Project: **REViSITE** **Roadmap Enabling Vision and Strategy for ICT-enabled Energy Efficiency** (www.revisite.eu)	

Title:

Technical results of D3.1 Vision for multi-disciplinary ICT-enabled Energy Efficiency

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Overview of the deliverable

This document presents the extracted technical outcome from D3.1; it contains the most relevant information from the deliverable for the tasks to follow. The baseline for the development of the REViSITE vision is made by the current visions (sector and non sector specific) supplemented by expert views, analysis of state-of-the-art RTDs, ICTs and the potential of their application and anticipated impacts on a cross sectoral basis. The REViSITE vision builds on the interpretation of current visions and the envisioned implications of the full uptake of ICTs as an enabler for ICT4EE across various sectors. The REViSITE vision will lead to more transparency in identifying ICTs that can positively impact on energy efficiency, by categorising where ICT adoption and development should be focused, based on anticipated level of impact.

Technical results

The methodology to generate the REViSITE vision uses three steps. STEP1: ICT related components which were extracted from the reviewed visions were clustered using the SMARTT taxonomy categories, the common items among each of these categories were summarised. STEP2: A content analysis of the text in the reviewed visions was carried out based on a number of codes. Sections of text which referred to these codes were extracted as they appeared in the various visions documents and were classified using the SMARTT taxonomy categories then analysed. STEP3: The third set of information used to generate the vision was the feedback following the two questions addressed to the REG which were: (1) ”In one or two sentences describe your vision for ICT4EE”; and (2) “Please describe (if applicable) how your vision aligns to any of the SMARTT taxonomy categories”.

The value of the cross sectoral approach to the sectors is based on the premise of abstracting sector specific issue to a more general issue, identify possible general ICT solutions, and then focus on adopting or adapting as a sector specific solution. The SMARTT Taxonomy was used to categorise ICTs, aligning them to a generalised life cycle that is recognisable to specific sectors. ICTs need to focus on: Specification & design, Materialisation, Automation & operation support, Resource & process management, Technical integration and Trading and transactional management. REViSITE can more clearly identify ‘what’ ICTs should be adopted or developed, ‘where’ they should be applied and ‘how’ they are likely to impact on sustainability. These ICTs are foreseen to contribute to the realisation of the vision where new services for EE are widely available; processes and systems are integrated; design and automation systems are interoperable with the availability of cross sectoral data exchange standards; knowledge sharing related to energy consumption and grids loads is enhanced and facilitated; Infrastructures for distributed collaborative engineering are available; Open

platforms for monitoring, automation and control are widely used; embedded / SMART (which means new generation as per REViSITE) systems are in operation; and new business models geared to EE are implemented with a shift from 'consumer culture' to 'prosumer culture'. The framework for the vision development is summarised in Figure 1 below

