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Distributed Renewable Energy: Anticipating Energy Development in Communities

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In the last few years, two significant trends have emerged in how we generate our electricity in the United States: a steady increase in the generation of power from renewable sources, and the integration of smaller, more dispersed facilities into a power-generation landscape that has up until now mostly consisted of massive, centrally located plants. This movement toward decentralized facilities, or "distributed generation," has thus far been gradual. However, the pace of change could speed up substantially because of a shift in how electricity generated from distributed sources — and how much of it — is allowed to be loaded onto the electrical grid.

Recent policy changes in cities and states across the country suggest that movement in this direction might be picking up steam. For example, in the spring of 2012, the California Public Utilities Commission (CPUC) essentially doubled the capacity of the state's net-metering program, which allows homeowners with rooftop solar systems to earn utility bill credits for power sold back to the electrical grid, while Vermont's 2012 Energy Bill more than doubled the amount of local, renewable energy it would allow to be brought online. In New York, the Long Island Power Authority (LIPA) launched a program that pays solar operators a fixed rate for electricity generated for 20 years. And the Los Angeles Department of Water and Power (LADWP) began accepting applications for a demonstration program that would tap into the more than 12,000 acres of recently identified rooftops within the LADWP service area that could host solar panels.

All of this occurred over the course of a few weeks. If these changes are representative of more widespread efforts and trends — and it appears that they are — we appear to be on the verge of distributed renewable energy facilities becoming increasingly visible and vital elements of our built environments.

One common denominator in the news from Vermont, Long Island, and Los Angeles is the involvement of the Clean Coalition, a nonprofit organization working on clean energy policy in the U.S. at the national, state, and local levels.

The Clean Coalition promotes CLEAN (Clean Local Energy Accessible Now) programs to facilitate the transition to local energy systems by revising the policy, regulatory, and financial structures that have generally limited distributed generation of energy. CLEAN programs influenced the recent developments in Vermont, New York, and California, and provide a useful example of how changes to legislative or regulatory policy can open the door for systems that utilize energy generated from a large number of widely distributed sources alongside, or even instead of, centralized power plants.

This *PAS Memo* defines distributed generation, discussing some of the primary benefits and obstacles to the distributed generation of renewable energy. It describes how regulatory and policy changes, including CLEAN programs, could set the stage for a substantial increase in distributed generation and presents considerations planners should make in anticipation of such a shift. Rather than occurring in the hinterlands, generation of energy, in one form or another, will increasingly be a part of the local landscape.

Small wind turbines power the Crissy Field Center in the Presidio of San Francisco, California. Photo by Josh Hohn.

What Is Distributed Generation?

As a concept, and in the context of the built environment, distributed generation (DG) is perhaps best defined by distinguishing it from its opposite: the "central-station" model. A central-station power plant is a large-scale facility, located in a single, often remote, location. The electricity it generates is transmitted over long distances to the load centers — typically urbanized or industrial areas — where it is consumed. The majority of our fossil-fuel and nuclear power plants have followed the central-station model, which makes sense in that it places locally undesirable land uses in locations removed from populated areas. A coal-fired power plant is not likely to be perceived as a neighborhood amenity.

Fundamental Energy Metrics: A Review

Most discussions of energy include terms that may not be a part of most planners' everyday vocabularies. Even concepts that are vital to understanding what a power-generating facility might mean for the built environment don't always translate beyond regions. For example, it is generally assumed that one megawatt of power generated and put online is enough to supply 750 typical homes in California at any given time. But California has some of the strictest energy-efficiency standards in the state, and ratepayers on average benefit from the coastal climate. Other factors, like the amount of space required to develop a facility of a certain capacity, vary by technology. A utility-scale solar PV developer, with current technology, could assume 6-7 acres of land would be necessary to develop a plant capable of producing one MW of power. Thus, 60-70 acres of land used for solar PV would provide power to about 7,500 homes in California. These numbers will vary from state to state based on local climate, efficiency standards, and other variables.

