DESIGN FORESIGHT INITIATIVE

ENERGY STRATEGY PAPER

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EXECUTIVE SUMMARY

The Chicago region's energy system is central to its economy. It is also highly complex, composed of a vast and interconnected grid infrastructure, a multi-jurisdictional regulatory framework, and a diverse array of public, private, and nonprofit stakeholders. These two features necessitate that energy be included in any long-range planning effort for the region. This strategy paper's contents will inform *ON TO 2050*'s energy-related recommendations, both for CMAP and its partners.

In addition to its importance and complexity, the regional energy system is undergoing a significant transformation. Economic, environmental, and social drivers are creating a number of trends that are changing the sector, ranging from new technologies to shifting relationships between stakeholders. While many of them will benefit the region and its residents, they could also come with costs and disruptions. Effective planning and a holistic perspective are necessary to navigate these changes.

In collaboration with CMAP and a Steering Committee of energy experts, Foresight Design Initiative convened four working groups to discuss important topics in the sector. The working groups developed desired outcomes for the future of the regional energy system, and identified a number of strategies to achieve them. They include: capacity-building resources to empower and align stakeholders; policy recommendations; and innovations to existing programs. CMAP can play a central role in many of the strategies, while others are best led by relevant partners. These interventions are opportunities to capitalize on the evolution of the energy system, and maximize its economic, environmental, and social benefits for the region.

1 ENERGY IN *ON TO 2050*

PURPOSE

Energy is the invisible force that powers the region's economy. It moves goods and people, powers industry, lights homes and commercial buildings, and affects many quality of life factors. Consequently, the monetary and non-monetary costs of energy will shape future decisions about whether to work, live, and do business in the region. This system's importance makes its effective management crucial to any long-term, holistic planning effort.

In addition to being central to the economy, the regional energy system is highly complex. Nearly every sector, from manufacturing to real estate to consumer technology, has a stake in its cost. Meanwhile, the regulatory processes, markets, and physical infrastructure that influence prices and delivery cross jurisdictional lines and levels of government, and are always evolving in response to technological development, market innovations, and changing consumer demand. This preponderance of elements makes it challenging to initiate and implement significant changes.

Recent years have seen notable shifts, resulting in new opportunities. This paper explores and evaluates this ongoing evolution, and its potential effects on the region. It will discuss: the ways in which the region's energy system has changed in the years since *GO TO 2040*; outcomes that will maximize benefits for the region; and strategies that will contribute to achieving these objectives.

Key Terms
Where relevant, key terms and acronyms are defined throughout the paper.

CMAP'S ROLE

The complexity of the energy system demands a collaborative, cross-sector approach to managing and improving it. Many of the issues discussed in this paper are within CMAP's purview of transportation, land use, and related issues, but it also addresses areas that are under the jurisdiction of CMAP's partners. Each stakeholder group identified in Section 3 has a role to play; key implementers, including CMAP, are noted for the strategies in Section 5.

For the purposes of this paper, "the region" refers to CMAP's territory in northeastern Illinois, comprised of Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will counties. "Regional energy system" refers to physical infrastructure, regulatory frameworks, and market forces that directly impact the generation, transmission, and consumption of electricity. Due to difficulty in connecting with utilities in the natural gas sector, it was omitted from the scope of this paper.

DEVELOPMENT PROCESS

A five-member steering committee provided support and oversight for the development of this paper. Its members are:

- Andrew Barbeau, President, The Accelerate Group
- William S. Haas, Principal, Inova Energy Group
- Bradley Klein, Senior Attorney, ELPC
- Jane S. Park, VP of Regulatory Policy & Strategy, ComEd
- Rebecca Stanfield, Senior Director, Western States, Vote Solar

Foresight Design Initiative, a Chicago-based innovation studio, led the research process and produced content with input from the steering committee and four expert working groups. These focused on the following topics: building energy use, generation sources, transportation energy, and electricity infrastructure. The working groups contributed input on accomplishments in the past five years, desired outcomes, and implementation strategies. Appendix B contains a list of participants.

2 REGIONAL ENERGY SINCE *GO TO 2040*

CMAP's energy recommendations in *GO TO 2040*, released in 2010, focused on reducing carbon emissions. Its goal was to reach annual emission reductions of 119 MMTCO2 by 2015 and 47 MMTCO2 by 2040, the region's achievable contribution to stabilizing global temperatures by 2050. The plan recommended three high-level approaches to achieve this. Accomplishments from the intervening years include the following highlights, just a few of the accomplishments that are part of a larger evolution of the energy system.

LINK TRANSIT, HOUSING & ENERGY USE THROUGH LIVABLE COMMUNITIES

In the transit-rich Chicago region, reducing vehicle miles traveled (VMT) has been a key strategy for reducing carbon emissions from transportation. Transit-oriented development (TOD), which is anchored by train stops and other transit assets, has become a regional priority to mitigate car travel. The City of Chicago passed a TOD ordinance in 2015, and a number of suburban communities, including Evanston, Mundelein, and Elmhurst have also adopted the practice for new projects. Many municipalities have received support for local plans that advance sustainability from CMAP's Local Technical Assistance (LTA) program, which provides resources to help governments implement plans in accordance with *GO TO 2040*.

The shift towards more livable, energy-efficient communities has been catalyzed by new services, most notably car sharing, bike sharing, and charging infrastructure for electric vehicles (EVs). For example, Divvy, the local bike sharing provider with the largest service area in North America, reached 10 million riders in 2016 after three years of service. The City continued to build support for this and other services in its early 2017 update to the Sustainable Development Policy, which added bikeshare sponsorship, EV charging stations, and EV charger readiness to its menu of compliance options. The Congestion Mitigation and Air Quality (CMAQ) program and the Transportation Alternatives Program (TAP), both administered by CMAP, are significant funding sources for transportation investments that support livable communities.

Vehicle Miles Traveled (VMT)
The total annual miles of vehicle traveled per capita in a state or urbanized area.

