

## **The Influence of Climate on Architecture Synthesis of Ecology, Technology and Architecture for the Current Millennium**

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### **Abstract**

The steadily decreasing natural resources and the parallel increasing world energy consumption, in combination with the international oil price developments, are important factors for the actual situation in the world and are indicators to think about an enhanced use of renewable energy sources and to support strongly their application world-wide. Global prognoses and the problem of climate change and its consequences on life and the planet indicate, that a change towards sustainable development is very important. The energy situation in the world, in combination with the rapidly rising global energy consumption and the increase of the world population are reasons to act in various global levels, to meet the challenges of the future. In concern of this actual development renewable energies and their application in the various sectors, also strongly in architecture, should be considered more seriously and their support should be enhanced.

The human constructions and the influence climate has on them will be described in this paper. The adaptation of shelter and architecture to climate will be shown and with it the various expressions of the human constructions and architecture due to the basic climate conditions of the various locations in the world. The climate has always been a fundamental factor since the construction of the first shelter. The climate, the climatic regions and the environment of human constructions have determined effects on the type, style, expression, form, dimension, interior and outside design of buildings. In former times there has been a direct connection between architecture and the climate region in which the constructions have been built. The Synthesis of Ecology, Architecture and Technology and the influence of climate to the design and construction is the main objective of the presentation. The use of renewable energies in architecture will be shown in particular in the application and integration of photovoltaics in buildings (BIPV).

The bioclimatic architecture of the past and present, including an overview of the up to date bioclimatic factors and examples world-wide will be presented, including a profound demonstration of building integration of photovoltaics and an unique BIPV scheme for the practical use of architects and engineers.

### **Introduction**

The steadily decreasing natural resources and the parallel increasing world energy consumption, in combination with the international oil price developments, are important

factors for the actual situation in the world and are indicators to think about an enhanced use of renewable energy sources and to support strongly their application world-wide. Global prognoses and the problem of climate change and its consequences on life and the planet indicate, that a change towards sustainable development is very important, if we would like to create an environment worth living for our children and future generations. The energy situation in the world, in combination with the rapidly rising global energy consumption and the increase of the world population are reasons to act in various global levels, to meet the challenges of the future. In concern of this actual development renewable energies and their application in the various sectors, also strongly in architecture, should be considered more seriously and their support should be enhanced.

### **Climate Change / Consequences**

‘The revolution of the globe gives the heartbeat of day and night which regulates the activities and responses of natural life.’ (Olgay, 1960: 1)

Global temperatures have risen consistently for the past 140 years and it is now widely accepted that this change is linked to man-made greenhouse gas emissions that have increased with industrialisation and the burning of fossil fuels. The use of the expression climate change is better than global warming because it encompasses many kinds of effects.

The scientific community has reached a strong consensus regarding the science of global climate change. The world is undoubtedly warming. This warming is largely the result of emissions of carbon dioxide and other greenhouse gases from human activities including industrial processes, fossil fuel combustion, and changes in land use, such as deforestation. Continuation of historical trends of greenhouse gas emissions will result in additional warming over the 21st century, with current projections of a global increase of 2.5°F to 10.4°F by 2100. This warming will have real consequences for the world, for with that warming will also come additional sea-level rise that will gradually inundate coastal areas, changes in precipitation patterns, increased risk of droughts and floods, threats to biodiversity, and a number of potential challenges for public health. (Claussen, 2004)

### **Why a change is needed / World Situation**

The actual situation in the world shows the importance of a way towards a sustainable future, following facts why a change is needed.

The concern regarding environmental crises on both the local and global levels reflects a general acceptance that the present form and degree of resource exploitation and our associated consumption practices are unsustainable. The continued disappearance of forest cover, land degradation the loss of biodiversity, air and water pollution, and the changing chemistry of the atmosphere all clearly reflect the inappropriateness of our present activities and the need for more effective environmental protection. The Concerns over the relationship between human activity and development and their influence on the environment are long-standing.

### **Renewable Energy**

The conference in Bonn, Germany, in 2004 “Renewables 2004” concluded with a strong declaration by 154 governments that renewable energy should and will play a major role in the energy economy of the 21st century.

Renewable Energy is becoming more and more important, with the increase of the actual oil prices in mind even more. In a report, *The Price Of Power*, New Economic Foundation (NEF) says: 'Renewable energy is the great, barely-tapped solution to the two great challenges of the coming century - poverty and global warming.' (Kirby, 2004) The report refers to the costs of natural disasters mostly linked to global warming reached \$60bn last year, with the warming triggered by the burning of fossil fuels - coal, oil and gas.

### **Use of Renewable Energy Sources (e.g. Photovoltaics):**

Our increasing awareness of many pressing global realities is helping us to understand the impact of human actions on the environment and on human quality of life. Indeed, the concept of sustainability is, in itself, a reflection of this growing awareness and of the need for new cultural values. Thus, it has been suggested that: Perhaps we are beginning to move towards a new global ethic which transcends all other systems of allegiance and belief, which is rooted in consciousness of the interrelatedness and sanctity of life. Would such a common ethic have the power to motivate us to modify our current dangerous course? There is obviously no ready answer to this question, except to say that without a moral and ethical foundation, sustainability is unlikely to become a reality.

