"SUSTAINABLE FUTURES: ANALOGIES BETWEEN ALASKA AND DESERT REGIONS"

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by

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ABSTRACT

This paper focuses upon the similarities and characteristics between the United Arab Emirates and a State of the United States, Alaska. The climatic disparities aside, these two entities have rather striking similarities. The United Arab Emirates population is a little over a million and Alaska's population is about 600,000. Both entities are primarily exporters focused on oil. Both of them have interest in energy efficient buildings and are trying to sustain a style of life and a standard of living appropriate to their expectations and means without deteriorating the environment.

An examination of sustainable architecture and application of approaches to sustainability in a general policy will enable the author to propose a map to the sustainable future, incorporating what has worked in the past, what is possible in the future, the energy cost of various types of architectures, and their expected life time and maintenance cost. Emphasis will focus on how to build awareness of sustainability issues and methods of embarking on a sustainable path for development and infrastructure-building. Energy efficiency education and research models utilized in Alaska will be exemplified.

Particularly important is an exhaustive assessment of local, on-site, renewable resources, such as wind and solar energy. Essentially, what is described is a methodology to develop the tools, professional experience base in a university setting, and the right set of questions to ask when approaching a sustainable culture and civilization.

Economic evaluations tend to discount the future too radically, to allow appropriate evaluation of sustainability in that development. For this reason, this paper will be somewhat heretical in its economic approach. Economics will not be the driving premise for the decision making suggestions made. Decisions should be focused on energy efficiency, durability, ability of a system and infrastructure to minimize the input of outside energy and investment, and it should feed the local environment, enriching it both culturally and biologically. All of these examples will be elaborated.

Keywords: sustainable, renewable energy, engineering, sustainable architecture, energy efficiency, renewable resource analysis.

SOME STARTING COMPARISONS

Without pushing what is at first thought, a strange comparison to draw, that of Alaska and subtropical deserts, let me make relevant comparisons to set the stage for an analogous model for assessing sustainable architecture and energy development.

Alaska has approximately 610,000 inhabitants, spread over a wide area, with disparate climates, including some very dry (< 25 cm precipitation per annum), and extremely cold. Housing therefore, and all architecture must meet the severe environmental stresses that an extreme climate places on buildings, while being affordable, durable, and sustainable (not yet a clearly defined term). Similar conditions exist in the U.A.E., and generically in desert regions around the world, but in the hot dry extreme of climate, not the cold.

Some comparative benchmarks, and perhaps a better name for them might "crucial necessary transitions".

1. A primary need is to agree politically on the need and desirability for a sustainable future. This is a political problem, and even agreeing to a definition of sustainability can be contentious. If this agreement to a definition becomes a roadblock, then agreement to a set of goals, which achieve various degrees of sustainability in policy, can be a useful compromise. Don't allow the goal of a sustainable future be lost in political stalemate. Compromise is better than failure.

2. Intensive review of existing architectural infrastructure is the only way to set goals and get an appropriate appreciation for the present situation, and for how much needs to be done.

Some guidelines include an exhaustive, comprehensive inventory of building stock, renewable energy resources, and an examination of the history of vernacular, local housing and its use of materials. These are the areas of learning, the basic elements, of building a sustainable architecture, housing stock, and ultimately helps steer a nation or state toward sustainability. Buildings are a huge portion of total energy use often accounting for 30% of national use, an amount often equal to transportation energy use.

The inventory of housing stock is generally available to some degree from property or tax records, and can be obtained from many existing data sources (= considerable work, but feasible). Assessing local renewable resources for desert regions is primarily a search for ample and accurate wind and solar energy data. Wind prospecting can be aided by specifying GIS system parameters, although anemometry and meteorological records can help as well. Solar radiation is clearly the prime resource for desert regions, whereas in high-latitude or temperate regions can (and often must, due to seasonal variations) utilize a combination of wind and solar renewable resources.

In order to focus on the similarities between Alaska and desert regions, it is best to examine an entire menu of solar applications to an integrative, ecological architectural concept. First, notice the facades on Figure 1, in which photovoltaic cells of a particular type (glass encased) are utilized for three architectural purposes: 1) they provide shade to the interior of the building; 2) they provide electrical energy; 3) and they provide a durable (glass), esthetic, and in the author's opinion a quite beautiful exterior weatherproof shell to the structure. These photovoltaic panels in Figure 1 are manufactured by Pilkington Glass', German Division, in Gelsenkirchen in the Ruhr Valley of northwestern Germany. Both buildings shown are located in the Ruhr Valley as well, an area not famous for its clear sunny weather.

Here then, is an example of an elegant application of a solar technology in a broad integrative application, which could be engineered to provide shading, by increasing the density of the photovoltaic cells in their mountings. Note also that the facades are the vertical walls of these example buildings, NOT the roofs. Figure 2, which is data for a site in Alaska, shows why, at higher latitudes this is quite a logical alternative for optimizing solar energy collection, and this orientation has the additional advantage of keeping snow cover off the collection surface. In semi-tropical desert climates, the roof shading options for using this material are more appropriate. However daylighting is a large integrative architectural concern, and these photovoltaic panels can have daylighting uses as well.

ARCHITECTURAL INTEGRATION OF DAYLIGHTING

In a recent article in Solar Today magazine, veteran Passive Solar design scientist, Dr. J. Douglas Balcomb made the following statement (Balcomb 1999):

> "Among design strategies, daylighting — the use of natural light to replace artificial light — fills a unique niche. *It stands alone as the most important design issue*."

He adds that there are at least five good outcomes and reasons to design for daylighting:

- — improves the aesthetics of the indoor environment
- — enhances the productivity of the occupants
- — decreases peak electric loads
- — reduces emissions from fossil fueled powerplants
- — saves on energy and operating/maintenance costs.

