The New Fuel: Efficiency

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ABSTRACT

Emerging new technologies can drastically reduce the energy consumption of buildings in the United States. In this article we look at overall energy usage, where our supply sources for energy emanate, and how they are used throughout the United States in the different demand sectors. With a goal to reduce buildings' energy consumption to zero energy, different building components are discussed, including the building envelope, HVAC, fenestration, lighting, energy recovery, hydroelectrics, photovoltaics, and energy recovery. We discuss the different components that are commercially available today.

DISCUSSION

There is a saying in the energy business, "There are six sources of energy: oil, natural gas, coal, nuclear, renewable, and *conservation*." The easiest way to have more is to use less—to be more energy efficient. Conservation, specifically energy efficiency, is the easiest and best way to have more of our energy resources. For quite some time, people have discussed the concept of greatly reducing the energy consumption of buildings, or even creating something called a zero energy building. A zero energy building is not necessarily off the grid. It can simply be a building that produces more net energy than it consumes but can effectively use the grid as power storage. In the middle of the day, a net zero building would use photovoltaics to generate electricity, and the building itself would be so efficient that it would have net excess power to contribute to the grid. Then at night, when the photovoltaics are not working, the building would pull the energy contributed to the grid during the day, effectively using net zero power (the origin of the "zero energy" moniker).

There have been high-efficiency energy design guides and codes adopted and accepted throughout the United States that are geared toward making commercial, residential, and industrial buildings more efficient. In this article we will discuss in more detail what it takes to make a building sufficiently energy efficient to actually be called a zero energy building. If we became 30% more efficient, we would be able to accomplish dramatic reductions in energy consumption and manage our energy usage such that we would not be an importer of energy but actually could become an exporter of energy, dramatically reforming the nation's trade deficit.

According to the United States Department of Energy, there are more than 120 million homes and 70 billion square feet of commercial building space in the United States. Collectively, they expend 40% of all energy consumed in the United States and slightly more than 70% of all electricity generated. Any typical building can theoretically be hooked up to a large enough photovoltaic system. But experience has shown that doing this involves a very heavy investment in photovoltaics, which can be a very expensive investment. From a practical matter, it is more cost effective and more reasonable to approach a zero energy building design by first conserving as much energy as possible and then sizing the primary energy generator to the new, greatly reduced load.

From our discussion it can be seen intuitively that it is not going to be difficult to reduce the energy consumption of typical building construction by more than 50%. Consider the different components that are really needed to create a passive, or zero energy, building.

The first component is the envelope. The first step is to tighten up a building with walls and floors, typically at R-40, and roofs at R-60 or better. When a building is this tight, normal infiltration nearly disappears. Code mandates mechanical ventilation to bring air in, or the use of energy recovery, which is needed to make the air in the building safe and to meet the ventilation standard, ANSI/ASHRAE

62.1, 2004.

The next component is lighting. Old standard high efficiency was one watt per square foot. New LED lighting, which is commercially available but very expensive at this time, can take this lighting load down to less than an order of magnitude, under 0.1 per square foot or better. Many buildings exist today with lighting easily over 2 watts per square foot using old, inefficient T-12 lighting. In many states, there has been a push to incentivize the replacement of old lighting with new, high-efficiency T-8 or T-5 lighting. The LED is an order of magnitude more efficient than these new ones.

The next component is the HVAC (heating, ventilating and air conditioning) system. The latest widely accepted standard is ANSI/ASHRAE 90.1, 2004, where minimum ER standards are in the low teens, or 11 to 13. New technologies can easily exceed an ER of 60, while geothermal or other typical systems with an ER of 20 or better are common.

The fourth component is to recover energy from the air that is mandated by code to be exhausted from the building. This consists of anything (from polluted indoor air to bathroom exhaust to simple air turnover) needed to keep the indoor air quality good. Traditional technologies and air to air energy recovery are typically 45% to 50% efficient, with very high static pressure drops. There are new high-energy efficiency technologies emerging with efficiencies over 90% and extremely low static pressure drops, as low as a quarter of an inch. This provides twice the energy recovery, using one fifth of the power consumption. Again, the trend here is that with high energy efficiency, buildings emerge as much as ten times more efficient than the status quo.

If all of these energy-reduction options are combined, the overall effect is that the photovoltaic system can be one tenth smaller. Given the fact that photovoltaic systems are extremely expensive, this will make a zero energy building relatively cost effective, even on a first-cost basis. However, the true measure of the cost efficiency of a building is what is measured over a lifetime of use, or life-cycle costing.

