TOWARDS ZERO NET ENERGY BUILDINGS

INTERVIEW WITH GREG KATS, SENIOR DIRECTOR AND DIRECTOR FOR CLIMATE CHANGE POLICY, GOOD ENERGIES INC

By Jonathan Spencer Jones

WITH buildings accounting for as much as 50% of energy use and 45% of carbon emissions, they offer an important target for efficiency and conservation measures. Along with the use of advanced technologies, has developed the concept of the "zero net energy" building.

In this interview, Greg Kats, senior director and director for climate change policy at clean energy investor, Good Energies, Inc., discusses the greening of buildings and the steps towards zero net energy buildings.

Greg Kats

WHAT IS YOUR BACKGROUND?

Previously I was director of financing for efficiency and renewable energy at the Department of Energy for 5 years under the Clinton administration, with a $1.5 billion annual budget.

One of things we did there was to start what is now known as the International Performance Measurement and Verification Protocol (IPMVP), which has become the standard measurement and verification protocol in the US (e.g. for all federal building upgrades and for ten billion dollars of energy efficiency retrofits) and has been widely translated and used internationally. Because of its standardisation and the emphasis on measuring performance and transparency, it has enabled third party financing and off balance sheet financing. The finance can be structured to have recourse to the savings themselves rather than to the host or to the ESCO that is doing the work. That's an important threshold in efficiency financing.

Now I am with Good Energies, a several billion global clean energy investment fund, which invests in areas such as photovoltaics and renewable energy project financing globally. We also invest in energy efficiency in green buildings, which is the area I lead. Our investments generally in this space are about how we get to zero net energy buildings and accelerate the transition to a low carbon economy.

WHAT IS A ZERO NET ENERGY BUILDING?

For a building to be zero net energy it has got to be both extremely efficient and generate renewable power on site, e.g. from solar photovoltaics. What it means simply is, as in net metering, that the power that is generated on-site and supplied to the utility offsets the power that is used in the building.

Zero net carbon is slightly different because there are other parameters. For example it takes energy to construct a home with building materials such as cement and wallboard containing a lot of embedded energy and that needs to be offset. So zero net energy can be defined as either operational or whole building. Another issue is whether one is offsetting some of the CO_2 by buying green power or renewable energy credits. If one can do that, then one can have a zero net energy efficient building with some onsite generation and by buying green power offsite. One has to do that if it is a commercial building over 4 or 5 storeys because it is unlikely to be possible to locate enough power generation onsite, given the limited roof area.

WHAT ARE SOME OF THE INVESTMENTS YOU HAVE MADE IN THIS SPACE?

Recently we have made two smart grid related investments. One is with AlertMe, a Cambridge UK-based company that has delivered around 17,000 of its home area network products. These are about giving energy information to homeowners in real time and giving them control over their energy use. The products are based on the open ZigBee architecture and have a very good clean and simple user interface, and they enable an energy use reduction of about 20%.

The second is with Tendril, which provides the energy management architecture and user interface between utilities and users. Utilities are increasingly being mandated by the regulating bodies and other entities to reduce energy usage and provide energy efficiency, and they also want to be able to access virtual peak load reduction as an alternative to building additional peak generators. With the world getting warmer and more air conditioning being used, the peaks are getting peakier, and one way to avoid the capital cost of building new peakers that are used for maybe 200 hours per year is to gain access to end users and have them pre-heat or pre-cool or do other things to essentially reshape the load to cut the peaks. Tendril provides utilities with the architecture to do this.

One of our favourite investments is in Sage Electrochromics, which makes a glass that can be darkened or lightened by running a small current through the multiple micron-thick surface coating layers. Consider on sunny days, it's really bright with a lot of glare and a huge amount of solar heat gain, which is the driver of air conditioning in buildings. One can use shades, but external shades are expensive and internal shades take up space, gather dust, and don't keep out solar heat. With the electrochromic glass, one can dial down to about 3% light transmissivity in direct sun, letting in enough light to work without artificial lights but keeping out almost all the heat, or increase the transmissivity up to 65% on overcast days to allow natural daylight in.

We have another investment in a company called Microstaq, which applies microelectronic systems to air conditioning giving much tighter and more intelligent control over thermal expansion and pressures and temperature. The mechanical thermal expansion valves are replaced with small silicon-based chips that have very fine controls and are intelligent, providing about 20% savings on conventional air conditioning.

HOW DO ALL THESE PRODUCTS STACK UP?

For these products to be successful they have to be integrated into a smart building. With the electrochromic glass one can get 15% to 20% energy saving, and a home area network system can cut energy use by 10% to 15%. As one adds these up one can start to see how it is possible to get to a 50% energy reduction in buildings cost effectively.

