Appendix B Project Description

User Practices, Technologies and Residential Energy Consumption (UserTEC)

1. Summary (maks. 20 linjer)

According to the 2012 Danish energy agreement, improving energy efficiency and managing intermittent energy are both crucial for increasing Denmark's share of renewable energy. Although much has been done to increase the energy efficiency of buildings, results from demonstration projects on low-energy buildings show that users do not understand the design intentions and functionality of these new buildings, and that they have serious difficulty in controlling the technologies that the buildings contain. This not only influences their everyday lives negatively, e.g. in a poor indoor environment, it also leads to an increase in energy use. Balancing intermittent energy production is not only dependent on efficiency improvements but also on accommodating consumption patterns and energy storage in buildings. Hence, ensuring efficiency and flexibility calls for taking user needs and behavior more into consideration. Otherwise the gap between actual and expected energy performance of buildings will persist.

This project will provide an extensive understanding of user practices and knowledge of how different users interact with new energy efficient technologies with the aim of identifying the socio-technical conditions for overcoming this gap. With access to unique data on households' consumption patterns, technical and sociological analyzes will provide results to be used in designing and developing new efficient technologies that better meet user needs. In cooperation with a number of leading international universities, project findings will also be subject to international comparisons. Project results will contribute to the development of a sustainable and healthy housing sector - an essential pillar in the welfare society.

2. Objectives of the project (max 15 linjer)

The objective is to establish a scientific knowledge base for the development of building design solutions, systems, and technologies with user-interfaces that enable energy conscious behavior without jeopardizing a comfortable and healthy indoor environment. This entails:

1. Developing, testing and comparing methods for describing household practices, energy consumption and technology use
2. Detailed studies of user practice with building technologies to analyze the gap between intended building design/performance and user understandings and practices.
3. Developing and testing prototypes of new smart technologies and user-controlled technologies.
4. Examining and enhancing communication between building industry, utilities, and households regarding smart technologies.
5. Suggesting new directions for policy and actor involvement within construction, renovation and building management.

3. The main results of the project (max ½ page)

The project will provide technological and sociological results:

1. Prototype development and performance testing of new user-adapted building solutions and technologies that can provide cost effective energy savings in buildings and help improve the future housing stock.

2. Development of new models and simulations tools for realistic predictions of buildings energy use.
3. New knowledge on users' interaction with building services and technologies that will enable the development of improved communication, feedback and control platforms.
4. A communication toolbox that enables end-users, building industry and utilities to envision, test and assess future use situations.
5. Analytical methods, based on practice theory, that allow for detailed studies of different user groups' energy consumption, needs and satisfaction.
6. Theoretical contributions to the social sciences regarding the interplay between energy consumption, practice theory and policy.
7. New approaches in interdisciplinary research that combine qualitative and quantitative methods.
8. Better understanding of users' energy consumption to develop market based solutions for energy efficient consumption, utilising combinations of technologies and communication.
9. New business opportunities for industries based on the insights from the prototype development of more user-adapted, energy efficient technologies and communication, feed-back and control technologies.

4. Background and hypothesis of the project (max 1½ page)

User practices, needs and satisfaction with regard to buildings, perceived indoor environment and energy consumption are not static. Sometimes technical standards and norms developed to insure healthy, comfortable and energy efficient buildings fuel the development of new social norms of comfort that lead to unexpected increases in energy consumption (Shove, 2003). As this illustrates, the relation between the introduction of energy efficient technology and building materials, changes in user behavior and the reduction of energy use from private households is far from simple. This project examines the complex interplay between materials, technology, policy and practice; viewed from a modeling, communication and learning perspective, as well as from the important perspective of developing prototypes of new integrated technological solutions.

It is well documented that the energy consumption levels of different users living in completely identical buildings can vary by several hundred percent (Karlsson and Moshfegh 2007; Gill et al., 2010; Gram-Hanssen, 2010). It is also documented that these differences only to a limited extent can be explained by well-established consumer categories as socio-economic variables or lifestyle groups (Santin et al, 2009; Steemers and Yun, 2009). Furthermore, when new efficient technologies are taken into use, the expected energy savings are most often not realized (Larsen and Brunsgaard, 2010). This discrepancy between what is theoretically possible and actually achieved may be due to erroneous assumptions regarding user behavior, particularly as many users do not value and use new technologies as prescribed. Another possible explanation is that the new technologies effect user expectations and lead to an increase in comfort norms. Within a techno-economic approach this last issue is known as the rebound effect, where energy savings are invested in higher comfort (Sorrel et al, 2009) and within a socio-technical approach this is taken even further to show how new norms of comfort continually have risen together with the development of new technical possibilities and efficient technologies (Shove, 2003). New communication technology and smart meters are often thought of as a way to circumvent these problems, but there is little evidence to suggest that it will automatically achieve a significant reduction in energy demand (Darby, 2010).

Summarizing; the problem is that user practices, technology and building materials cannot be dealt with as isolated factors. The technologies, including the building components and the building themselves are integral parts of the users' everyday lives. It is these interrelationships and the ways in which they are communicated to households that are our basic unit of analysis.

