rewarding for energy companies and utilities that move boldly and learn quickly from challenges and failures.
- Embrace the power of connected physical assets and then work relentlessly to manage the value of data flowing from these devices and sensors.
- Integrate BTM IoE initiatives fully into operations, billing, and efficiency programs. The same is true in front of the meter, and it is especially important that T&D IoE plays embrace a high degree of automation and machine learning to fully optimize the foundation assets and improve margins.
- Orchestrate multiple devices and sensors in a distributed network. This includes the vital communications networks on which the two-way connectivity takes place, with sufficient bandwidth and architectural design to flexibly expand as the rapidly increasing number of IoE devices interconnect.
- Aggregate and analyze large volumes of data. This includes data management, data storage, analytics, and providing the key insights that lead to positive outcomes for energy savings, lower costs, and increased customer engagement and satisfaction.
- Combine early IoE learnings with emerging non-energy services such as security, both physical and cyber, asset monitoring, preventive and predictive maintenance services, and automation of homes and businesses.

3.2.5 Transactive Energy (TE)

TE is a power and energy platform through which economic- or market-based exchanges facilitate decisions and transactions involving the generation, distribution, and consumption of power. TE unlocks peer-to-peer transactions among both active and passive prosumers.

A major characteristic of Energy Cloud platforms is that they allow value to be created in the energy ecosystem by a diversity of parties and in a variety of new ways. TE is essentially an energy system in which economic- or market-based platforms are used to make decisions involving the generation, distribution, and consumption of power at the edge of the grid. Currently, transactions involving power are being executed, but only in wholesale and over-the-counter markets. Similarly, with the exception of Europe, DER are interconnected onto some power grids on a for-pay basis, but they are limited to fixed arrangements with a handful of providers, such as a distribution utility or a third-party aggregator.

A major characteristic of Energy Cloud platforms is that they allow value to be created in the energy ecosystem by a diversity of parties and in a variety of new ways.

TE platforms marry and expand upon these activities. Extending iDER, T2G, B2G, and IoE platform networks, TE enables power providers of any size to trade power and/or energy—and on a granular basis. It is also expected to expand a power provider's stable of potential customers to all market participants. TE platforms are expected to see billions in software-related investments, technology integration, and fees by 2030. Global revenue from TE software used in VPPs, for example, is expected to exceed $5 billion by 2030, with more than 40 million customers participating in TE markets that same year.[16] With the commercialization of blockchain applications and other emerging technologies that lower the barrier to entry, this number could grow much more quickly.

2017 was the year in which blockchain-based TE trials gained traction. There are many examples worldwide in which blockchain has been deployed within emerging TE platforms, including the following:

- Conjoule, a spinoff from German utility Innogy, is developing an edge-centric TE platform that matches energy production and consumption among renewable power prosumers and end users. Guaranteed transmission savings are passed to participants, reducing overall energy costs.
- In Europe, a project called Scanergy simulated a blockchain-based methodology for trading green energy within a Belgian neighborhood.
- A small but live TE market using blockchain was recently launched by LO3 in a neighborhood in Brooklyn, New York.
- IBM and Samsung have partnered to develop a proof-of-concept blockchain technology for large-scale networks of interacting devices, and a number of startups are developing blockchain-based transaction products.

16. Navigant Research, *VPP Transactive Energy Revenue Streams*, 2Q 2017.

Blockchain is just one potential technology required to make TE a reality. TE is predicated on the changing value of any DER that is connected to a network and customer load flexibility. To allocate this value, the system must have visibility into every load and source on the network at all times of day. To gain this visibility, all participating loads and sources are ideally connected, and the orchestrators of these networks must have access to this data. This data will be of use in network control systems, and so we expect a convergence of existing advanced distribution management systems and DERMSs with new network pricing and valuation software to emerge.

While blockchain provides a ledger for energy transactions, markets still require settlement and new billing functionality will have to be developed to balance debits and credits of each market participant. DER owners will likely demand near real-time visibility into their energy consumption and production and their debits and credits. Service providers will also likely wrap these customer portals into other areas, including DER performance monitoring and energy efficiency programs.

There are several types of TE opportunities in development and demonstration. Like IoE, this includes both grid-centric and edge-centric forms, but hybrid and combination forms are possible:

- Grid-centric initiatives are focused on enabling DER and improving reliability to the benefit of the network utility. These models are limited to exchanges of power and perhaps capacity, demand, load, or ancillary grid services.
- Edge-centric initiatives generally focus on maximizing the value of distributed assets, which benefits the DER owners. These 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 HVAC unit gets to respond to a DR opportunity).

Key energy company and utility success factors include the following:

- Leverage organic learnings from grassroots efforts rather than seek to reinvent the wheel or roll out alternatives with limited capabilities.
- Remain involved in market formation and orchestration to monitor the network of actors. As with any peer-to-peer network, threats from intentional harm, unintended consequences, fraud, and abuses of privacy are increasingly present.
- Focus on opportunities to collect fee-based revenue by brokering transactions, but keep an eye on blockchain developments, which could obviate the intermediary. Energy companies and utilities may also see only to be an enabler of the network, collecting data in exchange for network access (e.g., Facebook and Google).
- Leverage cobranding opportunities to improve the stickiness of the customer relationship to the utility brand. TE is an excellent opportunity to enhance customer value and independence through participation in blockchain and other TE trials.

3.2.6 Neural Grid

Neural Grid describes an autonomous T&D grid leveraging AI, connectivity, and sensing technologies to support ubiquitous automation, self-healing, seamless DER integration, customer engagement and involvement, and ultimately, integration of dispersed markets for TE.[17] Acting as a platform enabler, the Neural Grid is critical to realizing the full benefits of the Energy Cloud, including greater flexibility, resilience and self-healing capabilities beyond the smart grid, and optimization across a more complex and dynamic grid-edge network.

Navigant Research estimates that investments in Neural Grid infrastructure and emerging technologies through 2030 will exceed $700 billion.

Moving beyond simply digitizing the grid via smart grid initiatives currently underway and encompassing elements of iDER and IoT, the Neural Grid takes the largest machine in the world (and more specifically, the distribution grid) and gives it greater intelligence. If smart grid today (v1.0) implies the legacy mechanical power T&D networks enhanced by pockets of automation, connectivity, and IT, the Neural Grid implies a vastly enhanced and more powerful platform leveraging analytics, AI, and automation supplying the connective tissue through which the Energy Cloud network is built. Integrated intelligence is pervasive and manages the intersection of distribution networks with DER assets (solar, wind, microgrids, EVs, and DR programs), buildings, and cities.

Potentially picking up much of the $7 trillion-plus investment currently estimated for global T&D networks, Navigant Research estimates that investments in Neural Grid infrastructure and emerging technologies through 2030 will exceed $700 billion. Many of the core technologies that will enable Neural Grid functionality are not yet deployed at scale today, but are on the cusp of mass adoption (e.g., AI and 5G). This value growth primarily entails a reconfiguration of distribution grids to enable new network functions.

17. Navigant Consulting, Inc., *From Smart Grid to Neural Grid: Industry Transformation and the Top Five Technologies Poised to Bring the Grid into the Cloud*, 2018.

The Neural Grid will depend upon not only new technology, but also new business models designed to generate new revenue streams that replace the income from load that is moving to distributed, third-party owned assets. Data will be an increasingly valuable asset and is expected to feed many of these new business models as an input for products and services as well as an increasingly important measure of organizational value.

Energy companies and utilities, and especially emerging distribution system operators, are in a unique position to take advantage of these opportunities. Poles across the distribution grid that integrate small cells for 5G networks, for example, can enable ubiquitous broadband communications throughout the network. This would enable multiple new revenue streams for asset owners like vertically integrated utilities.

As with the Energy Cloud, as Neural Grid platforms take shape, the incumbent status of energy companies and utilities does not guarantee a dominant role. The unidirectional value chain that serves a captive audience in the energy company and utility model of today will be replaced by an intelligent, multidirectional power and data flow that allows diverse market participants and end users to function as providers or consumers—or both—of energy and other services. Energy companies and utilities as well as third parties such as telecom, blue chip tech, DER service and product vendors, and new startups will all maneuver to capture market share.

