NAVIGATING THE URBAN ENERGY TRANSFORMATION

BUILDING SMART AND SUSTAINABLE FUTURE CITIES

WHITE PAPER | PUBLISHED 4Q 2017

NAVIGANT

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ENERGY

NAVIGATING THE URBAN ENERGY TRANSFORMATION

Building Smart and Sustainable Future Cities

1 EXECUTIVE SUMMARY

1.1 A New City Energy Landscape

The importance of cities to the development of a sustainable, global economy that can address the need to increase prosperity, address climate change, and ensure the well-being of all populations is widely recognized. Local leaders around the world are committing to low carbon strategies and the use of new technologies as they shape the development of their communities to meet these economic, environmental, and social challenges.

Key to the advancing these ambitions is the future energy landscape of cities and communities. The shift to clean, distributed, intelligent, and mobile energy systems is essential, not only in meeting climate goals, but also other local priorities including improving air quality, reducing congestion, and ensuring the future economic competitiveness of a city.

This Navigant white paper looks at the critical elements of the emerging city energy landscape, including the spread of distributed renewable energy, building energy programs, and the rethinking of city transportation. The impact of these innovations is amplified by the advance of digital technologies and the new platforms and business models they are enabling. The paper outlines the opportunities and challenges that these new platforms offer to diverse stakeholders in the future urban energy market.

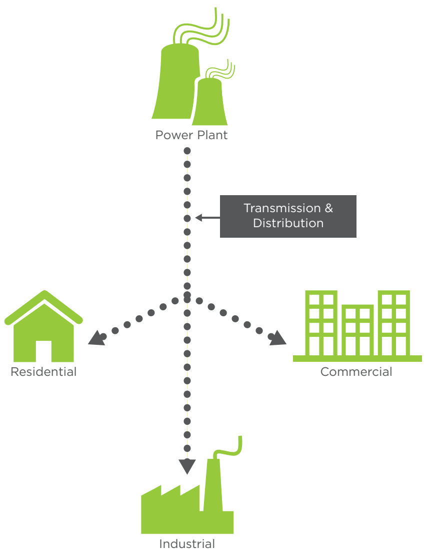
1.2 The Energy Cloud

Navigant characterizes the current transformation in the energy sectors as the emergence of the Energy Cloud, driven by new technologies including the impact of smart grids, digitization, and the Internet of Things (IoT), and the shift to renewable and distributed energy sources.

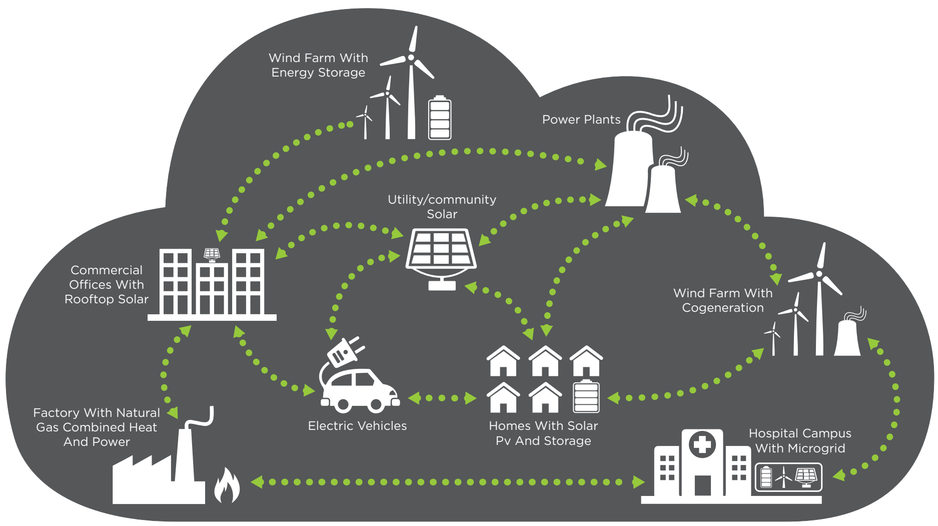
This model represents the shift away from centralized energy generation and distribution toward a highly distributed, networked, and dynamic grid in which technology-rich platforms such as integrated distributed energy resources (iDER), building-to-grid, transportation-to-grid, neural grids, Internet of Energy, transactive energy (TE) platforms, and smart cities are emerging. The ability of utilities and other players in the energy sector to create strong ecosystems around these platforms and to establish and leverage an orchestrator role will fundamentally shape the future energy market.

THE EMERGING ENERGY CLOUD

TODAY: ONE-WAY POWER SYSTEM



EMERGING: THE ENERGY CLOUD

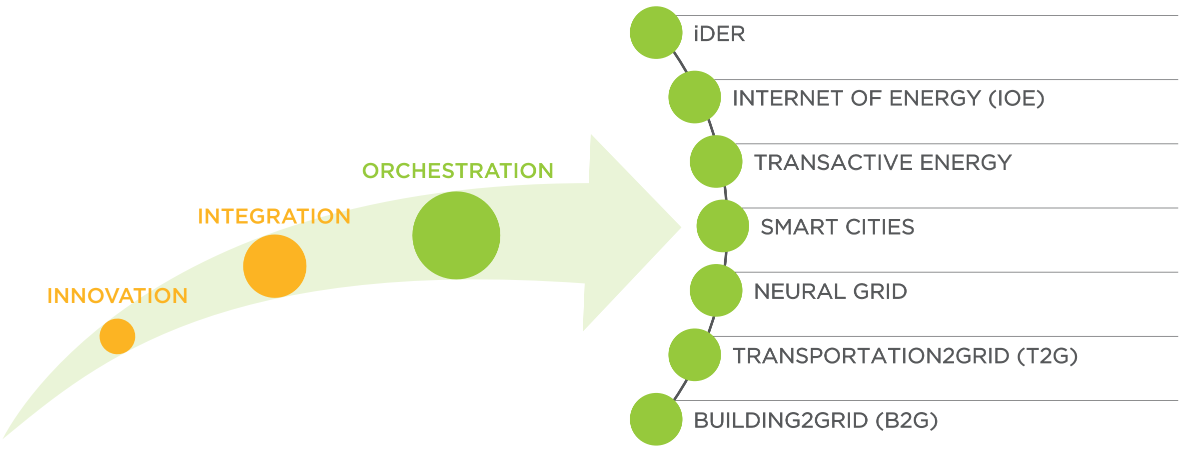


(Source: Navigant)

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

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

VALUE CREATION IN THE ENERGY CLOUD: FROM INNOVATION TO ORCHESTRATION



(Source: Navigant)

This transformation of the energy sector also provides the bedrock for the creation of the low carbon cities of the future. Creating urban energy ecosystems that can meet the needs of a global urban population of more than 5 billion people in 2030 requires cities, national governments, energy firms, developers, and their service and solution partners to develop new platforms for the efficient and effective management of energy resources across multiple sectors.

The parallel development of city platforms to support a wide range of city operations and services creates a further opportunity to explore and exploit synergies across multiple service areas. Concepts like the circular economy are being applied by cities to bring a more holistic view on these interactions to further reduce emissions and to stimulate new forms of economic development and commercial innovation.

1.3 Key Messages

There is no single model for the smart or future city nor is there a final endpoint. Cities and their partners have embarked on a journey that will be shaped by local priorities and conditions and marked by wrong turns as well as innovative and exciting leaps forward. Creating the low carbon city of the future will be a process of innovating, learning, and adapting for all stakeholders.

1.3.1 City Leaders

City and regional government leaders, regulators, planners, and other policymakers need to consider:

- Developing clear, actionable climate plans that can realize the potential of local climate action. This also means understanding the short-, medium-, and long- term benefits of energy choices for heating, transport, and buildings, for example.
- Promoting flexibility and adaptability within the urban energy systems. This includes establishing frameworks to promote service innovation to meet city goals for sustainability, reduced energy costs, and emissions reduction. It also requires new approaches to urban design and construction that embed smart, sustainable, and circular design principles in city planning processes.
- Working with partners to ensure the necessary investment in clean and connected infrastructure including communications networks, digital platforms, electric vehicle (EV) charging and alternative fuel networks, and next-generation heating and cooling systems.
- Aligning short-term pilot and innovation projects to longer-term city priorities, with a focus on the development of scalable solutions with viable business cases.
- Creating next-generation open data platforms and data hubs to enable all stakeholders to share information and apply innovative data analytics to city challenges.

