Think Bigger: Net-Zero Communities

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ABSTRACT

Achieving net-zero energy (NZE) across the building stock requires looking beyond individual buildings and considering net-zero at a community scale, for several reasons. First, it might not be feasible to achieve NZE in every building - this might be more realistic for buildings evaluated together. Second, multi-building systems offer opportunities for lower energy use through heat sharing and load diversity. Third, drawing a larger perimeter around multiple buildings and adjacent open space allows us to consider "nearby" renewable energy sources thus keeping buildings and urban densities in the NZE mix. And finally, only by looking beyond the building's skin can we consider other energy saving opportunities in water supply, wastewater treatment, transportation, and beyond.

This paper refers to an NZE community as a geographic cluster of buildings and adjacent open space and infrastructure than may also share common ownership or function. In this paper we discuss the need to address net-zero energy at the community scale, consider how this transitioning affects the definition of net-zero, evaluate two case studies and conclude with a set of policy recommendations.

Projects such as the Army NZE Project at select bases not only showcase the best available emerging technologies, but also new ways operating our buildings, how we can integrate shared resources across a community, and how best to map out the path to NZE. Community scale net-zero won't all happen at once. This paper looks at how actions can be coordinated over time, thus priming buildings and communities to be "future ready" by preserving options for future improvements towards net-zero.

Introduction

The Need to Reduce Energy Consumption

The United States accounts for about 20% of world energy consumption and within the U.S., buildings are responsible for about 40% of the nation's energy consumption and greenhouse gas emissions (DOE EIA 2010). Reducing energy consumption will save natural resources, promote national security, lead to reduced greenhouse gas emissions, create more jobs, and reduce the impact of rising and increasingly volatile energy prices.

Net-Zero Energy: An Evolving Goal

Because buildings account for such a substantial portion of energy consumption and GHG emissions, we need an ambitious goal to set long-term policy directions, unify the building market and have a large-scale impact. The goal of net-zero energy (NZE),[1] while it may be a long-term goal, also has implications for near- and mid-term actions. A successful approach to net-zero means addressing energy use as a long-term process of continuous improvement for both new and existing buildings. This process starts with near-term steps to reduce energy use in existing buildings at every opportunity (reducing the future lift required) and to provide technology-friendly infrastructure in new and renovated buildings that can accommodate future technologies more easily and at lower costs.

Transforming the energy performance of individual buildings is an important step towards net-zero. However, a comprehensive, long-term transformation to net-zero energy requires looking beyond the individual building footprint and considering net-zero at a campus or community scale. This is for several reasons:

- The NZE goal may not be feasible for every building but may be more realistic for a group of buildings evaluated together;
- Multi-building systems offer opportunities for heat sharing and load diversity;
- Drawing a larger perimeter allows us to consider "nearby" renewable energy sources so that we can keep larger buildings and urban densities in the NZE mix (rather than being confined to the low-rise buildings that represent most NZE buildings today; and
- Only by looking beyond the building's skin can we easily consider other energy systems and energy-saving opportunities like water supply, wastewater treatment, and transportation.

Net-Zero energy as an average for groups of buildings. A full scale transformation to net-zero energy is a major task, one that varies in difficulty from building to building with some cases being less likely to yield cost-effective results than others, particularly when considering existing buildings. The U.S. Department of Energy (DOE) has documented just ten NZE buildings in the Zero Energy Buildings Database[2] while a recent report by the New Buildings Institute has identified almost 100 potential examples (NBI 2012a). Other commercial buildings – but still not a noticeable share of the US building stock, have achieved 55%-70% energy reductions by implementing today's technologies and best practices (Harris *et al*. 2011; NBI 2012b).

Not all building types can easily achieve NZE performance; the level of difficulty varies by building type, site, and operating requirements (Griffin et al. 2007). Therefore, it often makes sense to apply the NZE criterion to groups of buildings or communities as opposed to each individual building, and to consider the average energy consumption of the group. This allows us to focus on the optimal building candidates for net-zero energy in clusters or communities to yield the highest benefits – recognizing that some building types may evolve at a slower pace. For example, in highly energy-intensive cases such as data centers, labs, biotech and other high-tech facilities, or remote sites such as telecomm and field research facilities, the cost of energy or need for energy reliability may be much higher than for typical buildings. As a result, investments in NZE-relevant energy efficiency and renewable energy technologies are economically rational at 2- 3+ times more than the average cost of electricity and fuel.

