ARCHITECTURE, ENERGY AND CLIMATE

Editors' Notes

The interplay between architecture, energy and climate is not a new topic. Architecture has always had to relate to climatic conditions while providing shelter from the sun, the rain, the winds or the cold. This is a main purpose of buildings: To establish an indoor climate different from the outdoor. In the Nordic countries fuels for heating buildings has been a vital necessity almost as basic as food and water, and lack of wood has caused illness and migration - scarcity of energy is not a new topic either [Kjærgaard]. The new aspects are that human civilization can foresee using up the global non-renewable reserves of oil, gas and coal, secondly that we are in danger of causing severe global climate changes due to emissions of greenhouse gasses, both aspects capable of pulling the carpet under human civilization itself as we know it. The huge energy consumption especially in the northern hemisphere is closely linked to industrialization, and the response from those aware of energy and climate problems has in some cases been to search for traditional and pre-industrialized ways of building and settlement. The idea of this theme number is not to flee from modern life and approaches, but to face modern conditions relevant in achieving sustainable urban development and sustainable architecture, the only truly modern architecture that exists.

Nowadays terms like green or sustainable are selling everything from major cars and flight journeys to architecture and politics. 'Sustainable' also headlines several articles in this theme number so it may be wise to encircle what sustainable actually means. The general definition in the Brundtland-report [World Commision] is well known: 'Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs', so is the reports statement that the field of sustainable development can be conceptually broken into three constituent parts: Environmental, economic and sociopolitical sustainability. The definition has been met by critique, some claiming the definition being too anthropocentric focusing on humanity rather than the planet as a whole, some claiming the definition to be vague. Accepting the anthropocentric 'common future'-approach one still has to admit to the point of vagueness: The definition does not tell us what to focus upon. What are we actually going to do on an operational level for instance as architects?
The former World Bank-economist, Herman Daly may provide some principal help in this matter. While the economy and the sociopolitical conditions are highly stable in the Nordic countries compared to most of the world, there are clearly some environmental problems, 'environmental' covering the physical environment and the biological life. In his article, Toward some operational principles of sustainable development [Ecological Economics] he identifies three main operational principles considering the physical environment:

1. The sustainable use of renewable resources cannot be faster than the regeneration.
2. The sustainable use of non-renewable resources
cannot be faster than it can be replaced by sustainable use of renewable resources.
3. Waste cannot be emitted faster
than the natural ecosystems can re-circulate, obtain or neutralize it.

The first principle seems pretty logical: Every time we chop a tree, we should plant a new one. If we relate the principle to building in the Nordic countries, most of the renewable resources that are used are Nordic wood and these resources are stable or increasing. We may question the ways of forestry and the impacts on biological life. We should also be aware that a marginal part of the wood used in Nordic buildings is Tropical timber which may derive from rudely exploited rain forests. But in general Nordic architects should not find it difficult to comply with the first principle concerning the physical environment.

The second principle is more debatable. An example of replacing non-renewable resources with renewable in a sustainable way could be to invest the profit from utilizing oil-reserves in windmills, so there will be corresponding renewable energy when the oil-reserves run dry. But exactly what non-renewable resources should we focus upon and how fast should we shift to renewable? In this context 'supply horizon' is a key term: If we divide the known world reserves of a certain resource with the current worldwide annual consumption the result will be the span of years we can expect the resource to last. As both the amount of 'known reserves' as well as 'annual consumption' will change, the supply horizon is a very uncertain figure and there may strong political and capital interests and technical discussions attached to such calculations. The [International Energy Agency] assesses the supply horizon of oil to be around 40 and of gas around 60 years, while coal reserves are estimated to last more than 100 years.

This means that most new Nordic buildings will still be here when oil and gas are reduced to marginal fuels. Coal causes more carbon dioxide emission per energy unit than oil and gas, so switching to coal is not a convincing option. Renewable energy sources cannot cover any high consumption. Though the consequences of the second principle may be hard to calculate, it seems obvious that buildings and societies geared for high energy consumptions will find it hard to comply with the second principle.

The third principle is as logical as the first. Waste water can be emitted into a lake, only if the lake can absorb its nutrients. While recent decades have seen several examples of waste emissions causing local or regional ecological break downs, it is now the global atmosphere and the global climate that are endangered by emission of carbon dioxide and other gasses. United Nations IPCC, the International Panel on Climate Change has set an average global two degree heat increase as the limit we must not overstep if we are to avoid dangerous and uncontrollable man-made climate changes [COP15]. In December 2009 at the United Nations Climate Change Conference in Copenhagen world leaders tried to agree on a treaty to succeed the Kyoto Protocol
and reduce emission of carbon dioxide also from the fossil fuels that runs our houses and societies. Some spoke of a 20% reduction in 2020, others were more ambitious. But these are just first steps, foresighted politicians and researchers speak of fossil fuel free societies in this century.
Using the term 'sustainable' in a trustworthy way especially when dealing with building structures supposed to last for a hundred years we should operate with marked decreases in the use of fossil fuels in a number of aspects related to architecture and urbanity: Producing building materials, heating, cooling and lighting buildings, cooling food and drying clothes, getting from home to work, leisure or shopping. Are architects geared for this?