1.3.2 Utilities and Other Energy Companies

For utilities and other energy firms, key considerations include:

- Engagement with local smart or future city stakeholder groups and leadership teams, and active participation in the development of low carbon city strategies. Energy companies can help chart viable programs to turn ambitious city energy and emissions targets into reality.
- Delivering benefits for all communities. Utilities have a unique connection to all city residents, which provides a strong basis for furthering community goals as well as helping improve and redefine customer relationships.
- Creating platforms for the delivery of new energy services that can also be a launchpad for innovative urban service offerings. Thinking holistically enables existing assets and services to become a base for expansion into other areas.
- Developing partnerships with technology providers. Utilities are important conduits to the market for many players, and the combination of sector and service knowledge with technology leadership is a strong proposition.
- Playing a role in the creation of new urban data systems. Energy data is a valuable element in any city data platform, and energy players should be proactive players in shaping new data exchanges and markets. Big data will also be core to building new products and solutions and building close ties with new and existing customers.
- Establishing themselves as key orchestrators of new urban energy platforms and the ecosystems they support. Playing a central role in these new networks is key to the development of new services and business lines in the city of the future.

1.3.3 Other City Service and Solution Providers

City service and solution suppliers outside of the energy sector (including those in the information and communications technology, buildings, transportation, water, and waste management sectors) need to lead the way in understanding the impact of new technologies on urban services. They must demonstrate to cities the value they bring, and find ways to include them in service contracts that still meet the often-tough financial conditions of public sector procurement. They also need to align with city carbon emission and other environmental goals, including circular economy policies.

A shift to focusing on the delivery of outcomes rather than technologies or existing service programs is increasingly important. Suppliers need to take a more holistic view of city requirements and the role that technology can play in meeting those needs. This also requires suppliers to support overlapping—and sometimes contradictory—priorities for city leaders as they look to deliver improved services, drive economic development, and meet sustainability targets.

1.3.4 Disruptors and New Entrants

The development of new platforms and "as a service" models offer flexibility to existing suppliers but also offer new players a lower cost of entry to emerging service areas. Mobility as a service, community energy programs, and smart street lighting are just a few examples of how technology is driving a shift to new smart services. This opens doors for new entrants to either compete or supplement existing service provisions.

Disruptive providers will look to fill the gap in this ecosystem if established players fail to adapt in time. Policy makers need to ensure there is room for competitive innovation that optimizes the options for cities and communities, while resisting attempts to land grab city assets or services to the detriment of the wider community.

Established providers also need to encourage innovators as part of their ecosystem to ensure they are continually developing their offerings, skills, and relationships through diverse innovation programs.

1.3.5 Other City Stakeholders

Most of the operations, activities, and investment that take place in a city is outside of local government control. This means that cities need a broad coalition of stakeholders committed to the policy objectives that will enable the low carbon cities of the future.

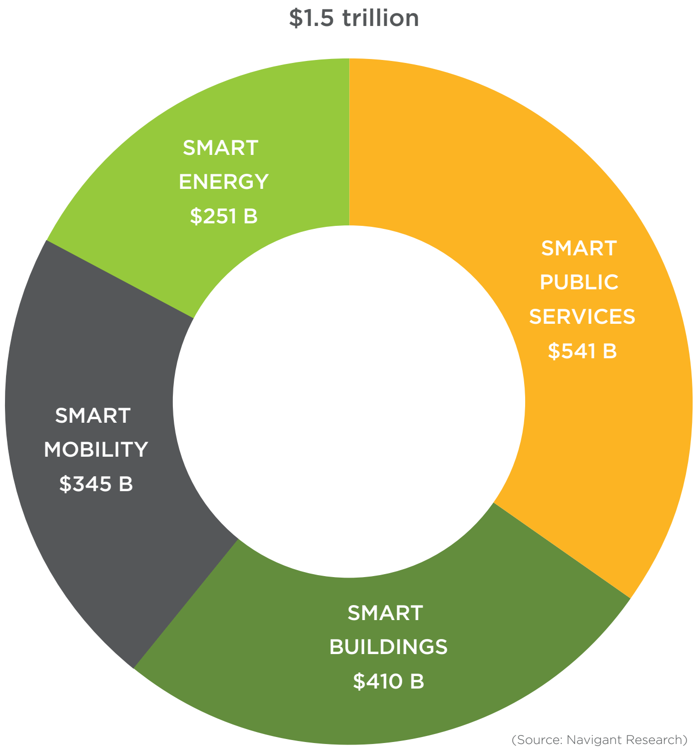
Property developers, commercial building owners, retailers, manufacturers, other city businesses, and community groups all have an important role in helping meet the strategic goals set for their city and region. City policies and regulations can mandate some changes that will improve energy efficiency and reduce overall carbon emissions, but much more will be done through voluntary practices and a recognition of the bottom line benefits of change. Reduced energy cost is one obvious spur to action, but other commercial benefits from a commitment to sustainability are also being recognized. These include increases in property and rental values, reduced production cost, new revenue streams from local energy generation, and increased brand value.

2 CREATING THE LOW CARBON CITIES OF 2030

2.1 Cities Step Up

The importance of cities to meeting global climate targets is undisputed. Cities are responsible for more than two-thirds of the world's energy use and greenhouse gas (GHG) emissions. Since the COP21 Paris agreement, cities leaders have been making commitments to deliver the necessary reduction in urban emissions to meet global climate goals. Achieving these targets will require a combination of new energy solutions, new technologies, new approaches to city management and operations, and the development of Energy Cloud platforms, on which partners can support cities in their transformation to a zero carbon economy.

SMART CITY SERVICES CUMULATIVE REVENUE BY SECTOR, WORLD MARKETS: 2017-2026



(Source: Navigant Research)

The work must start now. The C40 Cities Climate Leadership Group has estimated that 97% of the actions needed to achieve global emissions goals for 2050 will need to be implemented in the world's leading cities by 2030 if the goals set out in the Paris agreement are to be met. Given the speed of urban planning processes and infrastructure programs, cities and their partners need to instigate many of these projects within the next 3-5 years.

The city of 2030 will need to comprehend and manage a much more complex set of interdependencies between diverse aspects of city operations, infrastructure, platforms, and priority issues such as health, mobility, sustainability, and economic development. This requires new networks for collaboration between cities, 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.

This transformation touches every aspect of city services and infrastructure including energy generation and distribution, heating and cooling systems, building energy efficiency, transportation, water and waste management, and the efficiency of city services such as street lighting. At the same time, city operations are being transformed by digital technologies such as the IoT, smart buildings, artificial intelligence (AI), robotics, and automated vehicles. These additional innovations will unlock second and third-order opportunities as synergies with existing and emerging technologies increase.

While cities face many challenges in meeting their environmental, economic, and social goals, they can also benefit from a radical transformation in the way services are delivered, in their use of energy, in the way they manage their infrastructure, and how they collaborate with citizens, utilities, service providers, and other stakeholders.

CLIMATE ACTION PLANS OF SELECTED CITIES

CITY	COUNTRY	CLIMATE ACTION PLAN
Boston	United States	Reduce GHG emissions 25% by 2020 (compared to 2005 level), carbon neutral by 2050
Copenhagen	Denmark	Carbon neutral by 2025
London	United Kingdom	Reduce CO_2 emissions 60% by 2025 (compared to 1990 levels), zero carbon by 2050
Mexico City	Mexico	Reduce GHG emissions 30% by 2020 (compared to 2014 levels)
Munich	Germany	100% renewable energy powered by 2025
San Diego	United States	100% renewable electricity by 2035
San Francisco	United States	40% reduction in GHG by 2025, 80% reduction by 2050 (compared to 1990 levels)
Seoul	South Korea	25% reduction in CO_2 by 2020, 40% reduction by 2030 (compared to 2005 levels)
Stockholm	Sweden	Fossil-fuel free by 2040
Sydney	Australia	70% reduction in GHG by 2030 (compared to 2006), 50% renewable energy
Vancouver	Canada	100% of city energy from renewable sources by 2050

(Source: Navigant Research)

2.2 The City as a Service

The complex, dynamic, and interconnected urban energy landscape in 2030 will be the product of convergent developments in several sectors including energy, transportation, buildings, city services, and digital technologies. Common to all sectors are three vectors of change:

- **The creation of zero carbon cities:** Cities need to accelerate the shift to clean energy, energy efficient buildings, and low carbon transportation that will remove their dependence on fossil-fuel-based systems. They also need to embrace the concept of the circular economy to reduce waste and energy consumption.
- **The impact of digitization and automation:** The widespread deployment of sensor technologies and intelligent devices, the exploitation of big data, and an increasing role for AI and automated services will transform all elements of urban infrastructure, economy, and services.
- **The emergence of new business models:** The shift to low carbon, digital cities introduces significant disruption to existing business models and to the relationship between cities and their utilities, service providers, suppliers, and citizens. Common to all sectors is the growing user expectation that all services will be personalized, friction-free, and highly responsive.

These developments converge around the emergence of new platform ecosystems, which make possible the idea of the city as a service.

