Communities of the Future: Accelerating Zero Energy District Master Planning

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Communities of the Future: Accelerating Zero Energy District Master Planning

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ABSTRACT

Zero energy districts aggregate multiple buildings and optimize energy efficiency, district thermal energy, and renewable energy generation among those buildings so that on-site renewable energy can offset the energy use at a district scale. Zero energy districts have the potential to dramatically improve the economic competitiveness, resiliency, environmental quality, and energy independence of communities. The U.S. Department of Energy (DOE) Zero Energy Districts Accelerator (ZEDA) brings together district developers, planners, owners, national experts, and key stakeholders to develop the energy master planning documents needed for zero energy district development and replication. Through this effort, DOE is working with pioneering leaders to understand and address barriers to achieving zero energy districts. Each district partner will complete detailed energy master plans that provide the framework necessary to achieve ambitious energy goals. These complex projects represent billions of dollars of investment and are creating the communities of the future. ZEDA partners are using best-practice approaches to realize energy performance goals for the entire building and district life cycle. Their successful strategies will be documented and made available to promote replication in cities around the world that are setting aggressive energy goals. This paper introduces zero energy districts, reviews the structure of ZEDA, discusses the value of energy master planning, presents barriers to zero energy districts and how these are being addressed by zero energy district pioneers, and suggests pathways for wide-scale replication.

Zero Energy Districts

By 2035, 60% of the world's total building area is expected to be built or rebuilt (Architecture 2030). In addition, the global population shift to urban areas is accelerating: more than 54% of the world's population currently live in urban areas, and that figure is expected to be 66% by 2050 (UN 2014). These trends represent a unique opportunity to reengineer the way buildings and communities use energy and to minimize the negative impacts of that energy use.

Zero energy is the current state of the art for energy performance in individual buildings, and it is gaining traction in the marketplace. The zero energy concept can be extended to campuses, communities, and other collections of buildings such that the combined on-site renewable energy production—usually from solar photovoltaics (PV)—equals or exceeds the combined building energy use (Peterson 2015). Expanding zero energy to a district scale requires intensive planning from the beginning of the process and can provide access to numerous potential benefits that are not possible in individual zero energy buildings (Polly et al. 2016). Zero energy districts consist of multipurpose, energy-efficient buildings and use a variety of approaches to optimize energy use. For example, aggregating buildings' energy loads and using district-wide heating and cooling strategies that take advantage of waste heat can result in significant reductions in energy.

In addition, districts are valuable test beds for exploring new technologies and business models. Economies of scale, shared energy infrastructure, and efficiently coordinated operations

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can provide cost-effective energy-efficiency opportunities. A district might include tens to thousands of buildings—looking holistically at all these buildings and the supporting infrastructure can reveal opportunities to optimize energy demand reduction and renewable energy supply generation that are more cost-effective than is possible in individual buildings. Zero energy districts also have the potential to dramatically improve the economic competitiveness, resiliency, environmental quality, and energy independence of communities (Polly et al. 2016).

Economies of scale to improve efficiency can be realized by replicating high-performance design strategies among multiple buildings in a district, which can reduce design costs and improve quality assurance. Economies of scale also offer opportunities to purchase technologies, products, and services in larger quantities to drive down unit costs. Further, district and community design guidelines can serve as a district planning tool to increase local energy-efficiency requirements beyond local energy-efficiency codes.

Achieving zero energy can be challenging for certain individual building types because of high load densities and low ratios of roof-to-floor area (e.g., high-rise multifamily buildings) (Griffith et al. 2007). Approaching zero energy at a district scale can allow other buildings (e.g., warehouses with low load densities and abundant roof space) to balance these higher loads so that the district as a whole achieves zero energy.

