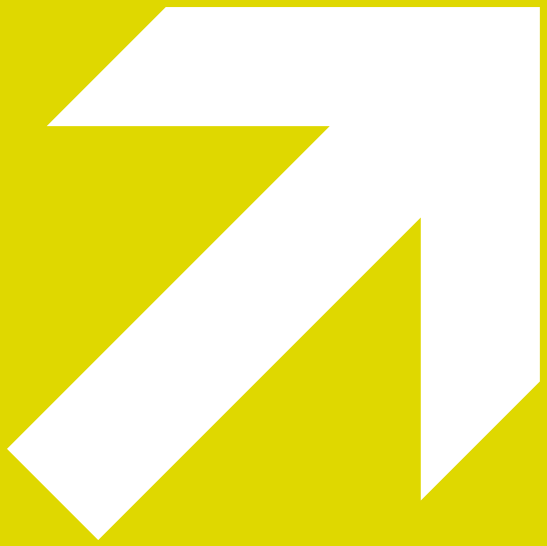

Sustainable Building

RESOURCE TRANSITION

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Introduction

Dear Readers,

The more information, the greater the confusion. This truism certainly applies in the case of “sustainability” – particularly in the building industry. On the one hand, there is a risk that sustainable building is becoming a skill that only very few are able to master and therefore, one that no longer plays a role in everyday construction operations due to a quest for perfection and an abundance of criteria. On the other hand, the inflationary, meaningless and often deliberately delusive use of the word means that it has been proposed as the “ugliest” word of the year on more than one occasion.

This booklet has been created to show that sustainable construction is not as complicated as it often seems. It is based on a series of essays that were published in the Bavarian State newspaper during the first half of 2016. The aim is to illustrate the most important issues in layman’s terms and thus bring clarity to the jumble of information. The approach is designed to be universal, which is why the statements regarding building materials are kept as neutral as possible. The fact that timber construction is nevertheless mentioned explicitly several times is in the nature of things and was difficult to avoid.

Enjoy the read and then building.
Best wishes

Peter Aicher, President

Embodied Energy

Photo: Günther Hartmann

The reduction of our energy consumption is a climate and political necessity and now a subject on which there is political agreement. In Germany, the Energy Saving Ordinance (Energieeinsparverordnung, EnEV) was introduced for a range of different building types. The aim is to limit the energy demand for heating. It does not, however, take the so-called embodied energy into consideration: the energy required for the construction, maintenance and disposal of a building. The production of building materials tends to account for the largest proportion of embodied energy. Mineral and metal building materials, in particular, require high temperatures for their production, and thus a lot of energy.

The energy once invested in the construction of the building and then "stored" in the building stock is lost and becomes irrecoverable once the building is demolished.

In many buildings, the energy consumption for the development of the building is comparable to the heating energy demand over several decades. The fact is, the smaller the proportion of heating energy, the larger the proportion of energy for the production of building materials within the total energy balance. If, however, the development of the building requires more energy than the heating for the next 100 years, the priorities of our energy saving endeavours are no longer viable. Then the time has come to question current strategies and establish new priorities.

The good news is that there is still considerable potential for energy savings in the field of building. One solution is to modernise, con-

“Instead of trying to achieve dwindling savings in heating energy, we should tap the savings potential in the embodied energy.”

vert and extend the existing building stock, instead of randomly demolishing older structures and rebuilding them. The other solution is to use building materials from renewable natural resources. Wood, a renewable natural resource, requires a comparatively small amount of energy for its extraction and processing. Timber is extremely efficient, which is proven by spectacular large-scale projects, such as the 84-metre-tall timber building “HoHo” that is currently under construction in Vienna.

The performance of wood is also based on a high energy input. It occurs during the growing process before the trees are harvested. The energy comes entirely from the sun and is used to construct complex molecular and cell structures by means of photosynthesis in a highly efficient way. So, whereas the “natural production” of wood and other renewable natural resources takes place without the generation of CO_2 emissions, the artificial production of mineral and metal building materials is achieved by burning fossil fuels and producing high CO_2 emissions.

