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Unintended Consequences of Going Green

I. LEED v Operational Costs

What is LEED

LEED stands for Leadership in Energy and Environmental Design and is a certification program for green buildings administered by the United States Green Building Council (USGBC). All new construction commercial buildings, institutional and high-rise buildings are eligible for LEED certification. In addition, there are programs for major renovation of existing buildings as well as new homes with entire neighborhood developments to be included in the future. Information is collected which satisfies submittal requirements based on a point system, buildings may be awarded a certification ranging from Silver to Platinum.

Mandatory Prerequisites Include:

- *Construction Activity Pollution Prevention* – During construction, soil erosion measures must meet EPA stormwater permit requirements or local standards.
- *Commissioning of Building Energy Systems* – The commissioning program must verify that the building's energy related systems are installed, calibrated and perform according to the owner's project requirements, basis of design and construction documents.
- *Minimum Energy Performance* – The project must meet minimum 2004 American Society of Heating and Air-Conditioning Engineers (ASHRAE) levels of energy efficiency.
- *Fundamental Refrigerant Management* – CFC-based refrigerants, which deplete the ozone layer and cause global warming, are not allowed.
- *Storage and Collection of Recyclables* – The building must facilitate recycling of wastes generated by its occupants.
- *Indoor Air Quality* – The building must comply with minimum 2004 ASHRAE ventilation requirements to maximize indoor air quality.
- *Environmental Tobacco Smoke Control* – Smoking must be prohibited or limited to designated areas.

Minimum Energy performance standards are currently 15 years old. Since the establishment of these performance standards, the price of electricity has increased approximately 2-fold in that same time frame. Most of the mandatory prerequisites have little to no effect on a building's energy performance.

Lowering building operational costs. Has the Green industry created unrealistic expectations for building Owner?

Most large buildings are custom designed and built complex machines. As such wall/roof configuration, fenestration, orientation, on a site, local and micro-climates and other factors all impact the overall operational costs. Add to this the complexity of selecting varying types of windows, insulation, HVAC equipment, smart controls, etc. and the ability to calculate with certainty the impact of any one material selection will have on the operational costs of a building are difficult. To some degree the "Green" industry's marketing of their products with claims that you can "save up to 40% on your energy costs" is like the auto insurance industry claims that you will save on your auto premiums. But is this really a problem if you save 30%, 10%, or even just 1% per year on your operational costs?

Installation of Solar Panels to augment or offset a building's power consumption is becoming common and is even required by code in some locations. There is currently no Industry Standards regarding financial projections for recoupment of investment on Solar Electric Systems. On existing buildings energy consumption is analyzed as well as the size of the roof. Financial projections will attempt to match the maximum output possible given the roof space with the building's overall consumption. This process has many variables such as:

- Location of building – how much direct sunlight will occur and for how long on an annual basis. (Nighttime, fog, cloud cover all need to be accounted for)
- The orientation of the roof – South facing is optimal.
- The size and geometry of the roof

Get any of these variables wrong and the financial projections will not be met, but how wrong is wrong? The amount of sunlight is an annual average. Was the estimate excessive to boost the overall output or was there a variation in weather pattern that deviated from the norm? The timing between a buildings consumption of power versus the Solar System generation of power can create gaps in these projections if not accounted for as power costs can vary during time of day. There is also the issue that the building occupants will change their behavior. A false impression can be created. Essentially, there is a Solar System installed so power is now "Free." Occupants leave lights on, lower the thermostat on hot days, use appliances or equipment more frequently, etc. This will increase the consumption of the building versus the analysis performed in sizing the Solar System. This change in behavior could cancel out any positive effect from the building's Solar System.

