

## HYPERAUBING, MORE WITH LESS: BEYOND EFFICIENCY



Fig 1: Synergies (Design by F. Kornberger, C. Finnema, D. Selje)

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WHICH ARE YOUR ARCHITECTURAL (R)SOLUTIONS TO THE SOCIAL, ENVIRONMENTAL AND ECONOMIC CHALLENGES OF TODAY?

### Research summary

Climate change, population growth and resource shortages are the most crucial issues of our time. Natural disasters, migration flows and waste accumulation are the most visible effects. While the population is decreasing in European countries, the global trend is a rapid growth, especially in cities. In this context, availability, distribution and an adequate management of resources are the fundamental issues we have to deal with. Saving resources means achieving a more effective use and a more equal distribution. While in the last decades energy production has been basing on peak demand, the use of renewables requires adaptation to the available sources, in terms of local as well as temporal availability. Architecture has the responsibility to understand these challenges and to adapt them to the human needs by synthesizing information and transforming it into physical entities. Today, the data that is continuously recorded and shared through digital media can be employed to reach these aims. The amount of information at our disposal is enormous and its correct use is fundamental to creating quality when and conserving our built environment. Architects are asked to improve its quality through design and planning approaches, which create strong synergies with the context and the available resources. Resource optimization and distribution is the main challenge for our future to assure more quality for all with less expenditure of energy: is this not the great challenge?

**Keywords:** Quality, resources, digital era, adaptation, synergies

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## 1. Introduction

In the recent decades energy efficiency has been considered the main factor to achieve carbon neutrality. Both on new as well as on retrofitted buildings, the quantification of the energy demand has been used as the key to evaluating sustainability. Even in international certification systems the evaluation of the level of sustainability is largely based on the criterion of efficiency. In Europe, although a considerable number of existing buildings have been refurbished reducing their energy demand, a significant overall reduction of carbon emissions has not yet been observed. One reason for this phenomenon is the increase in the individual living space that has occurred in western countries. Dwindling fossil energy sources, the need to reduce CO<sub>2</sub> emissions as well as a growing environmental and sustainability awareness in our society have in recent years set new challenges for the construction industry. Legal requirements, energy saving regulations and certifications necessitate a rethinking of design and planning processes. Control tools such as energy performance certificates for buildings or incentives to meet improved energy standards are established during the planning and implementation phases.

## 2. Research objectives

“From 1990 till 2013, the energy demand for operational energy in households increased about 9,2%. The tendency toward more and bigger households with fewer inhabitants per unit led to higher consumption”. According to the German Federal Agency for the Environment (Umweltbundesamt) even with a higher energy standard both in new buildings as well as in the retrofitted existing buildings, a reduction of the energy demand was not

observed in the Federal Republic of Germany. One reason for this phenomenon is the increase in the individual living space in many European countries. Higher energy efficiency in buildings does not necessarily have a relation to lower emissions. To achieve a significant reduction in CO<sub>2</sub> emissions in the built environment, reconsidering the rising demand for living space and the related requirements is imperative. The improvement of energy efficiency in buildings should be combined with appropriate responses to social issues of our time.

### *2.1 From energy balance to individual balance*

In order to get closer to the targets of the energy revolution in Germany, which is based on abandoning nuclear power by 2022 and using 80% renewable energy sources by 2050, it is necessary to reconsider the method for quantifying energy efficiency. In fact, considering that operational energy demand for buildings has not yet led to overall reduction of carbon emissions, other evaluation methods have to be identified.