[1] A net-zero energy (NZE) building is commonly defined as one that consumes no more energy in a year as it can produce on site from renewable energy sources (Torcellini, et al 2006). This definition, and its application to NZE communities, will be addressed in detail in a later section.

[2] http://zeb.buildinggreen.com/

Load diversity in multi-building systems. Thinking about a group of buildings as a system has another important benefit: it helps focus attention on the possible diversity of both electrical and thermal loads over different time-scales, from hourly (or shorter) to seasonal. This is especially significant when there are mixed uses among the group of buildings – or even within a single building. To mention just a few simple examples:

- Office building loads typically peak in the late afternoon in summer, as rising cooling loads add to the daytime base loads for lighting and office equipment – while in winter the peak may come during early morning warm-up);
- Restaurant energy peaks may come at mealtimes for cooking and afterwards for cleanup, although in some cases baking and roasting may take place much earlier in the day; and
- Both hotel and residential peak loads tend to be associated with morning and evening hours.

Clearly, if these and other mixed-uses are considered together, the total electricity generating and distribution capacity needed is less than the sum of individual peak loads due to load diversity. Utilities rely on this load diversity in planning and dispatching grid capacity but it is equally relevant to managing local micro-grids for a campus, military base, industrial park, or other collection of buildings – and to more effective use of on-site generation from either conventional fuels or renewables.

The same holds true for thermal loads: multiple buildings and mixed uses allow for better utilization of campus or district-scale heat (and chilled water) systems, and for heat-recovery and re-use "heat cascading" among nearby buildings. For all these reasons, net-zero energy is easier to achieve for a collection of buildings *managed as a system* than for any single building. In the case of thermal energy, it also helps if the buildings are co-located, given the thermal losses of large distribution loops. In contrast, electricity load diversity can be applied to groups of buildings that are not close by – provided the distribution grid is adequate to the task.

Preserving urban density in net-zero communities. A community approach to net-zero can also help avoid low-rise sprawl, which could be a result of pursuing net-zero for each individual building. Because a net-zero energy building is supposed to consume no more energy than it produces on site (typically with photovoltaic (PV) panels on the roof), most NZE buildings tend to be low rise and consequently contribute to low-density, sprawling development (Carlisle et al. 2009; Malin 2010). In general, today's NZE buildings are small (a few thousand square feet) and tend to be located in moderate climates (NBI 2012a). We need an approach to net-zero that allows for the diversity of building types, uses, and climates and also one that will not dilute urban density in favor of low-rise sprawl. Drawing a larger perimeter allows us to consider "nearby" renewable energy sources so that we can keep larger, taller buildings and greater urban densities in the NZE mix.

Off site renewables can also be considered if we group buildings and areas non-contiguously. In this case, the "community" is no longer a continuous geographical area, but a grouping of different non-adjacent sites that contribute to the same energy tally. Torcellini et al. (2006) argue that in some cases, especially in urban communities with taller buildings, higher density, and mixed-use development, it might be more economically feasible to use off-site renewables.[3] Moreover, low development density does not consider the full energy saving potential of neighborhoods and urban areas (including buildings, transportation, and utility infrastructure,) and also limits the developer's profit margin (Carlisle et al. 2009). In order to achieve NZE across a diverse building stock in various climates we need to target communities not just individual buildings.

Beyond the building's skin. There are opportunities to advance net-zero energy that go beyond the building's envelope, including grid system efficiencies, building/grid interaction, transportation energy, water and wastewater treatment, and more (Torcellini et al. 2006). By considering communities instead of individual buildings, we can pursue a more holistic net-zero goal that considers indirect and induced energy use, as well.