A combination of interoperable standards and systems, platforms sit at the intersection of highly scalable hardware, software, and service solutions. These are shared by a network of suppliers, service users, and customers interacting across the ecosystem. Such platforms are already disrupting or replacing linear value chains in several commercial sectors. Networked platforms allow new entrants and customers greater access to alternative solutions that may compete on efficiency, price, customization, or any combination thereof.

There are many roles in these new platform-based ecosystems, but arguably the most important is that of the network orchestrator. Network orchestrators become the point of coordination between technology partners, service providers, and customers, and are therefore able to maximize value through energy and business transactions. The players that control the platform have greater opportunities to scale their business rapidly and to insulate themselves from competition. Value is increasingly created through stickiness of a platform rather than differentiated products. The equity of a brand, in turn, is increasingly equivalent to the value of its ecosystem.

Uber and Airbnb have already shown how city services can be transformed through platform offerings but also 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 refinement of city policy.

Future city platforms will be multifaceted, reflecting the complex confluence of multiple sectors spanning energy, transport, buildings, and core city services. This sets cities on a path toward a city as a service concept enabled by a series of platforms that effectively work as an urban operating system. That operating system will not be a single technological solution. Instead, it will provide an architecture that will draw together the diverse and ubiquitous systems that enable the modern city. In this sense, it will function like an urban Internet. This loosely coupled, highly cohesive architecture built on open standards and interfaces will enable quick adoption of new technologies, applications, and service innovations.

In the energy sector, platforms unlock multiple new service and revenue opportunities, and offer plug-and-play opportunities for energy and non-energy actors alike. Platforms are expected to unleash a new era of intense competition and innovation within the energy sector as conventional boundaries between the power and utilities industry and ancillary industries blur.

The growing integration of energy policy with transport and building policy offers opportunities for exploiting other Energy Cloud platforms within the city context. This will require utilities and other potential orchestrators to develop platform synergies that create new value for integrated services and assets. This will also require the ability to develop extended partner networks with property developers, city service providers, technology companies, and others.

New forms of public-private partnerships (P3s or PPPs) will also be an important part of this mixture. New service models are evolving to meet these emergent needs in cities. However, this also puts pressure on service providers to include greater flexibility and scope for innovation in their propositions.

2.3 The Challenges

The benefits of intelligent, clean, distributed, mobile, and adaptable energy systems are becoming widely accepted across the energy sector by city leaders and their service partners. Many of the challenges are also well understood, including the financial constraints facing cities, complex governance and regulatory models, and the inertia created by legacy

UTRECHT, THE NETHERLANDS: CO-CREATING A CITY CLIMATE AND ENERGY PLAN

The municipality of Utrecht has the ambition to be climate neutral by 2030. This will have huge implications for basically all of its 345,000 inhabitants, and will require major efforts in both energy efficiency and renewable energy. But there are multiple routes toward climate neutrality. For instance, a major retrofit of existing buildings would dramatically reduce the demand for heating and allow heat pumps to provide sustainable heat. On the other hand, Utrecht has the oldest and biggest district heating system of the Netherlands. If this heat network could be powered through bio- or geothermal energy, the objective could potentially be realized with less effort. However, there are differences in (the distribution of) investment costs, organizational and logistical consequences, and social acceptance.

Inspired by the book *Tegen Verkiezingen* (Against Elections) by David van Reybrouck, Utrecht's deputy mayor for sustainability, Lot van Hooijdonk, commissioned a citywide conversation on energy on behalf of the municipal executive. Over the course of three Saturdays, 165 randomly selected residents of Utrecht were invited to deliberate on how to accelerate the energy transition toward climate neutrality. Apart from energy and climate, air quality, health, and citizen cooperation were addressed extensively. The approach to involve citizens in this participative co-creation process is unique from a democratic, societal, and policy point of view.

The residents drew up an energy plan, supported by a team of energy experts and with feedback from representatives of different stakeholder groups (e.g., housing corporations, the grid operator, opponents and proponents of wind power). Ecofys, a Navigant company, provided technical and economic expertise and contributed to the process and organization of the city talks, as well as provided fact sheets, and led communication through a website and blog.

The process itself gave a strong impulse to the city's energy and climate strategy. The plan provided concrete guidance for the municipality to act, both in terms of measures and procedures. It also served as the starting point for the municipal implementation program on energy for 2016-2019 and the years to follow.

infrastructures, both hard and soft. In addition, there are specific issues raised by the complexity and the uncertainty associated with the emergence of new operating models for cities and for the energy sector, including:

- **Complexity:** Making decisions on technologies and platforms in a world where change is rapid and outcomes uncertain requires new management approaches. A greater emphasis needs to be placed on adapting strategy in the light of experience and retaining flexibility, which runs counter to traditional operating models and long-term city service contracts. The public and private sectors need to work together closely and with new levels of trust and understanding if new technologies are to be deployed to the benefit of all.
- **Quantifying benefits:** Many of the investments needed to address the issues of climate change and the reduction in GHG emissions have a long-term payback that is not easy to fit into short-term electoral cycles or to measure against pressing issues around the city services and infrastructure. The challenge for city leaders is to demonstrate immediate benefits (e.g., air quality improvements, reduced energy costs) and to build broad support for longer-term strategies that will benefit the city in terms of health or economic renewal, for example.
- **Lack of control:** The shaping of future cities is dependent on changes in infrastructure, assets, and services over which cities have limited or no control. Energy policy and infrastructure, regional and national transportation, and commercial building stock are just some of the key elements that may be outside city influence. Driving change therefore requires strong stakeholder management, identification of interdependencies, and the layout of clear transition paths.
- **Skills and expertise:** Many cities lack the resources, financially and in terms of in-house experience and skills, to create and execute the necessary strategies and programs and to exploit the opportunities offered by new platforms or big data, for example. There is a need for strong partner networks to provide guidance and support. This entails new forms of private-public sector partnership as well as the development of closer ties to academia, community groups, and the voluntary sector.
- **Cybersecurity and privacy:** Concern is already growing over the volumes of detailed, real-time, and highly localized data generated in the modern city and its implications regarding privacy. In parallel, the more connected city infrastructure and operations become, the more vulnerable they are to cyber attacks. The importance of both issues to ensuring the acceptance and extended deployment of new technologies must be recognized by city leaders, regulators, service providers, and the technology industry.

3 LAYING THE FOUNDATIONS

3.1 The Building Blocks

Developments in the energy, buildings, and transport sectors are fundamental to the shaping of the future city's energy landscape. In addition, the deployment of digital infrastructure across the city—in the form of city data platforms and IoT networks—will change the possibilities for integrated city solutions in many areas, including energy management and GHG emissions reductions. New policy initiatives will also be important, as shown by the growing interest in the application of circular economy principles at a city level.

As shown below, each sector has its own dynamics and areas of innovation that must be brought into closer alignment if the potential synergies offered by the Energy Cloud in an urban setting are to be realized.

3.2 Cities and the Energy Cloud

The Energy Cloud scenario describes a radical transformation of energy markets. It envisions a world in which the power supply is cleaner and more distributed, where digital transformation embraces AI, the IoT, and blockchain-enabled networks, and where widespread electrification of the transportation sector means that power supply and demand become increasingly mobile.

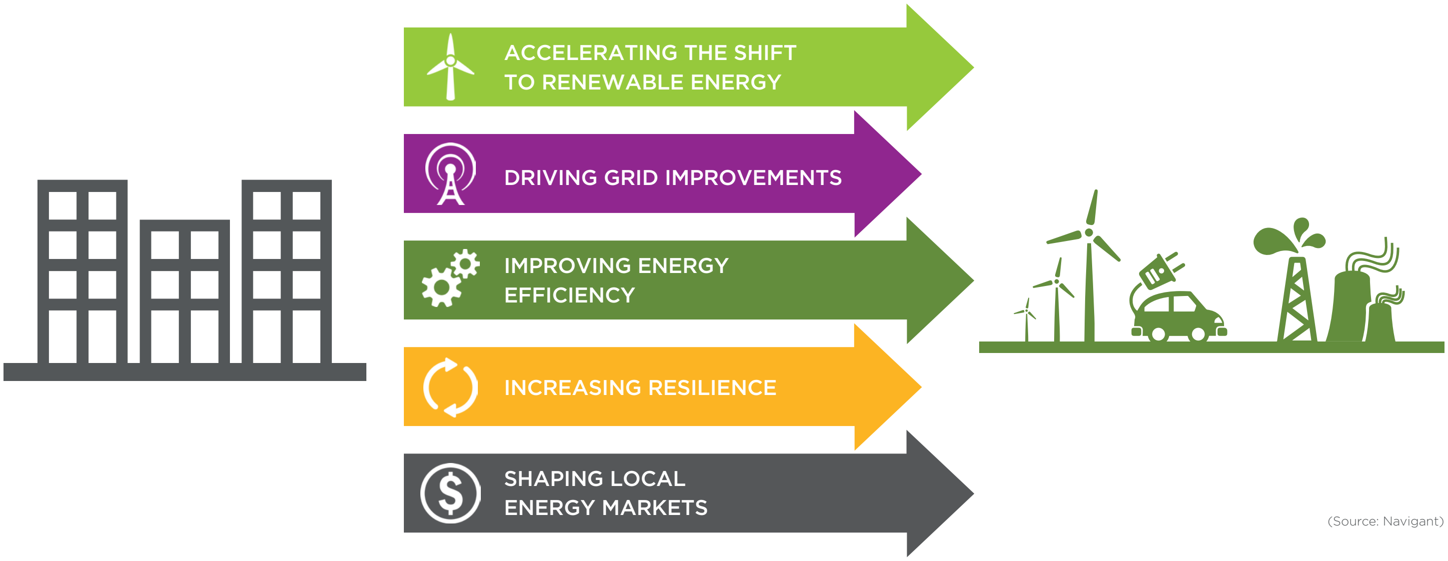
Utility business models will transform from bulk-asset- and supply-based to individualized services and network-based solutions more tuned to customers' shifting demands. Markets, especially retail, will be far more competitive. Ubiquitous AI and communications infrastructure will transform "dumb" grids into autonomous and self-healing networks (neural grids) that integrate clean, distributed, intelligent, and mobile 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.

