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POWERING SUSTAINABLE CITIES

KEY TRENDS AND PATHWAYS TO SUCCESS FOR CITY LEADERS



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Introduction:

As climate leadership has shifted from federal priority to a strategic decision often made at the local level, public sector professionals have risen to the task of developing and operationalizing long-term, community-scale initiatives within a rapidly evolving power sector landscape. But while clean electricity supply is at the core of most sustainable cities' plans. Many challenges remain. Drawing on the experience of energy industry experts and professionals from cities employing well-tested and emerging solutions, this paper outlines and interprets:

- **Global, regional, and local trends impacting cities' approaches to sourcing cleaner power**
- **How leading cities source sustainable energy**
- **Barriers, opportunities, and best practices**
- **Next generation sustainable power technologies to watch**

What Do We Mean by Sustainable Power?

Sustainable power, which we also call cleaner power, refers generally to electricity generation that is more efficient or lower in greenhouse gas emissions than the average grid electricity in the U.S. According to the Energy Information Administration (EIA), approximately 65% of U.S. electricity generation in 2016 was from fossil fuels, 20% from nuclear energy, and 15% from renewable sources. Sustainable power most often comes from renewable sources such as solar and wind (and sometimes hydroelectricity), but importantly, for the purposes of this white paper, we broaden the definition of sustainable power beyond renewables to include:

- Solutions that accelerate the transition to cleaner energy supply, such as battery storage
- Pathways that improve resiliency, such as microgrids, combined heat and power (CHP), backup generation, and other decentralized electricity systems, some of which run on natural gas
- Policy mechanisms that provide access to cleaner electricity for under-served populations

City policies and programs cover electricity supply — sources such as solar, wind, or conventional fossil fuel generation — as well as demand: the amount of electricity required to serve community needs. This discussion focuses on electricity supply, and does not address demand-side strategies such as building energy efficiency. It also ignores consideration of fuels for vehicles, transportation systems, and with one brief exception, heating and cooling of buildings — while these elements are integral to the broader sustainable power system, they merit their own analysis.

Disruption at Three Scales

Cities devising and implementing sustainable power strategies for their communities in 2017 do so in the context of dynamic, disruptive forces at three nested scales: Global/national, regional, and local.

Global and National Energy Market Trends

Massive Change

The electric power sector is undergoing massive change, and macroeconomic and political shifts are shaking up cities' relationships with sustainable energy.

- U.S. renewables are in many cases price-competitive with fossil resources
- Natural gas prices are at historic lows
- The U.S. Energy Information Administration (EIA) has identified 14 gigawatts of coal capacity earmarked for retirement through 2028 on top of ongoing plant retirements totaling many thousands of megawatts
- U.S. federal energy and climate regulations are shifting, and many, from participation in the Paris Climate Agreement to the Clean Power Plan, are being rolled back or relaxed

Other "game-changing disruptions" are also afoot, as outlined by the World Economic Forum:

- **Electrification:** The shift of vehicles and other traditionally fossil-fuel-dependent end-uses to electricity increases consumption aligned with renewable electricity supply
- **Decentralization:** Distributed energy resources such as solar, batteries, and energy efficiency disperse supply while helping control demand
- **Digitization:** Data-driven, "smart," and IoT technologies enable, at the very least, a reimagining of the energy customer experience

> *"We are trying to get things done now. We can't be waiting for the next great technology to come and save our lives."*
>
> **– City Sustainability Professional, Northeast**

Four Product Future

Transecting these megatrends, there are four broad categories of infrastructure investment and innovation that have the potential to support the transition to a cleaner energy future and the decarbonization of U.S. power markets: renewable energy, energy storage, controllable demand, and fast-ramping gas. This outlook is termed the "Four Product Future."