Another advantage of a district zero energy approach is that the diversity of load shapes among buildings (e.g., time of day, days of week, months of year) can lead to additional savings by creating opportunities for waste heat recovery and energy sharing. Diversity of load shapes also helps maximize the return on investment for the shared energy infrastructure. For example, the capacity of a district thermal system might be smaller than the sum of the capacities of individual building heating, ventilating, and air-conditioning (HVAC) systems because the buildings' heating and cooling demands peak at different times. In addition, because of their unique occupant needs, some buildings might be operating in cooling mode while others are in heating mode. A district thermal system can allow waste heat from cooling in one building to be used for heating in another building, improving overall energy efficiency.

Integrating energy needs and supply across a district can make the entire district more resilient during grid outages. Districts can be designed to include backup power and islandable microgrids that maintain critical services in the event of a grid outage. Many strategies used in districts to achieve zero energy (e.g., highly efficient buildings, renewable energy production, energy storage) also increase the resiliency of the district.

Last, the district might be at a more advantageous scale than individual buildings for managing aggregate loads and interactions with the larger power grid. Shared district infrastructure offers multiple value streams, including controlling and reducing peak loads, managing renewable energy exports to the grid, and providing voltage and frequency regulation support; however, harnessing the potential for zero energy at a district scale requires a new approach to district and community planning, one that recognizes the value and importance of integrating zero energy district design strategies, business models, and operations approaches.

The U.S. Department of Energy Zero Energy Districts Accelerator

To support the development and refinement of this new approach, the U.S. Department of Energy (DOE) launched the Zero Energy Districts Accelerator (ZEDA) in late 2016. DOE Better Buildings Accelerators are designed to validate innovative approaches that can be scaled to accelerate investment in energy efficiency. Accelerators are structured as targeted, short-

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term, partner-focused activities designed to address persistent barriers to increased efficiency. ZEDA encourages the expansion of zero energy districts by partnering with district developers, planners, owners, and key additional stakeholders to develop the energy master planning documents needed to achieve energy goals during the lifespan of the project (DOE 2016). ZEDA brings together districts, national laboratory researchers, subject matter experts, and national organizations doing related work to explore and address issues facing zero energy districts (DOE 2018). The goal is to help pioneering partners take their projects further, faster while identifying and refining promising practices and successes to share more broadly with the market.

ZEDA participants meet monthly for working group calls to discuss their challenges, promising practices, and other topics of shared interest. Past discussions have covered district thermal energy systems, utility considerations for zero energy districts, business models for district systems, microgrids, procurement processes for high-performance buildings, and public-private partnership financing structures.

ZEDA is a three-year effort, which is a brief period compared to the long development timelines of large district projects. Given that participating districts are in the early stages of development, ZEDA focuses on working with partners to create their energy master plans, which—when well crafted—can support the many decisions that lie ahead for their projects. With a comprehensive energy master plan, partners can establish energy goals and develop implementation approaches that take full advantage of the cost and energy synergies possible across an entire district.

Importance of Energy Master Planning

Historically, sustainability efforts during district planning focused on topics such as managing site water runoff, creating pedestrian- and cyclist-friendly urban corridors, and integrating green spaces. Although these and similar initiatives are important, optimized energy efficiency is a key element in any sustainable design process. As the benefits of improving energy efficiency at the building level have become better understood, interest has grown in the synergies of extending those benefits to groups of buildings to achieve zero energy at a district scale. Energy master planning is a critical success strategy for zero energy districts.

Careful energy master planning ensures that energy is considered early and often throughout the process and is addressed in cost-effective ways. Currently, optimal district thermal systems, smart electrical distribution systems, large PV and battery storage systems, microgrids, and best-in-class energy-efficiency strategies are not always well understood and thus not sufficiently optimized during the district planning process. This is largely because of a lack of integrated energy planning and modeling tools for use at the district scale (Aghamolaei et al. 2018).

Zero energy district planners can ensure that the most cost-effective strategies are incorporated into the design guidelines by establishing aggressive energy use intensity targets during planning and procurement processes (Scheib et al. 2014). In addition, district-scale energy systems, particularly those requiring excavation, must be considered early in the development process to ensure that they align with other infrastructure efforts. For example, load density of district-scale waste heat recovery and thermal energy storage needs to be balanced with infrastructure costs and reduced building loads resulting from aggressive energy efficiency.