Before taking into account such variables, a review of fundamental metrics related to electrical power and energy can serve as a basis for better understanding the capacity and size of energy projects, regardless of location.

Watt W)	The basic unit of electrical power. The power rating of a typical incandescent light bulb = 25 to 50 W.
Kilowatt (kW)	One thousand watts. The power rating of a typical residential solar photovoltaic (PV) system is between 1 and 10 kW.
Megawatt (MW)	One million watts. The power rating of a large distributed solar PV system is between 1 and 20 MW. The power rating of a typical remote, central-station solar or wind plant is between 50 and 500 MW.
Gigawatt (GW)	One billion watts. The power rating of a typical large coal or nuclear power plant is between 1 and 2 GW.
Watt-hour	The unit of electrical energy (one watt expended for an hour). A 100-watt bulb

(Wh)	consumes 100 Wh in one hour.
Kilowatt-hour (kWh)	One thousand watt-hours. The yearly electrical energy consumption of a clock radio is 40 kWh.
Megawatt-hour (MWh)	One million watt-hours. The yearly average household electrical energy consumption in California is 7 MWh.
Gigawatt-hour (GWh)	One billion watt-hours. Approximately 300,000 GWh of electricity is consumed annually in California.

Source: Al Weinrub, ***Community Power: Decentralized Renewable Energy in California***

The current shift toward supplanting aging fossil-fuel and nuclear-energy infrastructure with renewable energy facilities has mostly followed the same central-station model. This is because large wind and solar facilities require massive amounts of land to generate the same amount of power as their fossil-fuel-based counterparts, and such land can be amassed only away from developed areas. In areas where investments have been made in renewable energy at the utility-scale level, large swaths of agricultural, desert, or otherwise minimally developed lands now host wind turbines, solar farms, or other facilities. Each of these technologies has the potential to dramatically affect landscape character and affect natural resources on site or adjacent to the project area. Increasing concerns about conversion of agricultural lands and biological impacts can lengthen permitting processes and stoke resistance to proposed renewable-energy projects. In addition, arranging a route for the transmission of energy from remote locations can be as challenging as siting the project itself. Transmission construction costs and easement-related requirements can be prohibitive, and without a connection to the grid, there is no project.

'Central-station' type wind farm near Palm Springs, California. Photo by Josh Hohn.

Power generated at central-station facilities must be transmitted over high-voltage power lines such as these, which run through California's Antelope Valley. Photo by Josh Hohn.

Distributed development of renewable energy projects serves as a counterpoint to the central-station model. Renewable DG projects are located near or within the developed areas likely to use the electricity they generate. Typical capacities run from 1 MW to 20 MW, compared with central-station renewable projects that can range from 20 MW to nearly 1,000 MW for the largest geothermal projects and solar and wind farms. Renewable DG facilities are most commonly solar-powered projects, though wind power, geothermal plants, small hydroelectric facilities, and biomass incinerators are examples of other technologies that can be developed at a smaller, more distributed scale. Rooftop residential and commercial solar installations smaller than 1 MW also have potential to be a part of a network of DG facilities.

Benefits of Distributed Generation

In the 2010 publication ***Community Power: Decentralized Renewable Energy in California***, Al Weinrub lists the benefits of DG. Underlying a number of them is the presumption of a Renewable Portfolio Standard (RPS), which has been implemented in California and more than half of the rest of the states in the country. An RPS requires that a certain percentage of a state's overall energy supply comes from renewable energy by a certain time. In California, the current goal is that 33 percent of commercially sold electricity will come from renewable sources by 2020. As of 2010, the California Energy Commission estimated that approximately 15 percent of the state's commercially sold electricity met that standard. Weinrub argues that central-station renewable energy projects, even state-of-the-art solar projects in the Mojave Desert, simply take too long to permit and connect to the electrical grid, and that the RPS goals will not be met by relying solely on projects of that size. Instead, a larger number of smaller DG projects, which can more quickly be brought online, will be required to meet the RPS target.

