MSc Program
Renewable Energy in Central & Eastern Europe

Behavioural aspects of energy consumption in private households.

Participatory approaches for energy conservation.

A Master Thesis submitted for the degree of

"Master of Science"

supervised by

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Vienna, October 31, 2008

Affidavit

I, Elisabeth Bohunovsky, hereby declare

1. that I am the sole author of the present Master Thesis, " Behavioural aspects of energy consumption in private households. Participatory approaches for energy conservation.", 70 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
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Abstract

Within the last years, negative side-effects of increasing anthropogenic use of energy have been more and more recognised. Besides an enforced use of renewable energy sources and a more efficient use of energy, it will be necessary to reduce the level of energy consumption in industrialized societies in order to achieve a sustainable energy system. Although private households will play a crucial role in this transition, private energy consumption seems hard to tackle, as it results from highly complex patterns of decision making, life-styles, values, etc.

After introductory chapters including a situation and problem analysis, the master thesis demonstrates the degree of energy conservation that can be reached by behavioural changes of private households – based on Austrian climate conditions. Model calculations are applied for households with different behavioural patterns in regard to room temperature settings, ventilation habits, hot water and electricity use. The results show the huge potential for energy savings through behavioural changes. The assumptions on an energy saving behaviour resulted in an energy demand of minus 32% in comparison to the average. Squandering behavioural patterns resulted in plus 74% compared to the average.

The second part of the thesis starts with an introduction of the idea of participation and describes examples of participatory approaches in the context of private energy use. The idea of participatory approaches is then discussed along the theoretical framework of a socio-technical approach. Effects of participatory processes are shown, and limiting as well as promoting factors for a successful implementation are identified.

The thesis concludes that participatory approaches allow people to try out new behavioural patterns under "laboratory" conditions. They can provide an additional incentive as well as the information and support that are necessary to enable people to change their energy behaviour towards sustainability. They cannot be the only solution to decrease energy demand of private households. But they should be part of a bigger strategy that includes other endeavours to lead the system towards sustainability, such as political and financial incentives or directives.

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EC	European Commission
GDP	Gross Domestic Product
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ITC	Information and Telecommunication
MJ	Mega Joule (10^6)
Mtoe	Million tons of oil aquivalents
NGO	non-governmental organisation
PJ	Peta Joule (10^{15})
TJ	Terra Joule (10^{12})
TPES	Total Primary Energy Supply

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Energie im Alltag: Ist's auch Wahnsinn,
so hat es doch Methode.

[Energy in everyday life: madness, yet quite deliberate.]
(Thomas Berker, 2008)

1 Introduction

1.1 Problem description

Anthropogenic use of energy has tremendously increased within the past decades. While the world's total primary energy supply in 1973 was at 6,128 Mtoe[1], it reached 11,435 Mtoe in 2005 (IEA, 2007). Within the last years, negative side-effects of human energy use have been more and more recognised.

The main point of discussion is climate change, which is induced due to the use of fossil fuels. Especially since the warning reports of the IPCC in 2007 (IPCC, 2007) and the so-called Stern Review (Stern, 2007) on the Economics of Climate Change in 2006, which pointed out the economic costs of climate change, the issue of anthropogenic climate change seems to be widely accepted. But also other environmental implications of energy use (e.g. health implications due to air pollution and particulates, acidification, deforestation, impacts on biodiversity) become more severe as the demand of energy increases.

Besides the issue of climate change there are two further arguments against a perpetuation of the nowadays fossil-based energy system: the inherent danger of depletion and the uneven distribution of the resources. There are differing opinions about how long resources will last, and whether or not we already have reached peak-oil[2], but fossil fuels are non-renewable energy sources and thus resources will get more and more difficult to exploit. Moreover, resources of fossil fuels are unevenly distributed around the world. This results in high dependency rates on often politically instable countries for fossil energy sources, which might lead to the fact

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[1] Million tons of oil equivalent

[2] "Peak oil is the point in time when the maximum rate of global petroleum extraction is reached, after which the rate of production enters terminal decline." http://en.wikipedia.org/wiki/Peak_oil

that countries which do not own enough fossil fuels have a huge economic disadvantage against fuel-owning countries – a fact, which also implies a high risk of political conflicts.

In addition to these ecological, economic and political shortcomings of our current energy systems, also social deficiencies of the energy system need to be mentioned as there is a strong imbalance concerning energy availability of different world regions. Figure 1 shows the total primary energy supply (TPES) per capita for different world regions and Austria. OECD countries used 49% of the world's TPES in 2007, while they account for 18% of the world's population. In contrast, Asia used 11.2% of TPES while accounting for 32% of the population (IEA, 2007). And the numbers are even more dramatic if you look at specific countries.

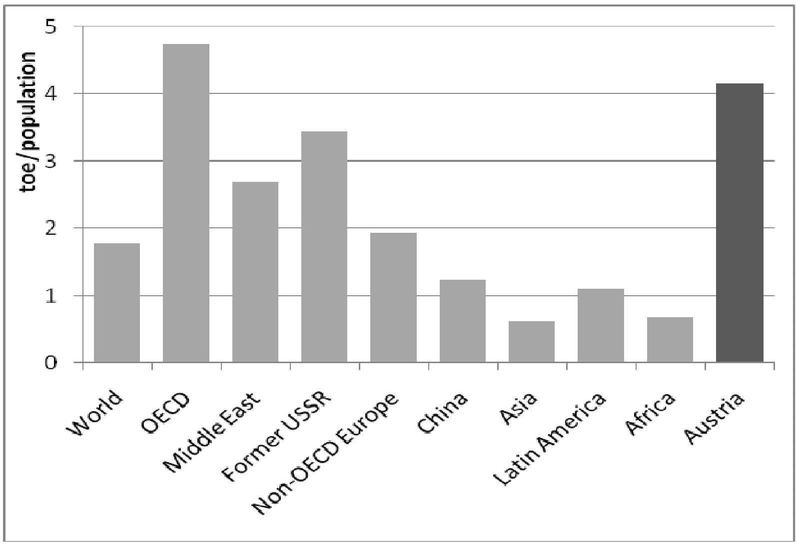

Fig. 1. Total Primary Energy Sources (TPES) per Population (toe/capita) for the world, world regions and Austria. Data source: IEA, 2007

Scenarios usually assume that energy use will further increase, although the extent of this increase differs significantly between different scenarios. The World Energy Outlook of 2006 (IEA, 2006) projects in its Reference Scenario that global primary energy demand will increase by just over one-half until 2030 – an average annual rate of 1.6%. Most of this increase (70%) will happen due to economic and population growth in developing countries. As energy use is closely linked to development, these world's regions will need more energy in order to further develop and to gain a better quality of life.

Regarding the shortcomings of today's energy system as described above and the need for many world regions to further develop, it seems clear that significant changes will have to take place regarding the world's energy system. It is difficult (if not impossible) to imagine a worldwide energy use per capita that is as high as in the OECD countries today – without accepting massive side effects.

There are two main leverages for this system change. The one is an enforced use of renewable energy sources; the other is reductions of energy demand through a more efficient use of energy.

Although renewable energies – which formed the focal point of the MSc program – are one very interesting possibility to meet (parts of) the world's energy demand, they cannot be considered as the solution to all energy related problems and it is illusionistic to believe that today's energy level (or an even higher one) can be uphold based on a renewable energy basis. Renewable energies, like biomass, wind, solar, hydro or geothermal energy, are not in danger of depletion, their lifecycle CO_2-emissions are usually quite favourable and they are also more fairly distributed among economies. Nevertheless there are clear limits to their use like: limitations of available land to grow biomass resulting in trade-offs between growing food and biomass for energy use; limitations of raw materials to produce solar panels; ecological impacts on rivers when exploiting hydro power; or social objections against wind farms; etc.

The second leverage, higher energy efficiency, would allow for the same level of energy services[3] with less primary energy demand. Thus, developing countries could increase their economic output (and thus hopefully their quality of life) without increasing their energy demand at the same rate and also developed countries could further increase their wealth without increasing or even while decreasing their energy demand. The difference between OECD's and other world regions' energy intensity[4] shows the huge potential for developing countries: OECD's energy use per GDP is the by far lowest in the world (0.20 versus 0.83 in China or Africa).

Nevertheless, what has not been reached so far is an absolute decoupling of economic growth (or human welfare) from energy use. As shown above, the OECD energy demand per capita is the highest – despite the low energy intensity of its

[3] i.e. the benefit or services obtained from using energy;

[4] i.e. units of energy per unit of GDP

economy. Energy efficiency has mainly led to economic growth and NOT to a reduction of energy demand. A similar effect can be assumed when increasing energy efficiency in developing countries – and thus the correlation between energy efficiency and a reduced total energy demand remains rather theoretical.

Following the arguments of the limits of renewable energy use and the pitfalls of energy efficiency, it is argued in this thesis that a total reduction of the world’s energy demand will be decisive for the success or failure of our future energy system. In order to achieve a situation of more equally distributed resources, it is further argued that it is mainly a duty of the developed countries to reduce their level of energy demand per capita.

Although a reduced level of energy use through energy efficiency is a widely acknowledged target especially in the Western World, it has proven difficult to achieve. Especially the energy consumption of private households seems hard to tackle, as energy is hardly seen as a cost factor in private life (at least in our Western society) and private energy demand results from highly complex patterns of decision making, life-styles, values, etc.

Energy efficiency gains have led to an increased level of energy services (more electrical appliances, higher room temperatures, etc.), price increases would be difficult to argue politically and would increase social inequalities within our society (and the effect is highly debated), and arguments on negative ecological impacts of energy use did not have the desired impact. The question thus arises if there are any alternative ways to change energy behaviour of private households.

Participatory approaches build on the experiences of everyday life and can provide a possibility to reach people not only on an intellectual and/or economic basis, but to approach them in a more holistic way. A first review on literature about experiences with participatory approaches to reduce energy demand of private households gave interesting insights, and thus the idea to look closer at this approach within my master thesis evolved.

1.2 Objective

When discussing potentials to reduce energy demand of private households, an increase of technical efficiency (efficiency behaviour[5]) has to be seen in the context of a changed energy-using behaviour (curtailment behaviour). Common approaches mainly focus on energy efficiency behaviour. Technology independent energy behaviour though can make a big difference in energy consumptions of private households and without taking it into account, efficiency gains are easily (over)compensated by (direct) rebound effects. Within this master thesis the focus is thus laid on behavioural patterns that do not depend on technical solutions (like switching off the light, etc.).

The objectives of this Master Thesis are (1) to show the degree of energy conservation that can be reached by behavioural changes of people in their private surroundings and (2) to identify participatory approaches that might help to enforce such behavioural changes.

According to the two objectives, this master thesis consists of two main parts:

(1) The first part deals with possibilities to reduce the energy use of private households by behavioural changes. The main research question of this part is: "How does behaviour influence energy consumption of private households?"

(2) The second part tries to answer the research question of how participatory approaches can help to make households more aware of energy consumption, to change their energy behaviour and thus to reduce their energy demand.

The according hypotheses are:

- Changes of energy behaviour in regard to heating, hot water use, usage of electrical appliances and mobility can reduce the level of private energy use significantly – without a necessity to invest huge amounts of money.
- Participatory approaches can help to make people behave in an energy conserving way.

[5] For definitions of the main concepts refer to Box 1.

BOX 1: DEFINITION OF MAIN CONCEPTS

- Energy behaviour: "Energy behaviour" in the context of this master thesis is defined as those aspects of direct personal energy consumption that depend on personal decisions. These include the decision for or against certain electrical appliances, the choice for more or less energy efficient appliances, the implementation of thermal insulation measures and behavioural patterns which are independent of technical aspects, e.g. switching off the light, using a lower washing temperature.
- Energy efficiency behaviour and curtailment behaviour: These concepts refer to an energy behaviour that aims at conserving energy. Energy efficiency behaviours are one-shot behaviours and entail the purchase of energy-efficient equipment or thermal insulation measures. Curtailment behaviour involves repetitive efforts to reduce energy use, such as lowering thermostat settings (Abrahamse, 2005).
- Energy conservation, synonym to energy saving: Energy conservation means a total reduction of energy use. In economic terms this means an absolute decoupling from GDP (in contrast to a relative decoupling, which means "using less energy per entity, but more in total").
- Energy efficiency: Energy efficiency means using less energy to provide the same level of energy service by technical improvements. In common language this term is often used in order to refer to "using less energy", which is often not the fact due to the rebound effect.
- Energy service: The energy service is the benefit out of the combination of energy with energy efficient technology, i.e. for example warmth, lighting;
- Renewable energies: energy generated from resources that are naturally replenished (e.g. solar, wind, hydro, biomass, wave)
- Rebound effect: Increasing energy efficiency in fact often does not reduce demand for an energy resource, as the level of the according energy service increases in parallel. This results in a lower decrease or even an increase of total energy demand – a paradox which is called the (direct) rebound effect (see also chapter 3).

Scope

The share of direct energy[6] to the total energy requirement in different European countries varies from 34% up to 64% (Reinders et al., 2003). Although indirect energy use is thus at least as important as direct energy use, it would exceed the scope of this master thesis to take both aspects fully into account. Nevertheless, when using participatory processes to make people more aware of their energy behaviour and potentials to reduce energy demand, the issue of indirect energy demand cannot be completely excluded (see also conclusions).

1.3 Approach and Structure

➢ Basic Data and Literature Research

In order to meet the objectives of the master thesis, literature and web research was undertaken regarding

- experiences and data on effects of curtailment behaviour in private energy use related to Austrian climate conditions); and
- examples of participatory approaches to reduce energy use in private households.

The literature review was done with the electronic journal database of the library of the Technical University Vienna[7], using relevant keywords as well as the function “related articles” as soon as an appropriate publication was found. Based on selected publications, further information on projects was looked up in the internet.

➢ Demonstration of Saving Potentials for Single Families

The data and assumptions on effects of different behaviour on energy demand of private households were discussed with two energy experts, namely Michael Hanneschläger (Energiepark Bruck/Leitha) and Armin Knotzer (Umweltberatung Wien) and implemented into simplified model calculations in order to demonstrate the impacts of different energy behaviour of private households. Details regarding the model implementations can be found in chapter 4.1 and 4.2.

[6] Direct energy use is the demand of electricity, heat and fuel. Indirect energy use means the energy needed in order produce consumer goods, deliver non-energy services, etc.

[7] http://www.ub.tuwien.ac.at/digitale_bibliothek/onlinezs.html

➢ Stakeholder Questionnaire

On September 23rd, 2008 a stakeholder workshop of the project "Effects of sustainable energy consumption for Austria (e-co)"[8] took place in Vienna. 23 stakeholders from science, consulting, energy sector, public agencies and NGOs took part in this workshop that aimed at presenting the project and first scenario ideas. At the end of the event 19 stakeholders filled out a questionnaire (in German, see Annex) which inter alia also included some questions in order to get feedback on some assumptions of this thesis. Those results of the questionnaire which are relevant for the scope of this thesis are included at several points of the thesis. A German report on the complete questionnaire findings is available upon request from the author.

➢ Guided Interviews

Based on the results of the desktop research, two guided interviews were conducted with selected experts. One personal interview was led with Armin Knotzer responsible for the energy consultation at "Umweltberatung Wien". Furthermore a telephone interview was led with Ricarda Rieck, project manager of the SHARE project. The aim of both interviews was to discuss their experiences with behavioural aspects of private energy use, to get further information on their work and to discuss their experiences with energy behaviour and according participatory approaches. Both interviews were led in German.

➢ Discussion and Interpretation

The examples of participatory approaches identified during literature und web research were described and discussed along the theoretical framework of a socio-technical approach. Moreover, limiting and promoting factors for a successful implementation were identified. Background information of this part is based on an extensive literature review and web research. Finally conclusions were drawn on the possible significance and applicability of participatory approaches in order to reach a system change.

[8] The project analyses the effects of sustainable energy consumption on the economy, the environment and on society by following the Austrian goals in the fields of energy and climate policy until the year 2020. For further information on the project see www.energiemodell.at

Structure

Following this introductory chapter, CHAPTER 2 frames the problem by describing the situation of energy use in Austrian private households (based on literature and web research) and CHAPTER 3 describes the issue of energy efficiency in a technical and political context (based on literature and web research).

