

Net Zero Buildings: A Federal Mandate

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Introduction

Buildings use an enormous amount of energy. According to the United States Energy Information Administration (EIA), in 2011 the United States used 97.5 Quadrillion British thermal units (Btu) of energy. Almost one third (1/3) of this energy was consumed in buildings and most of that was in the form of electric energy. Energy consumption drains operating budgets, contributes to air and water pollution, depletes non-renewable resources, and increases our dependence on foreign resources. Numerous programs have been put in place since the early 1970's to reduce energy use. A recent program has spun off of Executive Order 13514 which mandates all new Federal Buildings be net zero by 2030. These proceedings provide detailed information on that program.

Background

Buildings that generate their own energy were commonplace up through the early 1900's. Each building had to provide its own heat and light, typically by burning oil or coal on-site. These buildings were stand-alone, they had to generate the energy they used, moment-by-moment, and throughout the year. A major drawback of having these buildings burning coal and oil on-site was the soot and smog that blanketed major population centers with subsequent ill effects on the health of the building occupants, ill effects on the health of local inhabitants, and the deterioration of the local environment. In addition, the handling of coal and oil was dirty and dangerous work.



Figure 1 - Chimney Sweeper at Work

Using electric energy is much cleaner than burning coal or oil on-site; however, electric energy production requires more complex machinery and skilled personnel to maintain and operate it. As a result, the on-site generation of electric energy was too expensive for most building owners. However, by joining these buildings through a common electric distribution system, the cost and maintenance of the electric generating equipment could be shared by thousands of building owners which made it much more affordable. It was possible to produce the electric energy at a site or sites located hundreds of miles from the buildings that needed the energy, leading to the explosive growth of the electric distribution grid. Once the electric distribution grid was established, buildings became almost totally dependent on it so that, today, very few buildings generate all of their own energy.



Figure 2 – Large Electric Generating Station

Net Zero

A net zero building is a hybrid between the stand-alone buildings of the early 1900's that generated all of the energy they used and current buildings that are dependent on the electric distribution grid. In many ways, net zero buildings are similar to the electric hybrid cars of today which were developed as a stepping stone from gasoline powered cars to electric cars. The idea behind the hybrid car is to use the benefits of both energy sources: electric energy for stop and go driving and gasoline energy for long-distance trips. Net zero buildings also use two energy sources: energy generated on-site and energy taken from the electric distribution grid. But, to be considered net zero, the building also feeds electric energy into the electric energy grid from time-to-time, energy which is distributed through the grid to other buildings.

An example of a net zero building would be one with a large number of photovoltaic (PV) panels installed on its roof which convert sunlight into electric energy. During a clear day when the sun is bright, this building can produce more electric energy from sunlight than it needs. This excess energy can be fed into the electric distribution grid where it is used by other buildings nearby. During cloudy days and at night, the building still needs energy, but no sunlight is available to make electric energy with the PV panels. At those times, the building draws the energy it needs from the electric distribution grid. If,

through the course of one year, this building produces as much excess electric energy as it draws from the electric distribution grid, it is considered a net zero building.



Figure 3 – Aldo Leopold Visitor Center

Benefits of Net Zero

Buildings that generate their own energy offer numerous benefits including:

1. Reduced energy costs
2. Higher efficiency
3. Greater reliability

When a net zero building generates more energy than it needs, the excess energy is sold back to the electric utility that operates the electric distribution grid. Although required by law to purchase power from a net zero buildings, utilities have wide latitude when it comes to pricing that energy. If the utility has excess electric generating capacity, they typically offer the marginal energy rate which runs about 3-cents a kilowatt-hour. If the utility does not have adequate generating capacity, they can offer anywhere from 11- to 22-cents a kilowatt-hour. Before a net zero building is constructed, the design and construction team must meet with the local electric utility, provide details about the on-site generation, and secure an agreement regarding the buy-back rate which will be applied to the excess energy.

Electric generating stations typically use coal, natural gas, or uranium as a fuel source. Unfortunately, most of these fuels end up being wasted due to thermodynamic inefficiency. A state-of-the-art electric generating station that uses natural gas typically wastes two thirds of the gas it burns. Less than one third of that natural gas becomes electric energy delivered to users. If global warming becomes a more

urgent issue and laws are passed to force coal-fired generating stations to sequester the carbon they produce, their ratios are even worse. The best technologies available today would lead to only one fifth of the coal becoming electric energy delivered to users.

Currently, the electric grid is served by large, remote generating stations frequently located hundreds of miles from the buildings that use that electric energy. This setup is vulnerable to storms, accidents, or attacks, anything that could sever buildings from the generating stations. This situation is similar to the vulnerability that pre-dated the creation of the internet. When computers were large and few, massive amounts of data were kept in one place. A fire or vandalism could have created havoc as key information could have been lost forever. Now, with the internet connecting millions of computers and servers together, information is duplicated in many locations making it harder to destroy. Net zero buildings will increase overall electrical system reliability by increasing the number of generating resources on the distribution grid.