Given the capital requirements associated with deploying Neural Grid capabilities, partnerships will be critical, as demonstrated by early use cases:

- Enel, Italy's largest utility covering 86% of meters in the country, is deploying a fiber network, investing nearly $3 billion. The network will be used to connect a new generation of smart meters; the utility will also wholesale fiber capacity to other companies. By leveraging its network of poles, wires, and existing rights of way, the project will cost far less than what another company might have to spend.
- In Europe, ENTSO-E, the association representing 42 transmission system operators from 36 countries, has added the creation of an app store to its roadmap. Work has begun on a core platform for data exchange between national and regional grid operators, referred to as a Common Grid Model and Operational Planning Data environment (CGM-OPDE). The platform will be fully up and running in 3-5 years. It will be a key enabler for the intra-day trading of electricity and real-time market operations that are seen as crucial to managing increasing amounts of electricity coming from intermittent renewable sources such as wind and solar. The basic requirements for app development will be available in mid-2018.

Key energy company and utility success factors include the following:

- Understand the implications of a fully mature Neural Grid today and incrementally invest in future-proof technologies and programs. This may entail rethinking investments in bulk T&D systems. Many of these investments may become stranded in a Neural Grid future in which machine learning algorithms, communications infrastructure, and dynamic integrated assets do much of the heavy lifting for the grid.
- Reconfigure the network leveraging intelligent infrastructure and functionality to develop and accommodate new products and services. Embrace ubiquitous connectivity, analytics and predictive asset maintenance, automation and sensing, and more dynamic AMI infrastructure functionality.

- Look for opportunities to replace top-down command and control operations to more organically formed, bottom-up networks. Ultimately, these will prove to be the most scalable and flexible systems (i.e., compare the value to the customer of an open source Android app store versus preloaded bloatware).
- Monitor developments in AI closely. According to PitchBook, venture capital (VC) investors worldwide poured more than $10.8 billion into AI and machine learning companies in 2017, nearly doubling the total invested by VCs in 2016. Breakthrough innovation is expected to arise quickly with potentially massively disruptive impacts across the broader economy. The power grid is a good fit for future deployments.

3.2.7 Smart Cities

The Smart Cities platform describes the integration of technology into a strategic approach to improve sustainability, citizen well-being, and economic development in urban centers.[18] The transformation of urban energy is a foundational element of the smart city, including the implementation of smart grids, a shift to renewable energy, community energy programs, new energy market structures, and development of more resilient energy systems. In an increasingly networked grid, market control no longer emanates from centralized generation and transmission, but the center of customer networks. Organizations will increasingly compete to both widen and deepen connections across these networks. The equity of electric service provider brands, in turn, is increasingly tied to the value of the ecosystem to which it is connected.

Cities are seizing the opportunity to work with energy companies, utilities, and other stakeholders in the creation of new urban energy systems and solutions.

While cities represent only 2% of global land use, they are responsible for around 80% of global GDP. Cities are responsible for more than two-thirds of the world's energy use and GHG emissions. With urbanization trends continuing, cities move to the forefront of global action on climate change, and the impact of urban innovation programs on the future of the energy sector cannot be ignored. Affordable and reliable energy remains one of the basic features of an economically robust city.

Smart Cities sit at the confluence of major disruptions across multiple industries, including energy (e.g., smart grids and DER), transportation (e.g., connected and automated vehicles), water management (e.g., smart water networks), building services (e.g., building energy management), and core city services (e.g., smart street lighting). Forward-thinking city planners are developing holistic cross-industry approaches to the deployment of IoT and big data solutions to improve the efficiency of services to residents and businesses. As Smart Cities platforms mature, the benefits and innovations will naturally flow outward to neighboring communities across associated regions.

As such, the city of 2030 will need to comprehend and manage a much more complex set of interdependencies among diverse aspects of city operations, infrastructure, platforms, geography, and priority issues such as health, mobility, sustainability, and economic development. This requires new networks for collaboration between cities, energy companies, utilities, and other energy sector players, as well as transportation providers, building owners, telecommunication companies, and technology suppliers. Navigant Research estimates that this will create a market worth more than $1.5 trillion over the next decade for smart services across urban energy, buildings, mobility, and other city operations.[19]

Energy Cloud investments are a key element in a global smart city technology market. Navigant Research expects more than $250 billion in cumulative investments focused on smart city energy projects alone through 2030.[20] These developments amplify the shifts in the utility value stream to cleaner and more distributed generation and to a focus on adjacent opportunities for energy-related services in areas such as EV charging, B2G services, and smart street lighting.

The development of Smart Cities and the transformation occurring in the energy industry have much in common. Both developments are rooted in changing customer demands and rapid technology innovation. There are also shared drivers related to the advancement of clean energy responding to climate change and the transition to a low carbon economy, the possibilities offered by DER, and the digitization of energy products and services. Urban energy innovation is increasingly tied to developments in transportation (e.g., EVs), city planning around building efficiency and district heating, and housing (e.g., community energy schemes).

Cities are seizing the opportunity to work with energy companies, utilities, and other stakeholders in the creation of new urban energy systems and solutions, as demonstrated by the following examples:

- Working with local utility San Diego Gas & Electric (SDG&E), San Diego is positioning itself to be the EV capital of the US. It sees EV adoption as a vital element in its energy and carbon reduction strategy. Transport electrification is also a core element of the Columbus smart city program supported through the US Department of Transportation Smart City Challenge grant.

18. Navigant Consulting, Inc., *Navigating the Urban Energy Transformation*, 2017.
19. Navigant Research, *Smart City Services Market*, 1Q 2017.
20. Navigant Research, *Smart Cities*, 2Q 2016.

- Duke Energy has worked with other stakeholders in the Envision Charlotte programs to reduce the energy consumption in 61 of the city's commercial buildings by 19%, in the process saving $26 million in energy costs and 57,000 tons in CO_2 emissions. Vancouver is targeting zero emissions from any new buildings by 2030.
- ENGIE, the global energy and service provider, has recognized the importance of cities and communities in the Energy Transformation as a target market segment. The company's approach to cities of the future is also an important part of its plans to focus the company on the needs of a low carbon society. London provides a good example of ENGIE's work on new energy solutions for cities. As part of the development for the London Olympics in 2012, ENGIE developed a new Energy Centre for what is now the Queen Elizabeth Olympic Park. The low carbon district energy network was designed, financed, and constructed by ENGIE to serve the venues during and after the Olympics. The more than £100 million ($124.3 million) investment by ENGIE will be recouped through the sale of heating, cooling, and electricity under a 40-year concession agreement. The development is part of a broad transformation partnership that encompasses a range of services for the management of the park's buildings and services.
- It is estimated that over 50% of street lights in the US are owned by utilities. The need to increase the efficiency of those lights is a good example of the changing priorities for utilities as they work with cities to reduce their energy consumption. Like city managers, utilities are also recognizing that lamp poles are valuable assets that can be a platform for a range of intelligent services, including EV charging, mobile communications, and other smart city applications.
- The City of Chicago is working with ComEd and its partners to develop a Smart Grid for a Smart Chicago that will eventually see 4 million smart meters deployed in addition to smart grid upgrades to the city's electricity network. Cities are already the focus of extensive smart grid pilots that are demonstrating the increased control, flexibility, and integration enabled by a digital infrastructure for grid monitoring and management.

Key energy company and utility success factors include the following:

- Work proactively with city leaders to develop new forms of partnership to deliver city services. In this regard, city management itself becomes a process of orchestration, which energy companies and utilities can support. This will also require the ability to develop extended partner networks with property developers, city service providers, technology companies, and others. Smart city orchestration will be multifaceted, reflecting the complexity of a market that includes a confluence of several sectors spanning energy, transportation, buildings, and city services.
- Learn from disruptors like Uber and Airbnb that are already showing how city services can be transformed through platform offerings as well as how contentious such services may be. Many cities are striving to make sure they can benefit from such innovations while maintaining appropriate control over the quality of services through new regulations and the refinement of city policy.
- Build on the core elements of the energy platforms already described (iDER, T2G, B2G, IoT, and TE). Many of the technologies deployed within these platforms will be the enablers for a host of energy-related urban products and services.