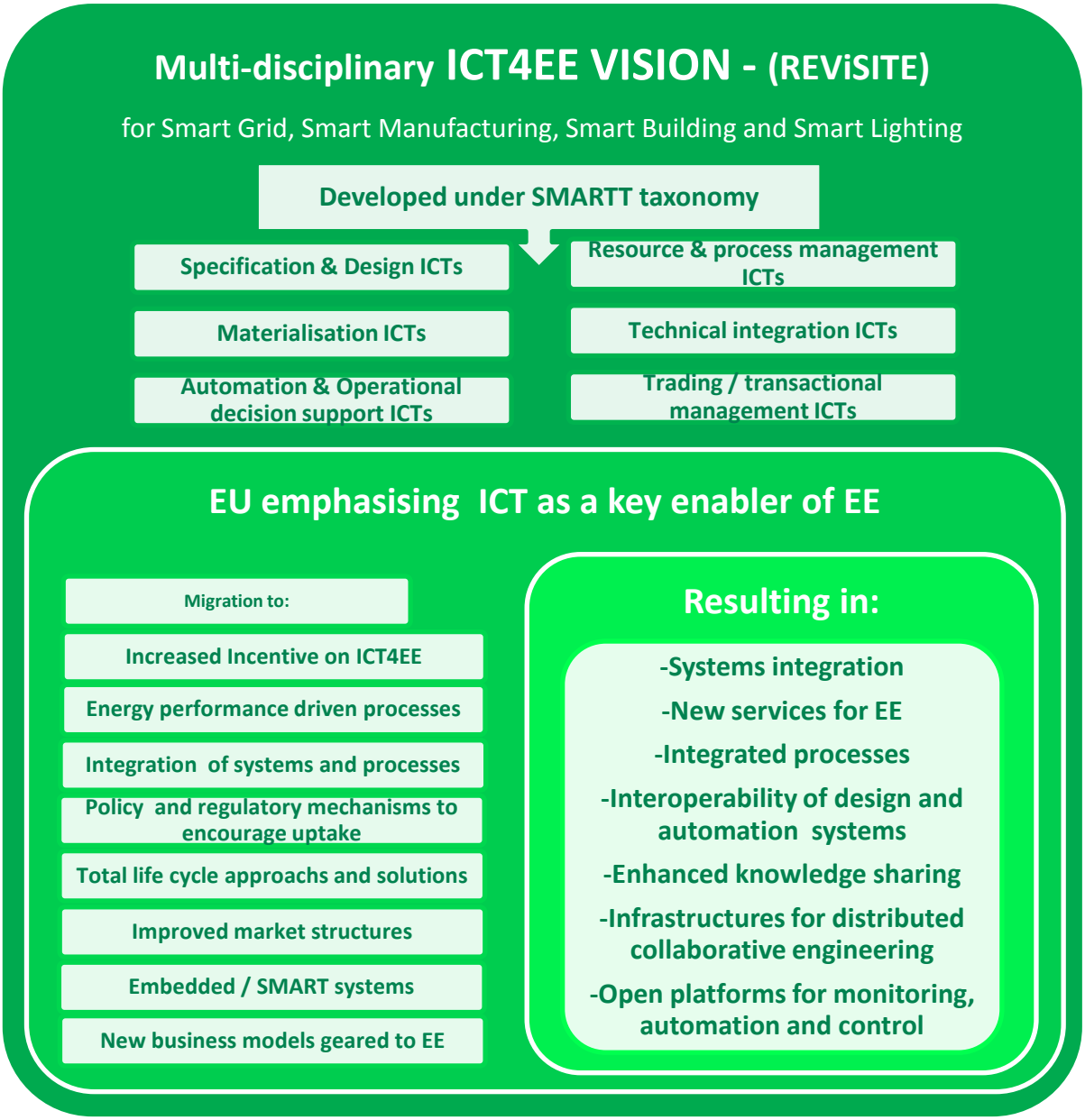

Figure 1 Schematic diagram of the ICT4EE vision (REViSITE)

Structured according to the SMARTT taxonomy the REViSITE vision for ICT enabled energy efficiency encompasses:

1. Specification & design ICTs

- 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.
- ICT for rationalisation / selection of components for better energy efficiency.
- Electronic catalogues of products / components including relevant attributes of energy efficiency.
- Causal Modelling ICTs – physical systems
- Design conceptualisation ICTs
- Human factor Engineering ICTs
- Product / component specification and selection ICTs
- Visual / spatial design

2. Materialisation ICTs

- 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.).
- Real-time communication.
- In the field Mobile Decision Support ICTs

3. Automation & operational decision support ICTs

- Embedded ICTs that permeate sectors providing the "intelligence" to monitor and control energy resources in smart sustainable ways.
- ICT systems that facilitate user control.
- ICT which act as learning systems, providing reliable, secure and affective decision support to energy producers and consumers alike.
- Building operating systems and district energy management systems with automation to install software in buildings or districts similar to installation on PCs and broker to serve energy trading similarly to software on computers now with varied level of interoperability.
- Predictive controls algorithms capable of solving optimisation problems in real time;
- Systems learn and adapt to user preference via incorporated anticipatory logic.
- Wired/wireless sensor networks act as a communication backbone to the Energy grid, a grid which interacts with both generation sources and storages aided by ICT enablers such as smart metering, electronic control technologies, wired and wireless modern communications means, and instruments for increasing customer awareness.
- Operational decision support ICTs that integrate high level diverse systems such as safety, security, weather & energy etc from individual, to district level.
- Embedded intelligent devices (micro architecture) for operational control, sensing &

actuation at machine, plant or building level
- Software & algorithms for operational monitoring & actuation of devices at machine, plant or building level
- Inference sensing Software & algorithms for pattern & signal identification
- User centred Data Visualisation ICTs
- Secure/resilient wired, wireless & optical infrastructure for operations