Transit-Oriented Development (TOD)
The creation of compact, walkable, pedestrian-oriented, mixed-use communities centered around high-quality train systems.

FOSTER SUSTAINABLE PRACTICES & RENEWABLE ENERGY GENERATION

There are a number of accomplishments that have accelerated the development of renewable energy in the region. The 2016 Illinois Future Energy Jobs Act will have a significant impact on the adoption of renewable energy and energy efficiency practices in the region. Among many provisions, the bill modernizes and improves the state's renewable portfolio standard (RPS) that will drive further development, as well as an expansion of energy efficiency requirements and resources.

On the regional and local levels, the City of Chicago, Cook County, and Evanston have all led bulk purchasing programs to encourage photovoltaic (PV) solar adoption. Chicago's initiative resulted in 461 kilowatts of new capacity, along with over $600,000 in total savings on installations. Cook County received a $1.2 million grant for community solar demonstration sites in 2015, which will allow apartment dwellers, businesses, and nonprofits to buy into solar arrays rather than installing them onsite. While community solar is still emerging, it has the potential to greatly expand renewable energy access.

The LTA program has also advanced this goal by helping local governments outside of urban Cook County to develop sustainability plans. For example, the Park Forest Sustainability Plan, adopted in 2012, includes goals for advancing efficiency and renewable energy. The Metropolitan Mayors Caucus manages energy efficiency grant funds for member municipalities across the region, which have also committed to energy efficiency goals through the Greenest Region Compact.

Renewable Portfolio Standard (RPS)
A regulatory mandate to increase production of energy from renewable sources such as wind or solar. In Illinois, the existing RPS was adopted in 2007 and requires that 25% of the state's electricity be generated by renewable resources by 2025.

Photovoltaic (PV) Solar
Panels composed of silicon cells that convert sunlight directly into electricity.

Community Solar
A local PV solar generation plant whose benefits are shared by several energy customers. These community members pool their investments in exchange for power and/or financial benefits.

PROMOTE RETROFIT PROGRAMS

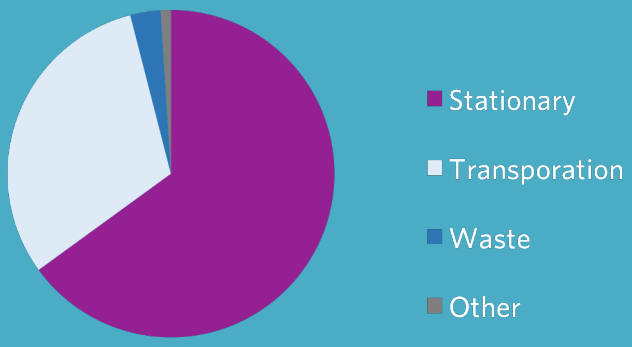
From 2010 to 2014, CMAP implemented Energy Impact Illinois (EI2), an alliance of municipal governments, nonprofits, and regional utility companies funded in part by a $25 million U.S. Department of Energy grant. Through financing and incentive programs for a variety of building types, EI2 cumulatively reduced energy participants' usage by an estimated 4 million kilowatt hours and 2 million therms of natural gas. This led to an annual reduction of 10,855 metric tons of CO_2 emitted in the Chicago region, and financial savings of $2.3 million among participants annually.

During this period, EI2 closely partnered with the City of Chicago, whose stationary energy sector, consisting of buildings and industrial facilities, saw a 10% drop in emissions between 2010 and 2015. This improvement can be attributed to a number of efficiency programs. The City's Energy Benchmarking Ordinance, which requires buildings larger than 50,000 square feet to disclose their energy usage, is one prominent example. Over 2,500 properties have reported, and those participating have seen improved energy efficiency ratings. Other government-led initiatives include the voluntary Retrofit Chicago program and public building retrofits across the City and Cook County.

3 SHIFTS IN THE REGIONAL ENERGY LANDSCAPE

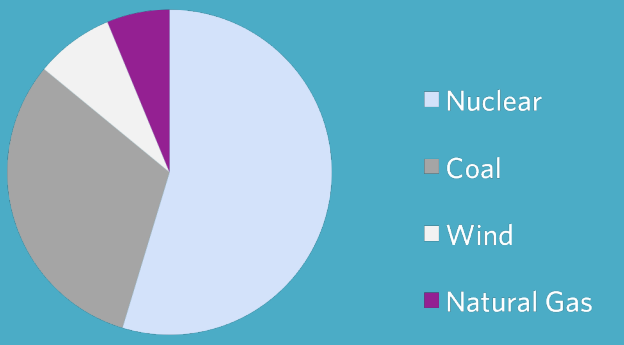
The regional energy sector is in the midst of potentially transformative shifts in how energy is generated, delivered, and used. This section will outline the various stakeholder groups involved, the high-level forces that are driving change, and key trends in the energy system.

REGIONAL ENERGY SYSTEM SNAPSHOT



Approximately 65% of the region's energy emissions are from the stationary sector, which includes residential, commercial, institutional, and industrial buildings. Transportation accounts for most of the remainder, with waste, water treatment, and agricultural sector emissions accounting for less than 5%.

Source: ICF International, Chicago 2010 Regional Greenhouse Gas Emissions Inventory.



Stationary sector emissions are due in large part to electricity consumption. In the state of Illinois, nearly half of generation comes from nuclear power, with the remaining capacity provided mostly by coal, wind, and natural gas.

Source: US Energy Information Administration, 2016.

STAKEHOLDER GROUPS & RELATIONSHIPS

ENERGY USERS

Every individual and organization in the region uses energy, whether in the form of electricity, natural gas, transportation fuels, or all three.

Small users include both single- and multi-family residential consumers, as well as small and medium-sized businesses.

Large users include large organizations that own or operate commercial space, industrial facilities, rail infrastructure, or vehicle fleets. Some, such as hospitals and data centers, have operations that are particularly energy intensive and acutely sensitive to reliability issues. Those in the private sector tend to be well-represented by industry groups like the Illinois Chamber of Commerce, and can be powerful advocates both for and against developments that impact them.