CHAPTER 4 shows potentials of energy conservation in private households. Three types of households (average, energy saving and energy squandering) were defined – based on an initial literature and web research. Their hypothetical energy demand for heating, hot water, and electrical appliances was described in order to demonstrate the potentials of energy curtailment behaviour. This exemplary approach was chosen as it best fits a participatory approach in terms of communication possibilities.

Part II of the thesis starts with an introduction of the idea of participation (CHAPTER 5.1; based on literature and web research).

CHAPTER 5.2 describes some examples of participatory approaches in the context of private energy consumption (based on literature and web research, personal interviews).

In CHAPTER 6 participatory approaches towards energy reduction are discussed, success factors and possible pitfalls are described. CHAPTER 7 draws conclusions on the possible significance and applicability of such participatory approaches.

2 Aspects of the Austrian Energy System

Austrian domestic primary energy consumption rose from 800 to 1,400 PJ between 1970 and 2005. In contrast to this increase of 81%, domestic energy production rose by only 15% between (Fig. 2) in the same period, which led to an increasing dependency of Austria on energy imports.

In 2006 oil was the most important energy source (42.2%) in Austria, followed by renewable energy sources with a share of 22.4%, natural gas with a share of 21.9% and coal with a share of 11.8% (Statistics Austria[9]).

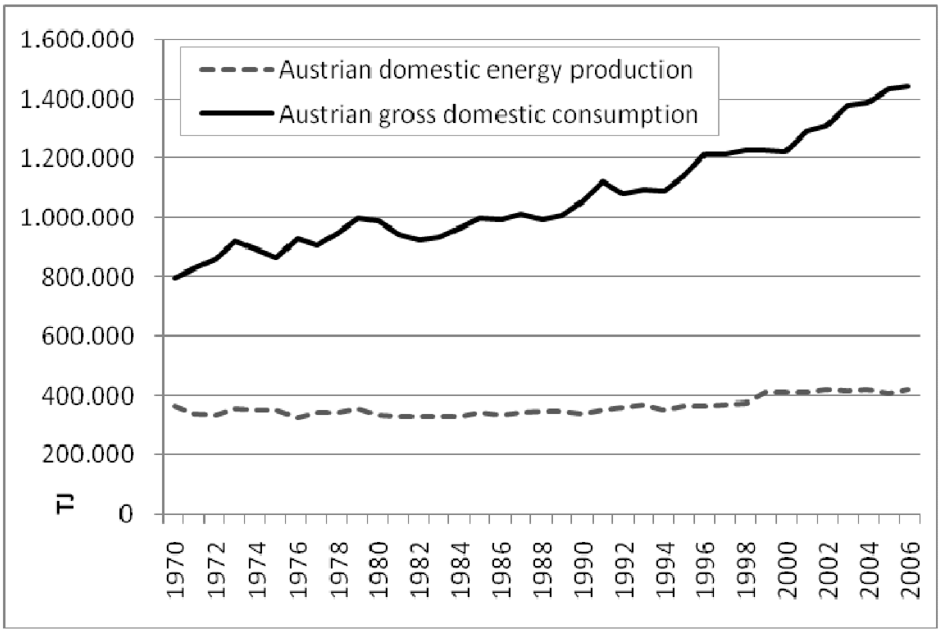

Fig. 2: Gross domestic primary energy consumption and domestic energy production of Austria between 1970 and 2006. Data source: Statistics Austria, Energy balance

Despite this significant increase of total energy consumption, Austrian energy intensity (GDP/gross domestic consumption) decreased by 4% during these decades. Nevertheless, this decrease could mainly be observed during the 1070s and 80s. If looking at a more recent time period, the picture changes: Energy intensity increased

[9]http://www.statistik-austria.at/web_en/statistics/energy_environment/energy/energy_balances/index.html

significantly in the period between 2001 and 2005 and even reached the highest value since 1991 in 2005 (Sattler et al. 2008).

The most energy intensive sectors in Austria are transport (31% of total final energy use in 2006), production (29%) – closely followed by private households, which use 25% of total final energy. Energy use by the service sector is continuously growing, whereas agriculture remains at relatively low level (Fig. 3).

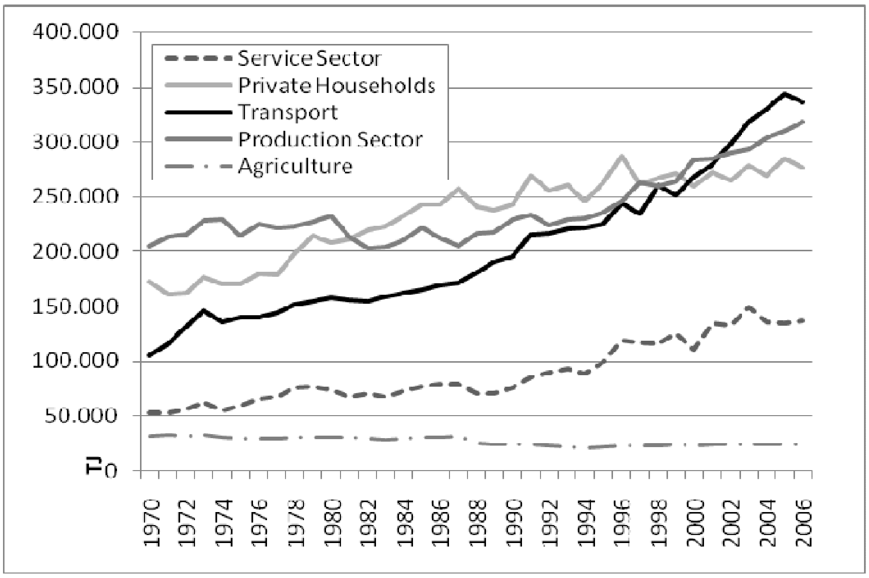

Fig. 3. Sectoral final energy consumption in Austria. The ups and downs of the private households are due to temperature differences in winters. Fig. 4 shows the same data for a shorter period and temperature adjusted. Data source: Statistics Austria, Energy balance

Figure 4 shows the development of the final energy consumption of private households (temperature adjusted for space heating/cooling).

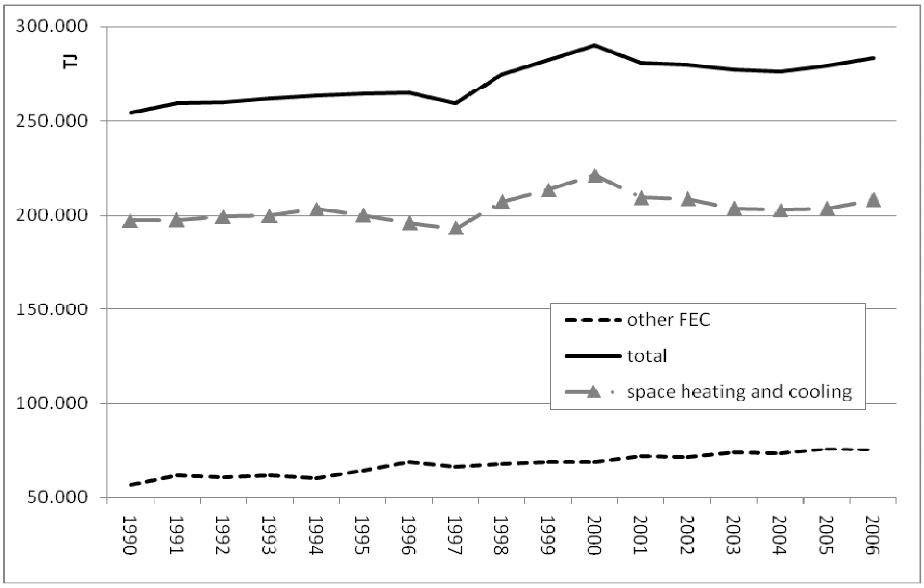

Fig. 4: Final energy consumption (FEC) of Austrian households without traction in TJ. (temperature adjusted); Data source: Statistics Austria, Energy balance

The increase in final energy consumption for space heating and air conditioning from 1990-2006 (5.5% when adjusted for temperature) is primarily due to the increase in the number of households (+21%) and an increase in the average floor space of dwellings (+16.5%). There was a significant decrease in the heating intensity of households (-25.1%) from 1990 to 2006 (related to the total floor space of main residences). This means an annual efficiency gain of 1.8% over the period under consideration (Statistics Austria[10]).

However, the remaining final energy consumption of households (excluding heating and traction) considerably increased (33%) from 1990 to 2006. This led to a growth of 23% of total energy intensity, i.e. energy efficiency deteriorated significantly in this area.

Fig. 5 gives an impression of different energy uses in Austrian households (without traction). Heating accounts for almost 80% of the total energy demand. The remaining energy demand mainly results from hot water, electrical appliances, lighting, information and telecommunication (ITC) and cooking.

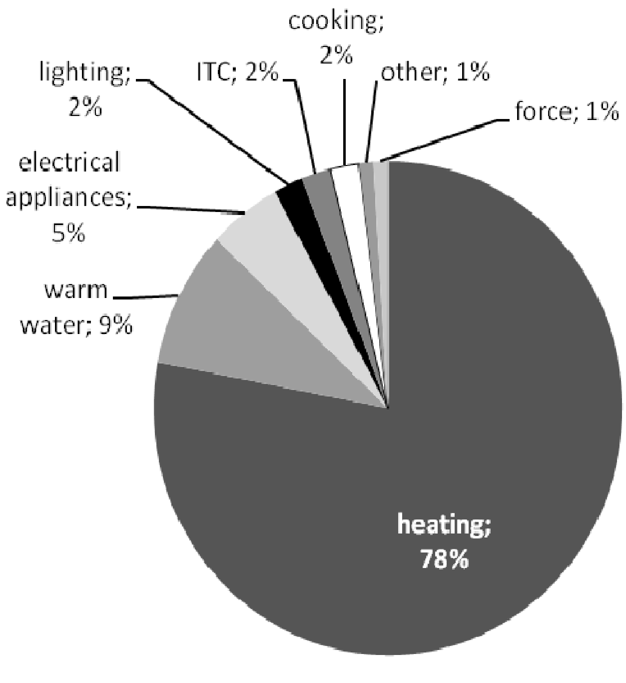

Fig. 5: Total final energy demand in private households per user categories. Source: prognos, 2005

10 http://www.statistik.at/web_en/statistics/energy_environment/energy/energy_efficiency_indicators/index.html

As already mentioned above, the total energy demand for space heating mainly increased due to changed living conditions of Austrians. In 1951 the average household size was 3.11 persons; in 2007 it was 2.32 persons (Statistics Austria, census data[11]). This development towards smaller household sizes (with a slightly increasing population) is directly connected to an increasing number of households and accordingly higher energy consumption. Heating demand remains more or less the same – no matter how many persons live in an apartment, and also electricity need per capita is higher the fewer persons live in an apartment (see figure 6).

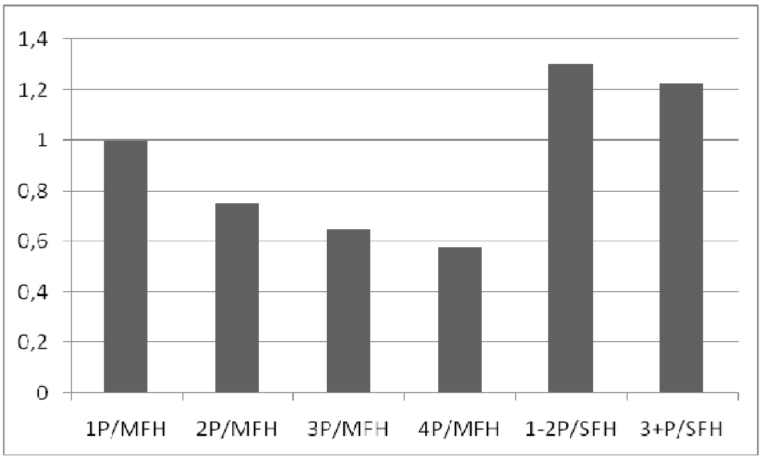

Fig. 6: Relative electricity need/person depending on living form (MFH: apartment in multifamily house, SFH: single family house, P: person(s); Source: after Brauner (2006)

Although the technical efficiency of electrical household appliances could be raised dramatically during the last decades (see e.g. Fig. 7), this was over-compensated by an increasing number of electrical appliances (Tab. 1) per household. Moreover, the above mentioned fact of increasing numbers of households, also contributes to an increase in electricity demand, as more households need more electrical appliances.

[11] http://www.statistik-austria.at/web_de/static/ergebnisse_im_ueberblick_023086.pdf

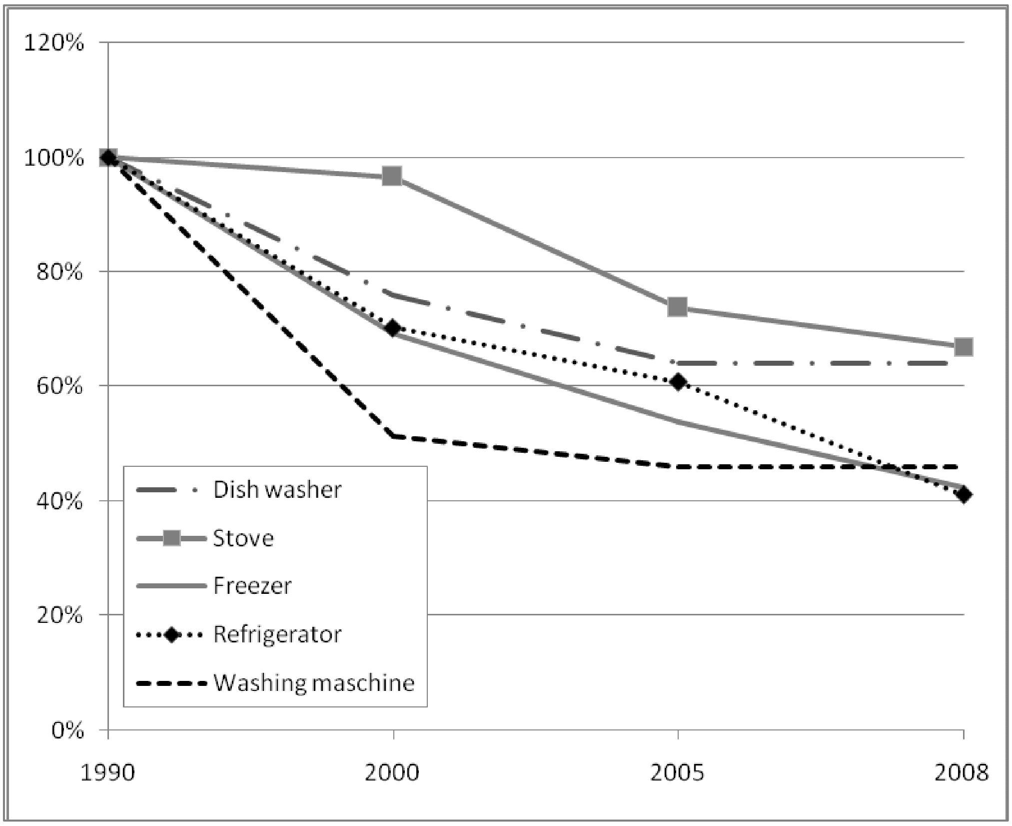

Fig.7: Efficiency gains of different electrical household appliances between 1990 and 2008. Data source: Forum Haushaltgeräte 2008

Tab. 1: Multiplication rate of selected private energy consuming consumer goods; *: between 1993 and 1999; ** between 1989 and 1999; Based on data from Statistics Austria[12]

Consumer product	multiplication rate between 1989-1999/2000
Mobile Phone*	15.00
PC	6.67
Video camera	3.40
Internet**	3.20
Cloth dryer	3.14
Video recorder	2.16
cable TV	2.16
Motorbike	2.00
season ticket for public transport	2.00
Dish washer	1.96
Satellite antenna	1.82
Hi-fi system	1.53
Freezing appliance	1.22
car	1.19
Washing machine	1.12
Electric kitchen stove	1.12

[12] Ausstattung der privaten Haushalte: http://www.statistik-austria.at/web_de/static/ergebnisse_im_ueberblick_021850.xls

3 Energy Conservation and Energy Efficiency

The reduction of total energy demand is a central element of scenarios that aim at a sustainable energy system, based mainly on renewable sources (e.g. Schweighofer et al. 2008, Stocker et al., 2008, Österreichischer Biomasseverband[13]).

