# Some Aspects to the Pollution Reduction Related with Built Environment

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Abstract: This work is formulating some of the factors leading towards the reduction of carbon emission into the environmental connecting with architectur and urbanistics. Within the architectural context, the emphasis will be put on the utilisation of the solar energy and its possible benefits. Further to that we will talk about a second pollution reducing factor, namely the use of low embodied energy materials in buildings. Here the role of adobes will be considered. While in connection to the urbanistics the optimal road network and the importance of the cycle tracks will be considered. The presented results are illustrated by case studies, carried out in Hungary.

Keywords: CO<sub>2</sub> emission, built environment, adobe wall, solar cell

## 1 Introduction

The environmental pollution is a very frequent subject of the current media. Industrial and other human activities cause water and air pollution and rapidly reducing the earth fossil based energy reserves [1-9]. As a result the biosphere is badly affected and biodiversity is endangered. The bio-complexity and regeneration came to a dangerously low level. In spite of the warnings from professionals, nothing seems to change in the tendencies of the harmful activities of mankind.

It is a real fact that in the last few decades we did witness a tendency for global warming. As a result we witness the growth in arid, desert regions, the reduction in size of the ice cap, and the general reduction in the water table followed by the un-availability of fresh-water. There are a number of theories for the explanation of the global warming. The chaotic origin of the climatic change however does not change our view of the dangerous situation. Global warming presently is undeniable fact. The greenhouse effect and the carbon emission are significant contributors to this process, which mostly the result of the usage of the fossil fuel for energy generation.

The reduction of use of fossil fuel, therefore the reduction of the harmful gases would grossly reduce the environmental problems, specifically the reduction in global warming up. Built environment, the building industry and operating the buildings are the biggest contributory factors to the energy needs; therefore they are the biggest harmful gas emitters. The rationalization of building construction process and building operation in an acceptable way would help the improvement of the present environmental condition.



FIGURE 1. The environmental and energetical startus in Hungary is charactrized by the temporal evolution of the pollution. The solid black line represents the total amount. The dotted red, green, and blue lines represent the contribution from coal, rock-oil, and natural-gas, respectively

In this present study, some of the factors in reduction of energy need and the associated harmful gas production will be described. These factors will be discussed after the showing of the country profile. The first three factors linked to architecture, while the other two are urban related in character. In every case we will point out the causes and give some recommendations towards the solution. In each case illustrations will be given by presenting case studies carried out in Hungary.

## 2 Country Profile

The illustrations of the dealed factors are Hungarian case studies [1-3]. At first, we have to give a country profile. Where, we deal the energy demand, and the energetical structure of Hungary. Furthermore, the building stock and the urbanistical system in Hungary are discussed.



**FIGURE 2.** Distribution of the primer energy demand among the main user sectors. The energy demand of the residental bulidings is very important.

Environmental and energetical startus in Hungary can be characterized by the CO<sub>2</sub> pollution [1-3]. The temporal evolution of the pollution is shown in Fig. 1. The black solid line shows the total amount of the pollution. The dotted lines represent the contributions from different primer fuels. The red, green and blue lines correspond with coal, rock-oil, natural-gas, repectively. The recent CO<sub>2</sub> pollution is  $48 \cdot 10^6$  ton, where the distribution is the following: 31% originates from production of electricity and heat; 27% from traffic, transport; 17% from communal sector; 21% from industrial source; 13% from other sources. The utilization of the renevable energy sources are very few. So, the pollution and the energy demand correlates each other.



FIGURE 3. The structure of the settlements influences of the type of the residential buildings

The distribution of the primer energy demand among the main user sectors is shown on the Fig. 2. The diagram shows that the energy demand of the residental bulidings is very important, third of the total amount. This value depends on the quality and type of the buildings [9-14]. The structure of the settlements influences of the type and also the quality of the residential buildings. The comparision of the town vs. village ratio is shown on the Fig. 3. The main part of the European population lives in towns. The average value is 73%. This value is lower in Hungary, it is only 64%. The energy demand for different building types is also different.



**FIGURE 4.** Energy save potencial in the case of different building types. (A) traditional house in village, (B) family house in suburb and in village, Traditional house in the city centre, (D) block house in town originate from socialistic time. The blue cube represents the total primer energy consumption in yearly (in PJ), the yellow cube represents the energy save potential (in PJ).