Developers must also determine early in the process how to maximize solar access at the site to take advantage of rooftop, parking canopy, and community-scale PV placement opportunities. If there is good solar access, they can determine the amount of PV required to

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achieve zero energy and then preserve access to that solar resource by minimizing shading from current and future buildings, trees, and other obstructions as well as allocating land for siting community solar.

It is also important to research and understand the local utility's interconnection rules to achieve an optimal electrical distribution design and avoid unanticipated utility charges. In projects for which microgrids and community resiliency centers are desired, integrating distributed generation and energy storage for both zero energy and energy surety (safety, security, reliability, sustainability, and cost-effectiveness) during outages should be included in the planning effort.

Based on DOE's experience with the ZEDA partners and national partners, a structured outline of the key elements of zero energy planning can help guide each district through the energy planning process. The detailed outline is provided in Table 1. Key sections include district vision and goals; stakeholders and community engagement; utility engagement; financial strategy and business case; energy strategy, including building-scale efficiency requirements and district-scale energy strategies such as district thermal planning and community-scale renewables; and operations and governance models.

Table 1. Zero Energy District Master Plan Structure

Primary Components	Key Elements to Address
District Description and Vision/Goals	• General description of planned district o Location, size, building types, uses, project timeline/current phase • Develop the general goals for the district (e.g., sustainability, resiliency, equity, economic development), and map how zero energy help provide a pathway to achieving those goals • Develop specific energy-related performance goals for the district, and the anticipated benefits of achieving the energy performance goals • Determine what "story" you want to be able to tell when all is said and done
Stakeholders/Community Engagement	• Identify the critical stakeholders, specifically related to the energy goals • Work to ensure stakeholders are engaged with respect to the energy performance goals • Propose how the energy performance goals can relate to the local community, such as economic growth, equity, and revitalization, and how to engage with respect to the energy performance goals
Utility Engagement	• Understand potential role for utilities in planning and/or ownership • Utility interconnection financial considerations • Incentives and pilot project opportunities • Opportunities for grid services • Access to data for benchmarking • Alignment of utility goals with district goals
Financial Strategy	• Potential ownership structure(s) • Conventional financing approaches • Alternative financing approaches • Scenario cost-analysis approach • Maximize economies of scale • Diversity factors in sizing • Quantify nonenergy benefits • Prepare building procurement approach to ensure that energy performance goals are met.
General Energy Strategy	• Definitions of energy-related metrics being considered/used (e.g., zero energy)

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Primary Components	Key Elements to Address

	• Energy modeling/analysis approach for different district design scenarios
	  o Existing consumption/benchmarking/minimum code scenario
	  o Alternative design scenarios
	• Building and energy systems retrofit/construction phasing strategy
	• Design guidelines and design advisory board
	• Utility interconnection technical considerations

Building-Scale Energy Strategies	• Building types and areas, including structured parking
	• Building efficiency levels for both new construction and existing building upgrades
	  o Relevant efficiency codes and targeted percentage reductions relative to code
	  o Energy use intensity targets
	  o Labeling/certification/recognition options
	    ▪ Residential: HERS, DOE Zero Energy Ready Home, ENERGY STAR® Certified Homes, LEED, Passive House, Home Energy Score, Home Performance with ENERGY STAR, etc.
	    ▪ Commercial: LEED, ENERGY STAR, ILFI Living Building Challenge, NBI, etc.
	• Building systems to interface with district systems
	• Solar access
	  o Available roof area maximization
	  o Solar-ready design guidelines
	• Batteries/load control for demand management and microgrids

District-Scale Energy Strategies	• Energy-efficiency characteristics of nonbuilding infrastructure
	  o Site and surface parking lighting
	• District thermal systems
	  o Load diversity and shared heat opportunities
	  o Centralized waste heat recovery opportunities
	    ▪ Data centers, sewer lines, shared ground wells
	• Large solar
	  o Parking canopy, community solar
	• Microgrids/batteries/load control at distribution/utility scale
	• Electric vehicle charging infrastructure and anticipated loads
	• Other sustainability strategies (e.g., water efficiency, waste reduction) and how they interact with energy strategy