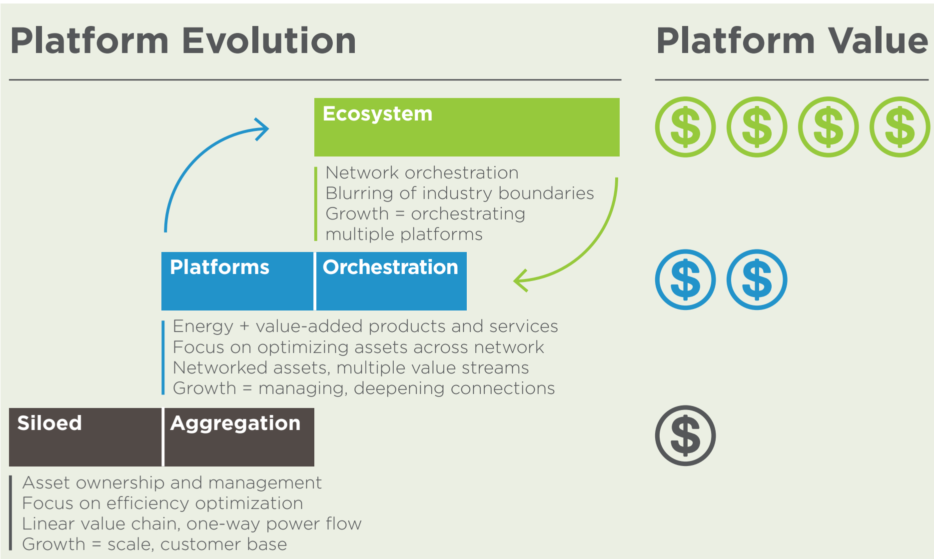
3.3 Enable the Platform, Manage the Energy Cloud

As the discussion around Energy Cloud platforms points out, opportunities to tap new revenue streams are emerging quickly in the energy industry. For new entrants and third parties, bringing digital and platform experience from other industries will be an advantage, though certainly no guarantee of success. These actors may be able to afford to enter Energy Cloud platforms with more advanced business models, but will still require access to a diverse stack of physical assets. Partnering will be key to unlocking products and solutions as well as creating lucrative synergies across emerging technologies.

Incumbent energy companies and utilities remain best positioned today to capitalize on the value of Energy Cloud platforms, but time is running out. Access to capital, scale, existing relationships with customers, and deep industry know-how are all key advantages. The ability to maximize the value of the Energy Cloud platform through better integration with centralized assets is a key differentiator. But based on emerging technology trends and increasing competition, Navigant estimates that energy companies and utilities have less than 5 years to reposition for the Energy Cloud or risk ceding significant market share to new market entrants. As discussed in Section 3.1, the future battlegrounds will be platforms focused on the energy customer.

This is a journey. The progression from command and control over siloed assets and linear value chains to Energy Cloud platforms and a transformed energy ecosystem entails a series of organizational step changes for energy companies and utilities. Ultimately, platforms are the gateway to the Energy Cloud ecosystem, as illustrated in Figure 3.6. Mapping a strategy through these stages can help mitigate major risks and seize the largest opportunities while developing an organization's ability to thrive in more complex and agile ecosystems.

Figure 3.6 Value Creation in the Energy Cloud



(Source: Navigant)

3.3.1 Rethinking the Utility Paradigm

It is important to acknowledge that this emerging, highly networked future challenges the traditional utility business model along physical and financial lines. Today's utility cost-of-service regulation model is still dominant in many regulated markets and is proving ill-equipped for the Energy Cloud. Current utility shareholder interests, accustomed to low risk and steady income and growth, are misaligned with a shifting public interest toward a more networked ecosystem of energy assets that are clean, intelligent, mobile, and distributed. Change will not be easy.

In mature industrialized markets, access to debt and large-scale infrastructure construction has largely delivered on its goal of widespread electrification, with basic power products prioritizing safety, reliability, and affordability. A greater focus on sustainability and emerging circular economy strategies are expanding the scope of these core electric service tenets.

Across much of Europe, retail unbundling means that many energy companies and utilities have already made the shift to a retail-focused business, including divesting many of their centralized assets. Here, the focus continues to be on building new value beyond commodity sales and embracing decarbonization of the energy sector.

In the US, the distributed system platform provider provides an early example of the utility as an enabling platform and the redefinition of regulated utility franchise. In the New York REV process, lawmakers have articulated System Planning, Grid Operations, and Market Operations as the three principal domains of the platform.

In emerging economies, Energy Cloud platforms offer opportunities to leapfrog expensive infrastructure requirements needed to support a linear generation and delivery model predominant throughout the 21st century. However, access to sufficient capital remains a challenge. Building out the most basic infrastructure to keep pace with demand and support energy access for the 15% of the global population that remains without basic electricity is an expensive proposition. As such, energy access remains focused on demand-side deployments of solar, storage, and other renewable configurations that eliminate exposure to fuel supply risk. Aggregation will be a key challenge to unlocking shared value across this fractured landscape.

The Energy Cloud ecosystem will be mostly built with a combination of shared ownership and ubiquitous digitization.

In all cases, the assets in the Energy Cloud will be managed by a broader set of stakeholders. At the same time, the energy system will increasingly decarbonize. The Energy Cloud ecosystem will be mostly built with a combination of shared ownership and ubiquitous digitization. This means that many actors will own and operate any number of distributed assets and interact with the network in different ways. As actors invest and build platforms, larger ecosystems of actors, products, and services arise. As ecosystems expand, there will be greater need for dynamic platforms to interact with the ecosystem, thereby creating a virtuous cycle of innovation.

While this reality is difficult to square with today's industry paradigm, there are many examples across the broader economy demonstrating the destabilizing impact that digitization and consumer-led innovation can have in combination with platforms. The internet, for example, launched when standard communications protocols and telephony infrastructure enabled packets of information to be transmitted among formerly siloed computers across a geographic network. This basic platform gave rise to the internet boom, which has since enabled the disruption of multiple massively profitable industries from retail to music to finance. The expansion of these ecosystems created opportunities for more scalable and user-friendly platforms to be developed (e.g., the smartphone), which in turn gave rise to still new ecosystems that have merged and blended with those already existing.

The predominant source of revenue for future trillion-dollar companies like Amazon, Alphabet (Google), Apple, and Microsoft is derived from ecosystems of products providing access to the network through platforms (e.g., phones and tablets) and services enhancing the value of the network (e.g., software as a service, photo storage, etc.). While these companies own some physical assets like real estate and data centers, they rely almost exclusively on existing infrastructure owned and operated by others to deliver their products and services. Rather than own assets outright, these companies rely on multiple platforms to manage and orchestrate ecosystems. Ecosystem value is enhanced by courting still more partners and customers to ecosystems.

3.3.2 Defining Platform Success in the Energy Cloud

For energy companies and utilities, the shift from a commodity-led value proposition to one focused on energy and non-energy value-added products and services is inexact. However, innovation today is sowing the seed of disruption tomorrow. Passive energy customers will be further enabled by demand-side technologies that allow them to not only manage their energy spend, but also tap into dynamic ecosystems like the Energy Cloud and underlying platforms.

