From ecological houses to sustainable cities

Architectural minds

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From ecological houses to sustainable cities. Architectural minds.

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Abstract:

Most Danish architects are educated in the Beaux-arts tradition putting aesthetics above techniques, and their work has the character of practice rather than science. This has influenced the development of environmental and sustainable architecture, of which the article gives a brief survey covering the period from the first oil crisis in 1973 to present day also seen in relation to resource, political and cultural preconditions. Sustainability forces architects to reintegrate techniques and urban and building utility as crucial parts of design considerations, while architects contextual approach needs to be widened.

Keywords:

Sustainability, energy, architectural approach, historic development of sustainable architecture.

Introduction

In the summer of 2009 most Danish architectural offices seems to have gone green. Homepages tell about sustainable awareness, and the Danish architectural magazines contain lots of articles, news stories and advertisements related to the subject. The title of the 2009 summer exhibition at the Louisiana Art Museum near Copenhagen sums it up: The future of Architecture is Green [web: Louisiana].

Indeed, there has been a remarkable shift during the last two or three year in which sustainability has moved from being a marginal and sometimes joked about phenomenon to being an indispensible part of building programs and architectural competitions, a phenomenon at the very center of the architectural field, at least when it comes to rhetoric.

For this, several reasons can be identified. In 2006 the Danish building regulations concerning energy consumption of houses were changed and sharpened in accordance with an EU-regulative in such a profound way that it is now difficult to do architectural sketching while ignoring concerns of heating and cooling [web: Erhverv- og Byggestyrelsen]. Energy and climate is no longer just an engineering concern. In 2007 the Intergovernmental Panel on Climate Change (IPCC) and Al Gore were given the Nobel Peace Prize marking a breakthrough in the worldwide acknowledgement of the current and predicted manmade global climate changes [web: Nobel Peace Prize]. In December 2009 the Copenhagen Summit will take place, where hopefully the world leaders will agree on a treaty to follow-up the Kyoto Protocol, making guidelines for reducing emissions of carbon dioxide causing climate changes - the biggest and most important political gathering ever in Denmark, with preparation causing spin-off to a broad field of activities including green building [web: Cop15].

And of course, leading up to current situation, since the first oil-crisis there has been 35 years of good-hearted attempts of linking architecture, energy and sometimes climate in a responsible way [Dirckinck-Holmfeld 1995], [Ibler 2008].

There have been societal and economical barriers to such responsible action, but also resistance within the architectural society itself, vigorous ecological images colliding with the cool modernist mainstream of Danish architecture. Now the architectural barriers seem to break and there is a general acceptance of the importance of reducing the need for fossil fuels for running buildings and society, in order to keep down carbon dioxide emissions. The question is now, to what extent architects can use the first 35 years of architectural experience, which have been focused on reducing heat loss from buildings? Are architects on the right track? What shall architects actually do in order to optimize the interplay between architecture, energy and climate?

Two major questions arise, when dealing with architecture: Firstly, how can our 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 our 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?

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 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 have hesitated jumping the green train: Just as much as architects may disregard the naïve, romantic images of early, homemade 'ecological' settlements in rural contexts close to nature, they may disregard the rationalist, calculating, engineering building-approach as it questions and collides with the - philosophically seen - romantic tradition and approach, that beaux-arts architects are brought up with, putting feelings, sensuality and aesthetics above cold reason [Marsh 2000].

Engineer and architect, the two main advisers of house building, also differ in another way: The engineer is normally a specialist, who knows a lot 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. 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. This has not been done yet, even though energy has been a rather important subject for the last 35 years.

