Zero-Net-Energy Buildings

The *2011 IEPR* (and previously the *2007 IEPR*) discussed the Energy Commission's policy recommendations about the pursuit of ZNE Buildings for newly constructed buildings within the Building Energy Efficiency Standards. These policies have been supported by the California Public Utilities Commission (CPUC) in the Long-Term Energy Efficiency Strategic Plan, the ARB in the *Climate Change Scoping Plan*, and Governor Brown's *Clean Energy Jobs Plan*. Further, Governor Brown's Executive Order B-18-129 calls for all new State buildings and major renovations that begin design after 2025 be constructed as zero-net-energy facilities. The Executive Order also calls for achieving zero-net-energy for 50 percent of the square footage of existing state-owned building area by 2025.

The *2011 IEPR* made the following recommendations related to ZNE delivery:

- The Energy Commission should adopt triennial building standards updates that increase the energy efficiency of newly constructed buildings by 20-30 percent in every triennial update to achieve ZNE standards for newly constructed homes by 2020.
- The Energy Commission should adopt reach standards for newly constructed buildings that provide best practices energy efficiency levels for the marketplace to strive for and to serve as a means to pull the industry rapidly to the level needed to achieve ZNE goals.
- The Energy Commission, CPUC, local governments, and builders should collaborate to encourage the building industry to reach these advanced energy efficiency levels in a substantial segment of the market through industry-specific training and financial incentives.
- The Energy Commission and CPUC should coordinate future investor-owned utility "new construction-related" programs with the Energy Commission's efforts to meet the ZNE goals through triennial updates of mandatory and reach standards. By offering incentives for achieving reach standards, providing technology demonstration and development, and conducting pilot programs for demonstrating ZNE solutions, new technologies and building practices will be integrated into upcoming triennial updates of the Building Standards quicker and with more success.
- The Energy Commission, CPUC, builders, and other stakeholders should collaborate to accomplish workforce development programs to impart the skills necessary to change building practice to accomplish ZNE in newly constructed buildings.
- The Energy Commission should adopt appliance standards that focus on reducing plug loads to enable California's ZNE goals to be achieved.

The Energy Commission, CPUC, and partners in the building industries have together made major progress on all of these ZNE delivery recommendations, centrally including the adoption of the 2013 T24 Building Efficiency Standards. This latest code update achieves 25 percent savings over existing code, and comes into effect January 1, 2014.

The *2011 IEPR* also made this additional recommendation related to the definition for ZNE Code Buildings:

> The Energy Commission and the CPUC should work jointly on developing a definition of ZNE that incorporates the societal value of energy (consistent with the time dependent energy valuation approach used for the California Building Energy Efficiency Standards).

The Energy Commission, working with the CPUC, has accomplished this recommendation, and proposes adoption of the following definition.

> "A ZNE Code Building is one where the ~~**societal value of the**~~ **net** amount of energy ~~**provided**~~ **produced** by ~~**on-site**~~ renewable energy sources **dedicated to the building** is equal to the value of the energy consumed annually by the building ~~**at the level of a single "project" seeking development entitlements and building code permits,**~~ measured using the California Energy Commission's Time Dependent Valuation (TDV) metric. A ZNE Code Building meets **an** Energy Use Intensity **value designated in Title 24 for each** ~~**by**~~ building type and climate zone that ~~**reflect**~~ **reflects** best practices for highly efficient buildings."

The adoption of this definition will enable the Energy Commission to update the California Building Energy Efficiency Standards for 2016 and 2019 with clear orientation toward the upcoming ZNE targets. Once the definition is incorporated into CPUC guidance to investor-owned utilities (IOU), it will help **to further** define **and target** activities of the utilities' emerging ~~**technology**~~ **technologies, codes and standards,** ~~**and**~~ new construction, **and other building-related** programs that will be needed to accelerate the shift to ZNE.

The goal for ZNE Code Buildings, established in the *2011 IEPR* and other California policy documents, applies to the design of the building and to its construction, before the building is occupied. The ZNE Code Building concept is that the building is designed with energy efficiency and ~~**on-site**~~ renewable energy production such that the net societal cost of the energy**, as measured under the TDV metric,** used over the course of a year is equal to zero. Actual energy bills will be dependent on how the building is operated by the building owners and occupants after the design/construction stage is long past, and will depend on the application of specific utility rates on their net consumption during each period of the day and month. Public education is important so that people understand that the estimated energy use for the ZNE Code Building is determined for the building design, and that the actual energy use of the building will be depend on how the building is actually operated. Public education should clarify the correct expectations for ZNE Code Buildings, and should also illuminate the benefits of ZNE Code Buildings in achieving optimum energy performance, ~~**improved statewide energy system reliability,**~~ reduced criteria pollutants, and reduced greenhouse gas emissions, as well as non-energy benefits such as improved comfort and building functionality.