Within technical sciences there is a growing interest in understanding user interaction with technology, as numerous research projects has shown, that the choice and operation of technologies in dwellings affects occupant's behavior, energy use and indoor environment. One example is the type of thermostat used for heating, which affects duration of heating periods, heating setpoint temperatures during day and night and risk of overheating (Santin et al, 2009, Shipworth et al. 2010, Peeters et al 2008). Another example is the type of ventilation system, whose operation is not understood by the occupants, and which affects window opening behavior (Erhorn 1988, Brunsgaard et al, 2012).

Recently within technical sciences, the growing awareness has also been seen in the different approaches of making models used for either predicting energy consumption or for optimizing technologies in the design phase (Brohus et al. 2009, Page et al. 2008, Reinhart 2004, Rijal et al. 2008). A forthcoming special issue of the journal *Architectural Engineering and Design Management* on 'The Impact of the Building Occupant on Energy Consumption' also illustrates this burgeoning interest. Social science research has primarily focused on describing and understanding households' energy consumption in terms of comfort (Shove, Chappels, Lutzenhiser, Hackett, 2008), and recent research have started to combine social sciences and technological studies on comfort issues (Buur, 2012). However, the technical scientific approach of modeling and predicting and the social science approach of describing and understanding have hitherto been rather separate domains and so far the social science approach have not contributed to technology development. This project brings these two approaches together, with the purpose of improving technology development and with the goal of developing more user-adapted technologies and buildings.

Previously, social science approaches have either used segmentation and lifestyle approaches or socio-economic perspectives. More recently, practice theory has been adopted within studies of energy consumption (Strengers, 2011: Hargreaves, 2011, Gram-Hanssen, 2010). Practice theory emphasizes the collective and structural elements of what people do and say rather than their norms, values and/or social status. Emphasis is given to what people do and to what structures the collective elements of these specific practices, e.g. technologies, competences and meanings. Hitherto, this research has primarily been based on case studies and qualitative studies. The ambition in this project is to broaden the perspective and include qualitative as well as quantitative analysis. Furthermore, the ambition of the project is to use these analyses very directly in working with technology design and development. Our hypothesis is that practice theory will be suitable for this purpose, as it has the ways in which people manage and communicate with technologies as its main focus. One of the basic ideas of the project is, thus, to distinguish different practices related to energy consumption, including its time dependencies, and to group and describe people according to variations in these practices. The hypothesis is that these groupings and variations in practices can be used when developing technologies and buildings that are more user adapted as well as when communicating with households on which practices are more energy efficient than others.

5. Innovative value, impact and relevance of the project (max ½ pages)
Increasing energy efficiency of buildings and the inclusion of buildings in a system with fluctuating energy production are strategic issues when it comes to increasing the share of renewable energy production and reducing society's dependence on fossil fuels. The societal impact and relevance of this project lie in the fact that both of these priorities are best addressed if consumers adapt and use the efficient technologies in the appropriate way. If user behavior is not taken into consideration, then it is likely that these strategic priorities will not be met. This project seeks to promote technology development that is better adapted to user needs and valued by the users. What we need, and what this project provides the foundation for, are technologies, products and buildings that can truly help and assist users in managing and substantially reducing their energy consumption, and do this in a way that does not compromise their indoor environment, comfort and health.

The project's innovative value is its analytical approach. While much of extant research has studied consumer groups based on characteristics related to the consumers' background and attitudes, and is premised on an assumption that behavioral changes follow changes of attitude, this project focuses on consumer practices and on the integral links between energy use and the consumers' everyday practices. Furthermore, the approaches taken to describe consumer practices are novel. They are based on several unique data sets, which will be analyzed in a cross-disciplinary team with the aim of using these insights for technical modeling and design purposes.

The commercial interest and importance follow from the societal relevance. The market share of energy efficient technologies, not only nationally but also internationally, is highly dependent on the extent to which users value these technologies. The value of a technology is, however, not something that is given, it has to be established. The interest of the participating companies in the project underlines the importance they see in getting a much more detailed understanding of user practices to be used for technology development.

6. Project's methodology and results (max 3 pages),

The project's research methodologies include technical analyzes as well as quantitative and qualitative methods from social sciences and humanities. The research will be organised in four different work packages (WP). The goal of WP 1 is to develop and test different typologies and understandings of users with regard to energy consumption patterns, practices and indoor climate requirements. WP 2 deals with ICT (information and communication technology) and user feedback, and it explores ways of developing feedback technologies. Results from WP 1 and WP 2 will provide the background for the work in WP 3 and WP 4. WP 3 focuses on developing and testing building technologies promoting energy savings without compromising the indoor climate and comfort. In WP 4 emphasis is given to how user involvement in construction and renovation processes can enhance the development of user-adapted technologies.