Ecological houses – The seventies

The first oil crisis in 1973 came as no less than a shock to the Danish society. The year before on the initiative of the so-called Rome Club a group of MIT-researchers had released its report, Limits to Growth, which on the basis of then advanced computer calculations predicted a global ecological collapse in the 21st century if the growth rates of population, food production, use of raw materials and energy and the emission of pollution that one had seen in the sixties continued [Meadows 1972]. The publication initiated much debate, though primarily in academic circles. But the oil crisis affected everyone. Suddenly it became obvious how depended we are on certain natural resources. Denmark was met by a total boycott by the Arab oil-suppliers due to pro-Israeli statements during the Yom-Kippur war. Out of the total Danish use of energy which had increased heavily during the previous fifteen years of increased wealth - including a doubling of the housing area and a car for a majority of Danish households - over 90% was covered by Middle-East oil [Lind 1999]. Now the taps were closed.

In retrospective the oil crisis marks the end of the 'happy sixties' and the foundation of a new, much more energy-conscious and energy-oriented

Danish society. In the following years, long term political goals were defined: Using different fuels instead of just oil, developing a collective heat supply based on combined heat and power plants, intensifying the search for and production of oil and gas in the North Sea and seeking energy savings. But the short time tactics in the winter of 73-74 had to rely on the ordinary efforts of common man. Car driving was prohibited on Sundays and people were advised to turn off electric light if not needed and turn off the heat at night, which people did. They also shut the doors and windows and installed wood burning stoves [Lind 1999]. Indoor climate was not yet a subject.

In the mid-seventies modern architecture and the ideals of rationalism, internationalism and structural honesty had already long been criticized. The thousands of grey concrete blocks erected according to rigid layout schemes that had spread over the Western and a good part of the rest of the world, were being heavily criticized for their lack of beauty, lack of relation to site and history, lack of psychological qualities and lack of contact between the occupants. The reactions against modernism were many and some included ecological considerations.

In the early 1970'es at Kunstakademiets Arkitektskole in Copenhagen the so-called Freja-group was founded, Freja being the Nordic answer to Aphrodite. The group had strong emphasis on ecological concerns and a very skeptical view to the modern city, it´s most famous publication being Handbook in rural settlement [Bak 1977], a guide book for urban residents who wanted to move to the country. The rural associations also blossomed in the names of the experimental dense/low housing schemes of the seventies such as Galgebakken (Gallows Hill, 1973-74), Gadekæret (The Village Pond, 1975-79) or Tinggården (The Thingstead Court, 1978) [Dirckinck-Holmfeld 1995], though all situated in urban contexts and using concrete as bearing construction, while the aesthetic expression slowly evolved towards traditional architecture with pitched roofs and even wooden coverings in the latest project.

Tinggården designed by Vandkunsten was the end-result of a competition initiated by the Danish Building Research Institute in 1970 about dense/low housing. The ambitions of this winning project were both social and ecological. Often seen as the incarnation of Danish architecture of the seventies, it succeeded in facilitating social interactions between occupants, and has inspired many dense/low housing complexes both in Denmark and abroad. After a long planning period, in the final project the scheduled number of solar collectors was heavily reduced due to economy, and calculations show that the heat-consumption of the housing complex is not below standard [Lauring 1998]. While the actual energy savings failed, this and contemporary building

projects helped linking ‘ecological housing’ to rural expression or settlement.

Concerning energy savings, other initiatives showed better results. On the heels of the oil crisis the new Building Regulations of 1977 contained two new important rules [Bygningsreglement 1977]: The total area of doors and windows could not exceed 15% of the total floor area. And thermal bridges could only be accepted to a very limited degree. The first rule meant that for the next eighteen years buildings with limited daylight conditions were built. Those modernist dreams of glass facades that had - during the sixties - slowly become reality not only in office buildings but to some degree also in housing had now crashed, leaving once again the window as a hole in a wall and the occupants and users in darker rooms.

There was a way to get around this obstacle: Rooms that were not heated could have lots of glass. This resulted in thousand of so called non-heated winter gardens and other glass extensions of existing houses. And a lot of the so-called ecological houses and housing complexes built in the following years were supplied with some sort of winter garden meant to pick up solar heat that could be transported to the fully heated parts of the house, thus reducing the need for supplied energy [Arkitektur DK]. The winter garden became a crucial ecological element and symbol.