If energy transition and climate protection are to be taken seriously, we have to overcome today’s tunnel vi-

“The energy consumption for the development of a building often compares with the heating energy demand of several decades.”

sion, which only concentrates on the heating energy demand. In order to obtain large energy savings, the energy for the production of building materials must be incorporated in our strategies, regulations and guidelines. What is more important for climate protection is the fact that energy savings are made immediately and not over an extended period of several decades as is the case when reducing the heating energy demand. Climate protection is based on limiting the temperature rise of the Earth's atmosphere as quickly and effectively as possible. If the ecosystems of our planet have too little time to adapt to the climate change, they will fail – with unforeseeable consequences.

We need a paradigm change in the building industry. The energy for the production of building materials can no longer be ignored and must be embedded in the regulations and subsidy programmes for energy-efficient buildings and refurbishments. Instead of trying to obtain dwindling savings in heating through ever greater effort, the focus should be on tapping the savings potential offered by the embodied energy. The effort/benefit ratio is much better in this case. The necessary data has already been recorded and is available on two central online databases. The time has come to utilise this know-how.

"The right selection of building materials can save large amounts of energy immediately rather than spread over an extended period of several decades."

Carbon Dioxide

Photo: Bayerische Staatsforsten AöR

Something in the German Energy Saving Ordinance (EnEV) is really strange. Despite stating in Article 1 that the aim is to attain a climate-neutral stock of buildings by 2050, all the following clauses revolve around energy – even though the emitted carbon dioxide (CO_2) is fundamental for climate protection. One could assume there is a connection between the two, which of course there is not. There are situations where very little energy is consumed, but large amounts of CO_2 are emitted and vice versa. The wrong reference criteria provide the wrong incentives and in turn, render the wrong decisions with the effect that the target CO_2 reduction becomes worthless: much action, but little impact.

A large amount of CO_2 is locked up in forests. The structural use of timber ensures that the CO_2 stays in the wood for further decades.

Heating with electricity, for example, has become extremely attractive due to the reduction of the primary energy factor for electricity. On 1 January 2016, the calculated primary energy demand dropped by, believe it or not, 25 per cent. The official explanation was that the share of renewable energies in power generation had risen. The fact is, however, that the total CO_2 emissions in power generation have remained almost the same because renewable energies have been replacing nuclear power and not coal. So despite the non-existence of a CO_2 reduction, there was an incentive to increase electric heating. If this leads to a rise in power consumption, the solution might be to simply build a new coal-fired power station.

Within the life cycle analysis of a building, heating is just one of many factors, but one with a long-term im-

pact. From short and medium-term perspectives, the production of building materials is of much greater importance. The amount of energy required in this case is often as high as the heating energy demand for several decades; however, there is a large difference between synthetic and natural building materials.

"Renewable natural resources absorb considerable amounts of CO_2 during growth, and the CO_2 released during extraction and processing is limited."

The difference is even greater when it comes to the carbon footprint, since renewable natural resources not only release limited CO_2 during their extraction and processing, they also absorb large amounts of CO_2 during their growth. To be precise: plants bind and break down CO_2, release oxygen (O_2) and incorporate carbon (C) in their molecular structure. The amount of CO_2 absorbed during growth is the same as that released during decay or combustion. For climate protection purposes, it is important to keep the CO_2 contained for as long as possible. This is exactly what happens when a material is used in construction – not forever, of course, but for several decades. It is precisely this period of time that is crucial, since the aim is to slow down the increase of CO_2 in the Earth's atmosphere as quickly as possible.