WP1: Users and their practices, needs and satisfaction (Gram-Hanssen, SBi)

This WP will develop and test different typologies and understandings of users according to their energy consumption, practices, use of technologies and indoor climate requirements. The typologies will focus on everyday household practices, incl. time-variation, and will build on different unique empirical data regarding household energy consumption that we have access to through our partners in the project. These include the following parallel studies:

- A study of households' indoor climate practices and their relation to energy consumption. Empirical data on time dependent metering of heat consumption will be provided from project partners Affaldvarme-Aarhus and Fjernvarmefyn.This will be supplemented by a quantitative survey among a representative group of these households and detailed qualitative interviews with selected households. This research is to be based on a PhD project situated at SBi, supervised by KGH, conducted in cooperation with Grundfos.
- Indoor climate and practice studies in three hundred households based on hour-based metering data for heat pumps, which can be regulated according to flexible electricity production. Energinet.dk and Insero Energy will provide access to these data, and allow us to follow how the intelligent heat pumps take part in shaping the everyday practices related to the households' indoor climate and comfort.
- An analysis of all households in Denmark using data from the CPR (demographic-personal data) and BBR (building data) databases combined with electricity and heat consumption. This is a unique possibility we have in Denmark due to extensive registration and to a recent law requiring utilities to report data to authorities. Furthermore time dependent electricity consumption combined with CPR and BBR data will provide a background for establishing different user profiles according to daily, weekly and yearly fluctuating electricity consumption. This research will be based on a PhD project situated at SBi, and will be done in cooperation with Energinet.dk.
- A study of ELMODEL-bolig, a model owned by the Danish Energy Authority and the Danish Energy Association, and maintained by IT-Energy. As part of the model, a detailed survey of 3000 households' technologies and practices is carried out every second year. Data from the last 20 years have been made freely available to our project. This will be based on a PhD project, situated at SBI and supervised by KGH.

An exchange of PhD students with Linköping University, Delft University and University of Cambridge will make it possible to compare Danish data with Swedish, Dutch and UK data on practices in everyday life and energy consumption. These comparative studies will include the use of different types of data and, thus, also address methodological issues. Joint publications are the expected outcome. Furthermore there will be cooperation with S. Darby on theoretical issues and with Grundfos on methodology in user-studies.

WP2: Information and Communication technology and user feedback, (Christiansen, AAU-Com)

The goal of WP2 is to integrate end-user perspectives in the smart technology development, thereby bringing design decisions closer to actual user practices and enabling user perspectives to drive innovation. WP2 focuses on the communication between construction companies, technology designers and utilities regarding user needs and user conceptualizations. WP 2 comprises the following activities:

- Developing a model of informational feedback supporting self-regulated, conscious control of energy consumption and design. Anthropological research will serve as the foundation for building a toolbox that includes feedback interface prototypes, videos, design games and workshop recipes. The toolbox will be used in workshops with different actors, e.g. the housing association Ringgården, SME-tech-companies and large utilities. The intention is to bring the toolbox to market.
- Design research papers analyzing the actions/approaches taken, thus, providing engineers, architects and designers with artifacts such as models, pattern languages, use-cases and examples that explain and exemplify user experience and requirements with regard to functionality.

WP 2 includes 1 PhD based at AAU-Communication, supervised by EC. There will be cooperation with S. Darby from Oxford University in the form of comparing results with her research. There will be exchange of PhD students with either Cambridge, Delft or Linköping University. Furthermore, Saseco, the housing association Ringgården and a select number of energy companies will participate in this WP.

WP3: Buildings and technologies promoting energy conscious behavior (Heiselberg, AAU-civil)

The goal of this WP is to develop new technical building solutions with improved usability and user friendliness and to demonstrate their effect on achieving an energy conscious behaviour among building users. The research will focus on user perception of building solutions and technologies with the aim of identifying the gaps between low-energy building design or renovation intentions and the user experience. The results will be analysed to determine key characteristics of user adapted building technologies and to develop new prototypes. The WP will investigate the new technologies' ability to promote an energy conscious behavior amongst users while at the same time providing a comfortable indoor environment. The work package will include the following studies:

- Detailed studies on user feedback related to operation of ventilation systems and window openings, and the users' ability to control indoor environment and energy use. Types of feedback technologies and types of communication in relation to operation of ventilation systems will be developed and tested in different user groups, and evaluated according to user friendliness and energy consumption. This research will be conducted by a PhD based at DTU, supervised by BWO, and partly financed by Velux.This study will be carried out in cooperation with WP1 and WP2.
- The development of new models for user behaviour, which can be used for more realistic predictions of energy use in new buildings and energy saving potentials in building renovation. New models will be discussed in relation to the EPBD regulations. This work will be based on the results of WP1 and connected to WP4.
- Identification and analysis of the key characteristics of building facade systems with integrated solar shading, insulating shutters, passive night cooling and ventilation and of their interaction and communication with the building users. Investigation of possibilities of implementing user adapted control and communication technologies in such building facade systems, followed by a development of new prototypes. Test and demonstration of developed prototypes through investigation of the user perception of their performance and their ability to both create a comfortable indoor environment and promote an energy conscious behavior. This research will be conducted by a PhD at AAU, supervised by PH, and partly financed by Inwido.

