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Working paper on general consumer preferences and restrictions

D5.1a of WP 5.1 from the Smart-A project

A report prepared as part of the EIE project „Smart Domestic Appliances in Sustainable Energy Systems (Smart-A)"

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Content

1 Introduction

The Smart-A project

The project „Smart Domestic Appliances in Sustainable Energy Systems (Smart-A)" aims at developing strategies how smart domestic appliances can contribute to load management in future energy systems. In order to do this, the project assesses the options for load-shifting by a variety of appliances across Europe and compares these with the requirements from energy systems both on the supra-regional and the local level. It is expected that these systems will have to integrate larger shares of renewable energy in the future, which are partly intermittent, and therefore will require a smarter management of generation, network capacities and demand.

The technical aspects of the assessment include an analysis of potential changes to appliances operation, of characteristics of local energy generation (from renewable energies and also cogeneration) and of load management requirements in the larger electricity networks. The project also features a detailed assessment of the acceptance of smart appliances operation by users, and an evaluation of the usability of available control technologies and communication standards. The overall potential of smart appliances is assessed based on a model which takes into account the variations of appliance use and the framework conditions in energy systems.

The project is conducted in cooperation with manufacturers of appliances and electric utilities. The findings from the analysis are being tested with experts in regional case studies in selected European countries.

This report

This report summarises the results of an analysis of existing European studies and reports on consumer research with regard to smart appliances, smart metering and variable electricity tariffs. Based on the data obtained, preliminary hypotheses for the consumer survey within the Smart-A project are derived.

2 Consumer preferences and restrictions

2.1 Introduction

For this working paper existing studies have been compiled on consumer behaviour and attitude towards smart appliances. It is well known that attitude and behaviour differ: Consumers do not behave as they should according to their attitude. So data on behaviour like use patterns are especially valuable for calculations but they also depend on the circumstances and the framework the consumer is experiencing. Since the envisaged smart appliances are not part of consumer attitude is a determinant of the willingness to buy such an appliance and helps to estimate the future market penetration.

2.2 Research aim and methodology

The aim of this working paper is to serve as an input for the work packages 2 (synergy potential of smart appliances) and 4 (energy networks) in an early phase. Moreover it helps to set the tracks for the consumer surveys in work package 5. Several European studies have already identified relevant parameters that are possibly important for the behaviour of consumers towards smart appliances in general. To draw the maximum advantage of the surveys they should – in addition to their main goal to provide the data for the scenarios of use needed for the calculation model – be comparable with other European studies´ results.

Although several consumers surveys on behaviour regarding smart appliances, smart metering and variable electricity tariffs have already been conducted in European countries and world-wide, results are often not available in detail. Almost no research institution would hand out their generic data. Usually not even the precise questions asked can be obtained. Industry also performs consumer studies but in a very focused way mostly on their products. These studies are not publicly available.

It was the central effort of this task to gather appropriate studies. As the main source internet searches (www.google.at, scholar.google.de), searches in social science databases (www.base-search.net, science direct) and project/energy databases (www.cordis.europa.eu, www.eceee.org) have been utilised. The keywords have been: smart appliances, smart domestic appliances, smart domestic appliances (+) consumer, smart appliances (+) consumer, home automation, digital home, smart home, vernetztes Wohnen, vernetztes Wohnen (+) Konsument, intelligente Elektrogeräte (+) Konsument, smart Wohnen, clever Wohnen. The websites of some research institutions that are working in this or a related field have been visited.

All projects and studies that were matching the goal to shed light on the consumers´ perception of smart appliances are presented in this working paper. Altogether 18 papers have been collected that seemed to deliver appropriate information. A detailed report describing the search strategies and the selected studies is available.

2.3 Overview of the analysed studies

1	Title:	**EFFLOCOM: Energy efficiency and load curve impacts of commercial development in competitive markets**
	Documents:	Summary report, 15 pages
	Author(s)/ organisation	Ove Grande / SINTEF
	Prepared for:	EU-Save-Programme, see also study no. 15
2	Title:	**Energy efficiency is EASY: new knowledge to change human behaviour**
	Documents:	Conference paper, 5 pages
	Author(s)/ organisation	Henk van Elburg / Ministry of Economic Affairs, Organisation for Energy and the Environment
	Published by:	ECEEE 2005, summer study, p. 1231 - 1235
3	Title:	**Energy related practices, representations and environmental knowledge: A sociological study**
	Documents:	Conference paper, 12 pages
	Author(s)/ organisation	Lorise Moreau, Anne-Laure Wibrin / University of Louvain, Institute of demography
	Published by:	ECEEE 2005, summer study, p. 1301 - 1312
4	Title:	**Socio- technical factors influencing Residential Energy Consumption SEREC, p. 1 - 222**
	Documents:	Final report, 222 pages
	Author(s)/ organisation	Francoise Bartiaux / University de Louvain, Guy Vekemans / VITO, Kirsten Gram-Hansen / Danish Building research institute
	Prepared for:	Belgian Science Policy / Scientific support plan for a sustainable development policy (SPSD II)

5	Title:	**User behaviour in energy efficient homes**
	Documents:	Report (phase 2), 68 pages
	Author(s)/ organisation	Jacky Pett, Pedro Guertler / UK Association for the conservation of energy
	Prepared for:	The Housing Corporation and the Energy saving trust, see also study no. 6
6	Title:	**Energy efficiency refurbishment programmes help, but are the end-users doing their bit?**
	Documents:	Conference paper, 5 pages
	Author(s)/ organisation	Winston Smith, Jacky Pett / UK Association for the conservation of energy
	Published by:	ECEEE 2005, summer study, p. 957 - 968
7	Title:	**User Centred Design in Smart Homes: Research to Support the Equipment Management and Services Aggregation Trials**
	Documents:	Report, 110 pages
	Author(s)/ organisation	Victoria Haines, et al. / Ergonomics and safety research institute (ESRI), Loughborough University
	Prepared for:	The Application Home Initiative (TAHI)
8	Title:	**Equipment Management Trial Final Report**
	Documents:	Report, 86 pages
	Author(s)/ organisation	-
	Published by:	ESRI, Loughborough University

9	Title:	**Probing a proactive home: challenges in researching and designing everyday smart environments**
	Documents:	Journal paper, 18 pages
	Author(s)/ organisation	Frans Mäyrä / Hypermedia Laboratory, University of Tampere, et al.
	Published in:	Human Technology – an interdisciplinary Journal on Humans in ICT Environments, Vol 2(2) 2006, p. 158 – 186
10	Title:	**User versus Utilities – The Domestication of an Energy Controlling Technology**
	Documents:	Book chapter, 22 pages
	Author(s)/ organisation	Margrethe Aune / SINTEF
	Published in:	Jamison, Andrew; Rohracher, Harald: "Technology Studies & Sustainable Development", München, Wien, 2002; p. 383 – 405.
		See also study no. 14
11	Title:	**Representing the demand side: 'deficit' beliefs about domestic electricity users**
	Documents:	Conference paper, 6 pages
	Author(s)/ organisation	Hannah Devine-Wright, Patrick Devine-Wright / Institute of energy and sustainable develoment, DeMontfort University
	Published by:	ECEEE 2005, summer study, p. 1343 - 1348
12	Title:	**WIM: Vernetze Haushalte – Ergebnisse einer explorativen Expertenbefragung**
	Documents:	Report, 21 pages
	Author(s)/ organisation	Joachim Rawolle / Institut für Wirtschaftsinformatik und neue Medien, Universität München
	Prepared for:	-

13	Title:	**Marktstudie – Intelligentes Wohnen Schweiz 2006-2008**
	Documents:	Summary report, 32 pages
	Author(s)/ organisation	Rene Senn / Gebäude Netzwerk Institut (GNI), Schweiz
	Published by:	GNI
14	Title:	**Customer response on price incentives**
	Documents:	Conference paper, 11 pages
	Author(s)/ organisation	Pal Naesje et al. /SINTEF
	Published by:	ECEEE 2005, summer study, p. 1259 – 1269; see also study no. 10
15	Title:	**Evaluating participation of residential customers in demand response programs in the UK**
	Documents:	Conference paper, 12 pages
	Author(s)/ organisation	Efterpi Lampaditou, Matthew Leach / Centre for energy policy and technology, Imperial college London
	Published by:	ECEEE 2005, summer study, p. 1271 – 1282 See also study no. 1
16	Title:	**Pacific Northwest GridWise$_{tm}$ Demonstration** **(California's Statewide Pricing Pilot)**
	Documents:	Overhead transparencies, 22 slides; final report is available at: http.//www.gridwise.pnl.gov
	Author(s)/ organisation	- / PNNL (Pacific Northwest National Laboratory

17	Title:	**Vernetztes Wohnen – Die Informatisierung des Alltagslebens, p. 129 - 217**
	Documents:	Book " Vernetztes Wohnen – Die Informatisierung des Alltagslebens", Berlin, 2001
	Author(s)/ organisation	Meyer, Sibylle; Schulze, Eva; Helten, Frank; Fischer, Bernd
18	Title:	**Preis, Verbrauch und Umwelt versus Komfort – der mündige Energieverbraucher**
	Documents:	Studie der deutschen Utilities Practice der IBM Global Business Services in Zusammenarbeit mit dem Zentrum für Evaluation und Methoden der Universität Bonn
	Author(s)/ organisation	Thiemann, Ralf, Passenberg, Ingo, Suer, Stephan, Krüger, Thomas, Schmitz, Martina

2.4 Categorisation

There are many different approaches to the topic – different theories, methods and ways of interpretation etc. In this summary the following six categories have been used to present the studies, to extract information and to draw conclusions:

- General information
- Energy and behaviour
- Design and user needs
- Demand side management / supplier opinions about the customer
- Electricity consumption / reaction on programmes
- Technology acceptance and acceptance of living in an interconnected smart home

2.4.1 General Information

Detailed general information of the electricity consumption in private households and of the impact of smart metering is the main topic of one study[1].

The aim of this study was to get to know customer response to different market based services in deregulated markets (Denmark, Finland, France, England and Norway).

A large potential for demand response/load management was found. For such reductions new technologies for metering are needed in all countries mentioned, as well as direct communication for automatic meter reading, remote load control and web-based services for customer information.

It was stated that more frequent metering is needed to support market based demand response. Taxes, which are a fixed price independent of the consumption should be removed, as they lower the price variations and represent a barrier to Time-of use network tariffs.

2.4.2 Energy and behaviour

There are many ways to examine energy related behaviour as well as the use of appliances. Either the consumers are interviewed on their current practice individually; as far as for innovative products and potential future developments focus groups are often used. On the other hand energy consumption and other actions are directly observed. The setting must be chosen appropriate to get significant results. For instance the consumer is living in an energy efficient building.

Six papers were delivering information on energy related behaviour of private households[2]. Since their focus and their approach were quite different their results cannot be compared. It is indicated whether results should be considered or conclusions will be drawn for Smart-A.

An interactive internet system that was able to communicate and give feed back to the consumer on a base of his individual circumstances was investigated. In the background of this system an extensive library was necessary which was containing information on the one hand for assessing the consumers´ behaviour, on the other hand to give an individually tailored advice to the visitor of the website. This system was implemented on efficient lighting and tested by 1000 households in the Netherlands. 500 households were asked about their "buying behaviour" before and after they have tested the system.

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[1] EU-Save Project "EFFLOCOM" ("Energy efficiency and load curve impacts of commercial development in competitive markets)

[2] Energy efficiency is EASY: new knowledge to change human behaviour", "Energy related practices, representations and environmental knowledge: A sociological study", "SEREC: Socio-technical factors influencing residential energy consumption", "User behaviour in energy efficient buildings", "Energy efficiency refurbishment programmes help, but are the end-users doing their bit?", "Users versus Utilities- The Domestication of an Energy Controlling Technology".

30% changed their behaviour against 70% who did not. These 30% were asked again about the effect of the website. Only 25% said that there was no influence. So this website can be regarded as an "best practice example" in this respect, but nevertheless the effect of this effort was limited.

A survey among 1000 Belgian households as well as seven in-depth interviews were conducted for a better understanding about the role of technical or environmental knowledge and representations on energy-related practices by social determinants. The relationship between these determinates has been investigated, i.e. between knowledge, environmental representations and sociological characteristics (habits, education, social representations, values, fashion).