Brauner (2006) e.g. showed how the reduction of energy demand correlates to the provision of green electricity: If Austria manages to use 1% less energy (electricity) per year, then existing hydro power will be sufficient from 2030 on. If our demand remains at the current (2006) level, a 10% increase of hydro, wind, biomass and solar energy would be needed. With an increase of 2% the share of hydropower will fall from currently 70% to 44%. 66% would have to be provided from thermal power stations or new renewables.

The main political approach towards reducing energy consumption is to increase the ***technical efficiency*** of energy use. The European Directive 2005/32/EC on establishing a framework for the setting of eco-design requirements for energy-using products, Directive 2006/32/EC on energy end-use efficiency and energy services or Directive 2002/91/EC on the Energy Performance of Buildings are examples for the European approaches to tackle this issue. European prime ministers at the spring summit 2007 in Lisbon agreed to aim at a reduction of the energy consumption by 20% until 2020. The according "Action Plan for Energy Efficiency: Realising the Potential" (COM(2006)545) stresses the cost-effective savings potential of residential buildings, with a full potential of around 27% of energy use (30% for commercial buildings).

Under the above mentioned EU energy efficiency directive (2006/32/EC), Austria is obliged to make savings amounting to 80.4 PJ in 2016, to be reached by way of energy services and other energy efficiency measures. This figure corresponds to 9% of the annual average amount of final energy consumption for 2001-2005 (excluding emissions trading companies and the federal armed forces).

[13] 34 Prozent Erneuerbare machbar. [34% renewables feasible]. Ökoenergie 71a.

Austria's contractual obligation to reduce its greenhouse gas emissions by 13% relative to the 1990 level by 208-2012 (Kyoto objective) constitutes an additional reason for using energy as efficiently as possible.

Nevertheless, increasing the technical efficiency of energy use does not mean a total reduction of energy consumption (i.e. energy conservation), as it always induces some kind of ***rebound effect*** – be it a direct rebound that more energy is used because the level of energy services is increased in parallel or be it an indirect rebound effect (i.e. energy efficiency leads to economic growth, as saved money is used for other consumptions which also need energy in order to be provided/produced). Rebound can arise mainly due to three reasons: more of the same (e.g. two fridges instead of one); increase of comfort and quality (e.g. higher heating temperature after insulation) or the market entry of marginal consumers (those who could not afford so far). Haas (2000) e.g. estimates that rebound effects reduce the energy saving potential for space heating in Austria for about 30%, as changing behaviour makes large part of the technical energy saving potential obsolete.

The above discussed fact that energy consumption of private households increased during the last decades despite the increase of energy efficiency, clearly shows the limitations of approaches that aim at a higher technical energy efficiency. Structural and behavioural factors foiled these gains (see chapter 2). Boardman (2004) concludes that "policy and the emphasis on efficiency rather than conservation is facilitating the development of larger appliances, cars and houses" and thus curbs the demand of energy. Increasing the price of energy (e.g. by taxes) in order to keep the price of the energy service the same while increasing energy efficiency or emission limits are two political approaches that might help to keep the rebound effect low.

Besides increasing the technical energy efficiency, there is also the possibility to influence the ***energy behaviour*** of private households. When asked, in which area they see the highest need for action and the highest potential in order to change the Austrian energy system, the stakeholders at the e-co workshop evaluated behavioural changes as most important, followed by technical energy efficiency and renewable energies (see Fig. 8a and 8b).

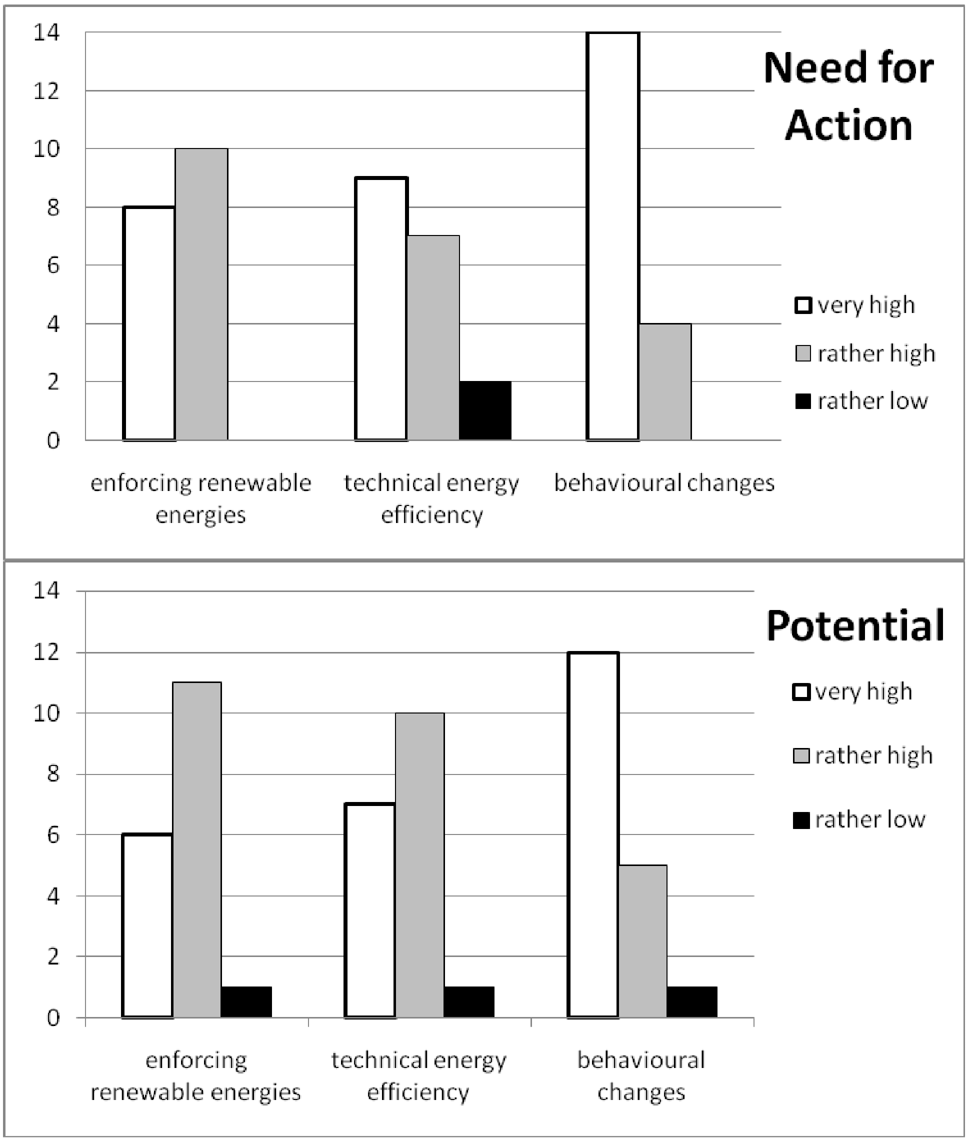

Fig. 8 a and b: Stakeholder evaluation of "need for action" and "potential" in regard to the three areas of action: renewables, efficiency and behaviour. "Very low" was selected by none of the stakeholders.

The stakeholders agreed to a very high extent to statements that stressed necessary contributions of households to reach a sustainable energy system (see statement 1,2,3 in Table 2). They are also convinced to a large extent that measures for thermal insulation and the technical efficiency of household appliances are insufficient to reduce the energy demand of households to a sustainable level (see statement 4).

Tab. 2: Stakeholder evaluation of statements regarding households' energy behaviour.

statement to be evaluated	agree	rather agree	rather disagree	disagree
1. Energy behaviour must change. A more conscious use of energy is a prerequisite for a transition of the energy system towards sustainability.	17	1	1	0
2. Households must be animated to reduce their direct energy demand.	15	4	0	0
3. Households must be animated to reduce their indirect energy demand.	13	6	0	0
4. Thermal insulation and a consequent improvement of the technical efficiency of household appliances are sufficient, to reduce the energy demand of households to a sustainable level.	0	4	11	4

Also the work of Weber et al. (2000) shows that „reflective consumption", which includes behavioural changes, has the most positive impacts (if nuclear energy is not accepted) on CO_2-emissions, energy demand and household expenditures.

But technical efficiency is by far easier to aim for than trying to influence energy behaviour – and structural factors (trend towards larger houses, smaller households, etc.) also can be seen as behavioural or lifestyle aspects. Poortinga et al. (2003) invested the acceptability of different measures. They found out that behavioural measures aimed at reducing direct energy use were more acceptable to respondents with a low income and to respondents with a low level of education – maybe because these are generally cost saving.

Limiting the size of living areas, influencing the type of building (single vs. multi-family houses), regulating the heating temperature, etc. are issues that are difficult to tackle politically. And even if it is decided to tackle the energy behaviour there are various aspects that inhibit behavioural changes of private households. This will be discussed in chapter 6.

Besides these constraints at the household level, energy efficiency is also a ***difficult topic for policy makers***. As already mentioned above, influencing the people's behaviour and wants, is politically difficult – especially if it comes to influencing life-style aspects such as living in the a single-family house with a garden, buying modern appliances, heating at a "comfortable" temperature, etc. Also measures to increase technical efficiency are more difficult to sell politically than measures to increase the share of renewable energy, as Negawatts[14] are difficult to show and a building with a very good thermal insulation does not look very different than one with a minimal one. Other hindering factors are the complexity of political responsibilities in regard to energy efficiency issues, deficiencies in education and training of multipliers as well as the fact that knowledge about energy efficiency becomes obsolete quite fast (Duscha, 2008).

[14] Negawatts are watts that have not been used (saved).

4 Potentials of Changes in Energy Behaviour

The aim of this chapter is to demonstrate that energy behaviour in regard to heating, hot water use, and the usage of electrical appliances significantly influences the level of private energy use. As a detailed analysis for all kinds of private energy use would exceed the scope of this master thesis, a simplified approach was chosen and applied using data from literature.

4.1 Approach and Method

In order to make different behavioural aspects as descriptive as possible, three model households were developed: average, conservers, and squanderers. Quantitative assumptions were made in order to calculate their energy demand. If available, Austrian data was used. If no Austrian data was found, German literature was consulted. The assumptions were cross-checked with Michael Hannesschläger and Armin Knotzer, both energy consultants.

As **heating** accounts for approximately three quarters of households’ final energy demand, the influence of behaviour on heating demand was looked at most detailed. Theoretical heating demand was calculated for three different model-families following a bottom-up approach. The technical assumptions (size, type, location of apartment, windows and walls) were assumed the same for all three types (Tab. 3).

Tab. 3: Assumptions on model apartment

width	8.0 m	**windows**	
length	12.5 m	size	1.7 m^2
height	3.5 m	number towards south	4
length north – towards outside	11.0 m	number towards north	3
length north – towards hallway	1.5 m	number towards east	0
gross floor area	100 m^2	number towards west	1
volume	350 m^3		

The ceiling and the roof were not considered, as it was assumed that the apartment lies between two other heated apartments.

Basic calculations assumed for all three households that they live in a not well insulated flat (post-war standard) with double-windows (box-type). In order to demonstrate the effects of insulation, the same calculations were performed including modern windows and a thermal insulation to low energy standard.

Behavioural aspects are assumed different for each household-type regarding
a) heating habits (set temperature, temporal and spatial temperature reduction) and
b) ventilation habits.

Two studies of the German Institut Wohnen und Umwelt GmbH (IWU, 2001 and 2003) served as main reference, as they comprise methodological issues and data on differentiating conserving, average and squandering behaviour.

In order to determine energy demand for **hot water** provision, assumptions on hot water demand were made on a per capita basis taking into account different behaviours (showering vs. taking a bath, other hot water uses).

Electricity consumption was determined in a top-down approach, based on data found in literature on high/low electricity need of households and different influencing factors, but not starting from single appliances and user patterns.

The book “Strom sparen im Haushalt” [Saving electricity in households] edited by Corinna Fischer and the study of Barbara Schlomann (2004) on energy demand of German private households and of the sector trade and services, served as main references for hot water and electricity.

In order to provide a comprehensive view on private direct energy use, energy demand for **individual mobility** has to be taken into account. Mobility accounts for 45% of energy demand in households with car, and only for 15% in households without car (Rauh et al., 2006). Thus driving a car causes a large share of private energy consumption. Nevertheless, it is difficult to add this form of energy consumption to other forms of energy uses in private households, as it is driven by different structural and behavioural conditions. For this reason it was decided to exclude direct energy demand for mobility.

Box 2 summarizes used variables and their abbreviations.

Box. 2: Variables

A_g = glass area of windows [m^2]
A_i = area of wall or window [m^2]
c_{air} = specific heat capacity of air [Wh/m^3K]
f_i = correction factor for walls towards unheated hallway with contact to outside air [-]
f_s = shading factor [-]
ft= temporal reduction factor [-]
fsp= spatial reduction factor [-]
g = solar gains factor [-]
hGFA = heated gross floor area [m^2]
HD = heating days [d]
HDD = heating degree days [Kd]
I_i = irradiation factor for south, east/west, north [kWh/m^2a]
L_T = transmission conductivity [W/K]
n = air exchange rate [1/h]
Q = heating demand [kWh/m^2a]
Q_I = internal gains [kWh/m^2a]
Q_S = solar gains [kWh/m^2s]
Q_T = transmission losses [kWh/m^2a]
Q_V = losses due to ventilation [kWh/m^2a]
$\dot{q}_i$ = mean heat flow density of inner gains [W/m^2]
U_i = thermal resistance, U-value for walls / windows [W/m^2K]
V_{net} = net volume of the apartment [m^3]
η = efficiency factor of inner and solar gains [-]
ρ_{air} = air density [kg/m^3]
$\overline{\vartheta e}$ = mean outer temperature during heating period [°C]
$\overline{\vartheta_i}$ = mean inner temperature during heating period [°C]

4.2 Calculations and Input Data

HEATING

Heating demand was calculated as the sum of transmission losses (Q_T), ventilation losses (Q_V), minus inner (Q_I) and solar gains (Q_S).

$$Q = Q_T + Q_V - Q_I - Q_S$$

Transmission losses were determined according to:

$$Q_T = L_T \cdot HDD \cdot f_t \cdot f_{sp} \cdot 0.024$$

The *transmission conductivity ($L_T = \Sigma(A_i \cdot U_i \cdot f_i)$)* was calculated separately for the walls towards north, south, east/west and the windows, differentiated according to U-values (walls, complete windows). A correction factor was applied for the part of the north wall leading towards the hallway (unheated room with contact to outside air). The ceiling and the roof were not considered; as it was assumed that the apartment lies between two other heated apartments (see Table 4). Transmission conductivity was also calculated for an apartment with optimal thermal insulation and modern windows (Table 5).