This WP benefits from industrial participation of Realdania Byg, Velux and Inwido as well as exchange of PhD students with Delft University of Technology and University of Cambridge.

WP 4: User involvement in renovation/constructions processes

This project will analyze the interplay between building design, user practices and energy use. Even though it is possible to build new and refurbish existing homes in ways that are very energy efficient, actual energy use is often much larger than the predicted energy use. One reason for this is that the design, refurbishment and construction processes are based on erroneous assumptions regarding user practices. The project will address how greater user involvement in these processes can provide insights that the professionals can use to improve these processes so as to help diminish the gap between predicted and actual energy use. The WP will examine user involvement in the various phases of the design and construction

processes associated with the building of new and refurbishment of existing housing. The WP augments WP 2 and 3, and will include:

- Case studies of user involvement in connection with the construction and refurbishment of new and existing homes – identifying the conditions under which user involvement leads to greater energy efficiency and when it does not.
- Analyzing if/how user involvement changes in the various phases of these construction projects and how this effects energy consumption
- Identifying the types of insights that user involvement provides and assessing how these insights can be utilized to minimize the gap between predicted and actual energy use.

This WP includes a PhD project supervised by SG situated at AAU-plan and will be conducted in close coordination with Kuben Management and other project partners. There will be exchange of PhD students with Linköping University and contact with S. Darby from Oxford.

There are some uncertainties related to the different WPs. In WP 1, these relate to the question of the extent to which all the data will be available at the time when we need them. Some data are already available, while others should be available from the beginning of 2013. If this is not the case, then some of the analyses may have to be postponed/rescheduled. However, given that much data is already available these uncertainties are not expected to seriously deter the project flow. In WP 3, uncertainties are related to the demonstration of prototypes in real buildings 3-4 years from the project start. These building projects cannot be identified until ½-1 year before the demonstration and this project will be dependent on the time schedule of these building cases. However, we are certain that it will be possible to find suitable buildings.

All work packages are subject to the uncertainties associated with human resource management, i.e. finding qualified PhD students and dealing with their possible leave of absences. In the quantitative and technological PhD projects, foreign applicants will be eligible, but for the qualitative projects, we need applicants with Danish language skills. It is, however, not as difficult to attract qualified applicants within this domain. Should the PhDs in WP 1 and 2 take a leave of absence, then this would entail that input from these WP's to WP 3 and 4 would not be as timely as preferred. These kinds of uncertainties are, however, not expected to substantially influence the overall project.

7. Project plan (max 2 pages+ evt. Gant diagram)

The project will start April 1, 2013 so as to allow the partners time to negotiate and agree on collaboration agreements. The first three months, from April – June 2013, is a project definition phase that will allow for detailed definition of the individual projects. The first project meeting will be dedicated to this and will focus on ensuring coordination and collaboration across the different tasks and work packages. This scheduling will also allow for recruiting PhD students, because the spring is often used for promoting potential candidates. The project runs for 5 years, continuing until April 2018. WP 1 and 2 start in parallel in 2013, and after two years WP 3 and 4 start, thus allowing results from WP 1 and 2 to be utilised in WP 3 and 4. In 2015, all four work packages will have begun and all the PhD projects will be active. Thus, this is the year when the international workshop and the international PhD course will be held. Resource allocation and milestones are listed below in Table 1 and a time table (gant diagram) is shown in Table 2. WP0 indicates the management of the project.

Table 1: Manpower allocation and milestones

Activity		**Participating**	**Milestone and date**
WP0	Project website	Management board (MmB)	Website running June 2013
	Advisory board (AB)	All partners + AB	Meeting April 2014, 2015, 2016, 2017
	Steering com.	All partners	Meetings April and September 2013-17
	Recruiting PhDs	MmB + supervisors	April 2013 and November 2014
	International PhD course	Int. partners and MMB	Announcing PhD course Jan. 2015 Running PhD course Sep. 2015
	International workshop	All partners	Invitation/promotion of workshop Jan. 2015 Running workshop June 2016
WP1	Comfort practice study	PhD 1, KGH, HNK Fjernvarmefyn Affaldvarme Aa Grundfos Cambridge-PhD	Theoretical review, journal article Nov 2013 Developed survey Dec 2013 Survey report and journal article June 2014 Interview report and journal art. may 2016 Final PhD theses June 2016
	Heat pump study	THC, Insero, Energinet.dk	Report analysis April 2014 Journal article May 2015
	National register analysis and time dependent elec.analysis	PhD 2, KGH, Delft-PhD, energinet.dk	Established dataset, Jan 2014 Analyses report and journal articles April 2015 Final PhD theses June 2016
	ELmodelbolig analysis	PhD 3, KGH, IT-Energi Linköping-PhD	Input to 2014 survey, may 2014 Journal article on practice clusters, may 2014 Longitudinal studies, journal art. Oct 2014 Cluster analysis, journal art. Oct 2015 Final PhD theses June 2016
	Theory and methods	KGH, S. Darby	Methodological journal article, June 2014 Theoretical journal article, June 2015 International comparison articles, June 2016
	Int. exchange of PhD's	Linköping PhD, Cambridge PhD	Three Danish, one Swedish, one Dutch and one UK PhD, exchanged March 2015
WP2	Develop toolbox,	PhD 4, EC	Toolbox described in journal article, Aug. 2014
	Test+Com. toolbox	PhD4, Saseco, Affaldvarme, Darby, Link. PhD	Toolbox tested, journal art. Dec 2015 Int. comparison journal article, Final PhD theses June 2016
	Int. exchange of PhD's	Linköping	Exchange of one Danish and one Swedish PhD, March 2015
WP3	User feedback on indoor climate	PhD 5, BWO, HNK, Velux	Report to be further used by PhD students and industry, June 2015. Journal articles Oct. 2015 Final theses
	Model Dev.	AJM, PH, KGH	Report and Journal article, December 2017
	Develop prototypes	PhD 6 1 Cambridge PhD	Two Journal articles, Dec. 2016 Two building technology prototypes Dec. 2016
	Test and demonstration	PhD 6, Inwido	Report and journal articles Sep. 2017 Two PhD theses (December 2017)