- **Renewables:** The only way to meet economy-wide carbon reduction targets is to dramatically increase renewable electricity production. The inherent intermittency of these resources will require investment in each of the following three elements.
- **Energy storage:** The ability to store energy during times of peak renewable production and tap into that power during periods with reduced wind or sun is key to a clean energy future.
- **Controllable demand:** Electricity demand from residents and businesses can be optimized to match conditions on the grid in real-time, ultimately reducing reliance on fossil fuels. An example is the increasing availability of "smart" appliances that can base run time on grid availability.
- **Fast-ramp gas:** Unlike nuclear, coal or older gas-fired power plants, state-of-the-art natural gas-fired generation can typically come on and offline multiple times per day and ramp in minutes. In combination with the above resources, fast-ramp gas generation can balance volatility in renewable generation.



Figure 1

[1] ERCOT data

Regional Regulatory Context

Regional power sector policies affect the economics and viability of sustainable electricity supply opportunities, limiting or expanding cities' options. While the system is beginning to experience change at the macro scale, cities are still at the mercy of their position in relation to three circumstances:

- Policies set by the surrounding grid operator and state
- City position in a regulated or competitive electricity market
- In regulated markets, affiliation with a forward-looking ("Utility 2.0") or more traditional utility

A few of the major regional regulatory initiatives driving strategies include:

- **Renewable Portfolio Standards:** At the state level, Renewable Portfolio Standards (RPS), enacted in 29 states and Washington, D.C., stipulate that suppliers provide a certain percent of electricity generation from renewable sources. RPS can drastically shift the market in favor of renewables. While there are important differences in how RPS is implemented in competitive and non-competitive markets, many states finding success implementing new renewables have used RPS as a tool.

  Massachusetts, for instance, increases its RPS 1% every year, signaling a consistent demand for new renewable resources, which has led to high-value Renewable Energy Certificates (RECs) and the addition of renewables. There are concerns, however, about a glut of supply and waning demand crashing the REC market in the state, quelling the substantial addition of renewables. In the meantime most communities have seen renewables increase as part of their fuel mix. In contrast, according to the Solar Energy Industries Association, Florida is an example of a state whose lack of RPS (combined with its prohibition of power purchase agreements), has hindered its solar growth.

- **Solar Rate Design:** Net energy metering (NEM) is a solar rate design that allows those who generate electricity from onsite solar power to be credited for feeding electricity they do not use back into the grid; customers are billed for the "net energy" they use. Amid varying levels of controversy, most states and many utilities have considered or implemented changes to their solar rate designs in the last three years to compensate for lost revenue and shifting of costs as distributed energy resources grow.

  Some states have revised their rates through compromise arrived at through a stakeholder processes. Others, like Nevada, eventually arrived at an agreeable legislative solution, but not before an unceremonious NEM rollback and a class action lawsuit brought by solar owners. This lawsuit alleged that the state and NV Energy misled customers by encouraging renewables development and then "conspired" to reduce incentives to reduce competition from solar.

  Value-of-solar (VOS) tariffs, currently in place in Minnesota and Austin, TX, also compensate customers for their generated electricity, but are calculated to more accurately reflect transmission, distribution, and avoided conventional infrastructure costs on the parts of utilities. Under VOS tariffs, customers buy energy at the retail rate and are compensated for solar generation at a separate rate, accounting for the benefits of solar minus its costs.

- **Utility Resource Plans:** Cities in regulated markets are, at a basic level, impacted by their utilities' plans for meeting demand. In some cases, that works in cities' favor: Investor owned utility MidAmerican Energy has announced its intention to provide 100% renewable energy to its electricity customers within coming years through increased investment in wind development. MidAmerican customer Iowa City, as a result, has the potential to focus on other sustainability priorities, such as curbing greenhouse gases from its landfill, since its own renewable electricity supply would be redundant if their electric utility follows through.