Governments are large energy users, but can be considered a separate category due to their unique and diverse portfolios, which include everything from public amenities like street lights to wastewater treatment facilities.

ENERGY SERVICE PROVIDERS

A large number of companies provide services in the regional energy sector, which range from generating, purchasing, and delivering power to helping users manage their consumption. Those directly involved in supplying and selling electricity can be grouped into the following categories:

Generation companies produce power through burning fossil fuels, nuclear fission, and harnessing renewable resources. For example, Exelon, through its subsidiary Exelon Generation, owns nuclear plants across Illinois and is based in Chicago.

Distribution utilities operate power lines and local substations that deliver electricity from generation sources to users. They typically serve as billing agents to energy users, and, in some cases, are municipally owned. ComEd is the electricity distribution utility for northern Illinois, including the Chicago region, and is a subsidiary of Exelon Corporation.

Retail suppliers purchase electricity from generation companies and resell it to users. While ComEd is the default supplier for much of the region, alternative retail electricity suppliers (ARES) offer different service contracts and generation mixes to consumers. Municipal aggregation allows local governments to buy power from ARES on behalf of residents.

Outside of these companies, a plethora of others provide products and services within the energy sector, from enabling technologies to system expertise. These include solar installers, engineering firms, energy efficiency contractors, and consultants.

POLICYMAKERS & REGULATORS

Decision makers at various jurisdictional scales play an important role in the regional energy system through policy and regulation. Federal agencies, ranging from the Federal Energy Regulatory Commission (FERC) to the Environmental Protection Agency (EPA), set high-level rules that can affect regional stakeholders in a variety of ways. Regional transmission organizations (RTOs) coordinate the markets through which capacity is bought and sold across state lines. The relevant RTO for the Chicago region, PJM Interconnection, oversees a wide geographic territory that spans from the East Coast through northern Illinois.

Many policies directly related to the Chicago region's energy system are made at the state level. The Illinois Public Utilities Act is the foundation for the state's regulatory framework, and the state's General Assembly has built on it over the years through legislation pertaining to the state's generation and distribution utilities. For example, the 2007 Illinois Power Agency Act first set efficiency and renewable energy portfolio standards, and formed the Illinois Power Agency (IPA), an independent body that manages the power procurement process for the state's distribution utilities. Other notable recent legislation includes the 2011 Electricity Infrastructure Modernization Act and the 2016 Future Energy Jobs Act. The Illinois Commerce Commission (ICC) enforces these laws, by reviewing and authorizing electricity rate changes and overseeing related legal disputes.

Municipalities and county governments can advance their own energy priorities, such as: building efficiency, through ordinances and codes; adoption of renewable energy, through bulk purchasing programs; and energy purchasing, through municipal aggregation. This latter strategy involves governments contracting directly with energy suppliers on behalf of residents, to offer lower prices or cleaner energy.

ADVOCACY ORGANIZATIONS

A variety of organizations advocate on behalf of specific communities, demographics, or issues that would not otherwise have influence within the market or in policy negotiations. As mentioned previously, CUB works statewide to educate consumers about energy and advocate for affordable rates. Groups like the Midwest Energy Efficiency Alliance, Illinois Solar Energy Association, and Wind on the Wires represent specific sectors. Numerous other organizations focus more generally on environmental issues at different scales, from the national (Natural Resources Defense Council), to the regional (Environmental Law & Policy Center), to the neighborhood-level groups that give voice to communities directly impacted by pollution. Others bring attention to issues facing low-income people and seniors, cohorts that are disproportionately affected by energy price increases.

EVOLVING RELATIONSHIPS

As the sector continues to evolve, the demarcations between these stakeholder groups are blurring. Both small and large energy users have more access to technologies like rooftop PV solar, EVs, and battery storage, complicating their traditional transactional relationships with distribution utilities. Utilities, in turn, are exploring new business models to account for this anticipated increase in distributed energy resources (DER) in Illinois. For example, ComEd is examining how DER, the proliferation of technology, and the ubiquity of data-driven insights will create a host of additional market participants, including entire communities, who will each seek to transact on the grid to develop their own energy-related solutions. Government agencies are simultaneously working to adjust regulatory processes for innovative services, while advocacy groups continue to search for ways to maximize benefits and minimize impacts for their constituents. The evolution of these relationships adds a layer of complexity to an already changing sector.

Distributed Energy Resources (DER)
Energy supplies and power sources that tend to be smaller than the typical utility-scale sources and are positioned closer to demand centers, frequently co-located customer sites. Rooftop PV solar arrays are a common type of DER.

DRIVERS OF CHANGE

While the changes in the regional energy system are happening at different rates and scales, they are rooted in several interrelated drivers that reinforce and complement each other.

MARKET FACTORS & PRICES

Over the past ten years, the nationwide markets for many new energy-related technologies have moved into maturity, or are swiftly approaching it. PV solar technology is one notable example. Installation costs have fallen by 67% since 2011, and utility-scale solar is approaching price parity with conventional generation sources. These trends have expanded the sector's role in the economy, with solar employment surpassing coal, gas, and oil nationally in 2016. Similarly, battery technology improvements have gradually reduced the cost and increased the driving range of EVs, whose widespread adoption could lead to substantial reductions in transportation-related emissions.

While the aforementioned cases are encouraging, market shifts can also threaten established industries and, consequently, the economies of entire communities. As natural gas prices have fallen, the nuclear plants that contribute power to the Chicago region and employ people across the state have faced competitive challenges. These impacts of otherwise beneficial market factors must be thoughtfully considered in any long-term energy planning efforts.

TECHNOLOGICAL INNOVATION

Technological advances are closely linked to market factors and prices, and are driving rapid change in the energy sector. In addition to the aforementioned examples, new software and hardware capabilities enable more sophisticated energy management tools, both for end users and utilities. For example, the "Internet of Things," which has revolutionized other sectors from telecommunications to transportation, allows faster and more automated communication between devices. It also facilitates collection of larger and richer sets of data, leading to more precise and strategic investment and action. These and other innovations have further catalyzed the deployment of energy system improvements.