One part of the use of renewable energy sources is the Photovoltaic technology (generation of electricity out of sunlight, in a semiconductor material, e.g. Silicon). The application of photovoltaics and their wide-spread use is directly connected with the use in architecture, in particular with the integration of photovoltaics into buildings (BIPV). If the use of BIPV through architects and engineers increases, also the world-wide objective of the Renewable Energy Sources (RES) utilisation will be strengthened. Therefore the architects have a huge responsibility for the built environment and the conscious use of energy sources and technologies, which are according to the world-wide objective of sustainable development.

Finding the best and most efficient ways for Building integration of photovoltaics, in combination with the desires of architects and on the basis of the up to date technology development in international research institutes, presents a main objective in the field of engineering science, including architecture research and technology. As a result of a research project about Building Integration of Photovoltaics a unique BIPV scheme for the practical use of architects and engineers has been prepared.

### **Climate and it's influence on architecture**

The climate, the climatic regions and the environment of human constructions have determined effects on the type, style, expression, form, dimension, interior and outside shelter. The adaptation of Shelter to Climate will be described and with it the various expressions of the human constructions and architecture due to the basic climate conditions of the various locations in the world.

“Since the beginning of time, man has been affected by climate and its influence over the earth. The first humans built shelters and lived in caves to protect themselves from the weather elements. However, the first documentation of architectural design with climate interests in mind dates back to fourth century B.C. in Greece.

The philosopher Vitruvius is quoted as saying, “We must at the outset take note of the countries and climates in which buildings are built’ (Olgay, 1960: 3). In Rome, architects made note of the reduction of temperature created by the huge stonewalls and their shadows. The walls were made of stuccoed brick and were typically twelve to twenty feet wide which allowed for an extended area to be captured in the shadows of the walls keeping the city cool

during the midday hours. The stuccoed walls are an example of climate-responsive architecture, or architecture that is constructed and built with designs that make use of the surrounding climate and its natural effects. Climate responsive architecture takes advantage of free energy in the form of heat and light. Each region of the world employs its own techniques and designs in its buildings that are best suited to that particular region and that encompass the region's cultural patterns. This is known more commonly as vernacular architecture, or 'forms which grow out of the practical needs of the inhabitants of a place and the constraints of the site and climate' (Olgay, 1960: 3). Vernacular architecture varies for regions of hot climate and regions of cold climate. Many of the same techniques are employed, but it is the way they are used in each respective climate that makes them unique.

### **Examples Past and Present**

The examples of the past in this concern and today's loss of the direct connection in 'modern' architecture to the various climatic conditions of the location of the building are the key factors for the future, in combination with the use of the material of a specific site, the interrelation of traditional methods of construction in a specific area and the application and integration of modern technologies. This paper intends to show the relation and connection between these mentioned factors and categories.

And the interrelation between these factors shows the way for a new architecture on the basis of the known ecological buildings and bioclimatic architecture – a vision for the Future of Architecture. The direct connection to the facts and worldwide developments mentioned before show the actuality and importance of such a new way of thinking, designing and construction.

Some hundred years ago the relationship between human beings and their environment was characterized mainly by their possibilities to adapt to the environment (as well as to the climatic conditions) and to live in harmony with it. The requirements for comfort were very different in the past and a comparison with today's comfort demands cannot be made, people were unable to tame nature to the degree to which it is possible today.

The continuous development of building materials and the parallel evolution of demands for comfort and better hygiene, the design and form of buildings changed, they became more open. With further development they presented also ecological overall solutions. The opening of the building continued with the architectural development and new "trends", the large-scale use of glass and the opening to the outside environment, with a parallel development of the building materials and a extreme progress in their quality criteria against cold and heat and other outside conditions. Today we achieved a building standard and technologies for indoor comfort to be nearly independent from seasons or climatic regions. Buildings of today are almost "changeable" in their location and have similarities around the world (e.g. Air condition, glass and steel structures, concrete constructions up to nearly in the past unimaginable height and comfort. We can find buildings today in Singapore, which might also have been built in Sydney, Moscow or Frankfurt, Los Angeles, etc.. This development of "unification" is not supporting the international goal of sustainable development in all the areas of our lives.

An intelligent answer to climate change and huge energy consumption specially in the building sector would be a architecture which responds to the local environment and climatic conditions, in combination with the above mentioned factors.

Today's buildings are very similar in their construction methods and integrated technologies and lost therefore nearly any connection and interrelation to the climatic environment in which they are build in. This is one of the other arguments - beside climate change, energy consumption rise, rising energy costs and tremendous growth of the world population, with city growth, and the international aim for sustainable development – to have in the future buildings, which respond to their climatic environment and the outside conditions of the specific location, with using as much as possible local materials, construction methods and forms (as far as possible in the urban and specific environment) based on the local and national traditions of a site and with integration of the newest technologies (construction technologies, materials, development of the integration of renewable energies and other up to date building technologies).

