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Implications of the 2000 Watt Society for Urban Planning and Economics

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Abstract

Based on the increasing popularity and dispersal of the concept of the 2000 Watt Society this paper analyses what defines the concept and what kind of implications and challenges are incurred in regards to urban planning and economics.

A sufficient amount of research in regards to the implementation of the concept exists solely in the area of building technology. Due to the very restricting targets that this concept sets, usage and user behaviour are crucial to achieve a successful reduction in energy consumption, therefore it remains questionable whether the goal can be achieved purely through voluntary alterations. In terms of urban embodiment there is considerable scope for building professionals to work increasingly on the separation of functions and using of economies of scale to reduce the share of per capita living space. Many of the possible solution approaches require a fundamental change to current economic habits including the decoupling of economic growth from haulage capacity and consumption levels, this challenge has not yet been analysed in existing research.

On the grounds of the difficulties associated with the implementation in all areas and the very restrictive nature of the concept it should be reconsidered whether it is commendable to constitute it as a legislative objective.

Keywords: Urbanisation, Environment, Energy, Regional Economics

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1. Introduction

The aim of this paper is to provide an overview of the 2000 Watt Society concept and its implications for urban planning and economics. Different criteria are selected which are analysed in view of determining where there is further scope for energy conservation under current conditions. The criteria were selected upon a base of given criteria from the Novatlantis specialist department and extended on the grounds of a theoretical framework, which underpins the considerations made surrounding the economic implications of the concept.

Section 2 describes the origins of the concept and explains its underlying theorem, as well as its political embedment. In the third section an overview of the given options for intervention is presented. The fourth and main section describes the criteria that were selected for further scope analysis and describes the challenges and implications encountered in implementation with each criterion. Finally, we conclude by summarising the implications for our current economic structures and urban planning practice in Switzerland.

2. Background

The concept of the 2000 Watt Society was first introduced by the Swiss Federal Institute of Technology (ETH) Zurich. It has the intention of bringing down per capita energy consumption to 48 kilowatt hours (kWh) per day. The chosen limit is based on the average global consumption of the late 1990s, when the concept was first introduced. The 2000 Watt are the constant level of power that is to be achieved per capita per annum, this leads to a consumption limit of 17'500 kWh per capita per annum. The time frame for implementation is foreseen in two phases: by the year 2050 a reduction to a power level of 3500 Watt and 2 tons of CO₂ per capita should be achieved, by the year 2150 the aim is a final reduction to 2000 Watt and 1 ton of CO₂ per capita, out of the 2000 Watt a maximum of 500 Watt are to be covered by fossil fuels (Novatlantis, 2009).

2.1. Underlying theorem of sufficiency

The underlying theorem to this concept is the notion of sufficiency. The idea that every member of a society has a right to a basic level of provision or consumption, that there is however a point of saturation beyond which there is no benefit to consuming further amounts of that good. The

transfer of this notion to energy consumption was first made by Goldemberg, et al. who in 1985 derived that in order to live a satisfying life a limit of constant power of 1000 Watt per capita would be sufficient, anything beyond that level would not lead to an increase in quality of life (Goldemberg et al., 1985). Whether this notion is in fact applicable to energy consumption is, from an economic perspective, certainly debateable, as multiple studies have shown the relationship between energy consumption and GDP growth (for instance Soytas and Sari, 2003 or Lee, 2006). Despite the existence of contrary evidence (Huang, Hwang and Yang, 2008) it seems evident that this debate would be obsolete so long as all energy consumed could be produced from renewable and therefore less environmentally impacting sources. As long as the technical possibilities for fully renewable energy provision are not a given it does however seem legitimate to consider options which are based on energy conservation.

As it would seem inadequate to make assumptions on the estimated levels and impacts of future technological shifts, which might impact energy efficiency, the following paper focused on underlying premises that would have to be fulfilled if the concept of the 2000 Watt Society were implemented under current conditions. The global average in energy consumption has reached a constant power level of 2300 Watt per capita in 2011, the consumption in Switzerland is almost threefold that amount, annual per capita consumption reached 55'000 kWh around the year 2010, which would amount to a 6000 Watt Society (Novatlantis, 2009). The required reductions in energy consumption therefore amount to two thirds of the current levels.