Operations	• Identify who will operate/maintain energy systems • Determine how energy performance will be tracked o Understand if a public disclosure policy and ongoing benchmarking support this effort • Develop plan to ensure ongoing performance can be incentivized and/or required • Billing rate structure development and collections

Zero Energy Districts Accelerator Partners

As of May 2018, six district partners are participating in ZEDA. They represent diversity in the projects in terms of life cycle (new, repurposed, and existing communities), geographic location (New York, Minnesota, Colorado, and California), size (120–400 acres), and building types (commercial, light industrial, single-family home, and multifamily residential). The drivers

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for their ambitious energy goals include economic development, climate, innovation, equity, and resiliency.

In addition to district partners, four national partners with closely aligned expertise participate in ZEDA: Rocky Mountain Institute (RMI), U.S. Green Building Council (USGBC), EcoDistricts, and Xcel Energy. RMI is focused on providing expertise to the ZEDA district partners around innovative business models. In 2016, RMI published *An Integrative Business Model for Net Zero Energy Districts* detailing how pursuing net zero energy is not a cost but rather a significant value driver to district developers, parcel developers, and tenants that also creates a profitable business for an integrated energy services provider (RMI 2016). USGBC provides expertise related to their Leadership in Energy and Environmental Design (LEED) for Neighborhood Development process (USGBC 2014), and the USBGC Performance Excellence in Electricity Renewal system is the nation's first comprehensive, consumer-centric, data-driven system for evaluating power system performance (USGBC 2015). EcoDistricts provides planning and community engagement tools, such as Protocol and EcoDistricts Certified**,** which guide city makers to take a collaborative, holistic, neighborhood-scale approach to community design to achieve rigorous, meaningful performance outcomes that matter to people and the planet (EcoDistricts 2018). And Xcel Energy, a major U.S. electricity and natural gas company with operations in eight Western and Midwestern states, provides ZEDA district partners with a public electric and gas utility perspective. Within Xcel's service territory, there are multiple planned zero energy districts and 100% renewable cities, and Xcel is investigating novel utility partnering and planning approaches to support their customers in reaching these energy-efficiency and renewable goals (Xcel Energy 2018).

Following are summaries of each district partner project, which are adapted from project websites, publications, and project master plan drafts.

National Western Center

Location: Denver, Colorado
Size: 250 acres
Building/space types: Event centers, arenas, office, education
Building area: 2.8 million square feet
Description: *The National Western Center (NWC) is located on the historic grounds of the Denver Union Stock Yard Company, which currently hosts the annual National Western Stock Show convention. The redevelopment project will transform the area, doubling its footprint, with the goal of creating a sustainable, multipurpose campus that attracts visitors year-round. The project is aiming for a zero energy campus to include energy-efficient buildings and the development of on-site renewable resources by five years after full build-out. The project is a partnership between the City and County of Denver, Western Stock Show Association, and Colorado State University and is seeking innovative approaches to developing a technically and financially feasible campus-wide energy system to meet both thermal and electrical loads. The NWC strives to be an international model for an educational, research-and-development community to meet the needs of the 21st century* (City and County of Denver 2018).

Key Energy Opportunities:

- Potential for district-scale heat recovery from 72-in. diameter sewer pipes running above ground on-site
- Potential for advanced building controls that adapt to variable use of event and conference spaces

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- Large rooftops available for solar PV
- Engage with the private sector to form a public-private partnership to design/build/finance/operate the energy systems infrastructure for the campus.