Tab. 4: Assumptions and results for the calculation of transmission conductivity in badly insulated flat				
	[m²]	[W/m²K]	[-]	[W/K]
	A_{walls}	U_{walls}	f_i	Lt
Walls S - outdoor	36.95	1.38	1	50.991
Walls N - outdoor	33.4	1.38	1	46.092
Walls N - hallway	5.25	1.38	0.5	3.6225
Walls W - outdoor	26.3	1.38	1	36.294
L_T walls				**137.00**
	[m²]	[W/m²K]		[W/K]
	A_{window}	U_{window}		Lt
Windows S	6.8	2.7		18.36
Windows W	1.7	2.7		4.59
Windows N	5.1	2.7		13.77
L_T windows				**36.72**
Total transmission conductivity (L_T total)				**173.72**

Tab. 5: Assumptions and results for the calculation of transmission conductivity in well insulated flat				
	[m²]	[W/m²K]	[-]	[W/K]
	A_{walls}	U_{walls}	f	L_t
Walls S - outdoor	36.95	0.2	1	7.39
Walls N - outdoor	33.4	0.2	1	6.68
Walls N - hallway	5.25	1.38	0.5	3.62
Walls W - outdoor	26.3	0.2	1	5.26
L_T walls				**22.95**
	[m²]	[W/m²K]		[W/K]
	A_{window}	U_{window}		L_t
Windows S	6.8	1.2		8.16
Windows W	1.7	1.2		2.04
Windows N	5.1	1.2		6.12
L_T windows				**16.32**
Total transmission conductivity (L_T total)				**39.27**

Heating degree days (HDD):

As the assumptions for the insulation standard of the building where the same for all three model families, the heating degree days (HDD) are a main variable that influences the transmission losses $Q_{T.}$ The number of HDD depends on the inner temperature during the heating period, the length of the heating period (HD) and the mean outside temperature during the heating period.

The number of heating degree days is usually given for a standardized room temperature of 20°C and a marginal heating temperature of 12°C. When higher room temperatures are chosen, the number of heating (degree) days increases. Auer (1989) provides numbers of heating degree days for different room temperatures with a marginal heating temperature of 12°C (see Table 6). The HDD days vary +/- 11% with +/- 2°C as room temperature. When higher room temperatures are chosen, usually also the marginal heating temperature is higher, as people start to heat earlier. Unfortunately no according data is included in Auer for Vienna. But data for Linz and Wels was provided by Klaus Reingruber from Blue Sky Wetteranalysen in Gmunden. With marginal heating temperatures of 12°C for the conserver, 14°C for the average and 24°C for the squanderer, the HDD days for these places vary by -17% to +19%. The assumptions on HDD are thus rather conservative.

Table 6 indicates the assumptions on room temperatures in order to reflect the different heating habits of the model households.

Tab. 6: Assumptions and results for transmission losses; basis: Vienna inner city (Schottenstift), Source: Auer, 1989

Climate assumptions/data	**average**	**conserver**	**squanderer**
room temperature [°C]	22	20	24
marginal heating temperature [°C]	12		
heating degree days (HDD) [d]	3,464	3,073	3,854
Behavioural reduction factors			
factor for temporal reduction (f_t) [-]	0.92	0.79	1
factor for spatial reduction (f_{sp}) [-]	0.93	0.84	0.99
transmission losses [kWh/a]			
old building	**12,357**	**8,502**	**15,908**
insulated building	**2,793**	**1,922**	**3,596**

Temporal and spatial reduction (ft and fsp):

Furthermore differences in temporal and spatial temperature reduction influence the heating demand. This was reflected by two further correction factors according to IWU, 2001 (data for badly insulated houses). Regarding temporal reduction (f_t), it was assumed for average households that the temperature is reduced during nights, for conservers’ household it is assumed that it is reduced during nights and weekends (Tab. 6).

Ventilation losses (Q_V) is differentiated according to the ventilation habits of the model households, as

$$Q_V = V_{net} \cdot n \cdot c_{\rho,air} \cdot HDD \cdot 0.024$$

These differences were incorporated through a variation of the air exchange rate (n). The average was chosen according to the Austrian (ÖIB, 2003, p.10), squanderer’s behaviour was introduced according to the data in IWU, 2003, p.39 for squandering households. The air exchange rate for the conserving household was assumed the same as for the average, as IWU (2003) admits that 0.3 is actually too low and can lead to humidity problems. Differences in ventilation losses between the average and the conserver household thus result only from differences in heating degree days (HDD).

Table 7: Assumption and results for the calculation of ventilation losses

Variable	***average***	***conserver***	***squanderer***
n Air exchange rate [1/h]	0.4	0.4	1
V_{net} (75%) [m^3]	262.5		
$c_{\rho,air}$ [Wh/(m^3K)] - standardized	0.34		
L_V [W/K]	35.7	35.7	89.25
ventilation losses [kWh/a]	**2,968**	**2,633**	**8,255**

Inner gains were calculated as $Q_I = \dot{q}_i \cdot hGFA \cdot HD \cdot 0.024 \cdot \eta$

The mean heat flow density of inner gains (q_i) is the same for all three model households (3.2 for multi-family houses according to IWU, 2003). Variations imply for the heated gross floor area (hGFA): It was assumed that in average 75% of the gross area is heated, squandering behaviour means 91% heated, and with saving behaviour only 59% of the area is heated (according to IWU, 2001, p.36). As no data was found to reflect the correlation between different heating behaviour and differences in heating days (HD), the same figure for heating days (195 according to Auer, 1989) was used for all three household models.

Table 8: Assumption and results for the calculation of inner gains			
Variable	**average**	**conserver**	**squanderer**
mean heat flow density [W/m^2]	3.2		
heated gross floor area [m^2]	75	59	91
heating days [d/a]	195	195	195
inner gains (Qi) [kWh/a]	**1,123**	**884**	**1,363**

Solar gains ($Q_S = \Sigma(A_g \cdot g \cdot f_s \cdot I_i) \cdot \eta$) were calculated separately for the windows of the orientations south, north, east. Two variables influenced the final outcome:

The shading factor (f_s) of 0.75 (= for double glaze windows) was lowered for the squandering lifestyle to 0.46, which corresponds to the shading factor of windows with net curtains during days[15].

As the heating period of the average/saving household is limited to the fewer (colder) days of the year, their solar input is lower than for the squandering household. The irradiation factor (I_i) for the average household was taken from the climate sheet of ÖIB, 2003. The irradiation factors for the other households where estimated, according to the irradiation factors given for different marginal heating temperatures in IWU, 2003.

Table 9: Assumption and results for the calculation of solar gains			
Variable	***average***	***conserver***	***squanderer***
A_g - south [m^2]	4.42		
A_g - west/east [m^2]	1.105		
A_g - north [m^2]	3.315		
solar gain factor (g) [-]	0.82		
shading factor (f_s) [-]	0.75	0.75	0.46
I south [kWh/m^2a]	351	250	500
I west/east [kWh/m^2a]	211	130	330
I north [kWh/m^2a]	144	90	220
efficiency factor (η)	0.9		
Solar gains Qs [kWh/a]	**1,252**	**856**	**1,122**

[15] see Levolux, download from:
http://www.levolux.com/L_PDF_Files/Lev.%20Comp%20Analysis%20Table.pdf

Table 10 summarizes the transmission losses (Q_T), ventilation losses (Q_V), inner (Q_I) and solar gains (Q_S) and indicates the heating demand of the three model households.

Table 10: Summary of heating demand parameters, results for heating demand			
Variable	***average***	***conserver***	***squanderer***
Qt – baldy insulated	12,357	8,502	15,908
Qt – well insulated	*2,793*	*1,922*	*3,596*
Qv	2,968	2,633	8,255
Qi	1,123	884	1,363
Qs	1,252	856	1,122
heating demand Q [kWh/a] - baldy insulated	**12,950**	**9,395**	**21,679**
heating demand Q [kWh/a] - insulated	**3,386**	**2,815**	**9,367**

HOT WATER

Hot water accounts for about 9% of final energy demand in private households (Prognos, 2007). It is mainly used for personal hygiene and cleaning. Hot water in private households can be provided by different technologies, energy sources and separated or linked to heat provision: electricity (directly via heat pump), solarthermal energy, gas, oil, biomass, etc. As behavioural aspects are the focus of this master thesis, assumptions were made about the volume of hot water needed in different households.

Hot water demand in households strongly depends on the question, whether showering or bathing are preferred by the people. Short showers use by far less water than full baths. Schlomann (2004) analysed hot water demand for showering and bathing in the German population and shows weekly hot water need of the average German household, the lowest 10 and 25 percentiles (savers) and the highest 25 and 10 percentiles (squanderers) – see Fig. 9.

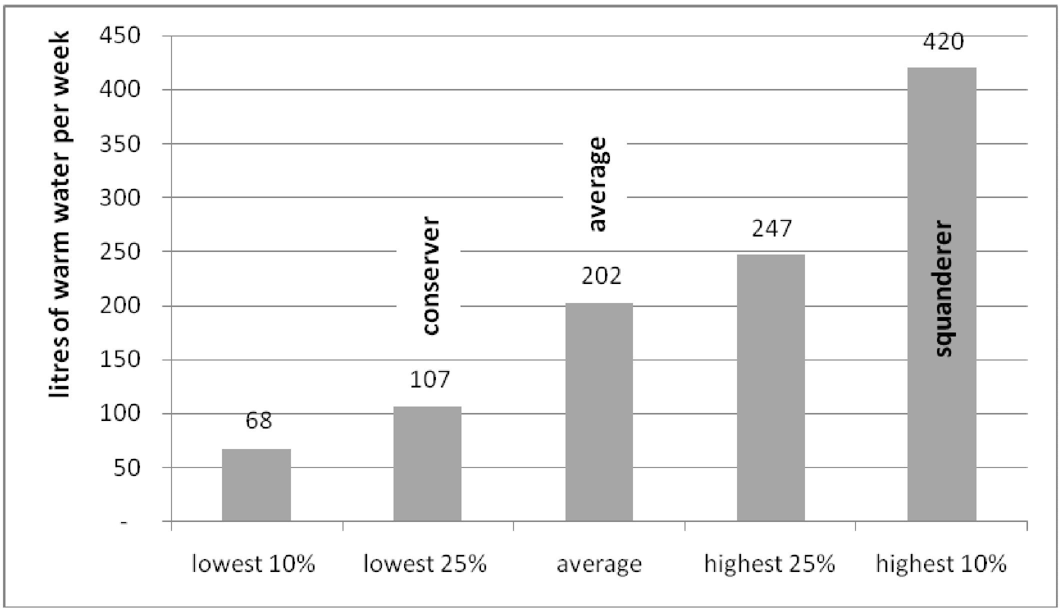

Fig. 9: Hot water demand for bathing and showering per person and week of German households. Divided in percentiles of the German population; conserver, average and squanderer indicates, which figures where used to describe different lifestyles; after Schlomann, 2004

When comparing these numbers to figures given in the literature and internet for average full baths and showers, a demand of 420 litres per person and week is reasonable for squandering behaviour, as it equals approximately two full baths and five showers. The lower percentiles though seem very low, as the hot water demand for showering is indicated between 75 litres[16] and 35 litres[17]. The lowest percentile thus comes up to only 8 min of showering per week using a flow restrictor – a number which seems very low and not desirable to be generalized. Thus, the number for the highest 10% percent was used for the squandering household, the average for the average household, and the lowest 25% percents for the conservers' behaviour – also indicated in Fig. 9.

Besides showering and bathing, possible demand for hot water also arises for personal hygiene excluding bathing and showering (hand washing) and cleaning. Buschatz et al. (2004) gives numbers of average demand per person and day for different categories, where dishwashing (3 l/person and day), room cleaning (3 l/person and day), and personal hygiene (without showering and bathing: 10 l / person and day) usually need hot water. These numbers were taken as the basis for

[16] Buschatz et al. (2004) for a luxurious shower

[17] www.wienenergie.at with flow limiter; or according to http://ooe.orf.at for a 4 min shower using a flow limiter; 40 l in Buschatz et al. (2004) for average shower);

the average households. For the squandering household the figures were increased by 2/3, the saver household was assumed to use half the amount of hot water for dish washing, and no further hot water for personal hygiene (using cold water).

In order to make the figures of hot water demand per person and those per household (Schlomann, 2004) comparable, a household of three persons was assumed. In total this approach summed up to 45 litres of hot water use per person and day for the average household, 20 litres for the saver family, and 80 litres for the squanderers. These numbers fit well to figures given in the literature[18] and were also confirmed by the consulted energy experts.

The demand of hot water was allocated to the according energy demand, following the conversion factor of 0.04 kWh/l used in the handbook for energy consultants (Joanneum, 1994), which corresponds to the energy that is needed to heat one litre of water by about 34°C[19]. The factual energy demand of course depends on the technology used. Table 11 shows the results for energy use for hot water for different time periods.

Table 11: Assumptions on energy demand for hot water preparation [kWh]

energy demand for hot water [kWh]	***average***	***conserver***	***squanderer***
per person and day	1.8	0.8	3.2
per person and year	657	292	1,168
per 3-person household and year	1,971	876	3,504

ELECTRICITY

Austrian households consumed 51.9 PJ (i.e. 14.4 TWh) electricity in 2004, i.e. an average of 15.15 GJ (i.e. 4200 kWh) per household (Statistics Austria, Energy Statistics[20]). In total 199 PJ electricity were used in Austria in 2004, thus about one quarter can be attributed to private households.

Electricity is used in private households for lighting, electrical appliances, (partly) cooking, ITC and (partly) hot water preparation. Behavioural differences can reach

[18] Buschatz e.g. states 30-40 (35-65 for single family households); Joanneum (1994) states 50 , 25, 75 as medium, low and high demand of hot water in households (Datenblatt 8); www.energiesparhaus.at lists 50 as normal, 25 as saving, 75-90 as squandering [all numbers in the footnote as litres of hot water/person and day];

[19] Based on the energy demand of 4,2 kJ to heat one kg of water by 1°C.

[20] http://www.statistik.at/web_de/static/gesamteinsatz_aller_energietraeger_2004_022680.pdf

from using the dishwasher/washing machine (not) fully loaded and/or at lower/higher temperature, (not) using/having a cloths drier, changing of light bulbs to energy-efficient lamps, leave the lights on in unoccupied rooms, (not) leaving appliances on stand-by, etc. Of course also the decision for or against appliances of high energy-efficiency plays an important role.

There is a high correlation between the number of appliances and the demand of electricity (Gruber and Schlomann, 2008) – thus the best way to save energy probably is to buy a minimum number of electrical appliances (see Fig. 10).

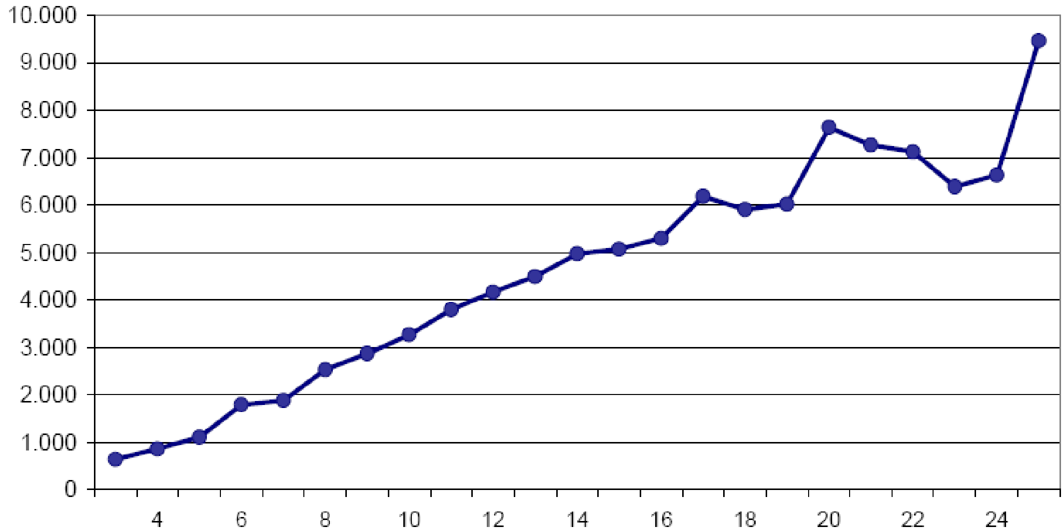

Fig. 10: Correlation between appliances ownership and electricity demand of households. vertical axis: kWh/year, horizontal axis: number of appliances; Source: Schlomann, 2004

The main influencing factors for electricity consumption in private households are hot water preparation, cloth driers, refrigerators and freezers, and aquariums, followed by air conditioning units, and electric kitchen stoves. (Gruber and Schlomann, 2008, Fig. 2.8). For Germany the economically feasible potential of electricity savings in households trough technical efficiency gains is estimated at 19% of the electricity demand in 2001– mainly from refrigerators, lighting, computers and circulation pumps (Duscha, 2006).

