HAL
open science

Vision of energy systems for smart cities

Andrea Cavallaro, Federico Di Gennaro, Jérôme Euzenat, Jan Peters-Anders, Anna Osello

To cite this version:

Andrea Cavallaro, Federico Di Gennaro, Jérôme Euzenat, Jan Peters-Anders, Anna Osello. Vision of energy systems for smart cities. [Contract] Ready4SmartCities. 2014, pp.35. hal-01180924

HAL Id: hal-01180924

https://hal.science/hal-01180924v1

Submitted on 9 Sep 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

READY4SmartCities - ICT Roadmap and Data Interoperability for Energy Systems in Smart Cities

Deliverable D5.2: Vision of Energy Systems for Smart Cities

Document Details

Delivery date:	M12
Lead Beneficiary:	D'Appolonia spa
Dissemination Level (*):	PU
Version:	1.0
Preparation Date:	13th November 2014
Prepared by:	Andrea Cavallaro and Federico Di Gennaro as representative of D'Appolonia project team, Jerome Euzenat (INRIA), Jan Peters-Anders (AIT), Anna Osello (POLITO)
Reviewed by:	Bruno Fies (CSTB), Mari Sepponen (VTT)
Approved by:	Technical Coordinator (UPM)

(*) Only one choice between:

- PU = Public
- 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)

Project Contractual Details

Project Title:	ICT Roadmap and Data Interoperability for Energy Systems in Smart Cities
Project Acronym:	READY4SmartCities
Grant Agreement No.:	608711
Project Start Date:	2013-10-01
Project End Date:	2015-09-30
Duration:	24 months
Project Officer:	Svetoslav Mihaylov

SEVENTH FRAMEWORK PROGRAMME

Revision History

Date	Author	Partner	Content	Ver.
07/08/2014	Federico Di Gennaro as representative of D'Appolonia project team	DAPP	Draft Version	0.1
09/09/2014	Jerome Euzenat	INRIA	Reviewed part 2.3.3	0.2
10/09/2014	Jan Peters-Anders	AIT	Reviewed part 2.3.2	0.3
12/09/2014	Anna Osello	POLITO	Reviewed parts 2.3.1 and 2.3.4	0.4
18/09/2014	Bruno Fies	CSTB	Quality check review – First round	0.5
22/09/2014	Andrea Cavallaro as representative of D'Appolonia project team	DAPP	Implementation feedback from first QC round	0.6
25/09/2014	Mari Sepponen	VTT	Quality check review	0.7
30/09/2014	Andrea Cavallaro as representative of D'Appolonia project team	DAPP	Final version – almost done	0.8
03/11/2014	Andrea Cavallaro as representative of D'Appolonia project team	DAPP	Integrated SAB expert contributions to the final version	1.0

Statement of originality:
This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Table of Contents

1 Introduction 5
1.1 Purpose and methodology 5
1.2 Document structure 5
1.3 Contribution of partners 6
2 Vision of ICT for Energy Systems for Smart Cities 7
2.1 Vision behind FP7 Smart City projects and CIP 7
2.1.1 Structure of the Visionary scenarios 14
2.2 Definition of the R4SC Vision 15
2.2.1 Vision of the Citizens 16
2.2.2 Vision of the Building Sector 18
2.2.3 Vision of the Energy Sector 20
2.2.4 Vision of the Municipality 23
2.3 Vision at ICT System Layer Scale 26
2.4 Vision at Business Process Level 28
3 Integrated Vision for ICT supporting Energy Systems for Smart Cities 31
4 Contingency Actions 32
4.1 Workshop Organisation and Collection of NEW Inputs for the Vision 32
4.2 Summary of next roadmapping activities 32
5 Conclusions 33
REFERENCES 35

Acronyms and Terms

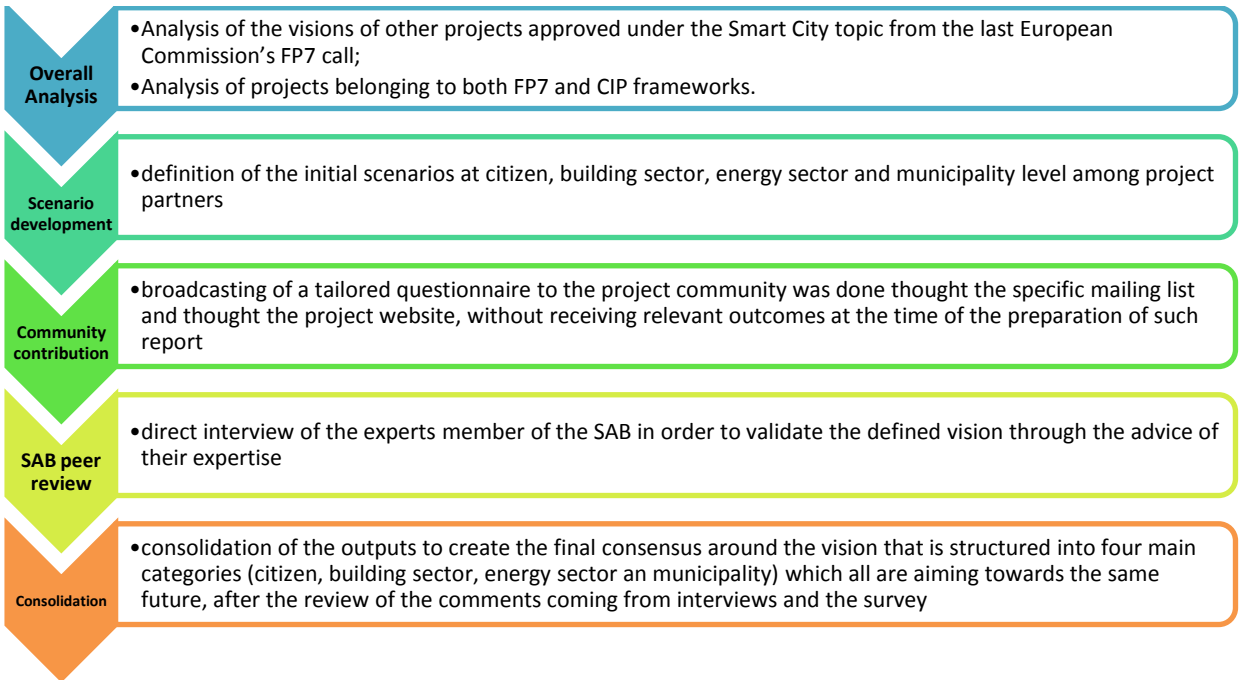
CIP	Competitiveness and Innovation Framework Programme
DoW	Description Of Work
ECMs	Energy Conservation Measures
EV	Electric Vehicle
FP7	7th Framework Programme
GHG	Green House Gas
ICT	Information and Communication Technologies
R4SC	Ready4SmartCities Project
WP	Work Package

1 Introduction

1.1 Purpose and methodology

This document proposes the vision for ICT for energy systems of smart cities as a set of visionary scenarios presenting foreseen and desirable developments and innovations as well as best practices and opportunities for a widespread knowledge transfer appearing in the horizon of the next 10 years and beyond.

Those scenarios were built on a consensus process, which is based on an iterative process that consists of the following steps:



An updated version of such vision will be provided by M19 by the partner responsible DAPP for feeding the final roadmap that will be released by partner VTT in D5.6 and improved accordingly.

1.2 Document structure

The document is structured in the following sections:

- Chapter 1: Introduction presents the purpose and general background of the deliverable D5.2 Vision of Energy Systems for Smart Cities;
- Chapter 2: Describes how the vision is based on a comprehensive state of the art initially started in D5.1 Conceptual Framework and Methodology and further set of results coming from initiatives under the umbrella of the Smart City paradigm;
- Chapter 3: Represents consolidated and integrated vision;
- Chapter 4: Describes the next actions for enhancing the vision toward the implementation of the final roadmap;
- Chapter 5: Conclusions focuses on the description of next steps and the main findings followed by acronyms and terms and references.

1.3 Contribution of partners

D'Appolonia has had the main responsibility to prepare this document. Review of scenarios has been divided between partners as follows:

1. Citizens scenario reviewed by POLITO;
2. Building Sector scenario reviewed by AIT;
3. Energy Sector scenario reviewed by INRIA;
4. Municipality Sector scenario reviewed by POLITO.

The online survey for tailoring the vision of ICT for energy systems for Smart Cities among the urban scale classification was prepared by D'Appolonia in collaboration with CSTB and VTT and it is still available at the following URL https://it.surveymonkey.com/s/PP2NKHK. Unfortunately no reply was obtained in duty time for the preparation of the present report.