The necessary transformation of city operations, services, and infrastructure over the coming decades has much in common with these changes in the energy sector. Both developments are rooted in changing customer demands and rapid technology innovation. There are also shared drivers related to the advancement of the clean energy agenda, the transition to a low carbon economy, the possibilities offered by DER, the digitization of energy products and services, and close interconnection between energy, transportation, and building sectors.

THE BUILDING BLOCKS OF THE URBAN ENERGY CLOUD

(Source: Navigant)

HOW CITIES ARE SHAPING THE ENERGY SECTOR



(Source: Navigant)

Cities are far from passive players in the emergence of the Energy Cloud. There are five key areas where the energy transformation is influencing future cities and in return where cities are becoming more influential in shaping this transformation.

- **Accelerating the shift to renewable energy:** Cities are increasingly proactive in setting targets for their power utilities to shift from fossil fuels to renewable energy in generating electricity to help meet carbon emissions targets. Munich, for example, aims to move to 100% renewable electricity consumption by 2025, while London has a target to generate 25% of its energy locally by 2025. Almost 400 US mayors have committed to the Paris climate goals as of November 2017. Cities are also encouraging residential and commercial energy generation through programs to support solar power, combined heat and power systems, and other community energy schemes.
- **Driving grid improvements:** Support for renewable generation by city authorities increases the pressure on utilities to deliver an infrastructure that can integrate these new resources in a manageable way and accelerates other changes in a city's energy services. Cities have been the focus of extensive smart grid pilots that demonstrate the increased control, flexibility, and integration enabled by a digital infrastructure for grid monitoring and management. Cities are likely to also be key locations for the deployment of the next generation of neural grids, a vastly more powerful platform of hard and soft assets leveraging ubiquitous connectivity, the cloud, robotics, AI, edge computing, and pervasive sensing to perform a variety of energy and non-energy applications.
- **Increasing energy efficiency:** Collaboration between city departments and local energy utilities to improve energy efficiency is one of the simplest and most effective measures for reducing the energy footprint of a city. Coordinating programs for energy efficiency improvements is an obvious step and enables cities and utilities to target the most appropriate residents, businesses, and communities for retrofit and rebate programs. Boston, for example, is working closely with local utilities (National Grid and Eversource) to reduce its $50 million-plus energy costs and to meet the goal set in 2007 to reduce GHG emissions 25% by 2020 and to be carbon neutral by 2050. The city is targeting energy consumption across residential and commercial properties. Other initiatives include the introduction of an energy management system for the city's public buildings and the deployment of LED street lighting.
- **Increasing resilience:** Resilience has long been part of the debate about the nature of smart cities, but it is becoming a much more central part of the discussion. Resilience requires an assessment of each city's complex and interconnected infrastructure and institutional systems that span the physical, economic, institutional, and socio-political environment. Energy networks are at the heart of this complex web of infrastructure interdependencies. A failure in the electricity network, whether from climate change, weather events, technical failure, or terrorist acts, can have a dramatic impact on water, sewerage, health, communication, and transportation systems. After the experience of Hurricane Sandy, New York is looking to increase the use of distributed generation alongside other grid and market innovations to provide an energy infrastructure better able to cope with future events of that scale.

- **Shaping local energy markets:** One of the most significant trends emerging around smart cities and their energy policies is an increasingly proactive approach to energy issues. Cities are becoming active players in their local energy markets, collaborating with existing utilities but also increasingly willing to challenge and, in some cases, even compete with those providers. Hamburg, for example, took back control of its energy grid in 2014. In the UK, several cities, led by Nottingham and Bristol, have set up or are in the process of establishing new city-owned energy companies. The Energy Cloud offers many new roles for cities, utilities, and other players, and we are likely to see new forms of cooperation and competition emerge.

The emerging Urban Energy Cloud vision is of a smart city that integrates large- and small-scale energy initiatives and solutions, including major infrastructure investments, citywide improvements in energy efficiency, and distributed energy resources (DER). In the process, cities will become clusters of smart energy communities that can exploit the benefits of new energy systems. These developments will need to be orchestrated at district, city, and regional levels, as well as aligned with national policies for infrastructure investments and market regulation.

Cities and communities will need partners to develop and manage this complex network of energy innovations, services, and resources. These requirements offer immense opportunities to utilities, service providers, and technology companies as they help cities drive productivity improvement and economic development from energy, transportation, and technology innovation. This means that utility energy-related services need to align with a wide range of city priorities, including social inclusivity, economic development, and environmental improvement.

3.3 City Platforms

3.3.1 The Impact of IoT

The transformation in urban energy over the next decade and further is part of a wider transformation in urban infrastructure and services that is being driven by the deployment of IoT solutions and other smart city technologies.

Citywide sensor networks are becoming a realistic option within smart city developments. San Diego's city sensor network, Bristol Is Open in the United Kingdom, and Helsinki's air quality monitoring platform are examples of city sensor networks that are testing the ground for city-scale IoT deployments. These networks are complemented by the development in city-scale data platforms such as the Dubai Data Platform.

MADISON, WISCONSIN: PEOPLE POWER AND THE ENERGY CLOUD TRANSITION

Madison, Wisconsin (population 200,000) is a city in the Midwestern United States, home to state government and the flagship campus of the University of Wisconsin. In 2016, the city adopted an Energy Work Plan to identify key areas of interest in renewable energy, energy efficiency, social equity, and economic development. A year later, in March 2017, the Madison City Council unanimously passed a resolution that included a goal for powering city operations with 100% renewable energy and net-zero carbon emissions. Navigant and Sustainable Engineering Group were selected to develop scenarios for city policymakers to consider options to achieve this goal. Madison's experience provides a microcosm of the larger transition occurring in the energy industry, and demonstrates one path in which utilities and cities can collaborate to meet their goals and the needs of stakeholders, including citizens and shareholders.

Madison decided its best option was to work together with the local utility that supplies the majority of electricity and natural gas to city facilities and buildings. Madison Gas and Electric (MGE) supplies approximately 80% of electricity and 100% of natural gas. MGE had stated goals to supply 30% of its retail electricity with renewable sources by 2030 through its MGE Energy 2030 Framework.

The city and MGE entered into a memorandum of understanding in August 2017, in which the parties agreed to identify key staff from each side that would meet on a regular basis to discuss implementation of identified areas of mutual interest. Topic areas include expanding solar energy generation, expanding the use of EVs and other transportation-related topics, promoting energy efficiency, and identifying opportunities to build social equity and economic development into these initiatives. Through this arrangement, both parties have made progress toward mutually identified goals. A recent coauthored grant application will yield the first three all-electric Proterra Catalysts buses in Madison next year. Discussions with Alliant Energy's Wisconsin Power & Light, which supplies the remaining 20% of electricity to Madison facilities, are also gaining momentum.

For Madison, people power and collaboration is key to moving closer to realizing 100% renewable energy.

As the number of cities developing smart city strategies continues to grow, and as existing programs evolve, there is an increasing interest in more integrated approaches to the development of city platforms. A city platform can be considered in this regard as an integrated capability for coordinating data and services across multiple operational domains at one or more levels.

3.3.2 Developing Platforms for the Future City

The future city platform is not a single service or product category but rather a perspective on the development of the digital city infrastructure. Like other elements of the city infrastructure, it will be complicated and diverse. The shape such a platform takes for each city will be determined by the specific needs and circumstances of each city, but it will also be determined and limited by the products and architectures being developed by industry. Cities will define their own platforms, but they will do so within the constraints and influences of broader technology industry developments. Moreover, as demand spreads from early adopters to a broader majority of cities, there will be a growing standardization of requirements and more need for off-the-shelf and as a service models.