Concerning the actions the people would be ready to undertake versus those that have already been undertaken it was found: Almost nine people out of ten are in favour of almost all actions that were proposed to them. The proposal to install a more efficient heating system, which requires a significant financial investment had been carried out by only 12,4% of the respondents and 59,8% of the people are in favour of it, which is less than for the other proposals. In the same way only 45,2% of the people do not use an electric dryer or agree to do without it. Concerning the actions that had already been undertaken, insulation improvement is most often named (28,5% of the respondents). Then we find actions which are economic such as "installing water saving showerheads" or "installing (more) energy efficient light bulbs". Only 1,9% of the respondents claimed to use renewable energy but 80,3% were in favour of them. The results of this study – although no detailed data are given – are valuable for Smart-A.

A comparison of residential energy consumption between Belgium and Denmark shows that in Belgium the electricity consumption per household is higher than in Denmark. This may partly be explained by the fact that more households in Belgium have tumble dryers, washing machines and electric fans. A study was directed to explain the differences in excess. It was found that these could not be sufficiently explained by different attitudes. So detailed measurements of peak loads, standby loads and working conditions were performed. Four different methods to give a feed back to the participating households were used and evaluated: quick scan, energy diary, electrical audit and energy assessment. Generally, it can be said that the most valued elements of the methods were those, where participants got personalised information. This means that participants rather liked customized than general advices.

An overview is given about all possible constraints and levers for changes in energy-related practices: *energy policies, market pressure* – high market prices act as lever, *social pressure* - either to consume more (break) or to consume less (lever), *comfort* – either a break (high indoor temperatures in winter) or a lever (comfort effect of better insulation), *daily routines* – habits remain hard to change, *social influence* – friends, colleagues, neighbours, family members, the media watched or read etc, *income, agency feeling* – either helplessness sense (break) or agency feeling (small changes are possible), *environmental values, identity factors, technical aspects*.

Another study was about people living in buildings, which were recently subject to energy efficiency improvements (insulation, central heating replacement etc.). The people's behaviour was related to the results that they achieved by this. Either the category ‚desired results' (= people got the required results from the energy efficiency improvements) and the category ‚behaviour style' (distinguishing between efficient, reasonable and inefficient behaviour styles. Whether a household was classified as efficient depended on factors like its stated and observed heating patterns, etc.) were compared with other influencing factors. This study renders valuable insight into possible important factors that should also be considered in the Smart-A consumer research.

In Norway an electricity metering and controlling technology (calles E-Box) was investigated in a pilot project. The so called E-Box was used to control electric room heaters via internet or manually. A Time-of-use-tariff was offered simultanously. The box may contribute to reductions in electricity consumption (especially when customers did not regulate temperature at all before), but can also increase the bill. Distinctive user groups were identified by their reaction on the device and the results of their electricity consumption. Although the tariff structure was very simple this pilot project could nevertheless be useful, if additional data on the savings and on the categorisation of the users could be obtained.

2.4.3 Design and user needs

The design in the everyday smart environment and user needs on energy management were examined in three studies[3].

A research into interface design and user needs has been conducted. The problem is that connected home systems are often misused or under-used, because they are difficult to understand and operate. So, the successful introduction of smart technologies into the home is related to a number of challenges: Consumers may be resistant to the new concepts that the smart home presents, they may have limited technical experience to operate the system effectively which may reduce their motivation to use it, etc. Focus groups with users of smart homes give valuable insight into customer prejudices and reservations. For instance: The tariff recommendation will not be the best for the customer but for the supplier, data recording may be misused ("big brother"). Less invasive communication methods with the supplier are preferred.

One study posed questions on target groups, expressed requirements and latent needs regarding smart homes. The following three offerings were identified (1) demand side tariff optimisation, (2) energy advice and energy saving tips, and (3) indication of user energy profiles. The latter was also the focus of the study.

[3] "User Centred Design in smart homes: Research to Support the Equipment Management and Services Aggregation Trials", "Equipment Management trial", Probing a proactive home: challenges in researching and designing everyday smart environments".

Another study derived design principles from a human-centred perspective: Rather than increasing the complexity of life the new technologies should enhance the hominess of homes, protect peace, provide relaxation, intimate human relationships and shelter from the pressures of modern life. The experience – prototype is used more than an analysis or description of use behaviour. Research was done to qualitatively understand people's relationships to their homes and home technologies. As a special example the acceptance of a pillow with integrated smart home technologies was investigated. Interesting results were the following:

- Homes are a sensitive environment where people often hold rather conservative attitudes towards smart technologies. The typical idea of smart homes received in the media is the one of very visible technical elements, which dominate the space. Thus many people have difficulties imaging smart home technologies to be rather invisibly embedded than intrusive.
- The social acceptability and usability of the technologies can be enhanced, if familiar, comfortable and reassuring designs are used to provide these complex technologies.
- People have a lower threshold for delegating ambient elements, such as air conditioning, heating and security, to proactive technology's control, whereas they are sceptic that smart technologies will take a strongly proactive, intention-anticipating role in their personal lives.

2.4.4 Demand side, suppliers and experts

Three studies take a closer look to the demand side and to the opinions suppliers and experts in the business are expressing on customers.[4]

A study was on UK electricity industry stakeholder; in which terms they are speaking of electricity consumers when talking about demand side management (DSM). This is interesting as an increased deployment of reneweable energy also implies DSM measures to refer to the customer. It was concluded that representatives of the UK electricity industry do not represent customers in a way that they are participatory or communitarian (energy citizens). 'Innovation' was rather contributed to 'new actors' or participant in the industry itself than to domestic electricity users. Thus the change from a centralised to a more decentralised system seems to be not only constrained by industry regulations, but also by commonly-held representations about the 'typical electricity consumer.

Another study focuses on the market of home automation systems and components. A survey among several producers in this field on the consumer and on his reservations

[4] "Representing the demand side: 'deficit' beliefs about domestic electricity users", "WIM: Vernetzte Haushalte – Ergebnisse einer explorativen Expertenbefragung", „Marktstudie: Intelligentes Wohnen Schweiz 2006-2008"

with respect to these products yielded results that were rather general. For instance, the consumer does not know everything about the possibilities and benefits, etc. But there are some useful statements, too:

The consumers have the apprehension that numerous errors may appear. As several different and incompatible infrastructures are offered the consumer does not know which one will endure in the long run. Therefore even interested customers hesitate to buy the products. Nearly all producers share the opinion that the local dealers do not have the appropriate qualification and ability to convince customers. That is a big problem because especially these new technologies need to be offered in a special way, as the consumers are not sure about the benefits and the use. There is also low acceptance among the traders of these technologies.

Another study was a survey in Switzerland among stakeholders, architects, general contractors, real estate bureaus, producers of prefabricated houses, social housing association, etc. Customers and suppliers of home automation products were excluded. When asked how their own customers would like "smart living", they said that 93% are too less informed, they think it is too expensive (67%). Customer-demand is missing (63%) and "smart living" is too complicated (50%).

When asked what they themselves are experiencing or missing, 85% critisize that too many and confusing terms are used, 59% stated that information search is too time-consuming, 56% criticised that suppliers for information were missing and 49% stated that the existing information was incomplete.

2.4.5 Electricity consumption and programs

Three broad programmes of variable tariff introduction have been found[5]. The electricity consumption and the reaction of customers were analyzed. Detailed results are only available for two of the programmes, the third is still ongoing.

The first programme which was implemented in Norway intended to analyse empirically the effects of two-way communication between consumers and power companies. Time-of-use (ToU) tariffs are used. The factor analysis which linked the electricity use profiles with the five examined dimensions 'comfort', 'economy', 'save', 'regulations' and 'home' sheds light on the relationship between end-user energy attitudes and their energy behaviour and is very valuable for the Smart-A project.

Interesting results are: Price signals are partially effective, depending on the value set of the consumers. E.g. the most important value dimension 'comfort' is only effective with the price signal. ToU tariffs are necessary to really change the day profile of electricity consumption regardless of the weighing of "comfort". Generally, energy consumption is

[5] "Customer response on price incentives", "Evaluating participation of residential customers in demand response programs in the UK", "California's Statewide Pricing Pilot – Overview of Key findings"

socially robust, therefore other findings indicate that regulations through price directives seem to have little impacts. But measures aimed at energy saving developed and adapted to specific population groups displaying particular patterns of consumption, can manage to strike the 'right' attitudes and thus give rise to considerably change of behavioural patterns and a reduction of energy consumption.

A detailed simulation of domestic electricity consumption in the UK was done in another study. The aim was to evaluate when and to what extent specific electric devices contribute to a household's demand. These data were combined with data about household composition, socio-economic characteristics, life-style and energy use characteristic. The study authors conclude with regard to ToU tariffs that the current tariff structure in London (with lower tariffs at night) is not very efficient for the reduction of peak loads, as it only focus on electric storage heating and electric water storage. Instead of that ToU tariffs should give incentives to shift the electricity use of dish-washers, washing machines and tumble driers to off-peak hours, as this would not cause much inconvenience to people.

In a trial in the US consumers were offered several pricing concepts: (1) Time of Use (TOU) tariff, (2) Critical Peak Pricing (CPP), (3) Critical Peak Pricing, where consumers were informed 4 hours ahead and critical peak period could vary in length from 1 to 5 hours. These critical days were mostly days with high energy use for air conditioning.

Results showed that the TOU tariff led to a 6% reduction in the first year of the trial, but dropped to 0% in year 2. Furthermore, residential CPP reduced peak demand on critical days by more than 13%, while appeals for load reductions on critical days in the absence of price incentives did not result in demand responses. Overall CPP did not lead to changes in total energy use during the entire year. Consumer acceptance was very high, whereby consumers preferred CPP with one day ahead notification. Most of the costumers said they would prefer to continue on the new rate after the pilot project ended.

2.4.6 Acceptance of "interconnected living" and "smart homes"

There was one book[6] delivering an in-depth analysis of several factors that compose and explain a positive attitude – the acceptance – regarding home automation and the "smart home"-concept. 80 interviews were conducted for this survey. The book also provided generic data of the evaluation, so a detailed picture is drawn on the whole issue. The presented findings are very valuable for the Smart-A-project.

The acceptance of technology was composed of the attitude towards technology, the use of technology and the purchasing behaviour. It was compared with the age, sex, education, income, biography concerning technology (experiences in the job, family, leisure

[6] "Vernetztes Wohnen" ("Interconnected living")

with technology) of the participants. The results showed that the acceptance was higher for male interviewees, interviewees with a higher income and interviewees with a higher education. Most of the respondents declared that they were strongly influenced by the way technology was dealt with in their parents´ home. People living in urban areas showed a higher acceptance, as well as people, who had technical jobs.

Four types of households with different needs for organising and practical assistence were defined: The single household, the Young Dual-Career Families, the Empty Nest-couples and the senior households. Technology acceptance was nearly the same in all types of households. Only young Dual-Career families and Empty-Nest couples had a little higher acceptance of technology.

It could be seen that there was a correlation between a high acceptance of technology and a positive attitude towards „smart home“. Furthermore there was also a correlation between a low acceptance of technology and a negative attitude towards „smart home“. In general most of the people had a rather negative attitude towards “smart home” (50% negative, 30% positive, 20% indecisive). Since people had no practical experiences this assessment of the „smart home“ happened due to ideas and imaginations.

There was a significant difference between the senior households and the other household types concerning the preferred applications of smart homes. Security was most interesting for seniors, while others were mainly interested in energy management (this has changed a bit since 1997). Seniors also likely tended to think that they could manage things better on their own than with technology. Younger generations were more open-minded towards the connection to external networks than older generations.

A decisive criteria is the costs in relation to the anticipated benefit of “smart homes”. Three groups were characterised: Firstly, those who considered the costs of an installation to be too high. Secondly, those that would appreciate certain practical applications, but also considered the costs of the whole system to be too high. Thirdly, households that were not subjected to economic constraints preferred professional services rather than technical support.

“Smart home” surveys were performed in 1997 (the major part of the book is dealing with this survey), in 1999 and in 2001. Over time there was an increase of the acceptance and also the perception changed correspondingly to the status of this issue in the public and in the media.