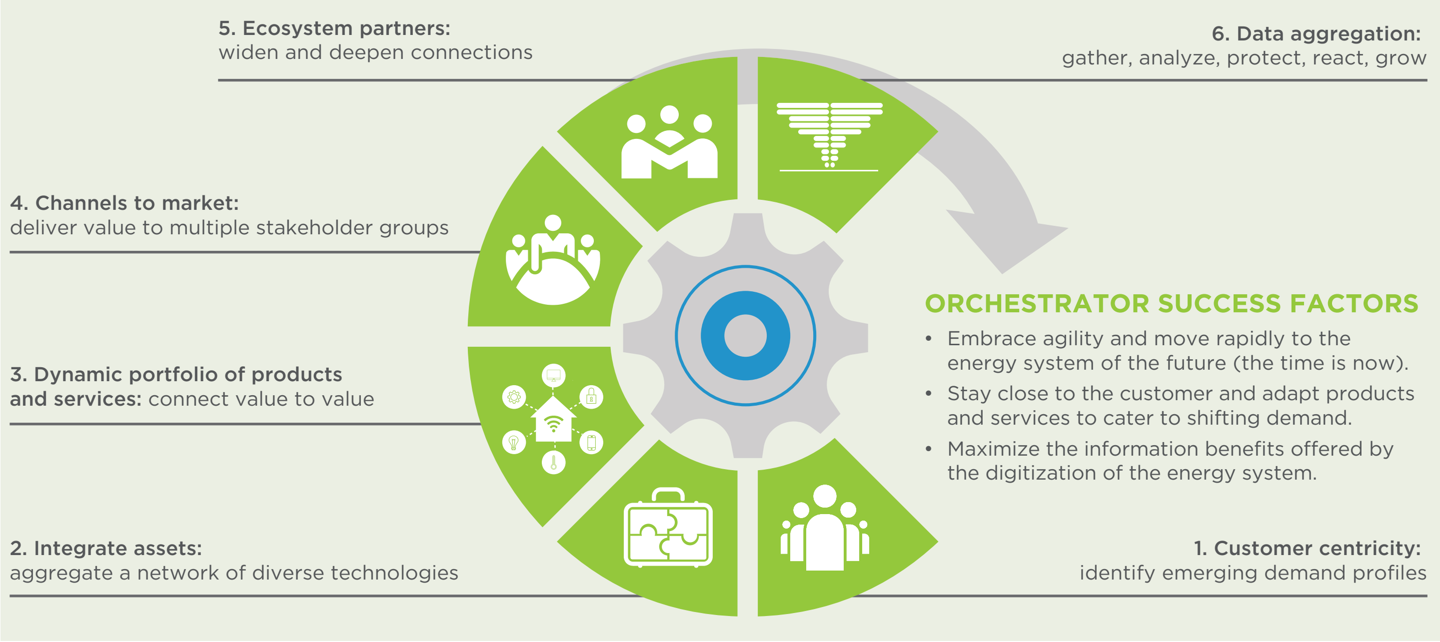
While there is no one-size-fits-all strategy appropriate for all situations and markets, a wait-and-see approach risks missing the boat in a market that is becoming more open, competitive, and innovative. Energy Cloud transformation means that both the customer value proposition and earning revenue selling 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 energy company/utility and customer.

Energy companies, utilities, and third parties sitting at the center of emerging Energy Cloud platforms will need to accomplish the following:

- Understand and meet the needs of your customers.
- Foster the interconnection and business models of other actors across the network.
- Meet the expectations of regulators (where applicable) and advance policy goals. This is especially important for regulated entities.
- Interact and balance with the bulk system.

To achieve this level of operational sophistication, the grid itself, its systems, and the people that operate it will need to enhance system knowledge and remain adaptive. Figure 3.7 describes six success factors for capturing value within emerging Energy Cloud platforms.

Figure 3.7 Energy Cloud Platform Orchestrator Success Factors



(Source: Navigant)

3.3.3 Taking the First Step with Customer Centricity

Gone are the days of the ratepayer. Today's customers expect more from their energy provider than just electricity service and are increasingly interested in understanding their energy consumption, reducing their use, accessing new products and services, and helping the environment. At the same time, customers have also come to expect higher level service experiences and extended capabilities. They are becoming more proactive, demanding more choice, and expecting more tailoring of services.

Tomorrow's customers will expect a service experience on par with other industry leaders. The proliferation of customer-centric business models and the rapid scale-up of platform pioneers like Airbnb, Netflix, and Uber provide a glimpse into how the energy company and utility of the future must operate. Growing up with the tools to manage engagement with their physical and digital worlds at their fingertips, first-time energy company/utility customers will expect greater lifestyle integration from their energy providers. C&I customers are facing similar pressures to keep pace with sustainable, innovative, and customer-centric business models.

It is no surprise that attitudes across the industry toward significant customer-centric investments are changing. Navigant surveys shows that senior leadership are more likely than ever to support multimillion-dollar projects designed to shore up customer experience or engage customers in new ways.

Meanwhile, the days of a once-a-month bill have morphed into potentially ongoing conversations and numerous points of contact that energy companies and utilities will need to embrace and exploit to remain competitive. From online, mobile, and social networks,

changing tools for engagement create a myriad of choices that seek to meet current customer expectations. Websites with sophisticated self-service capabilities, mobile applications, and online chat support are just a few of the engagement channels now considered standard. Coupled with visibility into real-time prices, integration of engagement channels across Energy Cloud platforms will improve loyalty and stickiness across the network.

Grappling with both revenue decline and increased competition from new market entrants, energy companies and utilities are increasingly partnering with vendors to evolve their products and services. Many new business models in the Energy Cloud are expected to reflect the anything as a service model (XaaS) gaining steam across the broader economy in which underused physical products and assets are transformed into services. Network orchestrator roles offer opportunities to leverage Energy Cloud platforms to reach a network of stakeholders with value-added products and services. These opportunities will require a strategic approach to innovation that embraces agility and flexibility to adapt to accelerating transformation.

4 PATHWAYS TO SUCCESS

4.1 Capitalizing on Energy Cloud Disruption

Described as the Fourth Industrial Revolution by the World Economic Forum, a global economic shift is underway that is characterized by the ubiquitous adoption of digital technologies that, "Blur the lines between the physical, digital, and biological spheres."[21]

The impact will be felt across nearly every sector of the global economy:

When compared with previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear pace. Moreover, it is disrupting almost every industry in every country. And the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance.[22]

There is a velocity of change associated with the Fourth Industrial Revolution that raises the stakes for all stakeholders. Due to its exponential evolution, it can be difficult to observe the signals and even more of a challenge to anticipate their specific impacts:

For leaders, the acceleration of innovation and the velocity of disruption are hard to comprehend or anticipate and that these drivers constitute a source of constant surprise, even for the best connected and most well informed.[23]

21. Klaus Schwab, *The Fourth Industrial Revolution*, World Economic Forum, 2016.
22. Schwab, *The Fourth Industrial Revolution*, 2016.
23. Schwab, *The Fourth Industrial Revolution*, 2016.

The energy industry will face historic disruption as well. Blending traditional assets, services, and customers while unlocking many new technologies, business models, and relationships (e.g., prosumer-to-utility, prosumer-to-consumer, consumer-to-service provider, etc.), anticipating the impacts of an Energy Cloud future will be no less challenging than anticipating the impact from innovation and disruption across the broader economy. For an industry that has evolved methodically for nearly a century and a half, this future state is no longer a question of if, but rather, when—and more importantly, how.

How to marshal the organizational will to pivot proactively toward this emerging future remains a difficult challenge. Adding to this complexity, the level of industry disruption is presently so high that it is impossible to paint a clear picture of what the industry will look like in a decade's time.

Energy companies and utilities will need to rethink many of the time horizons and approaches that have anchored strategic planning in the past. Long-term, integrated resource plans and 5-year strategic plans are not sufficient to address a more explosive Energy Cloud evolution. On the other hand, heavily regulated markets where there is little competition will see a more gradual evolution. Still, in both cases, 30-year assumptions are a riskier bet and may expose the energy company or utility to stranded asset risk.

Capitalizing on Energy Cloud platforms will require the following:

- Define your organization's Energy Cloud platform strategy.
- Decide which business models you want to deploy.
- Execute your vision.

4.2 Define Your Organization's Energy Cloud Platform Strategy

With traditional market structures disintermediating and long-standing stakeholder relationships shifting, market transformation will affect nearly every aspect of the energy company/utility value chain. Energy companies and utilities will need to play both offense and defense. At the same time, they will need to balance the tradeoffs, as either one approach or the other will dominate the culture of the organization. Navigant recommends a dual-track approach that is reflected in your organization's innovation strategy.

4.2.1 Play Both Offense and Defense

Incumbent energy companies and utilities possess strong asset and investment liability in their traditional commodity business. While this represents a critical source of recurring revenue for the current business, it is declining in overall importance and, coupled with reduced load growth in many markets, profitability. First and foremost, energy companies and utilities must employ defensive tactics to protect this core business. The goal is improved capital investment and operational efficiency to maximize cash flow to fund continued innovation across Energy Cloud platforms. New growth must come from emerging customer-centric opportunities.