The carbon abatement costs are surprisingly low for timber constructions. The Munich architect Holger König, a pioneer in the field of life cycle assessments, calculated the carbon abatement costs for five

"The carbon abatement costs are surprisingly low for timber constructions, much lower than those for wind power or photovoltaics."

buildings in 2015. He summed up the construction costs and the carbon footprints for the completed timber structures and a fictional standard development. Then he compared the extra costs with the amounts of CO_2 saved. The worst result was €69 per tonne of CO_2 saved – much less than is the case for wind power or photovoltaics. Thus, building with timber is an extremely cost-efficient climate protection measure. Moreover, the CO_2 is saved immediately and not over a long period, as is the case when reducing the heating energy demand.

The Paris Agreement on climate change emphasises the importance of offsetting carbon emissions through carbon sequestration, or in other words, carbon storage. The potential of this method, however, is usually underestimated. A study published by Prof. Hubert Röder from the Science Centre Straubing in 2014 illustrates that in Bavaria approximately a third of the CO_2 emissions released by burning fossil fuels are currently being offset through forest growth and the use of timber as a construction material. If we succeed in doubling the use of timber in building construction and halve carbon emissions, our beautiful Bavaria could in fact be climate neutral!

"Approximately a third of the carbon emissions in Bavaria are currently being offset through forest growth and the use of timber as a construction material."

Material Resources

Photo: Günther Hartmann

Which raw material is used most in the world today? The answer is sand. Sand is used to produce a range of different materials. Large amounts are used in the building industry to make concrete. However, not every type of sand is actually suitable. Desert sand, for instance, has grains that are too round and smooth. That is why the booming city of Dubai imports its sand from Australia, where it is removed from the seabed along the coast with devastating consequences for the local flora and fauna.

The demand for sand is high. Too high. The architect Werner Sobek illustrated this phenomenon in a presentation at the Munich Science Days using an allegory of a wall along the equator: If the current population growth of 125 million persons per year is multiplied with 490 tonnes of mineral building materials, the average use per person in Germany, the result is a global demand for 60 billion tonnes of mineral building materials per year. If this quantity is converted into a 30-centimetre-thick wall, how high is a wall around the equator, a total length of 40,000 kilometres? The answer is two kilometres high!

We will face a severe shortage of resources if we continue in this way. The option is to either build less or switch to construction methods which significantly reduce the consumption of resources. The material use in so-called lightweight constructions is only a fraction of that used in conventional solid mineral constructions. This is, in fact, achieved by

HA Schult's installation "Trash People" at the Tollwood Winter Festival 2015 in Munich took an artistic approach to our production of waste.

“The consumption of material for lightweight constructions is only a fraction of that for conventional solid mineral constructions.”

the load-bearing structure, which is reduced to a skeleton of slender posts with insulation placed in between – similar to the historic half-timber framed houses. The added benefit is a decrease in the heating energy demand. There are two possible materials for the posts and beams: metal and wood.

Metal and wood have a further advantage: they are easy to recycle. This is an important aspect since half of our disposed waste today stems from construction and demolition work. Mineral construction waste can be crushed and used as a road sub-base, but that is an extreme case of downcycling with a definite loss of the energy originally invested in the building material. Metal is the best material in terms of recycling; however, the melting process consumes a particularly large amount of energy. Wood, on the other hand, can be reused or turned into other wood-based materials with limited use of energy.

The increasing pressure from environmental scientists and organisations to bring about a transition in resource use is valid. The endeavours should not replace our climate protection programmes, but complement them in a meaningful way. Climate change is closely associated with the consumption of resources: the extraction, transportation and processing of raw materials always requires the use of energy. Generation of any of this energy by burning fossil fuels produces gaseous waste or, to be precise, the greenhouse gas CO_2.

Avoidance of waste, whether in the form of gas or solid matter, is a core aspect of an environmentally sustainable economy. The main aim should therefore be to move from a linear to a circular economy. The construction industry plays a key role in this respect since it is not only one of the largest consumers of raw materials and energy but also one of the greatest producers of waste. That is why this issue should be tackled first if the aim is to ensure a successful transition to a sustainable use of raw materials.