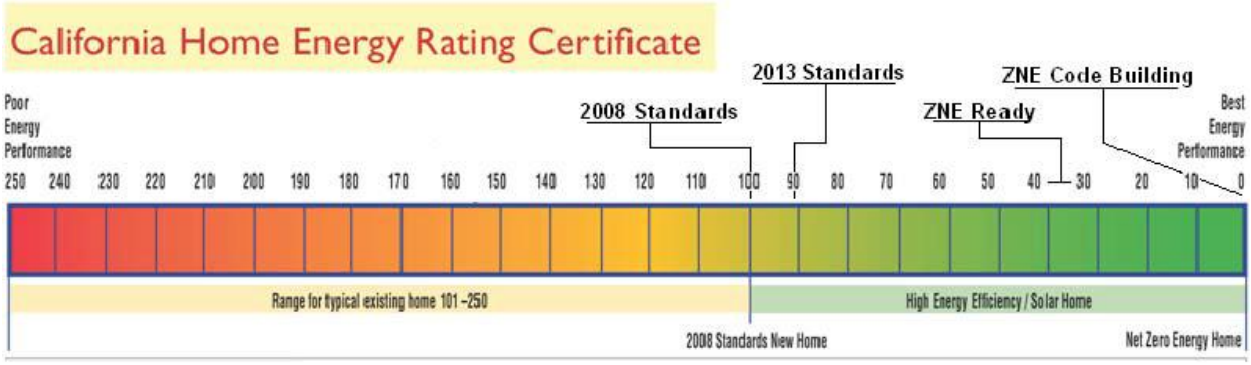
For a building to achieve the ZNE Code Building requirements, substantial energy efficiency advances will be required. Together, the California Building Energy Efficiency Standards, California Appliance Efficiency Standards and the federal Appliance Standards**,** and appropriately-sized ~~**onsite**~~ renewable power production will enable newly constructed buildings in California to reach the ZNE Code Building requirements. Building owners and occupants will count on buildings that have zero or very low energy use levels, depending on how they are operated.

The California Building Energy Efficiency Standards necessarily focus on the capital improvements of the building itself (its physical assets), since those are under the control of the building designer and builder; the Standards cannot influence the portable equipment that is brought into the building later ("plug loads"). Plug loads can, however, be influenced by California and federal appliance standards that apply to portable equipment used by building occupants. The ZNE Building Code determination will be based on "typical" levels of portable "plug load" equipment.

~~**There will be particular buildings or situations where it will be infeasible for the building to meet the ZNE Code Building requirements. In adopting the ZNE Building Code requirements, the Energy Commission will use normal building code practice to establish specific exceptions for these cases. An example of a possible exception would be allowing the use of off-site renewable energy sources where the site cannot accommodate collocated generation of any sort.**~~

The Energy Commission's California Home Energy Rating System (HERS) Program established the California HERS Scale (Figure 1).

Figure 1: Standards on the Home Energy Rating System (HERS) Scale



Source: California Energy Commission

The California HERS Scale establishes a rating score of 0 for the ZNE Code Building. The scale benchmarks a home built to comply with the 2008 California Building Energy Efficiency Standards at a score of 100. A home built to comply with the 2013 Standards will have a HERS of around 90 (varying by climate zone). The graphic also shows a "ZNE Ready" level to represent a home with the energy efficiency improvements that sufficiently reduce demand so that the addition of ~~**onsite**~~ renewable power production could achieve ZNE (the "ZNE Ready" level assumes that the ~~**onsite**~~ renewable power production is not actually installed). A home built to be "ZNE Ready" would have a HERS score in the range of 30 to 40.