Defensive strategies seek to protect the energy company/utility role at the center of the grid, which inevitably favors a more conservative vision of market evolution. This creates a similarly conservative business culture, which engenders a fear of failure. For an energy company or utility, failure typically means an unplanned outage or poor customer service. However, failure, and more importantly, how a company deals with failure, are inescapable elements of innovation and must be embraced more holistically across the organization to capitalize on opportunities within the Energy Cloud.

For regulated aspects of the grid, stakeholders, including regulators, should work together to anticipate the impacts of technology innovation. Since long-term capital investments are still required to maintain the bulk grid, ensuring that capital costs can be recouped and stranded assets avoided will be in everyone's best interest. Here, energy company/utility service as a public good remains critical even though its financial value may decrease. Those entities engaged in bulk generation and transmission will need to lobby for an economic return to support these activities in the future in accordance with overall grid needs. Further downstream where competition will increase such as across Energy Cloud platforms, defensive tactics should focus on customer retention and service. Here, the impact of technology innovation will be greatest and more difficult to anticipate. Staying relevant and competitive means catering to an expanding array of customer demands.

To play defense, energy companies and utilities should do the following:

- Engage more proactively with customers and regulators to understand customer choices vis-à-vis price and reliability.
- Upgrade infrastructure with cost-effective solutions and redesign operations to be more flexible and facilitate the integration of DER.
- Find equitable ways to share appropriate value of DER across all participating and non-participating customers for T&D services (the value of the grid) in an unbundled manner relative to today's regulated rate structure.
- Develop a portfolio of customer, energy company, utility, and third-party owned renewable and DER assets to appeal to environmentally conscious customers, as well as prosumer customers, while also diversifying the asset base.

Offensive strategies, meanwhile, focus on targeting customer-focused, high growth opportunities, which may result in significant departures from the core business. This approach assumes a more aggressive transformation of the market. History proves that most business model innovations are introduced by market newcomers rapidly deploying new technologies that address emerging customer needs. Through partnerships, acquisitions, and in-house solution development, traditional energy companies and utilities must stay on the offensive to keep pace. Although the payoff can be high, market timing can determine whether an initiative succeeds or fails.

To play offense, energy companies and utilities should do the following:

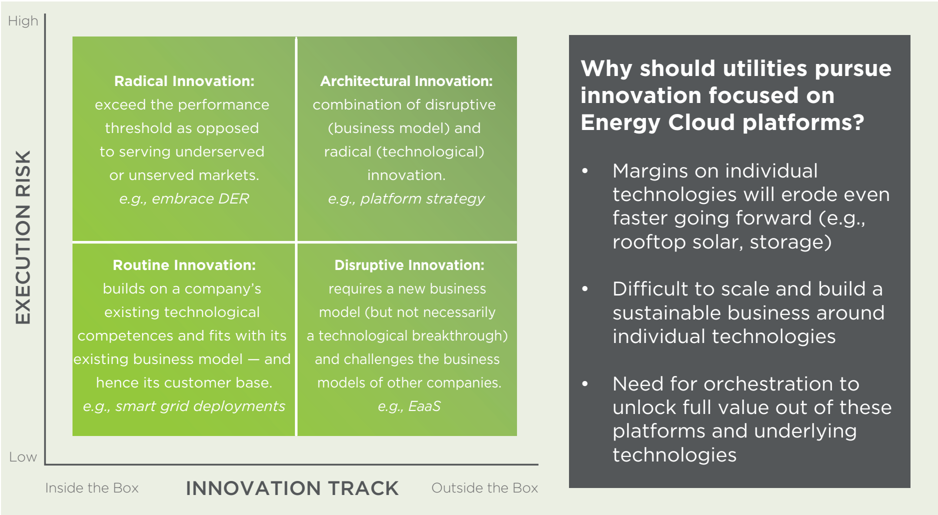
- Decide which Energy Cloud platforms to invest in (iDER, B2G, T2G, IoE, TE, Neural Grid, and Smart Cities).
- Innovate around new revenue streams through the development of new business models, products, and services.
- Implement a holistic approach to planning that accounts for both current and future interdependence across technology, policy, regulation, economics, and customer demands.

4.2.2 Managing Innovation Uncertainty

Innovation cannot be done for the sake of innovation: it must address a business goal that cannot be managed through operations. As emerging Energy Cloud platforms illustrate, the innovation imperative for energy companies and utilities goes well beyond the technology itself. New business models, customer centricity, data harvesting, and operational goals all require an innovation mindset as well.

Figure 4.1 presents four categories of innovation that may be leveraged in the Energy Cloud.

Figure 4.1 The Energy Cloud Innovation Matrix



(Source: Navigant)

Execution Risk describes the level of investment the organization is comfortable exposing to uncertainty, how much time it is willing to wait for innovations to be profitable, and how much failure they are willing to endure.

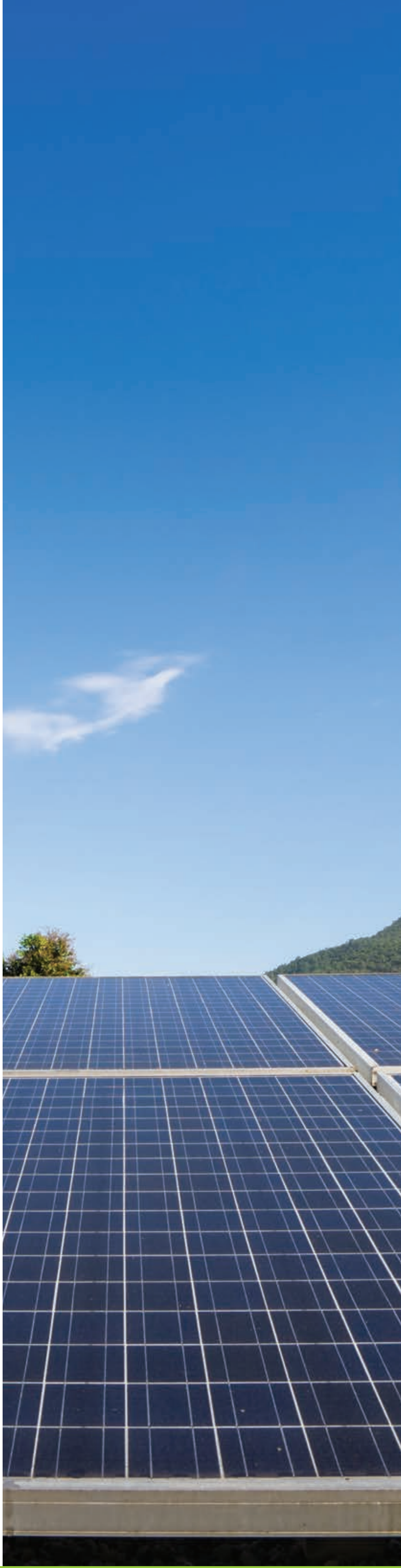
Innovation Track describes the degree of deviation from the core business. **Inside the box** focuses on innovation around the incumbent business. **Outside the box** looks at opportunities that either extend or compete directly with the core business.

Each innovation approach involves different calculations around the degree of execution risk and deviations from the core business (i.e., Innovation Track) the organization is willing to absorb. With each, the goal is to improve financial performance, whether that be in commodity energy products or non-energy products and services for many third parties:

- **Routine Innovation:** More incremental and typically yielding limited returns, but lower risk means this approach is more palatable for energy company/utility interests. Focus tends to be on asset performance, efficiency, and reducing downtime, all factors that conserve cash rather than attempt to return a multiple over and above the initial capital outlay. Offloading generation to a third party fits in this quadrant.
- **Radical Innovation:** Requires more capital exposure than Routine Innovation, with a greater focus on embracing emerging technologies as a replacement for incumbent solutions. This may also yield improved efficiencies and performance, but also target opportunities to expand the core commodity business. Large-scale adoption of utility-scale renewables and DER largely fit in this quadrant.
- **Disruptive Innovation:** More focused on deploying new business models that may leverage incumbent technologies. The focus is on repositioning the business to adapt to changing market demand and remain competitive. Bundling services through energy as a service (EaaS) approaches fits in this quadrant.
- **Architectural Innovation:** A blend of Radical and Disruptive Innovation, this type of innovation entails a total overhaul of the existing business. Here, the focus is on harnessing highly disruptive technologies and delivering transformative products and solutions to the market. Becoming a V2G charging network operator fits in this quadrant.