	Int. exchange of Phd's	Cambridge PhD	One Danish, and one Cambridge PhD's exchanged Dec 2017
WP4	User involvement case studies	PhD 7, SG, Linköping PhD	Case studies report, Dec. 2015
	Users and construction phases	PhD 7, SG, Linköping PhD	User involvements in different phases, two journal articles, Dec 2016
	Utilisation of insights	PhD 7, SG, Linköping PhD Grundfoss	Report and journal article, June 2017 Final PhD thesis , Dec. 2017
	Int. exchange of Phd's	Linköping or Cambridge	Exchange of one Danish and one Swedish or UK PhD, Dec 2016

Table 2, timetable for every half year of the project time (Gant diagram)

Activity		2013		2014		2015		2016		2017		2018	
WP 0	Project start meeting	X											
	Advisory board meeting			X		X		X		X			
	Steering committee meetings		X	X	X	X	X	X	X	X	X		
	International PhD course						X						
	International workshop							X					
	Final project meeting											X	
WP 1	Comfort practices, incl. PhD 1		X	X	X	X	X	X					
	Heat pump study		X	X	X								
	Register and time analysis, PhD 2		X	X	X	X	X	X					
	ELmodelbolig analysis, PhD 3		X	X	X	X	X	X					
	International exchange of PhD's and S. Darby				X	X							
WP 2	Develop toolbox, incl. PhD 4		X	X	X								
	Test+Communicate toolbox, PhD 4				X	X	X	X					
	International exchange of PhD's				X	X							
WP 3	Development of models						X	X	X				
	User feedback indoor cl., PhD 5					X	X	X	X	X	X		
	Study user practices, PhD 6					X	X	X					
	Develop prototypes PhD 6						X	X	X	X			
	Test and demonstration PhD 6								X	X	X		
	International exchange of PhD's							X	X				
WP 4	User case study, PhD 7					X	X	X	X				
	Users in constr. phases PhD 7						X	X	X				
	Utilization, PhD 7								X	X	X		
	International exchange of PhD's							X	X				

8. Project's international dimension (max ½ pages)

The project's interdisciplinary approach is also mirrored in its international partners – two partners have a strong technological focus and two employ more sociological approaches in understanding users' everyday lives with energy and technologies. This collaboration with internationally renowned people and environments within both the technical and social sciences will allow for the development of interdisciplinary approaches to understanding user

practices, technology development and energy consumption. These partners include Professor Koen Steemers, University of Cambridge; Professor Henk Visscher, Delft University of Technology; Professor Kajsa Ellegård, Linköping University, and Dr. Sarah Darby, University of Oxford.

In collaboration with these international partners it will be possible to compare Danish results with international data and approaches. The collaboration will include an exchange of senior researchers and PhD students, a number of scientific publications, the development of a common PhD course, and hosting an international workshop open for other participants as well. Some of the publications will be written together with our international partners, i.e. when results from our projects will be compared with results from their projects. All of our international partners are involved in relevant projects that can be used for comparison with different parts of our projects.

This international collaboration will help ensure a high international standard in the project. It will provide international references and comparisons and, thus, enable us to detect cultural differences and similarities between countries. This is both of scientific relevance and of relevance to the private companies operating on an international market. Furthermore, the international dimension is ensured through the international publications and participation at international conferences that are part of the project's publication strategy.

9. Legal and ethical aspects etc. (max ½ page)

In the quantitative study of households, register data will be used that are protected by the Act on Processing of Personal Data (Persondataloven). It is thus required that we make an application to the Danish Data Protection Agency indicating the purpose of the study, what type of data we will be using and who will take care of the data. The handling time for this type of application is usually 2 months. The project is not based on very sensitive data, and it is, therefore, not likely that there will be any restrictions or problems. We have experience from other projects using the same type of data and have never previously met restrictions. The data will be provided by Statistics Denmark and only extracted in an anonymous form.