The second rule about thermal bridges had an interesting architectural side effect on the brick-built Danis h houses. The fact that the outer walls outer leaf and inner leaf were no longer attached as they had been for instance around doors and windows also meant that the outer leaf was in general no longer part of the bearing system but functioning primarily as a rain screen. Brick walls are not the optimal rain screen, and the new rule accelerated a development towards multi-layered outer walls, each different layer serving

its specific purpose. As rain shields can have many forms, the possibilities for architectonic expression were widened, and the old modernist dogma that a building should express its construction became redundant by the cause of heat insulation [Marsh 2000].

At the late seventies, modernism was on its heels. Romanticism was preferred to rationalism, traditionalism and regionalism to internationalism, desired images to structural honesty [Nygaard 1995]. Concrete was covered by non-concrete, and small windows had replaced glass facades which only survived as winter gardens, the new ‘eco-architectural’ element: A light room producing passive solar heat. Ecological architecture was now a common term having something to do with energy consumption. But in fact, no one has ever come up with a convincing definition of ecological architecture or ecological houses. The term was and is free for use. Slowly, during the seventies ’ecological’ evolved from being a scientific, descriptive term to being a normative one, without any norm-criteria, but with lots of images and associations mostly of a rural kind [Lauring 1998].

Back to the City - The eighties

As the Shah of Iran was overthrown in 1979, the Iranian oil production dropped and prizes rose. They continued to rise the following year as the Iran-Iraq war broke out and thus the decade

started with huge transfers of capital from the Western to the Arab world causing inflation and unemployment in Western countries including Denmark [Lind 1999]. Slowly the prizes fell again and slowly the Danish long term energy strategies started to work. Oil was replaced by coal. Combined heat and power plants where the heat loss from producing electricity could be utilized for heating, were built across the country, and more buildings joined district heating. All in all the total energy consumption were kept stable. The North Sea production of oil and gas started to grow, and by the end of the decade the self-sufficiency of energy had gone from about zero to 50 % [web: Energistyrelsen maanedsstatistik].

The seventies had in Denmark both politically and culturally been dominated by the left wing, but now there was in markedly swift to the right. Danish youth abandoned the multi colored, hippie-like or rural dress code of the past decade and started wearing black, as did architects. Architecturally there was a strong shift from social and ecological concerns to aesthetical. I 1977, Charles Jencks had invented the term postmodernism, indicating that modernism was a finished chapter [Jencks 1977]. In international architecture historical references now blossomed, from the merry works of Venturi and Stirling to the severe new rationalism of Ungers [Nygaard 1995]. Along with this historical orientation there was a renewed interest in the city. Where the modernists had expanded the city with new building projects out in the open fields, architects now returned to the historic remains. As heavy industry were shut down or moved away due to economy or environmental demands, the industrial areas could be used for other purposes. The architectural positions of how to reuse and restore the city were many, but one thing was certain: Urbanism was in, rural approaches were out.

Ecology was out too, at least among architects. Being strongly connected to rural or even anti-urban approaches and aestheticism, ecology was considered a rural phenomenon of the past. The baby was thrown out with the bath water. And as oil prizes were low for most of the decade, the economic stimulus for saving energy was low. A few architects, especially Boje Lundgaard went on exploring the architectural potentials of passive solar heat through a number of housing projects [Dirckinck-Homfeld 1995], but most architects lost interest. The site was the city, the subject granite rather than greenery, and energetic city life rather than fossil fuels.

While the architects left, ordinary people stayed on the subject of ecology and housing. During the eighties and nineties several country-side eco-villages were established, often with people building their own free-standing houses in their own designs, colorful villages with a variety of forms far from both modernism and postmodern infill-design, thus widening the gap between the ethic and social oriented ecology and aesthetical focused architecture [Bech-Danielsen 1997].