Status quo suggests incumbent energy companies and utilities will continue to invest and maintain the bulk grid as a public good with a primary focus on commodities. However, in a mature Energy Cloud landscape, this means lower margins and slower growth. Alternatively, they may choose to strike a Faustian bargain, chasing higher margins and growth in energy and non-energy products and services that deviate significantly from the core business. Yet, this need not be an either-or choice, which risks prematurely limiting the range of options in front of the energy company/utility.

Dual-track innovation seeks to optimize the benefits to the organization of inside-the-box innovation (i.e., Routine and Radical Innovation) while also dedicating energy and resources toward outside-the-box initiatives (i.e., Disruptive and Architectural Innovation). Pursuing a dual-track strategy allows the organization to hedge lower margin, higher revenue opportunities with potentially higher margin, lower revenue certainty opportunities.[24]



24. Navigant Research, *Utility Innovation Blueprint: How to Manage the Challenge of Dual Transformation*, Commissioned by Oracle, October 2017.

Under dual-track innovation, the inside-the-box pathway targets opportunities closely aligned with the core business. This includes optimizing the core business to maximize operational and capital efficiency and free up resources for more ambitious innovation initiatives. Most energy companies and utilities already have inside-the-box initiatives in place.

Inside-the-box innovation may include low risk or high risk initiatives, but typically steers clear of significant departures from the core business area. Examples include the adoption of utility-scale renewables and ongoing smart grid investments to embrace digital opportunities. Another example is investing in customer-centric DER opportunities such as demand-side management, EVs, and community solar plus storage. Such initiatives are already quite common.

Outside-the-box innovation focuses on opportunities that embrace more significant departures from the core business. These may involve lower risk ventures or riskier strategies that have the potential to yield substantial returns. While EaaS platforms are not new in the energy space, service-based business models represent a departure from core commodity-based sales and fit within the Disruptive Innovation category. More aggressive, still, Energy Cloud platform strategies force a radical rethink of main purpose and strategies for profitability. In Smart Cities, for example, energy companies and utilities may play an active role in pairing energy-focused revenue with non-energy services such as managing a digital network of smart lighting infrastructure or fleets of electric buses or harnessing machine learning across a network of interconnected things to drive value across an ecosystem. For many third parties, outside-the-box strategies are likely more engrained in their organizational DNA.

Energy Cloud platform strategies force a radical rethink of main purpose and strategies for profitability.

If successful, the second (outside-the-box) track could cannibalize the core business by delivering greater revenue and improved margins. To be successful, second track initiatives must be cultivated and resourced appropriately. They should also be insulated from ongoing first track initiatives as well as shareholder scrutiny to give new ideas and business models sufficient runway to navigate inevitable growing pains and false starts.

A Navigant Research study commissioned by Oracle outlined the following energy company/utility best practices for approaching innovation:[25]

- Incorporate innovation into a long-term strategy.
- Engage stakeholders early and often.
- Create an innovation culture.
- Optimize innovation delivery.
- Maintain momentum.
- Embed innovation in business operations.
- Look beyond the organization to innovate.
- Continue learning and refining.

4.3 Decide Which Business Models You Want to Deploy

Two examples of outside-the-box platform-focused business models—EaaS and network orchestrator—represent a step change in energy company and utility approaches to delivering value to end customers. While the former is not new to the industry, the network orchestrator business model represents a significant departure from existing paradigms. Analysis shows that service-based and network orchestrator business models across fast emerging combination technology platforms have the potential to scale faster and yield greater profit margins than the traditional asset-focused and supply models that currently dominate the industry.[26] Furthermore, network orchestrators play a critical role in improving access to real-time price signals, which further enable Energy Cloud platforms.

The energy industry appears to be warming to this reality. When asked in a Navigant survey what business models utilities should pursue to harness the full value of DER, a majority (nearly 60%) of *Public Utilities Fortnightly* readers selected energy platform provider and network orchestrator.[27]

4.3.1 EaaS and XaaS

The global economic shift away from the manufacture of goods and commodity value chains to more capital efficient services model is already well underway across the broader economy. Among the largest employers across the US, service-based workers represent around 90% of the total workforce, which is the result of a trend more than 50 years in the making. A similar shift can be observed in other mature industries around the world. Increasing digitization of the power and utility industry is ushering in an era of service-based products and services.

Within energy, emerging models range from EaaS solutions and BTM-focused opportunities targeting IoT, lifestyle, and comfort. EaaS, by far the most common of the more innovative service approaches today in the power and utility industry, includes the comprehensive management of a customer's energy portfolio—including energy assets, operations, and services that span supply, demand, and program management. These solutions often incorporate new products, services, and technology solutions. Navigant Research forecasts show the EaaS market generating $220 billion in annual revenue by 2026 across C&I customers.[28]

When asked in a Navigant survey what business models utilities should pursue to harness the full value of DER, a majority (nearly 60%) of *Public Utilities Fortnightly* readers selected energy platform provider and network orchestrator.

EaaS shares many similarities with today's energy service companies. The market currently consists of third-party vendors, electric power companies, energy service companies, and others. They seek to deploy niche technical, financing, or procurement solutions such as solar power purchase agreements, energy service performance contracts, and deregulated electricity market retail brokerage services. Examples include the following:

- **Energy portfolio advisory solutions:** Comprehensive, enterprisewide strategic guidance to help customers navigate their unique procurement, energy management, financing, business model, and technology opportunities across all energy management and sustainability needs.
- **Onsite energy supply:** DG solutions like solar PV, combined heat and power, diesel and natural gas gensets, microturbines, and fuel cells that improve energy supply.
- **Offsite energy supply:** Including electricity procurement options from offsite sources in retail choice deregulated electricity and gas markets and from emerging large-scale, offsite renewable energy procurement business models.
- **Energy efficiency and building optimization solutions:** Comprehensive energy efficiency assessment, business case analysis, financing, implementation, monitoring and verification, and building commissioning services to reduce energy spend and use.
- **Load management and optimization solutions:** Comprehensive, end-to-end energy management solutions to optimize energy supply, demand, and load at the site and enterprisewide, including DR, distributed energy storage, microgrid controls, EV charging equipment, and building energy management and building automation systems and software controls.

25. Navigant Research, Utility Innovation Blueprint: *How to Manage the Challenge of Dual Transformation*, Commissioned by Oracle, October 2017.
26. Barry Libert, Megan Beck, and Jerry Wind, The Network Imperative: *How to Survive and Grow in the Age of Digital Business Models*, 2016.
27. Navigant Consulting, Inc., *State & Future of the Power Industry*, 2017.
28. Navigant Research, *Energy as a Service*, 3Q 2017.

4.3.2 Network Orchestrator

Every company uses one or more of four basic business models: asset builder, service provider, technology creator, and network orchestrator.[29] Among Fortune 500 companies, linear business models (asset builder, service provider, and technology creator) on average scale more slowly and are less profitable than the platform-focused network orchestrator business models (Figure 4.2).

Figure 4.2 Value of Energy Cloud Platform Orchestration

Business Model	Scale Factor	Profit Margin
Asset Builder	X 1.5	29.5 %
Service Provider	X 2.5	47.1 %
Technology Creator	X 4.7	61.6 %
Network Orchestrator	X 5.8	69.5 %

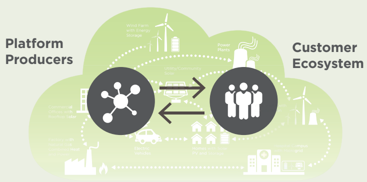
Enable scalable, disruptive energy technologies

IT/OT convergence, data-analytics on steroids

Unlock multiple new energy and non-energy services and revenue opportunities

Customers will determine how value is created, quantified, and distributed

Capturing Platform Value Through Orchestration



Orchestrator Differentiators

1. Achieve scale and deliver value through connectivity. **2.** Enable multi-sided exchange of value across platform. **3.** Leverage ecosystem to enhance platform value.