In 1998, researchers of the Swiss Federal Institute of Technology (ETH-Eidgenössische Technische Hochschule Zürich) introduced the vision of the “2000 W society” to represent a goal in terms of energy demand: over the course of a year no person in western countries should exceed 2000 W of continuous power demand including e.g. operational energy for living, mobility, nutrition, infrastructure, etc. This value is the threshold of the world average rate of total energy use and approximately corresponds to consumption in Europe in the 1960s. Nowadays the average demand of a European citizen is three times as much: roughly 6000 W. The most effective way to reduce demand and consequently emissions is to reduce our

impact. In a word: sufficiency. Sufficiency, a term which is rarely used, and whose significance is not unambiguous, defines what is enough. In ecology the term Sufficiency (from lat. *sufficere*, to suffice) stands for the aim to reduce negative environmental consequences through a reduction of the demand for consumer goods.

While efficiency, which has an analytical character, is used to evaluate a wide range of cases and processes, sufficiency represents a rather unsystematic and seldom used alternative for a qualitative evaluation. Although sufficiency cannot be classified as a scientific quantitative evaluation system, it should not be neglected when formulating design and planning proposals as the careful management of resources is the issue of our future. In this context models based on sufficiency offer the opportunity to focus on the quality of our built environment and of our living spaces. Sufficiency in buildings means reducing individual space and creating common areas for shared activities, balancing strictly private sectors with shared spaces for semi-private activities. Built surfaces as well as public spaces are considered fundamental resources. In a framework where the effectiveness in using resources appears to be the basic parameter for evaluating sustainability, sufficiency seems to be strongly related to a future oriented - sustainable - model.

## 2.2 Indoor comfort

Another basic issue to be reconsidered is the indoor comfort conditions. Increasing comfort requirements have given rise to a strong improvement in the building envelope in terms of building physics to obtain better indoor comfort conditions with a lower energy demand. These targets are reasonable in new buildings, when the planning process includes

them in the early phase. Dealing with the built environment, especially in the case of social residential buildings of the second half of the 20<sup>th</sup> century, requires a different approach. All evaluation systems based on the energy balance define certain temperatures as a basic condition for the living space within the thermal skin of buildings. This criterion leads to an incorrect evaluation of existing buildings. Most evaluation processes for residential buildings consider all built space as a homogeneous zone with same comfort requirements.

A study of the EON Research Center of the RWTH Aachen University (Rheinisch-Westfälische Technische Hochschule) analyses the so-called "rebound effect" in retrofitted residential unit blocks. Three identical units were refurbished with different concepts and monitored before and after the intervention. The study compares the predicted values to the recorded data. Independently of the adopted measures, in all cases the recorded consumption was higher than the expected demand, due to the different behaviours of users who desired different comfort levels - and therefore higher indoor temperatures - than before the refurbishment. In addition to that, original, not refurbished buildings have a lower consumption than the calculated demand. The study demonstrates on the one hand a different behaviour in existing buildings due to a different users expectation and on the other hand energy balance is a not the appropriate evaluation tool for existing buildings. Nevertheless, as the building stock determines the identity and the building culture of our cities, considering its conservation and transformation is a high priority. Reducing energy demand while increasing architectural quality seems to be the strongest motivator for refurbishing the stock.

### 3. Methodology

In contrast to the common approach, which places the highest priority on thermal insulation of the building envelope and new installations to reduce demand and emissions, the project's main task is rethinking living spaces in post war residential complexes. Instead of adapting existing buildings to given functions, the capacity of buildings is the driver of transformation.

#### 3.1 Capacity

Integrating new functions and different climate zones in existing building creates synergies between spaces and energy flows. The so-called functional mix presents the opportunity to experiment with combinations of different energy demands in terms of temporal availability, energy sources and temperature levels. Based on this assumption the building has to be considered one element of a complex system and the "smart grid" is one of its levels. Buildings are adaptable elements in relation to the city, or, more generally, to the context in which they are situated. It seems necessary therefore to create a vision that incorporates the building in the context of the city and in the relationships it imposes. In fact the city offers a wide range of systems, structures and alternating demands which can and must be linked and shared. The target should be

shifted from achieving absolute values of energy efficiency for individual buildings, the current practice supported by existing legislation, to identifying measures and interventions with a high degree of accuracy which will lead to the "smart city".