  Where a utility signals long term interest in convention fossil fuel generation or when city-utility collaboration breaks down, cities are more likely to take action to secure their own sustainable supply, often through independent renewables procurement. Some communities are signaling with grid-altering action that they are no longer satisfied with the pace of progress coming from their utilities, and shifting to Community Choice Aggregation models, discussed later in this paper. Others are taking uncommon action: the City of Boulder, CO, plans to break away from incumbent regulated utility Xcel Energy

to reach independently for ambitious 2050 climate and energy goals. The city received initial state Public Utility Commission authorization in September of 2017 to begin taking practical steps to create a municipal electric utility (such as purchasing power substations). This threat of "load defection," among other stimuli, is spurring utilities to modernize; adopt more renewables and storage; and incorporate new business models that rethink the role of distributed energy resources.

Carbon Pricing: Programs such as the eastern states' Regional Greenhouse Gas Initiative (RGGI) and Assembly Bill 32 in California focus on driving up the cost of carbon-intensive generation resources by pricing CO_2 emissions, giving lower-carbon resources a competitive marketplace advantage.

> *"We spend a lot of time informing and educating consumers, as if they will do XYZ if they just come to understand all the benefits. Obviously that's not the case. Instead, we have to step outside of our roles to think about what's important to the customer."*
>
> **– City Sustainability Professional, West Coast**

Community Priorities

Cities are increasingly challenged by residents, NGOs, regional and national coalitions, and other stakeholders to prioritize climate action and sustainable electricity supply goals. But they're tasked to do so within existing budgets and without shorting other city priorities, all while safeguarding reliable, affordable electricity for their populations. Budget structures, financial resources and spending priorities obviously vary.

Competing for Funds

Some cities report grappling with how to fund upgrades to aging infrastructure. Improving the resilience of those systems can sometimes pull attention and capital resources from the task of securing a sustainable electricity supply. In other cases, depending on budget structure, cities report using renewable energy contracts as a way to secure low-cost electricity and long-term price stability, freeing up operating funds for other uses.

Equity Focus

While a more sustainable fuel mix at the grid level has climate and air quality benefits for all, cities increasingly are seeking ways to remove embedded inequity in the distribution and pricing of onsite and community renewable energy resources. (For more information, see the section on equitable supply later in this paper.)

Support for Renewables

Support for renewable energy among city administrations has become widespread, and adoption is growing:

- In June 2017 the U.S. Conference of Mayors (USCM) put their support behind a (nonbinding) target of 100% renewable energy for cities by 2035
- Nearly 70% of cities surveyed by USCM and the Center for Climate and Energy Solutions (C2ES) already generate or purchase some clean energy
- As prices have fallen, renewable electricity has been decoupled from political ideology, bringing conservative-leaning cities into the sustainable energy fold
- Hundreds of U.S. mayors pledged to uphold the tenets of the Paris climate agreement following the signal of formal withdrawal of the U.S. from the accord

With elected officials rallying behind renewables as part of a sustainable energy strategy, cities report that current — and especially visible — solutions such as rooftop solar sometimes outshine higher impact approaches in the eyes of elected officials and community members, even in situations that don't pencil out economically, putting city sustainability professionals in a tough spot.

Renewable Energy Credits

A dynamic power sector and changing political winds have made certain formerly fashionable approaches more routine. Some cities rely on the purchase of Renewable Energy Credits (RECs) to meet sustainable electricity goals, either exclusively or to complement direct sustainable energy supply. They report that RECs remain an inexpensive and convenient option depending on source and quality, but many cities are shifting to sources that are direct and/or add additional renewable resources to the grid. The City of Houston, for instance, has purchased RECs to balance out its municipal government's electricity use since 2008, and uses more than 1 billion kWh of green power annually. Recently,

however, the city began supplying 10.5% of its electricity from offsite solar through a 20-year power purchase agreement (PPA). The city continues to purchase RECs to cover a combined total of 89% of its municipal electricity use.

5 Solutions from Leading Cities

Cities and counties are working inside and outside the typical channels to bring next generation sustainable power solutions to their communities. These five solutions, tested by leading communities, are entering the mainstream.