Regarding the question of countryside versus city, there are several energy-problems related to free standing houses in rural context such as building surface and heat loss per floor area, lack of efficient infrastructure and the use of cars, so the actual environmental impact and ecological results of country life can easily be questioned. In the late eighties two Australian researchers, Kennworthy and Newman carried out a global

survey of 32 major cities showing a very close interdependency between density of population and use of gasoline for transportation [Kennworthy 1990]: The closer we live together the less fuel we use. In cities with less than 30 human beings per hectare the gasoline consumption rises dramatically. The close relation between density and use of gasoline was later confirmed is a survey including 22 Nordic cities [Næss 1994].

The urban-oriented architects had many environmental arguments on their side, but they did not use them as they did not think of this matter. At the end of the eighties architects were far from being green, and environmentally seen things were turned upside down.

Urban ecology and more passive solar - The nineties

Our Common Future, the so-called Brundtland Report written by the World Commission on Environment and Development and published in 1987 [World Commission 1987], introduced the term Sustainable Development linking physical sustainability closely to social and economic sustainability, and described in broad terms the principles to avoid that ecological collapse being foreseen in 'Limits to growth'. Emission of carbon dioxide and the resulting green house effect was mentioned as one out many threats, but in the following years this matter grew in importance among the environmentally concerned.

In 1993 the highly influential politician Auken took over The Danish Ministry of the Environment. A year later it´s field of responsibility covered both environment and energy thus paving the way for foresighted strategies linking energy with climate [Energistyrelsen 1995], resulting among other things in a marked increase in wind (and wind turbine) production and several environmental urban and building initiatives, all in all making environmental issues a central part of both research and politics and putting Denmark in the forefront of environmental action including the negotiation of the Kyoto Protocol of 1997 [web: Cop15].

In this decade of stable economy, decreasing unemployment and growing optimism, postmodernism were on retreat and slowly being replaced by New Modernism in favor of glass and light. The new Building Regulations of 1995 concerning energy were still totally focused on space heat consumption [Bygningsreglement 1995]. With better insulated windows the allowed area of windows and doors went up from 15 to 22%. Also the alternative 'energy target'-calculation method was now in use, including heat loss due to transmission and ventilation and heat contribution in the form of passive solar heat, internal heat gains plus the effect of heat accumulation in thermal mass. Using the energy-target method, there were no restrictions on the amount of windows, as long as the calculated heat consumption did not exceed a given limit corresponding to the consumption of a standard house.

Those architects, whose visions of glass facades had been suppressed for almost two decades, quickly caught the opportunity. Beside the current modernist tendencies and a legitimate wish for better daylight conditions in buildings, passive solar heat had gained a strong reputation for being ecological, so the urge and arguments were many. In 1996 a national architectural competition called Eco-house 99 was arranged. Five out of six proposals had large glazed areas facing south-southwest, and the two winning projects had almost 100% glass on the southern facades**.** Besides these and other environmentally ambitious housing projects a lot of totally glass-walled office buildings were erected in the late 1990's. Terrible indoor climatic conditions and energy consumption three times as high as reg

ular offices – mostly due to immense cooling demands covered by electrically driven cooling systems – were a common result [Sinding-Jensen 2002] . The glass offices looked modern but were not geared for the energy critical 21st century.

Now the architectural strategies of the so-called ecological houses were being questioned. As the two Eco-house 99 winning projects were being built and taken in use, the one showed big problems with overheating with temperatures between 30 and 45 degrees Celcius in the 1st floor rooms during the summer months, while the other one showed that predicted advantages of passive solar is in reality very dependent upon the habits of the occupants [Dollerup 2002], [Hans Bjerregård 2001]. Calculations later carried out by the Danish Building Research Institute showed that the reductions in primary energy consumption were very limited, partly because it is difficult to utilize so much passive solar heat, partly because there is a great heat loss through big facades, and partly because the energy embedded in glass production is relative big [Marsh 2000] [Statens Byggeforskningsinstitut 1999] .