This infrastructure will be enabled by multi-protocol networks that can support a diverse portfolio of devices and use cases, from low-power, low-cost services for asset and environmental monitoring, to essential systems for critical infrastructure and public safety. These systems will provide an immense flow of real-time data that will transform our understanding of how cities work. Using big data tools, including machine learning and AI, cities and their public and private partners will be able to optimize energy and resource flows to enable zero carbon environments and a circular economy.

To prepare for this new environment, cities need to:

- Develop a strategy for city data and IoT networks and understand the balance of short-, medium-, and long-term needs.
- Develop an ecosystem of business partners for the IoT and big data evolution with utilities, the private sector, and universities.
- Work with other cities and international bodies developing standards for smart cities and IoT.
- Above all, understand the city platform is an emerging concept—not a solution in itself but something to be shaped for and by a city with its partners.

ROTTERDAM-THE HAGUE, THE NETHERLANDS: ROADMAP FOR THE NEXT ECONOMY

Navigant, commissioned by Third Industrial Revolution Consulting, under the leadership of the US sustainability economist and author Jeremy Rifkin, joined a team of global experts to develop a Roadmap Next Economy (RNE) for the Metropolitan Region Rotterdam-The Hague. The aim of the initiative was to help the 23 constituting municipalities, with a total of 3.6 million inhabitants and 1 million houses, meet their ambition of being an innovative, economically strong, sustainable, and accessible region.

The RNE identifies a multi-commodity smart grid, a large-scale renovation of existing residential areas, hydrogen for zero-emission public transport, and the transition to a circular economy as key enablers for sustainable welfare. The one-year project resulted in a 530-page master plan that is publicly available and provides the narrative for the transition to a fully sustainable economy by 2050 along five well-developed transition paths. For each transition path, tens of scalable proposals have been provided and prioritized to enable immediate implementation, with near- and longer-term goals and metrics.

Navigant contributed to the Smart Energy Delta transition path by providing expert knowledge on the energy transition and the opportunities it provides for social, technical, and economic innovation for the region. Insights, proposals, and project ideas were developed with active participation from dozens of socio-economic actors from government, the business community, academia, and civil society.

3.4 Buildings and the Future of Urban Energy

3.4.1 Building Energy Becomes Part of the Solution

Addressing the consumption of energy in city buildings is arguably the biggest challenge in the creation of future low carbon cities. In total, up to 70% of urban energy consumption can be attributed to buildings.

Cities are already working with urban developers, utilities, building owners, energy services companies, and technology providers to improve energy efficiency in both new build developments and renovation projects. Around the world, a series of eco-district projects are mapping the possibilities for energy efficient buildings integrated into renewable energy sources and low carbon mobility services. Navigant Research estimates that by 2025 the global annual market for building energy efficiency will have reached $360 billion.

Municipal green building policies are critical, as cities have the most control over their own buildings and can lead by example. For example, San Francisco requires its municipal facilities to achieve Leadership in Energy and Environmental Design (LEED) Gold certification. In addition, city governments have established green building codes to encourage the private sector to adopt smart building technologies as well. The City of Boston requires all large-scale developments to achieve certification under the appropriate LEED rating system. Cities are also offering incentives that reward private-sector uptake of smart building measures.

Energy efficient buildings are increasingly also smart buildings. Building control and automation systems are evolving to incorporate advanced building energy management systems and new adaptable and highly granular IoT-based systems. These developments are enabling the monitoring and optimization of building performance, supporting centralized management across portfolios of buildings, and paving the way for new connections between individual buildings and the city's digital and physical networks. Smart buildings are a vital part of any city program that aims to address energy efficiency and for the development of distributed and adaptive energy networks. The Envision Charlotte program, for example, has reduced 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 of CO_2 emissions.

One of the reasons that buildings are so important to the urban energy picture is the challenge of providing space heating and, increasingly, cooling to buildings. The shift to electrification of heat and the greater use of renewable sources for heating is an important step forward. Also important is the greater integration of heating systems with other elements of the urban Energy Cloud. So-called fourth-generation district heating systems are being designed to use renewable energy sources, reduce overall energy consumption, and to be part of more adaptive, two-way energy systems.

The city of Antwerp, Belgium, for example, is the site of new area development, where residential and office spaces and schools are built to Passive House standard and connected to a low temperature district heat, which initially gets its heat from gas boilers, but will eventually use industrial waste heat. In Salzburg, Austria, a whole social housing district has been renovated, and new buildings have been integrated into the heating system. Large-scale solar thermal generation and solar thermal storage was integrated into a newly built microgrid system.

Intelligent building control systems are key to this integration and will be increasingly tied into grid and market systems. Building controls, for example, can automatically switch on the heat pump of a building if surplus electricity is available in the grid and the heat storage of the heat pump is not fully changed.

Data flows between building systems and the wider energy systems are critical to creating low carbon communities, enabling buildings to become active participants in the Energy Cloud. These data flows will become increasingly complex and valuable as IoT, AI, and machine learning become fundamental elements of building management and control systems. This digital foundation is also the basis of a new kind of partnership between technology and service providers and building owners. IoT-based intelligent building services will create new recurring revenue streams and forms of ongoing engagement.

HAMBURG, GERMANY: MAPPING URBAN HEAT DEMAND

The City of Hamburg has agreed to realize a climate target of 80% CO_2 reduction until 2050. By 2020, the aim is to save around two million tons of CO_2 compared to 2012. An action plan provides relevant measures to achieve these goals, for example, the construction and repowering of wind turbines, a heat supply concept, and energetic district planning.

For the building sector, there are numerous support programs for energy efficiency measures in residential and non-residential buildings. Furthermore, an exchange between electricity, gas, and district heating networks to compensate for variations in solar and wind power should support the development. To strengthen the city's influence on energy supply, a referendum on the repurchase of the city's energy grids (electricity and gas distribution grids and the district heating supply) was instituted.

In addition, an area-wide GIS-based investigation of the building stock was conducted by Ecofys, a Navigant company, using information on the heat distribution networks to assess the options for low carbon energy supply solutions. The City of Hamburg converted the information to an online tool, "Heat cadastre Hamburg." An ongoing R&D project, GEWISS - Geographical Heat Information and Simulation System Hamburg, seeks also to combine building stock information with heat grid information. Additionally, it looks to simulate the future energy demand of all buildings in the city and to match the heat distribution and supply system to it, so that strategic heat planning is interlinked with urban development.

Providing information on the structural and social background of the diverse urban areas, combined with urban fabric requisitions for long-term planning, stakeholder identification, renewable and low carbon heat generation, and distribution requirements, these GIS-based tools help to localize specific urban fabric clusters, serving as starting points for a tailored low carbon development on the urban area level. The tools also help to quantify and scale actions and to identify barriers and drivers on the path to meet the city's climate targets.

3.4.2 Buildings in the Energy Cloud

Any building is part of a complex network of services for energy, water and waste management, telecommunications, and transport. Traditional approaches leave the buildings as endpoints in those networks, utilizing services but remaining oblivious to the wider network. In the future city, this perspective changes so that buildings become active elements in the sustainability program driven by these networks.
For example, as more and more buildings become energy generators and part of sophisticated demand management programs, they become integrated with the energy grid. Water recycling and waste management systems also link the building more tightly into a city's ecosystem. In addition, a building's integration with transportation systems can include the provision of EV charging points or a connection to traffic and public transport information systems.

The extension of building systems from standalone applications focused on the operation of a single building to hubs within a wider network of energy and environmental monitoring systems will be one of the most dramatic changes in the technical infrastructure of the city. Navigant Research estimates that only 0.5% of the commercial building stock globally is actively participating in the energy system today, but by 2026, more than 9% will be involved. This development will create new roles and opportunities for all players in the sector. Building-to-grid services open opportunities for market coordination, engineering, and technology implementation services, for example. Network orchestrators for buildings enabled as energy assets will realize significant new revenue streams and enhance energy reliability and resilience.

3.5 The Age of Low Carbon Mobility

3.5.1 Rethinking Urban Mobility

Around 20% of a city's GHG emissions can be attributed to private and public transportation, and approximately 70% of that amount can be attributed to road transportation. In addition, pollution from urban traffic is recognized as a major contributor to the 3 million premature deaths attributed by the World Health Organization to outdoor air pollution. The need to provide clean, decarbonized, and efficient transportation is key to many challenges facing cities and is increasingly connected with developments in urban energy systems. In parallel, the advent of automated vehicles (AVs), integrated and intelligent transport management systems, and mobility as a service options (MaaS) are radically transforming city transportation planning and provision.