The following are among the other benefits of DG detailed in *Community Power*:

- **DG is increasingly cost effective.** The economies of scale associated with central-station power projects can be offset almost entirely by environmental and transmission costs. Plummeting prices — particularly associated with solar energy — increase the feasibility of smaller projects.
- **DG provides local, equitable economic benefits.** Billions of dollars of capital investment will be required to bring enough renewable energy projects online to meet goals. The greater degree to which projects are decentralized, the greater the possibility that costs related to sales, installation, and maintenance could be integrated into local economies, particularly if labor is locally sourced.
- **DG minimizes the environmental impact of renewable energy.** Solar facilities can be placed on existing structures and fragmented or previously disturbed lands can be utilized by wind or solar generation. Little to no new transmission infrastructure may be required.
- **DG provides increased energy security**. The failure of a centralized power source can

affect entire communities. With decentralized generation, there is less of a chance of disruption to the entire system when either a power plant or transmission line goes down. Widespread distribution of many smaller systems results in a more resilient energy supply.

In addition, DG factors prominently into two current trends in energy and community planning: Smart Grid initiatives and EcoDistricts. Smart Grid initiatives seek to improve the reliability of the power grid through a variety of measures, including in-home energy management, demand response, time-of-use pricing, and integration of renewable energy. Decentralized sources of power help stabilize available energy for the Smart Grid, which in turn helps to counterbalance the variable, intermittent nature of renewable DG, namely solar and wind. EcoDistricts, as **defined by the Portland Sustainability Institute**, are the outcome of a comprehensive strategy to accelerate sustainable development at a neighborhood scale, integrating buildings and infrastructure with community and individual actions. Locally generated energy provides energy autonomy and resilience for EcoDistricts.

There are clear links between DG and issues that are of concern to planners. In addition to the explicit or implicit environmental, permitting, and economic development factors just discussed, the placement of decentralized renewable-energy facilities in urbanized areas invites a host of social and physical considerations. Renewable energy facilities, on balance, don't elicit the emissions-related concerns that fossil fuel plants do, but the crude placement of a block-size "solar garden" in such a way that it partially divides an existing community could substantially undo some of the positive associations with renewable energy that an urban area might otherwise enjoy.

Beyond the practical matters of available space, environmental conditions, and a location that provides interconnection to the electrical grid, renewable DG projects must be thoughtfully sited. Permitting such projects should be no more complex than any other mechanical project, and rooftop projects, for the most part, require even fewer permitting considerations. So why is it that distributed renewable energy projects, which can be easily deployed and could quickly begin reducing our collective demand for the burning of fossil fuels, are not more prevalent? Why are there not arrays of solar panels on the roofs of warehouses and factories everywhere? Why do we not see more wind turbines or biomass converters on the agricultural lands that ring our cities?

The Williams Building in downtown Boston has a 30-kilowatt solar system mounted on its roof. Photo courtesy DOE/NREL.

Barriers to DG

In general terms, barriers to DG are most prominent at two separate points in the development process. The first has to do with interconnection, both in terms of ability to load generated electricity on to the grid and the financial terms under which such electricity is sold. The planning profession has limited influence, if any, over this part of the process. The interconnection of a "wholesale" DG (WDG) project, in which electricity generated is sold to a local utility, is a process that can vary by utility — and even by application within a single utility. Because it is typically an opaque and unpredictable process, it is typically expensive.

On top of that, legislative or regulatory policy can limit or prohibit interconnection. Current net metering arrangements in most states, based on existing regulations, emphasize energy savings as opposed to establishing revenue streams for investors. This limits development of most rooftop solar to individual residences that are able only to reduce their utility bills; any electricity generated in excess of what is needed by the residence cannot be sold back to the local utility. Large properties that consume little energy and tenant-occupied rental properties lack incentives to invest in the installation of DG systems. Any developer of a WDG would face many of the same risks as developers of large central-station projects without the benefit of the larger potential return on the initial investment. All of this can make it difficult to attract financing for WDG projects.

