Renewable Energy, Climate Change, and Entrepreneurship

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1. Introduction

In 2012 and 2013, Professor Warren Palmer invited me to speak at Beloit College on energy efficiency in buildings and payback analysis. The theme of both lectures was how our firm, Hoffman Planning, Design and Construction, Inc., that provides professional services in planning, design, and construction has been developing a process to design and construct highly sustainable or green commercial buildings at equal to or less than the cost of conventional commercial buildings. In the course of those lectures, I noted that in our experience conventional payback analysis did not seem useful when applied to green buildings. Payback analysis in the context of green commercial buildings was at best a limited tool, and at worst highly misleading. Frankly, traditional payback analysis was often getting in the way of our clients making wise choices in buying green commercial buildings.

When asked to participate in the 2014 Miller Upton Forum panel discussion on “Energy Efficiency, Climate Change, and Entrepreneurship”, I decided to re-examine Hoffman’s recent innovation in green building through the lens of entrepreneurship.

Previously, I had not even considered whether the commercial building design and construction services we were providing to clients would be categorized as entrepreneurial.

For the last fifteen years we have been striving to provide green buildings in all of our projects and to survive in a market place dominated by conventional...
buildings. As a provider of green buildings, we focused on designing and constructing a product for our clients that lived up to our green claims and allowed us to stay profitable.

The nature of what is meant by a green building is rapidly evolving. The green building of the first decade of the 21st century emphasized energy and water efficiency, responsible materials and products, and good indoor air quality among other attributes. That view has rapidly expanded in the second decade of the 21st century to now encompass zero net energy, or at least zero net energy capability. A zero net energy building is one that produces as much energy on-site from renewable sources as it needs over the course of a year. Such a building will typically import power from the grid at some times and export power at other times. An office building that uses less than 40 kBtu/square foot/year is at the zero net energy capable threshold. Simply put, these buildings are highly energy efficient, and because they are so efficient, it becomes feasible for on-site renewable energy, usually solar photovoltaic, to supply much or all of their energy needs. Professor Warren Palmer’s invitation to participate on this panel gave me reason to reflect further on what we had been doing at our firm since the turn of the century. That reflection was aided by the very helpful 2010-2011 Annual Proceedings of the Wealth and Well-Being of Nations recognizing the work of Miller Upton Scholar Israel Kirzner (Chamlee-Wright 2011). It led me to quickly realize that what we were doing in green buildings was an entrepreneurial activity as described by Kirzner. In the same publication, Dierdre McCloskey (2011) asks and answers a rhetorical question: “What works? Creativity. Innovation. Discovery.” Our experience agrees with her answers.

2. Green Buildings at No Incremental Cost as a Form of Entrepreneurship

What we were doing in our firm’s continuing innovation, testing, monitoring, and benchmarking of building construction cost, operating performance, and energy use was entrepreneurship. Our product was green. The types of commercial buildings we were designing and building included office buildings, med-

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3 thousands of British Thermal Units per square foot per year
Renaissance The angel clinics, schools, retirement communities, religious facilities including monasteries, and some manufacturing buildings. These buildings cost our clients less than a conventional building both to purchase and operate. We were surviving and profitable as a firm during the last recession, a particularly difficult time for our industry. More importantly, we were not alone. Many other firms in various parts of the sprawling green building industry, including materials and building product suppliers, were also innovative and entrepreneurial, and together as a result we are rapidly transforming the nature of commercial buildings.

I want to draw a direct line between entrepreneurship and renewable energy and climate change. A green building (built green and performing green) provides superior indoor environmental quality and uses less electricity and natural gas than existing or conventional new buildings, and hence reduces greenhouse gas emissions in its operation. A substantially reduced level of energy use also enables on-site renewable energy to meet much or even all of the building’s energy needs. Depending on the building size, design, and location, a zero net energy building is often now feasible from the standpoint of physics, and from the standpoint of economics. The feasibility for a zero net energy building using on-site solar in terms of physics depends on the building’s energy needs relative to the surface areas available, including roof area, parking lots, vertical surfaces, and finally land area for ground mounted solar systems. For high-rise buildings, net-zero on-site energy is not feasible. For many one, two, and even three story buildings, it is physically feasible. The argument for economic feasibility depends on whether on-site renewables can compete with energy from the utility company. The case for on-site renewable energy becomes particularly salient when a zero net energy building can be delivered in the market place for less than or equal to the first-cost for a conventional building.