#### 3.2 Impact

This method delineates a transformation strategy that does not deeply intervene in existing structures. The building stock is considered an embodied energy store that is worth keeping. Interventions are planned to assure accessibility, to better adapt to contemporary living standards and to enhance comfort conditions by adding new layers, which include new functions and optimize the envelope in terms of building physics. But the main structures are kept and each proposed measure is evaluated with regard to its impact on the amount of embodied energy. The aim of this approach is to consider embodied energy as a main factor to determine the level of sustainability for the intervention. As in European countries the energy production from renewables is gradually increasing, the primary energy factors will decrease in the next few decades leading to a different ratio between operational and embodied energy. The influence of embodied energy, both for new and existing buildings, will play a major role in achieving carbon neutrality.



Fig 2-3: Transformation (Design by Antoniou, P., Ochwat, A., Schnotale, G.)

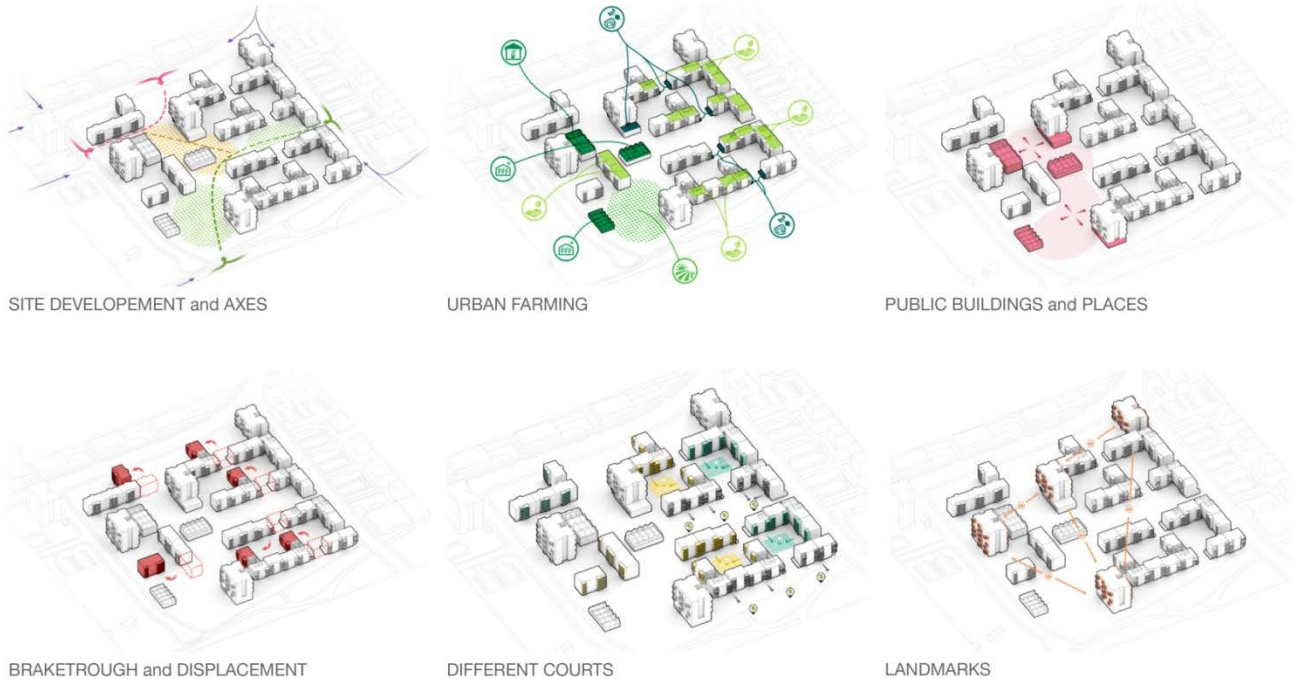


Fig 4: Strategies (Design by A.L. Boe, S. Dielenschneider, E. Mildemberger)