(Sources: Navigant, The Network Imperative)[30]

The network orchestrator model leverages improved connectivity across the Energy Cloud, harnessing vast interconnected networks of assets and customers. Across the broader economy, businesses that leverage this model deliver value through a combination of digital connectivity and relationships or network capital. By creating a platform that participants use to interact or transact across the network, companies employing this model may sell products, build relationships, share advice, collaborate, and more.

More advanced platform plays extend the value stack to physical assets as well. Amazon, Google, and Apple are rolling out physical solutions in the form of voice-controlled assistants, personal computing, connected smart home products, and in some cases, driverless cars. Through partnerships, many players across the energy industry are beginning to assemble into network arrangements related to Energy Cloud platforms.

Adopting network orchestrator best practices enables an expanding opportunity for energy companies and utilities to deliver individualized products and services. While there is no pure-play network orchestrator at scale in the energy industry today, we are likely to see serious efforts within the next decade.

4.4 Execute Your Vision

Changing customer needs, evolving policy and regulation, and accelerating innovation around DER and digital technology will drive the creation of more distributed transactions and dynamic business models across Energy Cloud platforms. The Energy Cloud transformation means that organizations must take a more holistic approach to strategic planning while also remaining nimble in the face of rapidly evolving ecosystems and a convergence of industry interests.

29. Barry Libert, Megan Beck, and Jerry Wind, *The Network Imperative: How to Survive and Grow in the Age of Digital Business Models*, 2016.
30. Barry Libert, Megan Beck, and Jerry Wind, *The Network Imperative: How to Survive and Grow in the Age of Digital Business Models*, 2016.

This will require an organizational rethink of traditional approaches to customer segmentation and solutions, rapid adaptation to policies and regulations, embracing highly disruptive technologies, an overhauling of traditional business models, and increasingly sophisticated operations. Navigant's Energy Cloud Playbook identifies five areas of focus to begin building a portfolio of capabilities to take advantage of platform opportunities (Figure 4.3).

Figure 4.3 The Energy Cloud Playbook

(Source: Navigant)

4.4.1 Sponsor a Cross-Functional Innovation Team

Historically, energy companies and utilities have not been regarded as leaders in innovation. Traditional regulatory constructs have focused on a safe, secure, and reliable service model with predictable shareholder returns. Few regulatory jurisdictions have modified this traditional risk/reward structure.

While energy companies and utilities will still play a central role in the Energy Cloud transformation, their culture must shift to maximize new value creation. Culture eats strategy for breakfast, lunch, and dinner. No strategy can be successful without a culture that is organized and focused around a shared vision. There will be failures, and the organization must be willing to accept these setbacks, learn from them, and improve solutions based on these experiences.

Leadership should aim to build one or more cross-functional teams that can ideate without constraints, anticipate a diverse set of risks, and stitch together disparate solutions. Long-term integrated resource plans and 5-year strategic plans are no longer sufficient. Internal culture must be ready to adapt to shorter time horizons and away from approaches that have anchored strategic planning in the past. This is underpinned by holistic and agile strategic planning process. Dual-track innovation can reinforce these success factors by allowing leadership to insulate a group focused on outside-the-box innovation from the needs of the core commodity business.

4.4.2 Assess Market Shifts

The focus of Stage 2 is on understanding the rapidly shifting landscape. Within each individual Energy Cloud platform, a diversity of actors and new combinations of technologies mean that innovation will continue to accelerate. Anticipating opportunities requires sifting through an increasingly complex landscape. Your team should have access to information and insights to stay ahead of market shifts and their potential impacts on customers, policies and regulations, current and emerging technologies, business models, and operations.

As Figure 4.4 illustrates, anticipating the potential for disruption requires scenario planning of trends toward clean, intelligent, mobile, and distributed energy and their impact(s) across multiple dimensions. These dimensions include customers, policy and regulation, technology, business models, and business operations.

Figure 4.4 Energy Cloud Scenario Planning

Megatrends	Customers	Policy & Regulation	Technology	Business Models	Operations
Clean	Rise of community choice aggregation Carbon free energy Sustainable	Clean Power Plan (US) 20-20-20 (EU) Paris Accord	Utility-scale renewables Distributed renewables Intelligent devices	Utility-scale renewables Distributed renewables Intelligent devices	Renewables integration Transmission upgrades Load balancing
Distributed	Self-generation/ storage Security/ reliability Cost savings	Self-generation incentive Net energy metering Feed-in tariff	DER Volt/VAR Microgrid	DER build, own, and operate Energy services Microgrid as a service	Aggregation Two-way power flow Asset management
Intelligent	Accessability/ control Transactive energy Digital communication	Grid modernization Standardization Smart meter target	IT/data analytics Advanced metering infrastructure Blockchain	Network orchestration Variable rate design Smart grid as a service	IT/OT convergence Customer engagement Cybersecurity
Mobile	EV model diversity Mobility Carbon footprint	Clean vehicle tax credits Access to restricted roadways TOU rates	V2G Autonomous vehicles Microgrid-in-a-Box	Mobility as a service Charging services Fleet orchestration	EV integration Charging infrastructure Data management

Impact Dimensions

(Source: Navigant)

In the Energy Cloud, this stage becomes increasingly critical. The diversity of actors entering the traditional energy space, the sheer volume of emerging technologies, and the complexity of the opportunities (e.g., IoT and blockchain) mean that more information will need to be processed and synthesized to support innovation efforts.

4.4.3 Identify Opportunities

Stage 3 is focused on paring down the broad array of potential opportunities to a focused set of targeted solution areas. These may be selected for any number of reasons—to shore up weakness in the existing business, enhance or optimize current assets, or move aggressively into new areas of growth. These may be specific to one or more customer segments, targeted geographies, and Energy Cloud platforms or they may include a range of generalized opportunities across the broader Energy Cloud ecosystem.

4.4.4 Develop Solutions

Assuming opportunities have been identified that meet organizational criteria for further development, Stage 4 begins to move toward deployment and scaling. Prioritized solutions should be ready to deploy quickly and flexible enough to allow for rapid iteration post deployment. Except in cases where strategic, more capital-intense solutions have been identified, capital efficient, flexible, and custom-centric solutions should be prioritized.

Before deployment, processes should be in place to support rapid scaling up (or down) of solutions. The ability to merge solutions within and across platforms, and eventually with the broader Energy Cloud ecosystem, should be considered.

4.4.5 Innovate, Optimize, or Abandon

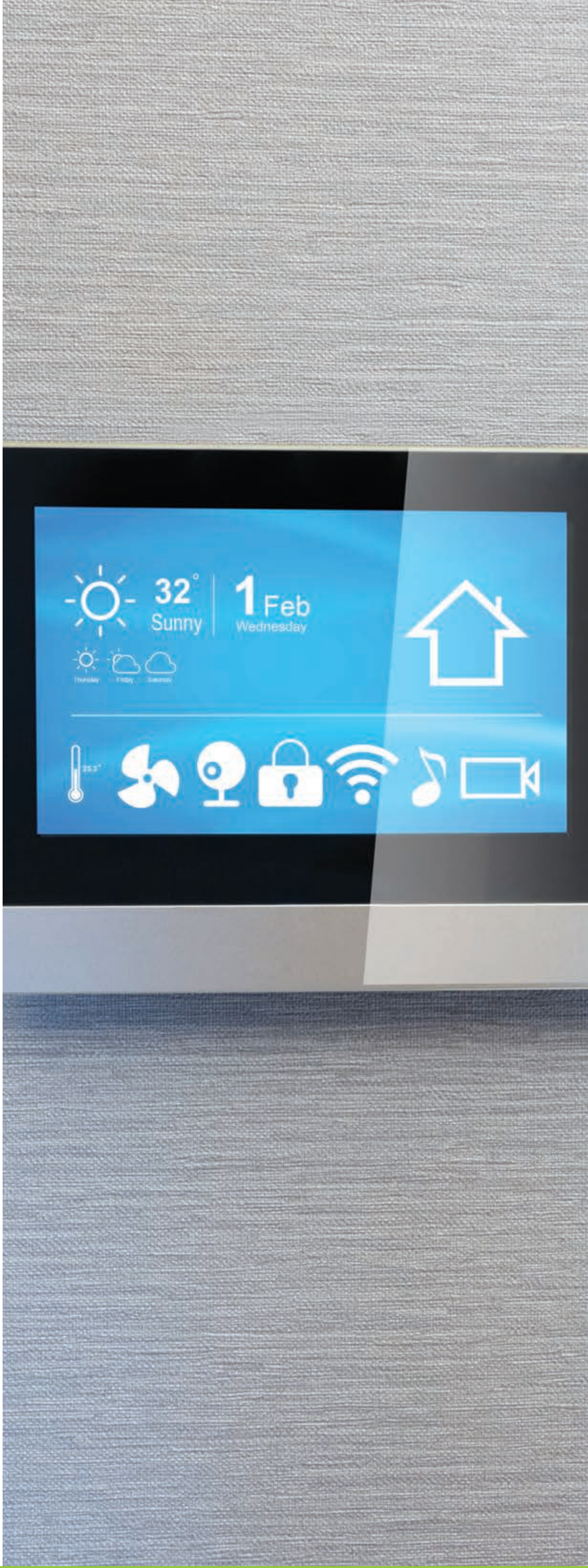
Stage 5 is focused on measuring the performance of deployed solutions against pre-deployment assumptions, identifying synergies across other deployed platform solutions, and pursuing opportunities to mine data to enhance solution profitability. Ultimately, each deployed solution should trigger one or more decisions around whether to further innovate around the solution, optimize to improve its performance, or drop the solution to redirect capital and resources.