FIGURE 5. House stock in Hungary according the building material. Significant amount of the building are from adobe

The energy consumtion and save potencial in the case of different building types is shown on Fig. 4. In the village, two types of houses exist. One of them is the traditional rural house (A) built from adobe or brick. Another one is a conventional family house (B) built from new type of brick. In the town are three types of the residental buildings. One of them is a traditional high house built from brick (C). Another one is the family house mentioned before (B). The third one is the block house built from reinforced concrete (originated from the socilaistic time). In the Hungarian vernacular architecture, the house with adobe wall is very popular. Significant amount of the building are from this material. House stock in Hungary according the building material is shown in Fig. 5.

## **3** Architectural Proposal

#### 3.1 Problems due to Air-conditioning

The global warming up, like everywhere else, in Hungary also shows its effect. 20-30 years ago the average summer temperature hardly reached 30 °C. Nowadays, however often goes to 30-35 °C. This temperature is unusual to the population therefore in offices and public buildings as well as in private dwellings; the air-conditioning is becoming more and more popular.

These installations are mostly in use when the sun radiation is the strongest, when maximum energy is arriving to the surface of the earth. Instead of using the sun radiated energy the devices are run on mains electricity, generated from burning fossil fuel. This results in positive feedback, contributing to the causes of further increase in global warming.





The increasing popularity of the air-conditioning is not the sole factor in global warming and there are some other, more environmental friendly ways to achieve cooler conditions (i.e. passive cooling, evaporation etc.). Here, the love of comfort and the short-sightedness plays a significant role as well. We do not consider future generations that inherit a rapidly warming world from us.

Generally, air-conditioning installations are operated by mains electricity. The obvious solution would be to operate these installations by solar cells [15, 16]. For this however more human environmental awareness would be necessary. One possible solution would be to force people by EU law, to operate these installations by solar energy only. Usually those who can afford to finance air-conditioners can pay extra for the solar energy source as well to operate the installations. This law would apply to the public buildings initially and gradually extended to private dwellings as well.

#### 3.2 Heat Storage versus Heat Insulation

As we mentioned earlier air-conditioner installations have alternative solutions. In Hungary the rural architecture uses high heat-capacity adobe wall construction. The cob adobe wall has high specific heat capacity and larger mass because it stores the heat it well suited for heat equalization [17-19]. As a result the inside temperature of adobes is moderate and tempered. Adobe constructed houses are still relatively common in Hungary. It is unfortunate, that these houses are becoming less popular they are demolished and replaced by modern "comfortable" dwellings. The new buildings are built of porous bricks and have light construction, because the Hungarian building regulations govern the heat insulation only. The result is the wide application of the cold climate controlled installations.



FIGURE 7. Adobe construction has many agvantages: equalize the inside clima and humidity

Adobes have many advantages [20, 21]. Beside the equalized inside climate, the humidity is tempered too. The walls of this kind are called "intelligent" walls. This type of construction is cheap, because the material for it is coming from local sources. On the top of it the building is ecological, because its material requires low energy to make.

Our proposed solution is to build dwellings adobes, where the circumstances exist and function and the construction allows its use. The existing adobes should have to be preserved and renovated/ modernized. This requires the introduction of technology of specific renovation and the knowledge of installation of modern conveniences. Demolishing of these buildings should be prohibited; preservation orders should be issued because most of them are listed or historic buildings. Adding to that, the building regulations governing the heat insulations in buildings should be modified accordingly.

### **3.3** Role of Solar Cells in Architectre

The investigation into solar cell technology is one of the fastest growing research fields nowadays. The initial Si based crystalline and poly-crystalline solar cells were followed the thin film cells, whose efficiency reached already much higher level. The lll-V base substances used in space research, gradually found their way into everyday applications also [22].



FIGURE 8. Three main types of the solar cells for architectural usage: (A) solar cells from bulk material (crystalline and polycrystalline silicon solar cells); (B) thin films solar cells (amorpous silicon based and CuInGeSe based solar cells) (C) solar cell with concentrator element (GaAs based high efficient solar cells)

In our technology based on mostly electronics, the source of power is primarily is electricity. Without it our present communication network operation or our domestic life style would not exist. We hope that our developing technology will result similar improvement in the efficiency of energy generation as well. Let us consider one field, namely the lighting technology. The incandescent electric bulb was followed by the high efficient neon tube, which is gradually replaced by LED illumination. These are wholly compatible with the solar cell operated energy sources. It is likely that similar development will follow this trend in the other fields, where electric power is the required as energy source.