Key Terms in the ZNE Code Building Definition

~~***Societal Cost***~~

~~**The societal value of energy includes forecasted energy system costs that Californians pay for energy. This cost of delivering energy to meet building energy demand depends upon when and where it is needed. The societal value of energy is established by the concept of Time Dependent Valuation, first used in the 2005 California Building Energy Efficiency Standards.**~~

Time Dependent Valuation

The societal value of energy for ZNE is established by the concept of Time Dependent Valuation, first used in the 2005 California Building Energy Efficiency Standards. Time Dependent Valuation is based on the forecasted seasonal and hourly costs for generating, transmitting and distributing electricity, and producing and distributing natural gas and propane. TDV values are established for every hour of the year for each type of energy in each of California's 16 climate zones. The **set of societal values considered under** TDV ~~**values**~~ **is specific to the metric's intent to** recognize the premium utility costs that must be paid for energy consumed during peak conditions compared to the substantially lower costs during off-peak conditions – as a result, energy efficiency improvements that drive lower on-peak energy use are highly valued by TDV.

The TDV values that the Energy Commission adopts are based on a forecast of the mix of energy system resources that are expected to be in operation over the 30-year time horizon analyzed for the Building Energy Efficiency Standards. For each 3-year cycle of the Standards, TDV is updated to incorporate the most recent publicly available information on energy systems costs and the forecast is re-evaluated resulting in true up adjustments to the TDV values to capture the impacts of changing energy supply and demand conditions and policies. The Energy Commission will work with all stakeholders in the 2016 Building Energy Efficiency Standards proceeding to update the current TDV values to reflect changes in California's electricity generation system resource mix.

TDV provides a systematic way to recognize the societal value of energy savings accomplished through different times of the year. In theory, buildings with low TDV energy consume less energy during peak conditions, resulting in a reduction in electricity system peak demands, saving Californians the high costs of new power plants and distribution systems on-peak and helping to make the California's energy systems more reliable. For TDV to work in practice as intended, the following is needed: 1) retail rates must reflect the cost of service, and 2) geographic and temporal variation must be taken into account in both TDV calculations and applicable rates. Achieving this requires ongoing cross-agency work on both TDV development and rate reform.

While TDV was designed to value energy consumed by a building it has not yet been enhanced to appropriately value renewable energy generation located on the distribution grid. These modifications are critical to ensure that the TDV metric can appropriately value distributed generation production without shifting associated costs to non-ZNE customers. In the interest of accuracy it will be important to regularly update the cost and benefit values for renewable energy generation in the TDV metric for each subsequent code cycle as well as previous cost effectiveness analyses of distributed generation systems for Title 24.[1] It will also be important to develop a comprehensive test method and performance rating system for DG systems to ensure the value assigned by TDV is delivered, including considerations for climate zone impact on production. These enhancements will be based on relevant research findings and addressed through the TDV update process in the 2016 Building Energy Efficiency Standards Proceeding.

Building On-Site, Single Project, Renewable Energy Sources, Development Entitlements and Building Permits

[1] "Draft Cost-Effectiveness of Rooftop Photovoltaic Systems for Consideration in California's Building Energy Efficiency Standards", prepared for the California Energy Commission by Energy+Environmental Economics, May 2013.

ZNE Code Buildings will be required to ~~**incorporate on-site**~~ **dedicate sufficient** renewable sources to ~~**serve**~~ **offset** the remaining energy demands of the building after energy efficiency capital improvements. ~~**Each single project seeking development entitlements and building permits must install enough renewable energy on-site to reduce the TDV energy of the project to zero.**~~ The ~~**single project**~~ **building** would typically be a single building but could include a bigger project that is seeking (or has approved) development entitlements for more than one building.

Dedicated

There will be a significant number of buildings or situations where it will be infeasible for the building to meet the ZNE Code Building requirements. In adopting the ZNE Building Code requirements, the Energy Commission will use normal building code practice to establish alternative compliance methods which preserve the intent off-setting building consumption with dedicated renewable generation. The inclusion of "dedicated" in the definition provides market actors with flexibility to continue explore and research various least-cost renewable energy solutions that do not compromise the reliability and stability of the California electric grid. Dedicated refers to least-cost on-site and off-site options for associating a renewable energy source with a building that do not result in cost shifts to other customers. These options would need to be vetted through the Title 24 Rulemaking process and concurrently would likely require revisions to existing rate and tariff structures under California Public Utilities Commission jurisdiction.

Energy Use Intensities

The Building Energy Efficiency Standards will set requirements for each ZNE Code Building that include energy-use intensities for each major end-use (for example, space heating, space cooling, lighting, water heating) in TDV energy. These energy-use intensities will be based on evaluation of best practices for highly efficient buildings during Standards update proceedings.