2.2. Political Embedment

A majority of the Swiss cities has now adopted the 2000 Watt Society as long term legislative goal, which makes its implementation mandatory. The city of Zurich adopted the concept in 2008 through popular vote and it is now embedded in the municipal code (City of Zurich, 2010 (1)). The cities of Zug and Lucerne adopted the concept in 2011 (City of Zug, 2011; Schmid, 2011). Furthermore the concept is now embedded in series of national strategies such as the climate goals of the federal council, or in the national energy perspectives for 2035 (Volume IV). The concept is therefore of high relevance for the implementation of national and local strategies and policies.

3. Given options for intervention

The given options for intervention are based largely upon innovations and norms in building technology. The Swiss Society of Engineers and Architects (SIA) have published a path to energy efficiency (Effizienpfad Energie) as well as recommendations for sustainable planning and building (Empfehlung SIA 111/1). There is a high amount of knowledge concerning optimal renovation strategies and building standards, such as the Switzerland based series of MINERGIE®- Labels. While there is considerable scope for energy savings through improved building standards, a reduction by two thirds of the current consumption levels requires further measures. Novatlantis calculates a reduction in energy consumption of 20% for the domain “living”, the total required reductions should however amount to 69% of today's total energy demand. Therefore the majority of savings need to be made in a domain other than building technologies.

This is mainly where deficits in current research and practice are found. When it comes to the effective visualisation of the 2000 Watt Society concept, there are clear target values and starting points for implementation, however there is a lack of knowledge concerning their end effectiveness and as to which measures have the highest degree of efficiency. Furthermore it remains unclear what concrete measures are to be undertaken by the various professions.

4. Selected criteria for further scope analysis

In order to determine which starting points present potential for further scope in the implementation of the concept, a series of criteria were selected and analysed. The selection of criteria was based on target areas defined by Novatlantis (Novatlantis et al. 2010), which selected the criteria “living”, “mobility”, “nutrition”, “consumption” and “infrastructure” as its starting points. For the purpose of this analysis the criteria “nutrition” and “infrastructure” were excluded seeing as the options for change are mostly already defined (for instance by reducing meat consumption and favouring local produce) or depend largely upon the implementation of technical innovations respectively.

To obtain an in-depth view on the challenges related to urban planning and economics the criteria “architecture and building typology” as well as “usage and user behaviour” were added. The criteria usage and user behaviour was identified as being of high relevance seeing as the goal is

focused on per capita consumption and it is therefore highly dependent upon individual actions and responses, which are embedded in a context of individual networks, social norms and economic customs.

4.1. Mobility

Switzerland is a highly mobile country, because of the relative wealth and compact size there is very extensive infrastructure, especially in transport. The adverse effects of this can be seen in the levels of average daily travel distances. In the last decades there has been a trend of rising average daily travel distance, regardless of the mode of transportation.