The most recent study showed that increasing attention was paid to the undesired invasion into privacy; while the easement of the everyday life and security were the most often mentioned advantages of “smart homes”. These categories were followed by the energy-management-functions and their economic advantages.

3 Interviews with business professionals and stakeholders

3.1 Aims of the interviews

In addition to the literature search interviews with experts in the white goods industry as well as experts in consumer-related businesses should provide further input to the topic.

The aims were in specific:

- to discover whether there is industry research in this area that has been performed but has not been published and if possible to access it,
- to gather the perception of various experts coming from different fields of the business concerning the consumer respectively the customer,
- to further shed light on the consumer's behaviour versus his attitude, how to motivate consumers and what strategies are supposed to be successful,
- to get feedback on the SMART-A project and to announce the project in the community and outside.

The data and other results from this task will be used for the design of the questionnaire for the survey as well as for the design of the qualitative research.

3.2 Contacts to interview partners

Most of the experts are known by one or another team member. Only a few experts have been contacted based on internet sources, but those persons did not answer. Since there were several team members involved in proposing the interview partners and also some of the interviewees were suggested from persons during the interview, the interview partners were sufficiently wide spread.

Table of contact persons and data:

Manufacturers of white goods:			
Franz-Josef Wipperfürth	Electrolux, Head of Product Development DishCare	franz-josef.wipperfurth@electrolux.de	Germany
Fabricio Dolce	Electrolux Home Products Italy S.p.A., CTI -AE	fabrzio.dolce@electrolux.it	Italy
Jos Naenen Van Dyck	Fagor electrodomesticos	jnaenen@fagorelectrodomesticos.com	Spain
Luis Garate	Fagor electrodomesticos, Head of DOMOTICS Division	luisgarate@fagorelectrodomesticos.com	Spain
Jose Manuel Marcos	Fagor electrodomesticos, Head of Marketing of	jmmarcos@fagorelectro	Spain

	DOMOTICS Division	domesticos.com	
Sabine Hering	Miele Wäsche- und Bodenpflege international	hering@miele.de	Germany
Alain Xhonneux	MTS/Merloni, GPM - ESWH-GSWH	alain.xhonneux@be.mtsgroup.com	Belgium
Engineers and Consultants, sensors and smart metering producers:			
Simon Leach	Intertek ETL SEMKO (testing, inspection and certification of electrical products), www.uk.intertek-etlsemko.com	Simon.leach@intertek.com	UK
Rene Kemna	Founder and Consultant VHK, (consultancy firm for industrial product design and development, technical policy research of energy efficiency and passenger logistics, www.vhk.nl)	r.kemna@vhk.nl	Netherlands
Ing. Edwin Ploder	PTS Energie mit Strategie is a GmbH that has developed the PTS TM tariff manager)	info@pts-ploder.at	Austria
Guido Tschulena	Sensorberatung www.sgt-sensor.de	info@tschulena.de	Germany
Research, university:			
Dr. Harald Schäffler	Fraunhofer-Institut für Solare Energiesysteme ISE	harald.schaeffler@ise.fraunhofer.de	Germany
Paolo Bertoldi	IES (JRC) Ispra, Italy	Paolo.Bertoldi@jrc.cec.eu.int	Italy
(Market) research, consumer representatives. Energy agencies:			
Annegrete-Claudine Agricola	German energy agency, Head of Energy Efficiency with Electricity	agricola@dena.de	Germany
Holger Brackemann	Stiftung Warentest, Abteilung Produkttests II	H.Brackemann@stiftung-warentest.de	Germany
Friedemann Stöckle	GFK market research company www.gfk.com	friedemann.stoeckle@gfk.com	Germany

In the following each expert was assigned a number which is kept as an internal reference. Since anonymity was guaranteed the statements of the experts are only characterised by this internal number. German answers have been translated by the authors of the study at hand.

3.3 Questions and Answers

The experts got a letter with the list of the questions (see annex) and a short description of the SMART-A project (2 pages). The interviews were conducted by telephone and typically took between 30 min. up to 60 min. Usually the interview was started with a question regarding the work of the expert and on his/her relation to smart appliances.

3.3.1 Existing studies on consumers and smart appliances

During the interview all experts were asked whether they had done any consumer research or whether they know any existing studies on how consumers react on smart appliances.

Some of the expert´s companies are conducting consumer research, but it is focussed on consumer reaction on recent technology and new appliances: The sales of appliances, amongst others energy efficient appliances, the avoidance of stand-by losses, etc. This sort of research is always done by professional market research companies, like GFK. GFK itself has no “smart appliances-section” in its consumer polls and in the household diaries that are organised.

Manufacturers act differently during the development of a smart appliance and also during market introduction, this is corroborated by the statements of experts of white good manufacturers but also by experts of other companies. It was said it depends on the “company´s philosophy” the way it handles this issue.

Parts of new appliances like switches or touch panels are often tested in their own testing laboratories. Some do usability-tests prior a product incorporating a new concept is put on the market, others perform market research after the product has already reached the market to get an image how consumers liked it. General information on consumer behaviour is often gathered by press articles etc. Apart from inter-connectivity many other features of appliances are submitted to on-going change and manufactures strive not to “look old fashioned”. In one case the innovative technology was hidden behind an “eco-button” because the manufacturer felt that he would need more information on consumers and for the consumers if he wanted to advertise it actively.

A project with quite similar research question as asked in the questionnaire (see annex), was also started in 2007 by Fagor, Telefonica and BSH in Spain; until now no results are available. Research questions are among others: how does the consumer feel about being controled permanently, what does he/she wants to get in exchange, at what point will he/she be willing to except inconveniences.

Smart appliances are still rather perceived as a research topic, so experts claimed they would look for information in research databases. Miele (as a SMART-A project partner) has put together all studies that they know of, but hasn't been commissioning a specific research with the focus on consumers` reaction on smart appliances for its own purposes.

Appliances with "smart" components like start-delay, or the possibility to prolong action (washing machine) to get a better result with less energy are well established for some years already. So studies on such appliances are quite old. Studies on smart metering and tariff structure models were also conducted in the 1980s and 90s, especially on the question "Does a consumer needs less energy if he/she knows how much he/she is using?". An Esprit-Project has been mentioned for which a field test in 150 households had been performed to test different household communication systems and different tariffs. People were overstrained with the complexity of the systems. Today this might be less of a problem.

Some utilities were mentioned that want to introduce smart metering systems and will perform some studies on the feedback, e.g. Gmunden in Austria. Two projects of ISE Freiburg alas are not publicly available; the first with a utility on various consumer feedback possibilities/systems and the other one on tariff models. An interviewee referred to the energy box of Edelia, an EDF group company as a present initiative of a large utility (see: www.edelia.fr).

There were some smart home trials in UK and an evaluation of the DDC project in UK in the EEDAL-Conference 2006. Less specific were hints to visit fares like Domotechnica or Hometec and to consult European technology platform on smart system integration (www.smart-systems-integration.org).

3.3.2 Perception of smart appliances and the SMART-A project

The SMART-A project is focused on only a specific aspect of a smart appliance: the interoperability with electricity supply respectively the adeptness to react on the requirements of the grid. The experts were asked how important they judge this feature in comparison to other design features of an appliance of the future.

In every interview a vivid discussion of the meaning of smart appliances was started which went beyond the initial question. It is not possible to reflect all of the statements in details so only those parts that were rather focused on the initial question are given here. Some of the statements can also be read in chapter 4.4.

Only few experts accepted features like a "start delay"-button as smart. Several claimed that a smart appliance is not smart without being integrated in a smart system, either a smart metering or a smart home. An essential feature of a smart appliance is its ability to communicate within a network. Thus the project name was perceived a bit misleading by some experts.

> "Ihre erste Frage zielt doch nicht auf die appliances in erster Linie, sondern auf die Anwendungen von Optionen, die smart metering beinhalten." (1) [„I suppose your first question is not aiming at smart appliances but rather at options that can be realised with smart metering."]
>
> „SMART-A ist eine bestimmte Form von demand response, aus unserem Verständnis, wenn es darum geht, einen kurzfristigen Effekt im Lastgang von Kunden zu erreichen durch entsprechende Tarife oder Anreizsysteme." (10) ["SMART-A is in our opinion a demand response activity to reach a temporary effect on the load curve of the customer via a tariff offer e.g.."]

Manufacturers stated that the development of smart appliances is still at its beginning and that many obstacles have to be overcome. Since the smart environment for the appliances no matter how smart it is, is not developed they are not adequately installed and employed. The convergence group at CECED (European Committee of domestic equipment manufacturers) has been mentioned several times as an initiative of manufacturers to solve the open questions and to act in unison. This group has also commissioned the University of Palermo with a study that identified as the big beneficiaries the utilities respectively the transmission and network operators. Without utilities that offer a special tariff for customers with smart appliances the manufacturer bears a double risk: Not only the appliance has to be developed but also an organisation has to be set up to deliver the smart appliance and corresponding services on the market.

> „We have always strongly believed in home automation. It has been not so easy as we had thought." (8)
>
> "From the Ecodesign studies you see that the single appliance, the isolated appliance has really reached the zenith of performance in terms of efficiency.…The step forward is to think instead of isolated appliances of "social appliances." (4)
>
> "[Unsere Strategie ist es, jeweils] Minimum ein Gerät kommunikationsfähig zu haben." (5) [„Our strategy is to have at least one model of each product group of the major appliances that is interconnectable."]

Nevertheless the SMART-A approach is perceived as important for the possibility to get smart appliances into the households by means of better tariffs. But several open questions e.g. in the field of standardisation need to be cleared.

> „Da müssen sie die Geräte dann auch schützen, dass sie nicht mitten im Arbeitsvorgang abbrechen…Die Normung muss ja auch berücksichtigen, dass in Geräte mit größerer Öffnung, wie Trockner und auch schon Waschmaschinen, dass da dann Kinder hineingehen können und dann zu Schaden kommen könnten." (5) [„You have to protect the appliances because they should not stop while they are in the midst of their work cycle…The standardisation has to bear in mind also that children could climb into the appliances that have an opening wide enough, e.g. tumble driers or washing machines."]

Last not least it was mentioned that smart appliances – as well as appliances controlled via DDC like in UK – provide the possibility to take another step forward in environmental policy goals.

> "I think it will be very important, because it [DDC] is a very simple method that can relief the stress of the grid. It is not saving our climate but it is a tool in the box. It is also an "all gain"-measure." (7)

3.3.3 Statements on the motivation and attitude of consumers

The interviewees were asked how they judge the attitude of consumers in private households concerning the SMART-A topic. It was clear for all of them that smart appliances as for the SMART-A project i.e. interconnected in a smart demand side energy management, have to be beneficial for the household. At least people have to renounce the service the appliance provides temporarily; they cannot start the operation at any time, etc. Two incentives to get the agreement of the household were mentioned in the first row: either people gain an economic benefit or people want to contribute to reduce the environmental burden.

> „Ich glaube, dass das weniger mit smart appliances zu tun hat, sondern eine grundsätzliche Herangehensweise ist. Die große Menge der Verbraucher braucht, um etwas zu tun, um sich auf etwas einzulassen, das Gefühl davon einen Nutzen zu haben, einen Vorteil zu haben. Den kann man immer sehr gut monetär eintriggern." (1) [„I guess that is quite general and is not related to smart appliance in specific: Most people will only act if they feel to profit from it, to have an advantage which is at the best a monetary one."]
>
> "I think, for the customer it is not important [to have a smart appliance]. Unless there are financial incentives for him, unless he gets a better tariff because he allows the appliance to be switched on or off. There is no other benefit for the consumer. Unless he is an environmentalist." (2)
>
> "[Die Attraktivität] hängt ja nicht vom Gerät alleine ab, sondern im Prinzip muss man auf Seiten der Energieversorgers Angebote haben. Was wir aus Studien kennen ist, dass die Konsumenten beim Kauf eines großen Haushaltsgerätes neben der Leistung, der Energieverbrauch und auch der Wasserverbrauch schon relativ weit oben stehen. Das ist nicht nur aus Gründen der Umwelt, sondern es sind auch die entsprechenden Kosten, die sich da auf´s Budget schon erheblich niederschlagen. Entscheidend ist in diesem Zusammenhang: Gibt es entsprechende Angebote des Energieversorgers? Warum soll ich mir als Verbraucher ein solches Gerät kaufen?" (3) ["What counts is not the attractivity of the appliance itself but the offer of the utility. We know from various studies that consumers rate electricity consumption as well as water consumption quite high. Not only because of environmental concerns but also because the subsequent expenses already have an impact on their household budget. So it is crucial in

this respect: Are there any offers of the utility? Why should the consumer buy such an appliance?"]