In the qualitative studies of households, participating households will be made aware of the purpose of the study and informed about the ways we will make data anonymous, and based on this information they will be asked to participate. Data collection and contact with households will follow sound social science practices (Kvale, 1997) in order not to compromise anyone taking part in the study.

10. Publication and promotional strategy and exploitation of results (max 1 page)

The project results will be communicated through scientific papers presented at international conferences and workshops and afterwards submitted for publication in international journals. The relevant journals and conferences vary with the topics of the work packages. For WP 1 and 4, the main researchers are already connected with the following international research groups where results will be communicated:

- ECEEE, European Council for Energy Efficient Economy. Conferences every second year.
- ESA, The European Sociological Association, working groups on "Environment and Society" and "Consumption", with conferences every second year.
- EEAST, The European Association for the Study of Science and Technology, with international conference every second year.

For WP 2, the main researcher is already connected with the following research groups where results will be communicated:

- CHI conference 2013 in Paris will be a target for conference papers: www.chi2013.org
- The greening of industry network's yearly peer reviewed conferences

For WP 3, the main researchers are participating in an international research project initiated by IEA, IEA ECBCS Annex 53 "Total Energy Use in Buildings - Analysis and Evaluation Methods", where the main focus is on how to integrate user practices in the analysis and evaluation of energy use in buildings. This project includes participation of 23 research groups from 14 countries worldwide. Researchers are also active in the Active House Alliance (www.activehouse.info), which is a European industrial network with the purpose of promoting houses with a healthier and more comfortable indoor environment for the occupants.

In total, the project will contribute with approximately 30 papers. These include 3-4 papers from each PhD project and approximately 1 paper for every 6 months of research time for others. Articles will be presented at relevant conferences, as indicated above, and submitted for relevant international journals including: Energy Policy; Energy efficiency; Building Research and Information; Energy and buildings; Journal of Industrial Ecology; Journal of Consumer Policy; Journal of Environmental Policy and Planning; Journal of Cleaner Production; Sustainability: Science, Practice, & Policy; Journal of Consumer Culture; Housing, Theory and Society; Artifact; Design Issues; Design Studies; Indoor Air; Building Simulation; Sustainable Built Environment.

During the project and related to all work packages, press releases will be made on results of public interest. SBI has a professional team to support this and has a long record of press releases when it comes to the subjects of energy consumption, indoor environment and households' everyday lives; many of which have been given great exposure in national news media. Policy makers are thus informed about results from the project through public media; however, relevant results will also be communicated more directly to relevant authorities. This will also takes place through participation in our advisory board from energy authorities and the ministry of housing, urban and rural affairs.

Due to the potential commercial interests in the results of WP2 and WP3, the patentability of all results will be carefully considered prior to publication. A collaboration agreement will be drafted and signed before project start, addressing the legal aspects related to intellectual property rights and patents. Other results will be freely available to all companies with an interest to use results in developing their products.

11. The participating parties and project management (max 4 sider)

The project leader will be Kirsten Gram-Hanssen, who is an experienced project leader with competences from several national and international projects. The project is organized in 4 work packages - each with a work package leader. Kirsten Gram-Hanssen is also leader of WP1. The project leader will together with work package leaders - Ellen Christiansen (WP2), Per Heiselberg (WP3), and Susse Georg (WP4) - constitute the management board (MmB). It will meet regularly to coordinate and report progress as well as to discuss strategic research matters. The management board is responsible for the daily technical and administrative management in WP0, dealing with the management of the project.

The management board will meet approx. every half year with the steering committee, which includes representatives from all project partners, Danish as well as international. The steering committee provides recommendations regarding research performance, perspectives and strategies, seen from both an academic and an industrial, commercial and strategic

perspective. Steering committees meetings will partly be organized as (1) workshops where research partners and other partners work together on relevant selected topics including project results, problems and questions, and (2) as meetings where plans and progress are discussed and decided. The international dimension and the scientific merits of the project are thus dealt with in dialog with the international partners at the steering committee meetings. Planned activities will be presented and discussed, relevant synergies with international partners' projects will be determined and more detailed cooperation, including exchange of PhD students and common publishing activities, will be arranged. Similarly, strategic questions regarding how to ensure project relevance will be dealt with in close cooperation with the industrial and organisational partners.

An Advisory Board consisting of a broad mixture of relevant actors will be established. The following have all accepted to be in the advisory board and have expressed enthusiasm and interest in our project: The Danish Association of Construction Clients (Bygherrer foreningen), Director Henrik L. Bang; KAB (non-profit housing association), Building Director Rolf Andersson; Architect Company Vandkunsten, Partner Jan Albrechtsen; the Ministry of Housing, Urban and Rural Affairs, Lars Misser and Danish Energy Authority, Marie Kring. These will be supplemented by representatives from Danish building associations. The purpose of the advisory board is to get a broader perspective on the project's strategic perspective, relevance and utilization of results. The Board meets once a year in connection with every second steering committee meetings to discuss research directions and achieved research results.