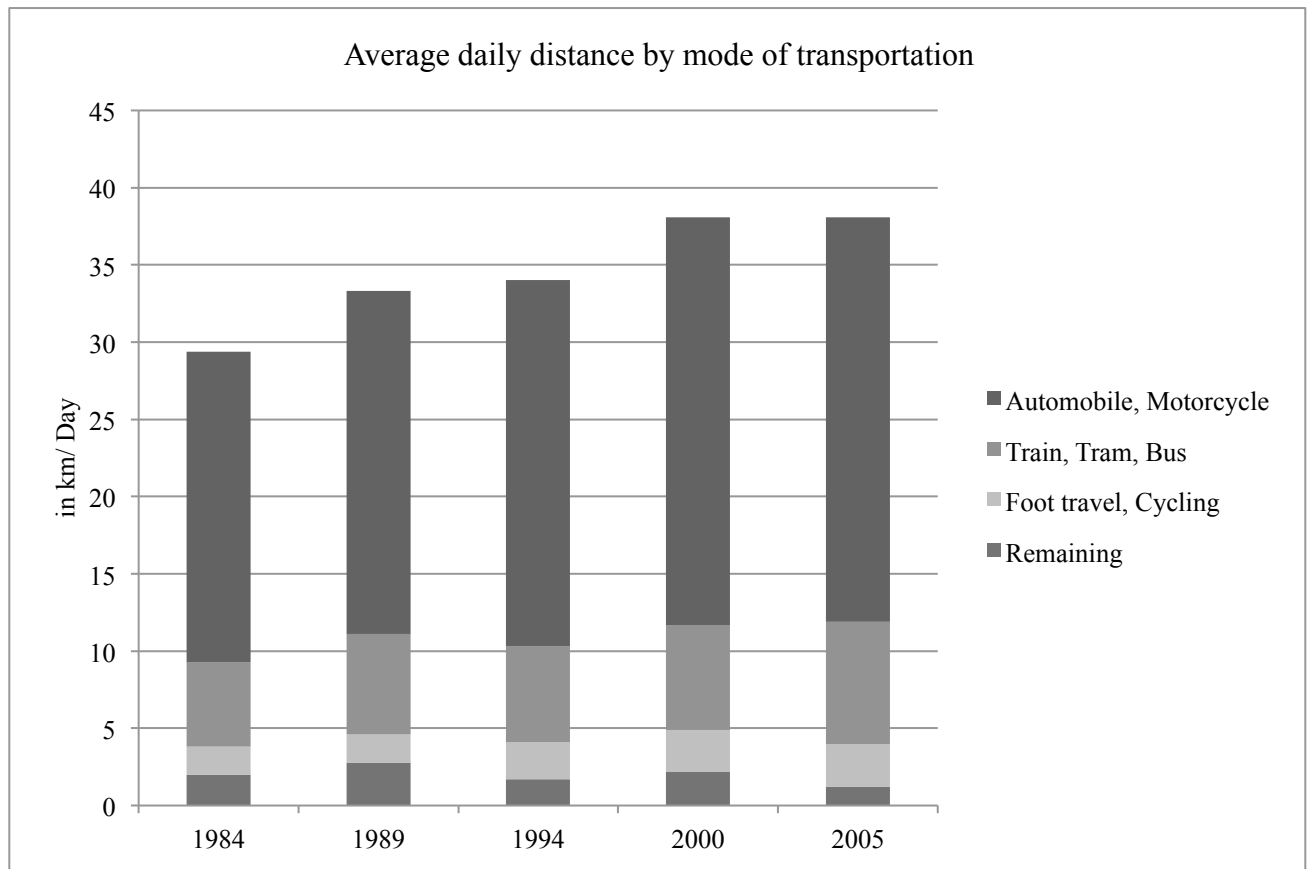


Figure 1: Average daily distance in Switzerland (Swiss Federal Statistical Office, Micro census, 2005).

If we consider Adams' theory of Hypermobility (Adams, 1999) this trend is not likely to be reversed but instead fuelled by the further development of infrastructures. This is a trend that, especially in Switzerland, still finds broad political support. Only recently² a further initiative to

² On the 9th of February 2014

support the upgrade of rail infrastructures was passed in a popular vote with 62% yes votes. While the move to support public transportation may seem beneficial, the effective energy savings are not given, seeing as there has not been a switch in the mode of transportation but rather a plain increase in mobility. Furthermore the provision of infrastructures for public transportation has considerable energetic costs, which are bound to outweigh the energetic benefits incurred through the savings in operation and production of vehicles (Canton Zurich, 2009).

An important factor in increasing overall mobility is economic structural change. The increasing specialisation has led to the necessity to split the production of goods into multiple, highly specialised, production steps. This also allows for an overall higher level of value creation, which is vital in supporting the growth economy. The spatial consequences of this trend are that it is not feasible to place all production steps in geographical proximity, which consequently increases the overall levels of mobility and goods haulage.