To address these issues, cities are promoting the adoption of low carbon vehicles as well as a greater emphasis on other mobility options. In an increasingly connected environment, cities have now become the focal point for a range of new, shared vehicle mobility options such as carsharing, bikesharing, and rideshare applications. Leading cities are now taking this multimodal approach to transportation a step further by connecting these different modes to create on-demand, sustainable, personalized, and flexible urban transportation systems.

The clear benefits in reducing GHG emissions, improving urban air quality, and localizing the energy supply have led governments and regulatory agencies to view the electrification of transportation as inevitable. Fleets of electric cars, trucks, taxis, and buses will enable people and goods to be moved without direct emissions and will be integral to the launch of MaaS 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.

Over the next two decades, ubiquitous connectivity, vehicle electrification, and, ultimately, automated driving will combine to enable a range of mobility services, from on-demand buses to automated taxi services to first-/last-mile connections with transit. At the same time, cities are promoting the development of smartphone apps that let consumers select from all possible mobility options and pay for them through a single portal. These innovations will change not only how people move about in cities but also how cities are designed and managed.

3.5.2 Automated, Connected, and Clean Transportation

While there is significant investment in automated driving technologies, and considerable enthusiasm among the media, the public, and investors, the reality is that the challenges of making the technology work in a world of aging infrastructure, varying weather conditions, and wildly divergent economics will likely lead to much slower adoption than some optimistic projections. Navigant Research projects that 21% of the global vehicle fleet will be enrolled in automated mobility service by 2035.

Cities need to ensure they have the digital infrastructure to support the development of more connected and automated transport systems. Cities are already looking at the need to invest in their communications infrastructure—and notably the advent of 5G networks—but they also need to look at the data platforms required to provide integrated and optimized mobility services.

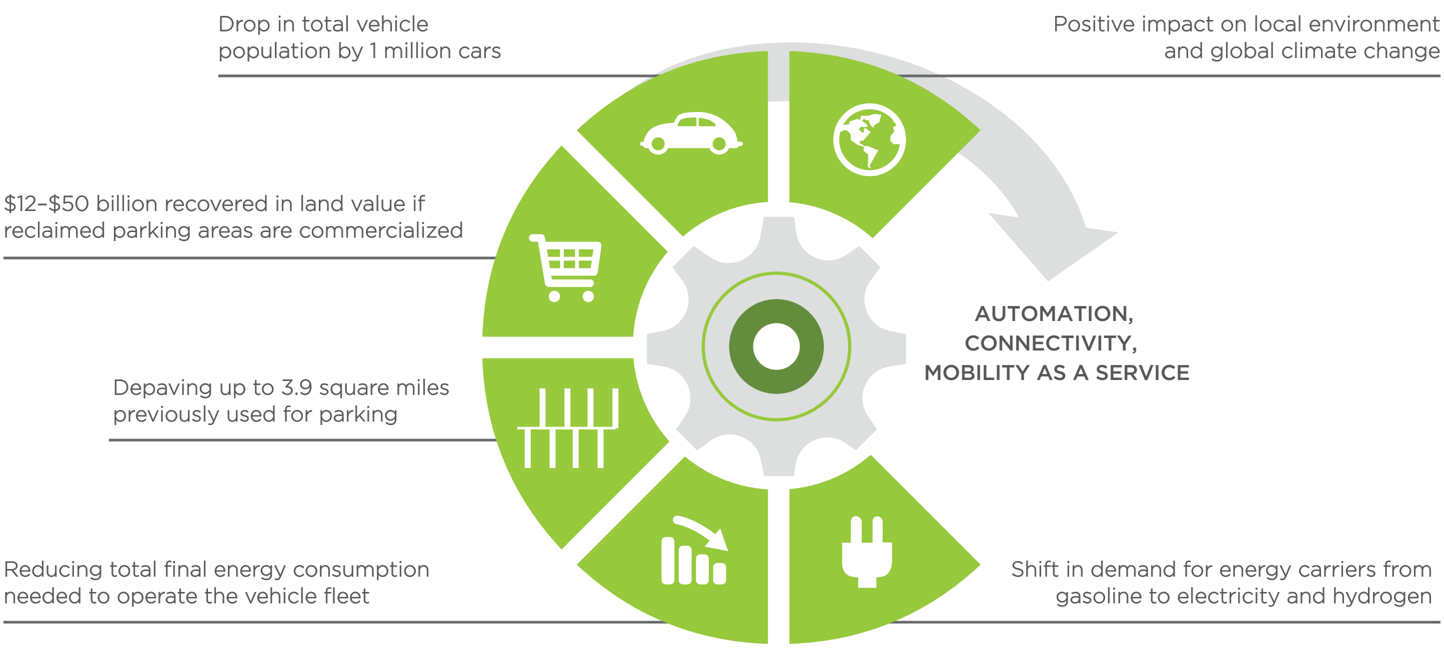
MILTON KEYNES, UNITED KINGDOM: INTEGRATING AVs INTO CITY MOBILITY PLANS

Milton Keynes is one example of a city looking at the integration of multiple facets of transportation innovation, including EV support, AV trials, real-time mobility data, and citizen mobility apps.

In October 2016, one of the first AV demonstrations in Europe took place in the town as part of a 3-year demonstration project. New protocols are expected to be developed for AVs, as well as the continued testing of the public reactions to both driverless cars and fully automated, self-driving pods for pedestrian spaces. The UK Autodrive project has announced a goal of having 40 of these pods operational as a limited public service by summer 2018. The first AI-enabled traffic management system in the world will be deployed in Milton Keynes by fall 2018. Supported by an Innovate UK first-of-a-kind grant, Vivacity Labs will install 2,500 video sensors to monitor major intersections and 13,000 surface car parking spaces to reduce traffic congestion. When fully deployed, the system will be able to dynamically prioritize emergency vehicles, buses, and cyclists when appropriate.

Milton Keynes is also promoting the concept of cloud-enabled mobility. A trial project connects users with real-time data to enable informed local travel decisions (e.g., booking and billing systems). The information is made available to the public via a citywide app. The next phase of the project will involve analyzing the findings from the user trial, as well as using MotionMap to enable new forms of public transport, including AVs and mobility on-demand.

IMPACT OF DRIVING AUTOMATION, CONNECTIVITY, AND MaaS IN A MODEL CITY



(Source: Navigant Research)

The leading cities are already providing an environment to test AVs in various forms, including private vehicles, taxis, and buses. This is not only a question of technology but also how AVs will transform city mobility options and spatial planning assumptions. Navigant analyzed a high adoption scenario of AVs into the total fleet in a model city with 3 million inhabitants who collectively own 1.5 million personal vehicles. Due to the synergistic effect between driving automation, connectivity, the MaaS model, and the switch to cleaner powertrains, significant improvements can be achieved in several areas of concern to city governments and citizens.

3.5.3 The Transportation-Utility Nexus

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

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

Automakers, energy aggregators, and charging network operators are partnering with utilities to incorporate EVs, providing a platform for energy services, demand response (DR), and grid ancillary services. By 2019, more than 220 MW of EV load in North America is expected to be available for DR or load shifting during the day.

3.6 The Circular City

To limit climate change by the end of the century to the 1.5 °C ambition expressed in the Paris agreement, annual emissions should stay below 39 billion tonnes CO_2e (43 billion tons CO_2e) per year by 2030. Compared to the business as usual scenario, there is a gap of 26 billion tonnes CO_2e (29 billion tons CO_2e). Climate policies already in place and committed to under the Paris agreement can deliver a reduction of 11-13 billion tonnes CO_2e (12-14 billion tons CO_2e). Of the remaining emissions, an analysis by Ecofys, a Navigant company, and Circle Economy estimate that circular economy strategies can contribute to further mitigating the emissions gap by about half.