Community Choice Aggregation

- **What it is:** Community Choice Aggregation (CCA), also known as municipal aggregation or government energy aggregation, is a scheme in which local governments or other community coalitions pool their electricity load to contract for or develop electricity resources on users' behalf. CCA is not new — some programs have existed since the late 1990s — but as solar prices have fallen, a variety of new CCA schemes have emerged.
- **How it works:** Like for-profit retail electric providers in competitive electricity markets, community choice aggregators partner with existing utilities for transmission and distribution.
- **Benefits:** CCA appeals to communities in un-restructured, partially restructured, and competitive markets unsatisfied with utility pricing of renewable products and the speed of renewables integration. In most cases, CCA programs focus on delivering increased renewables content. Many of these non-profit entities also tout lower rates, local control, transparency, and the benefits of competition, and consumers opt in or out depending on the rules of each CCA.
- **Pitfalls:** Critics warn of potential price inflation and disagree with automatic or "opt-out" programs. Some state programs (such as Illinois) have been troubled by changes in transmission and distribution rate structures that make CCA less price competitive.
- **Early Adopters:** Seven U.S. states permit CCA. California, Illinois, Massachusetts, New Jersey, New York, Ohio and Rhode Island have enacted such legislation, and it is under consideration in Delaware, Minnesota, and Utah.
- **Case in point:** The California Community Choice Association (CalCCA), a growing consortium of CCAs in the state, projects a 2017 annual load of more than 10,000 GWh and a customer rolls of 915,000 accounts. Sustainable elements offered by members of CalCCA include programs to reward or incentivize electric vehicles, energy efficiency, and onsite solar, as well as programs intended to provide value for low-income customers.

District-Scale Energy Supply Systems

- **What it is:** Falling renewable energy costs and innovations in storage, controls, and tracking mechanisms have brought more sustainable integrated neighborhood-scale supply systems within reach for municipalities. While distributed generation is not new, advanced district energy supply systems that combine smaller, localized energy grids with defined loads are increasingly being adopted by cities.
- **How it works:** Most often implemented in a bounded area with an existing governance structure, district-scale energy supply systems integrate a generation source (such as solar), storage (batteries), and controls with the electricity load of defined user group — homes, businesses, and sometimes electric vehicles.
- **Benefits:** Given appropriate circumstances — often cases in which there is an element of municipal control or public-private partnership — neighborhood-scale energy systems benefit resilience and enable access to renewables, reducing emissions.
- **Pitfalls:** The new physical infrastructure involved in neighborhood-scale systems, as well as their hands-on, customized nature, can prove cost- or space-prohibitive.
- **Early Adopters:** Boston, New York, and Pittsburgh — whose mayor recently signaled an interest in linking multiple microgrids, and whose Almono development site will aim to incorporate new energy technology and a creative, resilient energy infrastructure — have been leaders.
- **Case in point:** The City of Santa Monica, with help from a $1.5 million California Energy Commission grant, is designing an "Advanced Energy District" at and around its City Yards project, the renovation of an existing city-owned site that hosts public works operations. The project aims to develop a microgrid featuring onsite renewable generation and energy storage, as well as EV charging and controls, to serve city-owned facilities at a 14-plus acre site and possibly neighboring private buildings.

Solar, combined heat and power, energy storage, small-scale waste-to-energy, and electric vehicle-to-grid technologies are being considered.