I can now confidently claim, based on our work and that of others in our industry, that a green zero net energy building can be delivered in 2015 at conventional first cost in some common situations. If this assertion holds, we can readily see why payback analysis does not work. The usual paradigm that we’ve had drilled into our psyche is that reducing or eliminating a commercial building’s monthly energy bill requires additional investment, i.e. a higher first cost. Con-

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4 A zero net energy building has a net-zero carbon footprint in its operation. The construction of a building has an unavoidable carbon footprint as it requires energy in the building materials and components as well as in the construction process including delivery of materials to a site.

5 First cost is defined as the total of all design and construction cost including site work.
Conventional wisdom has been that a green building requires increased expenditures on insulation, windows, lighting, and mechanical systems compared to conventional commercial construction. In this traditional view, the building owner can pay back the added investment with the savings from the smaller energy bill in coming months and years, but the green building will still have a higher first cost. What I’ve just asserted, however, is that there need not be any additional up-front cost, and instead we have often seen a first cost reduction in our greenest buildings. Thus, the payback calculation yields a zero year or negative year payback.

3. The Impact of Carbon Pricing in the Commercial Building Market

Before considering some of the specifics of the entrepreneurial activity that is resulting in zero paybacks or less for green commercial buildings, it is useful to consider this experience in the context of Robert Stavins’ work. One of Stavin’s central themes at this year’s Miller Upton Forum might be paraphrased with the broad statement “we’ve got to get energy prices right” if we hope to make fundamental changes in our patterns of energy use and carbon emissions. The price of energy must include the external costs caused by its carbon content. Stavins has noted policy challenges with respect to principal agent problems, spillover effects in research and development, and many other challenges that remain even if energy prices are right (Stavins 2015). The foremost challenge, however, is getting the cost of carbon into energy prices and making the discussion one of science and economics.

The USGBC (U.S. Green Building Council) notes that 40% of U.S. energy use is attributable to buildings, and that buildings are responsible for a proportionate share of the U.S. carbon footprint. Given the magnitude of energy use and cost in commercial buildings (a subset of all buildings), it is important to ask: how much difference would getting energy prices right make to a commercial building buyer? Our clients occupy the buildings we build for them, and thus are not impeded by the principal-agent problem in leasing.

I’m going to draw on the example of a current client in considering how much their decisions might be altered by getting the price of carbon right. The

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6 The U.S. Green Building Council Website www.usgbc.org provides a wealth of information on the built environment and green buildings.
client is in the early stages of making significant changes to four campuses. The client’s current annual energy bill at these campuses (without any carbon cost in the pricing) is running in excess of $1 million per year or about $1.30 per square foot per year. These are energy costs at Midwestern utility rates, and thus may seem low to those from California or the Northeast. The total project cost is roughly $250 per square foot for the new facilities, not including deconstruction costs for some buildings that no longer meet the client’s needs. In addition to updating their campuses to better serve their needs, a goal of the client is to decrease its operating costs per square foot for energy at current utility rates.

What impact would higher energy prices that priced in carbon have on the client’s decision-making for improving its campuses? As we have estimated the carbon footprint for this client, we can adjust their current energy bill for a given cost of carbon to gain some perspective of how large carbon pricing looms in this context. Using what some would consider a high cost of $50 per ton of CO\(_2\), the annual energy operating cost of the existing facilities would rise from $1.26 per square foot to $1.85 per square foot. Because of the efficiency levels designed for the client’s new buildings and improvements in its existing facilities, the estimated annual cost of operating the revised campuses is estimated to be $1.60 per square foot if a cost of $50 per ton of CO\(_2\) were included in their energy prices.

While energy operating costs are important information for the client, the magnitude of the new construction cost per square foot ($250) suggests that a $0.59 per square foot increase in annual operating costs due to a CO\(_2\) price of $50/ton is not likely to be a dominant factor in the client’s new construction decisions. In other words, how much impact does adding $375,000 per year in energy operating cost due to carbon cost have on an $80 million project? This client, typical of our other clients, has multiple building goals in providing spaces that meet various functional needs, comfort, indoor air quality, daylight and views, occupant control, and ease of maintenance to name a few.