Not only the secondary sector is affected by this need for mobility. Many service-based industries rely on strong client contact and personal interactions between their employees. While there is some scope for web-based interactions and flexible work models like home office days, personal contact is increasingly viable for the development of trust networks and the communication of authenticity to the client. These are factors of growing importance as levels of competition within the market rise; a situation that can be termed to be true as the overall shift to the tertiary sector continues. With increasing levels of globalisation further challenges are incurred through increasingly international networks, both within a given business and in the relationship of a business with its customers and suppliers.

Next to business-induced travel, mobility in leisure time plays a considerable role. With 16,6 km per capita and day it is the largest travel inducing activity, making up 45% of all travel purposes (Swiss Federal Statistical Office, 2011). Approximately half of all trips undertaken for leisure purposes are undertaken through slow modes of travel (such as cycling or foot travel), which somewhat reduces the significance seeing as these are low-impact modes of travel. However it has also been established that with increasing income levels day trips or trips with overnight stays increase (ibid, 2011), which consequently are more energy intensive trips seeing as they are normally undertaken with motorised modes of travel. This might present some scope for the

landscape planning domain to make cities more liveable and local recreation areas more accessible, ultimately however this domain is also dependent upon citizen behaviour.

Novatlantis has defined for mobility to take up a quarter of all energy consumption, which would result in a per capita allowance of 12 kWh per day. Following the assumption of Novatlantis that 1 Litre of fuel corresponds to 0,1 kWh the consequence would be that in a car which consumes 7,5 l/100km on average, one could drive exactly 16km a day. Of course one may argue that there are significantly more efficient vehicles, however the average consumption for a new car was still at 6,21 l/100km in 2012 in Switzerland (Swiss Federal Office of Energy, 2013). This value is probably largely induced by the high level of wealth, which allows people to buy more consumption intensive vehicles. Going with the assumption that the average consumption on a vehicle will be reduced to 3 l/100km this leaves around 40 km per capita and day in mileage. This may seem like a significant amount, however considering that the average distance covered per capita was already 38,2 km in 2005 (Swiss Federal Statistical Office, 2011), with rising tendencies, this amount is not excessive.

4.2. Living and Working

If financial constraints are not regarded the main driver for housing preference is location (Reed, Mills, 2007). That in turn highly depends on the socio-demographic background of an individual. While younger and elderly generations are increasingly situated in cities, the preferred form of living, especially for families, is still detached housing. In Switzerland detached housing makes up the majority of all building stock and is still on the rise; while in 1990 the percentage of detached housing in total building stock was 53,8% this has risen to 57.7% by 2012 (Swiss Federal Statistical Office, 2012).

Combined with “comfort trends” such as utilizing increasing amount of living space per capita, fuelled by an increasing number of single person households - in Switzerland living space requirements have risen from 23m² per capita in 1955 to 46m² per capita in 2005 (City of Zurich, 2011) - a higher amount of technological devices in households and increasing space heating temperatures, it becomes evident how the implementation of the 2000 Watt Society requires profound societal change in order to be successful.

Nevertheless there are some starting points, which can help to support the reduction of energy

needs in this domain. For urban planning and architecture they are threefold: increasing density, using economies of scale in building planning, and reducing unnecessarily heated living space. As has previously been demonstrated the main building form in Switzerland is detached housing which presents an inefficient use of resources seeing as it is a very land-extensive form of living, which also increases mobility needs. Denser urban forms can be achieved by introducing minimal utilisation numerals³ to municipal building regulations. In Swiss urban planning utilisation numerals are already commonly used in municipal building regulations, however only as maximum values, in order to preserve a given urban character. However for energy conservation principles the introduction of minimal values should also be considered.

The highest savings could probably be achieved by introducing the principles of economies of scale into building planning. That is to say that through sharing as many facilities and technical devices as possible, the need for resources is reduced. This could be introduced by sourcing out certain living functions that are now part of our private living space to a communal facility on the building or even neighbourhood level; this can entail anything from playrooms for children, or office space to communal kitchens. Depending on the level of outsourcing more savings can be made; however they also require varying degrees of social flexibility. While communal neighbourhood offices might be a popular idea, having common kitchen facilities will most likely be perceived as a large constraint for the majority of people. Therefore it is questionable whether there would actually be a demand for such ways of living. This would effectively have to be tested in a pilot. For conventional real estate investors such a trial would in all likelihood be too risky.