FIGURE 9. Solar cell integrated building facade (A) from out-side and (B) from in-side

The application of solar cells in architecture is very versatile [23-25]. Its compatibility with the use of glass makes it applicable as windows or curtain. There are solar cells in the form of roof slates or roofing tiles therefore they can be used for roofing. The solar cells can be used to control the climatic conditions of the building by using them as shades, absorbing the solar energy and protecting the inside environment. When solar cells installed over the roof, the air gap applied can be used to the benefit of the ventilation of the inside rooms modifying the climatic conditions. It is rather unfortunate, that the use of solar cells in Hungary is behind of the other Western European countries. This is due to the long paying off time and the lack of state support. Mostly the dedicated supporters of ecology or the technological fanatics use solar cells on their roofs. Unfortunately in this case the short time interest overrides the long term benefit.

The application of solar cells, in architecture, brings to the surface three of the problematic areas. First, the knowledge of solar cell technology and application of the architects in Hungary is not as good as in Western circles therefore further education is required in this field. Second, EU laws are required to regulate the ratio of the solar cell covered surfaces in architecture. Third, it is necessary to compel the governments to support the scheme of solar cell installations and not to leave it to the human environmental consciousness entirely.

# 4 The Effect of Urbanization

### 4.1 Settlement Structure

In this part we are dealing with the problems related urbanistics. In Budapest but characteristically in other post-socialist cities are frequently cut across the street fabric by wide motorways (Nagykőrösi út, Szentendrei út, etc). These new avenues are usually in the same level as the other streets. The local streets are closed, giving only limited number of crossings with large distances between them. These restrictions are enforced not only on the motorised but also on the pedestrian traffic as well. Avenues like these cut into the fabric of the city. To get to the other side of the road requires long round journeys, causing more pollutions due to the longer journeys. As a result, the larger traffic volume generated noise degrading the living conditions of the city dwellers. For noise reduction, walls are erected by the roads, which divide one part of the city from the other communities.



**FIGURE 10.** Highway and its connection with the city. The high way crosses the city fabric (A) and (B), The local traffic is restricted. The sunk high way (C) and (D). The local traffic did not restricted

The reason is simple. The short term benefit wins over the long term benefit. In socialism the rapid and spectacular building projects are the important factors and not practicability or usefulness. Unfortunate but the politicians' mentality in the present multi-party system has not changed significantly. The re-election requires eye-filling and spectacular results. The ecologically sound and useful projects need longer time scale and circumspect planning. The damage caused by politics only shows up later.

The solution is already presented in living examples. In Western European cities similar motorways are cutting into the city's fabric. Here usually the multi-lane road is sunk below the local traffic. The local roads are crossing over the wide road. The walls of the multi-way road covered with acoustic insulation. There are examples for underground road system as well. Above the multi-way traffic the local life goes on without un-effected. In long term these are the ecological traffic solutions and the road level motorways cutting into the fabric of the city need rectification. The demolition of the old and the rebuilding of the new road system however is an expensive proposition.

The development of the road network in a settlement is a self-assembling process. As time progressing, a structure develops similarly to branches of a tree. The structure shows self-similar fractal features. The roads develop along the most used and shortest passages. The most ecological road network planning is the copy the natural settlement structure. When more settlements are growing together, new road network will be needed to serve the needs of the combined community. This is a typical example for the need of careful planning, when interfering with a self-similarly developing natural assembly.

#### 4.2 Infrastructure Favouring Non-motorized Traffic

An important topic regarding the study of urbanization and pollution is the role of the bicycle in urban traffic [26,27]. For most people it feel natural nowadays the use of motorized transport, wherever they go. As a result, a few miles walk represents a great difficult task. In Budapest and all over Hungary the bicycle receives unfavourable treatment. Recently, a great country wide road building project was initiated in Hungary. This project was very popular, the expenditure was widely approved and it was advantageous to the ruling political party leading to higher electoral votes. Building bicycle tracks however is politically not so attractive.

There is one and only real bicycle track goes from the city and this leads to the bend of the Danube, a place which is regarded as a beauty spot for hikers. Cities are not connected with bicycle tracks at all; villages are not very often either. The political elite regard the bicycle as hobby horse or a device for hiking. It is not regarded as a proper transport for going to work. Experience shows however that a better quality bicycle is good enough for 40-60 km regular ride to work. The bicycle track is cheap, relative to the building and maintenance cost of a

motorway, causing less pollution and the fitness of the user's increases and their life quality with it.



**FIGURE 11.** (A) The traffic by bicycle inside of the city is not only ecological but economical, too. (B) In our country, the cycling and the cycle

The love of comfort is overwhelming. Humans become comfort lovers and gave up exercises. To return to walking or cycling requires self-sacrifice and surrender of comfort. Not many people are ready for these changes in their attitude. The political elite are not a leading light in these transformations. One of the solutions would be if the EU would compel the governments to build bicycle tracks.

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