The four SAB expert interviews were conducted by D'Appolonia (2 SAB experts) together with CERTH/ITI (1 SAB expert), VTT (1 SAB expert). The other three experts will be provided a reliable contribution during the second year of the project when such vision will be updated.

2 Vision of ICT for Energy Systems for Smart Cities

2.1 Vision behind FP7 Smart City projects and CIP

A smart city is an efficient, liveable, as well as an economically, socially and environmentally sustainable city. This vision can be realised today, using innovative Information and Communication Technology (ICT), and taking advantage of meaningful and reliable real-time data generated by citizens, building and energy sectors, transportation and city infrastructure.

Many FP7 and CIP projects look at this holistic goal and their purpose is to accelerate the transition between the old concepts of the city towards the new more efficient one. Each project is a single brick in the direction of building a new and more efficient ecosystem.

The overall framework of the smart city is summarised in the following picture, which represents the framework for the R4SC vision for ICT supporting energy systems of smart cities. This structure, as described in D5.1"Conceptual framework & methodology" and showed in Figure 1, can be substantially summarised in the following elements:

- Urban Scale, which can be further divided into the following four sub-elements:
  - Citizens
  - Building sector
  - Energy Sector
  - Municipality
- ICT System Layer
- Business Process
- Life Cycle approach

The last three sectors are transversal and have an impact in all the urban scale sub-elements.

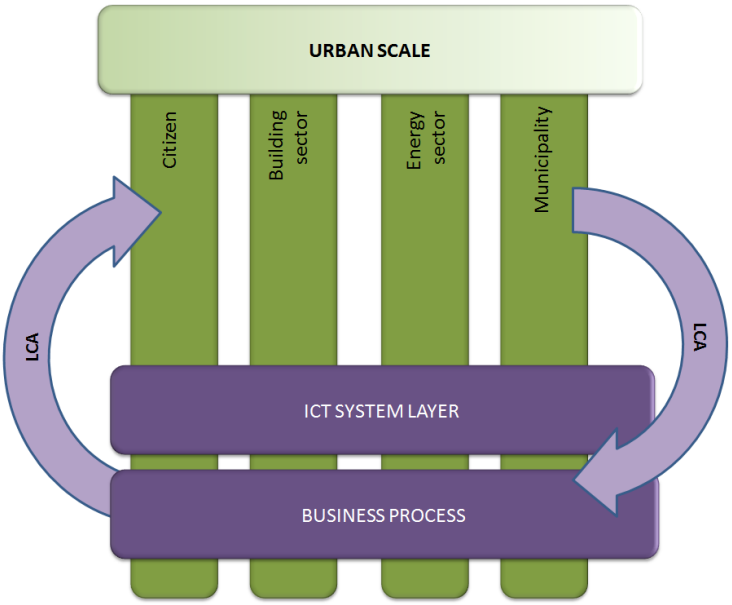


Figure 1: *Integrated Smart City*

As described in R4SC DoW, the main projects on which the vision analysis starts from are the following FP7 and CIP projects:

Table 1 – *Peer projects under the Smart City topic from last FP7 call and FP7 and CIP related projects that will be analyzed for the project vision consensus building process*

RELEVANT PROJECTS				
PROGRAMME	**CALL**	**PROJECT NAME**	**PROJECT VISION**	**Targeted Layer (citizen, building sector, energy sector, municipality)**
FP7	**DG Connect Call 2013**	BESOS	Enhance currently existing neighbourhoods with decision support system to support coordinated Energy Efficiency Management Systems in Smart Cities, and at the same time provide citizens with information to promote sustainability	Citizen, energy sector, municipality
		DIMMER	Development of a web-service oriented, open platform, with capabilities of real-time district level data processing and visualization	Energy sector, citizen
		e-balance	Development of a system for people with people aiming at providing solutions to improve the energy efficiency of present and future neighborhoods and smart cities considering both technical and non-technical aspects	Energy sector, municipality, citizen
		OrPHEuS	Development of Cooperative Control Strategies for Smart Cities´ Hybrid Energy Network Control System Solutions	Energy sector
		CITYOPT	Holistic simulation and optimization of energy systems in Smart Cities obtained through the creation a set of applications and related guidelines that support planning, detailed design and operation of energy systems in urban districts.	Energy sector, municipality, building sector
		DAREED	Development of a platform of ICT services to promote energy efficiency and low carbon activities at the level of neighborhood, district and city by involving all stakeholders who have an active role in making energy decisions and provide the right information at the right time for decision making	Energy sector, municipality
		CIVIS	To enhance, integrate and validate enabling ICT solutions for energy-optimized and socially empowered smart cities. From a “transaction” view of ICT’s role in smart grids to a socio-technical and holistic perspective, Society, enabled by ICT, can exert	Municipality, energy sector

			a “shaping” capacity on the energy grid. Involving stakeholders, a logic of reuse, interoperability and scale up	
		DoF	Coordinate different technological ecosystems to make them collaborate. From ICT, to Smart Grid, from districts to cities	Municipality, energy sector
		INDICATE	Creation of a decision support tool for cities based on the concept of first help the city to plan, second help them to reduce, third help them to integrate renewable and other systems and finally help them to optimize those systems and then start again	Municipality, energy sector
		OPTIMUS	Develop the OPTIMUS approach on the linking of Smart Cities with Energy Optimization, through a thorough analysis of the Smart Cities concepts and ideas, in relation to Energy Optimisation techniques and methods. Define, collect and semantically model data from different types and sources, which can help to understand the influential factors in the energy consumption in a city.	Municipality, energy sector
		CoSSMic	Stimulate transition to more local energy production based on Renewable Energy Sources (RES) . This will be achieved through the coordination the energy consumption patterns and the use of storage capacities in a neighborhood, and adapt usage patterns to the situation, we can absorb the fluctuations with less total storage capacity, reduce the demand on the central power grid and reduce the need for carbon based backup power generation capacity.	Energy sector
		iURBAN	Development and validation of a software platform that will integrate different ICT energy management systems (both hardware and software) in two European cities. Local Decision Support System, Centralized Decision Support System, Cloud-based services and access to energy open data are the main characteristic of the system.	Energy sector, municipality
	DG Connect Call 2012	ORIGIN	Orchestration of Renewable Integrated Generation in Neighbourhoods	Energy sector, municipality
		SkyNet	Smartgrid KeY NEighborhood indicator cockpit	Energy sector
		EEPOS	Energy management and decision support systems for Energy Positive neighbourhoods	Energy sector
		EPIC-HUB	Energy Positive Neighbourhoods Infrastructure Middleware based on Energy-Hub Concept	Energy sector, municipality, citizen
		IDEAS	Intelligent NeighbourhooD Energy Allocation & Supervision	Energy sector
		NRG4Cast	Developing real-time management, analytics and forecasting services for energy	Energy sector

			distribution networks in urban/rural communities	
		URB-Grade	Decision Support Tool for Retrofitting a District, Towards the District as a Service	Municipality
		COOPERATE	Control and Optimisation for Energy Positive Neighbourhoods	Energy sector
		INERTIA	Integrating Active, Flexible and Responsive Tertiary Prosumers into a Smart Distribution Grid	Energy sector
		ODYSSEUS	Development of an Open Dynamic System (ODYS) enabling the 'holistic energy management' of the dynamics of energy supply, demand and storage in urban areas, on top of an open integration platform supporting the integration scenario's for designated urban areas	Energy sector, municipality
	DG Connect Call 2011	S4EEB	Development and delivery of a prototype to optimize the existent Building Management Systems (BMS) by means of acquiring, identifying, monitoring, and adding the parameter of occupancy level in buildings and surroundings to enhance operations and eliminate unnecessary consumptions of energy for Heating, Ventilation, Air Conditioning, Lighting (HVACL), and other existent production and consumption systems, maintaining users comfort through the integration of a low-cost novel network of audio sensors with other building sensing and controls	Building sector, energy sector
		CASCADE	Development facility-specific measurement-based energy action plan for airport energy managers underpinned by systematic Fault Detection Diagnosis (FDD) Methods	Energy sector
		SEEDS	Development of a novel Self Learning Energy Efficient builDings and open Spaces Facility Management system based on open architecture suitable both for retrofitting existing buildings and open spaces and for new building design.	Building sector, energy sector
		BEAMS	Development of an advanced, integrated management system which enables energy efficiency in buildings and special infrastructures from a holistic perspective	Building sector, energy sector
		KnoholEM	Elaborate an intelligent energy management solution based on existing knowledge representation technologies like functional modelling and ontology, which will be used in the context of smart buildings in combination with Building Automation Systems for energy efficient buildings and spaces of public use	Building sector, energy sector