The energetic benefits of sharing living space are further demonstrated in Appendix 1, which illustrates the differences in the need for space heating according to occupancy rates.

The final point of action in this domain would be the reduction of heated living space. If analysed in detail it seems apparent that many areas within a given apartment or house are heated, despite their infrequent use. This applies to corridors, storage rooms or even bedrooms, which are mostly only used at night. This would suggest that it would be advantageous to have a distinction between frequently used rooms which would be permanently heated; such as living rooms, rooms

³ Utilisation numerals are the quotient of gross floor space over plot area (there are some specific deductions which do not have a significant impact and are therefore disregarded)

which require only limited heating, such as the bedroom and rooms which require no heating such as storage rooms or corridors. Such a distinction obviously results in considerable design restrictions, seeing as the unheated rooms would have to face the exterior and only partially heated rooms would have to lie in between non heated space and fully heated space. Further restrictions are encountered through the modern trend of open plan apartments, which does not allow for such distinctions.

4.3. Architecture and building typology

The possibility for denser building typologies has already been discussed but there are a few additional points where there is further scope for action. As can be seen in many figure ground plans of cities there has been a historic tendency to build in very compact structures. Whereas the reasons for that are multilateral the principle should still be transmitted to current building practice because it improves the surface-volume proportion of buildings and therefore optimises energy consumption and it allows for more foot based travel. From an energetic point of view the ideal building would be nearing a sphere, seeing as that has an optimal surface-volume proportion. As this is not desirable from an urban design perspective and hardly feasible in practical considerations the goal should be to focus on optimising surface-volume proportions overall. Such a quotient could again be introduced in municipal zoning plans or building regulations.

Further options that could directly be implemented into planning practice are minimal building heights; these would of course have to be introduced in rigorous consideration of the surrounding urban environments so as not to interfere with place quality, and the orientation of new developments to make maximal use of passive energy through incident solar radiation. The building designs again would have to adapt optimally so as not to lead to adverse effects because of excessive solar radiation.

4.4. Consumption

The question of consumption is important for the concept of the 2000 Watt Society seeing as a reduction in consumption levels is an essential part of the concept. The quantitative definition of which goods are to be consumed less and in what scale is however, very difficult to pinpoint, and incidentally also not defined by Novatlantis.

The essential question of what levels of consumption are necessary and to which levels an individual should have a right, go in the direction of philosophical debates, which shall not be expanded further in this paper. However it is important to note that the definition of quality of life is supremely subjective. The author's hypothesis is that many people in today's western society would perceive the required reductions as highly restrictive, especially considering the short life span of consumer products today. Furthermore there is a profound conflict between the current provision of goods by businesses, which rely on high and frequent level of consumption, and the aspirations of the 2000 Watt Society. This conflict is further explained in the following section.

4.5. Usage and user behaviour

All considerations made in this section are embedded in a theoretical framework, which is demonstrated in Figure 2. It is based upon the assumption that all individual actions, which are ultimately relevant for energy consumption, are embedded in a context of individual networks, social norms and economic customs.