Community Solar

- **What it is:** Shared renewables – more commonly known as community solar, after its most popular generation type – allows one renewable energy installation to provide benefits to multiple customers, typically at the residential or small commercial scale.
- **How it works:** Community solar makes capital-efficient renewable energy possible in cases where behind-the-meter solutions are not: for renters and those with small, shaded, or otherwise inappropriate roofs.
- **Benefits:** A 2008 National Renewable Energy Laboratory (NREL) study found that merely 22-27% of residential rooftop area is suitable for hosting onsite solar, while 48% of commercial buildings have roofs too small to install solar to cover 20% or more of their electricity need. Community solar can also sidestep net energy metering rules, making it more cost competitive than onsite systems in some cases. Depending on the purchase mechanism (utility-sponsored, on-bill credited, or customer- or non-profit-developed projects), subscriptions can shield against rising costs. Depending on location and scale, projects can displace a dirtier grid fuel mix and improve local air emissions.
- **Pitfalls:** Because they are subscription based, new renewables are only added to the grid in the first round of subscription sales. Some jurisdictions cap the development of community solar projects at a certain number of MW.
- **Early Adopters:** Twenty-six states have at least one project, with a U.S. total of 108 MW installed through early 2017, according to the Solar Energy Industry Association (SEIA). California, Colorado, Massachusetts and Minnesota are leaders with growing programs and policies encouraging the arrangement are in place in 14 states. The trade organization Coalition for Community Solar Access, which promotes and facilitates community solar, has published a Policy Decision Matrix, a useful guidance document for designing community solar programs.
- **Case in point:** The Austin, Texas municipally owned utility Austin Energy initiated its community solar program for residential customers in January 2017 based on a rooftop array at a city-owned event center, with other neighborhood arrays planned. Subscribers pay a "Community Solar Adjustment" rate amounting to an extra $10-19 monthly for average users. The rate is fixed for 15 years, but subscribers are free to cancel at any time.

Equitable Energy Supply

- **What it is:** Recognizing that low-income populations and people of color are often disproportionately impacted by climate change, many cities are grappling with how to extend the benefits of sustainable energy supply to all. Despite falling renewable energy costs, cities are challenged to balance supply with affordability and access to those resources for low and moderate income residents.
- **How it works:** City approaches to equity in energy supply vary, from partnerships with NGOs and faith-based agencies to subsidies and grants to purpose-built Community Solar and Community Choice Aggregation systems that aim to address cost and access disparities. Communities have begun to explore financing tools tailored to communities underserved by typical models.
- **Benefits:** Sustainable electricity solutions such as microgrids and onsite solar that incorporate energy storage have the potential to protect vulnerable populations from the most visible effects of climate change, including extreme heat, while helping stabilize the expenses of residents living on fixed incomes.
- **Pitfalls:** Cities without robust existing programs to address equity may need to start from scratch, engaging stakeholders from the communities a city wants to support to define local issues and begin to confront diversity and inclusion before layering on the complexity of energy supply.
- **Early Adopters:** New York City Housing Authority, which provides public housing for 45,000, released a detailed plan in 2016 including renewable energy investment, climate resilience measures, and demand side interventions designed to improve energy efficiency and human health outcomes.
- **Case in point:** In early 2017, City of Los Angeles municipal utility Los Angeles Department of Water and Power established its Solar Rooftops program, in which the

agency pays homeowners $360 per year to host 2-4 kW solar arrays whose electricity feeds back into the grid. While there is no income restriction, residents in zip codes with least solar penetration were eligible first.

Decarbonized Thermal Energy

Note: this section represents a brief detour from power supply to highlight a sustainable thermal energy trend identified as a high priority by cold-weather cities.