From Buildings to Communities: Re-Defining Net-Zero

A variety of definitions have been offered for NZE buildings and, more recently, NZE communities. As noted earlier, in general a net-zero energy building is one that maximizes energy efficiency and then uses on-site power to meet the remaining energy needs. Similarly, a NZE community consumes no more energy than it is able to produce through renewables located in the community's perimeter or in surrounding non-urban areas (Carlisle et al. 2009). An NZE community also aims at reducing energy use across the entire infrastructure of the community: buildings, transportation, water, occupants' behavior, and more. The success of both NZE buildings and NZE communities depends on an integrated design approach and attention to energy performance over the full life-cycle, past design, construction, commissioning and the certificate-of-occupancy to tie in efficient operation and effective feedback on energy performance to operators, occupants, and owners (Harris *et al*. 2011).

Definitions that were developed for NZE buildings may be usefully adapted—with caveats—in defining net-zero energy in the context of a community. Torcellini et al. (2006) developed four possible definitions of net-zero energy buildings, which are a starting point for defining NZE communities:

- *Net Zero Site Energy:* A building that produces at least as much energy as it uses in a year, when accounted for in site energy (not including off-site electricity system losses).
- *Net Zero Source Energy:* A building that produces at least as much energy as it uses in a year, when accounted for in source (primary) energy, including electricity system losses.
- *Net Zero Energy Costs:* A building that receives at least as much annual revenue from the utility for on-site energy exported to the grid as the amount paid to the utility (or utilities) for energy used over the year.
- *Net Zero Energy Emissions:*[4] A net-zero emissions building produces at least as much emissions-free renewable energy as it uses from emissions-producing energy sources.

[3] This is in fact what load aggregators do in some electric utility service areas, especially those with time-of-use or demand response tariffs: group together customers whose combined loads, in the aggregate, are more attractive to the utility and can thus command as a group a lower rate (or better peak load response) than they could individually.

[4] This last definition can apply to either greenhouse gas (GHG) emissions or/and other air and water pollutant emissions.

Pless et al. (2009) go one step farther by proposing a classification grading system for net-zero buildings that ranks the quality of renewable energy sources used by a building. For example, in the building-ranking system, building integrated photovoltaics (PV) rank higher than the burning of wood even though both are considered renewable energy.

Recently, a report by the California Energy Commission expanded on the cost-based definition (#3 above) in an interesting way, one that encompasses several elements of the NREL proposed definitions:

> "A ZNE building is a building in which the **societal value** of energy consumed over the course of a typical year is less than or equal to the societal value of the onsite renewable energy generated. The societal value of energy is the long-term projected cost of energy, including the peak demand cost (time-dependent valuation of energy), the value of associated carbon emissions, and other externalized costs." (CEC 2011; emphasis added)

A definition for a net-zero energy community is more complex than for an NZE building because the spatial scale of a community encompasses energy used not only for buildings but also for industry, vehicles, and community-based infrastructure. Pursuing a net-zero goal for communities does present more opportunities for renewables. However, accounting for a much larger set of systems and components that make up the entire community also presents new challenges.

Net Zero Community Components and Approaches

We are not interested in only considering easy cases for NZE communities. For example, a collection of a few dozen single-family homes might be an easier group to transform to net-zero, however, we would consider that to be an NZE sub-division, not a community. Single projects, or even small groups of buildings separated from their context, do not account for the larger infrastructure in which they occur, such as energy required to move people and to deliver fresh water and to remove and treat wastewater and solid waste. Achieving an NZE goal for a group of single-family suburban homes, for example, while a useful step, will do little to transform the built environment. In the next section we address several components of a net-zero community and the overall approaches to achieve the goal.

Short-term *vs.* Long-term

A successful net-zero community is most likely to be achieved through an integrated set of short-term goals, which work towards the longer-term goal of net-zero. The goals and strategy will vary on a case-by-case basis depending on the ratio of new and existing buildings. While the ultimate long-term goal is for the community to consume only as much energy as it produces on site (or in adjacent open spaces), the range of actions over time to get to that goal are complex. An approach that focuses on maximizing energy efficiency first should also pay attention to preserving existing buildings and infrastructure where it makes sense and improving their energy performance through retrofits – given the energy embodied in existing buildings and the energy required for demolition, as well as aesthetic, cultural, and historic values. A recent NBI report identifies both net-zero energy buildings and buildings that are "zero energy-capable, which are energy efficient enough to be zero energy, but have not taken the final step of on-site renewable generation." (NBI 2012a) This concept of "net-zero readiness" can be adopted for NZE communities as well, through careful use of planning, zoning, and development permitting requirements.