A strong motivating factor for encouraging high-efficiency buildings is the alarming trend regarding our nation's energy consumption and sources of energy. In October, 2009 alone, United States petroleum imports (crude and products) totaled 10,652,000 barrels per day. At an average cost of $76 per barrel, this represents a transfer of over $24 billion that month. On an annualized basis, it equates to over $291 billion added to our nation's trade deficit. In 2008, the year of the world's highest oil prices, the figure was closer to $475 billion. As T. Boone Pickens says, this represents "the greatest transfer of wealth ever in the history of mankind." What we see, as we look at different national reporting sources, are some striking points that we can evaluate and discuss. The Energy Information Administration conducts the Commercial Buildings Consumption Survey (CBECS) to collect information and energy-related building characteristics; in 2003 CBECS reported that commercial buildings:

- Totaled nearly 4.9 million buildings
- Comprised more than 71.6 billion square feet of floor space
- Consumed more than 6,500 trillion Btu of energy, with electricity accounting for 55% and natural gas 32% (See Figure 1.)
- Consumed 36% of energy for space heating and 21% for lighting (See Figure 2.)

Using these percentages, if we made our HVAC systems twice as efficient, that would represent an 18% gross reduction in energy consumption. With lighting, if we improved our energy efficiency from one watt per square foot down to .1 watt per square foot, we would literally knock out the vast majority of the energy used for lighting. Just from these two examples, it is clear that we can make a significant impact on gross national energy consumption.

From Figure 1 we see that our largest source of energy is petroleum at 37.1%. In October, 2009, the United States imported 56.4% of its petroleum from foreign sources, as opposed to 67% in October, 2008. However, the decline is attributable to the decline in the economy. Without the changes recommended herein and elsewhere, the percentage of US foreign oil imports is expected to grow again as the economy improves. (Figure 2 shows recent data showing the top ten sources of crude oil and petroleum imports of the United States.)

As can be seen from Figure 1, a large percentage of energy consumption is by buildings, either industrial, residential, or commercial. It should also be noted that the electric power generation is basically used by the buildings. Totaling these numbers, we find that 72.2% of

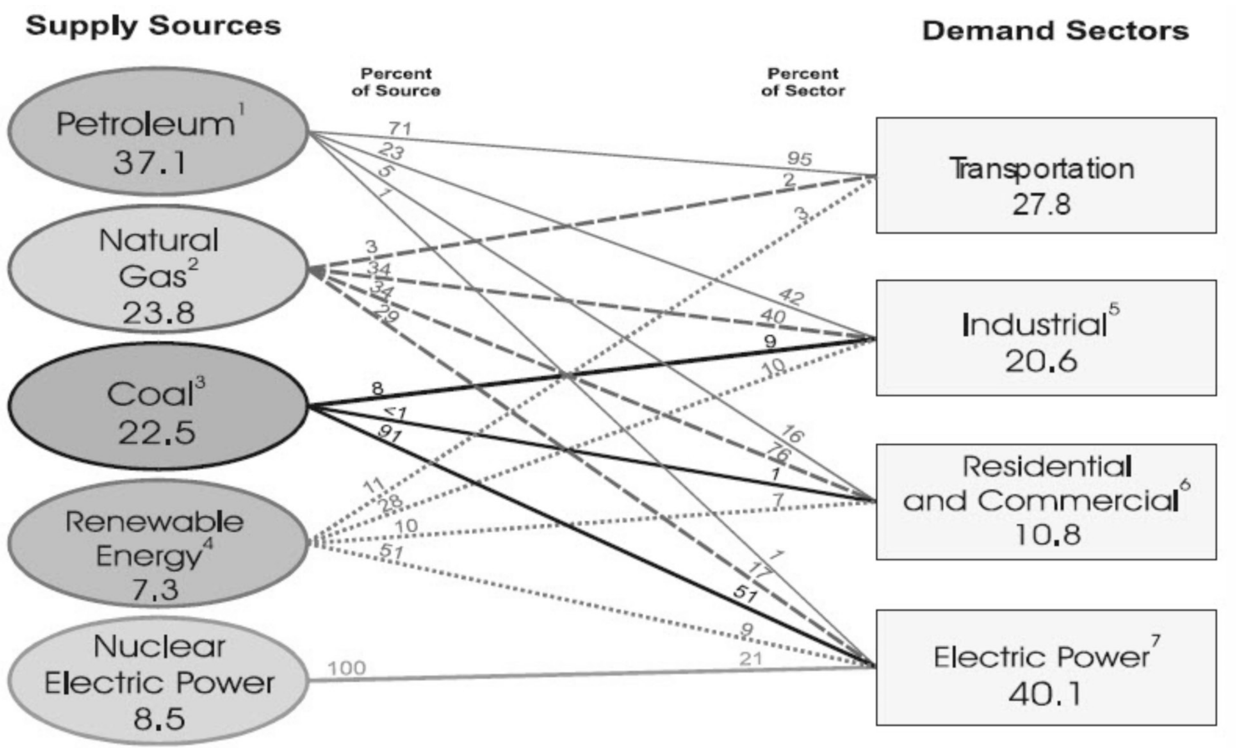

Figure 1. Note: as referenced form the Energy Information Administration Annual Energy Reviewed, 2008 measured in the quadrillions.