CONSUMER DEMAND

Energy user dynamics complement these market forces. Individual users' priorities are as personal and diverse as the people themselves, and depend on their knowledge of energy issues, income, community, and political affiliation. During deliberations over energy-related issues at the local and state levels, a cohort of advocacy organizations with diverse constituents and missions give voice to concerns ranging from affordability to environmental impact. They include the Citizens Utility Board (CUB), community groups like the Little Village Environmental Justice Organization, and nonprofits focused on advancing clean energy and efficiency, among others.

Large energy users, from corporations to educational institutions, are also driving cleaner generation and energy efficiency through investment, public goals, participation in certification programs, and policy advocacy. Like their constituents, their motivations and priorities vary, ranging from public image to cost and security concerns. Initiatives like RE100, a coalition of corporations committed to working towards 100% renewable electricity, have sought to harness the collective influence of progressive companies and accelerate demand for new energy services on a larger scale.

As technological innovations offer users access to new options and channels to communicate their preferences, utility companies and other energy service providers have devoted resources to better understanding consumer desires. Research from sources ranging from Accenture to the Smart Grid Consumer Collaborative shows that customers want access to customized energy services, including cleaner generation sources, connected devices, and individualized recommendations to save energy. This shift towards an energy services model in which users play a larger role in managing supply and demand is an important driver of changes in the sector.

DEMOGRAPHIC SHIFTS

Beyond the individual consumer, the evolving composition of the region's population as a whole, and its geographic distribution, is a potentially important driver of changes in the energy system. Relevant macro-level indicators include age, income, race, and education level. As these features shift over time at the regional scale, they could affect the other drivers and accelerate or hinder existing trends.

While it is difficult to predict the exact long-term demographic changes and their effects on the energy system, a number of relevant scenarios could unfold with varying outcomes. An aging population, for example, might drive demand for more walkable communities, reducing transportation-related emissions; however, a migration of millennials from urban to suburban communities might have the opposite effect. These are just two examples of shifts with potentially significant impacts.

PUBLIC POLICY

Public policy's role is to manage the preceding drivers, shaping market forces to effectively meet consumer demand and account for external costs that are born by society at large. This has traditionally focused on maintaining affordable prices and mitigating some of the externalities of generation emissions. The latter includes both local pollutants, such as mercury, lead, coal waste, radioactive waste, and nitrogen or sulfur oxides, that directly harm public and environmental health, as well as greenhouse gases like CO_2 and methane that accelerate climate change. Public policy contributes to long-term economic security by preserving individual and environmental health and, consequently, quality of life.

While policy has been a powerful driver of change, it is also a complex process to manage. Comprehensive legislation like the Illinois Future Energy Jobs Act can take years to pass because of the number of stakeholder interests that must be negotiated. Moreover, effective implementation and enforcement are as important as the regulations themselves. The multi-sectoral and cross-jurisdictional nature of energy infrastructure thus requires government and private sector coordination over time, and action at different scales.

CLIMATE & WEATHER CHANGES

In part, renewable energy deployment and energy efficiency efforts are intended to mitigate climate change through emission reductions. However, it is not just the prospect of more severe weather patterns that is driving a transformation in the energy system. These meteorological shifts are already happening in the region. Intensified storm events require more resilient grid infrastructure, while longer and hotter summers increase demand for cooling and, consequently, electricity.

Like demographic shifts, these trends are foreseeable but ultimately difficult to predict with precision. They require stakeholders in the energy system to prepare for greater uncertainty and more extreme events, so that they are able to protect their own assets and the regional economy as a whole.

TRENDS IN REGIONAL ENERGY

A number of trends are affecting stakeholder groups and reshaping the regional energy system. While their impact and advancement rates vary, each of them fundamentally affects the regional demand and supply of energy, as well as the feedback loops that enable the system to function effectively. Together, they create uncertainty and enable a variety of possible outcomes.

RENEWABLE ENERGY DEPLOYMENT

Renewable energy's expansion in the region has been driven by the steadily decreasing costs of installation and the state's RPS, enacted in 2007, which mandates that 25% of energy come from renewable sources by 2025. Although problems with the original RPS limited its effectiveness, updates in the 2016 Future Energy Jobs Act are projected to significantly accelerate development. Its provisions will require 2,700 megawatts of new solar development by 2030, from a current capacity of less than 100 megawatts, as well as approximately 1,350 megawatts of new wind development, building on a current capacity of over 3,800 megawatts.

In addition to cleaner energy resources, renewable deployment holds promise for the region's economic development. The Future Energy Jobs Act establishes several new programs to ensure balanced renewable development across market sectors. These include the state's first community solar program, which will enable those without access to rooftop solar to subscribe to a shared project, as well as low-income job training programs and new incentives for solar development on contaminated "brownfield" sites throughout Illinois.

Beyond 2025, the ongoing expansion of renewable energy in and around the region will depend on effective planning, continued grid modernization, and energy storage deployment. Wind and solar are intermittent resources that may pose challenges to grid stability if they expand too quickly without additional storage capacity. Additionally, distribution utilities will likely find their roles changing, as they must account for the impacts of DER like rooftop solar, which are most often managed and operated by users. Thus, while this trend will bring significant benefits, stakeholders across the system must plan for these potential long-term costs.

TRANSPORTATION ELECTRIFICATION

Much as the growth of renewable energy enables reductions in stationary emissions, electrification of personal, fleet, and transit vehicles has the potential to reduce transportation emissions. While the EV market is still nascent, it has grown steadily in recent years, catalyzed by lower prices, increased driving range, and installation of charging infrastructure. Nationwide, sales increased 36% from 2015 and 2016, and analysts have predicted that EVs could be cheaper than traditional vehicles by 2022.