In 2001 another survey showed that most of so-called ecological housing projects with winter gardens built since the early eighties had a considerably larger need for heat supply than ordinary houses [Dollerup 2002]. An obvious reason could be the fact that Danes long for daylight also on the darkest days, and the heated winter gardens create a tempting possibility. The survey was carried out in co-operation with the Danish Centre of Urban Ecology, another institutional initiative supported by the Ministry of the Environment and Energy [Lauring 2004]. Urban Ecology was characterized as an environmental effort with participation of occupants and other users in a specific city-area heading for holistic solutions to problems concerning resources, environmental impacts and (lack of) nature [Miljøministeriet 1994], and some of the main efforts in this field were the renewal of urban city blocks, especially their inner courts, with Hedebygadekarréen being the most ambitious example [Erhvervs- og Byggestyrelsen 2004].

At the end of the nineties, issues of environment and energy had a relatively strong position in peoples mind, very much due to political initiatives and State financial back-up. In spite of the first attempts of urban ecology resulting in attractive green courtyards, ecology was still considered very much a rural phenomenon, as first impressions seem to linger. There had been reconciliation between architecture and environmental ambitions, with aesthetical very convincing examples of passive solar housing. Though, among architects environmental architecture was still a marginal phenomenon, often associated with rural, homemade and untalented design. First impressions linger amongst architects, too.

The actual quantitative results of the so-called eco-houses were questioned, both regarding indoor climate and energy savings. On top of that, important energy issues were overlooked or ignored: Since the Building Regulations of 1995, in new typical terraced houses the primary energy consumption of electricity (non-heating purposes) had been marked higher than the primary energy consumption of heat (covering both room heating and hot water), due to better insulation, district heating and increased use of electrical appliances. This tendency was even stronger in offices [Marsh 2006].

Another comparison is quite as interesting: At the first oil crisis in 1973 the total Danish energy used for room heating was twice as high as the total energy used for transportation. In 1998 the steadily increasing transport energy for the first time topped the relatively stable amount of energy used for room heating [Energistyrelsen 1995] [web: Energistyrelsen aarsstatistik]. As stated previously spread rural or suburban settlement causes much more private transportation than dense urban settlement. This was not a topic being discussed, going green.

Efficient houses - The new millennium

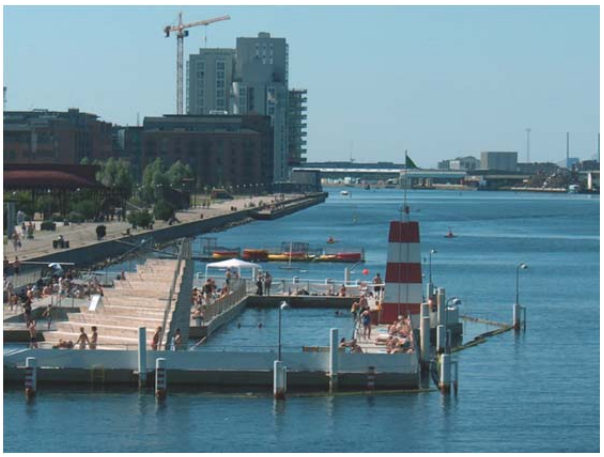
The attack on the 11th of September 2001 and the response in form of wars in Afghanistan and Iraq once again put the relation between the Arab and the Western World and the global oil interests on top of the international agenda. A few months later, a new Danish Government not only gave evident political and military support to the US response, it also cut down the support for those national renewable energy systems including three major offshore wind farms being planned, that could have eased the dependency on oil. Energy and Environment were once again split on two different Ministries, the new Minister of Energy claiming that he did not consider manmade carbon dioxide to be pollution [web: Folketinget], then stopping national research in solar cells and wave energy. In all fields the support for green initiatives ceased, researchers and alike being questioned in the Prime Ministers New Year Speech, when he claimed that 'the public shall not accept lifted fingers from so-called experts, who claim to know best' [web: Wikisource].

