Deliverable 4.3-1c
International workshop report 3: Roadmap Validation Workshop

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Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

SEVENTH FRAMEWORK PROGRAMME

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1. Executive summary

The second REViSITE validation workshop (VW2) was held on the 16th of June 2011 in Arnhem, the Netherland and hosted by Kema Consulting in the World Trade Center.. The workshop saw the participation of eight REViSITE Expert Group (REG) members, an expert panel comprising a wide range of academic institutions, research centres and companies from across Europe, and all REVISITE consortium members.

This event represents the third of five workshops[1] organized by REViSITE to interact with experts, aligned to ICT4EE (ICT for Energy Efficiency), in order to validate future research priorities and cross-sectoral opportunities identified by the project where ICT can positively impact energy efficiency. This workshop has mainly focused on the definition of the basis for the imminent development of the strategic research agenda.

The opportunity to interact with such experts was invaluable in both assessing positively the developed SMARTT taxonomy and the strategy undertaken for the imminent Roadmap development.

REG participation was very active and offered the consortium very high qualitative inputs for the future work of the WP3 of the project.

Key issues discussed during the workshop are briefly listed here and analysed in depth later in the document:

- Assessment of the already developed work about the Impact Assessment Model (IAM) and the SMARTT taxonomy, and sanity checking the identified research priorities identified so far by REViSITE for ICT for Energy Efficiency.
- Assessment of the strategy identified for the development of the REViSITE Roadmap, hence its SRA and the recommendation for standardisation proposals.
- Sanity check of tables containing the ICT research priorities representing the basis for the imminent development of the Strategic Research Agenda, definition of respective timeline for each of the research priority identified and definition of drivers, barriers and impacts for the macro categories that classifies the research priorities..

In conclusion the event provided a variety of important inputs for the REViSITE programme of work, in particular for the REViSITE roadmap development, and also it represented an initial investigation related to the recommendation for standards.

[1] The first workshop, the Community Validation workshop, (CW1), was held in Sophia Antipolis, Nice, during June 2010, and all the issues discussed have already been reported in Deliverable D 4.3-1a. The second workshop, the vision validation workshop (VW1) was held in Helsinki January 2011 and reported in D4.3-1 b

2. Abbreviations

BIM	Building Information Modelling
CMM	Capability Maturity Model
CO	The REViSITE consortium – participant members are listed in Appendix III
CVW	Community and Validation Workshop
DOW	Description of Work
EC	European Commission
ETP	European Technology Platform
IAM	Impact Assessment Model
IAP	Implementation Action Plan
ICT	Information and Communication Technologies
ICT4EE	Information and Communication Technologies for Energy Efficiency
LCA	Life Cycle Assessment
PM	Project Manager
REG	REViSITE Expert Group
SRA	Strategic Research Agenda (the ICT4EE Roadmap)
VW2	Vision Workshop 2
[REG]	Each name of people listed in Appendix II

3. The aims of the second Validation Workshop (VW2)

After the definition of the SMARTT taxonomy and the Impact Assessment Model, the next step for REViSITE was to develop a Strategic Roadmap for research priorities of ICT4EE.

To do so, the project planned to invite experts covering the four ICT4EE sectors to analyse their views about the next steps to be covered by R&D in order to innovate and to be available in time for the entire ICT4EE industry.

3.1 Purpose and target audience

The main purposes of the 2nd validation workshop, third of five scheduled workshops by the project, was to assess the basis for the upcoming WP3 roadmap development and to elaborate the REViSITE Strategic Research Agenda.

The working day focused on discussion about the Strategic Research Agenda, the Implementation Action Plan and the recommendations for the Standardisation bodies, trying to get out the most from experts belonging to the four different sectors invited and from their interaction with the CO.

The audience that took part in the event was represented by the REG with high expertise in each of the different sectors covered by the project. In brief the REG's expertise was in specific sectors as follows:

- 4 from the Smart Building sector
- 2 from the Smart Manufacturing sector
- 1 from the Smart Grid sector
- 1 from the Smart Lighting sector

The main objectives of the workshop were:

1. To sanity check the research priorities identified so far by REViSITE through the developed SMARTT taxonomy, for their adoption in the development of the REViSITE Roadmap
2. To identify and discuss about the relative timing for the research priorities identified and the respective drivers, barriers and potential impacts.

3.2 Outputs and Impacts

The work conducted during the workshop assessed positively what the REViSITE consortium developed so far and offered several inputs and feedback that will be considered for the imminent development of the REViSITE Roadmap, in particular for the D3.2 about the SRA and for the D3.4 about the Recommendations for standardisation proposals.

Furthermore the meeting proved again that experts from the four different sectors can work together sommthly and discuss and see some common solutions in terms of ICT for Energy Efficiency, although there are still basic differences as time differences between sectors and also the need for a common language.

The positive reactions of the REG on the day confirmed that the approach adopted by the project respect the common needs of an entire ICT for Energy Efficiency community, and that the results will represent an added value for the future.

Main outputs developed were related to:

- identification of timelines for the ICT research priorities identified by the CO through its already developed SMARTT taxonomy,
- definition of barriers, drivers and impacts of the macro categories of the SMARTT taxonomy, and
- initial discussion on themes related to standards needed in the field of ICT4EE.

The outcome tables developed during the brainstorming session have been collated and reported in appendix V.

They summarise the merged vision for the priorities of the ICT for energy efficiency topics needed in the short, medium, and long term respectively for each of the six macro areas identified within the SMARTT taxonomy.

Furthermore, for each of the categories identified among the SMARTT taxonomy, drivers, barriers and potential impacts have been discussed.

4. Description and official records of VW2

4.1 The approach to VW2

The organisation of the workshop foresaw several internal communication between partners of the CO and a consortium meeting the day before the Workshop, hosted in Arnhem, the Netherland by KEMA in its facilities.

During this meeting, the consortium scheduled and defined the strategy for the brainstorming group exercises, assessed the developed tables and the objective of the two focus groups, and the detailed guidelines on how to lead the tables filling exercise by the REG members who participated.

Also the aim to interact, and to promote further interaction between the REG themselves, apart from capturing their point of view, was underlined during the consortium meeting.

The consortium participated in the workshop with 11 members (listed in Appendix III).

The eight (8) REG members participating and their specific expertise are reported in paragraph 5.1 while their attendance is reported in Appendix II.

The detailed Agenda is in Appendix I.