In addition to these market forces, EV adoption in the region has been bolstered by federal and state incentive programs, though the latter have been frozen due to budget issues. At the local level, the Chicago Department of Transportation (CDOT) provides resources and funding for electrification of taxi and truck fleets through Drive Clean Chicago, funded in part through CMAP's Congestion Mitigation and Air Quality (CMAQ) program. As of 2016, it has deployed over 400 vehicles and 220 fuel stations, reducing carbon emissions by a total of 2,850 tons.

Ongoing transportation electrification would require additional investment in charging infrastructure. This, consequently, would put new pressure on the grid, as projected charging patterns could drive up electricity demand peak usage hours. As with renewable generation, improved battery storage is potentially key to accelerating transportation electrification, allowing users and utilities to better manage energy storage and consumption.

BATTERY TECHNOLOGY DEVELOPMENT & DEPLOYMENT

Innovating and deploying battery storage technology could accelerate important shifts in the energy sector. In addition to increasing the range and decreasing costs of EVs, improved batteries would allow utilities and non-utility owners of DER to better store and deliver energy, mitigating large fluctuations in grid supply and demand. This capability can address both the intermittency problems of renewable energy, the potential demand spikes associated with EV charging, and other intensive uses.

The region has been a leader in research, development, and deployment of battery storage. ComEd hopes to incorporate storage into a potential Bronzeville microgrid project as part of its efforts to study the integration of PV with batteries in a microgrid context as part of a DOE SHINES grant. The utility is also launching Illinois' first community energy storage pilot, to test the use of battery technology for power outage mitigation in residential areas where customers experience service interruptions, particularly in extreme weather events. There have also been a number of private sector demonstration projects at local sites, including the S&C Electric Company facility in Rogers Park. On the innovation front, the Joint Center for Energy Storage Research (JCESR), a public-private partnership based at Argonne National Lab, is aggressively developing the next generation of storage technologies.

For residential energy users, especially those who have already adopted DER and EVs, private companies like Tesla Motors offer in-home battery storage options. As DER and transportation electrification give users a larger role in grid operations, both utility-scale and distributed storage will likely be important to successfully managing it.

GRID MODERNIZATION

The electric grid is in the midst of a shift from a centralized, one-way power delivery system to a network with greater flexibility and communication between users and suppliers. These infrastructural changes, ranging from smart switching and monitoring technologies to advanced electric meters, improve efficiency and reliability, while facilitating the integration of renewable energy and battery storage. ComEd is in the midst of deploying these improvements across the region, mandated and funded by the 2011 Illinois Energy Infrastructure Modernization Act (EIMA). As they are implemented, they will enable a variety of future possibilities, from new utility business models to a more integrated mix of centralized and distributed generation capacity. A number of regional and statewide initiatives have been launched to study these opportunities. For example, the upcoming ICC-led NextGrid process has the potential to explore their possible effects on regulatory, pricing, and technology deployment frameworks.

ENERGY MANAGEMENT PROGRAM EXPANSION

As described in Section 2, energy efficiency efforts across the region have included new regulations, transparency efforts, and capital improvements. Program implementers are seeking to build on these efforts by incorporating operational efficiency, expanding to new property types, and addressing embodied energy, resource reuse, and lifecycle analysis. Grid modernization has also opened up new frontiers in demand response (DR), which achieves energy efficiency by empowering users to manage their consumption. The precise and real-time usage data, enabled by smart meters, can be coupled with specialized management software and hardware to respond to utility signals and automate user decisions.

Demand Response (DR)
A program that encourages electricity consumers to reduce or shift their usage during peak demand periods through time-based rates or other financial incentives.

MICROGRID IMPLEMENTATION

Microgrids allow key infrastructure to be "islanded" from the larger distribution grid in the event of a disruption. They have the greatest potential for facilities that are especially vulnerable to service interruptions, such as hospitals, data centers, and wastewater treatment plants. While the regulation and management of microgrids is still in the very early stages in the region, the Bronzeville neighborhood has served as a test bed. The Illinois Institute of Technology operates a microgrid on its Bronzeville campus, and is collaborating with ComEd to study whether this infrastructure could be expanded to other local institutions.

FUEL SHIFTS

Market drivers outside of the region directly impact its energy portfolio. The fall in natural gas prices, driven by expansion of fracking across the country, contributed to the closure of the Fisk and Crawford coal plants on Chicago's West Side, as well as the financial issues of various nuclear plants across the state. Similarly, gasoline prices influence the growth of the EV market. Uncertainty caused by the supply of natural gas and oil will likely play an important role in the region's energy future.

TECHNOLOGY USAGE CHANGES

Young people's habits and preferences are often referenced as representations of the future of the energy system. However, it can be difficult to predict the permanence of these trends. Though low car ownership rates among millennials has been touted as an indicator of future fuel emission reductions, there are reasons to be skeptical of long-term effects. This generation may simply adopt later in life, or rely on ridesharing services rather than individual vehicles or transit.

Other changes in technology habits already appear to be having an effect on the sector. The rise of smartphones and mobile applications means that younger consumers tend to be tech savvy and have different expectations about services. If this trend applies to their energy usage, it could make them more open to automated demand response and other emerging utility services.

FINANCIAL INTEREST IN EMERGING ENERGY MARKETS

As the markets for new energy-related technologies mature, and large institutions commit to using them, they have attracted increasing support from financial institutions. Global investment in renewable energy, for example, reached a record $285 billion in 2015. However, international agreements to address climate change have been vital to accelerating market forces. Geopolitical shifts that divert resources and attention from these efforts could impact the energy system's capacity for continued innovation.

TIPPING POINTS

Long-term energy planning requires a holistic view of these trends and their respective influences on one another. There are a number of possible tipping points, from price changes to market penetration, that could significantly accelerate them, leading to an expansion of new technologies that would fundamentally transform the region's energy infrastructure. While it is beyond the scope of this paper to predict when and how they could occur, stakeholders must plan proactively for the future landscape that they would catalyze.