Preservation and Redevelopment

While much of the recent attention to net-zero energy neighborhoods or communities has focused on residential single-family development, we believe than even larger potential lies with mixed-use communities such as military bases, university or health case campuses, or perhaps urban redevelopment zones and suburban planned-communities. For obvious reasons, new construction makes it easier to build in net-zero (and net-zero capable) features, but at least some of the same opportunities may be present in redevelopment of older neighborhoods – especially because older neighborhoods, designed before exclusive-use zoning became the norm, are more likely to have mixed building uses and buildings that were originally designed in the pre-air-conditioning period with good solar orientation, daylighting, high ceilings, and other climate-sensitive "passive" features.

Integrated Design

In early 2011, the Commercial Buildings Consortium (CBC, a public private consortium of 500 member organizations, led by DOE), released two major reports: "Next Generation Technologies Barriers and Industry Recommendations" and an "Analysis of Cost and Non-cost Barriers and Policy Solutions."[5] While the reports focus on individual commercial buildings and their path to net-zero, a number of the recommendations can be applied at the community scale. These reports found that achieving low- and net-zero energy performance depends less on individual technologies than on well-executed integrated design and integrated community systems-level analysis. The role of integrated design becomes even more crucial in the case of net-zero communities, as there are many more components to consider. The key is to consider the entire community as an integrated system rather than addressing each of the components of the community separately.

Involving Users

The users in NZE communities - residents, those who work on site, or those who visit to buy goods and services on site - directly impact energy use. The success of net-zero communities will require community cohesion and buy-in from users, in which owners and tenants are conscious and supportive of the goal of net-zero. Residents and users of NZE communities are also likely to self-, thus making this goal more achievable. Community involvement will be fostered through feedback and education. An open communication framework among utilities, businesses, schools households, etc. could be the first step to building a community of NZE supporters and contributors. The concept of "net-zero" thus goes beyond just buildings and infrastructure to become part of the lifestyle of those who live, work, shop, and recreate in the community.

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[5] http://www.zeroenergycbc.org/resources/cbc-reports/

Characteristics of Successful Net-Zero Communities

Emerging examples of NZE communities share a number of attributes, which can also yield a profile of sites that make good candidates for net-zero communities.

Scale

The strategy for achieving a NZE community may differ depending on the scale—which can range from only a few buildings to a large campus complex or redevelopment district. For designers attempting to achieve NZE status on each of these scales, there are numerous challenges (and opportunities). For smaller groups of buildings representing a smaller mix of uses, the developer may benefit fro building types and uses with very low energy consumption and ample roof or ground space for renewable energy installations, which makes meeting NZE goals more manageable. However, these smaller clusters also provide fewer opportunities to achieve the advantages of system scale and load diversity available in larger NZE communities.

For larger groups of buildings, whether on an existing campus or a new planned development, achieving net-zero goals is made more challenging by their sheer scale and the need to achieve and sustain major reductions in energy use in a larger number and range of building types. However, larger sites also allow power generation to be located in areas that might not otherwise be available in a smaller site. Thus, a college campus or army base might have the option of locating a solar PV installation (or a solid waste CHP unit) in an otherwise underutilized area unavailable to a smaller development.

Financial Criteria and Time Frame

The financial resources or requirements of NZE developers have a direct impact on the feasibility and success of these developments. Compared to conventional construction, NZE communities may have higher up-front development costs due to both building-level efficiency measures and infrastructure investments, including on-site generation capacity. Although these attributes convey significant value in the long-term by lowering operating costs, it may be challenging to find buyers and lenders who are prepared to attribute full value to long-term cost savings. For conventional real estate development structured around immediate sale or short-term asset holds, the economics of NZE-type assets can be very challenging under current property valuation practices. Consequently, successful financing of an NZE community at present requires a client who intends to have a long-term ownership or financial involvement. Government or institutional clients, corporate headquarters, or “buy and hold” investors are therefore ideal clients for NZE developers and owners.