4.2 Structure and overview

The VW2 has been structured into three different topics:

1. Brief presentation of the project for new attendees and of its results up to date and general feedback;
2. Brief presentation on SMARTT taxonomy, specific sector SRA for Building, Lighting, Manufacturing and Grid given by the CO
3. Two parallel breakout sessions (focus group) focused on a brainstorming exercise for sanity check the research priorities identified, for the identification of their timeline (short, medium or long term) and identification of the respective drivers and barriers.

In relation to the structure, the organisation of the event has been divided into three different sessions:

- The first session focused on gathering from REG both general feedback about the project progress and about the REG views on the future ICT4EE roadmap
- The second session focused on plans for the Roadmap development, which included plans for the SRA development, and initial identification of gaps, barriers and drivers, to address the focus of the work about the recommendation for standardisation proposals.
- The last session has been implemented through focused brainstorming exercise carried out by the REG. after dividing them into two groups each led by a consortium member.

The first part of the workshop lasted for about two hours, and comprised the first two sessions above listed. During this time general discussion about the project and the difficulties that the project would face took place. The CO clarified several doubts that arose from REG members such as:

- How the project is willing to face the problem about the multi-speed of different sectors
- Which kind of technologies, or principal research lines are the focus of the project, and which are the main categories to deal with
- What is the timeline identified for short, medium and long term

The second part of the workshop started at the second part of the morning session and lasted for the rest of the day. It ended just before the final discussion on general feedback about the overall day[2].

A very active interaction between all participants underlined the interest that experts belonging to different sectors showed towards REViSITE. This part also foresaw the general feedback for the project, and specific for the SMARTT taxonomy and the REViSITE Vision for ICT for Energy Efficiency.

It also proved the high potentiality behind the taxonomy developed, since it has been seen as a common language for all experts belonging to different sectors.

The following table offers an overview of the action carried out during the overall workshop:

Part of VW2	Input by the CO	Output by the REG
1st Workshop part	REViSITE general presentation and Results achieved Foreseen Strategy for the REViSITE Roadmap Implementation	General Feedback on the project and on an ICT4EE roadmap perspective in general Clarification questioning and feedback Inputs and suggestions for a better cross-sectoral understanding
2nd Workshop part	Brainstorming exercise explanation, Tables for SRA inputs	Filled tables with inputs: • sanity check of the research priorities identified, • identification of the respective timelines needed and • identification of drivers and barriers

Table 1: Input-Output actions during the working day

[2] All REG members have been interviewed and asked for permission for publishing their interview on youtube. Such interviews can be seen at the following link: www.youtube.com/revisite .

4.3 Procedures and Outcomes

4.3.1 First part workshop

During the first part of the workshop participants discussed about general feedback concerning project achievements, and about their vision of ICT for Energy Efficiency in general.

REG also provided some general feedback about the developed work.

The related minutes are reported in appendix IV.

Since one of the major aims was also to achieve interaction between experts from different sectors, REViSITE tried to push comments on topics that could be of common interest and that could lead to cross sectoral solutions.

The CO presented to the audience the overall information and findings of REViSITE. During presentations the REG-members had the opportunity to comment and feedback on the various topics exposed.

In order of appearance the following presentation took place:

- General presentation of REViSITE
- Description of respective Strategic Research Agenda for each of the sectors covered by REViSITE:
    - GRID
    - Lighting
    - Building
    - Manufacturing
- Description of the proposed methodology for the definition of the REViSITE cross-sectoral Roadmap, its Strategic Research Agenda, Implementation Action Plan and the recommendation for standards.

During all of the above presentations the REG interacted with the CO to expose their comments and to ask for clarification about specific and strategic issues undertaken by the project.

Topics covered by the discussions have been:

- Clarification about the methodology related to the REViSITE Roadmap development
- Clarification about the topics covered and the respective definition of the SRA Strategies adopted and entities expected to be involved in the process of the definition of the SRA

Some of the REG also expressed their view, as briefly mentioned above, about the differences of timing between the four sectors, e.g. in respect of the life cycle of each sector specific technology, about the focus needed by all sectors towards the final user that once he / she receives the technology developed is left alone with it.

Following a picture of the general discussion:

Figure 1:Pleanry Session Discussion

Figure 2: Plenary session discussion

4.3.2 Second part VW2: brainstorming exercise

The second part of the day continued with a brainstorming exercise organised with the precise scope to investigate the ICTs technologies, according to the REG and consortium expertise, which will have the most impact on energy efficiency in the short, medium and long term.

The CO provided the two groups with tables containing the ICT priorities identified so far by the project asking them to provide an overview about the timing expected, if short, medium or long term for them to be available on the market.

The second part of the exercise, developed after the lunch break, was focused on the identification of the respective drivers, barriers and impacts for each of the categories of the REViSITE taxonomy where the ICT research priorities were embedded.

The following figures summarises the two specific working groups with the name of participants[3]:

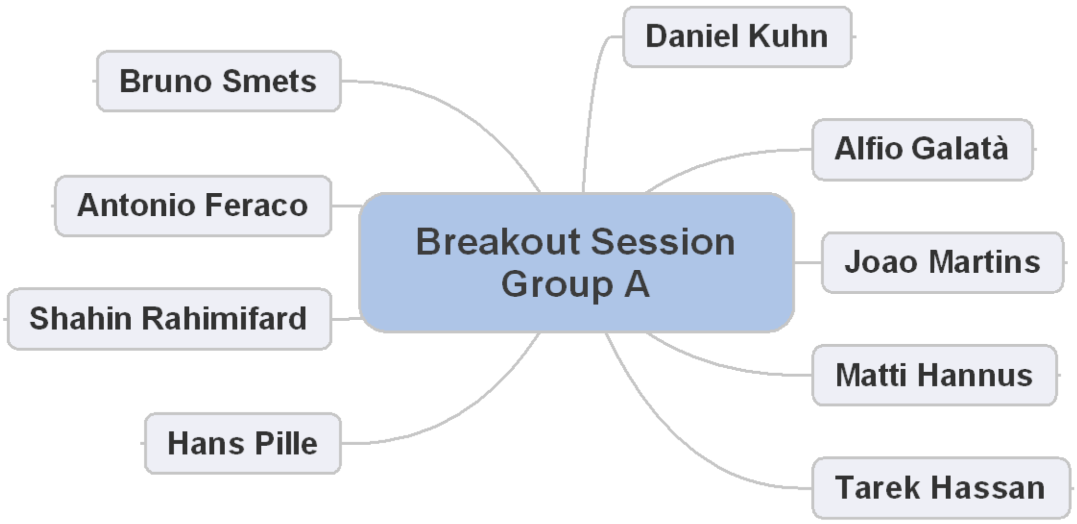

Figure 3: Breakout session: working group A

[3] All participants have been asked for permission to publish respective names and pictures.