4 DESIRED OUTCOMES FOR THE ENERGY FUTURE

As the regional energy system evolves, its key role in the economy and the diversity of its stakeholders require that the transition be managed with prudent and well-considered outcomes in mind. While there will be tradeoffs between objectives, a vibrant energy future for the region requires a holistic and integrated approach.

1 CLEAN

A clean energy system minimizes the harmful byproducts of generation and use, including greenhouse gases and pollutants. Benefits include climate change mitigation and improved air and water quality that can contribute to public health. Creating such a future will require: widespread adoption of utility-scale and distributed renewable resources; proliferation of personal and fleet EVs; and an efficient built infrastructure designed to minimize any remaining fossil fuel consumption.

2 RELIABLE & RESILIENT

As mentioned in Section 3, extreme weather events, increased peak demands from rising temperatures, and transportation electrification could create technical challenges for the existing distribution grid. The future energy system must be designed to accommodate such new stresses to avoid disruptions, which can have a multitude of adverse impacts. Key elements include the application of smart technologies to ensure effective load management, battery storage to mitigate outages and reduce usage peaks, and cybersecurity measures to protect digital infrastructure. Building a more flexible and decentralized grid, including a mix of DER, microgrids, and utility-scale generation, could provide additional security against climate threats.

3 COST-EFFECTIVE

Improving the regional energy system has required significant financial resources, and will likely demand more. As they deploy infrastructure improvements and new technologies, utilities and other service providers must maximize return on investment and provide reasonable rates for customers. Innovative financing strategies, such as public-private partnerships and quantifying societal costs and benefits, could contribute to a more value-driven mix of system and technology investments.

4 AFFORDABLE & EQUITABLE

The transformation of the energy system comes with both costs and benefits to residents across the region. Research suggests that low-income communities spend a disproportionate share of their income on energy costs, and communities of color have historically been more exposed to the local environmental impacts of electricity generation. Thus, they must have equitable access to products and services to mitigate these issues. Understanding and addressing the financial, environmental, and social needs of these users, as well as other vulnerable groups like seniors, will be critical to avoid replicating existing inequities in the region's energy future.

5 USER-CENTERED

As the energy services sector expands, the existing system must evolve to simplify the user experience. Distribution utilities are already envisioning a shift to a platform business model, where a variety of options from multiple providers could be bought and sold in an integrated way. This type of structure could encourage innovation by allowing new companies to offer their services through trusted channels, and provide a streamlined interface for an array of offerings.

6 FLEXIBLE

The complexity of the region's energy system and uncertainty of its future demand that infrastructure and regulatory frameworks accommodate different scenarios. Large, static investments without alternatives could lead to stranded assets, resulting in higher long-term costs. By maintaining flexibility rather than committing to a single "lane" toward the future, decision makers can adjust to reversals in trends, such as demographic changes, economic growth or technological developments, that have an impact on regional energy prices. For example, unexpected population shifts to more walkable communities could impact the location and scale of EV charging infrastructure investments.

5 STRATEGY RECOMMENDATIONS

Navigating toward and achieving the desired outcomes will require managing change both within and across a range of sub-systems, including buildings, generation and distribution infrastructure, and transportation. The working groups described in Section 1 identified opportunities and recommended high-level approaches to evolve the regional energy system within the time horizon of the *ON TO 2050* plan, ranging from policy approaches to program innovations. CMAP has a central role in some of them, while others are best led by relevant stakeholders.

As described in Section 3, the relationships between stakeholder groups, scales of infrastructure, and technologies in the energy sector are evolving. Moreover, achieving all of the desired outcomes will require extensive coordination and planning. The following strategies have potential to build system-wide capacity to navigate complexity towards this holistic vision, and to facilitate the system-specific strategies.

1 STAKEHOLDER FORUM

Because energy affects all aspects of the region's economy, it is difficult for diverse stakeholders to reach a consensus on policy changes. Working group participants suggested that it could be valuable to discuss and collaborate on challenging topics in a neutral forum outside of the regulatory process. Models include the Illinois Energy Efficiency Stakeholder Advisory Group, which meets regularly throughout the year to discuss efficiency efforts, and the Illinois Smart Grid Advisory Council.

According to the working groups, these and other existing forums vary in their value for participants, and hold lessons for possible future efforts. They identified five criteria for effectiveness:

1. *Focus* on a specific energy-related issue or initiative;
2. *Incentive*, financial or otherwise, for stakeholder participation;
3. *Structure* that is clearly defined and appropriate for the focus, including leadership, facilitation, ongoing communication, and opportunities for meaningful input;
4. *Endpoint* for the forum to work towards, such as a deadline or output; and
5. *Capacity* to take initial steps toward implementation.

The Future Energy Jobs Act's implementation and the ICC's NextGrid process will likely yield many opportunities for multi-stakeholder discussions on pressing issues. The Steering Committee identified the following energy-related topics that could emerge in the near future:

1. Maximizing DER benefits
2. Assessing microgrid potential and role
3. Ensuring access to affordable clean energy for all communities
4. EV infrastructure planning

POTENTIAL IMPLEMENTERS

The specific organizations would depend on the forum's focus. However, each would likely require:

1. A convener and a neutral facilitator; and
2. Participants from relevant stakeholder groups, including utilities, other service providers, large energy users, and advocacy groups.

2 DATA MAPPING FOR TECHNOLOGY DEPLOYMENT

Grid modernization efforts and associated new technologies have introduced location-based variables into managing the energy system, and will continue to be deployed throughout the region in the coming years. Each of these types of investments can vary in economic, social, and environmental value depending on the specific sites and their surrounding communities. The working groups suggested that an accessible regional mapping tool for regional stakeholders, with the ability to layer relevant data sets from various sources, could make future infrastructure planning and deployment more cost effective and equitable. In addition to energy usage, these indicators might include outage frequency and sensitivity, exposure to local pollution, and property values.