		CitInES	Design of a decision support tool for sustainable, reliable and cost-effective energy strategies in cities and industrial complexes	Energy sector, municipality
		ISES	Intelligent Services for Energy-Efficient Design and Life Cycle Simulation	Energy sector
		NICE	Networking intelligent Cities for Energy Efficiency	Energy sector, municipality
		SCUBA	Self-organising, Cooperative, and robUst Building Automation	Building sector
		SEAM4US	Sustainable Energy mAnageMent for Underground Stations	Energy sector
		Campus21	Development of a platform for the integration of existing ICT-subsystems supporting energy, building, and security systems management.	Energy sector, building sector
		Semanco	Semantic Tools for Carbon Reduction in Urban Planning	Energy sector, municipality
		Adapt4EE	Augmenting the contemporary architectural envelope by incorporating business and occupancy related information thus providing a holistic approach to the planning, design & evaluation of energy performance of construction products at an early design phase and prior to their realization.	Energy sector
		IREEN	Delivery of a comprehensive strategy for European-scale innovation and take-up in the field of ICT for Energy Efficiency and performance in large areas including neighbourhoods and extended urban/rural communities.	Energy sector, municipality
	EeB.PPP NMP 2013	DESIGN4ENERGY	Building life-cycle evolutionary Design methodology able to create Energy-efficient Buildings flexibly connected with the neighbourhood energy system *(under negotiation)*	Energy sector, building sector
	EeB.PPP NMP 2012	RESILIENT	Interaction and integration between buildings, grids, heating and cooling networks, and energy storage and energy generation systems	Energy sector, building sector
		AMBASSADOR	Absolute Management system at Domestic and District level	Citizen
		EE-WISE	Energy Efficiency Knowledge Transfer Framework for Building Retrofitting in the Mediterranean Area	Energy sector, building sector
		ENBUS	Energising the Building Sector!	Energy sector, building sector
		GE2O	Geo-clustering to deploy the potential of Energy efficient Buildings across EU	Energy sector, building

				sector
		NEWBEE	Novel Business model generator for Energy Efficiency in construction and retrofitting	Energy sector
		PROFICIENT	SME network business model for collective self-organised processes in the construction and retrofit of energy-efficient residential districts	Energy sector
		UMBRELLA	Business Model Innovation for High Performance Buildings Supported by Whole Life Optimisation	Energy sector, building sector
CIP	**CIP ICT-PSP 2012**	Smart Build	Implementing smart ICT concepts for energy efficiency in public buildings	Energy sector, building sector
		SmartSpaces	Development a service comprising innovative ICT-based energy decision support, awareness and management service components	Energy sector
	CIP ICT-PSP 2011	SHOWE-IT	Real-life trial in Social Housing, of Water and Energy efficiency ICT services	Energy sector
		E3SOHO	Reduction of 25% of energy consumption in European social housing by using ICT-based integral solution	Energy sector, citizen
		EDISON	Development of a Smart Energy Platform (SEP) aimed at delivering an efficient lighting system by using jointly ICT components and smart system	Energy sector
		GREEN@HOSPITAL	Development web-based energy management and control system for the optimization of the energy consumption in hospitals	Energy sector, building sector
		VERYSchool	Development of customised energy savings strategies and ICT solutions for EU schools.	Energy sector, building sector
	CIP ICT-PSP 2010	ICE-WISH	Demonstrating through Intelligent Control (smart metering, wireless technology, cloud computing, and user-oriented display information), Energy and Water wastage reductions in European Social Housing	Energy sector, citizen
	CIP ICT-PSP 2009	eSESH	Development and piloting new solutions to enable sustained reductions in energy consumption across European social housing by providing usable ICT-based services for Energy Management (EMS) and Energy Awareness (EAS) to tenants.	Energy sector, citizen
		BECA	Balanced European Conservation Approach – ICT services for resource saving in social housing	Energy sector, citizen
	CIP ICT-PSP	BEST	Improvement of the energy efficiency in public buildings and street public lighting,	Energy sector, building

	2008	Energy	by the ICT-based centralized monitoring and management of the energy consumption and production, and to provide decision makers with the necessary tools to be able to plan energy saving measures.	sector
		LITES	Development and production of a smart, LED based street lighting device that is compatible with EU electrical standards, to prove that solid-state lighting using LED technology can drastically reduce energy consumption. The device can be used on secondary streets, commercial access routes, alleyways, pedestrian walks, cycle tracks, university paths and other thoroughfares.	Energy sector, municipalities
		SAVE ENERGY	Development of a local platform showing the resource and device integrator part, enabling the interoperability of sensors, actuators and meters. This layer will integrate into the central platform middleware which allows the integration of bus systems, mobile and computer platforms.	Energy sector
		HosPilot	HosPilot is a demonstration project intending to propose energy reduction by adding intelligence and incorporating ICT. Addressing only Hospital technology areas in Lighting and HVAC targeting as Healthcare, Construction, ICT and Energy sectors.	Energy sector

This document is thus a collection of the visions identified in the previous projects and provides an attempt of integrated vision for the Smart City framework. The resulting vision will be shared firstly among project partners in order to validate it through the advice of their expertise; then a second round will be made by setting a questionnaire upon this provided vision among SAB expert group plus potential external experts belonging to the project newsletter.

2.1.1 Structure of the Visionary scenarios

The vision of ICTs for energy systems for smart Cities is substantially based on the above mentioned structure. The incoming energy systems for the future cities have to make cities more safe and secure, environmentally sustainable, and efficient from the energy point of view. This goal should be achieved through the adoption of improved design, construction, and maintenance tools, systems and solutions directly linked to advanced sensors network, electronic equipments and other integrated ICT systems.

In order to describe this concept, it is necessary to identify several fields to be addressed for a better comprehension of the different points that will enable and fasten the development of ICTs supporting energy systems of Smart Cities.

Table 2 shows the template provided in the next paragraphs for each of the visionary scenarios identified in the four roadmap segments. This table presents the structure of each visionary scenario.

Table 2 : *Structure of the elements of the vision*

Scenario title
This field contains the title of the scenario
Description
This field includes the concrete story / description of the vision and how it is implemented, with all the elements which will include the concept of the ICT supporting energy systems in smart cities, each of them declined according to the related sector/scale/level.
Envisaged ICT needs
ICTs and their progress beyond the state-of-the-art; the main technologies and solutions that need to be developed in the next future to make the scenario real;
Impacts
The adoption of the above described elements will have several impacts, such as energy efficiency and sustainability (including social, economic and environmental impacts). The changes after the development of the ICT will be visible at different levels and with different intensities.
Stakeholders and Beneficiaries
This field describes the stakeholders, which will be affected by the development of a smart city: for example the citizen, the municipality, the energy providers/utility, building sector etc.. Each of them according to their demands and necessities.
Key Enabling Factors
In this section, all the possible influencing and enabling factors are listed, taking into account their role in facilitating the adoption of the smart city concept
Barriers
Potential barriers that could hamper the achievement of the various visionary scenarios

2.2 Definition of the R4SC Vision

The Ready4SmartCities vision has been collected by stating the development needs for energy systems of smart cities and especially on how ICT is enabling it. The proposed scenarios represent the development needed and foreseen based on the 20-20-20 targets and 2030 and 2050 targets agreed in environment, energy efficiency and sustainability policies by European Commission (EC). This kind of development is needed to adapt to targets of lowering emissions, increasing energy efficiency and improving the overall performance of energy systems. The Vision is structured into four visionary scenarios for ICTs supporting energy systems of smart cities from the points of views of:

- Building
- Municipality
- Citizen
- Energy

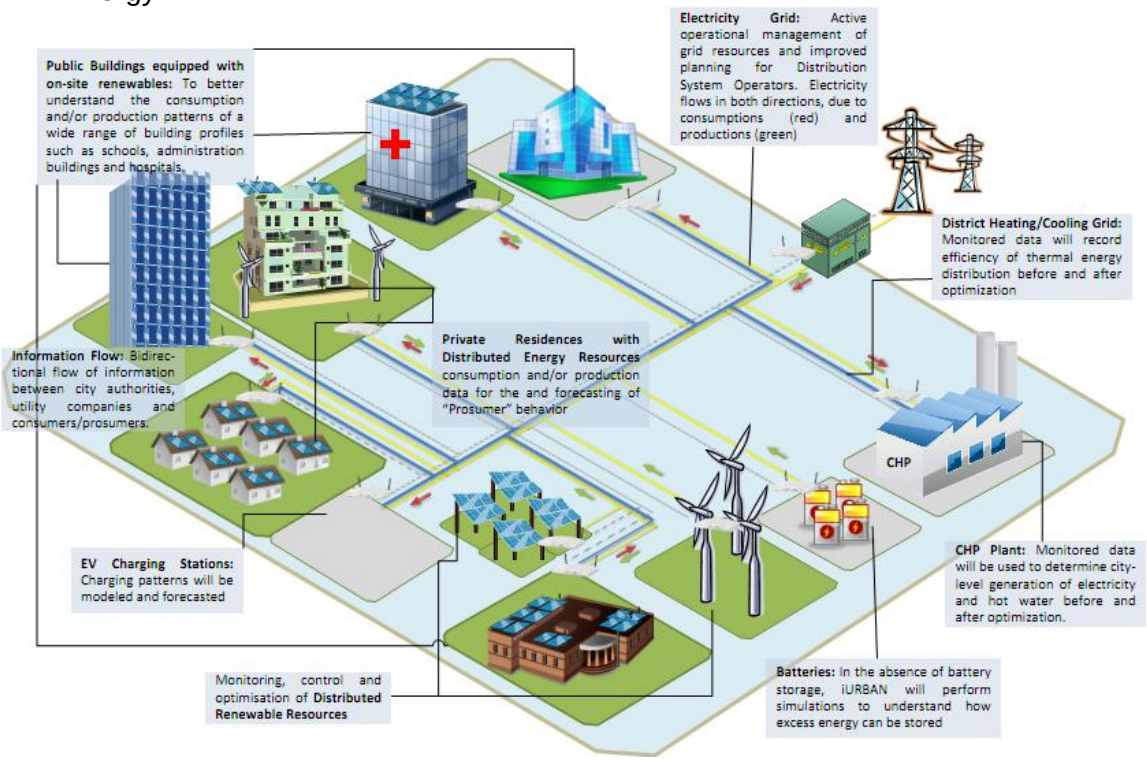


Figure 2: *Urban Scale Vision: Smart City Structure (http://www.iurban-project.eu)*

As you can see from the figure above, the structure of a Smart City is made by single elements (buildings) which must cooperate with energy systems, e.g. infrastructure (electricity grid, district heating/cooling grid), enabling elements for the infrastructure (such as electrical vehicles (EV) charging stations), energy producer (power plant, renewable energy utilities) and information flows (such as energy consumption and production data).

2.2.1 Vision of the Citizens

Citizens are involved in the energy systems of Smart City development as fundamental players, in both the following ways:

- Citizens are final users of the energy system, thus making their involvement and feedback crucial providing them with information on how to improve their energy efficient behaviour
- gathering their feedback and offer possibilities to affect to city's systems design and operations.

Citizen are a vital part of the Smart City concept, as you can see from the figure below, and all the elements are linked each other.

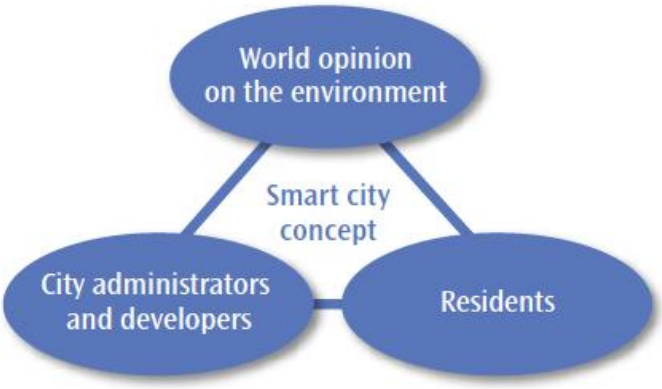


Figure 3: *Citizen and Customers Map (http://www.hitachi.com/products/smartcity)*

Table 3: *Citizen Vision*

Scenario title
Citizens needs for ICT supporting energy systems of smart cities
Description
The Citizens are key actors in the Smart City. The ICT infrastructure need to be developed together with citizens to get user-friendly solutions that meet the increasing demand for affordable, clean and easy energy availability. *The Citizens will increasingly start to act as energy prosumers (energy users that also produce energy in their buildings) that both consume and produce energy by themselves. In addition with the increasing use of "connected objects", citizens become the real actors of their own energy demand by making their own control settings for their use of energy appliances according to various indicators such as energy price levels, carbon foot print, being then also active participators in demand side management. They have opportunity to decide, how much they are willing to pay for using electricity in different equipment and with what kind of environmental impacts during peak hours. Also gamification approach provides new opportunities for engaging especially young generations e.g. to improving energy efficiency, energy savings and improving of sustainability of daily actions and behaviour.* ***The expectation becomes a real network around the citizen that will uniform several energy services to***

meet the individual needs *[2].*
For example, to create "digital linkage" across city core systems and the analysis activated by key patterns in the city's information data. Develop a clear and transparent system of user's fees and charges that reflect the real costs of providing citizen centric services, thus encouraging both more direct demand for services management by the citizens and lower costs burden on public finances.[3]

Envisaged ICT needs
ICTs are opening up many new opportunities for European citizens and consumers. There is a wide range of applications including energy management, healthcare provision, transport systems, as well as innovative interactive systems for entertainment and learning. Innovation in ICT can help improve and facilitate active participation of citizen and enable personalisation of energy profile and can also tackle problems associated with the energy demand.
Impacts
The values of the city residents who want prosperous urban lifestyles that offers a good quality of life with decreased environmental impacts and better energy efficiency. Citizens will be positively affected by these changes, because (among other aspects) also the working environment will benefit by an increased and optimized lifestyle.[2]. *Furthermore the prosumers' role of the citizens necessitates the reflection of more details on the "producer" side in the sense "How are they going to produce energy? Which are the most cost-effective alternatives?" This represents an evolution of the role and the life style of citizens.*
Stakeholders and Beneficiaries
Smart city stakeholders include city administrators, developers, residents, and groups sharing opinions on the environment. *Citizens represent the people who are active within the city: living, working, learning, or travelling. They are seeking to fulfil their own needs, and to achieve a better quality of life that is comfortable, prosperous, convenient, interesting, and safe.* *Those sharing opinions on the environment include groups that desire to help protecting the environments at local, national, and international level. These groups are often focused on maintaining biodiversity, decrease carbon emissions and making an effective use of natural resources.[2] [4].* *Citizens' involvement is beneficial and should be not restricted to use and administration of house appliances energy consumption, due the fact the environmental footprint of citizens goes beyond it; one of the most significant extensions is the one to transport and mobility.* *PoP cards and other incentives and mechanisms may be used for the promotion of energy savings in the full length of their everyday life. Private electric vehicles could be linked to the citizens' own energy repository, not only and directly to city's energy system (probably only public transport has been anticipated).*
Key Enabling Factors
The Communication Strategy is essential to keep a real information flow of citizen's needs. *ICT allows e.g. smart-phones to act as enablers for transactions (mobile payments, e-wallet). Also Connected Digital Signal that displays specific messages automatically and advertisements based on target customers' characteristics. The introduction of new multi-function facilities allows, at Building and neighbourhood level, to supply better results for residents at a lower cost. This new approach allows the city's administrators to deliver different types of services at reasonable costs, and residents will gain one-stop access to various services at an appropriate price. [7]*

2.2.2 Vision of the Building Sector

Building sector corresponds to **buildings that are interconnected to the surrounding built environment and where ICT solutions have an active role with respect to Energy Efficiency.** The neighbourhood can be seen as a composition of "smart" buildings, city infrastructures, transportation, street, public area etc., along with significant energy production and storage utilities. As you can see below, Buildings are strongly linked with the District/City level because they act as single points which give inputs (data, energy) according a continuous flow. Using interoperability as basis for data communication, several tools are available to manage correctly a big amount of heterogeneous data from BIM (at building level, for energy simulations) to GIS (at district/city level, for interrogation of the data). This flow is the base for the management of the entire system, and it is vital to ensure a proper balance of the energy involving people (user and manager) improving their awareness on energy consumption.