Estimated Crude and Products Imports to the U.S. from Leading Supplier Countries August 2009

		(Thousand Barrels per Day)	% of Total Imports	% of Domestic Product Supplied
1	Canada	2,282	25.0%	12.2%
2	Venezuela	1,036	11.4%	5.5%
3	Nigeria	898	9.8%	4.8%
4	Mexico	851	9.3%	4.5%
5	Saudi Arabia	765	8.4%	4.1%
6	Algeria	542	5.9%	2.9%
7	Russia	512	5.6%	2.7%
8	Iraq	500	5.5%	2.7%
9	Angola	364	4.0%	1.9%
10	Colombia	238	2.6%	1.3%
	Other	1,136	12.5%	6.1%
	Total	9,124	100.0%	48.7%
	OPEC Countries	4,427	48.5%	23.6%
	Persian Gulf Countries	1,464	16.0%	7.8%

January-August 2009

1	Canada	2,242	22.2%	12.0%
2	Venezuela	1,108	11.0%	5.9%
3	Saudi Arabia	1,051	10.4%	5.6%
4	Mexico	956	9.5%	5.1%
5	Nigeria	724	7.2%	3.9%
6	Russia	621	6.2%	3.3%
7	Angola	492	4.9%	2.6%
8	Algeria	469	4.7%	2.5%
9	Iraq	461	4.6%	2.5%
10	Brazil	306	3.0%	1.6%
	Other	1,651	16.4%	8.8%
	Total	10,081	100.0%	54.0%
	OPEC Countries	4,789	47.5%	25.6%
	Persian Gulf Countries	1,763	17.5%	9.4%

Source: DOE, Petroleum Supply Monthly, October 2009

Figure 2. Estimated Crude and Products Imports to the U.S. from Leading Supplier Countries, August 2009

the energy used in the United States is used either directly for residential, commercial, or industrial buildings, the electric power to drive these different buildings, or the infrastructure supporting them.

If we were to reduce our electricity usage and energy consumption for heating, cooling, and ventilation in these different building types, we would find that we could easily have more energy for transportation in the United States. Another way to look at this is that more energy would be available for storage, say in batteries or pressurized air, and more natural gas would be available for trucks and cars in the form of compressed natural gas or liquefied natural gas. By making buildings more energy efficient, we can use the energy that is already being produced to power, light, heat, and cool buildings and thus have more domestic forms of energy available for transportation. (Figure 3 illustrates the locations of the major known natural gas shale basins across the United States.)

This would have many benefits, such as:

1. Improving our economy. (Oil- and gas-producing jobs have some of the highest average payrolls in the economy and one of the highest multiplier effects for creation of additional jobs.)
2. Reducing our nation's trade deficit.
3. Making the United States more energy independent.
4. Greatly improving air quality.
5. Significantly helping to achieve compliance with national ambient air quality standards, due to greatly reduced air emissions resulting from greatly reduced electricity generation.
6. Reducing greenhouse gas emissions.
7. Improving the environment and the world in which we live.

In Figure 4, we see that electricity accounts for more than half the energy consumed for commercial buildings. We see that 55% of the energy is electric, totaling 3,559,000,000,000 Btu per year.

In Figure 5, we see that more than half the energy consumed in commercial buildings is for lighting and heating. Further, we can note that HVAC, lighting, ventilation, and water heating is 80% of the energy consumed in a typical U.S. building stock. However, in Figure

Figure 3. **Source: American Clean Skies Foundation, compiled from various sources; Navigant Consulting; CNG-Now.com**