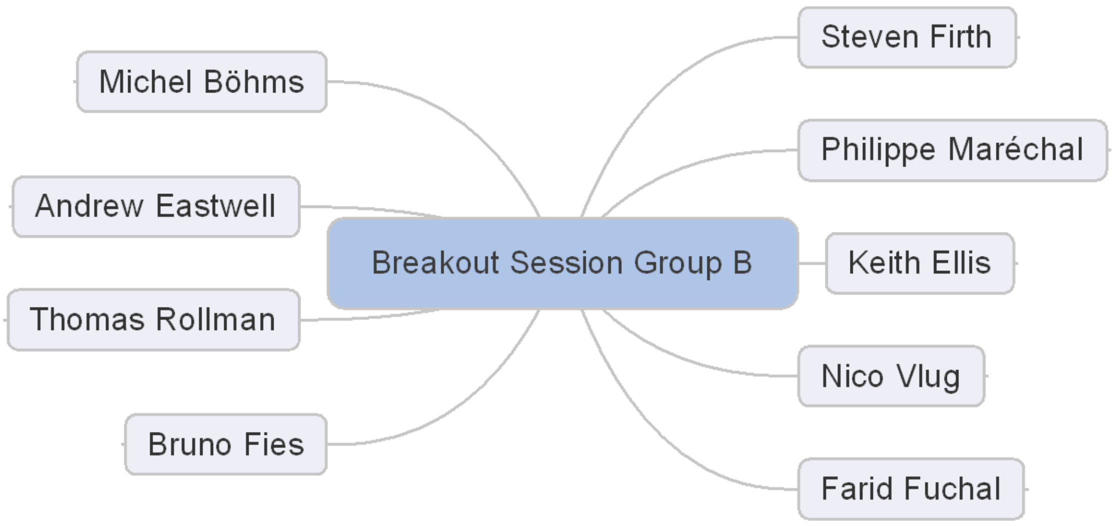

Figure 4: Breakout Session. Working Group B

The exercise has been organised as follows:

1. REG have been divided accordingly to their expertise in two groups[4], A and B, together with CO members in order to provide guidance to the tables filling,
2. One CO member led the brainstorming session; in the specific VTT for group A, and Intel for group B.

The resulting tables are in appendix V.

Following some pictures of the brainstorming exercise:

[4] Division has been made in order to cover the most possible sectors in each group.

Figure 5: Group A Brainstorming Exercise

Figure 6: Group B Brainstorming Exercise

4.4 REG post-event feedback

After the event all REG members have been asked to provide the consortium with their feedback about the day and about the overall aim of the project.

The following are the comments and the feedback gathered by the CO:

- The need for benchmarking framework for comparing themselves

- Need for moving to cognitive analysis phase to have a better understanding of the behaviour of operators and manufacturers and knowledge about it for the designing processes.
- Technology exists, but it is always a stand alone technology. Usually it happens that once the technology is developed then it is no more maintained or improved.
- Do not use so much acronym, avoid as far as possible to use acronym.
- The day workshop was very productive, especially between the building and the manufacturing sectors. It offered the opportunity to identify common problematic and, more important, also common potential solutions easily identifiable through the use of the SMARTT taxonomy developed by REViSITE.
- Thanks for nice hospitality, my first time here, but I feel that we have been working for long. That in terms of contents this is not a criticism but a suggestions, it is too hard in one day to be concentrating in everything.
- I found this day very fruitful, I have worked in REEb before and the way this kind of workshops are gathering experts from outside the consortium is very useful. Indeed is hard to focus for 5 or 6 hours but very fruitful. Exhausting. VERY GREAT INDEED
- My second time here, I agree, for a short time for the work we had in mind, and very well brainstorming. It is very important this kind of work, I think it is not finished, but after this day it will be more easier in doing it.
- I would have felt to receive more information in advance. Facilitator is better informed on the arguments. From a Philips perspective we are concerned about ICT to the fact that can be an enabling technology in guiding the final user to improve its behaviour.
- For me the question is if there is any research needed... There are a lot of algorithms that only needed to be translated into various other sectors. It is specific to the application of that part of the process you are considering to see where the big gaps are. The day was challenging and very fruitful.

All these comments and feedback will be used and aligned within the development of the REViSITE Roadmap by the REViSITE project.

5. Event Evaluation

5.1 Event participation

The total number of attendees for VW2 was 19 with 8 REG (appendix II) and 11 persons from the consortium (appendix III). The REG members and their expertise is reported in the following table:

N	Expert	Smart Grids	Smart Manufacturing	Smart Buildings	Smart Lighting	ICT
1	Dr-Ing. Thomas Rollman		X			
2	Michel Bo□hms			X		
3	Joao Martins			X		
4	Philippe Maréchal	X				
5	Bruno Smets				X	
6	Shahin Rahimifard		X			
7	Andrew Eastwell			X		
8	Alfio Galatà			X		
TOTAL by AREA		1	2	4	1	

Table 2: REG members and expertise

5.2 Impact on the VW2 scope

As per the aim of the working day the CO succeeded to gather important feedback, but furthermore to define inputs under the umbrella of the SMARTT Taxonomy, inputs that would represent the basis for the on-going development of the REViSITE Roadmap.

Such inputs offered a confirmation that most of the ICT for energy efficiency research priorities identified are common needs for all the four specific sectors, and furthermore they provided the CO with a logical and common timeline for each of such research priorities.

The brainstorming exercise and the interaction lead to fruitful information gathering and strategy definition for the upcoming work.

Basically the VW2 impacted positively on the scope foresaw by the consortium and offered a solid basis for the upcoming work.

It also proved that experts belonging to the four different domains were keen and interested in looking towards solutions that embrace all the four sectors (Grid, building, manufacturing and lighting) under a common umbrella.

This also underlines the potentiality behind the SMARTT taxonomy that has been positively used as the common language for all the four sectors involved in the project.

5.3 Comments on the VW2 event

The CO considered this workshop a very fruitful one, both for the fruitful discussion seen between REG from different expertise, and above all for the inputs and feedback received during the day.

The audience participating showed a high level of interest in REViSITE activities, and through the continuous interaction which emerged during the workshop many inputs have been gathered for the on-going activities of the project.

