Affordable Net Zero Housing and Transportation Solutions

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Today the built environment expends 43% of US energy. In the past ten years the science community has begun to tackle this issue with research on the concept of net zero buildings, or buildings that combine energy efficiency and on-site renewable energy production to use no net energy from off-site sources (Dannenberg, 2007). This policy brief explores some of the issues related to net zero construction, as well as variation in state policy approaches that support a net zero construction approach. Current issues affecting net zero are the lack of definitional clarity, the broad range of policies needed to construct net zero housing, and the cost of implementation.

When using the term "net zero," the resource to which one is seeking to become net zero in must be articulated. The most common type of net zero sought to reach is "net zero energy," thus The U.S. Department of Energy defines a net zero energy building as one where the source energy consumed is less than or equal to the energy produced by on-site renewable energy resources (Dannenberg, 2007). The term has expanded over the last decade, however, to refer to other environmental concerns. At this point, a "net zero" building may also refer to net zero carbon emissions, net zero carbon, net zero energy, net zero waste, or net zero water use.

Net zero carbon emissions however, seems to provide the best basis for overall decrease in emissions and energy use, as well as the ability to monitor and track its impact on the environment. Net zero carbon emissions refers to achieving net zero carbon emissions by balancing a measured amount of carbon released with an equivalent amount sequestered or offset.

Currently, there is no consensus on what constitutes a net zero energy building or home. However, researchers have agreed on the factors to consider when developing a definition of net zero energy buildings. The building system, energy infrastructure, climate, and weighting system are key factors to consider when developing a definition (Deng, 2014). The weighting system converts the physical units of different energy carriers into a uniform metric. The building system can encompass the aspects of the built structure necessary to achieve net zero energy consumption and the onsite renewable energy power source. These renewable energy sources are defined within the U.S. as biomass, hydropower, geothermal, wind and solar. The energy

infrastructure includes the type of delivered energy on the grid, and the existing aggregate net metering policies, which allows a renewable energy source site to connect to a public utility power grid, and to transfer surplus power generated on site to the grid to offset the power drawn from the utility. The importance of the type of delivered energy depends upon the net zero goals of carbon, energy or emissions. Climate plays a role in how one develops the building system, as this affects renewable energy source options, building materials and the sheer possibility of net zero energy consumption. The weighting system includes import and exports of energy. The weighting system can determine the feasibility of net zero energy housing (Sparn, Lieko, & Christensen, 2016).

Why Net Zero?

Net zero construction is becoming a more common environmental goal. For example, The Energy Independence and Security Act of 2007 mandates the following future targets:

- As of 2025 all new commercial buildings must be zero net energy according to the Department of Energy standard and
- By 2050 all US commercial buildings must be zero net energy including retrofits of pre-2025 buildings.
- As of 2020, all planning for new Federal buildings requires design specifications that achieve zero net-energy use.
- As of 2015, large government buildings have to start showing progress, and at least 15% of any Federal agency's existing buildings and building leases above 500m^2 must conform to zero net energy and ongoing improvements are required (Kibert & Maryam, 2012).

The rationale for net zero goals such as these federal targets is based on potential environmental, economic, social, and health benefits, as well as the ability to become less dependent on foreign energy sources. "Reducing energy use in buildings must be a major part of the solution as we work to combat the escalating costs and impacts of climate change," said Brendan Owens, chief engineer at the U.S. Green Building Council, the advantages include lower environmental impacts, lower operating and maintenance costs, better resilience to power outages and natural disasters, and improved energy security (DOE, 2015). For consumers, it provides a decreased energy bills and superior insulation quality, as well as higher resale values for their homes or buildings.

Challenges for Net Zero

However, these goals are unrealistic without a more refined definition of net zero energy buildings. The existing Department of Energy definition does not address the timespan, whether that be monthly or yearly, in which the site has to balance the intake and outtake to zero, therefore becoming net zero. Another challenge to the current net zero energy definition provided by the Department of Education is that it does not address carbon emissions specifically, which is a key part of the climate stabilization 2050 goal. While the DOE's current conception of net zero moves the United States in a better direction, without mentioning emissions, it will be difficult to measure progress and impact.

<u>Definitional issues</u>

- What is the timespan of qualifying as a net zero energy building or home?
- Wouldn't net zero carbon be the more effective measure than net zero energy, since, "electricity generation accounts for 41% of all CO_2 emissions and is the largest single source of CO_2 emissions" (EPA, 2011) and the climate stabilization goal requires reduction of carbon emissions by 95% in the industrialized world by 2050?
- More attention should be paid to other net zero goals, and not focus too much on energy and risk ignoring other potentially more important environmental challenges in some locations.
- What is the point of changing to net zero if my grid source is renewable and is it fair to demand that individuals who have a nonrenewable grid source change while others may not have to?