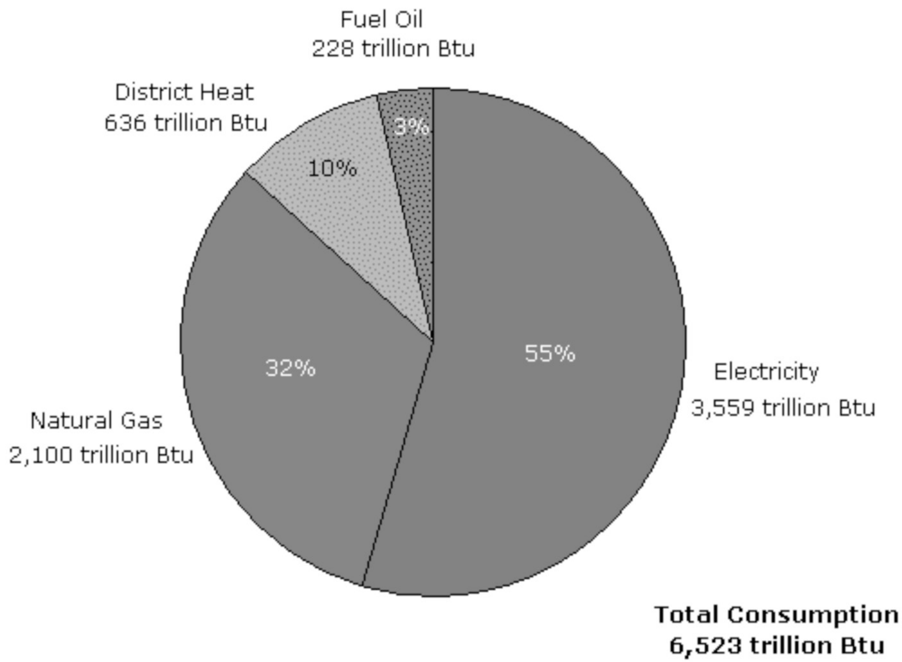

Figure 4. Electricity accounts for more than half of the energy consumed by commercial buildings.

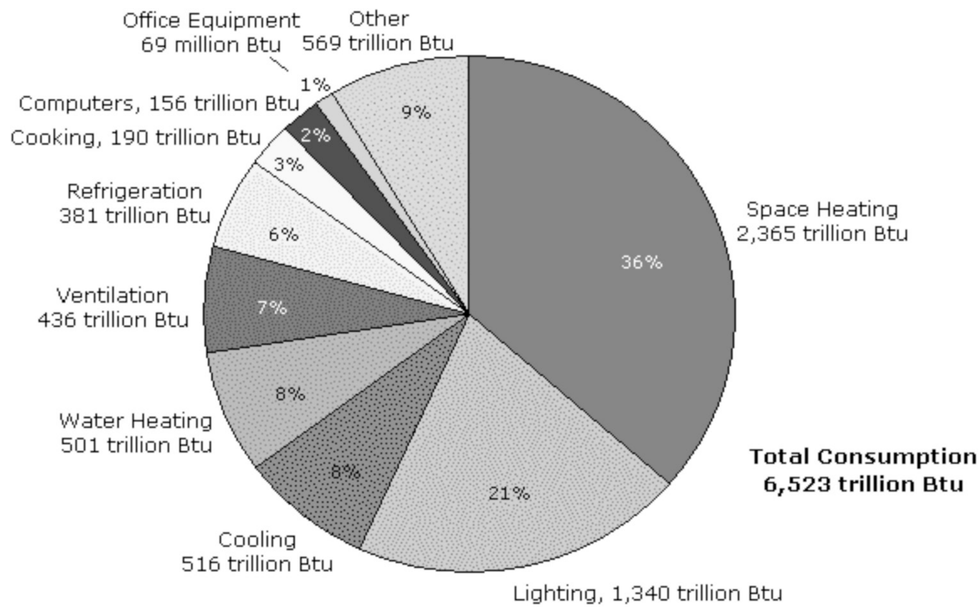

Figure 5. More than half of the energy consumed in commercial buildings is used for space heating and lighting. Reference: Energy information Administration, 2003 Commercial Buildings Energy.

5, ventilation is understated. Only the power to drive the ventilation fans was considered. In reality, the energy needed to heat and cool the incoming ventilation air is represented in the cooling and heating segments of this chart and *actually accounts for over half of the energy consumed by commercial buildings in the United States.*

Individual reports have stated that in high occupancy uses such as schools, ventilation can create 70% of the heating and cooling load. If we look at passive buildings and high-efficiency, energy recovery HVAC, this energy consumption can be cut in half, and in a net zero building this consumption can be cut by an order of magnitude. This not only reduces uncomfortable drafts and comfort issues, it also saves a lot of energy and makes it literally 10 times more practical to have a building running just from photovoltaics.

To review major trends in the history of ventilation (see Figure 6), we can make the following observations:

- The highest ventilation rates were in the late 1800s.
- The lowest ventilation rates were in the 1980s.
- The most challenging engineering design is after 2000.

Ventilation can have a huge impact in buildings as the building envelopes are tightened up, making the building more energy efficient. As mentioned above, ventilation rates were at their highest in the 1800's, and the lowest ventilation rates that we have seen in the last hundred years were recorded in the 1980's. Moving fast forward to the year 2009, we find that the most challenging engineering design is NOW. While the ventilation rates took 80 years to reduce to 5 cfm, they are now shooting up to over 20 cfm or more for some applications.