The REG also allowed the CO to interview them for gathering their specific views about both REViSITE and the workshop itself, and also about ICT for Energy Efficiency in general. Such interviews have been published on YouTube after taking the permission from the interviewee.

They have been uploaded into the REViSITE YouTube channel at the following link: www.youtube.com/revisite.

5.4 Chairman assessment and global evaluation

The workshop was a very productive and fruitful event. The consortium was able to obtain from the REG an expert view on the development of the work within REViSITE particularly in relation to the development of the SRA themes and topics structured under the REViSITE taxonomy.

The very useful and helpful feedback we obtained from the REG will guide the next stages of the project for finalisation of the SRA.

This gave confidence to the consortium that the project is going on the right track, which in addition to the peer review and consultation processes we apply for all key deliverables we gained a much clearer view for the way forward.

6. Conclusion and recommendations

6.1 Conclusion and lessons learnt

VW2 represented the third of the planned workshops in REViSITE and the second workshop based on discussion related to the achieved results of the project. The REG feedback was positive concerning the overall approach and methodologies developed by REViSITE CO, whilst recognising the complexity of the project's scope.

VW2 also provided an important input for the imminent development of the REViSITE roadmap, hence for its SRA, IAP and for the following recommendations for standardisation proposals.

It offered the opportunity to gather multi-sectoral inputs from a heterogeneous poll of experts from the 4 sectors covered by the project.

Hence, the workshop itself had a positive assessment about the previously developed REViSITE SMARTT taxonomy and the Impact Assessment Model and it also provided very useful assessment and inputs for the REViSITE Roadmap development, both for the Strategic Research Agenda and for the Recommendations for standardisation proposals.

The feedback and the discussions developed, during the overall day and after the brainstorming exercises, strengthened the already well-developed foundation of the project and provided the consortium with clear directions for the future works with respect to the REViSITE roadmap development, offering high level details concerning both the research priorities that will have the most impact in the upcoming years and the drivers and barriers to be faced commonly in ICT for Energy Efficiency.

7. Input for D3.2

7.1 Input for D3.2 – Summary from the breakout session

To summarize the inputs received from the two focus groups, the following tables have been elaborated with respect to the SMARTT taxonomy index and the groups respective discussions. The details of the entire discussion, per categories and research priorities, are reported in tables in Appendix V, here for convenience we report the results of the second part of the working exercise, that is the brainstorming focused on identification and definition of the barriers, drivers and impacts for each of the SMARTT taxonomy category:

SMARTT Taxonomy	Group A	Group B
Specification & Design		
• Drivers	Regulations. Customer expectations. Economic benefits. Integration of energy generation / harvesting, transmission, consumption, storage, reuse (energy). Integration of product, process, plant (PPP).	Demand side, government and cognisant shareholders, also economic in terms of construction, production efficiency in follow on phases
• Barriers	Demand side, government and cognisant shareholders, also economic in terms of construction, production efficiency in follow on phases	
• Impact		
Materialisation ICTs		
• Drivers	Legislative / cost saving. Integration of product, process, plant (PPP) considering multiple views.	Demand side, government and cognisant shareholders, also economic in terms of construction, production efficiency in follow on phases
• Barriers	Users interface. Knowledge of energy usage distribution	
• Impact		
Automation & operational decision support ICTs		
• Drivers	From off-line to near real-time. From near real-time to real-time	Economic Tariffs, regulation
• Barriers		lack of auto actuation in residential space, perceived limited benefit in changing especially when taking an individual citizen or single dwelling view.
• Impact		
Resource and process management ICTs		
• Drivers	ISO 5001 Standard for energy management (DIN 16001)	Economic, Mass Market, desire for simplicity & some tech push
• Barriers	Some barriers to entry in terms of SME access to analytics capability	
• Impact		
Technical Integration ICTs		
• Drivers	Integrated Product Policy (IPP) Common Protocol Holistic functionality of all systems	Political Desire to control energy flows that transcend sectors, economics seen as a barrier & driver barriers, political and social views in terms of privacy
• Barriers		

• Impact		
Trading / transactional management ICTs		
• Drivers	Integration of energy generation / harvesting, transmission, consumption, storage, reuse	Economics, CO_2 impact, energy security / independence, openness of rate, decentralisation & integration of bulk, RES & EV's
• Barriers	Lock-in in terms of vendors trade	
• Impact		

8. Appendices

Appendix I: Agenda of the VW2

09:00	*Arrival, coffee*
09:25	Welcome, organisation, agenda (10’) (by KEMA & LOU)
09:35	Presentations by new REG members
09:40	Project status and targets for the day (20’) (by LOU)
10:00	Parallel group work, 2 groups, tables 1 – 3 (Short, medium, long term priorities)
11:00	*Break (Coffee)*
11:30	Parallel group work, 2 groups, tables 4 – 6 (Short, medium, long term priorities)
12:30	*Lunch & Coffee*
13:30	Parallel group work, 2 groups, tables 1 – 3 (Drivers, barriers, impacts)
15:00	Parallel group work, 2 groups, tables 4 – 6 (Drivers, barriers, impacts)
16:00	Discussion (20’) (by VTT)
16:30	Update on the next REViSITE Workshop (10’) (by LOU)
16:45	*End of meeting*

Appendix II: Expert Members Group attending the VW2.

Name	Organisation	Signature
Thomas Rollman (representing Reiner Anderl)	TU Darmstadt, Germany	
Michel Böhms	TNO, The Netherlands	
Joao Martins	UNINOVA, Portugal	
Philippe Maréchal	CEA / LITEN, France	
Bruno Smets	Philips Lighting, The Netherland	
Shahin Rahimifard	Loughborough University, UK	
Andrew Eastwell	BSRIA Limited, UK	
Alfio Galatà	Agsaving, Energy Management & Building Automation, Italy	

Appendix III: Consortium Participants

Name	Institution
Tarek Hassan	Loughborough University
Keith Ellis	Intel Labs
Daniel Kuhn	Fraunhofer
Hans Pille	Kema Consulting
Nico Vlug	Kema Consulting
Matti Hannus	VTT
Antonio Feraco	INNOVA SpA
Bruno Fies	CSTB
Farid Fouchal	Loughborough University
Steven Firth	Loughborough University

Appendix IV: Minutes of the VW2 (extracts from discussions)

