Payback

This is a brief discourse on the reasons behind the current need for energy efficiency in buildings and the inadequacy of using a “payback” method on analysis in the decision making process. Now on the surface of this it would seem that there would be wide agreement on energy efficiency in buildings however although people can agree on the merits of this phrase few will agree on the actual implementation and the degree to which it is important to maximize this attribute in buildings. Likewise it would seem that analyzing the payback of the “additional” cost due to an energy efficiency strategy that exceeds the current standard practice in your region. I would like to argue that not only does it make sense to regularly exceed these standards by a wide margin but that it is the prudent thing to do. Looking into the future (I am writing this in August of 2011) by means of projecting the cost of fuel in a linear fashion and dividing to see in how many years the fuel saving strategy will “pay” for the added construction cost is missing the essence of the difficulties that will be arising in the future. These, I think, will be different in kind and added to the present fuel cost rises as the new costs as a result of the challenges that emerge.

In order to provide the basis of this argument we first need to digress somewhat into the basics of global climate change. Only the briefest of facts will be necessary for the purpose of this discussion. 70% of all the fossil fuel ever burned in the history of the world has been burned since 1970. The CO_2 that is released into the atmosphere stays there for an average of 1,000 years, this number is a very difficult number to compute as the carbon cycle is complex but the point is that it is on the order of hundreds of years rather than weeks as it is with the water vapor cycle. This begins to suggest an answer to the question of why is climate change happening now, and so rapidly, and is not a slower and more linear process.

The second point is that we are expected to experience a minimum of 1.5^o to 4.5^o Celsius change upward for average global temperature change by the end of the 21^{st} century. While the 1.5^o represents the minimum the 4.5^o does not represent the maximum. The difficulty with these projections is that no-one can know with accuracy what the results of human behavior will be in the next 90 years as it pertains to emissions, but even if we can avoid the higher range of these estimates it seems we are in for at least 2^o C increase. As a point of reference 20,000 years ago where I am right now in New England there was a mile or so of ice above my head. This ice age was the result of about 6^o C of downward global temperature change. This is the answer to the question of why is anyone worried about a few degrees change.

This is all the background we need to see what may be coming. We here in the United States are now living in a climate change denial bubble. This bubble is the result of a number of factors which are not the subject of this essay but which have diverted, derailed, and clouded the political debate on this subject. The scientific debate on whether we have forced the climate through man made emissions ended in the nineties. The political debate on that same subject elsewhere in the industrialized world ended shortly thereafter by the turn of the century. This is not to say that a great deal has been done elsewhere about mitigating emissions (although there are some important steps being taken) but it is to say that the US, as the leading industrialized country is not leading the charge in this important area of implementation.

When this bubble bursts, and all bubbles do, we will be in another place with regard to climate change mitigation and adaptation. My opinion is that in response to this obvious threat we can expect to see at the very least a carbon tax and potentially rationing in an attempt to catch up to where we should have been with emissions standards had we been paying attention. This brings us back to our built environment and its energy characteristics. The energy consumption profile of our building stock is built-in as it were, an represents a kind of fly wheel effect where the time and costs to change this are so large and so slowly accomplished that it operates on a time scale an order of magnitude greater than the election cycles of 2, 4, and 6 years of our government representatives. This is not a scenario that exhibits great adaptability or flexibility.

It is of course difficult to look ahead and most of our policies and procedures are based on looking behind as a guide to the future. This supposes that the future will follow as a linear progression from the past. While this may be right most often one lesson we can learn from the past is that there are times when this is decidedly not the case. In these anomalies there are situations and behaviors not seen before that emerge from the complex interaction of the players. A good example of this is the energy crisis of 1973. This was a political crisis rather than an ecological crisis and resulted from the growth of the oil producers advancing to the point where they could band together to control most of the production of a commodity which had grown to become essential in the world market. It seemed suddenly to be a fragile system based not on technological issues but political arrangements that could easily disrupt or possibly entirely shut off the supply. Worse than this perhaps it seemed there was also an expiration date to the whole thing, that one day regardless of the politics it would run dry.