Beyond these clear advantages, people universally (this is Balcomb's claim, in any case) like daylit spaces. This does not mean that daylighting is simple. The decision to use it, and the recognition of its value must be integrated early into the design process. For all regions of the earth, the issues are merely those of clearly understanding the local solar geometry, i.e., the sun angle range. Determining the properties of materials which affect daylighting: reflectance properties, thermal mass storage, infrared absorption and reflection, all become part of the necessary skill base of the "sustainability architect".

Again, Balcomb (1999) discusses these aspects as "building physics", pointing out that our familiarity with buildings has given us a strange complacency, a misperception, that we really understand the "obviously" simple ways in which buildings work, but in reality don't have the appropriate humble respect we should for the slow, subtle and complex behavior of buildings. A deeper understanding of building function, and its interaction with materials choice, needs to be a part of the professional education of architects and engineers, and by this point the author intends to urge deeper inclusion of building physics and science into the professional curricula at universities.

Windows deserve a deeper review in the context of daylighting. They are perhaps too simple and problematic to be included in the Desert climate design menu due to their uncontrolled heating (overheating) aspects. Unshaded, untinted, uncontrolled solar gain is the nemesis of hot desert climates. An entirely different context for windows emerges from the hot desert zones, where heat is more a problem than a need, which is how it is viewed in temperate heating climates. A short diversion into word etymologies will make this point.

The English word "window" has a fascinating and instructive origin. It comes from the northern European climatic experience, from Old Norse, the parent language of Norwegian, Swedish and Danish, and part of English. The original words were "vindr auga", literally "wind eye", or "eye to the wind". The names comes from the small glazed opening in the wall of a coastal house, used by the inhabitants to keep watch on the weather, an important environmental observation for people who fished to survive the winter in a stormy ocean. Thus they had an "eye to the wind", a word which eventually became window in English, a name for a glazed opening in a wall which is now the universal English word for a glazed opening.

The point here is that materials, option menus, names for building elements, all have language and cultural complexity. Does window translate completely to the Arabic word "nafiza"? It is doubtful. There are clearly serious elements of a sustainable architecture which <u>ONLY</u> those with local or indigenous knowledge can fully appreciate or for which they can evaluate appropriate or inappropriate materials or technology.

Although much more needs to be said to fully explore the comparisons of sustainable architecture and building science, economic aspects always need to be addressed in this most scrutinized area of human endeavor, buildings. The most crucial question regarding economics of sustainability, particularly for buildings, is what design life should we be striving for? Is it 20 years, 100 years, 300 years? This choice sets the context for life cycle costing. In the past fifty years in the U.S., rarely has any building been evaluated for or expect to have an economic life of more than 20 years. But wood frame houses, and many other public buildings clearly last much longer, and certainly they should! What then is an optimum life for a sustainable architecture? This is a vastly complex question to answer with any certainty, because so many embedded assumptions are contained in it, and make a political answer to the question difficult and contentious.

It is possible to reframe and somewhat simplify the economic issues by putting a set of demands on architecture, and which ultimately demand a long functional life cycle for architecture which can be considered sustainable. Perhaps 100 years is a good goal for economic life.

To maximize lifetime, while minimizing costs, maintenance, cash flow, and building failure, here then are a set of demands which must be met:

A. Minimize embodied material throughput. Utilize local materials which are light in weight, durable, and inexpensive, in clever, vernacular ways.
B. Minimize what is commonly called the "environmental footprint" of the building. This means the building should not require large amounts of imported energy, but rather use as much renewable energy on-site as is feasible, and consequently not result in increased greenhouse gas emissions, and ultimately the process of having the building contribute to its own undoing, by causing the climate to change to a different one from that for which it is designed. (This is probably impossible to evaluate in money.)
C. Simplify controls and ventilation through design. This can be complex and risky, but can radically reduce operation and maintenance costs, a major portion of life cycle costs in most modern buildings.

As an example of a building which embodies many of these considerations, let me show you the new Reichstag building in Berlin, Germany. A most striking feature of this interesting public structure, is the new central dome and its details and multiple functions. (Figures 3 and 4, plus slides)

This imposing structure is a virtuoso technical design achievement, and is a national political and cultural symbol, the center of the newly re-established capitol of unified Germany, as well as the new seat of the German government. It is the re-built Reichstag. The design is by the British architect, Sir Norman Foster, who utilized all available site energy as well as daylighting and passive natural ventilation aspects, incorporated in the new dome structure. Additionally, groundwater reservoirs below the structure, in a confined aquifer, allow for pumped storage of seasonal heat and cooled water for the expected building needs for both in alternating seasons. There is a 40 kilowatt photovoltaic (PV) system on the roof of the Reichstag, and more PV is installed on the roofs of other buildings in the cluster around the Reichstag.

While this is perhaps, not the best possible example of an economic life cycle, it is nonetheless a compelling example of what the will to utilize exemplary renewable energy, design and aesthetic approaches to a building which is expected to last. In this, it is a stunning achievement, and utilizes the old Reichstag building in a "facelift" remodeling.

SOME CONCLUDING REMARKS

Sustainable design and the effort at working toward a sustainable culture is perhaps one of the greatest challenges humans have ever faced. It requires vast changes in how we view the world, and how we operate, build, and live in our cultural contexts. In this brief paper, only a few crucial points and examples could be cited, and the vast need for education, curricula, and new well-prepared professionals could not be made emphatic enough. But it is real, and our survival in a better world depends upon it. Let us continue to work toward that goal, and to spread whatever knowledge we have gained, and share our experience to all who need and care to know.

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