"Metal and wood are easy to recycle. This is important since half of our disposed waste today stems from construction and demolition work."

"The melting process of metal requires a large amount of energy. Wood, on the other hand, can be reused or processed with little impact on energy resources."

What we need is a three-pronged approach consisting of (1) a reduction of resource consumption, (2) an increase of resource efficiency and (3) a reduction of waste. If these measures were applied to the highly resource-intensive construction sector, (1) existing buildings would be upgraded, converted and extended, instead of demolished and replaced, (2) lightweight instead of solid heavy construction methods would be used and (3) reusable and recyclable building materials, in particular those deriving from renewable sources, would be applied. Constructions that would like to be labelled "sustainable", should ideally meet all of these requirements.

Compensation

Photo: Unsplash, William Hook

Supposing all farmers in one village graze their cows on a shared grassy area, so-called common land, what happens? All of them are happy and content so long as more grass grows than is eaten. When this is no longer the case, problems arise: firstly the milk yield sinks. Then the commercial sense of each farmer is to put more cows on the pasture. However, the advantage of an additional cow benefits only a single owner, whereas the risks from overgrazing are distributed among all farmers. And because nobody wants to be the one to hold back and risk losing out, more and more cows are added to the pasture until the cows die of hunger.

Opportunities to compensate for flight emissions by contributing towards climate protection measures have been around for a long time.

The “tragedy of the commons” phenomenon applies to all community assets. The belief that guilt or a sense of responsibility will solve the problem is foolish and naïve. There are really only two possibilities for those who are seeking a solution: privatisation or management. Either each farmer is responsible for a separate piece of grassland and its use. Or there are clear rules for the use of a common shared pasture. All other solutions lead to disaster.

Whenever individuals use communal property, the costs are borne by the community and there is a risk of the tragedy of the commons. This has wide application and can affect anything, ranging from the conditions of a public toilet to the speculative losses of large banks to CO_2 emissions. The tragedy of the commons refutes Adam Smith’s assertion that an invisible

“Effective environmental protection means, more than anything else, ensuring ecological cost transparency.”

hand will always make sure that the pursuit of self-interest benefits the commonweal as a naïve and wishful dream. It is for this reason that the government must lay down rules, which seek a balance between self-interest and social welfare in a wise and reliable way. However, interference in market activities is frowned upon today. Why is this? Different constitutions embody different conceptions. The Bavarian constitution clearly expresses in Article 151: “All economic activity serves the common good.” Hence, the state has a responsibility to govern market activity.

Effective environmental protection means, more than anything else, ensuring ecological cost transparency. The consequences of environmental damage should not be borne by the general public but should be included in the price of a product. In order to provide effective climate protection, the CO_2 emissions, or the carbon footprint, must be reflected in the price. This could easily be achieved by introducing a carbon tax or by making carbon offsetting mandatory. We have neither of these, quite the opposite in fact. Companies engaged in high energy and carbon intensive manufacturing, such as metal and mineral building materials, are exempted from paying the levy for renewable energy and are therefore at a clear advantage in terms of competition.

So long as there are no general rules, the currently practised methods will

simply have to be further developed. For the building industry, this means taking into consideration the total life cycle of a building, in particular the often very elaborate production of building materials. As climate protection is currently the most important and pressing issue, the focus should be on the carbon footprint rather than the energy footprint.

This does not mean putting a ban on certain building materials. Each one has its justification. However, there should be a fair and level playing field if the materials are in direct competition. “Fair” means: all building materials must make the same contribution to climate protection. Large carbon footprints must be offset! The climate protection organisation “atmosfair” for air travel, for example, shows how easy it is to compensate for carbon emissions. If these principles are implemented rigorously, the endless sets of rules and regulations can be put aside, since the market would then take care of the details much more effectively.

“Fair competition means: all building materials must make the same contribution to climate protection. Large carbon footprints must be offset!”

“The consequences of environmental damage should not be borne by the general public but should be included in the price of a product.”

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