What insights can be drawn from this example client and the prospective inclusion of carbon pricing? I suggest there are three main conclusions:

1. A commercial building purchase is a complex decision with many factors to be considered; energy cost, with or without carbon cost included, is just one of many considerations, and for most purchasers, energy operating costs are not the

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7 The carbon footprint is estimated based on the client’s utility bills and using the U.S. EPA Portfolio Manager.
most important consideration.

Including the cost of carbon in energy operating costs will increase the importance of energy efficiency; however, given the relatively modest size of energy costs in the context of the many considerations in the building decisions, including carbon cost is unlikely to transform energy costs into a dominant consideration.

However, including the cost of carbon in considerations of on-site renewable energy is an important change. Energy costs in the Midwest are currently at the point where over a 25 year horizon, purchasing electric power versus generating on-site solar electric power have about the same cost. We have started offering on-site solar options, and some of our clients are choosing on-site solar if the cost is about equal. Some prefer solar even if the price is marginally higher. Including $50 per ton of carbon in the price of utility-supplied power, equal to $0.05 per kWh, is a game changer since on-site solar would clearly reduce our clients’ electricity costs while achieving their green goals.

4. Entrepreneurship in Green Commercial Buildings in the Absence of Carbon Pricing

As we have not yet included carbon cost in our energy pricing, let us return to the development of green zero net energy buildings at no added cost relative to conventional commercial buildings as an entrepreneurial activity. The competitive advantage for a firm such as ours is that buyers should prefer a zero net energy building even at today’s energy costs. While energy costs may not be the highest priority for the building purchaser, the opportunity to avoid some or all energy operating costs is still a motivating factor in the building decision. Thus, buildings approaching or reaching zero net energy represent significant progress from design, construction, and competitive perspectives even in the absence of getting energy prices right.

I want to briefly note six milestone events in the timeline of our firm’s entrepreneurial efforts that brought us to this point and provide a couple of building examples. The first event occurred in 1999 following our firm’s decision to move in a consciously green direction. The first milestone was our construction of our own office building that incorporated a green design approach emphasizing daylighting. Design principles were guided by the Daylighting Program at the Energy Center of Wisconsin which was based in part on the work of Ternoey (1985). We wanted to design, build with our standard integrated construction management
approach, and then live with the new design. An important outcome of our experi-
ment was that the total building cost came in below average for similar office
buildings in the area. The building proved to be well accepted by employees and
visitors, and provided a living laboratory for our employees to understand the
design, construction, and operation of our emerging business approach.

Using the lessons learned in our own office building, we began to incorporate
similar design changes in most of our projects, including new public schools and
a large government administrative building. The second milestone event occurred
in 2002. We had designed and built over twenty blood clinics for a pharmaeuti-
cal client. With a new round of clinics on order, we decided to deliberately green
the design with what we call an integrated sustainable design approach. The great
fear in our company was that by greening the buildings we would price ourselves
out of competition. While some of us leading the change had fairly solid evidence
from our experience and experience of others that we could control cost, some of
our architects and construction managers were skeptical. Thus, we were encour-
gaged when the final costs came in on the first “green” blood clinic. The total proj-
ect cost had declined by over 2 percent. This very significant outcome provided a
highly visible example that green buildings made competitive sense.

One of the challenges in commercial building research is that it is very dif-
ficult to apply scientific control to innovation because of the complexity of the
product. It is too costly to build a commercial building as a scientific control and
then build alternate versions of the building for testing purposes. Some firms,
such as MacDonald’s and Wal-Mart do repeat standard designs. Even in these
exceptional cases, construction costs vary from location to location, and there is
limited interest in testing. We were fortunate to almost have a controlled study
when building the first “green” blood clinic since just the year before, we had built
a conventional blood clinic for the same client under similar cost conditions.