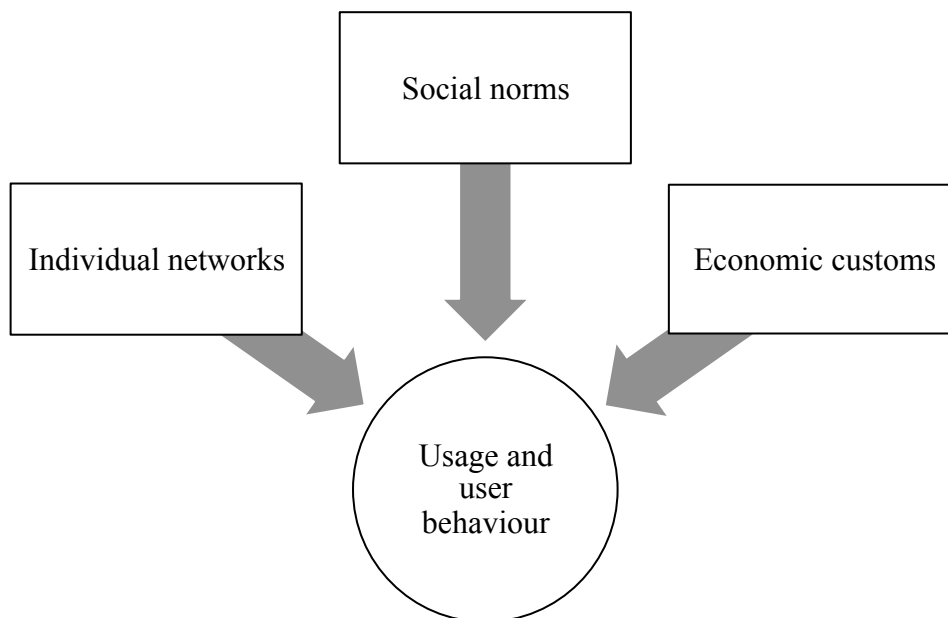


Figure 2: Theoretical framework of the determinants of usage and user behaviour

The individual networks include family ties, personal networks such as friendships and acquaintances and business contacts and networks. All of these can be highly regional or more internationally oriented. Social norms are mostly culture dependent and make up a considerable

factor as they might raise certain expectations of an individual belonging in that society, those can be the expectation to care for the elderly within the family or put familial or societal interests before personal interests or simply to maintain personal networks after a given set of conventions. The economic customs can be described with similar attributes as the social norms; they entail a certain set of conventions and expectations from businesses toward their employees. These would for instance be the willingness to commute or to accept temporary contracts.

These determinants bare a high relevance to economic questions because they provide a certain set of given parameters, which lead to behaviours that have a direct impact on energy consumption. The combination of individual networks, social norms and economic customs all lead to or sustain certain behaviours. For instance it might be acceptable to commute large daily distances, because the economic customs drive the individual to look for employment in a broader perimeter, while the familial ties prevent him from relocating altogether. Depending on the circumstances the determinants can act as either push or pull factors; what is however crucial is that in the majority of cases one of the determinants will be a push factor and another a pull factor, leading to conflicting interests and adverse behaviour in terms of energy consumption.

As seen in previous sections almost all of the influenceable criteria are ultimately limited by the way end users choose to act. While all the preconditions for a low energy lifestyle might have been met, user behaviour can easily throw off the energetic balance. A given user might live in a low energy development, which has minimal heating requirements, optimal connections to public transport, the place of work within walking distance, and options for local grocery provisions. If said user adheres to this lifestyle through out the entire year but only chooses to go on vacation to the Caribbean by plane once the overall energy consumption balance will still be too high.

The question that therefore must be asked in this context is: Are regulatory measures desirable and if yes to what degree? This is most certainly a political question, considering the strong limitations of the concept and its political embedment it is one that will have to be discussed relatively soon.

5. Conclusions

5.1. Implications for urban planning practice in Switzerland

The implications of the 2000 Watt Society concept for urban planning practice in Switzerland are that the local methods and instruments of planning such as municipal zoning plans and building regulations have to be reviewed under the aspects of improving energy efficiency. This begins with strategic instruments such as municipal concepts and mission statements and spans to planning instruments that are binding for landowners.

The options, which have been specified under the previous sections, include the introduction of minimal utilisation numerals, maximal surface-volume proportions, building heights and building orientation. All these could be easily implemented in existing planning instruments. Furthermore measures such as using scale economies or layered space heating in the design of new building developments should be discussed, developed and extended in the broader field of built environment practitioners.

