Technological and Investment Reasons to Require Net-Zero Energy Today

Net-zero energy capable buildings put in place today will streamline our transition to an energy efficient world.

Several governments around the world are putting in place strict regulatory requirements and goals to require new and renovated buildings to be net-zero energy buildings in the near future. This future requirement places significant risk in the market for any building owner considering a new building today or adding an existing building to their portfolio.

Introduction

Buildings require energy to operate and this energy can originate from either on site or off site. The majority of this energy is derived from fossil fuels that emit CO2 when they are burned, which is why buildings are estimated to account for 40% of the CO2 emitted when fossil fuels are burned[i]. In large metropolises, this figure increases due to the reduction in personnel transportation and industrial processes. Due to the climate effects observed around the world and the large portion of emissions buildings make up, several governments are imposing aggressive regulatory requirements and targeting net-zero energy to be required within one generation. Why wait? The technology exists today to design a net-zero energy capable building that could be put in place and will minimize the risk for the owner's long term investment.

What is a Net-Zero Energy Building?

If we look at a building site as a closed system and the electric and fuel meters as the entry and exit points for all energy used or generated on the site including in and on the building, we can define the net-zero site energy target. Further, as the intent of a net-zero energy building is to reduce CO2 emissions from burning fossil fuels, the site energy must be from renewable sources. So, a net-zero energy building is one whose amount of energy "imported" into the site is equal to the amount of renewable energy generated on site that is "exported" off the site. For electricity this would be equivalent to the electric meter rotating backward, electricity to the grid, and equal number of forward rotations, electricity from the grid, over the course of a year.

There are different definitions for net-zero energy including net-zero source energy, net-zero energy costs, and net-zero energy emissions[ii]. With the exception of the cost definition, they depend on the boundary of study: site, power plant, and atmosphere. The site definition is the easiest to understand and measure for an all electric building.

A net-zero energy capable building is one that is designed to be net-zero energy, but is not fully realized due to budgetary constraints in purchasing today's renewable energy expense. At some point in the future, incremental onsite renewable energy additions can be made so the building fulfills its net-zero energy status in time to meet regulatory requirements.

Regulatory Pressure is Building

Due to the rapid increase in climate change observations, many governments today are targeting net-zero energy requirements for new and renovated buildings as the final energy code. California's Public Utility Commission has set in motion a plan for all new California residential buildings to be net-zero energy by 2020 and all new California commercial buildings to be net-zero energy by 2030. Further, the Energy Independence and Security Act of 2007 puts in motion policies to be put in place for a new commercial building in the United States to be net-zero energy starting in 2030 and all commercial buildings in the United States to be net-zero energy by 2050[iii]. Lastly, the European Union Parliament voted with a 90% majority in favor of proposed amendments to the Energy Performance Building Directive that would require all member states to require all new buildings to be net-zero energy by 2019[iv].

These regulatory plans will only get more aggressive as research solves multiple issues associated with net-zero energy buildings.

Technology or Design?

Is the path to net-zero energy buildings a technology or design solution? It is actually both if you want to minimize the cost. For anyone who has designed a building to be off the grid, they know that minimizing the energy load requirements of their building by making it very energy efficient will save them money on the on-site power plant they need to purchase because they can buy a smaller one. The same concept applies to net-zero energy buildings, but energy efficient technologies can only do so much toward achieving net-zero energy. A building form that is not designed to maximize energy efficiency will put that building at a disadvantage.

For example, the satellite view of the building in Figure 1 is of a typical commercial building with a large floor plate design. Overlaid on the figure is a daylight analysis plot. The red line represents the threshold of 50 foot-candles, the light level necessary to do work at a desk. The owner can install very efficient lighting into the building, but regardless what technology is used, the lights will be on throughout the occupied day in this large interior region. The building in Figure 2, has a much thinner floor plate design and much more of its floor area has sufficient daylight to allow the lights to be off during the day. Further, the corridors are in the central portion where there is less daylight. Corridors require less lighting then workspaces, so this building will require much less electrical power to light it during the day. Therefore, it will be cheaper to retrofit or renovate this building to be net-zero than the building in Figure 1 based on the difference in their design.

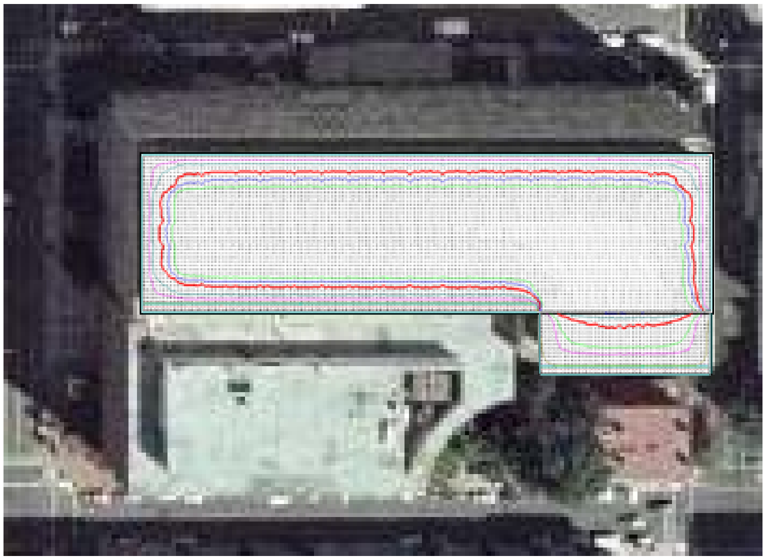

Figure 1- Floor area within red line will have lights on all day.