I'm at my desk and I need a certain amount of light to work with. In a smart office I would have the glass dim down to give the amount of light I need, and it would also keep the solar

This article first appeared in Metering International Issue 3/2009

heat gain out and so be cooler. At the end of the day as it gets darker the glass would start to lighten letting in more light, until it reaches the maximum 65% light transmittance, then the dimmable lights would start to kick on, and gradually increase in brightness. The quality of the light is higher as more of it is natural and I'm not running the air conditioning or internal lighting and so save on electricity use. Air conditioning and lighting are the two biggest drivers of peak usage and I am reducing both – but it must be done in an integrated way with smart building controls that integrate the lighting and air conditioning with the windows.

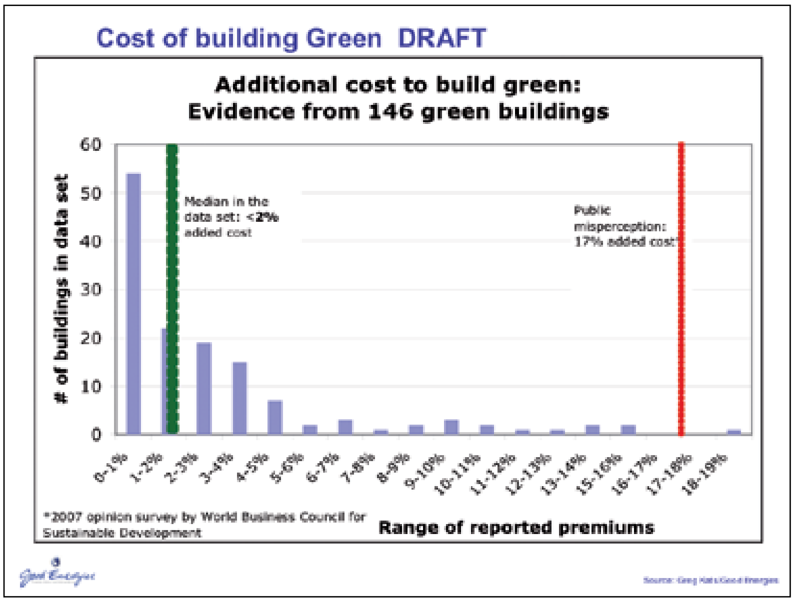
Using these kinds of technologies one may be able to cut the capital cost of a new building or a retrofit from for example, 200 t of air conditioning capacity to 100 t of air conditioning capacity. Add the lighting and smart controls, and one may be able to reduce it to 50 t. Then, because less air is being moved through the building to cool, the air venting and duct system can be smaller, so there are capital savings there too. Also as the air system takes up less space one may be able to reduce the floor-to-floor height, potentially enabling another storey to be added to a tall building in a height restricted area.

As these pieces add together, there are large additional capital and operating cost benefits, but a smart system is essential for making them work together and this is where a smart grid comes in. One can say to the utility that if you think it is going to be a peak day, on a time-of-use rate structure with capacity charges I can pre-cool or pre-heat and eliminate internal lighting, and have an agreement with the utility where I save money and they save money.

HOW DOES ONE GET THESE TECHNOLOGIES INTO THE MARKET PLACE?

People talk about green buildings and they are growing fast, but they make up at most 1% of total buildings in the US. The question is whether they are going to make the transition from an environmentally motivated niche to the mainstream. The answer to this question depends on whether green buildings are cost effective and whether they are viewed as cost effective.

Surveys have indicated that people perceive green buildings as costing a lot more than conventional buildings. If that perception stays green buildings will remain a niche. So to answer the question we undertook the largest survey of its kind on the costs and benefits of green buildings, and we looked at 170 green buildings in detail, out of about 400 buildings that were screened with detailed cost and benefit data. We found that the cost premium is only about 2%. If one maps the full benefits, then green buildings are a slam dunk.



Additional cost to build green – evidence from 146 green buildings.

But how one designs the building is important. For example if one puts in the electrochromic glass and efficient lighting but doesn't change the sizing of the air conditioning systems, then one won't get those capital cost savings.

We also stepped beyond the building footprint to the community footprint and we have detailed analyses of 10 residential development complexes, about 1,500 units in all. If these units were designed to be close to each other, leaving 50% to 60% of the site undeveloped, it would reduce the infrastructure costs, including the waste water infrastructure costs, saving over $10,000 per site. One can imagine a complex of units all having smart meters communicating with each other, so that not only the public infrastructure costs for water, waste treatment and roads are reduced, but also the investment required for power generation expansion can be reduced through green design and integration.

So it goes beyond the individual building to how we design communities and even cities to reshape the load.

WHERE DO RENEWABLES FIT IN THIS PICTURE?

We're going more and more to renewables, but there is a problem as renewables are intermittent and generally unreliable in terms of when they generate power. The sun generates most in the middle of the day but the peak demand is later in the afternoon, and some days are overcast and there is not enough solar, so the utility finds it hard to rely on for peak power. A smart building can deliver improved comfort while managing energy use in a way that cuts power costs for both the owners and utilities.