Recently a claim was made on a General Contractor's License Bond regarding a solar system installed on a single-family home. A Solar System is composed of panels which collect the sunlight and create DC electricity. The larger the number of panels the more power the system can generate. The power from the panels is run through an inverter which turns the DC power into AC power which can be connected directly to the building. On this single-family

home the number of panels was correctly sized based on the historical usage. Inverters can accept a range of power into them and are most efficient when the incoming power is in the middle of this range. Simplifying for this example and the nomenclature of small, medium and large. The contractor installed a single large inverter on this home which reduced the power output by 80% versus two (2) medium inverters. Two (2) medium inverters cost more to purchase and install than a single large inverter.

II. Products

Where are they sourced?

Like many other materials sourced from China (Drywall, Cast Iron Pipe, Windows, Sealants) Electrical Equipment like Solar Panels are not immune from deficiencies. Typical solar panels have a lifespan of 40 years and failure rate less than 1%. By comparison, Chinese panel failure rates are nearly 10%. This may not seem like a large difference but when you start looking at large solar installations with 1,000's of panels even a very small failure rate can create problems.

The way Solar Panels are wired may also compound this failure rate. Solar panels are typically linked together in chains of 9 to 15 panels. Like the Christmas tree lights of yesteryear, a single panel failure will take the whole string out. This can have a large effect on power output if not discovered right away.

Electrical equipment certifications include such organizations as Underwriters Labs (UL). UL relies on self-regulation and spot inspections to maintain a manufacture certification. Manufacturing to a certification standard has been an issue with Chinese manufactures in the past. There are examples of manufactures who have faked certifications examples – lumber liquidators wood flooring. So how likely are the products being purchased manufactured to that standard?

As with other foreign sourced materials warranty coverage and replacement parts/materials is an issue. Even if the manufacture acknowledges a warranty claim obtaining the parts or replacement materials can take months or longer. In the cases of widespread failures recourse options are limited.

Underlying Technology – does it work?

Within the 'Green' world some technology has been proven to work on mass scale – photovoltaic cells installed within common Solar panels as an example. Other technology may have sown promise within a research lab but the transition to mass production is not complete. The installation of Thermal Solar farms is such a technology. A series of mirrors are focused on pylon which superheats a fluid which in turn creates steam and then electricity by spinning a Turbine Generator. The research into this technology has shown promise with the goal of generating significantly more power in smaller space than conventional Solar Panel Farm. However, most of these facilities are operating at a fraction of their theoretical output. When output is falling short Investors are turning Insurance Carriers and Surety's to account for these shortfalls. There is also the added issue of increased bird mortality. Birds are attracted to the

reflections and or the pylon. If they pass through the focal point they are killed by the extreme heat.

The biggest limitation facing wind and solar production is energy storage. There is currently no easy way to store power generated to be used later a mass scale. During periods of overcast skies, no wind or nighttime – power demands still need to be met. On the residential home front, you may be familiar with a battery backup system currently being marketed. This system relies on batteries similar to your phone or laptop computer. Batteries lose efficiency over time as they are discharged and re-charged repeatedly. Your own experience with cell phones is good indicator of the problems that will most likely befall these battery backup systems.

Long term installations, no proven track record of performance – will it last?

Many "Green" products do have superior performance metrics when compared to their predecessors. However, longevity has been a problem as many products do not have a long term installed base. As an example, single-ply roofing membranes have become very popular. The two (2) main materials used to manufacture these roofs are PVC (Polyvinyl Chloride) and TPO (Thermoplastic Polyolefin). There are environmental issues with the manufacture of PVC as such LEED does not provide any credit for this material, but it does for TPO. However, there have been several premature failures with TPO especially in hot climates that have resulted in several formula changes to this product. PVC roofing has a significant number of installed roofs with membranes lasting in excess of 30 years. If ones TPO "Green" roof fails in just 7-12 years and it ends up in a landfill, which material was the "Green" alternative?

Note: TPO failure timeframe is similar to statute of limitation.