Single Ownership

Single ownership of the community’s buildings and infrastructure can also contribute to the feasibility of an NZE development. By working on the same construction schedule and calculating building energy loads in aggregate, decision-makers and designers are better able to allocate and balance energy loads efficiently throughout the site—a process that would be more challenging if spread among different actors. The sale or lease of buildings within a site subsequent to construction may dilute the unified decision-making ability of a single developer or owner. However, operating covenants or other arrangements for unified management of the community's infrastructure can help assure effective energy management over the long term. Nonetheless, single ownership – by a government agency, university, or health care organization (etc.) makes achieving and maintaining NZE status much easier.

New Construction *vs.* Renovation

When creating entirely new communities, designers have an ideal opportunity to achieve NZE status. For renovation of existing buildings and neighborhood renewal the challenge is greater, as some opportunities to optimize energy efficiency are no longer available or practical (e.g.. building orientation, massing, and solar exposure). Major renovation offers the best chance to improve energy performance in existing buildings, but it is difficult to do so while preserving other desirable building attributes, including historic and architectural features.

Case Studies

Army Net Zero Initiative Pilot

The US Army has embraced the concept of net zero communities by initiating a rather aggressive pilot project at nine Army bases, with the goal of achieving net zero energy by FY 2020. The Army's definition of net zero is that each base will produce as much energy as it consumes over a one-year time frame. While this might sound fairly straightforward, the Army very quickly discovered the many nuances of net zero energy. Some key issues related to where to draw the boundaries for net zero and how to deal with energy security versus net zero. The Army team decided that the boundary for net zero would be the physical boundary of each base, ruling out the prospect of using renewable energy produced off-site. Conversely, they do not include energy associated with employees and visitors or the delivery of goods and services to the bases. So the Army is looking primarily at minimizing the energy associated with the operating buildings and the base infrastructure, maximizing the use of renewable energy, and maintaining the desired levels of energy security, all within the bounds of acceptable cost-effectiveness criteria. Admittedly, this is quite a challenge, and the Army deserves credit for tackling it.

An interesting contrast between the Army's approach and a typical private sector NZE community is that the Army operates via command and control. In the case of their Net Zero Pilot, the message was promulgated from the highest levels in the Pentagon, and the rest of the organization lined up accordingly. This is not normally the case with non-military communities, towns and cities, where it is much more difficult to motivate and mobilize the general population behind something as all-encompassing as a net zero policy. Even under the command and control scenario, however, the Army is still faced with balancing the goals of net zero with many other, sometimes competing factors. When considering large-scale renewable projects, for example, important environmental considerations come into play: endangered species, wetland protection, trees, open spaces, the views from surrounding neighborhoods – all must be considered.

At the initial planning meetings at the Army sites, much emphasis was placed on bringing all the players to the table. The cast of characters included representatives from the local department of public works, planning agencies, environmental specialists, historic preservation proponents, engineers, facility managers, attorneys, and commanding officers.

The Army has taken an organized and pragmatic approach to achieving net zero, recognizing the need to start with energy efficiency. They have deployed energy audit teams to each location to identify every possible means of increasing energy efficiency, from no-cost/low cost facility operations and scheduling changes to larger capital improvements such as boiler or chiller replacements. Concurrently, renewable energy assessments are done to determine the maximum practicable opportunities for solar, wind, geothermal, wave, ocean thermal and tidal energy systems. The Department of Energy's Federal Energy Management Program reviews the results of these assessments and helps the Army to develop specific Net Zero Roadmaps for each site. The roadmaps will plot the course to net zero through FY 2020, including prioritization of projects, scenarios for contracting and financing, and on-going operations and maintenance for sustained performance into the future. Last, but certainly not least, is the need for organizational and individual behavioral change necessary for continued net zero performance in the years ahead.