- **What it is:** The search for decarbonized substitutes for fossil fuel-based heating in cold climates has led prominent cold-weather communities to consider everything from air and ground source heat pumps to sewage heat recovery.
- **How it works:** Wastewater from toilets, showers, and other sources as it makes its way through sewer pipes is typically about 60°F, depending on season and location. Using a heat pump, the heat from this wastewater is transferred to clean water without the two streams ever mixing, The preheated clean water then requires less energy to come to the temperatures needed for uses such as radiators. In warm weather, reverse heat pumps can use the 60°F water to dissipate building heat.
- **Benefits:** Given appropriate circumstances – often cases in which there is an element of municipal control or public-private partnership – neighborhood-scale energy systems enhance resilience and enable access to renewables, reducing emissions.
- **Pitfalls:** The new physical infrastructure involved in neighborhood-scale systems, as well as their hands-on, customized nature, can prove cost- or space-prohibitive.
- **Early Adopters:** Chicago, King County, WA (which includes Seattle), and the Boston area have installed or explored solutions. Urban Sustainability Directors Network (USDN) and Carbon Neutral Cities Alliance (CNCA) are behind an ongoing study in Boulder, CO, New York, Burlington, VT, and Washington, D.C. to develop large-scale, replicable residential renewable heating and cooling strategies. Thirteen "observer cities" will also contribute to the research.
- **Case in point:** Vancouver's Neighborhood Energy Utility provides approximately 70% of the annual energy demand of the Southeast False Creek community, including the Olympic Village, and is reported to reduce greenhouse gas emissions by more than 50% compared to a baseline case.

Tools and Technologies on the Horizon

Virtual Power Plants

Advances in sensors, software, and cloud computing have converged with accessibly priced solar energy and battery technologies to bring about virtual power plants, networks of distributed resources that are expected to provide 28,000 MW of capacity to the U.S. in the next half-decade.

Virtual power plants can be entirely grid-side or incorporate behind-the-meter generation and storage. Most integrate controllable demand technologies that are tailored to the needs of buildings that are tied together and remotely controlled by software and data systems. The goal of these virtual power plants is to collectively reduce customers' energy demand at peak hours and provide renewable energy supplies in targeted areas. This would allow utilities to offset some of the needs for power from conventional sources and avoid disruption on the grid.

Consumer Electricity-Sharing

The sharing economy principles that make possible AirBnb and Lyft are beginning to be applied to electricity. In Brooklyn, NY, the Brooklyn Microgrid (BMG) run by startup LO3 Energy has inaugurated what it calls "a peer-to-peer energy market for locally generated renewable energy."

Using the distributed digital ledger blockchain, BMG has made it possible for renewable electricity generators (in this case, residents and businesses with solar panels and specialized meters) to sell renewable energy (through a type of renewable energy credit) to their neighbors using a phone app, looping out the utility and opting out of net metering. The network is currently serving a small number of participants but shows potential to scale. Importantly, New York State's competitive energy market allows consumers to choose their retail electric provider, and state energy regulators are proactively changing rules to make distributed energy sources such as microgrids possible.

How They Built This: Advice from Leading Cities

Professionals leading city sustainability efforts shared the following tactics as tools that help them succeed:

1. **Dedicate staff resources** Leading cities report that few of their sustainability activities would be possible without at least one dedicated staffer to initiate, socialize, market, and support these efforts day to day.
2. **Employ your unique assets** Cities leading the charge on clean electricity know their strengths and leverage the resources they have to support their strategies. Cambridge, MA, where up to 1 in 10 residents is reported to have earned a doctorate, relies on their stakeholders. The city manager-appointed Climate Protection Action Committee, formed in 2000, supports implementation of the city's Climate Protection Plan. Many city sustainability professionals report collaboration with allies they've identified in other city agencies as a lifeline.
3. **Find funding** Cities lean on federal, state, and foundation grants to augment budget for sustainability projects when capital is scarce or unexpected opportunities arise. The City of Baltimore, for instance, recently used grant funding to hire an Environmental Defense Fund Climate Corps Fellow to draft an energy-focused strategic plan for city facilities.
4. **Access expertise** City sustainability professionals are often generalists, and they tend to know what they don't know when it comes to energy. When it's justifiable in a budget, they access consulting expertise. When it's not, they lean on regional and national networks for shared learning such as the Urban Sustainability Directors Network; the communities that form around benchmarking and rating systems such as STAR Communities, EcoDistricts, and 2030 Districts; and sustainability-focused forums for officials such as the Compact of Mayors.

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