From Figure 6, we can see how this ventilation trend progressed over the last century. It is interesting to note that during the period from 1900 to 1934, the entity that described the ventilation rate and provided some guidance for heating, cooling, and ventilating buildings was not called ASHRAE; it was called ASHVE, the American Society of Heating and Ventilation Engineers. With the advent of chillers and internal cooling, the need for excessive ventilation rates dropped, and the primary form of comfort was created by cooling the air, rather than over-ventilating a building. With the development of

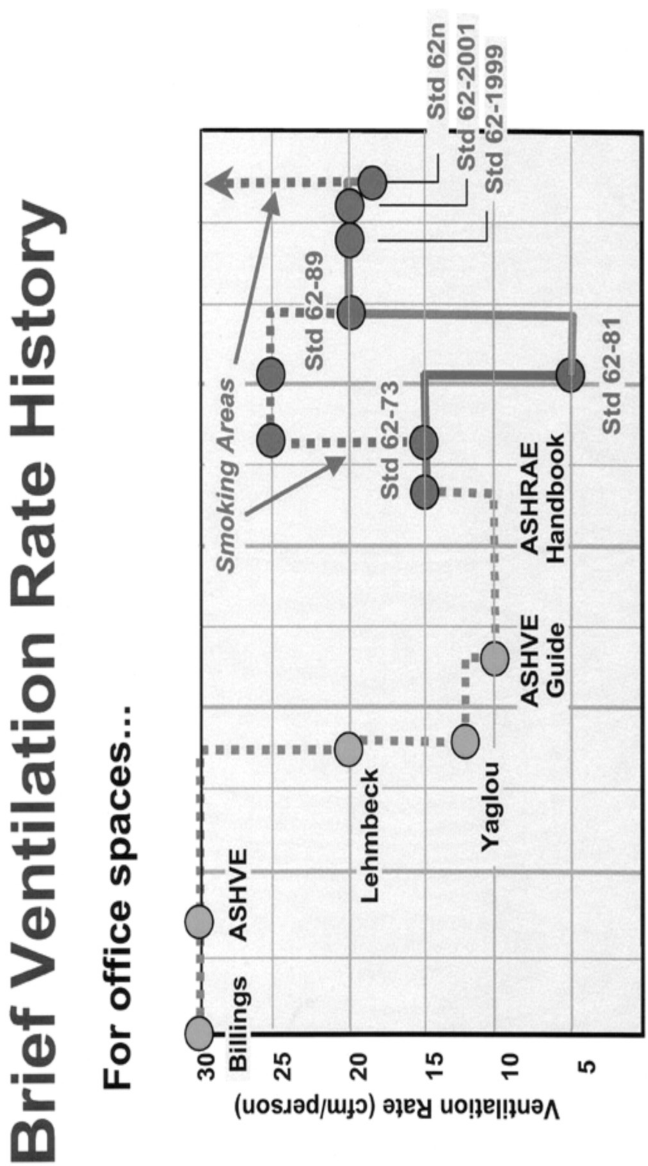

Figure 6. Ref.: Fred Kohloss, P.E.—Past President of ASHRAE "History of Ventilation Rates," June 2003

central air conditioning and mechanical refrigeration, ASHVE became ASHRAE.

We can see that the 1970s were affected by the energy crisis, which further reduced ventilation rates in an effort to save energy. From a practical experience, in a medium sized hospital, reducing ventilation rates from 20 cfm/per person (cubic foot of air per minute and per person in the building) closer to 5 cfm/per person can account for well over $100,000 of energy savings a year in a 100,000-sq.ft. building. In some facilities, misguided incentivized bonuses for building operators to save energy have created a situation where people are being rewarded for creating poor indoor air quality.

In 1980 there was large number of people stating that indoor air quality was a big concern, which again prompted the code-makers of the time to re-evaluate ventilation standards. While it took 80 years to go from 30 cfm/per person down to 5 cfm/per person, it took less than 20 years to go from 5 cfm/per person to what is now something in excess of 20 cfm/per person, as is shown well in this chart.

In Figure 7, we find that there is a fairly large percentage of people who are dissatisfied with indoor air quality when the air flow is below 10cfm per person. Looking at the left side of the graph, we see the percentage of dissatisfied visitors. At 10 cfm, there is over 20% dissatisfaction, and it varies between males and females. Going to a ventilation rate of 20 cfm per person, the percentage of dissatisfied visitors drops to below 20%. Getting up beyond 40 cfm per person, we find that the percentage of dissatisfied visits to the building drops to about 10%. People appreciate better ventilation rates, and the cost for this can be excessive.

We look at transportation as being 27.8% of energy consumption, and all buildings and infrastructure as being 72.2% of energy consumption. When bringing in ventilation air, we want to do so with low pressure drops and with good thermal pre-conditioning of the code-mandated fresh air that is being mechanically introduced to the subject building. The fresh air not only meets code but also helps people breath and enjoy better indoor air quality (IAQ).