Developing this type of tool would require a broad partnership between governments, private sector stakeholders, and nonprofits, with a long-term, trusted platform for hosting data sets. Cook County's community solar map, which shows the solar potential of specific land parcels, was created for future implementers with support from Elevate Energy, Environmental Law & Policy Center, and Metropolitan Mayors Caucus. A much larger collaboration, with additional support from utilities and other companies, would be needed to implement this type of tool for a wider variety of applications at the regional scale. Ownership, privacy, and security are concerns for many private sector data contributors.

The initial step for this recommendation would be to determine potential regional needs and use cases, identify relevant data sets, and determine how they might be effectively integrated and disseminated. Further opportunities for development could emerge from the Future Energy Jobs Act implementation and NextGrid process. CMAP was recommended as a host for publicly available regional data sets, which potential developers could draw upon to develop relevant tools.

POTENTIAL IMPLEMENTERS

1. Platform host; and
2. Data contributors, other relevant service providers, local governments, and related stakeholders.

3 COMMUNITY PLANNING & EDUCATION

ComEd's ongoing smart grid rollout and the Future Energy Jobs Act will bring new opportunities to advance the desired outcomes throughout the region. While the City of Chicago and Cook County are poised to take advantage of these, other municipalities across the region may face a variety of barriers. These include financial shortfalls and outdated building and zoning codes. If these issues go unaddressed, investments in a cleaner, more resilient, and cost-effective energy future will not be equitably distributed, which will inhibit the ability of the region as a whole to achieve desired outcomes.

Resources for education and technical assistance could help these communities work through complex processes, such as updating their building codes to promote energy efficiency, facilitating solar permitting, and installing EV infrastructure. Because of its reach and experience, CMAP is well-positioned to share best practices that bridge high-level energy goals and local concerns. Its LTA program should continue to incorporate considerations for desired energy outcomes into local planning work, including comprehensive plans, sustainability plans, and zoning and subdivision ordinance updates.

There are a number of other organizations that have a role to play in empowering communities. The Metropolitan Mayors Caucus has engaged municipalities across the region on energy efficiency, while local institutions like universities and hospitals are already investing in new energy resources. These stakeholders, in partnership with CMAP and ComEd, could serve as hubs for education and empowerment around energy issues, especially as infrastructure is deployed throughout the region.

POTENTIAL IMPLEMENTERS

1. Regional coordinating entity, possibly CMAP or Metropolitan Mayors Caucus;
2. Local partners, including municipal governments, universities, and community colleges; and
3. Utilities and other service providers.

4 INNOVATION HUB

Many emerging technologies that will affect the region's energy system, from DER to EVs, present regulatory, infrastructural, and cultural challenges that may present conflicts between the desired outcomes. Small-scale pilot projects could reduce the risks associated with disruptive changes, make the case for broader regulatory shifts and new business models to accommodate them, and introduce new technologies to the public to help make them more mainstream.

A number of existing energy services were piloted before becoming regular offerings, including real-time electricity pricing and smart metering. In addition to demonstrating benefits, these types of programs can spur investment from service providers, such as smart meter developers and solar installation companies, by giving them a foothold in the region. They can also serve an educational purpose, building organizational capacity to manage new technologies or programs.

The working groups emphasized that pilots must be carefully planned, implemented, and evaluated. Though financial resources will likely be available, a region-wide hub that provides non-monetary support to entrepreneurs could also be valuable for facilitating a broader array of projects. Services might include helping them through regulatory barriers, providing networking opportunities with other businesses, and coordinating resources from utilities and other investors. There are a number of local models for this type of hub, ranging from 1871 for general tech startups to Coalition: Energy for smart grid-related enterprises.

POTENTIAL IMPLEMENTERS

1. Regional coordinating entity, and;
2. Investors and technology partners, including utilities.

1 BUILDING ENERGY USE

As a large contributor to the region's energy emissions, buildings have been a priority for stakeholders. Efficient buildings contribute to a clean and cost-effective energy system, and with new technology can connect to the grid to contribute to greater resilience. Progress has been made to improve the region's building stock since *GO TO 2040* was released in 2010, and the Future Energy Jobs Act will create new opportunities for efficiency efforts. The Building Energy Use working group highlighted the following potential policy and technology approaches for further evaluation and study.

POINT-OF SALE EFFICIENCY REQUIREMENTS FOR EXISTING BUILDINGS

Enforcing energy codes for existing structures can be challenging. Policies that require efficiency improvements before an owner sells a building can be an effective strategy to achieve savings.

EXPANSION TO NEW BUILDING TYPES

While efficiency programs to date have been focused on structures like large commercial buildings, other property types like shopping malls, warehouses, and strip malls are a source of untapped potential. Educational efforts by utilities and other stakeholders should expand to include these property types and identify approaches to address their specific opportunities and challenges.

SMART GRID INTEGRATION

As new energy technologies are adopted more widely across large buildings, they provide an opportunity to play a larger role within the distribution grid. The working group indicated that policy incentives, technical assistance from ComEd, and clarification of data-sharing and security rules could encourage adoption of these devices and automation of demand response within buildings.

OPERATIONAL & BEHAVIORAL PROGRAM SUPPORT

Although the region's building stock is increasingly built or retrofitted with improved materials and technologies, efficiency still depends on everyday operational decisions made by tenants, owners, and managers. Financial resources for sharing best practices in these areas, in both individual buildings and across the sector, could enable advancements on the behavioral side of energy management.

HOLISTIC EVALUATION METRICS

Energy efficiency is typically evaluated in terms of primary impacts, such as kilowatt hour, therm, and financial savings. However, a number of secondary factors also influence a structure's total energy footprint, including water use, physical waste generated, and proximity to transit. The next generation of efficiency programs should incorporate and address this broader set of metrics.

CONSTRUCTION EFFICIENCY BENCHMARKS

In addition to continuing efforts for existing stock, local governments could continue to adopt advanced building codes for commercial and residential buildings. This would help set higher benchmarks for new construction and help mitigate their long-term carbon footprint.