Architecture itself was slowly swaying away from the cool new-modernism of the nineties towards more irrational and often soft and organic forms, very much helped by heavily improved computer designing techniques. In some of these projects the traditional relations between building and landscape were being questioned, buildings becoming landscape to walk on, Snøhetta's Oslo Opera being an international well-known example, and several works by Danish BIG being realized in and around Copenhagen, VM-Mountain internationally rewarded best housing complex of 2008 [web: VM-bjerget]. The measurable energy and carbon dioxide impacts of these projects may well be questioned, but they do represent an aesthetical urge to inspire from and interfere with nature although in a very cultural way, providing artificial landscapes for cities.

With Danish government backing out and financial sources drying out the green impulses had to come from elsewhere. Some came from municipalities. Some Danish Cities marked themselves with green and carbon dioxide-conscious profiles on planning, regulation and support, Copenhagen taking the lead including urban and architectural projects such as a wind farm outside the harbor, a coherent network of bicycle routes going through green areas, two harbor baths in the cleaned up harbor [web: Københavns Kommune] and further establishment of green parks and courts in the city. But also smaller cities like Albertslund and Kolding became front-runners for instance with

rules for energy consumption in new buildings stricter than the standard demands.

Another impulse came from EU. In 2006 the Danish Building Regulations concerning energy was changed profoundly as a consequence of an EU-directive on the energy performance of buildings [Europa-parlamentet 2002]. The new rules had to take their starting point in two premises: To assess the whole and the primary energy consumption. Now included was the energy for heating, cooling, hot water, lighting (though not in dwellings), building services (like pumps and ventilation) and system losses (heat loss from internal plant, pipe work etc). For calculated overheating going over 26 degrees, the electricity for running a standard cooling system to eliminate the overheating was included in the assessment. On the producing side, the building integrated energy production from solar heat and solar cells was included in the assessment. Primary energy consumption deals with the fact that most types of energy cause loss during production and distribution. The production of electricity had a current effectiveness of only 40%. Therefore electricity needs had to be multiplied by 2.5. Gas, oil and district heating were multiplied by 1.0. Also important was that The Building Regulations dealt with two classes of low energy buildings: Class 2 equals 75% of the energy frame, while Class 1 equals 50% of the energy frame [web: Erhvervs- og Byggestyrelsen].



To architects, the rules have all in all had great importance. While sketching buildings and especially facades, you now have to make close considerations concerning the need for heating and cooling when deciding the size and orientation of windows. What was once considered an engineering discipline is now an integrated part of architectural activity (causing lots of in-training courses).

The low energy-classes were meant to encourage optimization of energy performance of houses, and some municipalities have made the energy stricter classes part of the demands for new buildings on all or chosen development areas. Also the so-called Passive House-concept originally developed in Central-Europe has gained attention now resulting in predominantly single family houses with very low heat consumption [web: Passivhuse]. The passive house criteria operates with a max limit of 15 kWh/m2year for room heating, making mechanical ventilation with heat recovery a necessary part of the technical strategies and passive solar an important part of the architectural strategies. The Passive House standards cannot be directly compared to Danish low energy standards, but are in general considered stricter on the heating and less strict concerning electricity and total energy consumption. Some Danish Architect firms have now designed passive houses, including some aesthetically very convincing examples with good indoor climates [web: Komforthusene]. In the summer of 2009 passive houses are considered the state of the art among Danish architects, though also being teasingly competed by the so-called Active Houses having more focus on daylight, solar panels and solar cells [web: Active House]. All in all there are dozens of Danish architecturally promising examples of single family houses with very low heat consumption and a fruitful debate among

architects about technical means, technology slowly reestablishing its position as a crucial part of architecture, as Vitruvius once defined it: Architecture is about strength, utility and beauty, strength referring to technical qualities.