The project includes 7 Danish PhD projects. Due to the interdisciplinarity of the project, these PhD projects will be affiliated to different research schools at AAU and DTU. Furthermore, approximately 7 PhD students from our international partners (which are financed by the international partners) will be affiliated to the four work packages. In association with our international partners, we will develop and conduct an international PhD course with the aim of bringing the interdisciplinary research topic of our project to the fore. The course will be for all national and international PhD students connected to the project and will be open for others as well. WP leaders and international partners will serve as lecturers.

Project participants entail researchers from four departments at Aalborg University (AAU), one department of the Technical University of Denmark and from four international universities as well as some of the most important companies in the building and energy sectors – Velux, Inwido, Grundfos, Kuben Management, Saseco, IT-energi, Realdania Byg, Energinet.dk, AffaldVarme Aarhus, Fjernvarmefyn, and the housing association Ringgården. The following will describe these partners and their interest and qualifications related to the project.

AAU has a strong research base within the fields of user behavior, energy savings, low-energy building technologies, indoor environment, energy and environmental policies and regulation. In order to strengthen research within the building area, AAU has established Build.aau with the aim of developing and conveying knowledge to society about how to improve the built environment. Build.aau has approximately 300 affiliated researchers from architecture, building physics, energy control, mechanical systems, energy planning, physical planning, the humanities and the social sciences. It is, thus, the largest interdisciplinary research environment in Denmark within the field of the built environment.

The project leader is situated at The Danish Building Research institute in the Department for Town, Housing and Property, which has a longstanding tradition of working with energy consumption in an everyday life and practice perspective. This research builds on quantitative as well as qualitative research methods with the purpose of describing and understanding different patterns of households' energy consumption. The project leader is internationally renowned in the research community dealing with social science aspects of households' energy consumption. Three of the PhD projects will be situated at this department. The project will

expand the department's research within the domain of households' energy consumption, which is one of its positions of strength. From the Danish Building Research Institute, there will also be participation from the Department of Energy and Environment that conducts research on energy and environmental improvements in new and existing buildings including.

The leader of WP 2 is situated at the Department of Communication and Psychology in e-Learning Lab (eLL), which is an interdisciplinary research unit integrating historical, ethical, identity and organizational perspectives. A hallmark of eLL research is the attempt to mediate between understanding of practice and design for change of practice. The centre's research activities are characterized by an experimental, interdisciplinary approach, which draws upon theories and methods from pedagogy, technology, organization, and design. It seeks to develop user-driven innovation based on shared design languages and motivated by the principle of inclusiveness and sustainability.

The leader of WP3 is situated in the Architectural Engineering division, Department of Civil Engineering AAU, which has more than 20 staff members and is concerned with research and education in the analysis, design, construction, and operation of engineering systems for commercial, industrial, and institutional facilities. The research focuses on an integrated, multidisciplinary approach to achieve optimal building designs and pays special attention to their impacts on the indoor as well as the surrounding environment. This implies integration of architectural design with engineering systems like structural systems, energy systems, communications and control, lighting, acoustics, etc. Presently, the division is leading the Strategic Research Centre for Zero Energy Buildings (under the Danish Council for Strategic Research) and is involved in a number of other related projects.

The leader of WP 4 is situated in the Department of Development and Planning, AAU in the newly established research group "Design, innovation and sustainable transition (DIST)" that currently has 25 faculty members and is expected to grow. The department conducts research on sustainability, innovation, policy and has a long tradition of collaborating with companies, and with the creation of the DIST research group these research domains will be strengthen substantially. The DIST research group has a strong base within the field of science and technology studies and conducts research on innovation, valuation studies, the making of markets for new technologies across a number of empirical domains including energy systems, construction and the built environment. This research builds primarily on qualitative research methods.

DTU (International Centre for Indoor Environment and Energy, DTU Civil Engineering Technical University of Denmark) has an interdisciplinary team of researchers with expertise in the technical sciences, medicine, chemistry and psychology. It has performed numerous experiments (both laboratory and field) with human subjects, studying indoor environment and energy performance of buildings. In 2002 it was recognized as the best-equipped and most competent research unit in the world for multidisciplinary research on the indoor environment. It has a long tradition of involvement in national and international research programs on the influence of the indoor environment on comfort, health, productivity and energy performance of buildings and systems.

The international affiliated partners include three renowned research groups lead by Professor Kooen Steemers, Professor Kajsa Ellegård, and Professor Henk Visscher, respectively.

Professor Kooen Steemers, University of Cambridge, is currently the academic investigator on three large scale projects related to user behaviour and energy demand: two are UK-funded research projects ('Revisions' and 'Energy Efficient Cities') and the third is a new internationally funded project involving Universities of Cambridge, Tsinghua and MIT, called 'Low Carbon Urban Design'. The projects all take a large scale, urban starting point, and are focussed primarily on domestic energy use. The research is integrating questions of behaviour

with energy demand in all cases, thus, matching the overarching research ambitions of the "UserTEC" proposal.