However further research will have to be conducted, which would analyse what kind of urban structures and typologies are optimal for low energy intensity, and spark the discussion among planning professionals. This should also help to find further aspects that can be used for the implementation of the concept. On a national strategic level it is very hard to set binding agreements, due to the very strong federalist structures, which prohibit the state to issue binding planning documents, with only few specified exceptions.

5.2. Implications for economic structures

The exact implications of the 2000 Watt Society on economic structures can obviously not be defined, however it is clear that they most certainly will have to change in light of the implementation of the 2000 Watt Society. For one, the essential mechanism of value creation does not seem to be compatible with the concept, furthermore the strong shift to specialised industries with the accompanying effect of geographical dispersion seems to create further conflicts, as well as the strong internationalisation of some companies and industries. Seeing as the 2000 Watt society is an individual-related concept it is difficult to estimate impacts for business beyond the obvious connection between demand and supply of goods and services.

Considering how strongly interwoven and globalised our current economy is, it seems difficult to break from global dynamics such as structural shifts and internationally oriented networks. While it may be beneficial to consider supporting local value chains and business networks; this hypothesis would also have to be tested; it seems unviable and highly disadvantageous to try and separate economic activities in Switzerland from global economic dynamics. In order to achieve the highly restrictive targets of the 2000 Watt Society it seems however that these global economic dynamics would be adverse to fulfilling these targets.

Hence the author suggests that it should be reviewed whether it is really commendable to constitute the 2000 Watt Society as a legislative object in municipal code. While the concept may be very valuable in providing the right direction of impact in order to initiate energy conservation policies and measures, it would require significant economic restructuring, which does not seem desirable nor feasible.

Appendix 1: Need for space heating according to occupancy rates

| Assumptions for E-Classification values (Year of construction before 1975): | | |
|---|--|--|
| Detached housing: | 140 kWh/m ² a | |
| Terraced housing: | 120 kWh/m ² a | |
| Multiple dwelling units: | 100 kWh/m ² a | |
| Minimal legal provisions to date: | 48 kWh/m ² a | |
| Minergie-Label requirement: | 38 kWh/m ² a | |
| Minergie-P-Label requirement: | 30 kWh/m ² a | |
| <u>Detached housing:</u> | 1 Room (R): $140 \cdot 50 \text{ m}^2 = 7'000$ kWh/a 2 R: $140 \cdot 75 \text{ m}^2 = 10'5000$ kWh/a 3 R: $140 \cdot 90 \text{ m}^2 = 12'600$ kWh/a 4 R: $140 \cdot 100 \text{ m}^2 = 14'000$ kWh/a | kWh/a per capita:* 1 R: 7'000 kWh/a 2 R: 10'500 kWh/a 3 R: 6'300 kWh/a 4 R: ca. 4'650 kWh/a |
| <u>Terraced housing:</u> | 1 R: $120 \cdot 50 \text{ m}^2 = 6'000$ kWh/a 2 R: $120 \cdot 75 \text{ m}^2 = 9'000$ kWh/a 3 R: $120 \cdot 90 \text{ m}^2 = 10'800$ kWh/a 4 R: $120 \cdot 100 \text{ m}^2 = 12'000$ kWh/a | kWh/a per capita: 1 R: 6'000 kWh/a 2 R: 9'00 kWh/a 3 R: 5'400 kWh/a 4 R: 4'000 kWh/a |
| <u>Multiple dwelling unit:</u> | 1 R: $100 \cdot 50 \text{ m}^2 = 5'000$ kWh/a 2 R: $100 \cdot 75 \text{ m}^2 = 7'500$ kWh/a 3 R: $100 \cdot 90 \text{ m}^2 = 9'000$ kWh/a 4 R: $100 \cdot 100 \text{ m}^2 = 10'000$ kWh/a | kWh/a per capita: 1 R: 5'000 kWh/a 2 R: 7'500 kWh/a 3 R: 4'500 kWh/a 4 R: ca. 3'340 kWh/a |

* For 1 and 2 room apartments we assume an occupancy rate of 1 person, for 3 and 4 room apartments we assume occupancy of 2 or 3 persons respectively

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