Another company we've invested in is Ice Energy, which is basically a box of water with copper coils and coolant, connected to the air conditioner. At night when power is cheap the device can be cooled into ice, then during the day the system can be reversed to deliver coolth, displacing peak power consumption for air conditioning. And since night time is cooler air conditioners work more efficiently.

One can imagine a situation where one has a bunch of buildings, with on-site wind and solar and ice energy in a smart system that can reshape the load. With peak demand from 4-5 pm one can forward shift the renewables by meeting the afternoon air conditioning load by pre-cooling the ice-bear unit with night-time wind power. In this way the load can be integrated so the consumption of a building or set of buildings can be flat, or the demand can be reduced to give a much flatter baseload and avoid peak generation. The smart grid is what binds this all together, load shifting the renewables in a way that creates much more value than having all the pieces individually.

ARE THESE APPLICABLE ONLY TO NEW BUILDINGS OR CAN RETROFITTING BE DONE?

Out of the 170 buildings we looked at, twenty were retrofits and they also had about a 2% cost premium. Not all buildings are cost effective to retrofit as green, but the large majority are. LEED green buildings provide an average 34% energy and 39% water use reductions. These are office and commercial buildings, as there are still very few residential buildings that have followed LEED as the residential standard has only emerged quite recently.

Of those 170 buildings, eighteen had a 50% or greater reduction in energy use. Half of those added photovoltaics as well and those buildings are really starting to approach zero net energy.

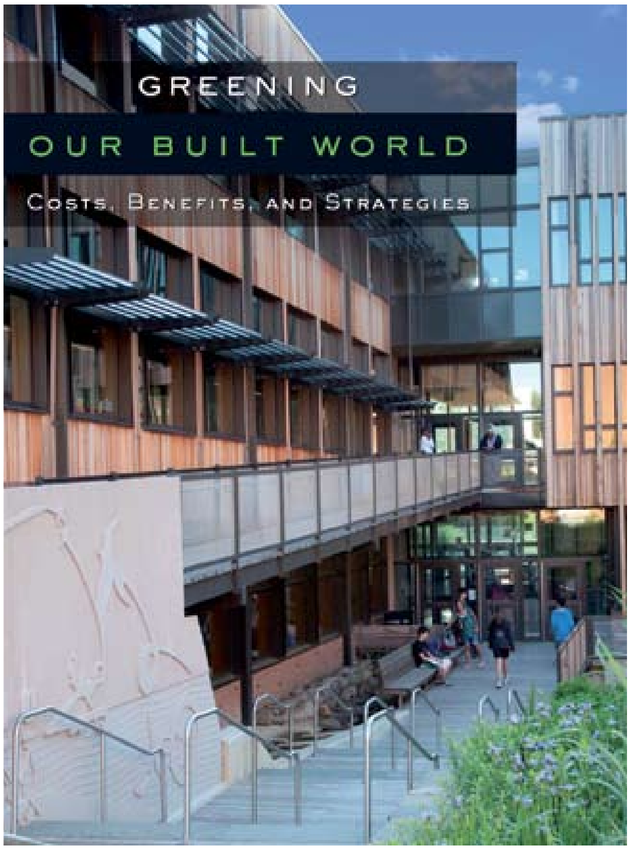
WHERE ARE THE GAPS?

We are close to doing a lighting investment and we are looking at distributed PV lighting investments in developing countries.

We also think embedded energy is important. For example cement is responsible for close to 2% of the CO_2 emissions in the US and close to 5% globally.

There are a lot of great technologies out there and it is important for them to find strategic investors who can help them understand how to map into green buildings and utilities and who can help them get deployed.

Understanding how to negotiate the federal and state entities is also important. Most states have substantial smart meter, smart building, and/or zero net energy programmes. California and Massachusetts for example, target zero net energy for new residential buildings by 2020.



ARE THE BUILDING ENERGY MANAGEMENT SYSTEMS WELL ESTABLISHED?

The basic building energy management systems are well established, but building intelligence varies. Smart energy management products like AlertMe are proliferating and allow control of individual work stations and appliances.

Although a building may be preset around a certain schedule, I would like to have the ability to control the lighting, air conditioning, etc. in my space. Typically it would have a sensor to indicate occupancy, and so when I come in the lights would come on and my PC which is powered down, would come up again.

There must also be more passive elements, so for example if say the south side receives the sun and the north side doesn't then one might install the photochromic glass on the south side but not the north side.

In California from January 1, 2010, users will generally be paying 2.5 to 3 times as much for peak usage as for off peak so end users have a big incentive to pre-heat or pre-cool or to reduce lighting by using natural lighting through dimmable controls or occupancy sensors. Financial incentives are increasingly being structured to provide very substantial incentives to pay attention to how building energy use works and to put in place smart metering and smart controls to move to towards zero net energy.

The concepts discussed in this interview and the green building survey will be discussed in more detail in the book "Greening our Built World; Costs, Benefits and Strategies," (Island Press) on which Kats is the lead author, to appear later in the year. MI

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