These were big changes not predicted in advance. In 1970 the average house in New England was built with almost no insulation, by 1980 the recommended amount was R19 in the walls and R38 in the ceiling; about 5 1/2" and 11" of fiberglass batt insulation respectively. This also required a big change in typical residential construction by using 2 x 6 wall studs and 2 x 12 roof rafters to accommodate the required thickness of batting. This found its way into energy building codes, something not seen before, and has been adjusted, tweaked, and debated ever since. The events of the oil crisis of the 70's were beyond our control here in the US and one could argue that the ripple effects have continued to this day there may be another change beyond our control of a different kind coming to us soon. Remembering that the predicted effects of global climate change are by definition global, and that there are other major players in this drama, the meta-effects will be far less predictable. These met-effects i.e. political and social responses to the ecological changes are unlikely to be beneficial in the short term as they will be survival reactions based on a perceived and perhaps limited set of options.

In the face of this perhaps too gloomy outlook it may seem that talking about buildings is too little too late and in some respects it is. If we are to mitigate in any meaningful way the climate change potential we must immediately address the power production problem and start taking fossil fuel power plants off-line in favor of alternatives. But buildings represent about 40% of the energy consumption equation so in the longer term it is important. But my point is more immediate than that and it is simply that those buildings which have the minimum of power usage requirements and/or are able to produce their own power are those that will have the adaptability and flexibility to be used in the future. In short they will have the quality of robustness. One definition (borrowed from communication theory) might be: the ability to maintain functionality despite a disturbance.

In nature some of the qualities that enable robustness are diversity and variation. A greater diversity of attributes in a population allows for a greater likelihood of a positive response to a disturbance because there might exist a group within the population that would be better suited to the new reality. There would be many possible groups from which to select. Likewise having a greater variation or a wider range of attributes within a population would also result in a more robust result. Those parts of the population less well suited to the new landscape would be found less and less in succeeding generations. Nature can have this kind of adaptability through genetic inheritance where variation and diversity could be said to be built-in to the mechanism; perhaps a self-organizing quality of life itself.

We may not be able to wait for the next generation of buildings to be adapted to the new energy/carbon landscape. When exactly will this new era dawn, it's not here yet. Clearly we have the ability to do the adaptations now and not, like nature, wait for the next generations. The target for the greatest future flexibility is to have the lowest energy needs possible. This means that they would be sufficiently low so that it would not matter what the energy source is because the needs are minimal and in fact can be supplied by the sun. These ideas are not new and can be done today with available technology. As the energy/carbon target gets lower and lower it becomes increasingly difficult and costly to do this in retrofit.

You can see the difficulty here, if new buildings are evaluated on payback of investment based on the current linear thinking of future costs then the needed building infrastructure will rarely be built. Also since the cost to retrofit is so steep relative to the current artificially low energy prices this strategy will only rarely occur. This is exactly what is currently happening. Looking back to 1970 again we can see that if you had suggested building production housing using 2 x 6 stud walls and 2 x 12 rafters to say nothing of filling it with insulation no-one would say then that it was cost efficient. By 1975 it would have looked prescient to have done that.

It is possible, but perhaps somewhat arbitrary, to date the historic preservation movement to the publication of Jane Jacob's book "The Death and Life of Great American Cities" in 1961. Since this time there has been a growing awareness about, and willingness to preserve, our shared architectural heritage. Even with incentives and a great deal of resources and laws only the significant and the adaptable have made it through the bottle neck. As long as it was financially more feasible to demolish rather than rehab whole parts of cities slipped away. But what if the future bottleneck economics is based not only on the cost of rehab but also the cost of carbon emissions will we not see a similar slide of even larger magnitude? Perhaps it is appropriate that those who cannot be adapted do not make it into the next generation but can we really afford this. Are we not now building into the environment the steep cost of either demolition or retrofit of even new buildings and not just the older or more marginal buildings of our habitat? What we should do about this now seems clearer, what seems increasingly clearer are the consequences to doing almost nothing (our current national strategy). Those institutions, neighborhoods, towns, cities and individuals that wish to emerge whole from the bottleneck should seek out a strategy of lowest possible energy needs and the highest possible adaptability.

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