As an iterative process, organizations should regularly rethink their offense and defense strategies, refine their innovation strategy, hone their business model approach, and continuously revise their pipeline of potential solutions.

5 CONCLUSIONS AND RECOMMENDATIONS

In the Energy Cloud, things work differently compared to today's energy company and utility business. Client and shareholder value creation will change dramatically as combinations of fast emerging technologies lay the foundation for dynamic platforms across the edge of the traditional grid. The power industry will both expand and collide with other industries, ushering in an unprecedented wave of competition and innovation. The grid will become increasingly clean, intelligent, mobile, and distributed.

Load growth forecasting will be more dynamic, T&D grid planning will consider non-traditional and non-wire solutions, and power generation investments will include customer and third-party owned resources. Regulatory frameworks, tariffs, and ratemaking will require a complete overhaul, as small tweaks will not work long term. Energy companies and utilities should develop their own Energy Cloud platform playbooks in addition to 5-year strategic plans and longer-term IRP and capital investment plans.



For **incumbents**, including energy companies, power, water, and gas utilities, oil & gas majors, large energy-intensive companies, and heavy manufacturers, as well as extractive industries across the value chain, the stakes are high. Navigant recommends a number of proactive measures, including the following:

- **Act now.** We estimate that energy incumbents, especially utilities, have less than 5 years to reorient their products and business models around fast emerging technology ecosystems like iDER, Smart Cities, and IoE or risk becoming a fringe player in the emerging energy economy. Position your organization at the center of one or more of these platforms with the strategic objective to assume a platform orchestration role building a network of customers with products and services.
- **Assess** the changing technology landscape and plan for multiple scenarios. Navigant estimates that cumulative technology and infrastructure investments in emerging technologies within individual Energy Cloud platforms—e.g., iDER, Smart Cities, and IoE—will attract billions in new investment within the next decade. Under the Energy Cloud scenario, aggressive technology adoption will result in more than $1 trillion in new value realized by the year 2030. As individual technologies increasingly converge, new solutions, business models, and opportunities will emerge far beyond anything deployable today.
- **Rethink** many of the time horizons and approaches that have anchored strategic planning in the past. Long-term IRPs and 5-year strategic plans are not sufficient to address a more dynamic Energy Cloud.
- **Play defense.** Engage more proactively with customers and regulators to understand customer choices vis-à-vis price and reliability. Upgrade infrastructure with cost-effective solutions and redesign operations to be more flexible and facilitate the integration of DER. Find equitable ways to charge DER customers for T&D services (the value of the grid) in an unbundled manner relative to today's regulated rate structure. Develop a portfolio of customer, energy company/utility, and third-party owned renewable and DER assets to appeal to environmentally conscious customers, as well as prosumer customers, while also diversifying the asset base.
- More critically, **play offense.** Decide which Energy Cloud platforms to invest in (iDER, B2G, T2G, IoE, TE, Neural Grid, and Smart Cities). Create new revenue streams through the development of new business models, products, and services. Implement a holistic approach to planning that accounts for both current and future interdependence across technology, policy, regulation, economics, and customer demands.
- **Foster a culture of innovation**, more agile and less risk averse than in the past. Status quo suggests energy incumbents will continue to invest and maintain the bulk grid as a public good while accepting lower margins and slower growth. Alternatively, these companies may choose to strike a Faustian bargain, chasing higher margins and growth in energy and non-energy products and services that deviate significantly from the core business. Pursuing both is possible—as with energy company and utility corporate structures maintaining both a regulated and unregulated business, for example—but difficult to execute effectively. One or the other typically dominates the corporate identity and culture. We recommend incumbents pursue both tracks as independent ventures resourced in parallel.
- **Be obsessed with customers, data, and value.** These should be leveraged in building new products and solutions and to increase stickiness with your customers.

Energy incumbents, especially utilities, have less than 5 years to reorient their products and business models around fast emerging technology ecosystems like iDER, Smart Cities, and IoE or risk becoming a fringe player in the emerging energy economy.

For the **disruptors**, including companies spanning the oil & gas, manufacturing, IT, automotive, retail, internet, telecom, security, and services industries, opportunities to capture market share abound. Navigant recommends the following:

- **Leverage your organization's key strengths and assets.** Customer relationships, technology solutions, cash, partnerships, scale, and digital expertise are all leverageable in the Energy Cloud. More critically, these are many of the tools needed to capitalize on new value opportunities across Energy Cloud platforms. Orchestration platforms are among the most powerful assets to do so.
- **Act quickly** to begin building brand recognition and establish a market position. Energy Cloud platforms are not only about energy. Viable products proven out in other industries may provide the Trojan Horse to enter the power and utility industry.
- **Bring an innovator's mindset.** The Energy Cloud means that conventional processes and assumptions around value creation will shift. Consumers are far ahead of regulatory reform, which suggests that unmet demand across the industry could be significant.

A cleaner, intelligent, increasingly mobile, and more distributed grid is just around the corner. Fully realized, the Energy Cloud will significantly reduce the amount of power flowing through the bulk grid and result in value shifting downstream to the customer and a reshuffling of market share among incumbent and new market entrants (**Section 2: Transformation**). New value will be created and captured across highly dynamic and disruptive Energy Cloud platforms (**Section 3: Opportunities**). Capturing value will require a more nuanced approach to innovation and taking advantage of EaaS and network orchestrator business models (**Section 4: Pathways to Success**). There are multiple innovation pathways, and pairing one track focused on improving the core business with a second track focused on outside-the-box opportunities is advised—especially for well-established energy companies and utilities. To prepare for organizational transformation and drive sustainable excellence into the future, we recommend energy companies and utilities adopt the Energy Cloud Playbook discussed in Section 4.4.

Additionally, Navigant provides solutions to support our clients in responding to the interconnected dimensions of Energy Transformation. Contact us to learn more about our transformation offerings:

- **Energy Cloud Transformation:** Offers our clients insights and a path forward supporting policy and strategy development, business model evolution, planning, and implementation of Energy Cloud platforms and other new businesses.
- **Clean Energy Programs:** Delivers full lifecycle energy program services focused on demand-side management and DER to our clients.
- **Energy System Transformation:** Supports clients with grid and power system changes due to increasing penetration of renewables and DER and an increased focus on resiliency, compliance and security, and flexibility.
- **Sustainability Solutions:** Helps corporate clients in pursuit of circularity and decarbonization driven by customer demands and regulation.
- **Technology Innovation and Management:** Supports clients in energy product lifecycle management with innovation strategy and implementation.
- **Energy and Capital Markets:** Offers our clients energy market forecasts and analytics and supports mergers and acquisition transactions, resource planning, and design for power and gas assets and markets.

Note: Editing of this report was closed on February 28, 2018

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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