No	Topics Covered	Action(s) by
1.	• Welcome to the participating audience • Presentation of Agenda of the Workshop	KEMA
2	• Brief description of REViSITE project • Description of REViSITE Community characteristic (not sector specific)	LOU
3	• REG presentation and affiliation (Both institution and expertise)	REG
4	• Presentation of the Draft Cross-Sectoral SRA	INTEL
5	• Questioning about: o Definition of Energy Efficiency o Technologies to be identified o Definition of Short, Medium and Long Term for ICT research priorities identified	REG
6	• Clarification of all issues raised by the audience	Consortium
7	• Description of the methodologies for the definition of the REViSITE SRA	VTT
8	• Brainstorming exercise for the two groups	Consortium + REG
9	• Presentation of outcome for the two groups.	Consortium + REG
10	• Feedback about the work carried out	REG
11	• General feedback about the workshop and about REViSITE in general	REG
12	• Interviews to REG participants	INN
13	• End of the workshop	Consortium + REG

Appendix V: Table Group A + B

Roadmap 1: **Specification & design ICTs**

Drivers	Regulations. Customer expectations. Economic benefits. Integration of energy generation / harvesting, transmission, consumption, storage, reuse (exergy). Integration of product, process, plant (PPP). Demand side, government and cognisant shareholders, also economic in terms of construction, production efficiency in follow on phases
Barriers	Legislation / regulations. Lack of knowledge about required time of usage. Understanding the multi-disciplinarily of ICT. Understanding user behaviour: why, when, where, by who energy is used. Showing how savings can pay investments. <0>
Impacts	

<table>
<tr><th></th><th>State of the art <3></th><th>Short term</th><th>Medium term</th><th>Long term</th><th>Vision</th></tr>
<tr><td rowspan="2">1. Design conceptualisation</td><td><G:> Requirements engineering & Graphical design tools. <M:> Requirement engineering, Energy dependency analysis; Tools for conceptual design of production networks. <B:> Requirement definition tools. <L:> Requirements definition, concepts selection and visualisation tools. No tools <?>. Cambridge Engineering Selector.</td><td>Requirements capturing using templates, user profiles and usage scenarios. Visualisation tools.
Extended EPBD concept (i.e. W/m2) for every process which involve energy use.
Simple tools for rough estimation of LC energy requirements.
More adopt tools from one to other/all Sectors. <1>
Integrate requirements for different levels and aspects (e.g. product, process, plant)</td><td>LC requirements models.
Complementary Usage scenarios (LC, abnormal situations). Model based visualisation.</td><td>Ruled requirements capturing from related system models; Auto-generation of requirements.</td><td rowspan="4">Integrated design solutions toward ICT4EE covering technical, commercial and regulatory factors along with a shared vision (e.g. energy pricing structures, linking insurance incentives with energy consumption).
Interoperability of design as a capability, the ability to share information model based collaboration.
Electronic catalogues of design details for better energy efficiency.
Models for energy consumption prediction at each layer, e.g. device level, location, process level etc.
Energy performance estimation is practiced, via:
• ICTs for identifying standards based performance indicators comparable to, for example, reference values other buildings or simulations.
• Certified assessment software.
• ICTs to predict total life cycle energy consumption taking into consideration the construction / materialisation stage.
• ICT based globally agreed methodologies, approaches and metrics for predicting the performance and energy impacts of ICTs and for assessing the energy impact of technological changes in construction, production etc.
Holistic simulation is utilised.</td></tr>
<tr><td colspan="4">Built E / Grids: Life cycle management & the integration into the wider echo-system is an area of interest for the EC. Resource based Holistic planning tools required. Together with a benchmarking Framework. [Tech/Practices require improvement, framework non-existent]
All: Tools/practises based on concepts/disciplines such as Cognitive work analysis & Human Factors Engineering required in terms of incorporating behavioural & target user considerations into design at an early stage [Tech/Practices exist a matter of proliferation]
Interesting point is that only Lighting sector scored this highly in the survey, perhaps survey examples did not help in that regard</td></tr>
<tr><td rowspan="2">2. Detailed design</td><td><G:> Standard software design tools. <M:> CAx, PDM, Green-PLM. <B:> General CAD tools. <L:> Lighting design & visualisation tools</td><td>CAD tools with design templates and product libraries. Energy related attributes well covered.
Consider energy as one design aspect</td><td>Interoperability between CAD tools and design applications. Performance analysis and visualisation.
Availability of meaningful EE info e.g. embodied energy.</td><td>Configuration based design enabled by reference system models, rule-based scaling methods and intelligent component objects. Use of simulation in design & validation. Impressive visualisation.
Implementation of energy consumption simulation in design tools</td></tr>
<tr><td colspan="4">High levels of current Sophistication in standalone contexts issue seen as been an integration issue in terms of linking 1-6 within specification & design in order to augment existing design tools moving towards systems similar to the BIM or PLM type visions
One Built E specific comment was that parametric tools that input into the detailed design process were poor for some elements e.g. Steel good, Services bad</td></tr>
</table>

3. Modelling	*<G:>* General performance estimation and simulation tools. *<M:>* Reverse Engineering, Virtual Reality tools, Digital Mockups or Smart Hybrid Prototyping. *<B:>* BIMs for AEC & FM tools. *<L:>* CAD data import to lighting design ools; Luminaire libraries	Domain specific product data models. Modelling existing products/ systems. Energy visualisation.	**All time spans of Topics 3-6:** Team felt that the progression of current SOTA in terms of the individual ICT themes here was dependent on the integration of the various teams along the design chain. General consensus that the technology is sophisticated in standalone contexts. But that integration of the various touch points e.g. HFE *<2>* output from design conceptualisation, specification / material information + feedback from the materialisation and operational phases of the life cycle need to be improved in order to augment existing models. In the main considered an integration issue in terms of moving from SOTA to	Model based tools (design, performance estimation simulation, etc.).	Functional product / system objects (vs. pure data objects) enabling new object oriented applications (e.g. agent based).	ICT for rationalisation / selection of components for better energy efficiency. Electronic catalogues of products / components including relevant attributes of energy efficiency. [5]
4. Performance estimation	*<G:>* Technically normal & emergency situations; financially incl. energy market effects. *<M:>* LCA. *<B:>* Cost estimation, LCA, Energy & indoor conditions simulation and visualisation. *<L:>* Technically enabled in Lighting design tools. Supporting tools for economic performance estimation available.	Static holistic KPIs (technical, economic and environmental). Estimation of energy consumption of the ICTs need (integrated consumption of product, process, plant).		Dynamic detailed KPIs, Validation through simulation. Consider energy consumption of ICT itself.	Real time KPIs.	
5. Simulation	*<G:>* Simulation of the power system, generating units, energy markets; state estimations & consumption forecasting. *<M:>* Simulation of energy consumption of the production system; integration with thermal building simulation tools. *<B:>* Building and system simulation, CFD, BIM-CAD import. *<L:>* Advanced lighting systems (presence + day lighting)	Simulation methods for design & validation. Dynamic and 3D visualisation. Inclusion of engineering aspects in simulation including VR technologies. Simulation integrated in detail design.		What-if analysis using simulation. Interfaced with models.	Live virtual models enabled by simulators and models.	