According to local climatic influences focus should be on design, orientation and location, and glazing aspects, as well as integration of planted areas, terraces and shading elements. The architect Ken Yeang (Kuala Lumpur, Malaysia) describes in his book *Bioclimatic Skyscrapers* convincingly the philosophy of building in various climatic zones. Climate zones and precipitation regions determine the development of building designs and the detailed modeling of the fabric of a tall building, with ecological demands always being kept in mind. Buildings of the future should reflect a harmony with their environment. For the various regions of the Earth this means a variety of bioclimatic designs. 'Less is more' should be the principle for the future buildings with regard to ecological demands. State-of-the-art materials and technologies, as well as past and modern designs should be adopted to minimize energy demand and integrate renewable energies and thus actively protect the planet.

The four climate zones, tropical, arid, temperate and cold presented by the distribution of climate conditions across the world. There have been made a analysis of each climatological characteristic as to its influence on traditional building forms, implementation, and typical characteristics of various building components in that zone. Solar heating and shading, as well as wind stress factors upon buildings, play an important role in this analysis (Daniels, 1995). The relationships of building and architecture to the environment is not one of adaptation, but more of construction and symbiosis. The environment in which one builds is itself built. The symbiotic relationship between architecture and the environment goes deeper than the climatically aware manipulation of building form and detail. Through its diurnal and seasonal course, the sun has often influenced the patterns of life, embedded in behavioural and cultural mores. The anatomy of the plan and section of traditional architecture often formed an integral part of the symbiotic relationship between, culture and behaviour. In the long period of cheap fuel and a belief in the infinity of resources, aided by technology, building has ignored its surroundings and also the delight which might come from a climatically sensitive response to them. The pollution of our life supporting atmosphere and ground by the produce of the combustion of fossil fuels and the dangerous by-products on an uncontrolled industrialised way of life lead to an urgency to design within a delicate and complex interconnected eco-system.

### **Proposals for a climatic Architecture**

Every potential building bears within themselves the possibility of responding well, or badly, to any given climate. The performance of the building and whether it does so well or badly, is depending on the design of its form, its plan, its section arrangements and heights, the size and layout of internal and external openings and connections, the thermal inertia and transparency of its construction, the orientation of its spaces, and finally in physical terms on

the design of the building's immediate external environment. The logic of climatic optimisation can infuse the entire design and influence its construction at many levels. As well, the buildings influence the surroundings they are built in, there is an interaction of the lack of it, every building modifies an external as well as an internal climate.

The knowledge of an appropriate climatic response was implicit in many traditional ways of building and of living. This knowledge today no longer automatically forms part of the architect's repertoire: it must be relearned. This contemporary loss is, however, offset by contemporary gains: those of new energy-saving materials, and a developed scientific understanding of the potential of our buildings to modify climate. We cannot forget the recent past, but we should add what our ancestors knew onto our own knowledge in architecture. (Cofaigh, et al, 1998)

### **Synthesis of Ecology, technology and architecture / vision for the future**

Bioclimatic architecture and the combination with the integration of the newest technologies and measures for energy saving will lead the way for a sustainable future of architecture, a Synthesis of Ecology, Technology and Architecture. Climatic conscious architecture is just one aspect of designing for a sustainable future. Solar architecture results in less energy use, an in turn, less pollution and the use of sustainable materials. The development of sustainable ways of building and using our dwellings is one of the most important tasks now facing architects. For the future it will be even more important how and in which ways buildings and settlements respond to climate and how climate will influence their construction and design. A combination of bioclimatic architecture known today, the new developing technologies (particularly for the developments in the Photovoltaic technologies and building integration of photovoltaics, BIPV). The architects of today and tomorrow should know how to integrate and use the technological developments in the best way and the bioclimatic architecture of the future might respond even in a better way to the climate conditions of a location or country and possibly include traditional ways of architecture in interaction with the integration of the new technologies. According to the Energy Research Group of the University College Dublin, 'Architecture is outside time. Climatically responsive architecture is an explicit reminder of the need for permanence, conservation, and of a respect for the world's resources. - This in contradiction to the fast turnover of today's society' (Cofaigh et al., 1998: 9).

### **Conclusion**

In the architecture of the future there have to be considered even more the interconnection between the various aspects of Ecology, Technology and Architecture with consideration of the influence of the specific climatic conditions on the Architecture itself. As described the several alarming facts about climate change and it's consequences, the world wide development towards sustainable energy alternatives, architects – aware of their responsibility to the future of the planet – should also consider their participation in this global development towards Renewables and their aesthetical integration into buildings and cities.

Consequently in the future the uniformity of cities and buildings in the world might hopefully decrease and in the same time increase the application of local materials, sustainable technologies, perfection of bioclimatic architecture for specific construction locations in the world and therefore that the buildings could better respond to the climatic challenges of the future.

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