The second barrier is the permitting of the physical project. In many communities, existing plans and zoning ordinances do not anticipate renewable energy facilities. It can be difficult to determine a clear path for permitting even a rooftop solar project based on existing codes. Projects that would develop a site with a renewable energy project (a collection of ground-mounted solar panels on a vacant lot, for example, or a neighborhood-scale geothermal or biomass facility), could be subject to an extended review process and additional costs because of a technical incompatibility between energy generation and the site's zoning. Renewable energy technology typically results in fewer impacts than many existing plans and codes envision when restricting "energy generation," such as gas and coal-fired facilities.

A 5-megawatt photovoltaic solar array sits atop the City of San Francisco's Sunset Reservoir. Photo courtesy San Francisco Public Utilities Commission.

On top of these issues, development of DG could be accelerated by developers able to leverage costs by developing a number of sites under one agreement with the local utility. If sites are located in different jurisdictions and there is little consistency between the jurisdictions in development regulations and permitting requirements for such sites, some of the financial efficiencies — and therefore incentive — will be lost.

Clearing the Path for Renewable DG

There are a number of organizations and initiatives focused on eliminating or reducing the first set of barriers described above, including the federal government. The U.S. Department of Energy (DOE) **Rooftop Solar Challenge**, part of the DOE's SunShot Initiative, is an effort to make solar electricity cost effective for homeowners and businesses. Participating efforts throughout the U.S. are evaluated on a series of action areas, which include interconnection processes, financing options, and net metering and interconnection standards. Progress is reported on the SunShot Initiative's **Solar Energy Resource Center** so that success in reducing the initial barriers to this type of renewable DG can be documented and potentially replicated by jurisdictions elsewhere in the country.

The Clean Coalition is another organization working to eliminate interconnection-related barriers through its **Local CLEAN Program Guide**, which comprises a series of modules designed to "help communities and local utilities evaluate, design, and enact CLEAN Programs based on global best practices and the expertise developed by the Clean Coalition while designing and advocating for local CLEAN Programs throughout the United States." As described by the Clean Coalition, a CLEAN Program, when implemented by a local, regional, or state jurisdiction, requires a standard and guaranteed contract between a renewable energy facility owner and the utility purchasing the facility's power. The rate at which the utility purchases the power is predefined and fixed for a long duration; typically, the utility will purchase all energy delivered by the generator to the utility's electrical distribution grid for 20 years.

The CLEAN program approach utilizes the primary advantage of the feed-in tariff, a mechanism that has been popular throughout the world as a means of stimulating renewable energy development. Germany, for example, saw the proportion of its nationwide energy generation from renewable sources jump from 5 percent to 20 percent between 1991, when a feed-in tariff was adopted, and 2011. Under CLEAN contracts, access to the grid is ensured by requiring the utility to predefine preferable locations for interconnection and present processes, costs, and timeframes so that all are transparent. A key component is having effective policies for adjusting prices in relation to market response. Judging from the early successes described in the introduction to this article, the Clean Coalition appears to be finding that sweet spot.

Other creative approaches related to net metering and financing are taking hold as well. In Colorado, for example, Xcel Energy has launched the Solar*Rewards Community initiative, which allows residents and business owners to purchase access to solar power without installing solar panels on their homes or businesses. The ability to invest in solar power, and the potential to gain from such investment, is available to property renters and those without access to enough sunlight to install panels themselves. This "community solar" arrangement was made possible through state legislation. Also in Colorado, a Property-Assessed Clean Energy (PACE) financing program has allowed property owners to invest in renewable energy on their properties with borrowed money that is typically repaid through a special assessment on the property.

The number of efforts and initiatives breaking down existing interconnection and financing barriers to DG are growing. As certainty grows for homeowners, business owners, and developers interested in installing DG projects, so will the need to adequately anticipate the planning and permitting activities required to do so.

CLEAN Programs Nationwide

The Clean Coalition cites a number of examples of CLEAN programs in the United States in which the primary incentive for development of renewable energy systems is certainty in the price paid for energy sent back onto the grid. The programs in Gainesville, Florida, and the state of Vermont are two of the more long-standing programs by now, while the CLEAN program in Palo Alto, California, has just recently been announced.