## 4. Results

Based on the above criteria, solutions were tested on a social housing complex of the 1960's in the Munich quarter "Neuaußing". Living in green areas, mono function buildings and car oriented traffic planning were the key points of the urban vision in post-war Europe. These quarters exist everywhere in central locations in European cities: while the real estate market in central areas is saturated due to the high demand for living space, the periphery still does not really attract people. Nevertheless these areas have a strong potential for the future development of cities, due to their concealed qualities: low density of urban structures, large-scale green areas, affordable prices, and good connections to

the city centre via the public transportation network. The proposals formulate strategies and models to refurbish and maintain the existing buildings, and, on the other hand, to develop innovative living models. Existing criteria defined by norms and regulations, such as homogeneous comfort conditions for the entire living space and building physics requirements for the envelope, were questioned and debated using exemplary alternative approaches.

Buildings were transformed through extensions, redefining proportions between collective and individual spaces and considering flexibility in floor plans as the main response to rapidly changing needs in our contemporary

society. Introducing new functions leads to greater variety in quarters where mono function has influenced the way of living leading to increased attractiveness. The “Hyperauring” projects increased density from approximately the current 40m<sup>2</sup>/person to roughly 20 m<sup>2</sup>/person, including the additions to existing buildings that were designed to generate common spaces and to achieve higher energy standards through passive systems. The use of advanced building installations combined with renewable energy sources leads to synergetic effects between the improved existing buildings and the new spaces.

Keywords such as densification, environmental awareness, and new mixed-use residential and mobility concepts show how far the idea of a lively and liveable city has changed in the last 50 years. Based on the objectives of CO<sub>2</sub> neutrality and a careful use of resources, models were identified and developed which included structural transformation of society and the notion of “sufficiency”. Efficient floor plans in refurbished buildings enable the generation of a reservoir of low cost and affordable housing with minimal transformation measures. Aspects of energy efficiency and ecological effectiveness were combined with economical and social issues, to guarantee a valid model for sustainable intervention. The level of intervention and the transformation measures for housing is a fundamental question for upgrading building stock in a socially acceptable way that is also compatible with the real estate market.

## 5. Conclusions

The project “HyperAuring” shows possible scenarios for upgrading existing building stock. The Kalkbreite Project in Zurich, Switzerland, already includes similar

strategies and approaches. Transforming existing buildings positively affects the urban space: inserting new functions and actors activates new flows. To diffuse similar models it is necessary to work on simple buildings that can be easily transformed. Flexibility in use assures a higher level of adaptation, especially when considering unpredictable future scenarios. Increasing requirements on user comfort, acoustics and thermal insulation and the related legal restraints have led to increasingly complex constructions and building systems. The consequences are increasing costs, higher error-rates in planning and building processes and complicated use. Stronger adaptation capability to local climatic conditions through effective passive measures as well as the implementation of functional requirements using simple constructions and practicing an efficient use of materials and energetic resources can be the key to assuring longer life cycles for buildings. Innovation can be attained through reduction. Simplification of construction and building installation and their connection with the constructional understanding of the building culture could be an approach to reaching this aim. The focus of the strategy is on the use of local materials, simplified building elements and the reduced use of installations. Furthermore, data records can assure an additional optimization both for consumption and comfort conditions. Through prediction and shared information, energy flows can be distributed in a more effective way. To reach the targets of the energy revolution in Germany as well as those of the Kyoto protocol for other countries, and to react to the consequences of the climate change, the increase in quality and attractiveness of our built environment is supposed to be the most effective measure. The key to a significant reduction of CO<sub>2</sub> emissions and a major factor for creating a

sustainable model for our cities is therefore to provide a high level of quality for the built environment and the public space. Because finally, in the debate about quality of life, the main issue is the amount of resource consumption necessary. Sufficiency means, more quality with less expenditure of resources.

## 6. Acknowledgments

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