The third milestone on this path of “creativity, innovation, and discovery”
was our participation in the design and construction of the Alberici headquarters
in St. Louis, completed in 2004. Alberici was seeking a high LEED® certification
on a conventional cost budget, so this project provided an entrepreneurial oppor-
tunity to apply our design principles on a larger scale project. We were brought
into the project at the mid-point in the design process after initial construction
cost estimates had been prepared. As Alberici is a construction contractor and was
building the facility for itself, we could then apply our set of developing design
features and observe the impact on the project cost estimates, the anticipated
energy use of the project, and the estimated LEED rating. The results suggested that we could reduce the project cost by $2.5 million, increase the LEED rating to Platinum, and reduce energy use. Alberici headquarters was ultimately certified at LEED NC v2 platinum and for a period of years held the highest LEED new construction certification rating. We have also been able to observe employees’ reactions to working in this facility and the building’s energy and water use. Information on other LEED platinum buildings revealed that the Alberici was one of the lowest cost LEED Platinum buildings and that its per-square-foot cost was very competitive with conventional buildings in the St. Louis area. (Hanson et. al. 2006) With this milestone, we were confident in the integrated sustainable design approach we were applying in our projects. By this time, we were committed to applying our green approach to all of our projects.

The fourth milestone was the application of our full integrated project delivery approach to the design and construction management of two public school projects in Wisconsin. The challenge and opportunity was to earn high LEED certification ratings in a context where both school districts had set budgets based on preliminary designs and conventional cost estimates for those designs prior to hiring our firm. Upon completion, both schools achieved LEED Gold Certifications, among the first schools in the country to receive that recognition. Moreover, the schools’ construction costs were 25-29% below the regional average for new school construction. These two schools showed the importance of sustainability in the competition for the work.

Our firm’s fifth milestone was the design of Holy Wisdom Monastery, a 34,000 square foot building with meeting, office, library, and dining facilities. Monastery leaders were committed to the construction of a highly green facility. In our mind, this implied a building with a very low energy requirement capable of meeting its energy needs with on-site renewable energy. Holy Wisdom Monastery was completed in 2009 with a 20 kW solar system at a construction cost of $209 per square foot and a total project cost, including design fees and the pipe organ expansion, of $246 per square foot. The monastery received a LEED platinum certification. With solar PV costs in 2009 at $7.90 per installed Watt, it was not financially feasible to provide for more than about 10% of the energy requirement with solar. But the energy requirement of 32.9 KBtu/sf/yr is within the range of what is considered to be a zero net energy capable building, the owner’s ultimate goal for their facility. (Hanson 2011)

For that segment of building owners interested in sustainable facilities, a zero
net energy building is the grand prize, one that is financially attractive to any owner if it could be provided at conventional cost. Our entrepreneurial activity led us to recognize the competitive and environmental potential of zero net energy buildings. Another indication that the market place is heading in this direction is The American Institute of Architects’ support of the 2030 Challenge that sets a sequence of aggressive goals leading to carbon neutrality for all new construction by the year 2030.

The sixth milestone occurred in 2014 with the addition of 126 kW of solar PV at Holy Wisdom Monastery. The new installation with the existing 20 kW system now supplies almost 60% of the monastery’s energy needs. Third party investors enabled the monastery to add the new solar system with minimal up-front investment. The monastery will essentially pay on a monthly basis the same cost for the solar electricity as they would have paid to the electric utility for green power, and slightly more than if it purchased fossil-based power. System ownership transfer will occur in year 15 with the monastery paying residual value at about 25% of the original system cost. Were it not for state limitations on interconnection capacity and the buy-back rates on power sold to the grid, the system could have readily been expanded to net-zero or carbon neutrality.

The issue of what is appropriate cost allocation for grid interconnection for on-site solar is currently a hotly contested topic. What this milestone solar system with third party financing demonstrated in combination with the previous milestone, however, is that a highly green building can be delivered at this time at a first cost very competitive with conventional buildings. Furthermore, the building has a low energy demand and provides 60% of that requirement with on-site renewables.

When we set out on our entrepreneurial path, we did not foresee our current ability to supply zero net energy buildings at equal to or less than conventional cost. As Kirzner says (2011:27), “the availability of pure profit opportunities which, in ways we admittedly do not fully understand, attract entrepreneurial attention.” As we included higher cost elements in our commercial building designs, we found ways to reduce costs of other components with the net effect of maintaining or reducing overall project cost as we built greener buildings. As a result, we increased our firm’s revenue and profitability as we emerged from the last recession. Our abilities in integrated sustainable design combined with our construction management process provide more competitive pricing and greener buildings.
Hawken et al (1999) named this phenomenon “tunneling through the cost barrier”: innovation that simultaneously reduces first cost and annual operating costs in green design and construction. The first time I heard of this concept twenty years ago, I thought it sounded great in theory, but what did it mean in practice? I could not come up with tangible examples at the time. Recently though, we have discovered how to tunnel through the cost barrier by reducing the number of light fixtures while using better fixtures and lamps; choosing windows that controlled unwanted heat gain and managed glare while reducing the need for solar shading devices; managing plug loads; downsizing HVAC systems; and using innovative financial arrangements for on-site solar. In the designs that emerge in this process, some building elements may cost more (say LED lights or a heat pump mechanical system), while others cost less (fewer solar shading devices and fewer light fixtures). But overall, aggregate first cost can be reduced as sustainable design also reduces annual operating costs, as shown by Holy Wisdom Monastery.