It was judged differently by the experts whether smart appliances will ever save enough energy to considerably reduce energy costs of the households. Some experts said energy is simply too cheap and savings are too small to persuade people to buy a smart appliance unless it is as cheap as the ordinary one. Others refer to the use of night or weekend tariffs that are widely accepted and successfully utilized. A parallel was seen to energy efficient and water saving appliances: People are asking for this at the point of sale being sensitive to the operation costs over the life span of the appliance. The energy efficiency is a popular criterion e.g. in Germany and Austria, whereas in south European countries load management possibilities are considered as an advantage.

Smart appliances are in particular attracting attention of people that are fond of innovative products and "last generation" products and who appreciate electronic functions and interfaces. These represent a certain consumer group. To extend the attractiveness to a broader public smart appliances and their utilisation should be associated with a modern and progressive life style.

> „Aber nach außen sagt man dann nicht, dass man Geld sparen will, sondern dass man stolz ist ein umweltschonendes Gerät zu haben. Ein intelligentes, schlaues Gerät zu haben findet ja auch jeder gut." (3) ["Directed to other people you do not admit you wanted to save money but you are proud of your efficient appliance. An intelligent smart appliance is very popular, too."]

> „Aber es ist mehr als das. Es ist ein Gefühl das Richtige zu tun, vielleicht modern zu sein, fortschrittlich zu sein. Das ist sicherlich motivierend und handlungsunterstützend." (1) [„But it is more than that. People have to believe they are doing the right thing, also they are modern, progressive. This will motivate them and will support responsible actions."]

As a deficiency it was stated that smart homes operated problem-free only if equipped with the products of a sole manufacturer – from the dishwasher to motor driven blinds. But people do not like to be dependent.

Concerning the income of the buyer's households slightly different opinions were expressed: either the high income as being conducive because smart appliances are probably the more expensive ones but on the other hand medium income households will be keen to reduce their energy costs.

It was found a prerequisite that smart appliances should not only operate in a demand side energy management system but also show its strengths to increase the user's comfort.

> „Es kommt auch auf die Wohnsituation an. Wenn Sie ein großes Haus haben, dann ist es schon sehr unkomfortabel durch jeden Raum zu rennen ob noch Licht an ist oder ein Fenster auf ist. Bei einer 2-Zimmerwohnung ist das natürlich kein Problem, aber bei einem Haus vielleicht schon. Das sind Fähigkeiten, die in Richtung Kommunikationsfähigkeit gehen und nur mit Vernetzung zu realisie-

> ren sind.“ (5) [„It depends also on the living conditions. If you live in a big house it is uncomfortable to look into all rooms whether the light is on or a window is open. This is no problem in a 2-room apartment, but in a house it might be. You need interlinked appliances or devices then.”]
>
> “And there are more considerations such as the additional comfort that smart appliances can offer. E.g. if you come home you find that the home is at a certain temperature, the lights are on, etc. You have also the protection, the safety measures etc.“ (8)
>
> „Die Gefahr ist, dass wir das Energiesparinteresse des Kunden zu isoliert betrachten und dafür eine eigene technische Lösung bauen, dass wir nicht das Gesamtbedürfnisspektrum der Kunden im Auge haben. Ich glaube, dass Monitoring-Funktionen, wie z.B. „Funktioniert meine Waschmaschine noch gut?“ oder das Erkennen von Verkalkungen interessant für Kunden wäre. Also, wenn das Gerät eine Funktion hätte, die den Energieverbrauch misst und dann die Intelligenz hätte festzustellen, ob was zu tun ist, das würde dem Kunden wirklich etwas bringen. Denn eine entsprechende Reparatur kostet gleich 300-400-500 Euro.“ (10) [“We should not detach the energy saving attitude of the customer from the whole spectrum of his wishes and needs and design a technical solution only for it. To my opinion [especially] monitoring features like e.g. to check the correct functioning or whether there are some calcifications are useful for customers…”]

Smart appliances should in any case leave the possibility to terminate the remote–mode and to continue with normal operation e.g. to immediately start to wash the clothes albeit with expensive electricity. For several experts there seems to be no doubt that this is prerequisite to the acceptance of customers.

3.3.4 Statements on the behaviour of consumers

The experts were asked: Which restrictions or which discomfort will be acceptable or just tolerable for the consumer who is using such a smart appliance? If possible the expert should specify his answer for various appliances (washing-machine, tumble drier, dish-washer, refrigerator, freezer, oven and stove, heating circulation pump, air conditioner, electric water boiler).

In the previous chapter the point was whether people could be motivated to use or to buy a smart appliance within a smart metering context. The focus of this chapter is to which extent people are willing to change their habits in case this is a pre-condition.

> “One is the perspective of the customers that are eco-devoted. To convince them to change their habit is not the problem, because they have already changed their habit. They would accept to move to night hours.” (4)

Experts expected fewer problems for refrigerators and freezers given the food quality is preserved. However for cooking it seems unfeasible because full control of the tempera-

tures is necessary during cooking. An intermediate position take washing, dish washing and tumble drying which could be set back to night hours if there are incentives.

Concerning the heating and the air conditioning people would not accept even small deviations from the desired room conditions. On the other side these systems have a substantial inertia, too. Intermittent operation will certainly remain unnoticed by the occupants, hence leaving much room for remote control.

At any rate the consumer will insist upon the possibility to override the external control putting the appliance into operation immediately.

> „Ich denke, das kann nicht die Lösung sein [dass der Konsument Einschränkungen im Betrieb akzeptieren muss]. Wenn ich grundsätzlich dem Verbraucher die Entscheidung überlasse, ob er sich systemoptimiert steuern lassen will durch ein gegebenes Programm und lasse aber trotzdem zu, wenn es heute nicht passt, weil ein Tag einmal anders aussieht als sonst, kann er jederzeit eingreifen, also diese Freiheitsgrade müssen auf jeden Fall da sein.“ (1) [“To my opinion it cannot be the answer to impose restrictions to the consumer. Even if the consumer agreed to let his appliances be remote-controlled, he must have the freedom to intervene on a day not everything is going on as usually.”]

Some experts said that consumers want to perceive the whole thing is worthwhile, is paying off. The consumer gets this impression if the appliance finishes a full operation cycle with cheap or green electricity.

> „Für die Akzeptanz des Ökotarifs, wie es beim SMART-A angedacht ist, ist es sicher grundsätzlich wichtig, wie lange der Ökotarif jeweils ansteht und genutzt werden kann. Zumindest in der manuellen Option sollte schon mindestens ein Arbeitszyklus möglich sein. D.h. maschinenbezogen, ein kompletter Waschzyklus sollte im Ökostromtarif begonnen und abgeschlossen werden können. Bzw. im Mensch-Maschine-Fall, z.B. beim Bügeln, sollte auch die gesamte Bügelwäsche mit Ökostrom erledigt werden. Ansonsten ist nämlich die Technik schnell zu aufwändig.“ (13) [“To obtain acceptance for the green tariff as perceived in SMART-A, the period is essential during which the green electricity is provided. Concerning the appliance at least one operation cycle should be able to be finished. Concerning a manually operated appliance like an ironing system, the work has to be completed. Otherwise the technology is too costly.”]

Some interviewees guessed that by no means the consumer will tolerate the mutilation of the appliances´ services (except for attractive tariffs, maybe). The consumer is accustomed to get these services whenever he wants and that electricity is always available. Contradicting other interviewees saw no problems with inconveniences or said this will depend on the living situation.

> „Es muss im Rahmen für den Konsumenten sein. Einfaches Beispiel: Ich bin berufstätig und vor 17 Uhr nicht zu Hause. Wann die Wäsche jetzt gewaschen wird, ist mir egal, Hauptsache, sie ist fertig wenn ich zuhause bin, damit ich sie dann in den Trockener tun kann. Dann haben sie eine andere Situation: Jemand

> der ständig zuhause ist, dem ist es vielleicht wichtig, dass sie gerade in einer bestimmten Zeit gewaschen wird.“ (5) [“It has to fit to the consumer’s situation. Let me give an example: If I am working and not returning home until 5 p.m. I do not mind when exactly the washing machine is operating as long as the laundry is done until then. If I am at home all the time maybe I want it done at a certain time.”]
>
> “No restriction that they notice. It is necessary they do not notice it, but they nevertheless need to be warned. People want to have everything, but without differences in use. E.g. they want to have an extra energy efficient appliance and technology has to solve it.” (7)
>
> „Wie weit das akzeptiert wird, ist dann sehr abhängig von den Zielgruppen und der konkreten Wohnsituation. Da gibt es sicher den Unterschied zwischen den Leuten in einem Eigenheim und jenen, die in einem Wohnblock wohnen, wo die Waschmaschine im Keller steht und sie daher nicht so flexibel auf diese Möglichkeiten reagieren können.“ (13) [“Acceptance depends on consumer groups and their situation of living. There is certainly a difference between people in their own house and people in residential buildings who have their washing machine in the basement and cannot realize the smart possibilities anyway.”]

Other aspects were mentioned that might be a barrier for the consumer acceptance.

> „Noise might be a negative difference when the smart appliance is operating usually during the night contrary to normal appliances, especially when living in a flat. Fears of wrong functioning, causing floods or fire are also there. People don’t like to have appliances on, although there are appliances always on. But people are not fond of this.” (7)
>
> „Elektrosmog ist auch ein Thema, was für Konsumenten ein Hindernis darstellen kann bei der Nutzung der smart appliances. Dabei ist es gar nicht nötig, dass immer hohe Sendeleistungen zur Verfügung gestellt werden. Aber es kann mental ein Problem sein.“ (11) [“Health concerns due to the electromagnetic radiation might also be an obstacle for consumers. Although signal intensity doesn’t need to be high they feel uneasy with it.”]

As the whole issue is quite complex people might remain sceptically and might not take up the new technology – but future might also show up with smart appliances in a smart demand side management-system.

> „Und da haben wir gemerkt, dass das sehr erklärungsbedürftig ist, diese ganze Problematik, und dass selbst Tarife, die nur Vorteile bieten, keinerlei Risiken, trotzdem relativ skeptisch und kritisch betrachtet werden.“ (10) [“We realized that everything needs to be explained thoroughly. Even tariffs that are beneficial for everyone, with no risks, are eyed at sceptically.”]
>
> „Das ist halt im technischen Bereich so. Wenn sie eine Innovation haben, die der Verbraucher so nicht kennt, gehen wir z.B. von einer Digitalkamera aus. Vor der Einführung der Digitalkamera konnte der Endverbraucher im Prinzip gar nicht

> abschätzen, was kann er mit so etwas machen. Und dann kommt so eine Innovation auf den Markt und plötzlich revolutioniert sich sein komplettes Fotografierverhalten. Komplett, von heute auf morgen. Und so etwas im Vorhinein abzuschätzen ist extrem schwierig. Man kann vielleicht über Laborsituationen etwas machen, und Simulationen." (11) ["This is the situation concerning technical products: if there is an innovation, let´s say the digital camera, you cannot estimate its impact. The innovation is introduced on the market and as a consequence the consumer's photography behaviour is revolutionised. Completely from one day to the other. It is difficult to estimate this in advance. Maybe you could put people in a laboratory environment or do some simulations."]

There was also a strong vote by some experts that smart appliances were no contradiction to the familiar standard of convenience.

> „Normalerweise kommt das nicht vor. Meistens gehen die Sachen parallel. Da gibt es keinen Kontrast. Es wird einfach angenommen, dass der Konsument [seine Geräte] genauso leicht wie vorher [nutzt], ohne es zu merken, dass die Geräte einfach weniger verbrauchen. …Es ist keine Strafe. Es ist einfach eine Sache, die von den Entwicklern gemacht wird und wo die Industrie dann investiert." (6) ["Usually this is not the case, things are in parallel, there is no contradiction. The perception is the consumer can simply [continue] while the appliance consumes less energy without noticing it. … It should not be a punishment. It is developed by engineers and implemented by industry."]