[5] The tables summarizes the inputs of both groups, A and B. The input of Group A is green color marked, while the input of Group B is yellow marked. The letter <G>, <M>, <B> and <L> indicate respectively the four sectors: Grid, Manufacturing, Building and Lighting. The text marked in purple indicates that the text was not so clear.

6. Specification & product/component selection	*<G:>* Sector specific specification methods. *<M:>* Rapid Manufacturing of parts from digital models. *<B:>* Limited tools. *<L:>* Luminaires in product libraries.	Specification templates, product & supplier libraries, e-market tools.	vision	Specification models, Model based product libraries and selection tools.	Partially automated component selection & procurement.	

Roadmap 2: Materialisation ICTs

<table>
<tr><td>Drivers</td><td>Legislative / cost saving. Integration of product, process, plant (PPP) considering multiple views.
Economic - optimisation of the materilisation process has financial attraction, time to complete etc and impact in terms of EE is essential a buy-product.]</td></tr>
<tr><td>Barriers</td><td>Users interface. Knowledge of energy usage distribution.</td></tr>
<tr><td>Impacts</td><td></td></tr>
</table>

<table>
<tr><th></th><th>State of the art</th><th>Short term</th><th>Medium term</th><th>Long term</th><th>Vision</th></tr>
<tr><td rowspan="2">1. Decision support & visualisation</td><td>Generic project planning tools.
ERP.</td><td>Tools to visualise the progress in materialisation phase using 3D models (e.g. derived from BIM or PLM), bar charts, flow-line schedules etc.</td><td>Using 3D/4D/VR models derived from BIM/PLM to visualize energy related data in materialisation phase.</td><td>Include energy related aspects into decision support tools (make or buy)
Decision support to select production strategies e.g. Offsite / onsite production).
ICT for proactive decision making (instead of support only).</td><td rowspan="4">In this case discussion was, in parts, more visionary then below, we should adapt.
ICTs to optimise / select production / materialisation / procurement (e.g. strategies for on-site/off-site production in construction or make-or-buy in manufacturing) methods based on optimum energy consumption.
ICTs to rationalise materialisation processes (in terms of planning) for more efficient energy efficiency (e.g. timing, sequence, etc.)
enable real-time communication in materialisation phase.</td></tr>
<tr><td colspan="4">Issue in terms of project planning not seen as being a technical one. Issue is often accessibility & openness. Larger orgs have access to the Skills [personnel], practices & tools that SME's in the main do not have. Current SOTA sophisticated enough to realise vision.
One possible short term item to consider is that often the platforms [network bandwidth, fit for purpose portable devices etc.] are not available to utilise ICT based modelling and nD content in the field…advancement here should be considered.
The link between design simulation & management system is not there, augmentations of BIM are required in that regard, comment was that Manufacturing are more advanced in that space in terms of interconnected process changes across the life cycle based on a digital model.
Whole life costing and component / material information also required & this links back to sub-cat [6] pod specification & design.</td></tr>
<tr><td>2. Management & control</td><td>4D Simulation of construction processes
Generic project planning tools.
Just in time.</td><td>Integrate energy related aspects into business processes in materialisation phase --> define energy performance targets
Integrated view
Tracking individuals on site.</td><td rowspan="2">All time spans of topics 2-3:
Automated tools for testing performance and validation of energy related requirements and design specifications.</td><td>Ict supported control mechanism --> real time target / actual performance comparison.</td></tr>
<tr><td>3. Real-time communication</td><td>Syndication tools (e.g. RSS).</td><td>Using RFID tags to track transport and status of components .
Reduction of wires</td><td></td></tr>
</table>

Roadmap 3: Automation & operational decision support ICTs

Drivers		From off-line to near realtime.	From near realtime to realtime.	
	Economic Tariffs, regulation			
Barriers	lack of auto actuation in residential space, perceived limited benefit in changing especially when taking an indivdual citizen or single dwelling view. <0>			
Impacts				

	State of the art	Short term	Medium term	Long term	Vision
Automated monitoring & control	Existing software, algorithms embedded microcontrollers, sensor / actuation hardware, variable speed drives, remote lighting heating & appliance control etc., Standalone component technology sophisticated enough to realize vision...issue is integration & interoperability of same. Manual … semiautomatic EMSs.	Integration of heterogeneous sensors i.e. sensor fusion. Advancement primarily sits within Technical Integration space. Move from decision support to decision making.	Short term + Virtual sensors, inference technology & non-intrusive load monitoring. Increased levels of autonomous diagnostics and machine-learning. Advancement again sits in technical Integration space. ICT to assist decisions on reuse of energy. Predictive control using presence detection with various technologies (mobile phones, infrared / thermal / noise sensors. Business models / services to capture usage patterns for learning and control adjustments.	Medium term + Autonomous machine level diagnostics, prediction and optimization, full integration and interoperability of sensor and actuation devices with optimized use of ambient resources e.g. natural light, free cooling etc. Planning tools for energy generation, distribution, consumption & reuse. From set point control to benchmark based control. nD models (e.g. BIM) enhanced with dynamic / realtime information.	Embedded ICTs permeate sectors providing the “intelligence” to monitor & control energy resources in sustainable ways. ICT systems facilitate user control through integrative data visualization ICT act as learning systems providing reliable, secure & affective decision support to prosumers. Building operating systems & district energy mgmt systems automatically install software & services in buildings / districts similarly to PCs now Predictive controls algorithms perform real time optimization Systems learn & adapt to user preference via incorporated anticipatory logic. Secure wired/wireless & optical sensor networks act as a comms backbone to the Energy grid, Realtime EMS. Active decision making by ICT.
	Technology was considered in the main sophisticated enough to realise the vision albeit typically in standalone scenarios. But of course increased sophistication in the embedded space is envisaged albeit incremental. Increased use of inference / virtual sensing was an area seen as promising in terms of moving beyond current SOTA. Again integration seen as paramount. Other important elements to consider were convergence of technology, a move towards an internet of things with communicating devices – with high levels of security and interoperability allowing for seamless holistic monitoring and control. But the emphasis given use-cases should be on ’actuation’ in order to maximise EE impact. This relates to comments regarding the next sub-catgory.				

