CAPITAL
ENGINEERING CONSULTANTS, INC.

Energy Optimization Study

Net-Zero Energy Buildings

INTRODUCTION

Capital provides accurate and informative energy modeling for projects including central utility plants, hospitals, government buildings, office buildings, schools and university facilities. We design and model both traditional HVAC systems as well as high-performance, low-energy strategies including passive solar, radiant chilled slabs and natural ventilation.

Our extensive experience providing comprehensive energy modeling services includes green specialized programs such as USGBC LEED certification, Energy Star and utility incentive programs like Savings By Design. These total building performance energy models demonstrate energy code compliance for new construction, additions, and renovations.

WHY NET-ZERO?

A Net-Zero Energy Building (NZEB) is engineered to generate more energy than it consumes annually with zero carbon emissions. Regulatory agencies are embracing the NZEB standards; in California the California Energy Commission has set a goal of all new non-residential buildings to be NZEBs by 2030. On the federal level, Executive Order 13514 directs that all new federal buildings shall be designed, constructed, and operated to achieve Net-Zero by 2030.

Considering that traditional buildings consume 40% of the total fossil fuel energy in the US, NZEB standards represent a critical step in reducing global carbon emissions. They also can drastically reduce the operating budget for a building, offering dramatic savings over a longer timeframe.

HOW?

A cost-effective NZEB must focus heavily on conservation because all energy consumption is offset, most commonly by a photovoltaic (PV) array. As prices for PV systems continue to fall, building a NZEB has also become more affordable.

Energy conservation, however, is even more economical for a NZEB, as it reduces energy use without installing additional PV. In order to identify the most effective conservation strategies, energy simulations are critical tools for pinpointing and visualizing inefficient systems and sources of heat waste.

By combining annual energy simulations with a life-cycle cost analysis, we can answer important design questions such as "Is it cheaper to install LED lighting than to add more PV?", "Is extreme performance glass more cost effective than additional insulation?" and "Can a high efficiency air conditioning system be less expensive than adding more PV?"

NEW SOLUTIONS

Designing a reasonably priced NZEB requires a different approach than designing a traditional structure. Previously, only the cost of fuel was considered, not the amount energy consumed, whereas NZEB design must weigh the costs of generating on-site energy.

For example, Capital recently analyzed a multipurpose school building where simulations showed that installing heat pump technology, would consume fewer energy units than gas equipment because of its higher heating efficiency. Annual operating costs for the gas equipment were lower, but due to the need to install offsetting photovoltaic generation, the heat pump technology had a lower 20 year life-cycle cost, as illustrated in **Figure 1**. Capital demonstrated that the owner could save $42,500 in onsite generation equipment by choosing heat pumps instead of gas fired equipment.

NEW TOOLS

Advanced NZEB low-energy systems are often difficult or impossible to simulate using conventional energy modeling tools. Only newest generation of simulation tools can model systems such as natural ventilation, radiant heating and cooling, and passive solar, and our Building Optimization team at Capital holds the experience and training to take full advantage of these features.

For example, Capital recently completed the mechanical design and whole building simulation of a 21,000 SF religious campus that had a NZEB goal. The conservation strategies relied on innovative low energy HVAC systems that traditional modeling tools were not equipped to simulate. By utilizing EnergyPlus, Capital was able to capture savings that could not be modeled in other programs. The result was a reduction in the necessary size of the PV array, and an owner savings of over $1,000,000.

Figure 1: NZEB Life-Cycle Cost