Sun Valley EcoDistrict
Location: Denver, Colorado
Size: ~100 acres
Building/space types: Multifamily housing, office, retail, events centers
Building area: 1.6 million square feet
Description: *The Sun Valley neighborhood is Denver's lowest income area and home to less than 1,500 people. The majority are residents of the Denver Housing Authority's 333-unit, distressed public housing site located in the heart of the neighborhood. As a nonprofit master developer, the Sun Valley EcoDistrict (SVED) Trust will oversee the design and construction of district infrastructure and roadways during the next 10 years and deliver district-based energy to achieve zero energy within the "SVED Core." SVED is committed to delivering projects with a social return and an economic benefit to community members and the city as a whole* (SVED 2018).
Key Energy Opportunities:

- Planning to build high performance public and low-income housing that can achieve zero energy
- Through a request for qualifications (RFQ), SVED is seeking district utility partners that will help finance, build, and maintain district energy systems.

Ford Twin Cites Assembly Plant Redevelopment Site
Location: St. Paul, Minnesota
Size: 135 acres
Building/space types: Small, medium, and large multifamily residential; office; retail; civic
Building area: 2,400 to 4,000 residential units, based on the current plans
Description: *Located on the former site of a Ford Motor Company factory, the Ford Twin Cities Assembly Plant Redevelopment Site aims to become a mixed-use zero energy district during a 15- to 20-year period. The City of St. Paul has developed a master plan for the space, and Ford Motor Company is currently seeking a master developer to purchase the land for redevelopment. As Ford's former Twin Cities Assembly Plant is redeveloped in the coming years, the vision for the site is a connected, livable, mixed-use neighborhood that looks to the future with clean technologies and high-quality design for energy, buildings, and infrastructure. The City of St. Paul received thousands of ideas and suggestions during the past 10 years, and these shaped the backbone of the proposed redevelopment framework for the St. Paul Ford site. Energy goals for the project include resilience, innovation, zero energy, energy efficiency, and cost-effectiveness. The foundation of a sustainable Ford site redevelopment is a site-wide, integrated energy system that incorporates renewable energy sources and design efficiencies. The site will be redeveloped from scratch, starting with the installation of new utilities, streets, sewers, and water. This provides an unprecedented opportunity to design and install a comprehensive and integrated energy system using the best, cutting-edge technologies and systems appropriate to site conditions. Development of buildings on the site will follow the start of infrastructure and proceed in phases across the site, with total site build-out expected to take 12–20 years* (Saint Paul, Minnesota, 2018a; Saint Paul, Minnesota, 2018b).

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Key Energy Opportunities:

- Saint Paul has one of nation's largest district thermal systems, and they are exploring potential for a next-generation system within the district.
- Potential for aquifer thermal energy storage (Saint Paul, Minnesota 2018c).

Western New York Manufacturing Zero Energy District
Location: Buffalo, New York
Size: 148 acres
Building/space types: Office, light manufacturing
Building area: 80,000 square feet for first building; total district area to be determined
Description: *The Erie County Industrial Development Agency has recently acquired approximately 148 acres of the 994-acre Bethlehem Steel Redevelopment Area, the largest brownfield in the Buffalo, New York, Niagara region. The first planned project in the district is designed to be a large, zero energy, light industrial building to serve as a "lighthouse project" to attract more zero energy development. The project will advance sustainable building design and construction and will ultimately tell the story of resiliency, urban and industrial regeneration, and innovation. The building will feature more than 80,000 feet of mixed-use manufacturing and commercial office space and will be powered by solar, geothermal, and wind energy to produce as much energy as it consumes on an annual basis. As the first certified zero energy manufacturing facility of its size in New York State, the project will result in a state-of-the-art, dynamic facility to showcase new advances in renewable energy construction. The facility will serve as a valuable hub for construction education and performance testing, energy management, and workforce training for the remaining district build-out and the greater region* (Erie County, New York, 2018).
Key Energy Opportunities:

- Pursuing zero energy for light manufacturing building, with zero energy leases for tenants
- Lighthouse project to be a model for zero energy approaches
- Potential for on-site wind because of proximity to Lake Erie.