- **Gainesville, Florida**. In 2009, Gainesville already had a commercial solar net-metering rebate program, which paid solar project owners with upfront cash but provided little incentive to maintain systems and ensure continued energy production. Planners with Gainesville Regional Utilities (GRU) replaced the existing program with a CLEAN program based on the European Feed-In Tariff model, the first such model in the U.S. for solar energy. The key was to provide the highest rate of renewable energy deployment at the least cost per kilowatt-hour generated. Implementing the CLEAN Program resulted in a more than 2,000 percent growth in the city's cumulative solar PV capacity and the addition of around 260 jobs over two and a half years, with an increase in electricity bills of less than 1 percent. GRU has filled all 32 MW of its CLEAN project allocations through 2016, and there is currently a multiyear waitlist for the program.
- **State of Vermont.** Vermont adopted the first statewide CLEAN program in the United States. Enacted in 2009, the program had an initial goal of stimulating 50 MW of new renewable energy generation. Applications for more than 172 MW of projects were submitted within the program's first eight hours of operation. Contract prices are based on the cost of generation plus a reasonable profit for the energy producer, and differ based on year and technology. As noted at the beginning of this article, the project capacity for this program was doubled in the beginning of 2012. The initial cap of 5 kW per installation was increased to 10 kW, which essentially opens the program up to larger residential installations and smaller commercial projects.
- **Palo Alto, California.** Launched in 2012 by the City of Palo Alto Utilities (CPAU), a municipal utility, Palo Alto CLEAN will purchase up to a total of 4 MW of capacity from solar resources in 2012, with minimum capacity per installation of 100 kW. While rooftop and carport-top systems are most appropriate for the CPAU service area, ground-mounted systems would also be allowed and there are no limitations on the type of solar technology used. CPAU expects to expand the program size starting in 2013 and may include other types of renewable energy and a larger range of eligible project sizes.

One important point to note: while Vermont's installation limits were only recently increased to 10 kW of capacity, Gainesville's initial specifications were for 1 MW maximum capacity for ground-mounted solar projects and 300 kW for building or pavement-mounted installations. Palo Alto's program requires a *minimum* of 100 kW. Assuming somewhere around 10 watts per square foot of solar panel, this means that 10,000 square feet of space would be required for a current solar PV system. Technology, including solar panel efficiency, is constantly improving, but the minimum size currently established by CPAU implies the development of relatively large DG facilities.

Source: Clean Coalition: ***www.clean-coalition.org/***

Planning for Distributed Generation

Assuming the continued successful implementation of mechanisms that create incentives for or otherwise enable DG, such as financing initiatives, feed-in tariff-based programs, or CLEAN programs, we will begin to notice more of it in areas where interconnection to the grid is feasible. What will this look like? Incorporating electricity-generating capabilities into new and existing structures will provide more renewable energy generation without substantially altering anything more than a building's roof or facade. This is especially true for solar and micro-wind installations, which are the most common technologies at this scale. But a wide variety of renewable technologies with different space and structural requirements could eventually become feasible, and the characteristics of preferable sites will vary.

A wind turbine in downtown Cleveland. Photo courtesy DOE/NREL.

What, then, are the best approaches to integrating renewable DG facilities into existing or planned communities? What is the best location for different types of projects, and what urban design principles could help facilitate the assimilation of new infrastructure into these areas? To what degree might DG factor into a community's economic development plans or climate action plans, and what are the implications for public health? Could a cluster of wind turbines on a community's periphery function as an informal greenbelt? Would CLEAN contracts allow for "pop-up" solar on temporarily vacant urban lots? Will our future parks also be our urban power plants?