In order to achieve reasonable estimates for conserving and squandering behaviour, a data research in literature was performed. Moreover the estimations were checked with energy experts. Schlomann (2004) performed a very detailed analysis of influence factors on private electricity demand for Germany. She gives numbers for average single/multi-family houses and also analysed the influence of income and extraordinary technical equipments, such as air conditioner, aquariums, etc. (Schlomann, 2004, p. 76).

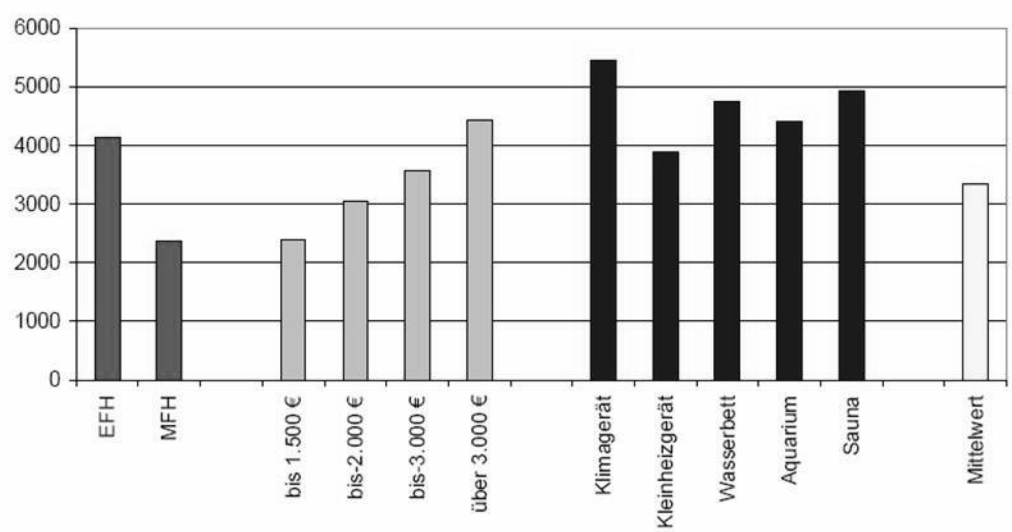

Fig. 11: Influencing factors on electricity demand: mean electricity consumption of building type, income, extraordinary equipment. EFH=single family house, MFH=multi-family house, bis x €=income up to x €; Klimagerät=air conditioning unit; Kleinheizgerät=additional electrical heating unit, Mittelwert=average;vertical axis: kWh/year; Source: Schlomann, 2004

Hofer (2008) uses an average electricity consumption of Austrian private households of 3,000 kWh. This is a little bit below the average of the German households which were included in the analysis of Schlomann (2004). While German households with only six appliances have an average demand of approx. 2,000 kWh, the electricity demand of households with many appliances can reach 7,000 and more kWh. Most households of Schlomann's analysis had about 9-11 appliances.

According to these numbers the following electricity consumption was defined for the three household types (again assuming a three person household) and accorded with the two energy consultants.

Table 12: Assumptions on electricity demand [kWh]			
Electricity	**average**	**conserver**	**squanderer**
per household and year [kWh]	3000	2000	6000

4.3 Results

Fig. 12 sums up the differences of energy demand in correlation to different behaviours. The black columns show the theoretical energy demand for heating, hot water preparation, and electricity of an average Austrian household. Light/dark grey columns show the in- or decreased energy demand for saving or squandering behavioural patterns. Heating accounts for 70-77% of the total energy demand, hot water for 7-11% and electricity for 16-19%. This corresponds well to the results of the Prognos study cited above (Prognos, 2005 in chapter 2). After insulation, energy demand for heating reduces dramatically.

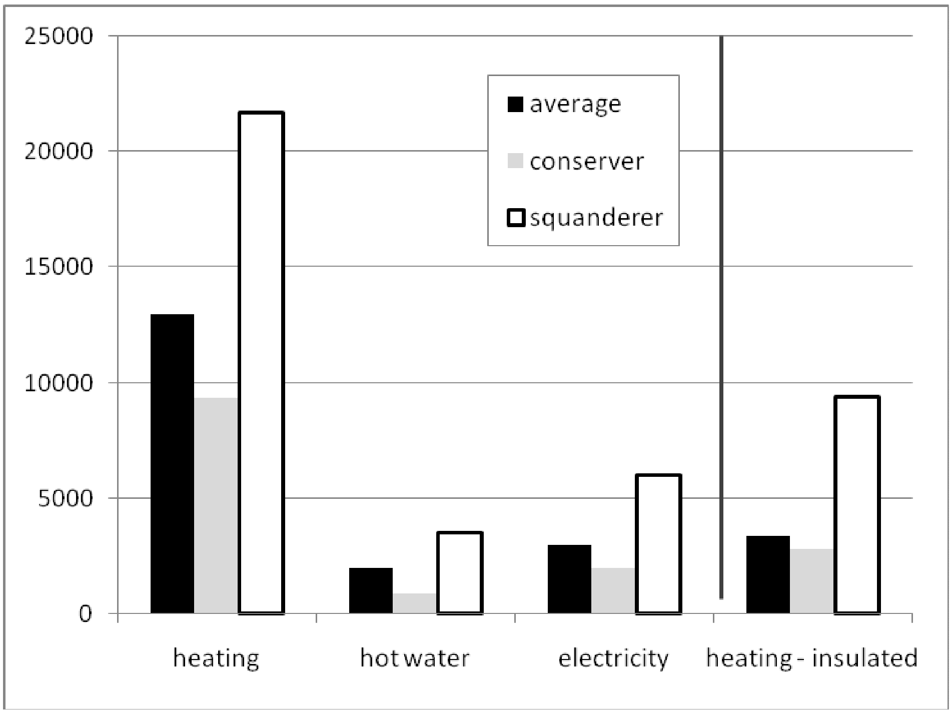

Fig. 12 Energy demand of hypothetical 3-persons households for heating (before and after insulation), hot water preparation, and electricity per year.

In total, the saving behavioural patterns assumed in the demonstration example results in energy savings of ca. 5,700 kWh (i.e. 20 GJ) in comparison to average energy behaviour. In contrast, the assumed squandering behaviour results in ca. 13,260 kWh (i.e. 48 GJ) additional energy demand compared to the average (see Fig. 13). After insulation, the saving potential gets smaller, but still contains a high potential: almost 2,700 kWh (=10 GJ) can be saved in comparison to average energy behaviour, squandering behaviour needs ca 10,500 kWh (=38 GJ) more energy per year.

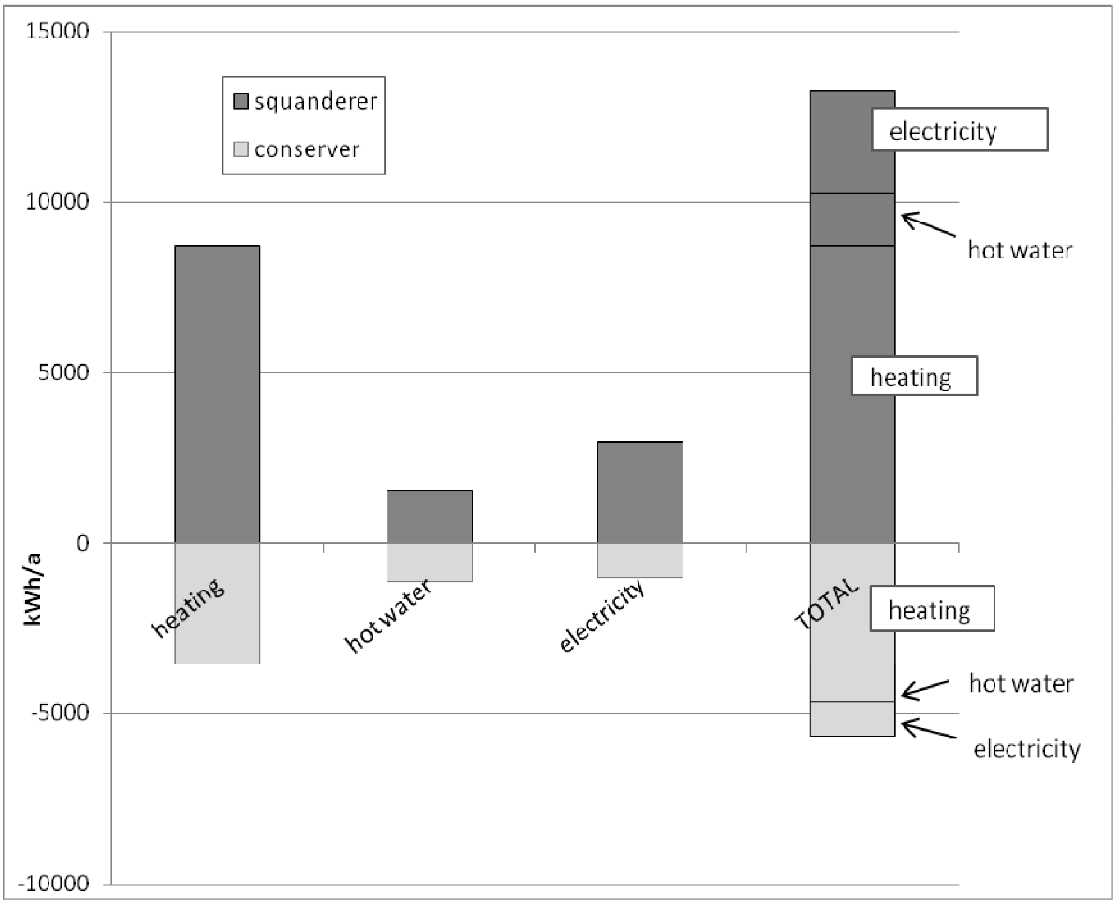

Fig. 13: Differences in energy demand for heating (bad insulation), hot water, electricity, and in total in relation to the average three persons household.

When looking more closely on the theoretical heating demand, the contribution of different behaviour in regard to heating temperatures and ventilation habits can be seen (Fig. 14). In a badly insulated flat, the heating temperature which mainly influences the transmission losses makes the biggest difference, whereas in well insulated buildings the ventilation habits contribute more to the total heating demand.

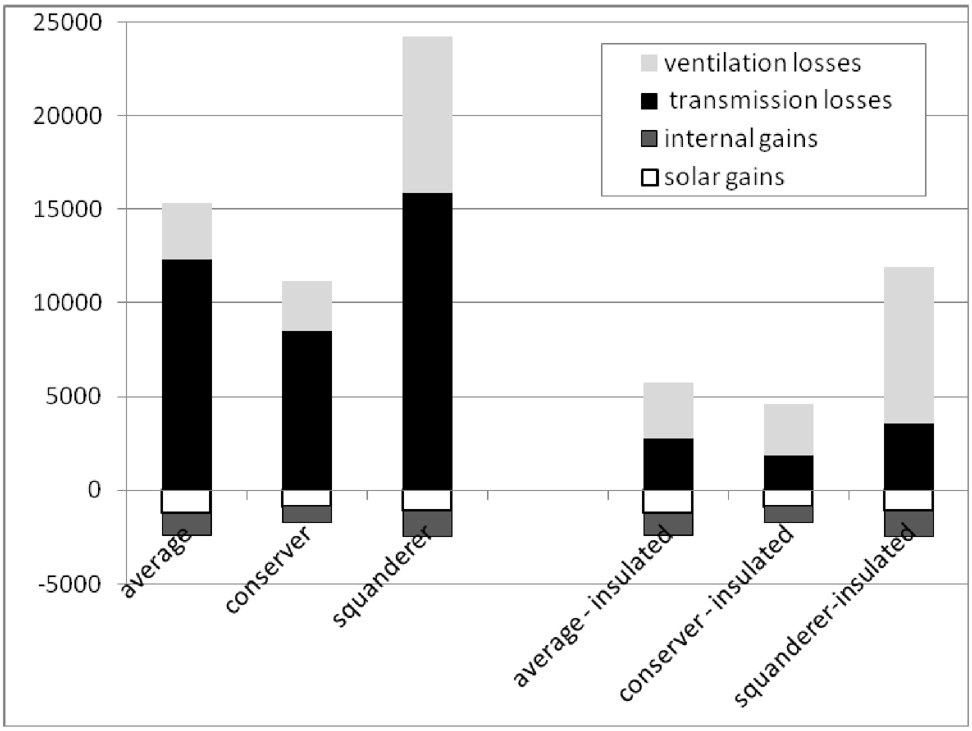

Fig. 14: Contribution of transmission and ventilation losses, solar and internal gains to the theoretical heating demand of the three household types. Gains are on the negative scale, losses on the positive scale, as it refers to resulting heating demand.

Although these numbers only show a very hypothetical situation, they correspond well to the experience of the energy consultants who were asked to cross-check assumptions and results. The results show the impressing potential of energy saving by just a few behavioural changes, such as:

- lowering the room temperature in general by a few degrees Celsius,
- lowering the room temperature during night and in selected rooms (sleeping room, hallway),
- applying better ventilation habits, and
- saving hot water and electricity.

The data on energy consumption of private households do not imply that energy saving behaviour is widely spread. This raises the question of how to make people more conscious on their energy use. Information, though an increasing number of reports on the importance of and possibilities for energy saving in the media and the internet, has so far not proven sufficient to change people’s energy behaviour. The second major impact factor, money, is neither the only important motive for energy conservation (Stern, 1992). In order to really touch people and make them think and act differently, additional ways of communication and interaction have to be found.

In the following, a short introduction on the principal ideas of participation is given, before its possible contributions to change energy behaviour are discussed.

5 Participation

5.1 What, why (not) and how?

Participation means the inclusion of persons in projects or processes who have a stake in the regarding issue – be it because they are affected by decisions taken within the project/process or because they can contribute their knowledge and ideas. Participatory approaches can be applied in very different situations: e.g. in development projects (e.g. when starting a building project), in political decision contexts, conflict situations, scientific projects, etc. (Arbter et al., 2007). People who are included are called stakeholders. They might be experts or scientists, sponsors of projects, political actors who have an interest in the problem, citizens (also called laypersons) or decision makers. When talking about stakeholders in this study, if not otherwise mentioned, I use the term to refer to all of these groups.

Depending on how a participatory process is set up and implemented, different advantages of participation can be realised. The following list gives some arguments why participatory approaches are applied:

- The experiences and knowledge of laypersons and the public can provide additional information that serves to create new ideas for solutions and can provide insight into possible impacts which would have been otherwise neglected;
- Only those who are integrated in the whole process (by stating their preferences and needs, bringing in their knowledge and experiences) will feel bound by and responsible for the agreed actions (increased ownership) and will be willing to accept the results, even though they might have negative impacts and incur unavoidable costs in the transformation phase.
- A careful selection of participants can help to include the knowledge and preferences of those who are usually not heard (poor, marginal groups, women, etc.)
- By integrating stakeholders and citizens, local capacities and abilities are build which might help to manage their own development. Thus participation

enhances civic and social competence and improves political skills and social learning occurs.

- It can increase or build trust in decisions and (political) institutions.
- Mutual understanding and respect between opposing parties is created.

SCOPE AND METHODS OF PARTICIPATORY APPROACHES

Depending on the reasons why to take a participatory approach and on the issue at stake, different methods will be used. It will strongly depend on the actually used methods which of the above mentioned positive effects can be realized. Arnstein (originally 1969) developed a typology of citizen participation, which displays the extent of citizens' power in determining the end product (see Fig. 15). Processes that rather aim at "educating" or "curing" participants are named "manipulation" and "therapy" and are classified as non-participatory. The next steps on the ladder ("information", "consultation" and "placation") allow participants to hear and have a voice, but they still lack power to really decide. The farthest reaching approaches in regard to decision making clout are processes, in which participants are seen as real partners and which gives them full managerial power.