One of the secrets to high-efficiency energy recovery or mechanical ventilation is sizing ductwork and equipment correctly so that pressure drops are very low. Very low pressure drops with very high-efficiency, reverse curve, air foil-bladed inline fans can result in energy efficiency ratings (EER) that exceed 100 in the winter time. This

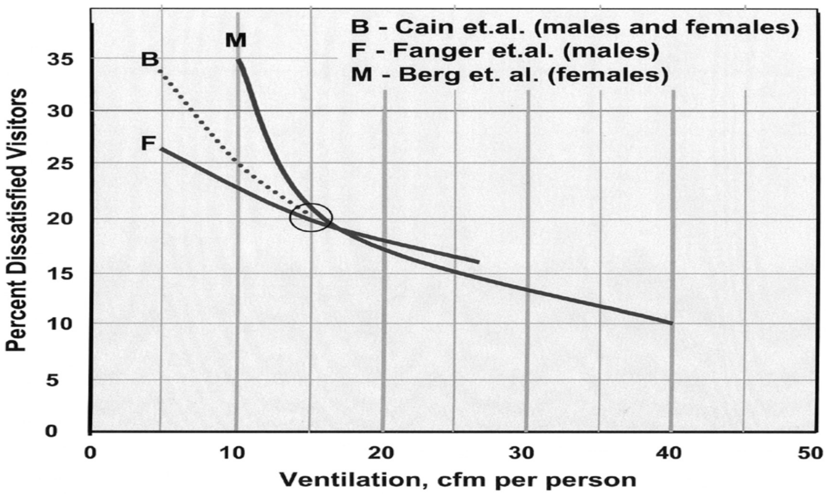

Figure 7. Ref.: Fred Kohloss, P.E.—Past President of ASHRAE "History of Ventilation Rates," June 2003

Figure 8

Figure 9. Reference: Building Performance Equipment Inc.® Case Studies

means that, with the right equipment, over 100 Btus can be recovered for every watt of energy used to run the energy recovery ventilator (ERV). This, again, is 10 times or an order of magnitude more efficient than the standard for typical HVAC equipment.

Referencing American Refrigeration Institute (ARI) Guideline V, 2003, we find the mathematical model for EER is further defined as shown below[6].

Integrating the Efficiency of the Energy Recovery Component with the Efficiency of Cooling and Heating Equipment

CEF can be defined on a comparable basis to existing EER and COP ratings, based on the performance of the individual components. The basic principle (illustrated here for the cooling case) is:

AAHX = air to air heat exchanger

$$CEF = \frac{\text{net cooling delivered}}{\text{total electric consumed}} \quad 8$$

$$= \frac{\text{cooling}_1 + \text{cooling}_2 + \text{cooling}_{n-1} + \text{cooling}_n}{\text{power}_1 + \text{power}_2 + \text{power}_{n-1} + \text{power}_n}$$

When an AAHX is combined with a unitary air conditioner, the AAHX provides a portion of the system cooling capacity, and the vapor compression cycle of the unitary air conditioner provides the rest. Consistent with the basic principle,

$$EER = \frac{\text{net cooling capacity}}{\text{total electric power consumption}} \quad 9$$

The cooling system combined efficiency ($CEF_{cooling}$) of a unitary air conditioner with an AAHX cooling component can be defined as:

$$CEF_{cooling} = \frac{\text{AAHX net cooling capacity}}{\text{+ unitary net cooling capacity}} \quad 10a$$

$$\text{AAHX electric power consumption}$$
$$\text{+ unitary electric power consumption}$$

The heating system Combined Efficiency ($CEF_{heating}$) of a unitary air conditioner with an AAHX heating component can be defined as:

$$CEF_{heating} = \frac{\text{AAHX net heating capacity}}{\text{+ unitary net heating capacity}} \quad 10b$$

$$\text{AAHX electric power consumption}$$
$$\text{+ unitary electric power consumption}$$

These equations are an accurate way to evaluate the addition of heat recovery and energy recovery equipment to traditional HVAC equipment. Using different types of energy recovery equipment can

Figure 10. Reference: Building Performance Equipment Inc.® Case Studies

add electric loads to the energy usage and affect the overall EER number.

From the case study illustrated in Figure 9, we find that high-efficiency direct counter flow energy recovery can have a very dramatic impact on an industrial application, in this instance providing indirect evaporative cooling or partial air conditioning for a mechanical compressor room. It can be noted that no traditional mechanical cooling was used, just a micro misting section in the exhaust stream, which added cooling to exhaust air without adding moisture load to the incoming fresh air.

Effectively this can reduce the temperature in the mechanical room from well over 120°F on a hot summer day to a more conditioned temperature of 86°F. While still not a comfortable office environment, this is a dramatic improvement for heavy physical work in an industrial setting.