> „Ich geh zur Haustür raus und da gibt es einen Schalter, damit werden alle großen Elektrogeräte, Standby-Geräte, bestimmte Steckdosen usw. ausgeschaltet und ich muss mir keine Gedanken machen, ob jetzt noch ein Bügeleisen an ist." (10) ["When I am leaving my home I turn a switch and all major domestic appliances, all appliances with stand-by power are switched off. I don't have to worry about a hot electric iron."]

3.3.5 Statement on information of consumers

In most of the interviews "information of the consumer" evolved as an issue although this topic was not in the questionnaire. The discussion was how far the consumer wanted to be informed and how far he should be informed e.g. on the technical background, on the tariff structure, etc. All experts were in favour of coherent and comprehensible information of the customer.

> "We are absolutely convinced that this is really so: The consumer, if he has a detailed information, e.g. how much he is consuming and what he can do, he is absolutely positively interested in such information." (8)

> "Wenn jemand dann handelt, dann glaube ich, die meisten Menschen brauchen wenige, einfache und klare Informationen. Und dann gibt es immer eine Gruppe, die wollen alles ganz genau wissen. Die wollen auch alles genau überprüfen und kontrollieren können. Aber das sind vielleicht 10%, die es ein bisschen genauer

> haben wollen und 5%, die es ganz genau haben wollen. D.h. es muss erst ´mal jedem einfach, schnell die Grundinformation verfügbar sein, und wenn er es genauer wissen will, ist es toll, wenn man es auch anbieten kann, und wer es ganz genau wissen will, dann ist es noch besser, wenn man das auch noch anbieten kann. Das ist in anderen Bereichen auch so, nicht nur bei smart appliances.“ (1) [“Most people who have decided to act need only few, coherent information. Nevertheless there are always some, maybe 10% who want to control and verify everything. And maybe another 5% scrutinise everything. Hence the basic information has to be quickly available, it is great if you have further information for those who want to know it in detail and it is fantastic if you also can provide in depth information for those who want to know everything. Generally this is the case not only for smart appliances.”]

An extensive discussion concerned the tariff structure which is combined with smart appliances. Its complexity might be high; particularly if there is an option to retrace single operations, whereas the corresponding savings would be only a few cents each. The strategy thus should be: help the customer to get an idea what is his load curve, what is his saving potential, what are appropriate actions like stand-by losses or peak load reduction.

> “Letztendlich läuft es darauf hinaus, dass er eine Vorstellung davon bekommen muss, was er sparen kann. Bisher ist die Problematik bei den Konsumenten nicht bekannt.“ (3) [“Eventually he should be able to imagine how much he can save. Until now customers did not deal with this kind of problems.”]

> “Wir haben durch ein paar Voruntersuchungen mit Kunden schon festgestellt, dass die Bereitschaft bei den Kunden im Augenblick noch sehr gering ist, sich mit solchen aufwändigen, relativ anspruchsvollen Technologien auseinander zu setzen, so dass wir überzeugt sind, dass wir erst Mal überhaupt mit Feedback-Systemen arbeiten müssen, dass die Kunden überhaupt erst Mal ihren Lastgang kennen lernen.“ (10) [“After some customer examinations we found that customers were not ready to deal with such an intricate technology. Thus we are convinced that feed-back systems have to be introduced first, to let the customer get to know his load curve first.”]

On the other hand an automatic system is also feasible.

> „Ich war ja jetzt in Wien auf der Konferenz „Metering and Billing“ und da hat ein Vertreter von „Capgemini“ vehement dafür plädiert, demand response, alles was mit Tarifen zu tun hat, Beeinflussung von Verbraucherverhalten, dass man das vergessen kann, dass die Leute daran kein Interesse haben, keine Lust darauf haben, sondern wenn, dann muss das komplett vollautomatisch funktionieren. Er sagt, dass die Energieversorger langfristig den größten Effekt erreicht haben, die einfach zu den Kunden gehen, sagen: hier ich will dein Haus anschließen, du kriegt dafür einmal eine bestimmte Gebühr, und dann werden entsprechende Geräte, Thermostate, mit einer Intelligenz ausgerüstet, meist über Powerline, und dann werden die – ohne dass der Kunde das merkt – vom Netzbetreiber aus ge-

> schaltet.“ (10) [“I visited the conference „Metering and Billing“ in Vienna. A presentation was given by a representative of „Capgemini“ who argued vehemently that demand response, everything that is related to tariffs, trying to influence consumer behaviour, you can forget about it. There has to be a fully automatic solution. To his opinion the utilities were most successful that simply contacted the customer, offered him a certain tariff or bonus if he let control some appliances which were in the following equipped with power-line and subsequently controlled by the utility without the customer realising it.”]

Some answers of the interviewees were also centred around the information that has to come with the smart appliance or the smart system the smart appliance is connected to.

> „Wie qualifizieren sie [als Energieversorger] eigentlich ihre Kunden, dass sie ihre [smart metering-] Systeme richtig nutzen können? Da sind erstmal sehr viele technische Möglichkeiten enthalten, aber ich muss das ja erstmal auch können, als Verbraucher.“ (1) [“How do utilities qualify their customers to correctly use the smart metering system? At least the customer has to cope with a bundle of technical solutions.”]

> “But anyway we go to the households, we have to tell them something the new refrigerator is doing. We are still not sure how much we can tell them. The reporting in the press – not on a prominent place, but still it was there – has been mostly positive, but there has been some negative reporting, too. And you don’t know, people might have understood it wrong…” (7)

> „Wir haben einmal einen Versuch „Waschen mit der Sonne“ durchgeführt. Da haben wir in Mannheim und einer anderen Ortschaft so 30 Kunden mit einer e-Mail täglich versorgt, wie der Sonnenstand ist…. da ging es nicht allein um den Bonus, der war eher symbolisch, sondern um den Umweltgedanken und es war dann auch klar: es ist schön und nett mit dieser täglichen Nachricht, aber das sollte dann doch in Zukunft automatisch passieren.“ (10) [“We made an investigation „washing with the sun“. 30 participants received a daily e-mail on the expected hours with sun [hence the pv-electricity]. The participants were totally eco-motivated, the financial incentive being almost nothing. But the conclusion of the participants was: allright with the e-mail but in the long run it should be automated.”]

> “The main problem is surely the communication on this. A clear, nice and really good presented communication to explain how the appliance works and how the consumer is able to terminate the smart function…” (14)

As consumers are often sceptical on savings promises of manufacturers and utilities official programs and tools were appreciated.

> “Because as I said, if it is the information of the manufacturer, it is not credible. That is why savings information has to be supported by official tools like energy efficiency labelling.” (14)

3.3.6 Country specifics

When the discussion moved on to country specific variations in consumer attitude most of the experts seemed to feel not really comfortable with this topic. Differences in the energy supply systems were stated at first. The interviewees also thought of cultural distinctions in electricity use in general and in the attitude towards purchasing and handling the major domestic appliances as well as appraising their services. But those differences probably decrease in quantity and quality. On the other hand behaviour is quite diverse, e.g. the way to do the laundry etc. The attention was also drawn to the eastern European countries but experiences with the consumers in these countries are still rare.

> „I think that there are differences and the differences were even bigger. But because of the economy homogenisation and because of the life style homogenisation the only differences [that will sustain] are more or less climatic differences. The cultural differences unfortunately seem to become "flat"." (4)

First of all the national electricity markets and the electricity supply are varying in the European countries. There were mentioned the monopolistic market (France) vs. a variety of distributors and suppliers (UK, Italy, Germany), various programs and goals of the government concerning energy consumption (UK, Netherlands: Gas was promoted), maximum power intake for private households in Spain and Italy, night tariffs in Germany, Austria and France, the level of grid reliability which manifests itself in the duration of supply interruptions for households, etc. These differences bring forth a specific interest in e.g. load management, time delay functions, etc. They also cause differences in what people are accustomed to encounter concerning the domestic appliances.

> „Ja, da gibt es sehr große Unterschiede. Nehmen wir z.B. Italien. Da sind die meisten Haushalte nur mit 10 Ampere abgesichert. D.h. die Leute sind seit jeher gewohnt Energiemanagement zu machen." (13) ["Yes there are big differences. Take e.g. Italy. Most households have only 10 A maximum current, this means people were always doing their energy management."]

In the background there are also cultural variations in the interaction with appliances:

> „Die Deutschen sind da eher konservativ [betreffend die Haltung zu smart appliances]. Da wird es aber große Unterschiede geben in Europa." (1) ["Germans are rather conservative with respect to smart appliances. But in Europe big differences will persist."]

> „Ich glaube Elektrolux hat da einmal eine Initiative in Italien gestartet, wo jeder Waschvorgang zu einem gewissen Preis verrechnet wurde. Die Maschinen wurden hingestellt und man hatte einen Automaten und musste Geld hinein geben. Das ist in Italien relativ gut angekommen und in Deutschland überhaupt nicht." (12) ["I remember Electrolux has launched an initiative in Italy to pay directly for each service of the appliance. Washing machines have been given to households and you had to pay according to the number of washing cycles. This was very popular in Italy but failed in Germany."]

> „Die Gewohnheiten sind sehr verschieden, aber trotzdem wird dann eine Art von Gerät gemacht. Die Geschirrspüler in Amerika sind nicht so verschieden von jenen in Europa. Und in Europa wird das gleiche Gerät von Spanien bis Schweden verkauft. Wenn sie fragen, wie wird von der Hand Geschirr gespült, dann sehen sie: die Praxis ist grundverschieden.“ (6) [“Although the habits are quite diverse, the appliance is not. Dish washers in US are not so different from those in Europe, and in Europe the same appliance is sold from Spain to Sweden.“]

The previous comment came from a product designer (technical part). Manufactures stated in contrary big differences from their point of view:

> “Features that are asked for can be very differently from country to country. If you take a fridge freezer: if you go to England, the refrigerator compartment is smaller than the freezer compartment. In Spain it is totally the opposite: you need a big fridge and a small freezer.” (8)

In addition there are also different levels of the general determinants of consumer attitude: the perceived value of the environment, the price of an appliance vs. the benefit etc.

> „Es ist einfach so, dass in Südeuropa preiswertere Haushaltsgeräte eingekauft werden. Ob das am zur Verfügung stehenden Einkommen liegt, an Traditionen oder anderem, da muss ich ehrlich sagen, dass weiß ich nicht. Die Märkte in Europa sind unterschiedlich strukturiert, es werden andere Preissegmente in verschiedenen Ländern nachgefragt.“ (3) [“It is a matter of fact that in southern European countries cheaper appliances are bought. I don’t know whether this results from the income, from traditions or something else. The markets in Europe are quite differently structured, different price segments are demanded by consumers.”]

> “In eastern European countries for me the ecological sensitivity is very low, probably accept from 1 or 2 countries like Poland perhaps. And of course in these countries money is all. Because people have low incomes. And for them it is not easy to afford buying these appliances.” (14)

> „Auch zu den Energieeffizienzklassen in verschiedenen Ländern, das ist eine komplexe Frage. Natürlich korrelieren Energieverbrauch und Preis in gewissem Umfang – selten wird ein besonders energieeffizientes Gerät auch besonders billig sein – aber man kann den Markt nicht nur so einfach erklären.“ (3) [“With respect to the energy efficiency classes this is a complex subject. Of course energy consumption and price correlate to a certain extent – a top energy efficient product is usually not the cheapest one – but you cannot explain the market as simple as this.”]

3.3.7 Statements on main actors to foster implementation

The interviewees were asked what could be the most successful strategies to increase consumer's attitude towards smart appliances and who has to be the main actor then: the energy supplier, the appliance producer, government, or who else?

Most of the experts stated it clearly: The major benefit is for the utility, that most often operates also a network and the transmission system. And the most profit of smart appliances controlled by utility requirements is drawn by an optimisation of the whole chain from generation, to transmission and distribution, to the consumer.

