Moving Toward Net Zero Energy Hospital Building

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INTRODUCTION

Over the past decade the implementation of Green Buildings has grown exponentially as more building designers, contractors, owners, operators and maintenance engineers recognize the benefits of Green Buildings. Efforts made by the building professionals toward Green Building Design has effectively demonstrated reduction in the demand for natural resources such as energy, water, building materials etc., and in many instances projects were rewarded for reduction in operating cost and capital investment for best long term project value. Similar benefits are recognized in healthcare projects.

GREEN HEALTHCARE BUILDING DESIGN

Green Healthcare Building Design continues to evolve with newer versions and rating systems published by the US Green Building Council, Green Guide for Healthcare projects to better serve the Green Healthcare building industry and to quantify results. Many new challenges lie ahead for Green Building Design including the proposed mandate for carbon neutrality by the year 2030, which has kept the sustainable building design momentum moving forward at a feverish pace. In 2008, the US Department of Energy (DOE) issued the Net Zero Energy Commercial Building Initiative with the goal of achieving zero energy commercial building by the year 2025. At the same time, DOE also issued the Energy Smart Hospital Initiative with immediate goals of reaching 30% energy efficiency improvement over current standards for new hospital construction and 20% improvement for existing hospitals. Energy Smart Hospitals provide the following benefits:

- Minimize impact of volatile energy costs
- Improve profitability
- Lower operational and maintenance costs
- Improved environmental quality and performance
- Reduce carbon footprint
- Create healthier patient healing and staff working environment
- Healthier communities

NET ZERO

This article is focused at looking a step further from Energy Smart Hospitals in moving toward net zero energy hospital building, in particular on a site energy basis. There are typically four accepted definitions for zero energy buildings (ZEB) that accounts for energy demand vs. supply and fuel conversions as follows:

- Net Zero Site Energy: A site ZEB produces at least as much energy as it uses in a year when accounted for the site.
- Net Zero Source Energy: A source ZEB produces at least as much energy as it uses in a year when accounted for the source. Source energy accounts for net energy required for generation and transport with typical recognized standard conversion factors used in accounting energy usage and for site generation.
- Net Zero Energy Costs: In a cost ZEB, the cost of onsite generated energy paid by the utility to the building owner is at least equal to the cost of energy paid by the owner to deliver energy services to the site by the utility in a year.
- Net Zero Energy Emissions: In an emission ZEB, emission free renewable energy use is at least equal to emission producing energy use in a year.

As published by the DOE, all types of buildings in the US account for 40% of the US energy consumption and 50% of the US carbon dioxide emission. 18% of that total is from commercial buildings. A typical US hospital consumes 2.5 times more energy than a commercial building with 30 pounds of carbon dioxide emission for every hospital square feet annually. Of the 8,000 US hospitals, $5 billion was spent on energy every year. Studies prepared by the US Environmental Protection Agency EPA and DOE projected future rise in energy cost and healthcare facility energy consumption based on the need for increase in capacity of healthcare facilities worldwide required to support the growth of aging population. Healthcare building design presents both challenges and opportunities in the development of a sustainable facility. Some of the challenges are:

1. The 24/7 operation of the hospital,
2. Infection control,
3. Indoor air quality,
4. High outside air ventilation rate,
5. Stringent temperature and humidity requirements for different spaces
6. Pressurization,
7. High rate of water use and
8. High degree of systems reliability and redundancy

ENERGY EFFICIENCY

Hospitals are among the highest energy consuming buildings with typically up to 48% of the energy required for heating, ventilating and air conditioning, 21% for lighting and 5% for domestic hot water heating (Figure 1). It is easier to conserve energy than to produce energy, striding in our attempt to achieve net zero hospital building, it is prudent to first increase the energy efficiency of the building and its mechanical, electrical and plumbing systems. This step will minimize the energy requirements for the facility and will make it easier to employ renewable methods to generate the energy. This strategy influences the practicality, size and economical feasibility of the renewable energy generation plant.

Figure 2 summarizes the energy efficiency improvements on a whole building energy percentage basis that included some of our proven innovative mechanical, electrical and plumbing systems design strategies and recommended renewable energy measures that balance the remaining energy requirements to achieve ZEB for four types of prevalent climatic conditions around the world. Each project with distinct parameters and goals will require different combinations of energy efficiency and renewable energy measures. Our experience shows that a key objective is to design and to manage energy usage wisely by "moving energy around" in the building, to minimize waste and to minimize the energy differences that require supplementing with renewable energy measures. Every sustainable project

IN SHORT

- **The implementation of Green Hospital Buildings has grown in the last 10 years due to the realiation by building professionals, the advantage and cost saving benefits.**
- **There are four definitions for zero energy buildings (ZEB) that accounts for energy demand vs. supply and fuel conversions.**
- **Renovation of existing hospitals provide a higher energy saving than a newly build facility.**

