In this first status report on Zero Energy Commercial Buildings, New Buildings Institute (NBI) gathered information to determine characteristics, costs, and features of Zero Energy Buildings (ZEBs) recently constructed in the United States. ZEBs (also called Net Zero or Zero Net Energy Buildings) have garnered attention over the last few years as a focus of some voluntary programs and public policy, most notably on the Pacific coast. Buildings constructed related to these efforts (the Living Building Challenge, for example) are just beginning to emerge.

For this report, we define ZEBs as buildings that use no more energy over the course of the year than they produce from on-site renewable sources. Information was gathered primarily from a variety of secondary sources, although personal conversations were conducted with some owners, designers and occupants. NBI located 21 ZEBs buildings in the United States, which had sufficient available documentation to enable some analysis.

In brief, NBI found that:

• ZEBs have been successfully built in most climate zones of the United States.

• The majority of ZEBs to date are small or very small buildings.

• All buildings to date use photovoltaic (PV) panels to provide their on-site renewable energy.

• Many of the earliest examples are academic buildings or environmental centers, in effect, demonstration buildings sometimes with low occupancy levels. More recent buildings include office buildings, K-8 schools and a credit union; buildings that represent large numbers of “average” or typical buildings. This trend is continuing, and ZEBs are becoming larger and more complex.

• ZEBs are constructed using readily available technology. An integrated design approach with careful attention to building siting and layout, envelope, mechanical systems, and electrical systems is critical to achieve the high levels of energy efficiency employed. Unique or experimental systems are infrequently used to reach net zero goals, but the emergence of new technologies will be a factor in the expansion to more building types.

• As the larger office buildings market moves towards ZEB, minimizing plug loads and other miscellaneous or “unregulated” loads is a priority.

• Reported incremental costs are only available from a few ZEBs, and conclusions or trends are difficult to derive from the limited information available. However, the few reported ZEBs appear to show lower overall incremental costs than the modeled estimates, possibly due to trade-offs with other features in the design and construction process. These costs range from 0% to 10%. Because of the limited information from the small data set of built ZEBs, NBI expanded the scope of the study in two ways. First, NBI reviewed data from a variety of additional low-energy buildings that we have studied for other purposes, and called these buildings Zero Energy-Capable (ZEC).

These buildings demonstrated energy efficiency levels in the range of the documented ZEBs, but many did not include any (or sufficient) on-site renewable generation to cover their annual energy use. There are 29 such buildings (see building lists in Appendix A). In addition, another 29 buildings were found that claimed to be possible ZEB or ZEC, but could not be verified and were not included in the study (see building lists in Appendix A). While identification of new projects continues, we now have a list of 99 projects including verified ZEB and ZEC buildings, as well as unverified “emerging” projects.

Second, NBI included a review of several modeling studies of ZEBs and ZE-Capable buildings. Based on these more extended reviews, it appears that the energy efficiency needed to achieve ZEB levels is readily available, at what are reasonable incremental costs for many owners. These studies showed incremental costs for common building types ranging from as low as 3% to a high of 18%, depending on building type, location cost factors, and climate (i.e. energy efficiency strategies needed in a given climate zone to achieve ZE-Capable levels of performance), not including an appropriately sized PV system.

Key overall conclusions of the study are that:

• ZEBs are uncommon, but increasing in numbers, building size and complexity.

• The efficiency levels needed for ZEBs are readily obtainable, with current technology and at reasonable incremental costs, for many common building types.

Three key recommendations emerge from this review of early ZEB examples.

Practical guidance is needed to help designers, developers, and owners identify areas of opportunity and available resources.

Data collection efforts should be enhanced as more ZEBs are constructed over the next few years. ZEBs are already entering a “second generation” of more typical building types. Ownership patterns and lessons learned from these examples could accelerate interest at both the market and policy levels towards ZEBs and ZECapable buildings.

A better basis for benchmarking performance can come from the emerging experience. With more examples of successful zero energy-capable buildings, the benchmarking focus can shift to a forward-looking target of zero energy rather than comparison with existing building stock. Centrally reported results, with associated building and occupant characteristics, could start with a relatively small set of cases, making increasingly refined benchmarking.

Text is taken from “Getting to Zero 2012 Status Update: A First Look at the Costs and Features of Zero Energy Commercial Buildings”, New Building Institute, March 2012.

Leslie Shao-Ming Sun Field Station: Higher Education
Woodside CA 13,200 SF 2002

Richardson Elementary School
Bowling Green, KY 77,000 SF 2010

Putney Field House: Recreation
Putney, VT 16,800 SF 2009

Aldo Leopold Legacy Center: Office, Interpretive Center
Baraboo, WI 11,900 SF 2007

Oberlin College Lewis Center: Higher Education
Oberlin, OH 13,600 SF 2000

IDeAs Z2: Offices
San Jose, CA 6,600 SF 2007

NREL Research Support Facility: Offices
Golden, CO 222,000 SF 2010

Energy Lab, Hawaii Prep Academy: Education
Kamuela, HI 5902 SF 2010

Photos show 8 of the 20 buildings listed in “Getting to Zero 2012 Status Update: A First Look at the Costs and Features of Zero Energy Commercial Buildings”, New Building Institute, March 2012.