Huntington Beach Advanced Energy Community
Location: Huntington Beach, California
Size: 660 acres
Building/space types: Multifamily, community center, industrial, education, commercial
Building area: To be determined
Description: *Oak View, located in Huntington Beach, California, was identified by the California Energy Commission as a good candidate for an Advanced Energy Community (AEC) demonstration project. The goal of the Oak View AEC is to improve grid reliability and resiliency by achieving zero energy with on-site renewables and storage. Oak View is low-income and includes mostly multifamily residential rental properties. Additionally, it maintains a commercial school zone and an industrial area with an open-air municipal solid waste treatment facility. Phase One of the project involves producing a scalable feasibility study; community outreach; economic analysis, including sustaining business models; and identifying the potential for workforce development. The goal of the project is to develop tools that will help plan and design an integrated set of energy infrastructure technologies and advanced energy technologies in a Huntington Beach community. The research will integrate new energy innovations with the*

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existing community electric grids, infrastructure, and buildings to maximize the cost-effective use of renewable energy sources, reduce emissions in the community, reduce life-cycle cost of energy consumption for ratepayers, and improve grid reliability and resiliency (City of Huntington Beach, California, 2018).

Key Energy Opportunities:

- Pursuing dramatic energy upgrades for a disadvantaged community
- Aiming to address grid reliability concerns with battery storage and fuel cell integration.

Energize Fresno

Location: Fresno Business District, California
Size: 1 square mile
Building/space types: Retail, community center, industrial, education, commercial, residential
Building area: To be determined
Description: *Energize Fresno is an AEC project in the business district of Fresno, California. The master community design aims to respond to the city's challenges of economic hardship and rising electricity demand while leveraging the city's considerable momentum in reducing overall energy consumption and expanding its renewable energy infrastructure each year. It is intended to provide a community-focused roadmap to mobilize the development of high-performance buildings, improve the security of Fresno's energy systems, and support reduced energy cost burdens for some of the most vulnerable populations in the state. Through an 18-month master planning process, the project leaders identified an "Energy Opportunity Zone" that would comprise a portfolio of commercial and residential projects across a range of building types and residential neighborhoods, including 13 development sites, two activity centers, two program enhancements, and two electric vehicle charging proposals* (State of California Energy Commission 2018).

Key Energy Opportunities:

- Identifying existing new construction and retrofit projects that can be enhanced through additional lighting, HVAC, battery energy management systems, solar, and battery improvements
- Planning to implement a virtual microgrid across all projects to harness district-wide demand management and electric energy storage.

Challenges to Zero Energy Districts

Advancements in energy technologies—both in terms of performance and cost-effectiveness—have made zero energy feasible; however, financial, governance, and implementation challenges to achieving more widespread adoption of zero energy districts remain. Some of the challenges facing developers include finding analysis tools for scaling zero energy solutions from individual buildings to the district, overcoming resistance to setting zero energy goals, quantifying zero energy district benefits, engaging utilities, dealing with finance and governance structures, and ensuring performance over time. These challenges are exacerbated in districts with multiple owners compared to those controlled by a single entity, such as a corporate campus.

The number of zero energy buildings is growing nationally, and that growth is supported through resources such as building energy modeling software, Advanced Energy Design Guides (Bonnema et al. 2012, Torcellini and Pless 2018), and case studies. There are currently, however,

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few dedicated tools and little expertise to support scaling zero energy solutions from the building to the district.

Multibuilding and district zero energy projects require more advanced analysis than an individual building. For example, it is important to understand and optimize load shapes and peak load reductions that align district-wide demand with generation. This can be accomplished through passive building efficiency design strategies, dynamic building load management, and thermal and electric energy storage within the district. The skills and tools needed to perform this analysis are being developed, but they are not widely available.

District developers can be reluctant to set firm zero energy or similarly aggressive energy goals because of the uncertainties of cost and technical feasibility and the current lack of zero energy district examples. When energy targets are not set initially, creative solutions and beneficial trade-offs that might make zero energy possible might never be suggested. This can result in a chicken-and-egg scenario where solutions are not offered because energy goals were not stated. District developers want to attract competitive vertical developers (the entities that typically build the buildings) to invest in their district. This requires balancing carefully crafted development guidelines that ensure that the overall project meets energy goals with enough latitude to entice vertical developers to the project.