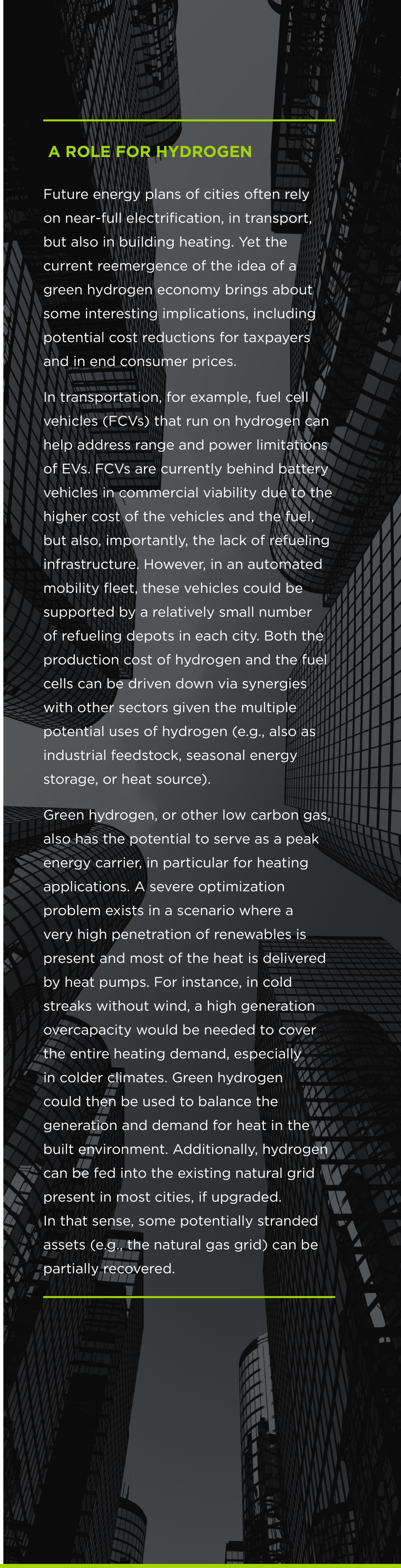
The circular economy describes the opportunities made possible by moving toward business models and policies that are, by design, regenerative and as waste-free as possible. The circular economy moves away from linear value chains based on take-make-waste and toward a circular approach that cycles products and materials many times and makes better use of existing assets. A circular economy strategy aims to increase prosperity while operating within the boundaries of a finite planet.

There are commercial opportunities for companies in adopting circular economy processes, but more importantly, there's an opportunity for society to redefine its relationship with resources. The intersection of the circular economy and future low carbon cities could unlock incredible positive environmental, social, and economic impact for a city or region.

The development of low carbon urban energy and transport services is a key element in the development of circular cities. But circular economy concepts also expand the concepts of sustainability to other aspects of city resource consumption, such as food production and the built environment.

A built environment based on circular economy principles would reclaim the inner-city land unlocked by a circular mobility system to create high-quality spaces where people would live, work, and play. The system would integrate green infrastructure (e.g., parks) with durable, mixed-use buildings designed in a modular way and constructed with looped and non-toxic materials. Buildings would have fully closed water, nutrition, material, and energy loops. They would be highly utilized, thanks to shared and flexible office spaces and flexible, smart, and modular homes. A report by Ecofys and the World Business Council for Sustainable Development studied eight materials that are responsible for 20% of global GHG emissions, 95% of water use, and 88% of land use. All circular economy measures related to these materials can substantially reduce GHG emissions, water use, and land use.

Even though transformation will happen to a large extent through new business-to-business or business-to-consumer solutions, governments and city planners can play an important role by providing a long-term perspective, investing in large-scale solutions, and developing new public-private partnerships. Amsterdam, for example, was one of the first cities to undertake a City Scan to identify key steps and significant opportunities that can help make it the world's first circular city. It is now home to a wide range of Circular Amsterdam projects. Peterborough in the UK has also set out an ambitious plan to be a circular city. Through Share Peterborough, an online, resource-sharing platform for businesses and other organizations in the city, members can share any available resources, including equipment, skills, spaces, and services. The platform now has over 100 members ranging from global corporations to local businesses and charities.



A ROLE FOR HYDROGEN

Future energy plans of cities often rely on near-full electrification, in transport, but also in building heating. Yet the current reemergence of the idea of a green hydrogen economy brings about some interesting implications, including potential cost reductions for taxpayers and in end consumer prices.

In transportation, for example, fuel cell vehicles (FCVs) that run on hydrogen can help address range and power limitations of EVs. FCVs are currently behind battery vehicles in commercial viability due to the higher cost of the vehicles and the fuel, but also, importantly, the lack of refueling infrastructure. However, in an automated mobility fleet, these vehicles could be supported by a relatively small number of refueling depots in each city. Both the production cost of hydrogen and the fuel cells can be driven down via synergies with other sectors given the multiple potential uses of hydrogen (e.g., also as industrial feedstock, seasonal energy storage, or heat source).

Green hydrogen, or other low carbon gas, also has the potential to serve as a peak energy carrier, in particular for heating applications. A severe optimization problem exists in a scenario where a very high penetration of renewables is present and most of the heat is delivered by heat pumps. For instance, in cold streaks without wind, a high generation overcapacity would be needed to cover the entire heating demand, especially in colder climates. Green hydrogen could then be used to balance the generation and demand for heat in the built environment. Additionally, hydrogen can be fed into the existing natural grid present in most cities, if upgraded.
In that sense, some potentially stranded assets (e.g., the natural gas grid) can be partially recovered.

4 DELIVERING ON THE VISION

4.1 The Urban Energy Cloud 2030

In Navigant's view, the 2030 energy landscape will be very different from today's:

- The Energy Cloud will be based on a mature set of technologies. Ubiquitous solar PV and energy storage create a customer-centric energy value chain where customers' consumption is largely met by self-generated electricity and economically traded among users.
- Utility-scale and distributed renewables account for 50%-100% of generation; DER uptake is widespread, accounting for the majority of new build capacity.
- High penetration rates of EVs put a strain on power network capacity, which is managed using pricing signals and automated DR. Buildings are also much more closely integrated into the dynamic grid (B2G) and use intelligent controls to optimize energy production and consumption.
- Data is as valuable a commodity as electrons. In 2030, the energy supply chain is fully digitized and its efficient operation is heavily based on analytics-based automation. This automation relies on significant volumes of data created by technologies within the Energy Cloud.
- The industry has undergone significant digital transformation. Data and artificial intelligence-based algorithms become important competitive differentiators. Data offers visibility into each prosumer's energy exports and imports, providing the fundamental basis of the TE market. This data also allows the newly formed distribution service orchestrators to actively manage the dynamic and volatile distribution networks, either through pricing signals or by actively interrupting the power supply.
- Utility business models have transformed from supply- to service-based. Rather than focus purely on the delivery of grid-sourced power, ESPs offer individualized products and services to suit their customers' specific needs. These services will include DER sales, maintenance, and aggregation; DR; energy efficiency initiatives; flexible, time-of-use charging; and TE platforms, as well as non-energy services as energy companies expand their footprint in other sectors.
- Energy markets are far more competitive in 2030 compared to 2017. The convergence of the traditionally regulated supply business model and deregulated, service-based model creates opportunities for new entrants and new business ventures of established energy firms. Many new service providers have entered the market—some successful, some not—seeking to exploit the new value streams from decentralized electricity.

This new energy landscape is mirrored by the development of complementary city platforms for IoT-based services, data-driven policy and operations, and the enablement of new innovations based on machine learning, blockchain technology, and robotics, for example. The transformation in city mobility enabled through AVs and MaaS capabilities will reduce city vehicle congestion, improve air quality, and contribute to the formation of zero carbon cities.

The convergence of energy and city innovation will lead to the development of new business models, standards, and regulatory environments that can enable multi-levelled orchestration services across this complex landscape.

Building the smart and sustainable cities of the future will be complex, challenging, and exciting. Success will depend on technological and policy innovations across several sectors and the creation of new forms of partnerships and collaboration. New business models will also emerge that are adapted to a platform-based digital economy, with the potential to scale more rapidly relative to asset- or service-based business models. This evolution will take many forms as cities and their partners adapt to local opportunities and challenges, but there are common elements in the journey that all cities will need to undertake in some form or another.

4.2 Recommendations for City Leaders and Other Policy Makers

Leading cities have now progressed from technology pilots to a focus on priority outcomes, the creation of demonstration districts, and the city-scale rollout of proven technologies. One of the biggest challenges is to understand the interplay between these different developments. What platforms—technical and commercial—will enable a digital, low carbon, sustainable economy to thrive? What forms of collaboration across sectors is necessary, and what common infrastructure is required? And how can new transportation services, zero carbon housing, local microgrids, and smart street programs address the issues facing poorer communities?

Several basic steps can help cities be better prepared to address these issues:

- City leaders and other policymakers have a role to play in enabling an environment that promotes flexibility and adaptability within the urban Energy Cloud. Cities should look to create platforms for collaboration and procurement on which cities and other stakeholders can drive innovation (technology and business models), develop business cases, execute pilots, and form partnerships to implement and scale new energy solutions.

ENGIE: HELPING CITIES TOWARD THE ENERGY TRANSITION

ENGIE, the global energy and service provider, recognizes the importance of cities and communities in the energy transformation as an increasingly important 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. ENGIE continues to evolve its offering to cities and communities and, in November 2017 at the Smart City Expo in Barcelona, it launched a new program focused on the creation of better cities today.