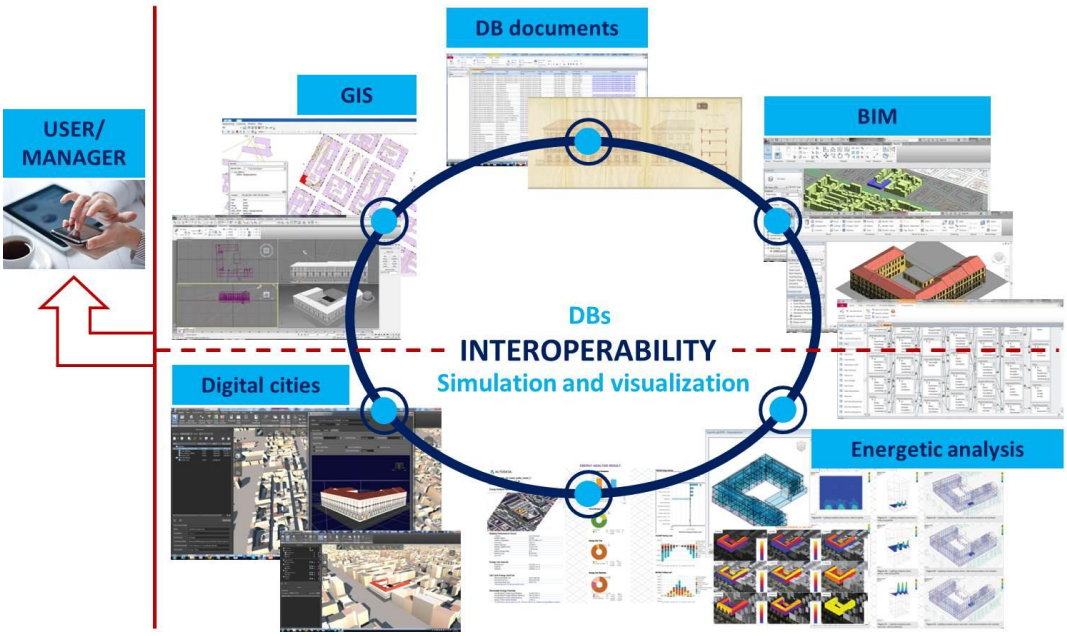


Figure 4: *Smart system at Building and District/City level (DIMMER project D3.1.1 - Hierarchy of the data: contents, standards and tools)*

Table 4 : *Building Sector Vision*

Scenario title
ICT for Building Sector to support energy systems of smart cities
Description
The approach of "Energy-Positive Smart Buildings" is transforming buildings from pure consumers to "prosumers" (energy producers and consumers). Building sector has energy efficient, nearly zero, net zero, and energy positive buildings with on-site renewable energy production, connected to the energy networks. Buildings have systems and tools for managing the building as an active consumer and producer in the city's

energy system.

Building Management Systems enable buildings to be also connected objects that are able to communicate and negotiate with the electricity and heat networks' systems. The energy management tool will enable intelligent energy trading and energy exchange between buildings and operation of buildings and their systems along with local energy generation and storage in a way that the overall efficiency of the concerned neighbourhood is increased. Smart buildings mean buildings empowered by ICT using current technologies as sensors, actuators, micro-chips, micro and nano-embedded systems. All these devices will allow collecting, filter and produce locally a huge amount of data (Figure 4). This data will be the necessary basis for a proper exchange between the buildings itself and the surrounding environment and therefore for the establishment of a Smart City. [6] By adopting different technologies and policies it will be possible to strengthen the use of the ICT tool to include such aspects already in the design phase of buildings and in smart building management systems [3].

As the big producer of data the sector has also the opportunity to learn and fine tune (by developing auto adaptive algorithms) its own energy behaviour and usage for better planning of on-site energy production, e.g. is it better to start a peak power plants to meet the peak load demand, or can energy loads be decreased via demand side management, or are there energy storage available (and dimensioned accordingly) and feasible to use.

Envisaged ICT needs

Information and Communication technologies (ICT) are in the heart of the smart grid and energy efficiency efforts with respect to buildings. Energy management and trading empowered with ICT has flourished and given rise to new innovative applications.

ICT makes it possible for the highly distributed energy system to be self-managing, self-sustaining and robust, and enables dynamic reorganisation and coordination of services markets. The Internet-based infrastructure is tightly coupled with the energy domain, and used to support the development of new mechanisms for trade based on supply and demand in the electricity market. Different models and scenarios for a highly distributed information-based energy infrastructure have emerged providing new capabilities. Transaction platforms provide services such as electronic marketplaces, facilitating the commercial activity associated with the buying and selling electricity and its derivatives, not only for utility companies but also for decentralised consumers and producers.

From the building and automation system point of view: there are lots of hardware and systems, but typically they are for monitoring and showing history data, and controlling based on it the near future. However, they should be able to forecasting future energy demand scenarios and deciding based on these, how the building is controlled. The smartness should bring smarter decisions in the long term, when it is now only used for short term controlling (next 5 minutes) of the building temperature and indoor conditions. There are lots of historical data reports already available for buildings, but still long term operation decisions are made by people reading these reports, and not ICT systems.

Impacts

Buildings will play a new and key role in innovative distributed energy production, and new associated business models, for renewable energy management, storage and peak shaving.

At building stage, each building shall be linked, as a node, to the others in order to collect all needed data and manage both the incoming and out-coming information flows and in consequence the energy flows. The collected data will permit to optimize the local distributed production and storage of energy/electricity, to deal with shaving consumption and generation peaks and the optimization of energy consumption, both at building scale and neighbourhood scale. The balance between supply and demand can be instantaneously managed, with higher precision.

By utilizing ICT to coordinate operations between the urban framework layer and the daily-life services

framework layer, the smart-city management will provide access to more information about supply and demand for more than what previously available. *Also techniques such as data visualization will make the information flow easier to understand and will help to include the user into the overall approach. By controlling the demand-side needs, it is possible to smooth the use of urban infrastructure equipment, without increasing the total energy demand and without harming the comfort of the users. For example, this approach can help to manage the demand in situations where the supply-side control is difficult, such as the output from solar power generation.* *The supply of energy will be provided during times of shortages by using system-wide control of all supply levels down to individual demands. In the case of electric power, for example, the available supply might be allocated according to public priorities, or by allocating only the exact minimum energy needed at that time. [2][3][4]* *The reduction of energy consumption through the use of ICT as key support technology is expected to be about 15% in the next years. [11]*
Stakeholders and Beneficiaries
The Private Sector will develop processes to enable open and collaborative innovation tools with potential customers. The Government will define a City Protocol to bring multiple groups together to establish a common language for Smart Cities. The Tertiary and service sectors will focus their R&D projects and business activities on developing products and systems capable to implement a digital ecosystem to manage the requirements of citizen. The final beneficiaries, more that the residents who will be the users and costumers of these digital services, will be ESCOs that will provide such services. [1][4]
Key Enabling Factors
In the next years smart buildings will be developed around the following elements within the smart city framework (taking into account the development of legislations, standards to be applied to smart home and smart building appliances): • *"intelligent" objects - embedded electronic chips, as well as the appropriate resources (i.e. including network platform) to achieve local computing and interact with the outside world.* • *"communications"- several sensors, actuators, all intelligent objects to communicate among them and with the services beyond the network;* • *"interactive interfaces" – new techniques of man-machine interactions (ambient intelligence, augmented/dual reality, tangible interfaces)that must be simple to use as much as possible, by properly combining intelligent and interoperable services,;* • *"wired and wireless sensor" – the investigation of the built environment will become possible with the use of device and, remote controlled devices.;* • *"platforms & networks" – actually the platform for implementing connected objects are mainly experimental. This infrastructure will manage information flows in real-time, on the top of optimization and decision support system for the management of energy production and consumption.[9][11]*

2.2.3 Vision of the Energy Sector

the Energy Sector covers the stakeholders involved in energy systems in smart cities refer to all energy solutions and technologies for energy supply (in other words: production), energy distribution, storage and energy demand/consumption/ use in cities. In this project the improving of energy efficiency of transportation and transportation fuel supply is excluded

from the project scope. In this scenario the energy users are also going to become producers of their energy, which usage will be optimised and holistically coordinated among various energy demand, distribution, storage and supply nodes.