Figure 1 Typical Hospital Energy Consumption

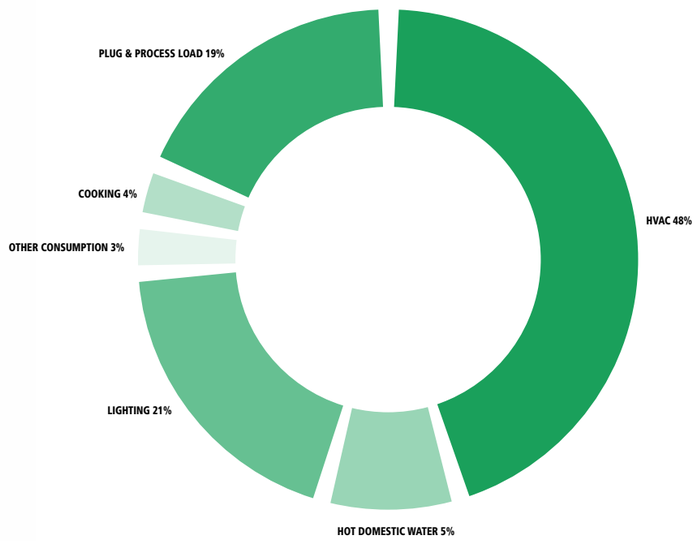

Figure 2 Net-Zero Energy Hospital Building Design Options by Climate

	Mid Climate (San Francisco Bay Area)	Cold / Hot & Humid Climate (Chicago)	Hot & Humid Climate (Abu Dhabi)	Hot & Dry Climate (Riyadh)
On-Site Innovation Design				
Passive Solar & Architecture	7.0%	10.0%	11.0%	11.0%
Day Lighting	2.0%	2.0%	2.0%	2.0%
Plug & Process Load	7.0%	7.0%	7.0%	7.0%
Water Savings	1.5%	1.5%	1.5%	1.5%
Heat Recovery (Primary) Constant Air Volume	8.8%	8.0%	-0.7%	10.0%
Heat Recovery (Primary) Variable Air Volume	12.6%	11.9%	10.1%	9.1%
Heat Recovery (Secondary) VAV	0.8%	1.2%	3.0%	3.2%
Heat Recovery (Tertiary) VAV	1.4%	2.0%	3.9%	4.0%
Unoccupied Setback	0.9%	0.8%	0.8%	0.5%
Displacement Ventilation	1.4%	1.4%	1.4%	1.4%
Fuel Cell / Cogeneration	2.5%	2.5%	2.5%	2.5%
Lighting	7.8%	7.8%	7.8%	7.8%
Sub-Total Innovative Design	54.0%	56.0%	50.0%	60.0%
On-Site Renewable Energy				
Solar	8.0%	7.0%	10%	10.0%
Photovoltaic	8.0%	7.0%	10%	10.0%
Geothermal	5.0%	5.0%	5.0%	0.0%
Wind Turbines	5.0%	5.0%	5.0%	0.0%
Off-Site Renewable Energy	20.0%	20.0%	20.0%	20.0%
TOTAL:	**100%**	**100%**	**100%**	**100%**

'Hospitals are among the highest energy consuming buildings'

should be analyzed based on the local environmental design conditions and available natural resources. For example, the Middle Eastern countries have extreme weather conditions with limited water resources but hospitals have a very high potable water use requirements. If one were to compare a hospital to a hotel of the same bed count, the potable water use of the typical hospital would be approximately three to four times that of the typical hotel.

The high demand for potable water presents many opportunities for significant water savings where additional energy can be saved because of the high cost in producing potable water and to dispose of water waste.

The design community has to continually work on the following important issues in the coming years to achieve the goal of a net zero energy hospital building:

- Educate the building owners/ stakeholders on the true costs and benefits of adopting green/ sustainable design solutions.
- Develop tools and processes to understand the complex interaction of building components and systems throughout the building life cycle in a healthcare environment.
- Develop new building envelope materials, components, systems and construction techniques to minimize building energy loads. For example double wall building façade systems employed by TJEG for projects in the harsh environments of Abu Dhabi.
- Develop ultra energy efficient MEP systems and components to minimize the energy usage.
- Develop ultra efficient water fixtures and systems and technologies to recycle and harvest the grey water.
- Develop new processes that minimize waste generation and provide maximum recycling opportunities.

CONCLUSION

In the past decade, the MEP industry has undergone a major transformation due to the implementation of sustainable building design measures on projects. The guidelines for sustainable building design for hospitals is being set by US Green Building Council "LEED", Green Guide for Healthcare, Emirates Green Building Council, and the Abu Dhabi Green Buildings Council. These are excellent guidelines for implementation of Green Buildings that encourage and initiate innovation for the new designs toward net zero energy buildings.

New construction healthcare facilities offer the greatest energy savings on a building-by-building basis. However, renovation of existing healthcare facilities will provide the maximum overall energy savings potential because of their long service lives remaining and the large number of facilities in operation. We encourage every design professional to integrate principals of the sustainable design into their practice when working on new and/ or renovation projects. These designs should look at reducing the overall energy and water consumption and related emissions of greenhouse gases. The facility will be rewarded with higher indoor air quality, lower buildings first and operating costs and above all an environment that meets its mission of saving lives. Effective stewardship of resources will improve the economic and environmental sustainability for the hospital facility, local community, and the world and will be a gift for our future generations. HB

REFERENCES

References available on request (magazine@iirme.com)