Operational decision support & visualisation	Existing Information Systems, HEMs <1> type devices, decision support dashboards	Energy dashboards and real-time communications regarding usage. Based on HFE, Data Visualization and cognitive work analysis principles. Rationalisation of parameters li le ict to reduce energy consumption.	Short term + What if simulations to support operational changes for optimal running of manufacturing lines, heating systems, micro-power generation etc. Tools to analyse information about energy consumption with respect to plans, other users, best practices etc. Tools to select priorities for corrective actions. Realtime inspection of gathered data. Smart metering networks to identify critical points on consumption.	Medium term + Full integration and optimized data visualization of diverse systems e.g. weather, security, energy, price information etc. From reactive decision support to active decision making.	
	Key elements to consider here was in the incorporation of HFE, cognitive based data visualisation and user-centered methods / disciplines. Nevertheless the key message here from the group was that EE impact of devices / solutions in this space would see limited or front-loaded success and that a move to greater levels of actuation was required. Even if with high levels of actuation we still need effect feedback to users to allow for understanding and learning while highlighting options available.				
Secure Wired / Wireless sensor networks & Quality of service	high speed wired / wireless networks, sensor hardware /software essential to sub-metering strategies, 6LoWPAN, ZigBee, PLC etc.	Secure backend wired / wireless communications with defined quality of service and privacy	Short term + Wide scale deployment of secure comm's networks with machine readable SLA's	Medium term + incorporated anticipatory logic, context aware user preferences including privacy	
	Again it was considered that technology in terms of standalone solutions was reasonably sophisticated, and again to realise the vision it was a matter of increased interoperability / integration. Where sensors are deployed they should be ambient powered sensors and/or allow for energy harvesting. Effectively a deploy and forget type scenario. While not EE related if privacy at hardware level right up through the software stack was not addressed this would serve as a barrier to EE across sectors.				

Roadmap 4: Resource & process management ICTs

Drivers	ISO 5001 Standard for energy management (DIN 16001). Economic, mass market, desire for simplicty & some tech push				
Barriers	some barriers to entry in terms of SME access to analytics capability.				
Impacts					
Inter-enterprise coordination	Contract & supply network management, process planning & scheduling, procurement, Intra-logistics, elements of Enterprise Resource Planning and Production Lifecycle Management etc.			Open source ICTs used by all. Shift from making projects (e.g. cons-truction) to making products (e.g. buildings).	Wide availability of ICT based services & infra-structure. ICTs to facilitate virtual enterprise business relationships. Plug-and-play companies.
	In relation to this sub-cat. the group felt there was essential to strands, Business relationship management type ICTs and supply chain management ICTs i.e planning scheduling, procurement, ERP etc Point made in relation to this topic was that different sectors were at different levels of maturity. It was felt Manufacturing was more advanced in terms of digital modelling & integration with regard supply chain & offered learning opportunities. Project to product shift in thinking required. Technology reasonably sophisticated but again in standalone scenarios. Work required in terms of re-routing and optimised transport algorithms. Group discussed a move towards modularity and mass customisation.				
Process integration	There is a fairly sophisticated level of ICTs in terms of business process integration, collaboration support, groupware tools, electronic conferencing, distributed systems, social media, business work flows, ERP (front end) systems etc. Enerit ISO 50001 software.	Waste management. Energy as part of Quality management (not currently addressed). Validation of process performance.		EE business models.	Enhanced value-driven business processes & ICT enabled business models. ICT integrated processes are adopted for EE (including: models developed within RTD initiatives, human, legal, contractors, economics, business models, liability). Video conferencing, groupware, social media and collaboration ICTs support process integration & new services reducing needs for transport and commuting.
	Group felt technology was at a level of sophistication to realise the vision in terms of virtual collaboration and communication. We will need to resolve technical privacy concerns to allow New business models that have EE impact e.g. working from your local coffee shop. Openness and transparency was seen as key to increasing accessibility in terms of business process integration It was felt 'cloud computing' might play a role here & in the next sub cat. [KM] in terms of offering accessibility to compute power and compute intensive services. Impact seen as sitting primarily in the transport / logistics sector with additional impact for built E in terms of the office v home work scenarios, future planning scenarios etc				

Knowledge management	Technologies in the Knowledge management space exist however augmentation in terms of data mining, analytics, modeling and knowledge creation is required given the vast increase in sensoring information that will result from realizing smart 'X' vision's.		Replicable ICT solutions and processes.		Enhanced knowledge creation, sharing & management including: Infrastructure, data mining & analytics, semantic mapping, filtering, consolidation algorithms, distributed data bases, catalogues of re-usable EE solutions etc.
	HPC *<2>*, data mining & analytics was felt to be in the main rarefied & at the behest of large organisations. Group felt the vision here should really be about Knowledge independence, openness & transparency. In terms of the technical challenge current SOTA needs to be augmented in term soft integration of heterogeneous in some cases new types of sensor data & parametric data, this needs to be coupled with advances in terms of event driven engines like CEP *<2>* in terms of moving towards a type of automated analytics. As such inference sensing & analytics, meshing capability, speech analytics, semantic search and at higher levels cognitive based data visualisation were seen as important elements in augmenting the area of knowledge creation as opposed to knowledge management where the technology was considered to be relatively sophisticated. Again idea was to push capability down the stack in terms of SME accessibility etc				

Roadmap 5: Technical integration ICTs

Drivers	Integrated Product Policy (IPP).		Common protocols.	Holistic functionality of all systems.
	Political desire to control energy flows that transcend sectors, economics seen as a barrier & driver barriers, political and social views in terms of privacy.			
Barriers				
Impacts				