4. Resource & process management ICTs
- Wide availability of ICT based services and infrastructure.
- Enhanced value-driven business processes and ICT enabled business models.
- ICTs to facilitate virtual enterprise business relationships.
- 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 and new services while reducing needs for transport and commuting.
- Intellectual property rights are protected (legally and technically e.g. via encrypting methods).
- Enhanced knowledge sharing including: Infrastructure, knowledge mining, semantic mapping, filtering, knowledge consolidation algorithms, distributed data bases, catalogues of re-usable EE solutions etc.
- ICTs for data mining & analytics in terms of energy consumption & optimisation
- Modelling & simulation ICTs e.g.: What-if scenario planning across sector life cycle
- Inter-Enterprise ICTs for supporting coordination
- Knowledge Management & creation ICTs
- Process Integration and collaboration

5. Technical Integration ICTs
- ICTs support compliance to Regulations and standards.
- Integrated infrastructures are implemented to support all ICT tools and systems for EE: design, collaboration, sensing/monitoring, automation, control, operation, services, energy trading etc.
- 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.
- Infrastructure for collaborative distributed engineering.
- Ability to share information in model based collaboration.
- Use of cloud based services for tasks such as data management, monitoring and analysis
- ICT standards and protocols for interoperability
- Real-time analytical ICTs e.g. Complex Event Processing
- Integration technology / approaches SOA & event driven architectures

6. Trading / transactional management ICTs
- Regulations and market models take into account the environmental aspects and ethical concerns of citizens (this may influence e.g. using ICT to track person's locations).
- Internet-style grid system supported by advanced hardware and management protocols for connections, whether for suppliers of power, for consumers or for network operators.

The market structures and regulatory mechanisms provide the necessary incentives.

- ICTs to assist in harmonisation of energy consumption across the district by identifying peaks and troughs of consumption.
- Integrated approach toward ICT4EE covering technical, commercial and regulatory factors (e.g. energy pricing structures, linking insurance incentives with energy consumption).
- Building operating systems and district energy management systems with automation to install software in buildings or districts similar to installation on PCs and broker to serve energy trading similarly to software on computers now with varied level of interoperability.
- ICTs based on citizens' energy profiles assist in optimisation of citizens' energy consumption.
- Virtualisation, advanced and reliable video conferencing, in the future companies rely on virtual building market, which could sell rules to reduce physical building by making software for multi use of buildings, as an example school may become a restaurant at night, build in a certain fashion to change the need for transport with effect on EE.
- ICTs allowing interchanges of consumers to be prosumers and vice versa.
- Trading & Energy Brokerage ICTs

As a result REViSITE suggests that Europe has to focus on a stronger role of ICT as an enabler of energy efficiency leading to migration to energy performance driven processes, integration of systems and processes, policy and regulatory mechanisms to encourage uptake of ICT, increased incentive on ICT4EE, total life cycle approaches and solutions, improved market structures and more embedded intelligent systems. This should ensure a wide availability of new services at reasonable costs to the providers and the users. Management, monitoring data analysis and decision making will become a service that is provided via a networked system similarly to the internet.

ICTs need to focus on: Specification & design, Materialisation, Automation & operation support, Resource & process management, Technical integration and Trading and transactional management. REViSITE can more clearly identify 'what' ICTs should be adopted or developed, 'where' they should be applied and 'how' they are likely to impact on sustainability. These ICTs are foreseen to contribute to the realisation of the vision where new services for EE are widely available; processes and systems are integrated; design and automation systems are interoperable with the availability of cross sectoral data exchange standards; knowledge sharing related to energy consumption and grids loads is enhanced and facilitated; infrastructures for distributed collaborative engineering are available; open platforms for monitoring, automation and control are widely used; embedded / SMART (which is the New Generation as per REViSITE) systems are in operation; and new business models geared to EE are implemented with a shift from 'consumer culture' to 'prosumer culture'.

This document will be further analysed in preparation for the development of the Strategic Research Agenda (SRA) and Implementation Action Plan (IAP). This analysis will be based on breaking down the vision into short / medium / long term requirements and may need to be refined in the next roadmap validation exercise including the relevant selected stakeholders drawn from the focus group together with the REG (REViSITE Expert Group). The identified items/areas toward the vision under the six SMARTT Taxonomy categories will steer the

generation of the Strategic Research Agenda of task T3.2 leading to the development of the implementation plan in T3.3 and eventually the REViSITE roadmap.

Keywords: Energy Efficiency, ICT, ICT4EE, Vision, Content Analysis, Taxonomy, Smart Grids, Smart Buildings, Smart Manufacturing, Smart Lighting.

Date: 02/08/2011

Dissemination level:

PU – Public

Project cofinanced by

SEVENTH FRAMEWORK PROGRAMME