UC Davis West Village- Public/Private Sectors (Academic/Private)

The feasibility of community-scale NZE development has been the subject of analysis and debate for many years. The largest planned NZE community in the U.S. is West Village, located on the campus of the University of California at Davis. In 2003, when UC Davis was preparing its Long Range Development Plan, providing local housing opportunities for students, faculty and staff was a key consideration, as was the ability of any newly built new facilities to meet their own energy demands. Since that time, the process and model for pursuing NZE at West Village has been the subject of much analysis (Finkelor et al. 2010),

UC Davis West Village broke ground in August 2009 as a targeted NZE demonstration community and the first residents—nearly 800 students, faculty and staff—began moving into 315 new apartments in August 2011. Approximately 2,400 students were welcomed for classes in January 2012. Single-family model homes are anticipated to be finished in late 2012 and the final phase of student housing is to be completed in 2013. At build-out, UC Davis West Village will provide homes for 3,000 students, faculty and staff, 662 apartments, 343 single-family homes, 42,500 square feet of commercial space, a recreation center and study facilities, all on 200 acres. The total Phase 1 cost is around $280 million, of which UC Davis invested approximately $17 million to bring utilities and infrastructure to the site. The university will recoup this investment through a surcharge placed on residents' utility bills.

The West Village project will integrate environmentally sound design practices; supported by nearly $7.5 million in federal and state grants to study NZE systems. In addition, the developer, West Village Community Partnership, is pursuing more general sustainability measures such as mixed-use buildings, multiple transportation options, generous open spaces, recreational opportunities and bikeway connections. Energy grants were awarded to explore waste-to-renewable-energy alternatives, to study innovative technologies and innovative business models related to solar photovoltaic systems, and to assist in the design and engineering of renewable energy systems.

Now working toward NZE operations, UC Davis and West Village Community Partners have performed electrical demand studies, energy efficiency studies, utility infrastructure design, solar photovoltaic system design, financial analyses and regulatory research to determine technological and economic feasibility. The University of California system is also drawing on the expertise of UC Davis faculty and six campus research centers specializing in water efficiency, energy-efficient cooling, lighting technology, and biogas energy systems.

It is estimated that the West Village community, if built to the efficiency requirements of California's Title 24 Building Standards (as of 2008), would have used 22 million kilowatts of electricity a year. With the full slate of energy efficiency measures (solar-reflective roofing; radiant barrier roof sheathing; high-efficiency light fixtures, air conditioning systems and appliances; thick 2" x 6" exterior walls for added insulation; and architectural elements such as generous roof overhangs and window sunshades), projected demand will come to about 11 million kilowatt hours, a 50 percent reduction. On-site renewable energy and conservation incentives are to meet the remaining energy needs on an annual basis.

Education will also be an important component of achieving NZE operations at West Village. To encourage conservation, residents will have access to a web-based tool that enables energy use monitoring by unit. Further, smart phone applications for monitoring energy use and remotely managing electricity use of lamps and plug-in electronics are being planned.

Going forward, the lessons of UC Davis West Village stand to provide interested stakeholders with an innovative framework for financially feasible, replicable NZE communities.

Policy and Program Implications

The challenge of encouraging NZE in government policies and programs is one of scale and timing. Community-scale development generally occurs over a period of decades and involves many properties and property owners, and decision makers. The challenge is to coordinate a large number of actions by public and private decision makers over time, prompting the decisions at each stage to add to the "future readiness" of that facility and the community as a whole, so that sequential improvements lead towards net-zero goals rather than focusing exclusively on "here and now" thinking. Government policies and programs to encourage NZE must be comprehensive, patient and persistent – characteristics that are difficult to build into programs at the federal level, or state and local levels, due to the ups and downs of budgets and public officials elected on a 2 to 4 year cycle. Still, government initiatives can intervene at key points: in the planning stage for new developments or redevelopment; in infrastructure grants and loans (water, sewer, roadways, transit); in supporting professional training curricula for planners and civil engineers, and in the deliberate use of federal facilities and federal lands to demonstrate and support NZE practices. In this concluding section we briefly discuss each of these options.