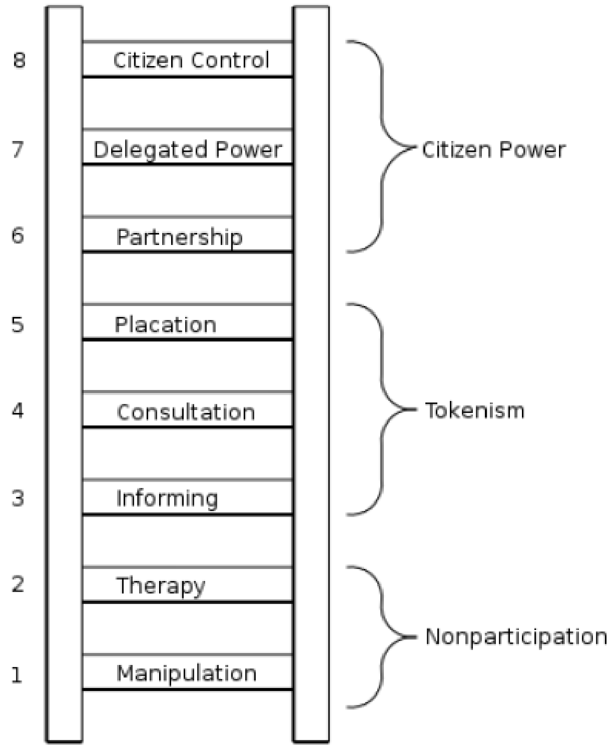

Fig. 15. Eight rungs on the ladder of citizen participation, Source: Arnstein, 1969

Within these degrees it still depends on the persons who are involved (experts, citizens, special interest groups, etc.); and on the number of persons who participate (small group of 5-10 or large groups or all persons of a certain age e.g. in elections) to account for the potential effects. The more far-reaching a chosen approach is in respect to people and methods involved, the more of the above mentioned effects will probably be realized.

Choosing the right scope and method of participation is not an easy task, but it is an important step in order to address the problem at stake in an appropriate way and in order to find applicable and realisable solutions. The choice of the method depends on the problem circumstances at hand, time considerations, available (financial and personal) resources, and the experiences of the stakeholders and of the team, which sets up and carries out the process.

In the following an indicative list of few possible methods is given, as it would exceed the scope of this thesis to give a comprehensive overview of participatory methods (see e.g. www.partizipation.at):

- Public hearing: an open forum, where the public can hear (government) proposals and can state their opinion about them;
- Citizen advisory panel: information and discussion of various aspects of a project in public; citizens' views and suggestions are gathered;
- Surveys collect views about a subject from individual citizens.
- Focus groups: 'Representative' citizens state their view as a proxy for public opinion and discuss a certain topic under the guidance of a trained facilitator. In the end, conclusions are drawn by specialists.
- Citizen jury: A cross-section of people affected (25-250 persons) meet for a few days, leading to a recommendation for decision makers.
- Area/neighbourhood forums: they are concerned with the needs (special question or full range of concerns) of a particular geographically defined area. The membership can be set or open; it is not fixed whether dedicated officers are participating.

Limits and Obstacles

Despite the many advantages of participatory approaches, they are not THE solution to all kind of problems. Methodological and contextual shortcomings can lead to the failure of participatory processes or restrict their positive potential. The Strategic Group on Participation (2004) describes in its Worksheet on Participation No. 3 possible pitfalls of participatory processes. Most of them can be avoided when participation is planned carefully and when participation is only applied in settings in which it is really possible to work in a participatory way. When there is no room for collaborative decision making, participatory approaches should not be applied (see non-participation or (partly) tokenism in Arnstein's ladder above).

It is important to be aware that the inclusion of actors automatically leads to the exclusion of others and thus raises the issue of legitimacy. In citizens' participation the group of people joining is often a small selection consisting of academics and the 'professional citizen' (those who are always there); single parents, workers etc. rarely participate. It is necessary to discuss who shall be included and who can be left out and to keep in mind those excluded. Either it is possible to bring their interests into the discussion at some point or the outcomes of the project have to be interpreted in a manner that reflects the fact that not all interests are taken into account.

Methodological or contextual shortcomings can lead to resistance of groups that do not feel properly involved or to sceptical perceptions of participants – and thus slow or threaten the whole process. The process might be seen as a waste of time, as arguments are not properly taken into account. Thus, participants either do not show up or only complain instead of working in a constructive way.

Participatory processes are very time and money intensive. In order to use resources carefully, such approaches should be planning cautiously, as failing can result in a loss of trust in research and policy making, and less acceptance of the results.

5.2 Examples of Participatory Approaches towards Energy Reduction

In the following examples of participatory approaches in regard to energy awareness and energy consumption of private households are described. It starts with an example of personal energy advice in Austria – which are considered as participatory as the content of the advice is adjusted to the interests of the consumers (tailored information). The other examples stand for more intensive forms of participation. As no such approaches could be found in Austria, these examples have an international background.

The examples were selected in order to represent a wide portfolio of different approaches. An important selection criterion was that quantitative results of energy reductions were available – which is only rarely the case (see chapter 6 "Success

Measurements”). Two of the examples were selected although they did not apply qualitative evaluation: one because it was the only Austrian example (personal energy advice) and SHARE Remscheid, because it applied an especially multifaceted and interesting approach.

The selected cases significantly differ in their scope. The Lummerlund project aimed at a reduction of electricity consumption only, whereas the personal energy advice project of Vienna aims at direct energy consumption of households (electricity and heat). The SHARE project sees energy use in a wider context of social housing, i.e. it includes also energy related aspects like humidity problems. The Dutch examples (Groningen and the Perspective Project) followed the widest approach and aimed at direct and indirect energy consumption. The main sources are given in brackets below the title.

PERSONAL ENERGY ADVICE

[Sources: Interview with Armin Knotzer, Umweltberatung Wien]

The Viennese example represents the only established Austrian instrument to reach citizens regarding energy efficiency. The given information on the Viennese programme mainly derives from an interview with Armin Knotzer, who is responsible for this instrument at the “Umweltberatung Wien” – the organisation that is set in charge by the Viennese government to implement the instrument in Vienna.

Personal energy advisory services in Austria are offered by the provinces (i.e. Bundesländer), energy agencies or the energy supply company. In order to get building subsidies, an energy consultancy by accredited institutions is usually compulsory before building activities. Personal consultation either takes place in the office of the consultant, via telephone or on-site. The costs for consumers are difficult to compare: e.g. in Vienna and Lower Austria a first advice is free of cost. In Vienna this means e-mail or telephone advice, whereas in Lower Austria it already takes place on-site. The Austrian Energy Agency provides an overview of according services[21].

[21] see http://www.eva.ac.at/%28de%29/esf/inhalt.htm

People usually contact the Umweltberatung Wien with specific questions in regard to their personal energy use, e.g. when they get a (too) high invoice for gas or electricity, when they plan to renovate their houses, etc. In the case of Vienna, a first advice via telephone or e-mail is given free of cost, more detailed advice and on-site consultancy is charged for on an hourly basis (55-80 € per hour). Usually it is the owners of single-family houses who contact the Umweltberatung, as the legal situation of decisions is too complicated in multi-family houses.

The expertise of the consultants covers a wide range of topics, covering behavioural and technical aspects of energy use, details energy pass calculations, but also other ecological aspects of building ("Baubiologie") like ecological building materials. The questions of the clients range from very detailed technical issues to general questions on energy issues or the need to complain about something/someone. Within the last years the demand to get advice for building renovation is increases. This trend is positively perceived by A. Knotzer, as new buildings are very strong regulated by existing standards, but "a lot of mistakes can be done when renovating a building". In total, the Umweltberatung Wien does a few hundred energy consultations a year.

The content of each consultancy very much depends on the questions and concerns of the client. Within a standard (comprehensive) on-site consultation, the consultant and the client would walk through/around the house and discuss all issues of energy use and requests of the client (e.g. regarding building materials). Usually different alternatives are offered to the client – regarding insulation, usage of renewable energies, energy efficiency measures, building materials).

According to Armin Knotzer, behavioural aspects are usually those discussed at first hand, as these are usually "most simple to implement as they do not cost anything". He named the issues of switching off the light, reducing temperature (during night), using power strips to avoid stand-by, the right configuration of the thermostats – issues which can also be well observed during the on-site visit. Interestingly, many of their clients are not aware of simple behavioural possibilities to reduce energy consumption, although according articles are issued in newspapers almost every week. They rarely observe unwillingness to implement behavioural advices.

Following these aspects usually the topic of humidity and problems with mould is discussed, as it needs action, followed by insulation, new windows and doors, and technical issues. The latter aspects are those which need financial investment.

Nevertheless, there are some advices which usually provoke objections by the clients – especially if it comes to measures that would change the appearance of the building and which background is difficult to understand. This is especially true for balconies or terraces, which often mean large heat bridges or the avoidance of gazebos. Also, people often decide for cheaper investment options, when alternatives are clearly presented – despite their preceding wish to act ecologically. Follow-up costs are hardly taken into account.

Unfortunately the Umweltberatung Wien does not evaluate the consultations in regard to energy conservation effects due to secrecy obligations and limited time resources. Armin Knotzer though has the impression that the clients are willing to change their behaviour and that they also implement at least some of their proposals (“when we give 5 advices, at least 1-2 are usually implemented”). This feeling is also backed by occasional revisitation of the households.

The Umweltberatung Wien once estimated the CO_2-savings resulting from measures taken due to their energy advice and came up with about 50t per household over a period of 20-30 years.

There is no programme of the Umweltberatung, which addresses people who do not get in contact with them on their own. A former market analysis showed that a maximum of 10-20% of the Viennese population is attracted by the offers of the Umweltberatung – mainly those who already think in a “green” way and those you are in the situation of change (i.e. moving, refurbishing, retiring, etc.).

WEBTOOL - GRONINGEN

[Benders, 2006]

The experiment took place between October 2002 and February 2003 and aimed at reducing direct and indirect energy requirements in participating households. Within the study an internet tool was used to communicate with the participants. The tool consists of a questionnaire measuring the energy requirement at the start of the experiment, information provision on how to reduce energy options, and a feedback section showing the effect of the changed behaviour.

Participants were selected on a voluntary basis: five thousand letters were sent out to a random sample of households in the city of Groningen, finally 347 started the experiment, 190 completed it. The participants were divided randomly into two groups:

- an experimental group that received information about the (personal) energy-saving objective, personalized reduction options, and personalized feedback,
- a control group which received no energy-saving objective, no personalized reduction options during the experiment, and no feedback. They were only asked to fill in two questionnaires regarding energy requirements and changes in appliance ownership.

In order to evaluate the success of the intervention, the energy requirements of the households was calculated based on the people's answers in the questionnaire and previous research. The average savings of total energy came up to 5.1% for total energy, 8.3% for direct energy and 3.8% for indirect energy (experimental group). The control group at the same time increased their average total energy demand by 0.7% (direct energy: +0.4% and indirect energy: +0.3%) Only the result for direct energy proved statistically highly significant. When leaving out the options concerning holidays, also the total energy became significant (due to wide spread in energy requirements for holidays).

Table 13 shows the most successful saving options of the study as well as the average savings due to these behavioural changes.

Table 13: Top 15 of the most successful savings options (out of 75). Source: Benders et al., 2006

Savings options[a]	**Average saving (MJ) per household**	**Standard deviation**
Total	11,950	
Other transport mode during holidays (D, I)[b]	1450	50,980
Less motor fuel due to car change or ownership (D)	1290	11,540
Shorter showering (D)	1250	4040
Room temperature lower during day hours (D)	1250	2570
Less eating of meat (I)	980	1650
Using energy extensive commuter traffic (D, I)[b,c]	780	6000
Room temperature lower during night hours (D)	720	2290
Less food thrown away (I)	620	680
Less frequent shower taking (D)	510	1180
Fewer rooms heated (D)	350	970
Appliances not on stand-by (D)	350	480
Closing inner doors (D)	350	850
Less dryer use (D)	310	1280
Using energy efficient light bulbs (D)	290	460
Sharing the newspaper (I)	253	2400

[a] (D) and (I) behind an option indicate whether this option refers to Direct or Indirect energy reduction.
[b] Energy required for public transport, planes, and touring cars is defined as indirect energy.
[c] The indirect part in driving a car is the energy needed to build and maintain the infrastructure.

Benders et al. (2006) conclude that from a qualitative point of view, the goals concerning the web tool were reached and that the tool is suitable for scaling up to a mass media campaign level. Also indirect energy use was successfully addressed, as four of the 15 top options were indirect energy reduction options.

COMMITMENT AND FEEDBACK - LUMMERLUND

[Source: Mack and Hackmann, 2008]

29 household (families with children) of a "low-energy" residential area were included in this project. The heating demand of the households was relatively low (due to the efficient construction of the houses), but electricity demand was above the German average. The aim of the project was to make people aware of energy-inefficient routines and to initiate the take-up of new electricity-saving ones.

The project lasted four weeks and started with an invitation letter containing information on energy saving potentials, which was followed by a personal visit of the project team. At this occasion an information leaflet was handed over and explained and the households were asked to set themselves a goal for energy reduction and to choose those behaviours that fit best for their specific situations. At the end of the visit, people were asked for a (verbal) commitment towards the project team to try out new behaviours during the project phase of four weeks. 19 families did so, who formed the intervention group. The other 10 families formed the control group. During the intervention period the households received weekly individual and comparative (to other participants) feedback. The most successful families received rewards.

In order to evaluate the success of the intervention, the weekly electricity consumption was monitored for six weeks before the intervention phase (baseline), four weeks during intervention phase and another 10.5 months afterwards (follow-up phase). Electricity consumption of the intervention group decreased significantly in comparison to the control group during the intervention as well as during the follow-up phase. In average 3% of electricity was saved (corrected from seasonal effects) and about 4.8 new behaviours were integrated into behavioural routines.

PERSPECTIVE PROJECT

[Source: NOVEM, 2000]

The 'Perspective' Project was a practical investigation into the energy consumption of Dutch households. It examined whether it is possible to reduce energy consumption through encouraging people to change their general patterns of consumption despite a rising income. Twelve households took part in the experiment, which was initiated by the Ministry of Housing, Spatial Planning and the Environment.

Over the course of two years (1996-1998), twelve households made efforts to reduce energy consumption (especially indirect consumption) through changing their spending habits. 'Indirect energy consumption' was defined as the energy necessary for the production, storage and distribution of products and services. The target reduction for both direct and indirect consumption was set at 40% for each household, compared to a similar 'average' Dutch household. The households kept track of the overall trend in their energy consumption by recording all purchases made each day. To determine whether an 'energy-extensive' lifestyle is compatible with rising disposable income, the households were given a 20% supplement over and above their usual income. Each was assigned a coach, who provided feedback and additional information about products and services as necessary.

On average, the twelve households achieved energy consumption 43% lower than that of comparable households. They cited the attractive aspects of their new-found energy-conscious lifestyle as being the fact that they now tend to purchase better quality, longer-lasting products, and that they tend to purchase more personal services such as an educational course or help with domestic chores. A significant conclusion to be drawn from this project is that a reduction in domestic energy consumption can indeed go hand in hand with an increase in income.

18 months after the conclusion of the project itself, eleven of the twelve households were subject to a follow-up investigation, the objective of which was to establish whether these households had maintained the changes in lifestyle and the economical consumption patterns they had adopted. This proved to be only partially the case (consumption of vegetables and meat, leisure time activities). It has proven more difficult for the households to maintain the changes in areas such as holidays, traffic and transport. Most of the households also displayed a slight increase in electricity consumption once the project had finished.

The most important reasons for the failure were the discontinuation of guidance, the financial contribution and difficulties in social acceptance of their "new behaviours".

SHARE Remscheid

[Sources: Mack and Hackmann (2008), telephone interview with Dr. Ricarda Rieck, Project Manager, B.&S.U. Beratungs- und Service-Gesellschaft Umwelt mbH (October 17th, 2008), and SHARE website[22]]

SHARE (Social Housing Action to Reduce Energy Consumption) was a project within the Intelligent Energy Europe Programme and consisted of a partnership of eight European agencies representing a wide range of social housing types in Europe. The overall project objectives were to increase sustainability of energy use, minimise associated carbon emissions, lower the incidence of uncomfortable temperatures, and reduce unaffordable fuel bills in social housing.