- Clear, actionable climate plans are necessary to realize the potential of local climate action. Local government often lacks public short- and long-term plans in areas where emissions will be locked in and choices are complex (e.g., district vs. electric heating, hydrogen vs. electrified transport, in-depth vs. superficial building renovations). There are several tradeoffs when considering each of these paths, but inaction will only delay the inevitable choice and reduce related short- and mid-term benefits.
- Cities need to continue to raise the bar on traditional approaches to urban design and construction. This includes embedding smart and sustainable design principles in urban planning processes. The potential of digital technologies needs to be considered as part of any new development.
- Pilot projects should be closely aligned to city priorities and assessed for business viability and for the potential for expansion. The focus should be on mainstreaming innovations and quickly scaling up positive pilot project results. Strong monitoring and evaluation programs should be an integral part of any pilot project.

The challenge for cities is therefore also one of orchestration. For city governments to create the conditions under which stakeholders can quickly move from developing a mutual understanding of each other's needs and challenges to co-creation of stable, scalable, and replicable solutions, there is no final endpoint determined by a single, engineered system. These complex environments need to evolve through a process of innovation, monitoring, and learning.

THE ROLE OF THE ENERGY SECTOR IN SMART CITIES

KEYS TO SUCCESS	THE ROLE OF THE ENERGY SECTOR
Strong leadership from government and city leaders is vital to coherent and sustainable smart city strategy.	Utilities should be active players in smart city leadership teams and stakeholder groups.
Building on existing assets to develop a distinct smart city vision aligned with local needs and goals.	Utilities need to help cities define their future energy roadmap. How to get from here to there to meet city ambitions?
Work with local communities in all aspects, from initial strategy to project design, deployment, and data collection.	Existing and new community energy projects should be included in all smart city programs. Energy innovations should benefit all.
Bring together public sector agencies, the private sector, and academia to form a network of partnerships.	Utilities and other energy players should be part of smart city networks—and catalysts for new types of collaboration.
Focus on innovative uses of data for policy development and the creation of new services.	Energy data is a valuable element in city data platforms. Utilities can be proactive players in shaping new data markets.

(Source: Navigant)

4.3 Recommendations for Utilities and Other Energy Companies

For energy firms, this evolution presents choices that link to other strategic decisions on their role in the energy transformation, including the split between regulated and non-regulated businesses, the provision of a portfolio of energy-related services and solutions, and the potential move into other sectors (including transportation). The evolution toward being an orchestrator across multiple domains is not the only path, but it is arguably the one with the greatest potential. Network orchestrator business models in other industries have proven faster growth, larger profit margins, and higher valuations.

To benefit from the development of smart cities and to play a leading role in their evolution, energy firms need to ensure their strategies are aligned with those of the city. In our assessment of smart city programs globally, Navigant has identified five common factors for successful smart cities. Each of these factors presents an opportunity for energy firms to establish their own place in these new urban energy ecosystems.

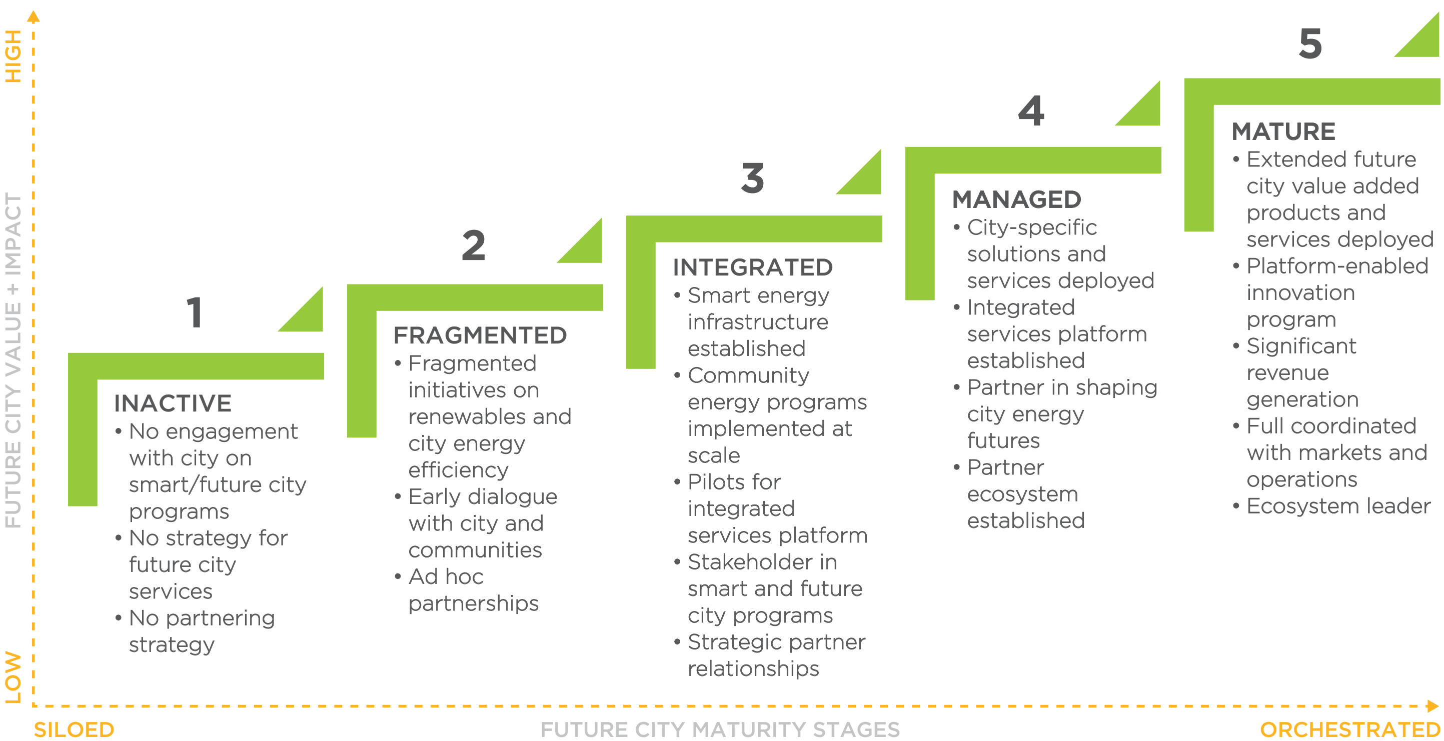
- **Strong leadership:** The leading cities have not only produced a guiding vision for a smart or future city, they are also embedding these ideas into their programs for service improvement and capital investment. Utilities need to be engaged in local smart city stakeholder groups and leadership teams and participate as active players in their development. Utilities bring unique capabilities and experience to support these programs.
- **A focus on local priorities and strengths:** Each city has its own priorities in terms of social, environmental, and infrastructure challenges, as well as distinct strengths in terms of its history and resources. Successful smart city programs build on those assets to develop a unique smart city vision that is aligned with local needs and goals. Utilities need to work with cities to define a future energy roadmap embedded in local realities. They can help chart a viable program for a city to turn ambitious energy and emissions targets into reality. They also need to demonstrate how energy-related services are connected to a wide range of city priorities such as social inclusivity, economic development, and environmental improvement.

- **Community engagement:** One of the biggest challenges for the further development of smart cities is increasing the direct engagement with citizens. Cities need to work with local communities in all aspects of their smart city programs, from initial strategy to project design, deployment, and data collection. A smart city strategy that does not engage with local communities has little chance of long-term success. Utilities have a unique connection to all city residents, which could provide a strong basis for furthering community goals as well as helping utilities improve and redefine their customer relationships. Utilities should also ensure that existing and new community energy projects are recognized as part of any smart city program.
- **Developing a new collaborative ecosystem:** Smart city solutions can only be delivered through a network of partnerships. The leading cities are notable for their ability to bring together public agencies, the private sector, and academia to address new challenges. Utilities should be key players in these emerging smart city networks and can be catalysts for new types of collaboration in the energy sphere. These new networks are also a key element in developing new services and business opportunities in the city of the future.
- **A data-driven transformation:** The rapid growth in the number of sensors and other intelligent devices deployed across the city landscape is creating an immense amount of new data that city departments need to manage and exploit to the benefit of all. Smart cities are looking at how they can better use that data to improve services and boost innovation. Energy data is a valuable element in any city data platform, and utilities should be proactive players in shaping new data exchanges and markets.

For utilities, this new urban energy ecosystem will drive the integration of multiple development streams toward new platforms for innovation and service delivery. While there are numerous subsidiary roles in this ecosystem—some very advantageous—the orchestration role presents the greatest opportunity for new revenue streams and value delivery.

The following figure provides a schematic view of how utilities and other energy players can evolve to play a central role in the urban energy ecosystem of the future. As well as outlining the evolution of technical capabilities and new business opportunities, the model also highlights the closer integration of the utility into the broader goals and strategies being developed for smart and sustainable cities.

FUTURE CITY URBAN ENERGY MATURITY MODEL



(Source: Navigant)

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