Table 5 : *Energy Sector Vision*

Scenario title
Energy sector
Description
Energy sector is closely interconnected with the building sector at its city scale systems and is participating to the local energy production and distribution, and as such, their systems are able to communicate and negotiate with Building Management Systems that are also considered as distributed energy suppliers interconnected with the rest via the energy networks. There are systems and tools for management and optimisation of the use of energy supply, storage and demand, based on better predicting of energy profiles and forecasting based on weather forecasts. *Energy sector operates the heat and cooling, and electricity supply, distribution and storage efficiently with the support of ICTs developed taking into account the intrinsic characteristics of various energy sources and networks (heat and cooling, and electricity supply). The use of different energy sources is balanced and optimised taking into account their own specificities, and predicted energy demand profiles and renewable energy yield forecasts. Heat and cooling networks are operated at the local and city level with the use of low temperature levels more efficiently, and increasing the overall sustainability and efficiency of district heating systems. On the other hand, electricity supply does not have clear city level systems or networks, but they work on national and international grids with various electricity distribution companies for different areas; and separately centralised large electricity producers. Electricity markets are global, e.g. European level electricity markets are foreseen. It is common to have energy brokers operating between global electricity grid and a group of consumers. However, electricity and heat networks have also linkages, for example via combined heat and power production (CHP), which operation and their better optimisation for different situations is easier via coordinated management of energy systems. New opportunities are rising for new actors in the local energy markets.* *Providing sustainable energy to citizens is a key challenge for cities over the coming generations. For example, possible blackouts are increasing in the wake of an overall energy security.* *a city information and communication infrastructure is central for its business and mobile investment. The final vision is to develop a Digital Ecosystem for holistic energy management of the dynamic energy supply, demand and storage in urban areas, on top of an open information network platform. All data, work to interface themselves and keep the system flexible, interoperable, adaptable and extensible.* *An open information sharing environment becomes the central place where all useful data for urban areas are reciprocity exchanged in a uniform and open way.[3][4]* *The use of multiple energy sources through ICT ensures all essential services for residents to continuously operate with using sustainable energy efficiently.*
Envisaged ICT needs
New ICTs have taken into account the intrinsic characteristics of various energy sources and networks (Heat / Cooling supply and Electricity Supply) and balance the use of them taking into account these specificities in an optimized way. *Embedded diagnostics methods, capable of running on local controller devices allow for early detection of*

anomalous energy consumption and/or malfunction of individual components (dampers, valves, coils, etc.) in sub-systems such as air handling, heating, cooling, or lighting. Load management algorithms consider future energy consumption and try to adjust the consumption curve by shifting or curtailing some of the loads. In case of system optimisation, the control strategy will use the information about the operation states, loads, weather conditions, tariffs, and equipment characteristics.

Anyway, ICT is not able only to support the technical administration in energy sector, but also the arising business models (optimum business models shall be identified cause the interaction and role of the participating actors in the energy sector are continuously changing and are expected to be variant), through marketplaces or similar, that would allow the pragmatic implementation of the new business relationships among producers, consumers, prosumers and distributors of energy. This and the wide use and link to smart grid are the major breakthroughs that can be expected in this sector.

Impacts

An efficient energy model allows to utilize renewable energy more efficienty and to reduce energy peak loads, and to achieve specific targets for reducing carbon emissions and saving energy. The adoption of easy-to-understand visual interface (dashboard) showing the amount of consumed electric power, gas, heating and cooling energy and related sustainability impacts will contribute in promoting energy-saving activities and fostering the use of renewable energy. A great effect, of such systems, will be to manage regional energy information, predict demand, and provide information on supply and demand. The coordination in real time of electric power generated from renewable energy, storage, and the power utilities will allow flexible allocation of electric power within the area. The optimization of the use of renewable energy will reduce daytime peaks in electric power consumption.

Stakeholders and Beneficiaries

A decision support for Energy Companies and for citizens, in order to optimize the distribution of energy in cities. Furthermore it will support the prevention or reduction of critical peak situations, inform about energy, CO_2 and cost reductions, and suggest response to users in demand and involve all the participants in the energy market.[8]

Key Enabling Factors

The Green digital actions in the energy domain will develop advice in demand response, through alarms on any type of device that can perform direct demand control of a large amount of heterogeneous energy-consuming devices in residential and commercial buildings. It will be possible to analyze how virtual units could affect the current energy situation of the city in terms of consumption, production, CO_2 emissions, etc by performing an energy simulation framework that supports "virtual units" such as storage, EV charging stations and other distribution resources, in the decision support system.

Smart building and Smart Home solutions for centralized and remote management of premises as Electricity/Water/Gas smart metering solutions to optimize energy efficiency through insight on real-time consumption.

In other terms, an energy market network supports different exchange models of energy at city level, and defines, which models will optimize local exchange of energy within the low-voltage grid[7][11].

Suggestion of some key enabling factors:

— the use of data to better adapt consumption time to both user needs and costs in front of incentive fees from the energy sector is key to smooth demand peak. It can only be enabled if (a) data is provided to consumers, or consumer devices, (b) they can take advantage of it without great effort, e.g., they do not have to look at data to take a decision but their electric car socket can suggest them to only charge between 1am and 5am. This automated choice from the consumer may be based on price, but it may also be based on sustainability: this consumer may prefer to consume at time when energy is produced from non-fossil sources even at a higher price. Again, this time, production data should be brought to the consumer for better choice.

— in the other direction, it is already in the plans of the energy sector to collect consumption data in real-

time. However, such data, directly collected from so called smart-meters, only concern the energy that they deliver. This may prevent the energy sector to optimise its offer to the real user needs, like offering a plan more adapted to usage. Companies have other indirect ways to recover this information, however, one can imagine that such data may be more readily available. This would have benefits for policy makers who could tune their policies to the actual needs, to energy providers who could adapt their offer to the actual need; this may also be beneficial to the consumer who would have is personal data available.
These two suggested factors rely on the capability to exchange and aggregate data. This requires some minimal interoperability. Semantic web technologies, have been developed for that: being interoperable and flexible.

2.2.4 Vision of the Municipality

Definition of Municipality: It is fundamental considering its enabling planning and decision making capabilities. Nonetheless the last crisis years have decreased consistently the municipalities' expenditure capacity in many countries, thus enabling (at least at level of awareness) the introduction of new solutions and services that will maximize the social and economic impact of public decisions.

Because technological innovation moves in several directions (smart building, smart mobility, e-health, e-government, etc.), as shown below, the vision of the Municipality must be interdisciplinary and requires analysis at different level using different tools in order to optimize the management and the integration of the data.

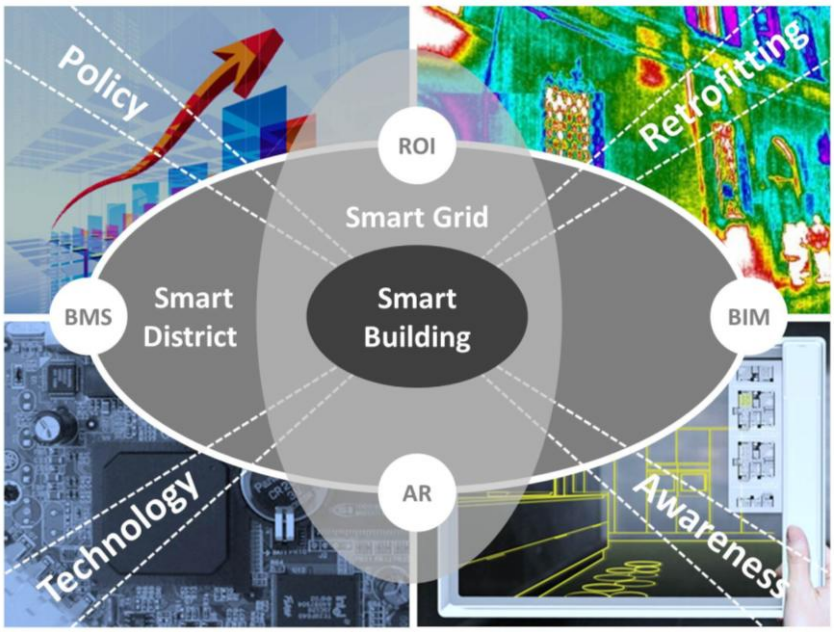


Figure 5: Conceptual schema for the interdisciplinary approach that is required at administrative level to be able to define new policies