Two major questions arise, when dealing with architecture: Firstly, how can our cities and buildings withstand the consequences of global climate changes? If the sea-level goes up several meters, in the lowland of Denmark the presently high-regarded attraction of living close to the sea may fade. And if the average temperature rises several degrees, also in Nordic countries people will seek the shade more often than now, both in and outside their buildings. Secondly, how can the way we build reduce the use of fossil fuels and emitted carbon dioxide in order not to contribute to global warming?

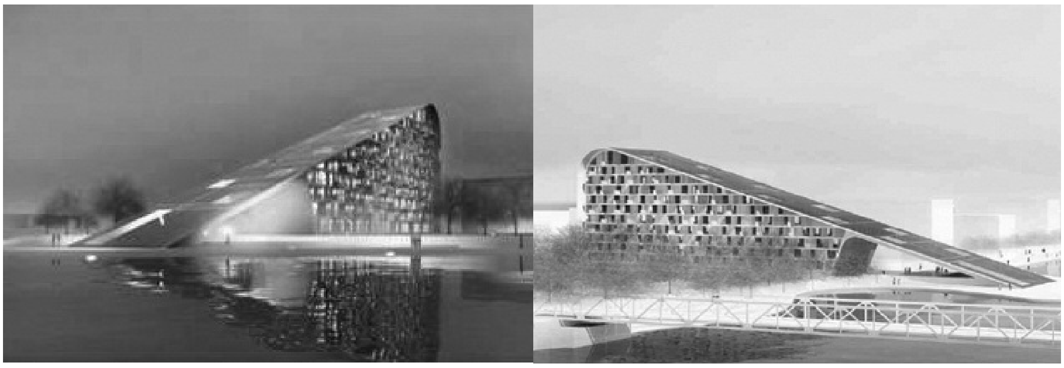

Figure 1 & 2
Bolig+. Competition project (2009) by Arkitektfirmaet C.F. Møller, Moe & Brødsgaard, Vogt Landschaftsarchitekten, Erik Juul, Cenergia, Scüco and Philips. Housing complex with solar cells on the roof.

The first question lies well within the borders of the traditional architectural task: How do we adjust our buildings to the actual environmental and physical conditions. Vitruvius spoke on this matter some 2000 years ago [Smith 2003], and clever architects have always related to the environmental conditions. Furthermore, the problem of for instance a raised sea-level is very easy to comprehend, it is easy to sense and imagine, though the exact future sea-level may be hard to calculate or predict precisely.

The second question is of a profound new character, regarding architecture: We can actually harm and affect the global environment far beyond the limits of the site we are building upon. This problem and its solutions are far more abstract. You cannot imagine or comprehend it just by looking, listening, using all your senses as architects are usually good at. The romantic tradition of using senses and feelings does not carry you all the way. Analyses, calculations are needed, rationalism may take over. Engineers may take over. This is another reason why architects may feel uncomfortable with climate change: Their professional position is under pressure, the role of the architect is disputed.

Engineer and architect, the two main advisers of house building, differs in several ways: The engineer is normally a specialist who knows lots about statics or ventilation or electrical systems, who can be very specific, deep and scientific in his or (more seldom) her limited field, and can provide small but well-proven parts to the bigger whole. The architect is – as often humorously expressed – a generalist who knows too little about everything. He or she has a broad approach, where the wholeness is important, and where every part has to fit the context. The window must fit the house, as the house must fit the site and the city. But in this respect, architects may have a good starting point when it comes to ecology, sustainability and global concerns. Architects know that everything is intertwined and works together as a complex whole, and many Nordic architects are brought up with the attitude that architecture has to relate to and reflect site and society [Lund 1991]. Maybe architects can use this traditional awareness of context also when handling the question of energy use and carbon dioxide emissions:

Knowing that the amount of private motorized transport has boomed during the last half century and knowing that use of cars are dependent upon urban density it is crucial to include urban consideration when speaking of sustainable architecture. A denser city development in many ways influences the environmental strategies on a building level, and raises some questions that have so far only been marginally explored. For instance: Dense building strategies cause shadows which seems to collide with those passive solar-strategies that have been predominant in the last four decades of architectural environmental strategies. But shadows may also be a positive condition as cooling demands are generally going up and will continue to do so in a future with rising average temperatures.

Urban considerations are crucial also in their own right. Most Danes prefer to live in single family houses with own gardens. Some of the reasons for this are the good possibilities of privacy and the freedom to carry out small building and other projects inside and outside [Gram-Hanssen, 2004].

Figure 3 & 4
CUBO architects (2008): Project for dense, climate oriented mixed use urban block in Ørestaden, Copenhagen.
Dwellings to the south, offices to the north.

