Tucson/Pima County Net-Zero Energy Building Standard

Net-zero energy building and a positive cash flow on day 1

Project Summary
December 1, 2011

If you can not measure it, you can not improve it.
-- Lord Kelvin 1824-1907

The Net-Zero Energy Building Standard project was sponsored by the City of Tucson Office of Conservation and Sustainable Development. Pima County Development Services, Building Safety and Sustainability was the principal research group with assistance from the University of Arizona College of Architecture and Landscape Architecture and Tucson Water. The goal of the project was to develop a building Standard that will provide a prescriptive set of rules for designing a building that generates as much energy as it uses. Through the course of the research four key concepts were developed:

1) The development of a primary metric called Energy Use Intensity (EUI) to measure the predicted and actual energy use. This is analogous to miles per gallon for a car. The current practice for energy efficient buildings is to define them as a percent better than a bench mark. However, this does not measure the energy use and therefore does not provide information needed to size on-site energy production. Therefore a primary metric of energy use intensity (EUI) is required. This metric is 1000 Btu per square foot per year or kBtu/sf-yr.

2) The embedded energy to deliver water to the building must be offset by on-site energy production to achieve net-zero status.

3) The development of an energy budget and the net-zero potential is defined by the ability of the building to generate on-site energy with the energy producing area limited to the building roof (and covered parking in commercial buildings). This requires that buildings be energy efficient which in turn decreases the amount of peak power capacity required by the utility.

4) The net-zero certification will be issued after one year of performance demonstrates net-zero achievement.

There are six parts to the final product or "deliverables" for the project: 1) the Net-Zero Energy Standard, 2) the Economic Analysis Report, 3) the Green House Gas Emissions Reduction Report, 4) a report on the use of evaporative coolers as part of a net-zero building, 5) a power point presentation used for stakeholder feedback meetings, and 6) the web page with interactive calculators and instructions on how to use the Net-Zero Standard.

Net-Zero Energy Standard: The Standard has a prescriptive residential section and a prescriptive commercial section covering apartments, office and retail. These building types represent approximately 30% of total energy use in the metro area. The first step for every project is to develop an energy budget based on the buildings orientation, shape and roof type. For each building type a maximum energy budget is established. The second step is to establish the buildings Energy Use Intensity (EUI) factor. This is the estimated energy that will be used by the building and must be less than the energy budget to be net-zero. Finally the Standard contains tables of building strategies that must be included in the building to achieve the Energy Use Intensity factor. The Net-Zero Energy

Standard also has a performance section for both residential and commercial that will allow buildings that can not use the prescriptive path to achieve a net-zero certification by using energy modeling software.

Economic Analysis: This report on the economic benefits of Net-Zero is one of the final reports of the project. This report introduces the concept of "nega-watt" as a way to compare the cost of building energy efficiency improvements to the cost of PV power and utility supplied power. The report also provides a methodology to determine when the cost of a nega-watt exceeds the cost of electricity produced by PV, thereby creating the tipping-point where further energy efficiency improvements are not financially beneficial and funds should be diverted to the purchase of PV. The key conclusions and recommendations of the Economic Benefits report are:

Conclusions:

- Nega-watts cost less than the cost of utility purchased power. In many cases nega-watts cost less than the cost of incentivized photovoltaic (PV) power.
- Cash flow positive: The decrease in monthly utility bills is larger than the increase in monthly amortized cost due to the energy efficiency improvements and PV power resulting in net positive cash flow to the building owner in the residential and apartment prototypes. The office and retail are not cash flow positive due to the high cost of efficient commercial air conditioning (HVAC).

Recommendations:

- Provide incentives to jump-start the market: reward early adopters, bridge the small cash flow gap in energy efficiency improvement cash flow. Market the program to create demand for the benefits of net-zero. Close the gap on long term financing. *Cash flow positive* is dependent on the inclusion of energy efficiency measures and PV into the initial financing for the construction. Existing loan products exist, e.g., EEM and 203(K) loans, but investor banks have been reluctant to purchase these mortgages due to perceived additional risk.

Green House Gas Emissions Reduction Report: The Net-Zero Building Energy Standard can be an implementation strategy for ten of the action measures listed in the City of Tucson, Community Economic Security and Climate Action Analysis report. These ten measures combine for 22.6% of the green house gas reduction potential identified in the report. The Net-Zero Standard itself has the potential to contribute another 12% reduction in green house gas emissions from the 2020 business-as-usual GHG emissions projection if the Net-Zero Standard is adopted as a mandatory Standard. If the Standard is adopted as a voluntary standard, the potential reduction is estimated to be 2.1%. It is recommended that the Net-Zero Building Energy Standard be a primary implementation strategy for the building related action measures.

Evaporative Coolers: Evaporative coolers, even when considering the embedded energy in water use 90% less energy than air conditioners while only adding 5.1% additional water use. They can reduce peak energy requirements thereby reducing peak costs to electric companies. There is modest increase in overall household water use associated with a cooler. This can be easily offset by simple passive water harvesting and xeriscaping, low flow fixtures or rainwater harvesting which are all requirements of the Net-Zero Standard. Because of the potential to use a cooler as a whole house fan for night time pre-cooling, a cooler can make a cost efficient and effective cooling system for a well insulated, high thermal mass home.

Web Page: A web page was developed by Pima County IT staff.. The web page includes the text version of the Standard as well as calculators to determine energy budget and EUI factors. There is also a calculator to check the economic assumptions of the report and to model the economics of proposed net-zero projects.