Table 6 : *Municipality Vision*

Scenario title

Municipality
Description
Cities are the most important producer of CO_2. Therefore a global reduction of greenhouse gas is necessary in mitigating climate change, and in this cities can play a role. Under the growing pressure by citizens and investors city policymakers are incorporating environmental sustainability and greenhouse gas reduction of emissions into their policies. Municipality plays a role in energy efficient and sustainable city planning, smarter controlling of street lighting, and other city infrastructures such as waste and water management. Transportation planning and use of electrical cars is included in the coordinated and optimised operation of city's energy systems. *The city generates an enormous amount of information. A traditional city cannot manage it but a Smart City is capable of collecting, managing and taking advantage from it to make better decisions. Making better decisions based on real-time information leads to optimized city costs and more sustainable solutions. From this point of view, the local administration and government play a key-role in the ICT support frame and they can carry out the control and supervision managing the organisation at different levels. The overall purpose of the municipality is to coordinate efforts and resources within companies in order to make them work together towards predetermined goals. Governance and city administrations provide support to implement the smart city goals, which may be achieved by:* *• setting up and monitoring short - and long-term goals and strategies;* *• setting up and monitoring values and guidelines;* *• providing management models;* *• guaranteeing compliance with laws and regulations;* *• encouraging a change from old models to new and efficient services.* *These management tasks will create the appropriate conditions to develop the municipal organization's services. To be successful, the enterprise architecture should be aligned with strategic management work and corporate governance activities. To manage a smart city it is important to identify each city's needs and then to formulate solutions which will facilitate its services. The results of these activities will be used as a feedback to maintain urban operations at high level. It will be necessary to take into account the needs of different city typologies in order to determine each development strategy.* *The national or local government plays a central role, however many different organizational structures are used at municipal level to include services provided by "third-sector" organizations. These organizations are not just involved in a single process of developing a smart city, but also in the on-going processes of development and operation, considering also ordinary and extraordinary maintenance activities of such systems. This situation requires to work together and to adopt practices and structures that are designed for the long term to enhance the value of the city. [3][4][5]* *The key is to create an efficient and sustainable place with intelligent public services. There is not just a single type of Smart City; each one can become more efficient and sustainable with different solutions that can be tailored to its specific needs. At this point it becomes relevant to promote energy saving activities by providing easy-to-understand visual data on the amount of consumed electric power, gas, and other energy sources. It will be possible to manage regional energy information, to predict demand, and to provide information on supply and demand. The municipality must grow together with the possibility, of adapting their structures and their capabilities, to the new innovative processes and employees. This will require a new generation of smart employees and decision makers capable to manage these infrastructures.[2][5]*
Envisaged ICT needs
All the knowledge generated at municipality level will be shared between different municipality using inter-organisational knowledge platforms that will contain all the information organised by term and will offer an easy way to be consulted.

The introduction of such new solutions and services will foster and maximize the social and economic impact of public decisions through comparison and real benchmarking among similar municipality.

Impacts

The municipal administration starts to build up a consensus up an improved approach for managing local resources to make a smart and sustainable city environment.

In general, it would be helpful if more was acknowledged on the specific "cross-domain" data that will be collected and how these are going to be combined in the context of the smart city. There is a wide potential of algorithmic combinations and complementary explorations that could lead to different levels of smart city administration (given the availability of the appropriate data). In general, the semantics of the project need to be further detailed.

Another important dimension of municipalities is procurement schemes. Optimal procurement schemes should be explored encompassing interaction and collaboration between municipalities, government, industry and citizens' bodies. However, perhaps this is out of the scope of the project, which is more ICT-centric.

Stakeholders and Beneficiaries

The private and public sectors work within the context of city development and operations. Smart city solutions will be easily implemented through a partnership between private entrepreneurs and public authorities.

The Municipality will act at the same time as the main stakeholder and the main beneficiary, because the adoption of smart systems will cause a positive effect both on citizens and also on the municipality process and structure itself.

City administrators include the local government and other agencies that seek to boost the long-term competitiveness and appeal of the city while focusing on factors such as convenience, comfort, and accessibility.

Key Enabling Factors

The key factors on municipal or local vision are to promote smarter energy systems in cities for example via: [1][5][7]

- *Smart parking with real time information and notification thanks to sensors embedded in the road;*
- *Fleet management that will offer solutions for fleets of vehicles identifying the position of all service operator vehicles in real time. It also produces multiple reports to plan the activity;*
- *Intelligent transport system that in provides real-time information on public transport, incidents, routes, stops, vehicle position tracking and travel time, thanks to the devices installed in the vehicles;*
- *Traffic management, community biking and electric vehicles infrastructures;*
- *Smart urban lighting, waste and watering management.*

Special attention should be paid to build up a few simple KPIs to support the decision of policy maker.

*The Smart City's KPIs have to be **reliable**, **timely** and **repeated periodically** and they have to be used to compare the different policies adopted in the countries to evaluate their effectiveness, the relationship between incentives and results, and an analysis of cost reductions.*

Four are the main aspects of analysis that have to be considered:

- ***Use**. That means the usage of services by the citizen.*
- ***Supply**. That means the type and the level of technological services provided by the City.*
- ***Network effect**. That means the capacity of the Smart City to offer standard and integrated services to all citizen.*
- ***Degree of expertise**. That means the capacity to use the innovative services of Smart City.*

Furthermore, the link between the Municipalities/Authorities and the Citizens shall be reinforced with the elaboration of integrative aspects on how citizens will be better engaged and involved. SmartCity is a centralized system, therefore the citizens should not only be able to "actively participate in the demand side management", but being also main feedback providers, participate in the design approach and be the recipients of personalized services. Gamification is good for engagement, but awareness and the possibility to actually provide feedback should come before that.

2.3 Vision at ICT System Layer Scale

The ICT level, as previously defined in D5.1 "Conceptual framework & Methodology", is transversal to the whole smart city vision.

It can be divided into:

- Processes, stakeholders: in order to fully enable energy efficient cities, energy efficient paradigms must be fully integrated with current stakeholder process, or by inception or by evolution of processes themselves.
- Applications: this layer is the key contact point within the smart city environment with all relevant stakeholders.
- Platform middleware: this layer is fundamental enabler of technologies related to system integration and interoperability.
- Databases and/or data sources (cloud, sensors…): this is the base layer that feeds other layers enabling information flows and actuation of energy efficient behaviours.