The standard Solar Panel has a lifespan of 40+ years. These panels utilize a glass panel to protect the cells. There are a number of manufactures producing shingles with integrated solar cells. In a number of these cases these cells are protected by a clear coating in lieu of glass. Most of these coatings as they age will crack, yellow and discolor with an expected lifespan of 7-12 years. If that occurs the solar cells will cease to function. As previously discussed how these cells are wired together will be important as a cell failure could deactivate large sections of the roof.

III. Tightening of the Building Envelope (Sick Building)

Newer "Green" materials have decreased the amount of outside air infiltration into a building occupied space. This improves the energy efficiency but also creates internal air quality issues. Heating Ventilation and Air Conditioning (HVAC) equipment will condition and recirculate the internal air. The recirculated air would include any contaminates. There is a limited amount of filtration that is possible while still allowing adequate air movement. Occupants within a building expel water vapor from breathing, cooking, showers, humidifiers etc. Unless expelled this water vapor can build up and condensate on various surfaces (including inside wall cavities). This can lead to the formation of undesirable organic growth (commonly referred to as mold).

As a building becomes tighter the internal air will become "stale" unless outside air is introduced. The introduction of outside air creates problems as it is most likely at a different temperature than the internal air and could include a different amount of water vapor.

Correcting the temperature and water vapor content before circulating inside the building will expend energy and reduce the overall efficiency of the system.

IV. Solar

No Off Switch – Suns Out, Power is on.

Solar Panels do not have an off switch, when the sun is out, they are energized. Even low levels of lighting can energize panels. This issue creates several problems.

When power goes out the utility requires the solar system be disconnected from the grid. This is to prevent electrical back feeds which could injure utility workers attempting to make repairs. Most Solar systems are not configured to supply power directly into a building on a standalone basis. Therefore, when the power goes out the building will go dark as well due to the utility disconnect requirement. In general, the addition of a backup battery, storage or standby power generator is necessary to keep power on even with a solar system.

Most Solar Systems produce power at 600 volts and higher. Typical firefighting tactics include cutting ventilation holes and access points in the roof. Water and electricity are not a good mix. When firefighters encounter solar systems, they change their tactics to provide a safe separation from high voltage electrical equipment. As a result, fires may not be put out as quickly and will cause damage to a larger area. Since even lighting can energize solar systems the safe separation distance is maintained even at night.

Installation methods

Solar panels are placed on roofs using one of two (2) systems; ballasted or attached rack. Each of these methods has associated problems. A ballasted system relies on weight to hold the solar panels in place. Panels are secured to a racking system and set on the roof on metal pads. The system is not secured to the building in any way. Solar installers like this system since it is quick to install and does not penetrate the roofing system. However, the metal racking system will expand and contract at a different rate than the building. This will cause the metal pads sitting on the roof to slide. Over a period of time this sliding motion will rub holes in the roofing system. The biggest issue with a ballasted system deals with seismic. This system is not secured to the building. During an earthquake racks and solar panels are free to collide with each other. As previously discussed, these systems are live and lack a shut off switch. The potential for fire or unsafe estray electrical currents is very high after a seismic event.

So, what's the alternative? Install the Solar Panels on a racking system which is secured directly to the building structure. This solves the problem of the system moving about during a seismic event but creates other problems. First and foremost is each attachment point having to penetrate thru the roofing membrane. Each penetration is a possible leak point and on large commercial buildings there can be thousands of penetrations. The racking systems are typically structural shapes including round pipes. This is an easy shape to waterproof on the outside but beware water which can flow within the pipe and on into the building. The same expansion and

contraction forces previously discussed still exist which will put repeated horizontal strain on each penetration.

Finally, irrespective of the attachment method used. Life span of a Solar Panel is 40 years+. The average lifespan of most roofing systems ranges from 10 to 30 years. When replacement of the roof system is required due to age, the Solar System is now in the way and must be removed to replace the roof. What happens in cases roof replacement is required due to a failure in material or installation, what about the Solar System removal?