This application of high-efficiency energy recovery improved workers' comfort and had a simple payback of less than one year! The following energy savings and reduced pollution are:

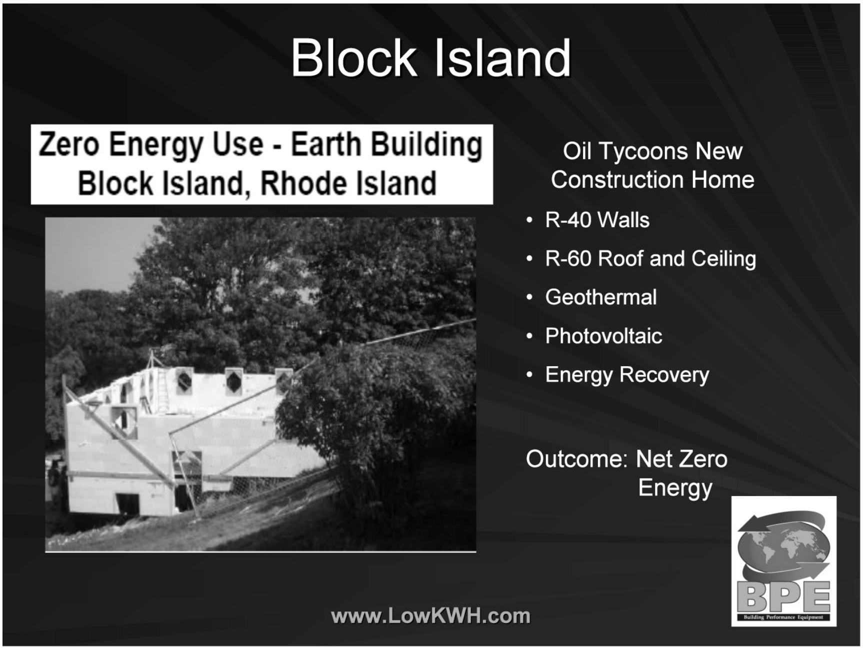

Figure 11. Reference: Building Performance Equipment Inc.® Case Studies

Energy Savings	Saving	CO_2	SO_2	NO_x	Cars*
Electric	188,853.00 kWh	104,435.71 lbs	213.67 lbs	258.4 lbs	9.12
Gas	23,135,820,000 Btus	1,108,899.85 lbs	2,268.71 lbs	2,743.56 lbs	96.85

*Equivalent number of passenger cars taken off the road in 1 year, based on estimated average 12,500 miles traveled per year, releasing on estimated 11,450 pounds of CO_2 per year. Referencing EPA Office for Transportation and Air Quality at www.epa.gov/otaq/consumer/f00013.htm

The biggest impact, however, was not energy savings but worker comfort! With very cold winters in New Jersey, adding energy recovery ventilation tempered 100% outdoor air well enough that cold drafts were reduced and workers' comfort and productivity improved.

This building is a good example of when everything is done right, the result can be a net zero energy building with great creature comforts and practical off-shore living. This could include well engineered and architectural features such as:

- Improved envelope
- High-efficiency HVAC
- High-efficiency energy recovery ventilation
- Earth construction (the structure being built into the side of a north facing hill)
- Photovoltaic panel, for electric power
- Lead acid batteries, for use at nighttime and when the sun is not shining

The ventilation was installed with dedicated outdoor fresh air, with the exhaust air pulled from the mechanical room via the lead acid batteries. It provided great IAQ while reducing or eliminating any problem gases from the battery storage system, resulting in a net zero energy building.

CONCLUSIONS

- Currently available technologies, tested in actual working buildings, can support net zero energy-use buildings.
- The initial cost is typically higher than traditional construction.
- The 20-year life cycle cost is a fraction of traditional construction.
- During energy price increases and blackouts, there are no business interruptions or business impact with net zero energy buildings having energy storage.
- High-efficiency lighting, building envelopes, energy recovery, and HVAC systems are all needed to produce a net zero energy building.

References

1. SPECS, 2008, Reinventing, Facilities Management, Dallas, Texas, March 9-10, 2008, Ventilation: The V in hVac Got Glow? Coauthor; Klas C.

Haglid, P.E. –CEO—Building Performance Equipment Company, Inc.® and Haglid Engineering Incorporated®. Coauthor; Carl Nottberg—Senior Vice President of Operations—US Maintenance, Coauthor; Wayne Barnes—Circuit City.

