MENLO SPARK *Climate Neutral for a Healthy, Prosperous Menlo Park*

SUSTAINABLE BUILDINGS: Hundreds of Carbon-Neutral and Zero Net Energy Buildings in the U.S.

Zero net energy (ZNE) buildings are becoming the new standard for achieving significant energy savings and reducing carbon emissions from the built environment, with hundreds of ZNE buildings already in use.[1] California is setting the highest levels of performance with ZNE policies leading to massive energy savings and carbon emission reductions.

Generally, ZNE goals mean that buildings use a combination of improved efficiency and distributed renewable energy generation to meet 100 percent of their annual energy needs.[2] There are alternate definitions, some of which focus on zero carbon instead of energy: "meeting the balance of energy needs from sources that do not produce CO_2 emissions and therefore result in zero net CO_2 emissions."[3]

In 2008, California set bold energy use reduction goals for all new homes to be ZNE by 2020 and commercial buildings by 2030.[4] San Mateo County is supporting cities advancing ZNE policies well ahead of the state requirements.[5] Palo Alto, as part of its climate action plan, is also supporting ZNE buildings and looking to phase out natural gas use in buildings.[6] Also, the University of California System pledges to be carbon neutral by 2025,[7] for which ZNE buildings will play a key role.

Overarching programs such as Architecture 2030 and Bioregional are encouraging widespread implementation of green standards and construction of ZNE and carbon neutral developments.[8] Other examples of Regional and City targets include:[9]

- Vancouver aims for all new construction to be carbon neutral beginning in 2020.
- Fort Collins Zero Energy District (Fort ZED) brings the city, developers, design team, and the local municipal energy utility together planning a two-block district to be Zero Energy (and water) as a district system, with integrated energy and water strategies.
- Getting to Zero: A Pathway to a Carbon Neutral Seattle includes ZNE buildings.
- Cambridge, MA adopted a Net Zero 25-Year Action Plan and also requires LEED gold buildings.

How to Achieve a ZNE Building:

1. Develop an ***integrated systems approach*** that minimizes energy use and increase comfort, through an air-tight, ***well-insulated*** building shell, design for ***daylighting***, and siting to maximize ***passive cooling and ventilation***.
2. Apply highly ***energy-efficient technologies*** including HVAC, lighting and control equipment.
3. Optimize the way the building operates and how people use it, including ***management of plugged-in devices*** and controls.
4. Install ***renewable generation*** to meet the remaining energy needs of the building ***or utilize carbon free grid power***.

HVAC Systems Play a Key Role. The Heating, ventilation and air conditioning (HVAC) systems designed for ZNE buildings do not use standard packaged units. Four HVAC trends are important:

1. Decoupling ventilation air from space conditioning,
2. Including energy recovery on the return air supply,
3. Moving away from forced-air ducted distribution systems, and
4. integration of ground- (geothermal) or air-source (electric) heat pumps.

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[1] Newbuildings.org and http://netzeroenergycoalition.com/inventory-infographic/
[2] http://energy.gov/eere/buildings/downloads/common-definition-zero-energy-buildings
[3] http://architecture2030.org/files/roadmap_web.pdf
[4] http://www.energy.ca.gov/title24/2016standards/rulemaking/documents/2016_Building_Energy_Efficiency_Standards_FAQ.pdf; http://www.californiaznehomes.com; also note that the U.S. Department of Energy issued guidelines in 2008.
[5] http://www.smcenergywatch.com/node/191 Many consultants and contractors experienced with ZNE design are listed here. Also, SERA Designs based in Portland does large commercial ZNE designs and recently opened a Silicon Valley office.
[6] http://www.cityofpaloalto.org/services/sustainability/sustainability_and_climate_action_plan/default.asp
http://paloaltoonline.com/news/2014/12/24/palo-alto-looks-to-fuel-switch-away-from-natural-gas
[7] http://www.ucop.edu/initiatives/carbon-neutrality-initiative.html
[8] http://architecture2030.org/ http://www.bioregional.com
[9] http://www.netzerocambridge.org/

Cities and counties that advance ZNE are increasing economic development and demonstrating community leadership, ingenuity, and resilience.

There are buildings of many types and sizes where ZNE has been achieved with acceptable incremental costs, with design and construction running from 0 to 15% more than conventional construction costs.[10] Some commercial buildings have achieved ZNE (or near ZNE) at little or no additional cost with a project team that utilizes integrated design. ZNE buildings also provide significant cost savings to residents and businesses, and bolster innovation and technological development.

More than one-quarter of the many ZNE and ultra-low energy buildings are larger than 50,000 square feet. Of those, half are over 100,000 ft^2. These larger buildings, which are more complex to design, construct and operate, clearly show the potential of ZNE for larger properties, according to an ACEEE study in 2014.[11]

Examples of large ZNE Buildings

Out of over 50 NZE buildings in California, 15 are office buildings, 3 are warehouses, one is a laboratory, and many others uses are represented.[12] PG&E published in depth Case Studies of six successful ZNE California projects:[13]

- Packard Foundation Headquarters, Los Altos, 49,000 ft^2
- Stevens Library, Atherton, 6300 ft^2
- IDeAs Office Building, San Jose, 6557 ft^2
- Watsonville Water Resource Center (office/Lab), Watsonville, 16,000 ft^2
- UC Merced Science & Engineering Building, Merced, 180,000 ft^2
- UC Merced Classroom & Office Building, Merced, 103,000 ft^2; occupied since 2006.