<u>Implementation and Policy Issues</u>

- What monitoring system is in place to ensure property owners are using truly renewable energy sources?

- How do you overcome metering laws that can dictate the possibility of reaching net zero energy consumption and how can individuals obtain information and supplies to convert to net-zero energy within their specific municipality?
- Although net zero designs may be profitable in the long term for building owners in terms of reduced energy costs, many are reluctant to pay any potential higher upfront costs for the construction.
- Lack of incentives for building owners to take on higher upfront construction costs for net zero buildings.
- Lack of awareness of net zero benefits among homeowners or building developers.
- Difficulty connecting local renewable power installations to electric grid (net metering, interconnection policies).
- Other obstacles to on-site renewable construction (building codes and local zoning).

Policies to Help Net Zero

Public policy measures can help overcome these challenges for net zero construction. Key aspects of state policy that should be taken into consideration are aggregate net metering, financial incentives, standardized interconnection standards, building energy codes, energy efficiency portfolio standards and renewable portfolio standards (Kibert & Maryam, 2012; Kadam, 2001). Aggregate net metering allows a renewable energy source to connect to a public utility power grid and the surplus power generated on site is then transferred to the grid to offset the power drawn from the utility. Financial incentives such as personal, corporate, sales and property tax incentives as well as rebate, grant and loan programs are key to making net zero fiscally feasible for the average American (Kadam, 2001). There is also a need to educate about the long term financial benefits of net zero for the homeowners economically and for the environment to further incentivize their participation (Todd, Chen, & Clogston, 2013). Standardized interconnection standards call for a standardized approach for how a renewable energy system can physically connect to the grid. Building energy codes that allow for or require environmentally friendly and efficient materials are needed, as well as codes that allow for renewable sources to be incorporated into standard construction practice. Energy efficiency portfolio standards and renewable portfolio standards are regulatory mandates to increase the production from renewable sources, which incentivizes net zero energy buildings.

For net zero housing to take place, net metering policies must allow individuals to buy and sell back to the grid, and individuals must be allowed to connect to the grid (Kibert & Maryam, 2012; Hobart, 2014). Although building energy codes, energy efficiency portfolio standards and renewable portfolio standards create a positive foundation to incentivize and support movement towards net zero housing, they are not required for net zero housing. However, without net metering and standardized interconnection standards that support off site renewable energy generation and sell back, net zero housing is not possible therefore needs an increased weighting in state rankings.

References

1. Environmental Protection Agency. (2011). "Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2009." *United States Environmental Protection Agency, Washington, D.C., April 2011. EPA 430-r-11-005.*

2. Dannenberg, Libby. (2007). "Sustainability 2030: Architects and Climate Change." *American Institute of Architects.* Retrieved from: http://www.ncsl.org/print/energy/LDannenbergAM07.pdf.

3. Deng, S. (2014). "How to Evaluate Performance of Net Zero Energy Building: A Literature Research," *Energy* 71, no. 15: 1-16.

4. Department of Energy. (2015). "Releases Common Definition for Zero Energy Buildings, Campuses, and Communities." *United States Department of Energy: Office of Energy Efficiency and Renewable Energy.* Retrieved from: https://energy.gov/eere/buildings/articles/doe-releases-common-definition-zero-energy-buildings-campuses-and.

5. Hobart, Stacey. (2014) "Study Examines Present-Day Policies and Fiscal Realities of Zero Energy, Living Buildings in Washington, DC. *New Buildings Institute.* Retrieved from: http://newbuildings.org/news/study-examines-present-day-policies-and-fiscal-realities-of-zero-energy-living-buildings-in-washington-dc/

6. Kadam, S. (2001) "Zero Net Energy Buildings: Are they Economically Feasible. *MIT.* Retrieved from: http://web.mit.edu.ezproxy.lib.purdue.edu/10.391J/www/proceedings/ZED_Kadam2001.pdf.

7. Kibert, Charles J., Maryam Mirhadi Fard. (2012) "Differentiating among low-energy low-carbon and net-zero-energy building strategies for policy formulation." *Building Research & Information* 40, no.5.

8. Sparn, Bethany, Lieko Earle and Craig Christensen. (2016). "At Net Zero Energy Home Grows Up: Lessons and Puzzles from 10 Years of Data." *U.S. Department of Energy: National Renewable Energy Laboratory*.

9. Todd, Jennifer, Chen, Jess, and Clogston, Frankie. (2013) "Analysis of Net Zero Energy Home Industry." *International Economic Development Council.* Retrieved from: http://www.iedconline.org/clientuploads/Download/edrp/IEDC_Net_Zero_Homes_Industry.pdf.