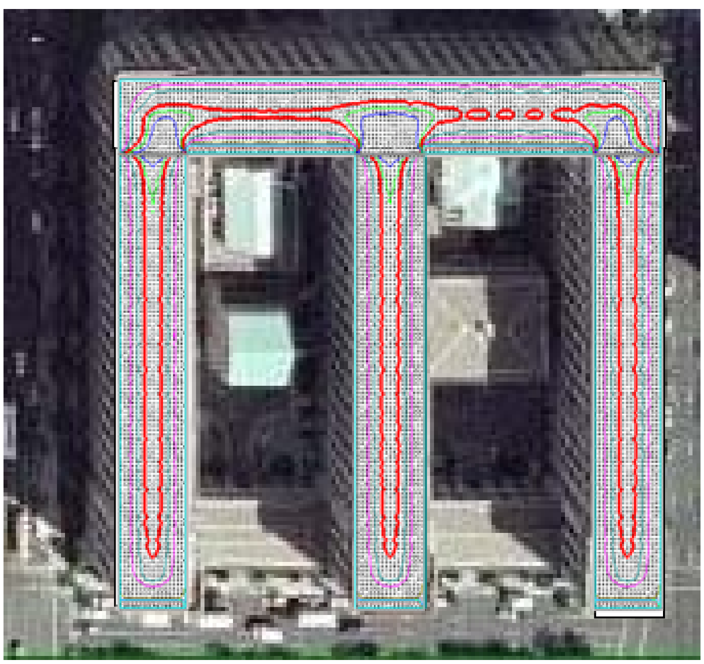

Figure 2- Much smaller area requiring lights to be on all day.

This is why the design of the building makes or breaks the possibility of a building to be as efficient as cost effectively possible. If the design is not as efficient as it can be then the renewable energy system required to achieve net-zero energy will be more expensive.

Key design areas for designing a building to be as energy efficient as possible are in the following table.

Design Area	Strategy
Lighting	Install the most efficient lighting you can afford for the best lighting design you can afford.
Daylighting	Ensure the building form, orientation, and its openings are designed to maximize natural light in the building without dramatically increasing the cooling requirement. Install lighting controls to turn off lights when there is sufficient natural light.
Equipment	Though not regulated today, specify the most energy efficient equipment (computers, elevators, vending machines, etc.) available.
Glazing	Select glazing that maximizes visible light transmission, minimizes solar heat gain and conduction, while balancing the beneficial passive solar effects.
Opaque Constructions	Optimize the construction assembly to minimize energy use while balancing HVAC operation schemes (night ventilation, etc.).
Natural Ventilation	If the local climate and neighborhood permits, design the building to maximize cross ventilation and stack effect.
HVAC System	If all of the above are done correctly and depending on the climate, some or all portions of the HVAC may be able to be eliminated.

These design areas are easy to address in new construction projects using today's building information modeling (BIM) and sustainable analysis tools. With these newer tools a design team can do this design optimization to deliver a net-zero energy capable design in a matter of days rather than the weeks it took in the past. For an existing building, the design is already there, but the owner does not know if the design is net-zero energy capable. Today there are technologies for capturing a building's geometry very quickly from digital photographs and creating the BIM model from such pictures. Once in the BIM model form the required analyses can determine if the building is net-zero energy capable. I expect this workflow to become common practice in considering a building purchase in the future.

Risky Investment

If an existing building is not designed to be a net-zero energy building, it is at risk of becoming obsolete due to the significant cost to renovate it after net-zero energy regulatory requirements are put in place or go into effect.

Is it likely in the future buildings that are not net-zero energy buildings will be uninsurable? The insurance industry has awakened to the risks associated with climate change and are identifying the connection of efficient buildings to lower risk. Will the risks associated with a building not being net-zero energy evolve to be similar to seismically unsafe buildings in seismically active regions of the world? Seismically unsafe buildings are uninsurable, cannot be financed for costly upgrades, and are abandoned. For example, the original 11-story city hall building in Hayward, CA remains abandoned today due to the seismic upgrades necessary to bring it to newer seismic standards[v]. There are numerous examples of abandoned buildings around the world where they are abandoned due to being uninsurable, unfinanceable, or cost-prohibitive to upgrade due to game changing regulations.

A growing number of insurers are identifying customers with green buildings as low-risk customers. These policies provide significant premium discounts for such energy efficient buildings[vi]. Will these policies evolve to be sticks rather than carrots and penalize inefficient buildings?

Conclusion

The building industry is rapidly changing and the regulatory, insurance, and financing markets are helping to drive this change. Fundamentally, a building that is capable of being a net-zero energy building due to its design is a much better investment than one that is not capable.

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[i] World Business Council for Sustainable Development, “Energy Efficiency in Buildings Executive Brief #2 - Our vision: A world where buildings consume zero net energy.” http://bit.ly/3m98iJ

[ii] Torcellini, P., et al. 2006. “Zero Energy Buildings: A Critical Look at the Definitions. ACEEE Summer Study on Energy Efficiency in Buildings.” Golden, Colo.: National Renewable Energy Laboratory.

[iii] Energy Independence and Security Act of 2007, Section 422 (c), http://leahy.senate.gov/issues/FuelPrices/EnergyIndependenceAct.pdf

[iv] European Parliament legislative resolution of 23 April 2009 on the proposal for a directive of the European Parliament and of the Council on the energy performance of buildings, http://bit.ly/2GVEb

[v] http://en.wikipedia.org/wiki/Centennial_Tower_(Hayward,_California)

[vi] Mills, E., 2009. “From Risk to Opportunity Insurers Responses to Climate Change 2008.” http://insurance.lbl.gov/opportunities/risk-to-opportunity-2008.pdf