One important utility or user related aspect is almost totally left out: The sustainable aspect of how to get to and from the houses. In 2004 there was an emission of 6.06 ton carbon dioxide per Danish citizen related to personal matters, divided on household (2,54), transportation (2.02) and material goods (1.49). The household is divided on heat (1.59) and electricity (0.95) [web: Klima- og Energiministeriet]. All these are average figures. 2.02 ton carbon dioxide for transportation equals approximately 840 liters of gasoline or 13300 kWh. Compared to average figures, the consumptions and emissions in modern houses are somewhat lower. In a typical terraced house of 120 m2 built according to the Building Regulations of 2008 and with three occupants the primary energy consumption for heat is 2200 kWh and for electricity 4400 kWh per person [Marsh 2008]. In low energy houses these figures are of course lower. This should be compared to the 13300 kWh the average person uses for transportation.

Conclusion

During the last 35 years there has been a marked change in importance comparing different kinds of energy consumptions related to architecture and building. The total Danish heat consumption has been relatively stable, but the supply system has gotten much more effective with an increased amount of district heating utilizing heat loss from the production of electricity. The consumption of electricity has gone up both due to electrical appliances and to architecture in need of cooling and mechanical ventilation. And the amount of private motorized transport has boomed. This has not yet had an architectural answer, passive houses with mechanical ventilation being regarded the state of the art. It is positive that techniques, passive as well as active, have regained their position as an integrated part of architecture. But the user and utility related aspects have to regain their position to, including considerations on lifestyle, traffic, patterns of settlement and of 'the good city' in order to be realistic when claiming sustainability of architecture. We cannot just continue the heat-saving focus of the last four decades.Architecture has traditionally been a practice rather than a science, a practice relying very much on visual images as inspiration or more directly as forms to repeat. This may explain why the idea of rural settlement as being the most 'ecological' or sustainable way of housing has lingered for several decades and continue to do so. The same can be said of passive solar, maintaining its position as key environmental architectural element in new buildings long after heating has lost in importance compared to non-heating functions including transportation. While architects has to be much more analytical making use of science-based information in order to truly claim sustainability of projects, he or she may on the other hand benefit from some traditional roles of the architect: To include techniques and close considerations on user behavior and preferences both on a building and a city level while designing houses, may seem new compared to the aesthetically focused architecture of the eighties or nineties, but is in fact nothing more than an Vitruvian approach revisited. Nor is the importance of relating the house to the urban context new to the architect, but the contextual considerations has to include also the environmental aspect of avoiding too much motorized traffic, an aspect desirable also in a local perspective. Thus, the role of the architect has to be rediscovered as well as reinvented.

Sustainable cities. The future.

What shall architects actually do in order to optimize the interplay between architecture, energy and climate? As has been said, it is not sensible totally ignoring the aspect of transportation and the interdependency between population density and need for motorized transport. A broader focus including urban considerations is needed. 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:Dense building strategies cause shadows and thereby influence the amount of direct sunlight. This seems to collide with those passive solar-strategies that have been predominant in the last four decades of Danish 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. A dense city with mixed use areas may decrease the need for transportation, as several city functions can be reached by foot, bike or public transportation. Mixed use has several social advantages in terms of keeping the neighborhood alive and inhabited through both day and night, but it also has some obvious energy potentials: Dwellings need sun and heating while offices and institutions are more in danger of overheating. Building space could be shared with advantages for all functions, giving sun and shadow where needed and perhaps operating with internal heat transfer from offices to dwellings.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]. 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.Sustainable urban development will depend on political action: On a national level traffic infrastructure will have to support dense urban settlement and municipalities will have to provide local traffic conditions, building sites and municipality plans supportive of new types of housing and city building. But architects have their very important part to play as well, not forgetting the visionary, ground-breaking potentials of architecture.

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