[22] http://www.socialhousingaction.com/share_in_germany.htm

The focus of the German case study was on positively influencing the behaviour of the tenants of social housing in a part of the city of Remscheid (incl. about 25 building units of two housing associations. The aim was to make the 4,500 tenants more aware of energy use and to motivate them to a more conscious use of energy. The complex impacts of changed behaviour should be demonstrated (e.g. ventilation habits and health issues). The idea behind was also to set up a "movement" of tenants, within which people pass on information, experiences and knowledge, activate and motivate themselves. The project started in January 2006 and lasted until June 2008. Final reports have not yet been available when finalizing the thesis.

Central part of the intervention was the formation of an energy forum. Meetings were organised three times: at the first meeting, which was planned as an energy consciousness building event, about 300 tenants took part. Besides information, questionnaires to the participants, there were also special activities for children (painting contest "How can we save energy?", "How can we teach our parents to save energy?"). The final event addressed only a smaller group of persons (those most active during the project), therefore only about 50 persons took part.

Besides tenants and the project coordinator B.&S.U, a number of other organisations were included into the forum: the two concerned housing associations, the city's health, environmental, and construction department, the local energy supplier, a heating technology provider and a consumer advice centre. They also formed the steering committee of the project, which met more than 10 times to coordinate actions. The idea to include a wide variety of organisation resulted from the wish to base the "professional partners" on an objective and thus neutral basis, which was positively evaluated by the tenants.

With the help of questionnaires the topics of interest to the tenants were identified. According to the project manager, these were: how to save energy when heating, ventilating, efficient appliances, avoidance of condensation (mould problems), but also smaller investments like thermostats, window sealing or new water heaters. The tenants also used the possibility to inform the project team about incidents of energy squandering in their living area.

Fig. 16. Forum meeting. Picture source: B&S.U.

In parallel an energy saving campaign with personal energy consulting was initiated, which included training on heating, ventilation, condensation in tenants' flats, the installation of a demonstration flat for energy saving and active delivery of information as well as direct, personal communication of easy and clear information.

The demonstration flat is[23] mainly used to show the difference in energy consumption of old electrical appliances and forerunner models, but also do demonstrate the formation of humidity and the resulting need to ventilate. More personalized information was given during home visits of the project team. About 100 persons visited the demonstration flat, about 40 personal consultations were provided.

Moreover an "energy competition" was initialized, which unfortunately did not attract many participants. About 100 households were invited to participate, but only about 15 households finally took part. They were asked to record their energy consumption over a period of eight weeks. The "competition" mainly activated persons who were already active within the project.

Unfortunately there was no monitoring of changes in energy behaviour or energy demand. Nevertheless, success factors were identified – see discussion (page 56).
The project manager of the German case study admitted that the aim to address those people who usually are difficult to address (mainly migrants) was not met, although

[23] The housing association decided to keep the demonstration flat also after the project end in order to have an instrument of informing (especially) new tenants.

also information flyers in foreign languages (Russian and Turkish) were distributed. The project partners are nevertheless optimistic that such process would probably need longer that the time available within the project. The stakeholders within the steering committee network thus agreed to continue collaboration in future.

6 Discussion

Any solution for the challenge of (too high) energy demand in private households is only as good as it fits the living conditions of the citizens and really leads to decreasing energy demand.

In the following, participatory approaches towards energy reduction of private households are discussed regarding their link to real life of people and their possible effects. Moreover, possible study designs as well as success factors and possible pitfalls are examined. Due to the limitations of a master thesis, this cannot be done in a comprehensive and exhaustive way. The main target was rather to tackle the issues in order to be able to arrive at conclusions regarding the adequacy of participatory approaches.

Socio-technical Context of Energy Use

Appliances are used and acquired in the context of socio-economic variables (e.g. household size, age, income), of soft factors (e.g. values, lifestyle) and pragmatic factors of everyday life (Berker, 2008). In order to influence the way how (and if) appliances are used a comprehensive approach must be followed – instead of only concentrating on technical issues. As technical solutions[24] are there, the "irrational" or "unknowing" user is sometimes blamed for foiling these approaches towards more energy efficiency. Instead of seeing users of technical appliances as a "disturbing factor", methods should be found that are able to integrate this social background of energy use into measures and efforts towards reductions of energy use, i.e. *socio-technical approaches* should be applied.

Three general starting points can be distinguished, when discussing approaches to change energy behaviour of private households: (1) energy efficiency, (2) structure, and (3) usage. Accordingly, interventions aim at (Hofer, 2008; Poortinga, 2003, Fischer, 2008a, Mack, 2008, Duscha, 2006)

[24] A focus on technical energy efficiency strategies may also lead to a prolongation of unsustainable structures. E.g. more efficient cars lead to an extended use of cars which are unsustainable due to other factors as well – such as noise, accidents or the destruction of land for road building.

(1) improving the energy-efficiency of products (characteristics of appliances or houses);
(2) influencing the decision to buy (house, appliance), i.e. shift in consumption or stock of appliances;
(3) changing the consumer behaviour (reduce temperature during night, days; ventilation habits), i.e. different use of products or different operating times.

Hofer (2008) and Duscha (2006) also differentiate small investments to improve a certain appliance (buy new energy efficient lamps, power strips to avoid stand-by).

In order to arrive at a real reduction of private energy demand, all three points must be tackled. Increasing the technical efficiency is only one of the approaches. Shortcomings regarding energy efficiency – both on a macro-level and on a household level – have already been discussed above (see chapter 3).

Duscha (2006) gives a very detailed structure of inhibitors towards an efficient use of electricity in households (Fig. 17). The inhibitors for decreasing consumption of

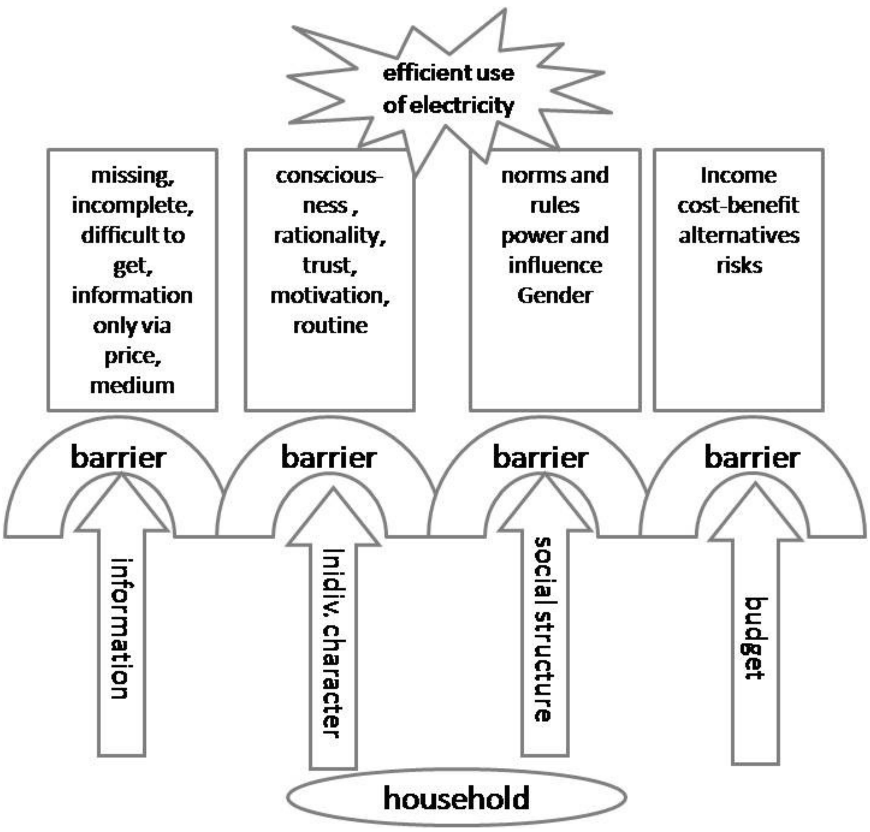

Fig. 17: Structure of barriers towards an efficient use of electricity in households. Source: Duscha, 2006 (translated from German);

heat are similar. Although, the structural components are probably stronger, as it is more difficult to move to another (energy-efficient) house/place than to buy a new electrical appliance; or to have a multi-family house renovated, as beneficiaries of energy-saving measures are often not those that would have to pay for it (i.e. often the landlord). The number and different characteristics of inhibitors give an impression of the fact that energy efficiency is by far no technical problem, but that energy consumption of private households is very much imbedded into routines, (unconscious) believes, motivations, financial aspects, etc.

Table 14: Overview of described projects regarding target dimensions, study design, duration and success

Short Name	target dimension	study design and duration	success measurement
personal energy advice – Austria	electricity and heat	personal energy advice on energy use in private households; 1 time visit;	no measurement
webtool - Groningen	direct and indirect energy	questionnaire, feedback and information via an internet tool; 5 months;	*total energy:* experimental group: minus 5.1% (control group: plus 0.7%); *direct energy saved*: minus 8.3% vs. plus 0.4%; *indirect energy saved*: minus 3.8% vs. plus 0.3%
commitment and feedback - Lummerlund	electricity	visit by project team, personal advice, self-set goal and feedback; 4 weeks of intervention, 1.5 months ex ante, 10 month ex post-evaluation;	minus 3% (after 10 months) 4.8 - 4.4 new electricity saving behaviours
Perspective project	indirect energy	personal coach for support and feedback; 20% additional income; 2 years;	minus 43% in comparison to similar households
SHARE	direct energy use	energy forum, home visits, demonstration flat, competition; 2.5 years	no measurement

A number of energy saving measures do not imply any monetary costs and no loss of comfort (e.g. washing at lower temperatures, using covers when cooking, etc.) – nevertheless they are difficult to implement in everyday life as it would need to change daily routines which are very conservative. Although no monetary costs are related to these measures they cause high mental costs, as new ways of behaviour have to be repeated quite often in order to make them to new routines (Mack, 2008). This might also be a reason why the effect of some projects decreases after some time period.

Due to the close link of energy demand to life-styles and living conditions, the issue is an ***ideal field for participatory approaches***. Participation allows the target group to bring up their ideas, needs and wants and can help to identify the shortcomings of measures or instruments in everyday life. Participatory approaches may better motivate people and ensure that measures are developed in compliance with the needs of the target group – thus increasing the chances for success.

THE EFFECT OF PARTICIPATORY STUDIES

The measurement of the success of participatory approaches definitely is a weak point. In order to get to relevant and meaningful results it is necessary to set up a very complex system of measurements, as seasonal, structural or different "soft" factors have to be excluded, and the measurements have to be done over a longer period of time (ex ante, accompanying, ex post and also a longer period after the study in order to allow for an assessment of long-term effects). Therefore there are not many studies that applied a quantitative approach (see e.g. SHARE). Even if quantitative results are available, it is usually difficult to compare them, as different methodological approaches have been applied.

Table 14 summarizes the qualitative results of the projects described above (success measurement). The results vary from 3% of electricity saving in the Lummerlund project to 43% of total (direct and indirect) energy savings in the Perspective project. The latter is an exceptional approach that builds on a very intensive consultation of the participants and on significant financial support for the participants. It definitely is a very interesting and successful example of an intervention study, but nevertheless it cannot be applied to a wider part of the population. Therefore, also the results have to be seen as exceptional and not repeatable. But also the other approaches can exhibit considerable reductions in private energy use, when taking into account that energy demand of private households in general is increasing and that the situation of the Austrian energy system could be significantly ameliorated when the total demand could be decreased by just a few percents (see chapter 3).

In order to extent the small case number of the examples described in this paper, a study of Abrahamse et al. (2005) was taken into consideration that examined 38 peer-reviewed studies dated from 1977 to 2004 in regard to the effectiveness of interventions aimed at reducing energy use according to the following criteria:

1. extent of behavioural change and/or reductions of energy use
2. extent to which these changes can be attributed to the intervention(s)
3. factors of (in)efficiency

They looked at antecedent and consequence strategies, i.e. prior to or after the energy relevant behaviour. Most of these studies report that the interventions taken resulted in energy reductions and some also give quantitative data – although the case numbers often were too little to show statistical significance and therefore results often cannot be generalised. The effects observed within these studies (Table A1 in the Appendix of Abrahamse, 2005) also vary to a great extent, but in general fit into the pattern that is given by the examples above. To name some examples on the "upper end"[25]: e.g. Becker (1978) applied a 20% goal and feedback three times a week over a period of one month and reports 15.1% reduction of electricity use, McClelland and Cook (1979-1980) applied continuous feedback over a period of 11 months and reports 12% average savings of electricity, Slavin et al. (1981) did combined interventions of rewards, feedback, information, prompts and goal setting and observed 11.2% savings for the group that was addressed for 14 weeks, or Winett et al. (1982-1983) report 21% reduced electricity use after personal audits. Many of the examples report reductions of energy use of about 4-5% with very different approaches such as monitoring, goal setting, feedback – mostly in combination with information. Abrahamse et al. also report on negative examples, where energy consumption raised despite interventions: Bittle et al. (1979) observed an increase in consumption for medium and low consumers of electricity after a feedback-intervention, Geller (1981) observed an increase of 2% after a three hours workshop, and McMaking et al. (2002) observed a 2% increase in electricity use (without cooling) after providing tailored information.

[25] The following examples are all cited from Abrahamse, 2005.

Taking into account the limited comparability and methodological shortcomings, one can nevertheless conclude that participatory and interventional approaches can make an important contribution to changes in energy behaviour and thus to reductions of energy consumption in private households.

Despite various difficulties of measurement, further efforts should be put in proving the success of participatory processes. Usually quantitative results are easier to communicate to decision makers and financial support for projects is easier to justify – even if the numbers are only estimates. Besides that it is necessary to evaluate the impact of studies in a qualitative way. The collection of information about impacts (change of behaviours, perceptions, evaluation of the process itself) by means of questionnaires or interviews should be a minimum requirement.

INFLUENCE OF STUDY DESIGN

Inferring from these different success rates, it can be concluded that the design of the participatory study has a significant effect on the outcomes. Nevertheless it is difficult to draw general conclusions. Abrahamse et al. (2005) state in their work that many different forms of interventions have proven successful:

- commitment (i.e. written or oral promise to change energy behaviour)
- modelling (i.e. the provision of examples of recommended behaviours),
- goal-setting (i.e. self-chosen or given goal of energy reduction)
- information
- feedback on energy behaviour and demand
- rewards (i.e. prizes for energy efficient behaviour)

They conclude that combinations of interventions are especially effective in reducing energy use. But small differences in the study design showed large effects on the outcome. E.g. goal setting is more effective in combination with feedback, and an easy to reach goal did not prove to have any effects, as it probably “did not seem worth the effort”. Feedback on energy behaviour and demand highly depends on the frequency, and comparative feedback is more effective when combined with a contest setting. Rewards can have an effect, but it probably is only short-lived. Regarding information Abrahamse et al. (2005) concluded that it depends largely on its specificity (i.e. tailored approaches) and is more effective when used in combination with other interventions.

In general, more personalized information approaches in the form of energy consultancy or tailored approaches have much higher effects than generalized information and are an important element to reduce energy demand of private households (ifeu 2007, p30, Abrahamse et al., 2007).
The study design of the Perspective project is most outstanding in regard to the support for the target group – and also achieved the highest reduction rates. Also the good results of personal energy advice can be related to the personal and tailored information – and the fact that it addresses mainly those persons who are already interested in the energy issue.

SUCCESS FACTORS

Besides the study design there are a number of factors that are cited in the literature as contributing to a positive result and that can or should be taken into account when setting up whatever participatory approach.

Most of the examples described above did not imply any **costs** to the beneficiaries. Only the personal on-site energy advice has to be paid for (if exceeding a first basic information, which has different scopes in the Austrian provinces). ifeu (2008) discusses the issue of cost acceptance and concludes that the subsidy for the beneficiary is an important factor when deciding for or against to ask for personal energy advice.