	State of the art	**Short term**	**Medium term**	**Long term**	**Vision** <2>
Integrated Infrastructure	There is a wide variety of systems / components / interfaces / technologies. They are limited (no holistic management).	Work towards a systematic adoption of Service Oriented Architectures (SOA) and towards the definition of Integration Service Platform (ISP).	Continue the process towards the adoption of SOA and enrich smart aggregation of Services on ISP, allowing the management of complex systems in a more efficient way.	Specification of an international (European?) framework defining the way services could be developed to be integrated/added to such ISP.	Integrated infrastructures are implemented to support all ICT tools and systems for EE: design, collaboration, sensing/ monitoring, automation, control, operation, services, energy trading etc. Infrastructure for collaborative distributed engineering.
	This category was seen as being a classic standards issue technology to integrate infrastructure components exists however there are many proprietary services/solutions vying for adoption. Again openness required. Of course disruptive technologies can play a part 'IP' being an example. Should move towards agreed SOA and integration platform				
Interoperability	Because of the variety of solutions, there is today too many non-interoperable solutions and interoperability among standards is partially implemented.	Definition / Extension of common models and languages allowing integration of information regarding energy efficiency Inclusion of EE in information models & standards Standardisation of design information.	Definition of an unified open communication standard for managing complex systems (at building or District level) from an EE perspective.	Integration of gateways from this Open Communication Standards towards other domains (like Transportation)	Universal control and communication protocol standards for system integration and interoperability are agreed and adopted. Interoperability is achieved for all stake holders over all life cycle stages. True System integration is achieved. Middleware to facilitate interoperability amongst different devices and systems.
	Again issue here seen as a battle of solutions, options seen as consolidation, standards or interface advancement (in terms of a disruptive innovation allowing for interoperable communications)				
Information / Knowledge Sharing	Level of sharing if very low (because of incompatibility among media, file format, language, etc.). Low reliability of information.	Elaboration of community forums for discussion; digital catalogues of products/sensors/services containing parametric information. Data of EE aspects of materials, products, processes. Tools to make use of EE data. Search mechanisms (ref. "ManuGoogle" idea from ManuFuture). Education & training on ICT4EE.	Easy access to knowledge about energy efficiency which is modelled according to standards and easily accessible; user awareness tools (syndication).	Template solutions based on good practices; ubiquitous and context-based access to inter-organisational knowledge platforms *<Short term>*	Ability to share information in model based collaboration.

	This level/layer inherits the issues of lower layers in terms of interoperability, semantic interoperability & consolidation of data structures etc. is required. An emphasis on integration of EE maybe needed.				
Compli-ance to Regula-tion	(Building Information) Model checkers.		Compliance validation methods & tools.		ICTs support compliance to Regulations and standards.
	Certification at a technological level needs augmentation, no comments offered beyond that.				

Roadmap 6: Trading / transactional management ICTs

Drivers	Integration of energy generation / harvesting, transmission, consumption, storage, reuse. Economics, CO2 impact, energy security / independence, openness of rate, decentralisation & the integration of bulk, RES & EV's etc <1>.
Barriers	Lock-in in terms of vendors trade etc. <0>
Impacts	

	State of the art	Short term	All time spans	Medium term	Long term	Vision <5>
District & neighbourhood energy management	District energy management has a long tradition and is based on well known technology. The new developments in this type of systems are mainly related to market integration, and sector liberalisation. Standardisation has been common practice in the user organisations and most known energy management systems are conforming to international standards. Integration with other systems is hardly ever a serious issue.	Support for DER and for intermittent loads, local generation and intermittent generation must be added to the logic of district energy management systems, as well as the support for two-directional flow (that is not only energy flowing towards the customer, but also energy flowing from the customer). Control functions, to optimise the usage of DER against market conditions must be added Tools to identify excess energy and needed energy.	**All topics:** Group saw these all as essential the one with the different levels a matter of scale & negotiation. At the heart was a need to push towards individual energy profiles, personal energy footprints so to speak Yes, technology needs to advance to allow for bi-directional flow of information in the context of distributed energy sources, control & optimisation algorithms etc. But the missing piece was seen as the personalisation of energy information & convey how the individual fitted into a bigger-picture in terms of the wider eco-system (district etc.) Context-aware computing seen as key here. Issue is resolution of any conflicts in terms of personal preferences as one moves up the stack so to speak from individual to facility to district level. To make this vision a reality group felt there needed to be augmentation of the existing SOTA are multiple layers. At the sensor level as	Further optimisation of control of DER over a wider area, must be added. Control algorithms that allow maximum usage of local capacity and yet maintain the stability of the grid must be developed Note that there may be conflicts of interest between the owner / user of the District Energy Management systems, responsible for the stability of the grid, the energy market participants, with their sales targets, and DER owners and consumers. Interlinking facility + district. ICTs to inform users to reduce consumption at peak load.	Ideally, the energy for an entire nation (continent) could be generated by DER or local generators. This would require <2> improved and stable control facilities and extremly stable grids. Transparency of carbon figures.	ICT for carbon trading. **All topics:** Group had a shot at a vision – Energy Profiling allows for value driven decisions at citizen, facility & district level. Vision is for Seamless flow of information that allows new business models to drive us to sense, understand, decide and act in sustainable ways.
Facility energy management	Facility energy management systems exist for considerable time, both as manufacturing (plant-wide) systems and in building systems. Here, with a wide range of user organisations and user sectors, standardisation is not widely accepted. Facility energy management systems are usually vendor-specific. Smart meters. Google Power Meter.	Most of the larger facilities do have extensive local optimisation of energy consumption and local production. The integration of the possibility to sell local generated energy on the market is less common. Also less common is the integration of Facility Energy Management systems in a regional information system enabling regional optimisation. This is a short term development. Local control to adopt to changing market situations and grid conditions.		Further optimisation, with respect to the energy market, and to product life cycle and production targets is required. Prediction models. New services to make use of smart meter information.	Facility energy management systems would typically "negotiate" with Regional or District energy management systems on their energy consumption, taking energy markets, product markets, economical and technical factors into account.	

Citizen (personnel) energy management	Citizen, or personal energy management systems e.g. for household usage, are not common. Some of the higher end premises do have some sort of home-control system installed. Such systems however hardly ever include specific energy management functions.	Basic personal energy information systems, which would typically be based on remote meter reading architectures, are to be deployed in the first stage. Such systems would not just monitor and report the household energy consumption, but would also typically report on the consumption of individual devices. Awareness tools.	described we need means of pulling in context sensor data, at a middleware level we need CEP type engines to identify or infer patterns, the analytics may sit at this level or they may be higher order, above all this we need new services & business models that drive behaviour ... ideally moving towards automated actuation based on user preferences etc.	The personal energy management systems would be enhanced with advisory functions that allow individual consumers to monitor and influence their consumption patterns, e.g. by switching off airco during a high-tariff period. Such advisory functions could, depending on contracts and tariffs, be turned into automatic control actions. Models & tools to allocate household consumption to persons.	Personal energy management systems should be able to control a household energy exchange to a maximum acceptable cost. Below that cost, consumption would be possible while any exchange that would cause higher cost would be reported or even restricted.	ICT to manage personal carbon footprint	