2. "Dehumidification: Using Air-to-Air Energy Recovery to meeting the Humidity Control Requirements in ASHRAE Standard 62.1 Addendum X." Department of Defense—Industrial Workshop, Orlando, Florida, February 2004 Author; Klas C. Haglid, P.E.
3. Department of Defense—Industrial Workshop, February, 2004, Gettysburg, Pennsylvania, Using Air-to-Air Energy Recovery for Industrial Process and Energy Optimization to Comply with 90.1 and Score with LEED, Author; Klas C. Haglid, P.E.
4. 1984 ASHRAE Handbook, HVAC Systems Volume, Chapter 7—Heat Recovery Systems. Published by ASHRAE
5. ASHRAE Standard 62.1-2004—Ventilation for Acceptable Indoor Air Quality (ANSI Approved), Published by ASHRAE
6. 2003 Guideline for Calculating The Efficiency of Energy Recovery Ventilation and Its Effect on Efficiency and Sizing of Building Systems, Guideline V., Published by Air-Conditioning & Refrigeration Institute, 4100 N. Fairfax Drive, Suite 200, Arlington, Virginia 22203.
7. 2005 Standard for Performance Rating of Air-To-Air Heat Exchangers For Energy Recovery Ventilation Equipment, Standard 1060. Published by Air-Conditioning & Refrigeration Institute, 4100 N. Fairfax Drive, Suite 200, Arlington, Virginia 22203.
8. 2004 ASHRAE Handbook, HVAC Systems and Equipment, Chapter 25—Air to Air Energy Recovery and Chapter 47—Heat Exchangers. Published by ASHRAE
9. ASHRAE, January, 2008, Two Approaches to Using Energy Recovery to Improve Overall System EER, Coauthor; Klas C. Haglid, P.E. –CEO—Building Performance Equipment Company, Inc.® and Haglid Engineering Incorporated®.– Coauthor; Sam Beil, Senior Applications Engineer—Berner Energy Recovery, Inc.
10. Lorman Educational Services, Indoor Air Quality, Energy Efficiency And Code Changes Author; Klas C. Haglid, P.E.
11. ANSI/ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy. Published by ASHRAE
12. ASHRAE—Summer Meeting, June 2006, Quebec City, Canada ASHRAE-SEMINAR 26: Operational Performance Strategies for Energy Recovery Systems. Speaking Engagement, Seminar and Presentation, "Using Fans Without Dampers to Control Outdoor Air Intake In An Energy Recovery System: Does it Work?"
13. Life-Cycle Cost Analysis—Produced by ASHRAE Technical Committee

7.8, Owing and Operating Costs. ASHRAE Website Link; www.ashrae.org/lifecycle

14. 2007 ASHRAE Handbook, HVAC Applications, Chapter 36—Owning and Operating Costs. Published by ASHRAE
15. ANSI/ASHRAE Standard 90.1—2004, Energy Standard for Buildings Except Low-Rise Residential Buildings. Published by ASHRAE
16. Energy Information Administration, Department of Energy for The United States of America, 2008 Annual Energy Review, DOE Government Website Link; http://www.eia.doe.gov/emeu/aer/pdf/aer.pdf

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Ben served from 2006 to 2009 on the Governing Council of the Oil, Gas, and Energy Resources section of the State Bar of Texas. He has participated in the creation and passage of numerous legislative acts regarding Texas energy policy and has published extensively in the field of Texas oil, gas, energy, and environmental legislation.

Klas Haglid, P.E., R.A., is an AEE and ASHRAE member. He is CEO and founder of both Building Performance Equipment Company, Inc.®, a firm that manufactures very high efficiency air to air energy recovery equipment, and Haglid Engineering Incorporated®, a firm providing HVAC, mechanical, and structural services for commercial and industrial properties.

Klas is past Chairman of ASHRAE Technical Committee 5.5 *Air to Air Energy Recovery* and past Chairman of ASHRAE Technical Committee 7.8 *Owning and Operating Costs*. As an active member of

ASHRAE, he has moderated forums and seminars, as well as presented at several ASHRAE annual meetings and published extensively on issues surrounding energy recovery and building-related HVAC issues. Klas was recently awarded the ASHRAE Distinguished Service honor at the Summer National ASHRAE Planetary Session. His work in central research for DuPont, as a staff consultant for Atlantic Electric, and with the United States Department of Energy for Ecolinks Projects (providing energy efficient retrofits and resolving many different HVAC challenges) has provided him the practical experience to solve problems. Klas also holds a number of patents for systems combining energy recovery devices with innovative controls to make buildings work more efficiently and reduce owning and operating costs.

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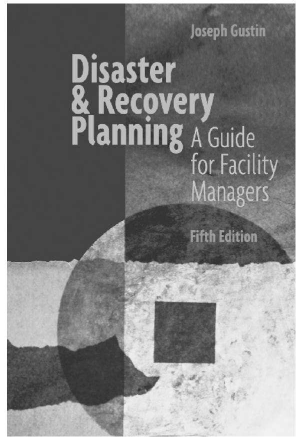

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