Zero energy strategies offer districts a pathway to increased resiliency, environmental quality, and competitiveness, but these attributes can be difficult to quantify and integrate into the calculations that support decision-making. Although cities, building owners, and tenants are increasingly setting goals around the same attributes that zero energy districts can provide—climate change mitigation, sustainability, resiliency, and energy independence, for example—the resources and processes to monetize these value streams and integrate them into business decisions are still nascent and underused.

As with any large development project, there are multiple points at which zero energy districts engage with their energy utility. These include historical energy data collection, load forecasting, incentive adoption, interconnection planning, tariff negotiations, and new generation integration. The strength of the district's relationships with the utility and the extent to which the utility's regulatory and business interests align with district goals often determine how these engagements proceed. Some districts report having difficulty engaging their utilities, notably around data requests and renewable energy planning. Utilities, for their part, cite privacy, outdated data management infrastructure, and bandwidth as reasons why data requests sometimes go unmet. Regarding renewable energy, although utilities might have existing energy-efficiency and renewable energy program offerings, their applicability to zero energy districts can depend on capacity and location as well as whether the district intends to retain the renewable energy certificates.

The technical energy planning efforts for district energy systems need to be balanced with practical governance and business models that support the financing, ownership, and ongoing operations of the systems. The planning, financing, phasing, and operation structure of district systems that service multiple entities can be quite complex and are often unique to each situation. This is particularly true for districts with many different owners and new developments in which there are few district energy system subscribers initially, but the number will grow over time. In these situations, there are several structural elements that need to be navigated, including how the systems are financed initially and how costs are recovered, who owns and operates the systems, and the best ways to phase construction, given that subscribership is expected to grow over time. Emerging approaches to these issues include system phasing of district thermal energy

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strategies to limit development and financing risks, partnering with third-party thermal and renewable developers and operators, and creating integrated district energy service providers to manage ongoing operations.

Even after zero energy and other energy goals are set, it might be difficult for master developers and other interested stakeholders to ensure that districts perform at levels consistent with their energy goals over time. This is impacted by the level of efficiency to which buildings are built, the development and integration of the renewable systems, and the ongoing performance of the district once it is occupied. In some cases, local governments provide incentives in the form of grants, density bonuses, expedited permitting, and financing to help zero energy districts achieve their goals; however, these incentives are typically provided toward the beginning of the project and are not linked to the final performance of the district, making it difficult for local governments to ensure that energy goals are met.

Promising Practices

ZEDA district partners are responding to these challenges through several promising practices. Districts are using building energy efficiency as a starting point in zero energy planning. This ensures that initial building investments maximize cost-effective energy efficiency, which reduces the renewables needed to achieve zero energy and "future proofs" the building against outdated technology and design approaches. This method works for specific new construction and retrofit projects as well as scalable approaches such as design guidelines with efficiency targets to cover all future build-outs in a district. Huntington Beach and Fresno, California, are following an efficiency-first loading-order approach by prioritizing large-scale energy-efficiency retrofits and deployments. SVED is building the district's first multifamily housing project to high efficiency standards and plans to create design guidelines to ensure that all subsequent construction follows suit. The first project within each district becomes a critical "lighthouse" project, becoming a model for the following projects within the district for how to best integrate cost-effective and aggressive energy-efficiency and renewable energy technologies.

Districts are also exploring innovative public-private partnership opportunities for designing, financing, constructing, owning, and operating zero energy district infrastructure through issuing requests for information (RFIs) and RFQs for utility service providers. In the summer of 2017, SVED issued an RFQ to select a utility service partner for district heating, electricity, water, and wastewater. SVED has used the RFQ to explore ownership and operational structure models for district-scale infrastructure and energy systems. NWC issued an RFI as a first step to finding a long-term energy partner to evaluate, finance, and manage the renewable energy infrastructure. By focusing their RFI on energy goals broadly, NWC allowed the respondents to propose creative technology and financing options to meet the goals. As a second step, NWC released an RFQ for a campus energy system provider with more specific terms.