> „Es geht ja darum, das ganze System, von der Erzeugung der Übertragung, Verteilung, bis zur Anwendung zu optimieren." (1) ["The point is: to optimise the whole system, from generation, transmission, distribution to consumption."]
>
> "The main actor is the utility…. But I think it is always part of an offer the supplier can make and it depends whether in this country there are peak tariffs or not, it depends on a lot of factors." (2)
>
> [Refering to the various actors involved] „Ich kenne keine Zusammenarbeit. Aber der Verbraucher braucht ja beides [das Angebot innovativer Geräte und die entsprechenden Tarife], es muss Hand in Hand gehen." (3) ["I don't know of any cooperation. But he consumer needs both, the innovative products that are offered and the accordant tariffs."]
>
> "If we talk about energy management, today the real value is not in more efficient appliances or something that we can confine in a product. It is in the entire chain from the generation, the transportation, the distribution and the usage. If we succeed to putting in place a synchronised chain, able to control the demand, able to distribute the energy without overcharging the lines, without demanding costly plants to run, we are able to deliver in a much more efficient and cost saving way the energy to the user. But to be able to have all the actors in place, actively offering, you need to distribute the advantages to all the actors." (4)
>
> „Und der Vorteil liegt größtenteils bei den Energieversorgern, da sie ihre Hardware, ihre Netze nicht so ausbauen müssen, weil sie flexibler sind. Dort liegt das größere Volumen an Kostenvorteilen und nicht beim Kunden, auch wenn der einen günstigeren Tarif bekommt." (5) ["Quite evident are the advantages for the energy suppliers, because they don't have to upgrade the grid, because they gain flexibility. These are the great benefits and the customer is left with peanuts even if he gets a better tariff."]

Beside institutions on national and EC-level also play an important role by promoting efficiency goals and campaigns or programmes to reach the goals.

> "In all countries you have the national energy agencies and they have to implement the savings, the energy savings which are "dictated", proposed by the authorities of the European union. All these agencies are working very hard to implement the energy savings programmes proposed by Brussels. If you look at

> Spain, Italy etc., every country has a very important agency. They have to translate the programme into reality in the very next years." (8)
>
> „Es müsste Programme auf EU-Ebene geben. Nationale Programme sind da zuwenig. Die Gerätehersteller agieren ja auch Europaweit, wenn nicht global." (8) ["Programmes on European level are necessary. National programmes are not enough far reaching. Manufacturers also act on a European level, if not on a global level."]
>
> „And then supported by the authorities in order to reach a global target. In the end, the interest is nor for the consumer, 40 Euro [he could save with a very efficient new water heaters] is nothing, but 6 million of water heaters saving each 400 kWh per year in terms of Kyoto target, 2020 target, it is another story." (14)

Designing campaigns one should not forget that people are already envisaging that cheap fossil energy will come to an end.

> "Honestly, if you see today the actual cost of energy is too low to be attractive from a simple perspective of cost savings. If you make a calculation imagining the current tariff the savings are few cents. While if you buy washing powder that is in offer you save more…. Costs that will change in the next future because energy costs will take into account more and more the CO_2 involved in the production or what are today's hidden costs of the energy." (4)

3.4 Additional interesting statements

This chapter contains statements of the experts that somehow did not tangle the main questions and therefore are not fitted into the previous chapters. Anyhow, they should not be left aside. In this chapter only the central parts of the German statements are translated.

<u>Statements on strategies to optimise the system, smart metering:</u>

"Man müsste doch fragen: Wo liegt erst mal der Nutzen von solchen Systemen. Es geht ja darum, das ganze System, von der Erzeugung der Übertragung, Verteilung, bis zur Anwendung geht es darum das gesamte System zu optimieren. Und an allen Bereichen gibt es Optimierungspotentiale und die Gesamtheit kann ich erschließen, wenn ich alles optimiere. Und jetzt habe ich aber hier, über die Kette des Systems betrachtet mindestens 4 Akteursgruppen: Ich habe die Erzeuger, die Verteiler, die Lieferanten und die Verbraucher um es nur grob zu sagen. So. Und wir haben auf europäischer Ebene ein zerstückeltes System. Die sind alle Einzelakteure im Spiel, sozusagen. Ein Erzeuger kann erheblich profitieren, wenn der Verbrauch, die Last gesteuert werden kann. Er hat aber gar keinen Kontakt mit dem Verbraucher. Der Verbraucher kann profitieren, wenn er Kostenersparnisse hat. Er kann darüber hinaus profitieren, wenn er weitergehende Information kriegt. Nicht nur: Jetzt schmeiß´ ich die Waschmaschine an, sondern auch wie er sie dann so energieeffizient wie möglich betreibt, da hat er zusätzliche Einsparungen. Und der Lieferant, der liefert erstmal nur. Dann könnte man sich denken, da

gibt es einen fünften Akteur, der den Verbraucher unterstützt bei seinen Bemühungen einzusparen. Das könnte z.B. ein Anbieter von Zähldienstleistungen sein, der die smart meters betreibt. Jetzt ist die Frage, ob dieser Anbieter erfolgreich arbeiten kann in so einem kleinteiligen Markt. Das kann ich auch nicht beantworten. Ein einziger Haushaltskunde braucht vielleicht vergleichsweise hohe Betreuung und hat aber einen vergleichsweise geringen Verbrauch. Bei großen Industrieunternehmen ist das ganz anders. Ich habe meine Zweifel, ob das für private Verbraucher wirtschaftlich ist. Aber vielleicht geht es doch. Das wäre eine genauere Betrachtung wert. Ich weiß auch, in Deutschland sind auch Energieversorgungsunternehmen aus verschiedenen Sparten dran, von der Versorgung über die Lieferanten solche Systeme auszuprobieren, aber die stehen meines Wissens ganz am Anfang. Da liegen noch keine Erfahrungen aus der Praxis vor." (1) ["If you look on the energy system the chain has at least four links: the electricity generation, the transmission, the distribution, the consumption. You can think of a fifth actor in this chain: someone who helps the consumer to save energy. This could be a smart metering service. There arises the question whether this could be commercially successful in such a small scale market, each customer needing time-consuming support. I am not sure about this, but maybe an investigation is worth it."]

"From one side there is a clear demand from the user to have things ready when he needs it, and more and more in a fast way, so he doesn't want to wait for 3 hours washing even if 3 hours would save energy. And he wants to have good results, not decreasing results. On the contrary the utilities would like to plan the use of the appliances according to the load, to move them to the "empty" hours. To balance the two in a comfortable way for the user, you need to limit the drawbacks of this situation to the user and to try to contract with the utility the right compromise between the needs of the user and the needs of the utilities without involving in this optimisation the user, because he cannot go there with a calculator, looking at the time, looking at the price. It has to be automatic." (4)

„(Im Falle einer Netzstörung tritt eine Notlastsituation ein.) ...Und dann ist das Hochfahren sehr, sehr schwierig. Da gibt es grundsätzlich 2 Strategien: Einmal; dass man, sollte das in der Steiermark passieren, auf Knopfdruck die 10 stromintensivsten Industriebetriebe wegschaltet. Das ist die Holzhammermethode. Mein Ansatz ist der: Jeder Kleinverbraucher hat einen Zähler und wenn man den Zähler mit einer Schnittstelle versieht, die man aktivieren kann, kann man die Kleinverbraucher aktiv einbinden in das Notlastmanagement. Ich habe in meinem Zähler 3 Schnittstellen vorgesehen. Eine für die sogenannten Nachtstromgeräte, wie E-Heizung, etc. Da drücke ich dann drauf, dann sind die alle vom Netz. Wenn der Verbrauch dann noch nicht weit genug abgesenkt ist, z.B. weil es tagsüber ist, dann kommt das nächste, dass sind die schaltbaren Normalverbraucher, sprich: Geschirrspüler, Waschmaschine, und und und. Und wenn das immer noch nicht ausreicht - und jetzt kommt dann mein Patent zum Tragen – dann kann man jeden Verbraucher auf eine Mindestleistung setzen, z.B. 500 W, und wenn einer weniger angeschlossen hat, dann passt es, wenn einer mehr angeschlossen hat, dann wird alles ausgeschalten. Der Verbraucher geht dann zum Zähler und sieht, dass eine Notlastsituation besteht und um wie viel er seine Leistung reduzieren muss. Dann

muss er selbst den E-Herd abdrehen, oder was immer er angeschlossen hat, bis er unter die 500 Watt kommt. Wenn so die Verbraucherlast flächendeckend massiv abgesunken ist, kann man das Wiederanfahren wesentlich eleganter machen. ... Der (von mir patentierte) Zähler hat aber noch zusätzliche Features, die den heutigen Bedürfnissen gerecht werden und eine Win-win-win-Situation herstellen. Es sind eigentlich 4 Zähler integriert: einer für den Hochlasttarif, den Schwachlasttarif, den Normallasttarif und für einen Rückliefertarif, wenn man eine Fotovoltaikanlage hat und einspeisen will. Und dann hat der Zähler noch eine Kommunikationsschnittstelle, das kann sein über GPRS oder UMTS, oder wie immer, und dadurch kann man mit dem Abnehmer 2-seitig gerichtet kommunizieren. D.h. ich kann den Zähler mit aktuellen Tarifpreisen laden, dadurch eine Energiekostenkontrolle durchführen." (9) ["In the case of a black-out of the electricity grid my vision is not to disconnect the most power-consuming industrial facilities but to activate the private consumers. Each gets a smart meter with a communication interface which allows it first to disconnect all switchable appliances like the electric heating and hot water heaters, then major domestic appliances that are connected to this interface. The load can be reduced further by my tariff manager - I have a patent on this – the consumer is authorised a certain power, e.g. 500 Watt, he chooses himhelf which electric devices he leaves on and which he turns off. In this way you can manage the restart of the regional energy system very elegant. …Integrated in my tariff manager are also some other features for a win-win-win-situation. In fact there are integrated 4 meters, for various tariff options and also a feed-in meter. By means of the interface my tariff manager gets also information of the current electricity prizes and thus can calculate cost and savings for the customer."]

(Critical) remarks to the policy of utilities:

"Yes, in California they are a lot [initiatives of utilities] looking on this [the demand side management] because they have a huge peak from very powerful air condition. You have 4 or 5 kW and it is always coming at 5 o´clock when people are coming from work. And they try to control the thermostat by the radio. They will not start if there are critical conditions on the grid." Question: "Do you think there is a similar trend in Europe or Italy?" "Yes, and it is growing. This summer [2007] in July there was a maximum in Italy. But it depends what is the policy they want. If they want to favour more air condition, and they put some switching on this may be people will stop buying them…" (2)

„In manchen Ländern haben Sie schon einen direkten Draht zwischen dem Warmwasserbereiter und dem Energieversorger. Und dann gibt es das, dass der Energieerzeuger sagt: Jetzt ist es Mitternacht, wenn ich alle Geräte anschalte, dann habe ich meine Zentrale voll ausgebeutet, voll ausgelastet. Und der Warmwasserbereiter wird dann auf 60 Grad gebracht und das wird dann auch beibehalten bis zum nächsten Morgen. Das ist für den Energieversorger günstig, aber für den Haushalt nicht, denn sie duschen ja nicht in der Nacht, aber das Gerät verbraucht Energie in der Nacht um die Temperatur beizubehalten. Also für den Gesamthaushalt ist es besser, das Gerät wird erst um 6 Uhr morgens aufgeheizt. Und diese smart control-Geräte [innovative Heißwasserbereiter] machen das auch, die wissen auch wie spät es ist und wann jemand anfängt zu duschen.

Also da sind die Belange des Energieversorgers und des Verbrauchers nicht gleich. Ich habe in ihrem Projekt sehr viel gelesen von load shifting, dass es so viel einzusparen gibt, aber dann gibt es auch negative Seiten daran.“ (6) [“In some countries hot water storage heaters are already remote switched. An energy supplier who starts to heat all appliances in the middle of the night may operate his facilities at full load and gains. Whereas the household that needs the hot water at the earliest in the morning looses because of stand-by losses during the night.”]