POTENTIAL IMPLEMENTERS

1. Utilities: financing and implementation partnership
2. State and local agencies and regulatory bodies: code updates and enforcement
3. Building and trade associations, construction and architecture firms, and efficiency program implementers: implementation and training

2 GENERATION & DISTRIBUTION INFRASTRUCTURE

The widespread deployment of distributed and utility-scale renewable energy, along with grid improvements and battery storage that enable it, is key to a cleaner, more resilient, and more equitable future energy system. Although many of the accomplishments in Section 2 set a foundation for the region, further action is needed to capitalize on them and plan for longer-term efforts. The following working group recommendations could contribute to achieving both near-term regulatory benchmarks and the desired outcomes.

EFFECTIVE PURSUIT OF EXISTING OPPORTUNITIES

The Future Energy Jobs Act will accelerate progress towards the state's renewable goals for 2025, contributing to a cleaner energy system. However, achieving the other desired outcomes will require effective implementation of all of its provisions, ranging from community solar to development on brownfield sites. It also represents an opportunity to foster more collaborative relationships between service providers and advocacy organizations.

INCENTIVES FOR INNOVATIVE GRID INVESTMENTS

In the long term, cost-effective and equitable deployment of renewable energy, especially DER, will require utilities to invest in battery storage and other enabling technology. However, existing regulations and compensation frameworks designed for a centralized grid may not enable utilities and other stakeholders to fully capture the value of a more optimal grid design in the future as it evolves with DER. Further evaluation is needed on whether certain regulatory features would need to be adjusted to capture the multiple types of value that these improvements create, while minimizing financial disruptions to the existing market for new technology. States like California have already moved in this direction, compensating utilities for investments that avoid costs to the grid.

DISTRIBUTION SYSTEM PLANNING

As the grid evolves to enable investments by users and non-utility providers, such as energy management tools or DER, it will require greater transparency and more holistic planning processes. While it is important to appreciate and address security concerns with potentially publicizing certain location-related information about the distribution grid, a more integrated approach to certain limited aspects of planning and deployment of new resources could be important to pursuing the desired outcomes beyond 2025.

STREAMLINED DISTRIBUTED ENERGY RESOURCE ADOPTION PROCESSES

Although installing DER has become less expensive in recent years, the complexity of permitting and zoning requirements can deter both large and small users who would otherwise adopt. Various interconnection and application review processes managed by utilities could be further simplified and streamlined, subject to the need for maintenance of grid stability and safety.

REGION-WIDE SOLAR INCENTIVE PROGRAMS

The City of Chicago and Cook County have both offered bulk solar programs in recent years to reduce prices for users, in partnership with energy service providers and nonprofit organizations. These initiatives successfully accelerated DER expansion in these territories during their availability. Scaling and replicating these types of programs at the municipal and county levels could make renewable adoption more cost-effective and accessible for users throughout the region.

POTENTIAL IMPLEMENTERS

1. Utilities: Grid investments
2. Local and regional regulatory agencies
3. County and municipal governments: Local program oversight
4. Energy service providers: Technology deployment
5. Advocacy organizations: Community and industry representation

3 TRANSPORTATION ENERGY

There are millions of personal, fleet, and transit vehicles across the region, as well as a variety of urban and suburban development patterns dependent on different modes. This makes the transportation system more difficult to change than built infrastructure. The Transportation Energy working group discussed the following combination of strategies to advance the adoption of EVs, while supporting public transit to maintain cost-effective and equitable travel options for diverse communities.

RESOURCES FOR CURRENT AND PROSPECTIVE EV OWNERS

As outlined in Section 3, EVs are a potent opportunity to address vehicle emissions across the region. Price and range anxiety, or the fear of battery depletion during a trip, were noted as two major barriers to widespread EV adoption. While market factors should lessen these over time, incentives, educational resources, and deployment of charging infrastructure, for both fleets and personal vehicles, could accelerate the process.

VEHICLE AND TRANSIT ELECTRIFICATION INFRASTRUCTURE

Effectively electrifying vehicles and other transit assets, including rail, will depend both on adoption of requisite technologies and addressing any related challenges. Any plan for deployment of charging systems or electric locomotives, for example, should consider their impact on land use and the reliability of the distribution grid. Given its role in the regional transportation system, CMAP could help municipalities plan for permitting EV infrastructure and work with RTA to facilitate expanded Metra electrification.

EXPANSION OF PUBLIC TRANSIT AND TOD INVESTMENT

Reducing vehicle miles traveled by providing viable, if not superior, alternatives to car travel is important to both improving quality of life and mitigating emissions. The working group emphasized that continued investment in the region's existing infrastructure, from rail to buses to walkable neighborhoods, provides cost-effective, reliable travel options for communities of all income levels. It could also foster regional security and resilience by building redundancy into the transportation system. This has been a priority for CMAP since its inception, and will play an important role in managing the energy system's transition.

FREIGHT AND HIGHWAY EFFICIENCY

In addition to diversifying travel modes and fuel types, improving the efficiency of existing transportation infrastructure would contribute to the desired outcomes. The region's highway and freight rail systems could be enhanced by deploying smart technologies and pursuing policy-based efficiency incentives, such as managed lanes. CMAP could play an important role in implementation, and is exploring these topics in more detail in other working groups.

POTENTIAL IMPLEMENTERS

1. Various governmental bodies: Planning and regulation
2. Utilities and other relevant service providers: Technology deployment
3. Fleet vehicle owners: Adoption and advocacy

A HOLISTIC EVOLUTION

Both the larger trends described in Section 3 and state-level opportunities, like the Future Energy Jobs Act and the ICC's NextGrid process, could accelerate the transformation of the region's energy system. While it is possible that these strategies will be pursued effectively without a long-term vision and planning, the complexity of the energy system and range of desired outcomes could make this difficult. This strategy paper will integrate a regional vision into *ON TO 2050*, and serve as a platform for CMAP and its stakeholder partners to collaboratively pursue a vibrant future energy system.

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B APPENDIX

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