Professor Kajsa Ellegård, Tema T, Linköping University is leader of the research group TEVS "Technology, Everyday Life, Society", involving 6 senior researchers and 10 PhD students. The research focuses on energy, technology and infrastructure in everyday life. TEVS are strongly involved in the national PhD school "Energy Systems Research Programme". Prof. Ellegård is and has been leader of several relevant projects including: Developing multilevel methods for visualizing energy use derived from time-use data (Swedish Energy Agency, 2006-2007), Household study within the national study measuring electricity use (Swedish Energy Agency 2003-) Methods for studying energy use in households (Formas 2006-).

Professor Henk Visscher of Delft University of Technology, is the leader of the Housing Quality research programme and the coordinator of several research projects related to energy efficiency in housing. His research group consists of about 20 researchers of which 8 are PhD candidates. The core subjects of the projects include 'policy and policy instruments', 'innovations in building and maintenance processes', 'diffusion and adoption of innovations', 'management of the housing stock' and 'performance assessment of residential buildings'. Within this last theme there are three PhD projects which will augment the UserTEC PhD projects.

The international expert Dr. Sarah Darby from Environmental Change Institute, University of Oxford has a long record of studies in feedback to users on energy consumption. She was part of the evaluation team for the major UK Energy Demand Reduction Project and is currently involved in the project "EVALOC, Evaluating low Carbon Communities", which is particularly relevant for WP3. Currently Oxford is applying for a project OxCRED with participation from SBI. If founded this project would serve as an excellent project for comparison with all the WPs in the UserTEC project.

The private companies represented in this project include some of the biggest companies within clean-tech in the building sector. Velux is a world leading company within the production of windows and skylights, including solutions for sun screening, roller shutters and remote controls. Velux also plays a leading role in the development of new sustainable building concepts which focus on improvement of user comfort and user perception. Inwido produces environmentally friendly windows and doors by focusing their resources, products and services on people's needs. Both of these companies' main interest in the project is the development of increased understanding of user practices especially related to indoor climate in order to further develop their own building components. Grundfos is a world leading manufacturer of pumps for use in and around the home for heating, water supply and wastewater, and they has a strong focus on the development of very energy efficient products. Their main interest in the project is comparing methods and understandings of user studies related to indoor comfort practices. Kuben Management is an advisory company for construction clients with a strong focus on achieving more sustainability in buildings and urban developments. Their interest in the project is to bring the project results into their advice for construction processes.

Also SMEs are represented in the project by Saseco, a company developing software specialized in solutions for energy and home control. Saseco's work with utilizing the synergies between automatic meter readings, wireless control and intelligent meters is at the core of our project and they are interested in results from the project to help further develop their products. IT Energy is another SME working with data analysis and software in the Danish energy sector. They are operating the prognosis model Elmodel-bolig, which has been used by the Danish Energy Authorities and energy companies to forecast and model energy consumption in households based on different scenarios for more than two decades. The

company is interested in the results of the project to further develop their model and other of their products.

Realdania Byg is a subsidiary of the Realdania Foundation and the primary objective is to accumulate a portfolio of historic and modern buildings, in keeping with the Foundation's strategy of improving the built environment. Realdania Byg's engagement and interest in this project is particularly related to the question of how new low-energy buildings interact with the users. Insero Energy is a newly started company attached to Insero Horsens, a foundation to create innovation and economic growth. Insero Energy work with developing and commercialising knowledge in the energy sector related to utilising ground source energy.

The energy companies are represented by two companies supplying households with district heating, Affaldvarme Aarhus and FjernvarmeFyn and Energinet.dk who are responsible for the energy infrastructure. These companies are among the more proactive with regard to smart metering and developing dialogs with households. Fjernvarmefyn has metering data for at least 20,000 households divided into monthly periods and for a minor group of 1000 households they can also provide hourly data. Affaldvarme Aarhus can provide hourly data from 1000 households and during 2012 they will roll out a broader metering program. These data are extremely valuable inputs to the project, but the project will also provide the companies with analyzes that they otherwise would not be able to undertake. The main interest that these companies have in the project is to learn more about the household consumption patterns and how better to communicate with the consumers. The final goal for some of the companies is to provide market based solutions for a low carbon society that are attractive to the consumers. The infrastructure company Energinet.dk is also interested in understanding fluctuation in electricity consumption and how it relates to different practices and types of households as well as in new approaches in modeling household energy consumption. Finally the project team also includes a nonprofit housing association, Ringgården that has several projects on improving communication with their residents on energy savings. Insights from the project will be a valuable input for their endeavors at becoming leading in thinking, building and creating a context for green living.

Thus, the partner institutions and industries represent all key competences needed to fulfill the goals of the project. All work packages benefit from synergies through cooperation in a multidisciplinary environment, with both private companies and international contacts.

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