Strategies and possibilities of other actors:

„Also für den Verbraucher ist die wichtige Entscheidung bei der Anschaffung. Zuerst muss man ja dann einen intelligenten Zähler installieren. Solange ich das freiwillig mache –wenn es verpflichtend sein soll, gibt es sicher andere Überlegungen – aber solange das freiwillig ist, muss ich die Initiative ergreifen, vielleicht auch Geld in die Hand nehmen und wenn ich das Haushaltsgerät neu kaufe, muss ich einen Mehrpreis zahlen. Ich kann mir gut vorstellen, dass die Stiftung Warentest oder andere dann einmal genau untersuchen, wie viel kann ich mir über die Lebenszeit des Gerätes eigentlich einsparen.“ (3) [“The crucial point for the consumer is the purchase. Then the smart appliance has to be connected to a smart meter. This means the consumer is always first to act, to pay an extra money. It would be fair that Stiftung Warentest or others evaluate how big are the savings in detail over the life cycle of the appliance.”]

Statements on smart appliances:

“To improve the single performance [of an appliance] is really difficult. The step forward is to think instead of isolated appliances of “social appliances”; appliances able to play different roles according to the energy conditions of the house or the region.…I try to name the connectable appliances in this way, because “connectable” looks at the technology and “social appliances” means that they are able not to be alone, not isolated but actively part to create a new offer, a new solution. They have to talk with the other actors and if they are able to find a correct way to have a different attitude they are able to deliver results to the user and in the end to deliver results to the other actors involved in the energy system. Just naming the appliances this way makes you look at them in a different way, to try to imagine what this social attitude means for an appliance and try to invent in a way to become part of the life without creating drawbacks for the consumer but helping.” (4)

“In the Middle Ages, in the castles there were the slaves and the jokers. The slaves were hidden in parts of the castle, delivering results without asking anything, trying to survive. Whereas the jokers, the singers or actors, were enlightening the king or the owner of the castle. This is similar to the situation in our homes: We have the slaves in the basement, the household appliances, the washing machines, etc. and we have the entertainment devices, that are our jokers. We are proud to show our friends the jokers but we don’t show the slaves. This is also why it is important to our business to get momentum in attractiveness. People like to be engaged in the jokers, to study the manuals, etc. But the quality of live depends on the slaves. The household appliances are also much more stable. You have to change the TV or DVD-Recorder 3 times in 10 Years. But the

household appliances have to last. If you have social appliances it will be much easier to adapt them to the changes that occur, e.g. children are growing and leaving home, etc." (4)

„Was man generell sagen kann, dass das Thema Vertrieb, dass sich da mittlerweile Spezialisten herauskristallisieren, weil man festgestellt hat – früher war immer alles plug and play, es geht alles ganz einfach – es ist aber deutlich geworden, dass die spezifischen Anforderungen sehr unterschiedlich sind, eben nicht so, dass das jeder so einfach integrieren kann. Bei PCs z.B. ist ja auch die Software schon vorinstalliert, weil man auch festgestellt hat, dass es sonst nicht funktioniert. Oder sonst muss man einen kennen, der einem den PC einrichtet. Nun finden sie einmal so einen Bekannten für Vernetzung! Damit aber steht und fällt alles, denn sie wollen ja nicht…, sie kaufen z.B. eine neue Stehlampe die in verschiedenen Lichtszenarien integriert sein soll. Sie stecken die ein, und jetzt möchten sie die Lichtszenarien mit drin haben. Und jetzt müssen sie erst einen Elektriker rufen und soviel bezahlen?" (5) ["Nowadays specialists emerge within the manufacturers sales department that work on interconnectivity issues, to integrate the appliances in a home automation environment because it is not so easy to match the specific conditions. E.g. take a look at PCs: Software nowadays always is pre-installed, because manufacturers realised that it is not easy to do the set up as a layman. Now imagine your new floor lamp. Would you be happy to pay extra for an installation expert that integrates it in your smart home?"]

"Let me explain the smart control of our hot water storage heaters: For us it is a way to save energy, because in storage heaters a lot of losses are coming from standby losses. You have to store a quantum and losses are directly linked to the temperature of the hot water. In our approach of smart control the idea was: lets say to have an intelligent electronic on board, able to recognise the behaviour of the consumer and to adapt the stored temperature to this behaviour. We have an average consume of hot water that is around 25 l of 60 degrees, by person and by day in Europe. But we know also that we have a lot of differences in terms of day by day consumption, for example you are taking a shower every day, but on weekend you are taking a bath. With the storage heater you have to store the biggest quantity that you consume during the week. Smart control understands on which days you want to take a shower or a bath. Smart control auto-adapts to your needs and saves energy… For the moment we have put on the market a new range of water heaters with this concept and it was the first time that somebody has put such an appliance on the market. We are using an eco button, this means, the consumer can choose to use it or not…They are on the market since one year and sales are around 20000 pieces since the beginning. We don't have any comment on it. Does it mean that nobody is using it? I don't know. It would be interesting to make a check. The problem was of course,… we are not able to demonstrate how the product is better then others, because we don't have a labelling on the product for the moment." (14)

"I have heard yesterday from somebody that in France – France of course is using a lot of electric storage – the biggest energy storage is the stored hot water, the total of all water heaters. So storage water heaters can help a lot in terms of peak saving in a house." (14)

Statements on consumer studies that are not publicly available:

„Ja, die Ergebnisse kann ich ihnen so mündlich erzählen, aber nicht hergeben. Also von der Aussage: Wir haben da die Attraktivität mit einer Variable gemessen von 1 bis 6, und im Durchschnitt lagen die [verschiedene Tarife und intelligente Stromzähler] alle so bei 3 bis 3,5 bis 2,5. Und wir haben da auch die Kaufbereitschaft [für entsprechende zusätzliche Haushaltsgeräte bzw. Ausstattungen] abgefragt, und das ist schon relativ ernüchternd. Auch ein Display, von dem ja oft gesagt wird, dass es attraktiv ist, ist in der Befragung sehr schlecht weggekommen. Das Display in der Wohnung, wo der Energieverbrauch online angezeigt wird, welches in England auch sehr stark favorisiert wird, und in Amerika z. T. schon eingesetzt worden ist. Aber ich bin mittlerweile überzeugt, das solche Befragungen nicht so viel Wert sind, sondern das man den Leuten solche Systeme geben muss, dass sie damit experimentieren können, sie Erfahrung machen lässt und dann auswertet, wie die konkreten Erfahrungen sind. Denn es ist nicht vorstellbar. Die Leute kennen ja ihren Stromverbrauch gar nicht, es ist ja keinerlei Vorstellung da, wie der im Jahresverlauf, Tagesverlauf, aussieht. Und deswegen glaube ich, dass die demand response Programme oder auch SMART-A im Prinzip schon der zweite Schritt sind. Und der erste Schritt ist, den Kunden überhaupt mal ihren Energieverbrauch mitzuteilen und dass sie sich einmal überhaupt damit beschäftigen.“ (10) [“In our studies we rated the attractivity of various solutions for tariffs and smart meters in categories from 1 to 6. All results were around 3, in the range 2.5 to 3.5. We also asked the willingness to buy one of these solutions including an information display in the home that is often favoured in UK and the US. It was disillusioning. But I am more and more convinced that these surveys are not worth while. Provide people with those appliances, let them experiment, and evaluate their real experiences, because people have no idea neither of those appliances nor of their energy consumption. To my opinion the first step is to teach the consumers and the next step is a programme like demand response or SMART-A.”]

Statements on consumer reactions:

„Wenn Sie einmal das Auto hernehmen als Pendant, was relativ viel Energie braucht: Das Auto betankten wir mit einem recht hochsensiblen System. Wir sagen: Oh, Diesel kostet jetzt 1,22, das ist hoch. Und dann sehe ich eine Tankstelle, die liegt bei 1,17. Dann denke ich: Oh, Wahnsinn, 5 Cent Unterschied! Dann fahre ich da ganz schnell hin. Ich schaue auch auf meinen Verbrauch: Wenn der Kraftstoff so teuer ist, dann fährt man doch nicht ganz so schnell, fährt kraftstoffsparend. Bei elektrischen Haushaltsgeräten und anderen Verbrauchern in der Wohnung sind sie über Jahre trainiert worden, dass der Strom aus der Steckdose kommt, sie zahlen einmal im Monat einen bestimmten „Abschlag“ und irgendwann mal im Jahr gibt es die Abrechnung und sie zahlen ein bisschen mehr oder weniger. Ich bin auf den Verbrauch nicht so sensibel, ich lass das Licht an, den Computer an, weil ich nicht darauf geeicht bin, dass das mich mein Geld kostet. (11) [“Take i.e. cars as an energy-consuming analogy: We have a delicate perception of our petrol consumption and the price. We look for cheaper fuel stations – “Gosh, 1 liter is 5 cents cheaper!” – we drive petrol-saving. In contrary to the electric

appliances. For years you have been trained to just flick the switch – it will be paid once a year."]

„Wo man auch aufklärend wirken könnte ist der CO_2-Verbrauch. Der CO_2-Verbrauch ist etwas, was den Leuten irgendwo nahegegangen ist und das wird es in den nächsten Jahren noch tun. Ein interessantes aktuelles Beispiel ist der CO_2-Ausstoß von Autos. Der ADAC in München hat eine Untersuchung durchgeführt, dass CO_2-Maßnahmen eine hohe Akzeptanz bei Verbrauchern haben. Ich vergleiche da auch mit dem Energielabel der Haushaltsgeräte A-B-C-D. Heute sind nur die A´s übriggeblieben und die B-C-D´s verschwunden." (12) ["The link to CO_2 emissions could also be helpful. CO_2 has somehow concerned people, e.g. car emissions. The ADAC, the German automotive society, has found in a survey that CO_2-related measures are highly accepted. For me there is also a comparison to energy efficient appliances. The lowest classes have disappeared from the market and only the better survived."]

„Wir haben Ende der 80er Jahre, Anfang der 90er Jahre in einem europäischen Projekt im Rahmen des ESPRIT Programmes mitgearbeitet. Das Überthema war Energiemanagement. Da wurde auch ein Feldversuch durchgeführt mit 150 Haushalten, die auf verschiedener Basis mit Geräten ausgestattet wurden und auf verschiedene Art verschiedene Tarife nutzen konnten. Das EVU hat dann immer eine Abrechung gemacht mit dem günstigsten Tarif, sodass immer ein best case für die Leute gegeben war. Das Projekt war grundsätzlich erfolgreich, ist aber in der großen Umsetzung am nicht vorhandenen Netzwerk im Haus gescheitert. Die Vernetzungsintelligenz war technisch noch nicht soweit und auch die Leute nicht, es hat zu einer Überforderung der Leute geführt. Das ist heute vielleicht schon anders. Wenn man bedenkt, dass in der Küche heute der Fernseher schon ganz automatisch drinnen integriert ist, denn am Abend, wenn man kocht, dann will man aber auch die eine oder andere Fernsehsendung anschauen können." (13) ["We participated in an ESPRIT-project in the late 80s/early 90s. The headline was energy management. A field trial in 150 households equipped with various appliances and various tariffs has been conducted. The utility always assumed the best tariff for each household. The main obstacle was the network: there were technical weaknesses. But people, too, were overwhelmed, at that time. Today it might be different, considering that you find a TV screen integrated into your kitchen units because in the evening people want to watch TV during cooking."]

4 Conclusions

Based on the information gained from the analysed studies and from the expert interviews the following hypotheses were derived.

- Consumer acceptance for smart appliances will be higher when no change in daily routines is necessary and an increase of comfort is achieved. Economic advantage via a tariff is a necessary pre-condition, while the price of the appliance and ecological motivation play a role too, but are not fundamental.

Daily routines/habits are hard to change, therefore it can be assumed that users will prefer technical solutions which help them to keep up their routines, instead of changing their behaviour. Consumers have a strong motivation to save energy, as long as usual habits and comfort are not affected (compare study "Preis, Verbrauch und Umwelt versus Komfort – der mündige Energieverbraucher"). It might be a chance to flag smart appliances with "modern", "advanced", etc.

- Smart appliances are not perceived in the same way as smart homes. Smart homes are associated with higher comfort and this is their only purpose. "Smart" is not a defined word in the context of appliances until now.