Generating Energy On Site

Several common technologies are available that allow buildings to generate the energy that they use. Some have been with us for a long time including the use of natural gas to make hot water or hot air. If your facility has a gas-fired boiler, domestic hot water heater, furnace, or unit heater, you already generate some of your energy on site.

Natural gas can also be used as fuel for cogeneration systems which generate electricity, heating, and cooling on-site. The benefits of a cogeneration are enormous. Cogeneration systems can achieve much higher energy efficiency than our current electric grid system: instead of wasting two thirds of the fuels we burn, we would waste less than one third.



Figure 4 – On Site Cogeneration Can Cut Fuel Cost by One Third

Hospitals, university campuses, office parks, and most building more than 100,000 square-feet in size could benefit from lower costs and greater reliability by installing a cogeneration system. Only politics stand in the way of the wide-spread adoption of cogeneration. The utility industry matured with the central power generation concept which they are reluctant to abandon in favor of a distributed generation concept. This situation is likely to change in the upcoming decade as utilities face a growing demand for

electric energy combined with nearly insurmountable issues that face the construction of new, large electric power plants.

Technologies that use the sun (solar) or wind as an energy source are expensive and have difficulty competing with electric energy purchased from the local utility. However, these technologies have the benefit of being renewable and clean which is an approach with broad public support. As the climate change issues continue to press our politicians, on-site renewable energy will be seen as more and more attractive. However, to deal with the first cost issue, we must first focus on making our buildings more energy efficient. It is far less expensive to save a kilowatt-hour than it is to produce a kilowatt-hour. Increased building energy efficiency with the goal of making buildings net zero, is the backbone of the Federal Government's current clean energy policy.

Executive Order 13514

Executive Order 13524 was issued by President Obama on October 9, 2009 to provide Federal leadership in environmental, energy, and economic performance. The objectives of this order are to increase prosperity, promote energy security, protect the interests of the taxpayers, and safeguard the health of the environment. To comply with this Order, Federal Agencies had 90 days to establish and report reduction targets for greenhouse gas emissions, energy intensity, water use, waste generation, and energy use from non-renewable resources. The Order also states that, beginning in 2020, all new Federal buildings will be designed to be net-zero buildings by 2030 and that 15% of existing buildings will meet strict reduction targets by 2015.

Although the goals of a clean energy economy and reduction of greenhouse gas emissions are clearly stated, the Order is also one that promotes good economic practices by seeking to reduce the Federal Government's operating costs for energy, water, materials, waste disposal, and sick leave/healthcare. Even though one third of the country is set against any new tax no matter what the need or benefit may be, the Order seeks to use only those methods that save money while improving the environment. To achieve these reductions in a way that is measurable, transparent, and does not burden taxpayers, the Federal Government implemented the Guiding Principles program.

Guiding Principles

The Guiding Principles program is administered by the Green Building Initiative (GBI) based in Portland, Oregon. GBI also administers the Green Globes® certification program that has many similarities to Guiding Principles. To date, over 250 Federal Government buildings have been certified. Certification is based on compliance with the following requirements:

1. An integrated, whole building, design approach is used for all new construction and major renovations.
2. Whole building commissioning is used.
3. Energy use must be reduced by 30% beyond current guidelines in new buildings and 20% beyond 2003 levels for existing buildings.
4. Solar energy must be used to meet 30% of the hot water demand.
5. Water use must be reduced by 20% inside the building and 50% outside the building.
6. Indoor air quality and thermal comfort must meet new industry standards, not just code minimums, and day-lighting will be provided in 75% of occupied spaces.
7. Make greater use of construction materials with recycled content, bio-based content, and materials with low or no volatile organic compounds (VOC).
8. At least 50% of all construction waste must be recycled.
9. Ozone depleting compounds must be eliminated.

Guiding Principles Compliance Rating Scale		
Compliance Score (%)	Compliance Logo & Rating	Building Attributes
100%		Meets total compliance to the Guiding Principles for Existing Buildings. A model for sustainable operations and the reduction of environmental impacts among federal government buildings.
80% - 99%		Achieves compliance to most Guiding Principles criteria, and serves as a leader in the sustainable operation of federal government buildings.
60% - 79%		Demonstrates progress in reducing environmental impacts of the facility, but additional work is required to begin meeting compliance to the Guiding Principles.
40% - 59%		Demonstrates a basic level of awareness of the environmental impacts of the facility. Significant improvement opportunities remain for this building.
0% - 39%		Assessed for sustainability; fails to meet minimum requirements to be Certified for Guiding Principles Compliance.

Conclusion

Federal Order 13514 doesn't target just Federal buildings, it also targets any business that provides goods or services to the Federal Government. Federal Agencies are directed to pursue "opportunities with vendors and contractors to address and incorporate incentives to reduce greenhouse gas emissions..." The General Services Administration, Department of Defense, and the Environmental Protection Agency are directed to work with the vendor and contractor community to provide information on tracking and reducing greenhouse gas emissions that result from providing products and services to the Federal Government. The Federal Government is using its vast buying power to say to businesses "Do as we do, or sell your products and services someplace else." You can learn more about Guiding Principles by going to the GBI web site: www.thegbi.org.