Other successful ZNE buildings in the Bay Area include:

- 435 Indio Sunnyvale office building (a retrofit), 31,800 ft^2
- Exploratorium, San Francisco, 330,000 ft^2
- Hanover Page Mill Building, Palo Alto, 90,000 ft^2
- IBEW Local 595 Zero Net Energy Center, San Leandro, 45,000 ft^2
- Delta Americas HQ office,[14] Fremont, 180,000 ft^2

[10] http://newbuildings.org/sites/default/files/ZNE_CommsToolkit_FAQ_CA.pdf

[11] In this study of more than 20 office buildings and more than ten multifamily buildings, 24% of the 33 ZNE verified buildings are renovations of existing buildings; and 25% of the ZNE buildings are privately developed. http://aceee.org/files/proceedings/2014/data/papers/5-1224.pdf

[12] NBI has a comprehensive and up to date database: http://newbuildings.org/wp-content/uploads/2015/11/CA_ZNE_Watchlist_2015091.pdf We found some ZNE buildings that aren't listed in NBI's database; those other sources are noted where applicable.

[13] A Sept. 2014 NZE Case Studies book by PG&E highlights 6 successful CA projects. http://www.pge.com/en/mybusiness/save/rebates/zne/index.page

[14] This ZNE building designed by J.J. Pan & Associates and constructed by Vance Brown general contractors includes a 616kW solar system and a geothermal system achieving a 60% reduction in energy consumption compared to traditional HVAC systems. The geothermal heating and cooling system uses a ground source heat pump connected to a loop field of pipes located up to 30 feet underground, and covering an area greater than 5 football fields. The building has bi-directional radiant floor and ceiling tubes embedded in the concrete slabs. In total, there is more than 92 miles of pipe circulating 12,000 gallons of water. http://www.delta-americas.com/news/pressDetail.aspx?secID=3&pID=1&typeID=1;4&itemID=5809&tid=0&hl=en-US

Most of these developments avoid on-site fossil fuel use. One example of an office building retrofitted with electric heat pumps to become zero gas and ZNE is the Oak Ridge National Laboratory Office Building.[15]

ZNE and all-electric homes are taking off. The Department of Energy issued Zero Energy Ready Homes certification guidelines beginning in 2008. Since then, the concept has gone mainstream with 6,000 ZNE units already built, according to the Net Zero Energy Coalition, illustrated by this infographic. A California Company called City Ventures has produced over 100 homes that are all electric without any additional cost premium on the homes.[16] Other states are also developing ZNE homes. Grow Community on Bainbridge Island, WA has at least 20 fossil fuel free homes that are electrically powered with air source heat pumps and heat exchangers to keep them warm and well ventilated in winter.[17]

What does Our Sustainable Future Look Like?

As Menlo Park considers plans to develop 2 million square feet of new building space, it is important to ensure that new buildings do not lock the city into a high carbon future. Without more attention to the current carbon emissions budget needed to meet the 2020 climate target, allowing significant new investment in more fossil fuels, such as natural gas heating, could make those safe climate targets impossible to meet.

On the other hand, new buildings that phase out fossil fuel use and approach net zero could help the City achieve its 2020 climate goals, and avoid large scale retrofitting of new buildings after the state 2030 ZNE standards phase in. Several cities like Santa Monica and Lancaster have implemented advanced standards that require solar on all new buildings (where feasible). However, ***given the clean grid energy that will serve Menlo Park and the high natural gas use that contributes 30% of current citywide carbon emissions, a focus on the carbon emissions of buildings could be more meaningful than on-site renewable requirements.***

A pathway to low carbon buildings includes both consideration of the carbon content of electricity and efforts to minimize on-site carbon emissions (e.g. natural gas). For example:

All new development of significant size shall evaluate and consider all measures to achieve zero carbon development, including fossil fuel reduction measures; and implement such measures where they are found to be feasible and cost-effective.[18]

Most buildings have an average lifetime of 50 years or more. As Menlo Park begins a building boom, let's consider a sustainable future that does not lock in higher carbon emissions. Menlo Park has an opportunity to show leadership on clean energy and low carbon buildings that are feasible and cost-effective. Low carbon building standards are worth the effort because they will provide more comfortable spaces for occupants, more value for owners and a more sustainable future for our city.

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[15] http://www.2030districts.org/case-study/oak-ridge-national-laboratory-office-building See more info at District 30, www.2030districts.org

[16] http://www.greenbuildersjournal.com/why-do-we-sell-all-electric-homes/

[17] http://www.bioregional.com/grow-community/

[18] Note that the "feasibly and cost-effectiveness" threshold is automatically included in any energy policy because cities need to apply to CEC for approval to go beyond current energy code (Title 24), and in doing so, submit analysis proving cost-effectiveness.