These questions and others like them indicate both the possibilities and the uncertainties surrounding DG and the built environment. First, however, communities that want to prepare for or pursue renewable DG should consider a broader set of questions:

- *Is your community as energy-efficient as possible*? There is tremendous value in the energy capacity found not by adding generation facilities but by reducing waste. A **June 2012 study by the American Council for an Energy-Efficient Economy (ACEEE)** concluded that beyond ensuring that homes, offices, and public facilities are energy-efficient, almost a quarter (22 percent) of current U.S. energy consumption could be replaced by what experts are calling "intelligent efficiency" — efficiency that operates within systems. In this case, systems include transportation systems and even entire cities. "Intelligent" or not, the comparison between a jurisdiction and a single home is appropriate here; you shouldn't put a single solar panel on the roof of that home until you know that the electricity generated will be used efficiently.

- *What renewable DG technology makes sense for your general location*? What natural conditions exist and might dictate the projects that could reasonably be anticipated? Cities such as Los Angeles and San Francisco have studied solar energy potential to the extent of identifying specific rooftops ideal for solar. Understanding solar resources, wind flows, proximity to water bodies (including the ocean and its tides), or the availability of biomass waste, for example, can help prepare for future projects, whether they are proposed by a developer or by the city or its utility.
- *Do you work in an area that has already planned for renewable DG?* Renewable energy ordinances, urban design guidelines, energy efficiency plans, and even plan updates have been implemented in various jurisdictions in the U.S., in acknowledgement of the increasing degree of intersection between land use planning and energy use. PAS Essential Information Packet 30, ***Planning and Zoning for Solar Energy***, provides a comprehensive survey of how a variety of jurisdictions have addressed this issue, and PAS Essential Information Packet 32, ***Planning and Zoning for Wind Energy***, includes model and sample ordinances for both large and small wind systems along with examples of how communities are adding support for wind energy into their comprehensive plans. It is important to note, however, that introduction of new standards or ordinances supporting renewable energy projects could be offset by unintended barriers in existing ordinances that could limit or prohibit their installation. The addition of new standards should be accompanied by a thorough review of existing codes and ordinances that could counteract the intent of renewable energy goals.
- *Based on the technology and capacity proposed, do you understand what a project would look like, how much total space would be required, and how it would serve your community?* If not, revisit some of the basic concepts presented here and look into regional specifications related to feasible technologies. Local, regional, and state utilities, as well as public utilities or public services commissions, increasingly include information on renewable energy in the information they make readily available. Their websites and information centers would be a good place to start.
- *Are there large- or medium-scale developments anticipated in your community that could incorporate DG?* Developers may be keen to include in a proposal an element of renewable energy, particularly if a feed-in tariff or other mechanism were to provide a financial incentive and ensure that electricity generated on site would provide enough power to meet the additional demand as well as put more power generated from renewable sources online.
- *What opportunities exist in your town, city, or region for the creative integration of a renewable DG project?* Now the questions initially asked above can be revisited. What unique features in the built or natural environments might be complemented by a renewable energy project? Unused or underutilized portions of existing manufacturing or industrial zones may be ideal locations for development of renewable DG facilities. Such projects can be co-located with **agricultural activities**, or incorporated into parks or open space as pieces of art (**even as a demonstration project**). **Examples abound**, and integration of safe and thoughtful, creative, even whimsical, energy projects into populated areas creates opportunities for education, public interaction, and additional facilities.

Distributed renewable energy is an eminently practical concept that has been constrained largely because of regulatory standards that have maintained uncertainty on the part of potential investors. This is changing. With investment in research related to interconnection and net metering, along with feed-in tariffs, CLEAN contracts, and other mechanisms, the doors to development of DG projects continue to open.

Though planners can do little to solve interconnection-related challenges, they should understand the issues at hand and be alert to any changes in state or local policy that might support increased implementation of renewable energy projects in their communities. As this happens, the need to plan for renewable energy developments and permit proposals in a smart and efficient manner will place planners directly at a major front in the effort to address climate change and achieve energy independence and community resilience. This is happening now, and there is much to gain, certainly on the part of investors and our environment.

The extent to which there is the involvement of an engaged and informed planning community is the extent to which our communities and built environments will share in the mutual benefits.

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