Several districts are using strong community engagement approaches to ensure community support for the zero energy district development vision. Huntington Beach is actively engaging with the Oak View community through an education and outreach strategy in both English and Spanish. They even tailored a popular game to serve as an interactive way to explore and share energy-saving strategies. To gauge effectiveness, Huntington Beach will measure the energy and sustainability literacy of residents both before and after the program. The city of Saint Paul took a long-term approach to actively engaging the community in the process of redeveloping the Ford site. They created a 25-member Ford Task Force comprising citizens who

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have a variety of professional backgrounds; the group met 39 times during a 10-year period. In addition to more than 20 large public meetings, the City of Huntington Beach—at the request of community members interested in discussing the project—offered to hold small, local "pop-up" meetings, an effort that ultimately engaged more than 1,300 citizens in the process.

Although utility engagement remains challenging, some partners have anticipated the challenges and contacted their local utilities earlier than usual in the energy planning process. Utilities increasingly recognize zero energy districts as potential test beds to explore new business models, technologies, and services. NWC participated in Xcel Energy's Partners in Energy Program (Xcel Energy 2016), which focuses on helping cities within Xcel's territory do energy planning. The NWC program, however, was tailored to help specifically at the district scale, and this has fostered many important interactions between the NWC project team and Xcel Energy. Key zero energy district planning elements—such as benchmarks, energy use intensity targets, energy-efficiency strategy feasibility reviews, and information about the utility's incentive programs for efficiency and renewables—were provided by technical experts from the Xcel Partners in Energy Program. Although not always as formally as the NWC/Xcel approach, many other partners are interacting with their utilities earlier than usual in the planning process.

Conclusion

District approaches can offer cost-effective pathways to achieving zero energy along with its associated financial, resiliency, and environmental benefits. In addition, zero energy districts are being looked to by cities seeking to drive revitalization of unused industrial sites and to rejuvenate their urban cores and boost quality of life (RMI 2018). As leading zero energy districts work through the development of the energy master planning process, they are identifying promising practices to overcome common district-scale zero energy barriers. The emerging zero energy district planning loading-order approach includes targeting zero energy individual buildings by setting beyond-code energy-efficiency levels of 20%–40% for individual buildings, planning to connect to a phased shared district thermal ambient loop connected to a central waste heat recovery source or shared ground source wells, rooftop and parking canopy PV systems to reach zero energy for low-load and low-rise buildings, and community-scale shared PV to offset the remaining district load. Microgrids and energy storage are emerging strategies that are being layered into this overall approach as well. Although the ZEDA partners have identified the technologies needed to achieve zero energy districts, they will continue to develop replicable models to navigate the modeling, financing, and operational complexity of zero energy districts at scale.

Additional technical challenges to realizing zero energy districts at scale that will need to be considered in the future will include integration of time of use and grid interactions into energy-efficiency and renewable energy approaches and analysis tools. Modeling tools that allow users to perform building-to-building, building-to-district system, and building/district-to-grid optimization analysis will help provide districts and their myriad stakeholders the information they need to achieve zero energy. As the concept of zero energy district master planning matures and more successful zero energy districts are completed, approaches to financing districts, owning and operating district systems, and creating accountability structures for performance will emerge. For example, many districts are exploring the implementation of ambient district thermal heat recovery loops owned by third parties. As these systems are deployed, installation and operations cost, energy savings, and cost-recovery structures will need to be measured and verified so that best practices can be identified and shared. As zero energy districts integrate

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distributed generation into districts as well as the utility grid, they will need to find uses for excess solar production, perhaps including the electrification of heating and hot water loads in buildings, the incorporation of distributed energy storage, the electrification of transportation, and the addition of flexible building loads and controllable community-scale loads such as water pumping. Realizing the multiple value streams possible from these approaches will require tailored planning and design tools combined with innovative business and partnering models that account for the added value from aggregated grid services and enhanced resiliency.

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