Federal Leadership in Community-Scale Facilities

In this case as in many others, the federal government can play a key role in setting an example for others. As we have seen, large multi-purposes federal facilities such as military bases, as well as health care campuses, residential training centers, overseas embassies and consulates, and many others offer significant opportunities for introducing NZE goals and demonstrating their feasibility. These sites all share a single owner (the responsible federal agency) with long-term ownership and operational interests. Many larger government facilities are also characterized by multiple buildings with mixed-use occupancies that provide the kinds of thermal and electrical load diversity mentioned above, on-site infrastructure such as electrical substations, district heating/cooling plants, and water/wastewater treatment systems – along with (in some cases) extensive land areas for siting renewable energy resources. At some sites there is also a strong preference, or legal requirement, for preserving and updating (or repurposing) older existing buildings with historic and/or aesthetic interest.

As always, the relatively easy cases to design around NZE, where a major campus facility is being built new from the ground up, will be much rarer than cases of existing facilities that are being expanded, shrunk, re-purposed, or modernized. For both cases, we already have statements of federal policy to implement all energy-saving and renewable energy measures that are cost-effective. While these policy statements might be further strengthened, with additional oversight to assure that they are followed throughout the federal facility planning process, additional policy criteria are needed to introduce the idea that planning and design decisions should also incorporate features that make the facility better prepared to incorporate additional technologies and systems in the long term – in other words to legitimize (and preferably require) investments that help make campus-level federal facilities NZE-ready. Finally, in the case of surplus federal properties, one of the criteria in evaluating proposals for their future use should be the degree to which plans for new uses will advance net-zero energy communities – within the surplused properties and for the surrounding area.

Innovations in Planning and Zoning Practice and Professional Education

To achieve significant change over time, state and local officials, along with their professional staff and consultants, need to be well grounded in concepts of community-scale NZE. One path is to build these concepts into professional training and continuing education curricula – a role that federal agencies could play with a relatively modest amount of money by working in collaboration with both the graduate education community and professional societies such as the American Planning Association, the International City/County Management Association, and the American Society of Civil Engineers. Sessions on NZE could also be presented as a regular feature at professional conferences, chapter meetings, and discussed in journal articles targeted to these and other organizations.

Targeting Federal Grants to Zero-Energy Communities

Even though federal agencies' discretional budgets are likely to be constrained for the next few years (at least) a number of existing programs can be re-aligned to put more emphasis on net-zero energy concepts and goals, and to support pilot projects, the further development of planning and decision tools, and the sharing of ideas and information among local practitioners. Examples of such programs include the HUD community Development Block Grants and Community Challenge Grants; the interagency sponsored "Partnership for Sustainable Communities" (HUD, DOE, EPA); and the grants and loan financing available (along with technical assistance) from the USDA's Rural Development program.[6] Similar opportunities exist to encourage and support NZE concepts within more specialized federal assistance, such as

[6] Program websites are at http://portal.hud.gov/hudportal/HUD?src=/program_offices/ comm_planning/communitydevelopment/programs; http://portal.hud.gov/hudportal/HUD?src=/program_offices/sustainable_housing_communities/HUD-DOT_Community_Challenge_Grants; http://www.sustainablecommunities.gov/; and http://www.rurdev.usda.gov/ Home.html.

funding for streets, roadways, and transit; water and wastewater systems; low-income housing; and others.

To complement these government based activities, additional emphasis on energy and NZE as a long-term goal could be introduced within voluntary programs such as the U.S. Green Building Council's (USGBC) LEED for Neighborhood Development rating system[7] and the Star Community index being developed jointly by ICLEI-Local Governments for Sustainability along with the USGBC, the Center for American Progress, and the National League of Cities.[8] These and other federal programs offer significant opportunities to use federal funding as leverage to focus attention more broadly on NZE opportunities at the community scale, not just for individual buildings, and to generate significant leverage for other public and private investment to help advance the NZE concept. Of course, it is also important to improve coordination among these numerous federal grant and technical assistance programs, as pointed out most recently in a Government Accountability Office report calling for more interagency coordination on building-scale green programs (GAO 2011).

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