It is very important for the target group to know that the consultants are **independent**. This was found out by ifeu (2008) for the personal energy advice in Germany, and also confirmed by Armin Knotzer for the Viennese consultancy. Also the project manager of SHARE stressed in the interview that the inclusion of diverse experts gave this institution high credits, as the tenants acknowledged that it "would not work on the housing associations' advantage, but really wants to help us".

Campaigns must account for their target group(s) and develop **target group specific** approaches. Poortinga (2003) found out that high income groups are rather willing to accept technical measures, whereas low income groups are more willing to change their behaviour, as it does not require any initial investment. Krémer (2008) also stresses this fact for campaigns that address the wide public and adds that the advantages for each target group have to be presented according to their specific type of motivation and in a way that touches them emotionally. Despite efforts to do so, it might be difficult to reach certain target groups. Within SHARE one of the main target groups were migrants. As reported above, flyers were printed in their main languages, but still it was not possible to address them[26].

Whatever study design is chosen, information of the target group forms an important part of it. Information must be **easy to understand** for the specific target group and should not only include information on the problem at hand, but also **practical knowledge**, as people want to know straight forward how they can change their behaviour and what this would change (see e.g. Mack and Hackmann, 2008).

Mack and Hackmann (2008) also claim that it is important to build on existing structures and that **existing needs were served first**. The latter was done, as the tenants had the possibility to state their wishes and problems during the first energy forum either during the discussion or in a questionnaire. Building on the people's concerns is a basic demand within participatory approaches, as – if unsolved – they can come up during the process and significantly interfere with it and even make a process fail.

POSSIBLE PITFALLS AND TRADE-OFFS

Relatively little is known about the **long-term effects** of interventions (Abrahamse, 2005). Experience has shown that good results are often drawn back after some time. As described above for the Perspective the new behaviours were only continued partially (consumption of vegetables and meat, leisure time activities), but some were difficult to maintain (holidays, traffic and transport, partially also electricity). Besides the missing guidance and financial aid, people stated difficulties in social acceptance of their "new behaviours". This issue of status and **social acceptance** is also mentioned by Berker (2008). He refers to the fact that usually it is important for people that their "good" behaviour is also acknowledged by others. As long as an energy saving behaviour is rather seen as (too) idealistic, (too) "green", etc. by the general public, it will be difficult to widely implement it.

[26] One might suspect that information flyers in foreign languages might not help, when other activities within the project (energy forum, events, consultation, etc.) were held in German.

There are a lot of energy saving behaviours which are widely applied by people who are in general conscious about their energy consumption (such as switching off lights in unused rooms and avoiding stand-by of appliances). But the **effectiveness** of these habits is low as many of these behaviours have a rather low impact on the total energy demand. When aiming at lowering the energy demand of private households these behaviours also play a role, but it is necessary to stress those aspects of energy use that really can make a difference. Following new heating habits results in much higher energy savings than some highly symbolic behaviours in regard to electricity use (see chapter 4). The most effective way to save (direct and indirect) energy lies in avoiding material consumption or profoundly changing consumption patterns – a way of life that is difficult to propagate and a consequence that politics fears as an inhibitor of economic growth. Nevertheless, comprehensive approaches to energy reduction must also take this aspect into account.

Participatory approaches can only address a **limited number of people**. Usually there is a trade-off between the number of persons addressed and the intensity of participation (Fischer and Sohre, 2008). Processes that include people to a high extent usually show better results than measures that reach many people on a generic level. The EU-Commission demands an extension of existing energy consulting instruments in its energy efficiency directive, though the form of energy consultancy (mainly on-site) applied in Austria and Germany, is time and money intensive and mainly addresses those persons who are already conscious about their energy use (see market analysis done by the Umweltberatung, chapter 5.2). Projects that address people in an active way and aim at initiating group processes instead of one-to-one interfaces could be a well balanced approach between intensity and widespread effect.

7 Conclusions

A reduction of the energy demand of private households is an important issue, which is recognized as such by politics as well as by experts. Nevertheless, the approaches thought of by different groups differ significantly. Existing policies mainly aim at an increase of technical energy efficiency. Although significant improvements were made in regard of this, no decrease of energy consumption in private households could be observed in the last decades. The believe that technical improvements such as an increase of energy efficiency and the enforced use of renewable energies can lead to a solution of current problems within the energy system (e.g. CO_2-emissions, inequalities in energy levels) builds on the idea of system improvement. The inability of our societies to solve the problems of the energy system rather calls for a system innovation (i.e. a profound change of the system).

A change of people's lifestyle towards a lower energy intensity and higher energy consciousness would constitute such a system innovation (or rather system change, as it is no innovation, but rather a recurrence of former lifestyles on another technical level). The potential of such lifestyle changes is high and the need for action is highly evaluated by experts. Nevertheless, examples of how to initiate such profound changes are rare and highly contested.

Yet there are historical examples that show how perception and behaviour can change. Pedestrian zones in city centres e.g. are nowadays a matter of course – a fact which nobody would believe when the first zones were implemented under huge protests. Seat belts are another example, which were highly disapproved when becoming obligatory, but nowadays are taken for granted. Thus, instead of claiming that "people will never change" attempts should be made to make changes possible.

Participatory approaches might be an instrument to reach people not only on an intellectual level, but also to touch them emotionally and to allow them to try out new behavioural patterns under "laboratory" conditions. As energy use in private households does not follow an objective cost-benefit calculation, but is embedded into a social context, participatory approaches can provide an additional incentive and the information and support that are necessary to enable people to change their energy behaviour towards sustainability. Only a wide social acceptance of any solutions will make it possible to exploit the whole potential of energy saving measures.

Starting from a socio-technical perspective, economic aspects of energy use (price of energy and energy services) need to be addressed in parallel to values and norms that influence people's behaviour (and that vary significantly from person to person, from lifestyle to lifestyle, etc.) and to issues of practicability within everyday life. Simply informing people about how and why to save energy or hoping that increasing prices of energy will change energy behaviour will not lead to the desired results.

Participatory interventions can help to overcome social, economic, or structural barriers that inhibit or override technical approaches. Within participatory approaches a comprehensive methodology can be applied that take all aspects of energy use into account. Participation can therefore function as a form of "social" marketing – complementary to incentives, subsidies or regulatory measures.

Experiences with according projects have shown positive and promising effects, although it is difficult to deduce hard numbers and direct correlations between the actions taken and the outcomes. Moreover the question of how to make the knowledge and experiences of studies applicable at a larger scale has not been discussed very much. The participatory approaches found in the course of this work, are all on research level and aim at better understanding underlying mechanisms. The only exception to this is the personal energy consultation. In order to further distribute participatory approaches, research should start to test approaches that cover a wider range of the population.

As direct energy use is only one part of the total energy consumption of private households, a system change must also include indirect energy consumption. The examples presented also show the much higher potential of such comprehensive approaches.

There seems to be a common agreement that it is impossible to change people's lifestyles (the only named exception is a catastrophe that forces people to change). Politics usually acts within this self-set limitation and refrain from any attempts that require different behaviour of people and could be seen in the light of "sufficiency" or "setting limits". Thus, a lot of effort will have to be put into giving participatory approaches a chance within real life.

In order to reach a sustainable level of private energy consumption it will need a mixture of (complementary) methods. Following the argumentation above, participatory approaches should have a fixed place within this set of methods. They cannot be the only solution to decrease energy demand of private households. But they should be part of a bigger strategy that includes of course also other endeavours to lead the system towards sustainability, such as political and financial incentives or directives.

8 Literature

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Annex

e-co Stakeholder Befragung

Mithilfe dieses Fragebogens wollen wir zusätzlich zu den Gruppendiskussionen im Rahmen des Workshops Ihre Annahmen zu einem nachhaltigen Energiekonsum privater Haushalte, aber auch Ihre Meinung zum Stakeholder-Prozess erheben. Die Informationen aus diesem Fragebogen werden für die Weiterentwicklung der Szenarien, aber auch für die Konzeption des weiteren partizipativen Prozesses von e-co verwendet. Darüber hinaus fließen Ihre Einschätzungen in eine Diplomarbeit zu „Participatory Approaches for Energy Reduction"[27] ein.

Wir bitten Sie, sich noch ein paar Minuten Zeit zu nehmen, um unsere Fragen zu beantworten. Ihre Angaben bleiben selbstverständlich anonym und werden nur für die oben genannten Zwecke verwendet.

A Ihre Rolle/Funktion und Interessen im Bereich „Nachhaltiger Energiekonsum"

1. In welchem der folgenden Bereiche arbeiten Sie?

Wissenschaft ☐
Beratung ☐
Energiewirtschaft ☐
Öffentliche Hand ☐
Interessensvertretung ☐
NGO ☐
Sonstiges: ___________________________________

2. Welche der folgenden Bereiche sind für Sie von besonderem Interesse? *(Mehrfachnennungen möglich)*

Erneuerbare Energien ☐
Technische Energieeffizienz ☐
Verhaltensänderungen privater Haushalte in Bezug auf Energieverbrauch ☐
Modellierung ☐
Energieszenarien ☐
Sonstiges: ___________________________________

[27] Lisa Bohunovsky, MSc-Lehrgang zu „Renewable Energies in CEE", Tu-Wien, Energiepark Bruck/Leitha

B Ihre Ansichten zum Thema “Nachhaltiger Energiekonsum”

3. Bitte stufen Sie untenstehende Aussagen auf einer Skala von „stimme sehr stark zu“ bis „stimme überhaupt nicht zu“ ein, indem Sie das zutreffende Kästchen je Zeile ankreuzen.

	stimme sehr zu	*stimme eher zu*	*stimme eher nicht zu*	*stimme überhaupt nicht zu*
Der Trend zum „Wohnen im Grünen“ ist / wird bald gebrochen. Weiteres Wachstum findet vor allem in den Agglomerationsräumen Österreichs statt.	☐	☐	☐	☐
Der Umgang mit Energie muss sich ändern. Eine bewusstere Nutzung von Energie ist Voraussetzung für eine Umgestaltung des Energiesystems in Richtung Nachhaltigkeit.	☐	☐	☐	☐
Die Anzahl der Personen pro Haushalt wird in Zukunft wieder steigen (Trend zum Singlehaushalt wird gebrochen).	☐	☐	☐	☐
Die Einführung einer CO_2-KARTE für alle BewohnerInnen Österreichs wäre die optimale Lösung, um den Energieverbrauch von Privatpersonen zu senken.	☐	☐	☐	☐
Die Neuinstallation von Ölheizungen sollte möglichst bald verboten werden.	☐	☐	☐	☐
Haushalte müssen zu einer Reduktion ihres • direkten Energieverbrauchs; • indirekten Energieverbrauchs angeregt werden.	☐ ☐	☐ ☐	☐ ☐	☐ ☐
Haushalte werden auf Komfort verzichten müssen, um ein nachhaltiges Energieniveau erreichen zu können.	☐	☐	☐	☐
Höhere Preise für Konsumgüter werden wieder zu einer höheren Reparaturrate führen.	☐	☐	☐	☐
Internationale Projekte haben gezeigt, dass alleine durch geändertes Nutzerverhalten einige Prozentpunkte Energie eingespart werden können. Solche Erfolge könnten mit genügend politischem Willen auch auf die breite Bevölkerung übertragen werden.	☐	☐	☐	☐
Positive Vorzeigepersonen/familien (role models) würden helfen, der Bevölkerung einen nachhaltigen Umgang mit Energie vorzuleben.	☐	☐	☐	☐
Thermische Sanierungsmaßnahmen und eine konsequente Verbesserung der technischen Energieeffizienz von Haushaltsgeräten reichen aus, um den Energieverbrauch von Haushalten auf ein nachhaltiges Niveau zu bringen.	☐	☐	☐	☐
Um die Bevölkerung zu einem geänderten Nutzerverhalten in Bezug auf Energie zu animieren, braucht es • breit angelegte Informationskampagnen. • individuell angelegte Beratungsangebote. • regionale kollektive Prozesse. • sonstiges…………………………….	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
Wenn das Bewusstsein zu geändertem Energieverhalten eine bestimmte Schwelle erreicht hat, wird der Rest der Bevölkerung gleichsam „angesteckt“ werden.	☐	☐	☐	☐

4. Erachten Sie nachstehende Aspekte einer „Energiewende" (d.h. einer Änderung des Energiesystems in Richtung Nachhaltigkeit) ***aufgrund der Diskussionen am heutigen Vormittag*** wichtiger oder weniger wichtig? Kreuzen Sie bitte das zutreffende Kästchen je Zeile an.

   Haben Sie Ihre Meinung in Bezug auf andere Themen geändert? Wenn ja, welche? Bitte unter sonstiges eintragen.

	wichtiger	*keine Änderung*	*weniger wichtig*
a. geändertes Nutzungsverhalten privater Haushalte	☐	☐	☐
b. technische Effizienzsteigerungen	☐	☐	☐
c. Lebensstiländerungen	☐	☐	☐
d. Erneuerbare Energien	☐	☐	☐
sonstiges:	☐	☐	☐
sonstiges:	☐	☐	☐

Raum für Anmerkungen:

5. In welchem Bereich sehen Sie den größten Handlungsbedarf bzw. das größte Potential zur Umgestaltung des österreichischen Energiesystems? Bitte kreuzen Sie die entsprechenden Felder an.

Handlungsbedarf	sehr hoch	eher hoch	eher gering	sehr gering
Stärkung erneuerbarer Energien	☐	☐	☐	☐
Technische Energieeffizienz	☐	☐	☐	☐
Verhaltensänderung	☐	☐	☐	☐
sonstiges:	☐	☐	☐	☐
Potential	sehr hoch	eher hoch	eher gering	sehr gering
Stärkung erneuerbarer Energien	☐	☐	☐	☐
Technische Energieeffizienz	☐	☐	☐	☐
Verhaltensänderung	☐	☐	☐	☐
sonstiges:	☐	☐	☐	☐

Raum für Anmerkungen:

6. Welche der folgenden Maßnahmen zur Erreichung einer „Energiewende" sollten getroffen werden? Bitte ankreuzen

- ☐ Emissionshandel - Versteigerung der Zertifikate statt Gratisvergabe
- ☐ CO_2 -Card
- ☐ Empfindliche Erhöhung der Mineralölsteuern / Einführung einer Kerosinsteuer
- ☐ Erhöhung der Einspeisetarife für Strom aus erneuerbaren Quellen
- ☐ Investitionszuschüsse beim Kauf von besonders energieeffizienten Haushaltsgeräten
- ☐ Investitionszuschüsse für Anlagen zur Nutzung erneuerbarer Energien
- ☐ Materialinputsteuer
- ☐ Ökologische Steuerreform
- ☐ Nutzung der Kernenergie auch in Österreich
- ☐ Streichung verkehrsfördernder Anreize (Pendlerpauschale, Kilometergeld)
- ☐ Überarbeitung des Subventionssystems nach ökologischen und sozialen Kriterien
- ☐ Verbot von Ölheizungen
- ☐ verpflichtender Austausch von alten Heizkesseln
- ☐ Wohnbauförderung nach strengeren ökologischen und energetischen Standards
- ☐ Regionale kollektive Prozesse

C Feedback zum Workshop

Welche Erwartungen hatten Sie an den heutigen Workshop? Wurden Ihre Erwartungen erfüllt?

Haben Sie im Rahmen des Projektes "Energiemodellierung" schon an Workshops teilgenommen?

ja ☐ nein ☐

Falls ja: Hatten Sie das Gefühl, dass Ihre Anregungen gut vom Projektteam aufgenommen wurden?

ja ☐ zum Teil ☐ nein ☐

Falls ja: Haben Sie Anmerkungen/Kommentare zum Stakeholderprozess im Projekt "Energiemodellierung"?

D Sonstiges

Haben Sie sonstige Anmerkungen? Fehlen Ihnen bestimmte Personen/Gruppen im Kreis der Workshop-TeilnehmerInnen? Sonstige Anmerkungen, Kritikpunkte, Vorschläge

Herzlichen Dank für Ihre Mühe!