For smart homes the following benefits are perceived: easement of everyday life, security, energy-management functions, economic advantages (compare study "Probing a proactive home"). This might be differently for smart appliances. If people suspect that they have to react to incoming signals or have to accept time delays, this might be perceived as less comfortable. In any case a smart appliance must have the possibility to override the external signal and to start the operation immediately.

- There might be a correlation between energy saving behaviour and acceptance of smart appliances.

People who are aware of energy labels behave to a greater percentage in an efficient style. Also people, who more often do certain energy saving actions had to a greater percentage an energy efficient style (compare study "User behaviour in energy efficient buildings"). Therefore it can be assumed that people already engaging in energy efficient behaviour will have a higher acceptance level of smart appliances and even of inconveniences caused by their use. People are motivated if they have the feeling they are contributing to relieve the environmental burden.

- Consumers are sceptical about the monitoring of their energy consumption. They prefer less invasive communication methods, which leaves it up to them whether to react or not. Correlations between the acceptance of monitoring and age and maintenance of comfort are likely.

On one hand consumers view consumption information as useful, as it helps them to save money. On the other hand they are afraid of a big brother effect and they fear that data recording might be misused (compare study "User Centred Design in smart homes").

Younger generations were more open-minded towards the connection to external networks than older generations. Seniors refused this very often. There were different reasons: less interest on dealing with communication and information networks, due to the imagination that there is the possibility of an external intruder to the own data and appliances, as well (compare study "Vernetztes Wohnen").

Energy saving measures and their control should not affect comfort. For controlling comfortable solutions for consumption information are required. 70% of consumers prefer monthly information with the billing. Consumers with higher income and education desire communication via a personalised internet portal. However this solutions requires an active inquiry by the consumer, which is opposite to the desires to maintain comfort. A display in the living room which shows the tariff and consumption could also be attractive. 63% consumers are interested in such a device (compare study "Preis, Verbrauch und Umwelt versus Komfort – der mündige Energieverbraucher") but this might be country specific.

- Consumers view smart appliances rather sceptical

Consumers had a rather negative attitude towards smart homes (50% have a negative attitude, only 30% view it in a positive way) (compare study "Vernetztes Wohnen", 2000). The attitude towards single smart appliances was often labelled with objections like it is "too expensive", "too complicated" or that such technologies are error-prone. However, this might have changed already with the broad uptake of cell phones, touch panels, smart devices, etc.

- Consumer acceptance correlates with gender, age, education, income, living situation.

Generally men have higher acceptance of technologies. Younger people will show higher acceptance, whereas elderly people have strengthened patterns of behaviour and won't accept smart appliances if they have to change their habits. Older people are interested in security aspects of smart homes, whereas all others think that energy management is most important (compare study "Vernetztes Wohnen").

The hypothesis is that consumers with higher income, higher education, living in urban areas, with technical profession will show higher acceptance level to smart appliances. Also men might show higher acceptance than women.

- Acceptance of different technical scenarios (see report WP 2) will vary depending on the respective device.

Consumers often do not connect the use of appliances with energy consumption and they do not think about their habits and they do not act rational in the sense of efficient (compare study "Energy related practices, representations and environmental knowledge").

As habits are very difficult to change it is likely that consumers will have more objections towards smart appliances which demand an adaptation of their behaviour (e.g. time delays of washing machine) than when their routines remain untouched (e.g. energy storage for refrigerator).

- Different consumer types will need different benefits to accept smart appliances

In the study "Equipment Management Trial" two sub-markets were envisaged: (1) people who are cash rich but time poor, (2) people for whom security is important, who want to know what their expenses are (no matter their income) and who tend to buy insurance products.

For people who act rational, economic reasons will be essential. Whereas people with a high ecological awareness might have a rather positive attitude towards smart appliances despite economic benefits.

- Types of households will have an influence on the acceptance level of smart appliances.

The study "Vernetztes Wohnen" differed between the following household types:

Single household: Low need for structure and organisation. Job, organisation of household and leisure are flexible and have not be arranged with someone else.

Young Dual-Career-Families: High need for structure and organisation. Everyday life has to be planed, but also has to be flexible.

Empty-Nest-Couple: Children have left house, equipment of house is saturated. Hardly any interest to optimize quality and time demand of everydays life work.

Senior household: Children or job don't structure everyday life – nevertheless daily routine is highly structured. (compare study Vernetztes Wohnen)

Regarding smart appliances Young-Dual-Career-Families might be a consumer group mostly in favour of these new technologies, if they ease their everyday life.

- Differentiated tariffs might increase the acceptance of smart appliances

According to the study "Preis, Verbrauch und Umwelt versus Komfort – der mündige Energieverbraucher" in case of differentiated tariffs with cheaper energy (e.g. during night) a majority would be ready to do the housework during these times, as long as comfort is not reduced. This is especially the use of washing machines, dish washers and dryers as well as the recharging of rechargeable batteries. An adaptation of habits and time management is refused. Cooking or the use of multimedia according to special tariffs is not desirable for consumers. A general division between day and night tariffs is desired. A reduced tariff for single week days is only desired by half of the respondents. Further differentiation e.g. on hourly basis don't make sense. The respective tariff should be long-lasting and predictable. An adaptation of consumer behaviour on short-notice in the sense of ad-hoc tariffs is rejected by the respondents.

5 References

Aune, Margrethe 2002: User versus Utilities – The Domestication of an Energy Controlling Technology, p. 383-405, In: Technology Studies & Sustainable Development ed. Jamision, Andrew and Rohracher, Harald, München, Wien

Bartiaux, Françoise; Vekemans, Guy; Gram-Hanssen, Kirsten; Maes, Dries; Cantaert, Madeleine; Spies, Benoît; and Desmedt, Johan 2006: Socio-technical factors influencing Residential Energy Consumption SEREC CP/52, FINAL REPORT, Brussels, p. 1 - 222

Devine-Wright, Hannah; Devine-Wright, Patrick 2005: Representing the demand side: 'deficit' beliefs about domestic electricity users, De Montfort University Leicester, p. 1343 – 1348

George, Stephen S.; Faruqui, Ahmad 2005: California's Statewide Pricing Pilot: Overview of Key Findings. MADRI Advanced Metering Infrastructure Workshop May 4, 2005, p. 1 – 22

Haines, Victoria; Maguire, Martin; Cooper, Catherine; Mitchell, Val; Lenton, Fran; Keval, Hina; Nicolle, Colette (2005): User Centred Design in Smart Homes: Research to Support the Equipment Management and Services Aggregation Trials, Ergonomics and Safety Research Institute, Loughborough University, p. 1- 110

Lampaditou, Efterpi; Leach, Matthew 2005: Evaluating participation of residential customers in demand response programs in the UK, London, p. 1271 – 1282

Mäyra, Frans; Sorone, Anne; Koskinen, Ilpo; Kuusela, Kristo; Mikkonen, Jussi; Vanhala, Jukka; Zakrzewski and the Agora Centre 2006: Probing a proactive home: challenges in researching and designing everyday smart environments, University of Jyväskylä

Meyer, Sibylle, Schulze, Eva, Helten, Frank, Fischer Bernd (2001): Vernetztes Wohnen – Die Informatisierung des Alltagslebens, p. 129 - 217, Berlin

Moreau, Lorise; Wibrin, Anne-Laure 2005: Energy-related practices, representations and environmental knowledge: A sociological study, University of Louvain-la-Neuve, p. 1301 - 1312

Næsje, Pål C. 2005: Customer response on price incentives, Trondheim, p.1259 - 1269

Pett, Jacky; Guertler, Pedro 2004: User behaviour in energy efficient homes, Phase 2 report, Association for the Conservation of Energy, London, p. 1 - 68

Pett, Jacky; Smith, Winton 2005: Energy efficiency refurbishment programmes help, but are the end-users doing their bit?, Association for the Conservation of Energy, London, p. 957 - 968

Rawolle, Joachim 2004: WIM: Vernetzte Haushalte – Ergebnisse einer explorativen Expertenbefragung, Arbeitsbericht Nr. 4/2004, Hrsg. Dr. Thomas Hess, Ludwig-Maximilians-Universität München, p. 1 – 21

René Senn, Richard Staub (2006): Marktstudie – Intelligentes Wohnen Schweiz 2006-2008, GNI – Fachgruppe „intelligentes Wohnen“, p. 1 – 32, Zürich

SINTEF 2004: EFFLOCOM – Energy efficiency and load curve impacts on commercial development in competitive markets, EU/SAVE 132/2001, Summary report, p. 1-14

Thiemann, Ralf, Passenberg, Ingo, Suer, Stephan, Krüger, Thomas, Schmitz, Martina (2007): Preis, Verbrauch und Umwelt versus Komfort – der mündige Energieverbraucher. Verbrauchsverhalten und neue Möglichkeiten zur Kundenbindung und Kundengewinnung für Energieversorger, p. 1 – 16

Unknown 2005: Equipment Management Trial, Final Report, June 2005, p. 1 - 86

Van Elburg, Henk 2005: Energy efficiency is EASY: new knowledge to change human behaviour, Utrecht, p. 1231 - 1235

6 Annex: Questionnaire experts / Fragenkatalog Experteninterviews

1.) Do you know any existing studies on how consumers (C) react on smart appliances or smart metering? Are there data available of questionnaires or interviews (or only summarising papers)?

Können Sie uns Studien nennen, in denen untersucht wurde, wie private Haushalte auf intelligente Haushaltsgeräte oder Stromzähler reagieren? Könnte man Daten der Befragungen oder Interviews bekommen (nicht nur zusammenfassende Artikel)?

2.) The SMART-A project is focused on only a specific aspect of a smart appliance: the adeptness to react on the requirements of the grid. How important do you think will this be in comparison to other design features of an appliance of the future (in the short run vs. in the long run)?

Im Project SMART-A beschäftigen wir uns mit nur einem speziellen Aspekt von intelligenten Haushaltsgeräten, nämlich ihrer Möglichkeit, auf die Erfordernisse des Stromnetzes zu reagieren. Was meinen Sie: Wie wichtig ist eine Entwicklung in diese Richtung in Vergleich zu anderen Ausstattungsmerkmalen oder –möglichkeiten von Haushaltsgeräten (einerseits im Zeithorizont von wenigen Jahren, andererseits in weiterer Zukunft)?

3.) How do you judge the attitude of consumers in private households concerning the SMART-A topic?

Wie schätzen Sie die Haltung von KonsumentInnen (K) in privaten Haushalten bezüglich der in SMART-A betrachteten Haushaltsgeräten ein?

4.) To your opinion: Which restrictions or which discomfort will be acceptable or just tolerable for the C who is using such a smart appliance?

Welche Einschränkungen darf Ihrer Meinung nach der Betrieb von intelligenten Haushaltsgeräten höchstens haben, damit sie von den K noch akzeptiert werden bzw. für diese gerade noch akzeptabel sind?

If possible: Specify answer for various appliances (washing-machine, tumble drier, dish-washer, refrigerator, freezer, oven and stove, heating circulation pump, air conditioner, electric water boiler)

5.) How could C be motivated to use smart appliances? What are in your opinion possible strategies to increase C´s attitude to smart appliances? Who has to be the main actor (energy supplier, appliance producer, government,...)? Whom does the C trust in?

Wie könnte man K motivieren, intelligente Haushaltsgeräte zu benutzen? Welche Strategien gibt es Ihrer Meinung nach, um die Einstellung von K zu intelligenten Haushaltsgeräten zu beeinflussen? Wer wäre dabei der Haupt-Akteur? Wem würden die K vertrauen?

6.) Do you think there are any country specifics concerning the attitude of C (restrictions, motivations) in Europe?

Glauben Sie, gibt es länderspezifische Unterschiede in Europa, was die diesbezügliche Haltung der K betrifft (Einschränkungen, Motivation)?

7.) Do you know someone in the industry (representative of a manufacturer of domestic appliances, load management or intelligent metering systems) we could refer to for information on the industry´s view of this topic?

Können Sie uns Kontaktpersonen aus der Industrie (Haushaltsgerätehersteller, Produzenten von Lastmanagement oder intelligenten Zählersystemen) nennen, die uns Informationen aus Sicht ihrer Unternehmen geben könnten?

Scheduled time per interview: 20 min. / Vorgesehene Zeit pro Interview: 20 Minuten