The construction cost of Holy Wisdom Monastery can be compared to a set of sixty buildings, approximately half of these were LEED certified at various levels but none at platinum and the other half not certified. These buildings were academic buildings with a similar mix of rooms to those found in the monastery building and are reported in a study by Davis Langdon an international construction management firm (Morris and Matthiessen 2007). As these buildings located on campuses are scattered across the U.S. and built in different years, the study controls cost for location and year. There is no discernible difference in the cost of the LEED certified buildings and the non-certified buildings. The reported construction cost ranges from somewhat over $200 per square foot to almost $600 per square foot. Holy Wisdom Monastery construction cost adjusted for year and location comes in at approximately $230 per square foot, at the very bottom of the cost range. This demonstrates viability of our entrepreneurial approach to a zero net energy sustainable building.

5. Lessons and Implications of Entrepreneurial Activity

One might think that the example of Holy Wisdom Monastery would make future marketing and sales of our green building services a slam dunk. We certainly use this and other examples in our business development, and they are helpful. Buyers in the marketplace, however, often have reservations. Working with hesitant building buyers is not unique to us, as I have heard similar comments
from other firms offering similar levels of green buildings at similar price points. One explanation for the hesitancy of building buyers might be that the concepts of marginal cost curves and payback analysis for added efficiency or renewable investments are so ingrained in the market place that potential buyers cannot fathom the notion of tunneling through the cost barrier. And even if one project managed the tunneling, can the next buyer of say a $10, $20, or $30 million building (the mid-price range for our projects) be confident that the process is reproducible for their project? Buyers have a tendency to focus on single project elements (LED lights for example) and want to think in terms of paybacks on each building element rather than looking at the aggregate project costs before and after the tunneling. Hence, my comment at the beginning that payback analysis sometimes gets in the way. And in our buyers’ defense, most of them are not routinely making $20 million purchases.

Our experience with entrepreneurship in green buildings is emblematic of the larger trends that I believe are common in the commercial building industry. The materials, MEP (mechanical, electrical, and plumbing) systems, windows including emerging smart windows, the emergence of smart building control system, are all evolving rapidly. Fluorescent lighting is giving way to even more efficient LED lighting before our eyes. Other highly sustainable, zero net energy buildings with good cost points are appearing on the landscape, such as the Iowa Utility Board’s new office building in Des Moines or the Bullitt Foundation Headquarters in Seattle. It is this rapidly evolving entrepreneurial action that offers significant prospect for pulling down, to use Paul Hawken’s phrase, CO₂ emissions from new commercial buildings and in retrofitting existing buildings.

What these entrepreneurial paths need for widespread use of on-site solar and other renewables in green buildings, however, is the adoption of smart grids and smart building controls so that we can more readily use energy price signals to enable the use of on-site and off-site renewable energy, optimize power generation and transmission, and provide incentives for energy storage. Including the cost of carbon emissions in the market place would obviously be helpful in accelerating the market for low carbon and zero net energy buildings. Energy operating costs are not so high as to be among the highest priorities in commercial building design for most building buyers. Including the cost of carbon, would increase the importance of energy performance. As I have argued, including carbon costs could be decisive in tipping more owners into including on-site solar. Without regulatory changes and investments in smart grids, we will continue, even when
carbon pricing arrives, to bump up against the limits we currently face in Wisconsin that prevented Holy Wisdom Monastery from moving to full zero net energy.

I hope my remarks have offered some perspective on how entrepreneurial activity is driving the green building movement. If we can provide zero net energy buildings at the same first cost as conventional buildings with the tools and methods we have in hand today, there is opportunity and some hope looking forward as we take up the challenges of climate change.
References