The degree to which such possibility can be established also in a denser city context may prove crucial in order to make people choose a dense way of settling. New types of housing need to be developed including larger terraces and other types of outdoor spaces above ground, and greenery will have to be an integrated part of the architectural strategies. If people are to choose denser ways of settlement, the 'good attractive city' becomes a sustainable parameter. Sustainable urban development will of course depend on political action, but architects have their very important part to play as well, not forgetting the visionary, ground-breaking potentials of architecture.
This theme number deliberately link different scales. It includes articles on urban development, traffic and land use, architecture, urban and domestic activity, and it discusses the role and education of architects. The articles deals with historic, current and future perspectives, but are all related to the main theme, Architecture, Energy and Climate.

Næss et al studies the relationships between urban form and travel showing examples of cities that have used spatial planning in order to promote more environmentally friendly mobility. The article explores how the location of residences relative to concentrations of workplaces, service and leisure facilities influences the physical mobility and its related environmental consequences. This forms the background for a review of a variety of strategies dealing creatively with environmentally sound transportation such as land use and urban design, examples deriving from Europe, Africa, Asia, Australia, North and South America.

Haase et al look into the building consequences of climate changes. How does one design sustainable low-energy buildings while still providing thermal comfort under warmer summer conditions? Even in heating dominated climates like Norway more stringent building envelope requirements to reduce heat losses during the heating period lead to the use of cooling equipment that uses additional energy. Especially in buildings with high internal loads like commercial buildings, this can easily lead to high energy use in the operation of those buildings.

Marsh et al examines past, present and future challenges for building energy consumption in Denmark. In new offices it is shown that electricity consumption now dominates the total primary energy consumption, whilst rising temperatures will result in falling heat demand and increased cooling. On this background, a new paradigm for zero-energy architecture is developed that focuses on functional disposition, spatial quality and built form as the driving force in a movement towards zero-energy architecture that has good day-lighting and indoor comfort, and is adapted to future climate change.

Lauring studies the beaux-art architectural approach and its influences on four decades of environmentally ambitious Danish architecture, from the rural ecological houses of the seventies to zero energy urban housing complexes of present day. The essence of architecture is a disputed phenomenon, different parties giving different weight to aesthetics, function and techniques. The radical increased importance of technical issues like low energy consumption therefore not only calls for new design solutions but also challenges the role of architects and the profile of architectural education.

Knudstrup tells of educational programs geared for tomorrow's energy efficient architecture. The key word is integrated design, a phrase that covers a wide range of different approaches integrating architectural and engineering skills. The education at Architecture and Design at Aalborg University is problem-based and project organized taking an interdisciplinary approach covering architecture, spaces, proportion and light in rooms, functional aspects, energy consumption, comfort, technology and construction which is all developed through well defined design phases. The article shows examples of student projects.

Bech-Danielsen looks into three types of environmental efforts: Grassroots primarily achieve their results through behavioral changes, engineers through development of technologies such as construction, insulation techniques, renewable energy supplies etc, while architects achieve their results by basing the architectural design on environmental considerations such as the layout of the house, minimizing the building surface, climatic adaption etc. The architect should be aware of all three approaches, since they all hold big energy saving potentials.

Andrade tells of the Bus Rapid Transit system, an effective and low cost alternative when handling increasing traffic demands and emissions. Curitiba in Brazil, Beijing and Johannesburg have implemented the system which integrate transport infrastructure, land use policies and urban design strategies for fostering sustainable mobility and reduce emission of green house gasses, a crucial matter in a world where in 2008 for the first time in history the majority of the world population was living in cities, 3.3 billion people all together.

All together these articles cover scales from cities to single family houses and subjects from climate technical considerations and user preferences to aesthetic concepts thus indicating a broad research landscape relevant in optimizing the interplay between architecture, energy and climate. There are lots of white spots though. I hope this theme number may inspire to continuous mapping.

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LITTERATURE

ECOLOGICAL ECONOMICS 1990, vol. 2, issue 1, pages 1-6. Herman E. Daly: Toward some operational principles of sustainable development. Amsterdam: Elsevier Science Publishers B.V., Amsterdam.

GRAM-HANSSEN, K., BECH-DANIELSEN, C. (2004): House, home and identity from a consumption perspective. Housing, Theory and society Vol. 21 No.1. pp. 17 – 26.

KJÆRGAARD, T. (1991): Den danske Revolution 1500-1800. En økohistorisk tolkning. København: Gyldendal.

LUND, N. (1991): Nordisk Arkitektur. København: Arkitektens Forlag.

SMITH, T.G. (2003): Vitruvius on Architecture. New York: The Monacelli Press, Inc.

WORLD COMMISION ON ENVIRONMENT AND DEVELOPMENT (1987): Our Common Future. Oxford: Oxford University Press.

WEBSITES

International Energy Agency: World Energy Outlook 2008. Executive summary.
http://www.worldenergyoutlook.org/docs/weo2008/WEO2008_es_english.pdf
COP15: http://en.cop15.dk/