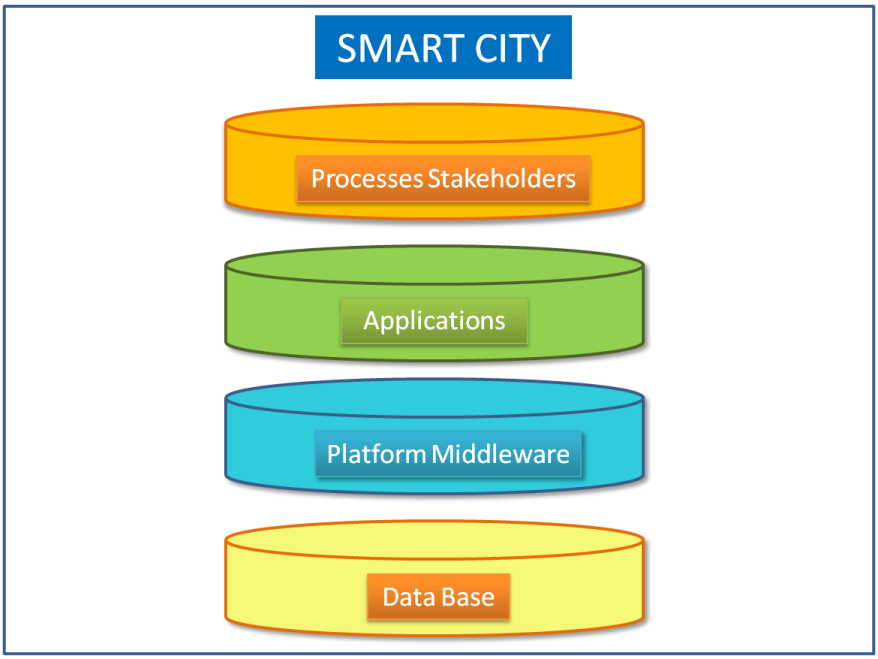


Figure 6*: System of Layers in the Smart City, as already described within D5.1*

Table 7 : *ICT System Layer Scale*

Scenario Title
ICT System Layer Scale
Description
The models for smart cities are designed as hierarchy infrastructures that have different functions and purposes. The ICT system is composed by several layers : • *Process and Stakeholders:* *Both these two elements must upgrade to the next level in order to fulfil and accomplish the modified needs of the smart city: processes must adapt to the new way of living and using the city, both from users and business workers. Furthermore, the stakeholders in a smart city can be divided into different groups, such as consumers (include people who live, work, study, or visit the smart city), city managers (local organizations such as government, real estate developers, and infrastructure operators), energy supplier (energy company that will manage resources and power grid) and public opinion group who wants to reduce the pollution load on the environment at global level. [2][7]* *Application:* *it represents a contact point between the frame of smart city and stakeholder; at this step, all technologies can be used in the cities to meet the growing challenges of expanding urbanization and financial interest of the stakeholders. [1][7]* *Platform Technical Architecture:* *the platform is not only a set of middleware components, but also includes the implementation of a set of horizontal application services. The information flow will be connected with the city environment and citizen's needs by an Application server. The platform will be based on several key components that going to work together to provide efficient smart system. This will be used by municipality and business administrator to model and define smart management systems and will enable the ability to manage complex application systems.[7]* *Data Base:* *All Data Flows come from the instrumental layer connected by several data sources including sensors, meters, cameras and unstructured data. These data sources will be controlled by a Data Acquisition system which will manage the information flow coming from the Smart City in real time.[2][11]*
Envisaged ICT needs
By these interconnected layers, all data flows and input will be mapped as a rank of events that, when combined with other event-related information, create a rich source of data to enhance decision making. The services framework with application and management systems are used to transform data and perform analysis. The layers can help stakeholders, developers and operators to take corrective actions and support decision making.
Stakeholders and Beneficiaries
Governments at all levels (State, local and regional), Public administrations, Developers (transport and city services, designer and architect, general contractors, energy service provider), Private Operators and Entrepreneurs will be affected. Moreover the adoption of such an ICT System Layer Scale will be possible only through several implementation actions by dedicated actors, such as system integrators and all the necessary technical stakeholders. [1]
Key Enabling Factors
Among all the several elements, which will be crucial to enable the ICT System Layer Scale (Municipality, citizens, energy provider etc) the System Integration will surely act as the main key factor and it will be the binding agent among all levels, so there will be the need to perform a huge activity to put together all the elements which constitute the different layers.

2.4 Vision at Business Process Level

Similarly to the ICT level, the Business level is transversal to all the key elements of the urban scale, as described in Deliverable 5.1. The main drivers in this segment are the following:

- Services definition & services data exchanges: open and scalable service definitions and data models are needed to fully enable interoperability among different city services.
- Energy management (short time forecasting / piloting / …): this process is fundamental at operation phases to take into account information flows coming from the different levels and layers.
- Simulation (Performance estimation / Cost estimation / Impact of Energy Conservation Measures calculation): this process is relevant during the design phase in order to identify the most energy efficient solutions.
- Optimization: this process is fundamental to improve energy management as well as energy efficient design with information coming from realized infrastructure.

The development of a Smart City ecosystem is a business opportunity for the implementation of new and advanced services for the Citizens: the general framework will be made by the interaction between Governance, Business Models and Services (see figure below.)

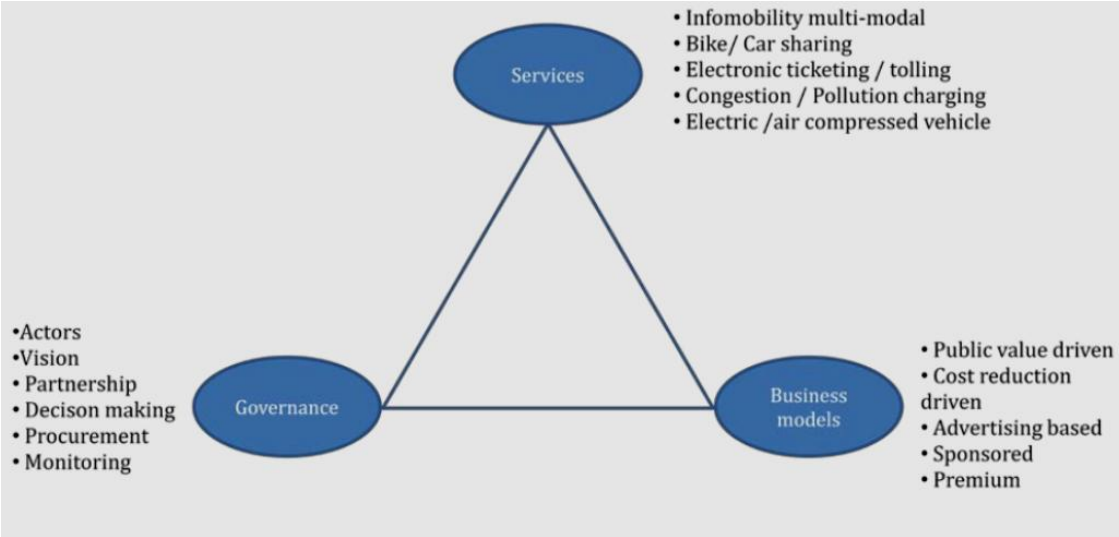


Figure 7: *General Framework on Business Vision for Smart City (http://eu-smartcities.eu)*

Table 8 : *Business Process Level*

Scenario Title
Business Process Level
Description
The deep changes, which will inevitably affect the concept of a city will impact also on the traditional business processes, by leading to a necessary re-thinking process of the old and traditional models towards a new and coherent business vision within the new smart city. Currently, a knowledge gap on... prevents the creation of a virtuous circle linking the adoption of innovative (integrated) services, new business models and governance mechanisms, However, there is a clear gap of tested projects or experiences based on the cost-benefit analysis, especially in business models. *For this reason there is a real interest towards smart business models and Business leaders cannot wait for current technologies that are still in the development phase to get advantages and to identify what progress will be really important. [1][2]* *The needs of Business leaders are to gain knowledge on forecast and to take competitive advantages where they have based their business strategies through the impact of these emerging technologies.* *In this context, the smart citizen becomes an active "prosumer-customer". The new business model will provide the energy customers with the opportunity to give their energy data resource to third parties such as Energy Service Companies, software developers, smart appliances providers and other entrepreneurs, through solar panel installers, window and insulation installers. Consequently these third parties can then offer products and services tailored to the customer's needs.* *It is clear that if the world of businesses and smart cities comes to be integrated on this citizen-centered vision, many more benefits will be obtained.* *At this time, Smart City strategies will enable new business opportunity in order to provide innovative services. [5]* *The Smart City is a need for the future of society, but it is also an opportunity for economic development based on all the new products and services such as smart government, smart buildings, smart mobility, smart energy and the environmental smart services.* *The ICT business tool will also encourage improvements to national regulatory frameworks to facilitate the widespread adoption of local, clean energy generation. The security framework to protect the robustness of the system and the Privacy approach will be adopted in order to assure the total privacy of citizens and guarantee that their data will be shared only with authorized third parties.[2][3][4]*
Impacts
The development and growth of the new Smart City will create several financial networks on governments and public financial institutions that have the capacity to define the necessary tools to promote innovation and the deployment of real solutions. *The complex processes of urban and territorial transformation on today's cities to become a Smart City entail a series of actions and local initiatives, which will create economical benefits but also a positive return in terms of environmental and social aspects.* *The economic returns resulting from national and international financial mechanisms will encourage the use of renewable energy sources and the reduction of CO_2 emissions, such as White Certificates, Green Certificates or Emission Trading Schemes.[1][10]* *Therefore the economic returns resulting by ICT support tool in a business approach will come from the sale of new services such as distributed energy management, energy produced or supplied into the grid, but also from the cost reduction of existing urban services, for both businesses and citizens, and finally the efficiency return generated by the increase in the quality of urban infrastructures.[7]*

Stakeholders and Beneficiaries
City administrations are the ones that have the capability to take advantage from the benefits offered by solutions and encourage the transformation of the cities into smart cities, improving their efficiency and sustainability. *The contractors are the companies in charge of providing services. They are responsible for implementing and developing an infrastructure that supports a Smart City.* *There are also Telco companies that will implement connectivity among urban elements, as well as developing solutions that analyze all the information data to make a smart city.* *For New Business and Entrepreneurs the technologies and facilities of a Smart City that will be activated represent an open digital ecosystem to generate ideas and services.* *Finally the citizens are the most important beneficiaries who will take advantage of the growth of better financial services and a more efficient environment.[5]*
Key Enabling Factors
At the business level there will be several elements which will act as enablers [6][9]: • *Development of a business model framework based on the concept of dynamic value networks of actors such as energy, service and information providers;* • *Development of business cases that demonstrate the economic interest of Smart Energy Management Systems to the energy provider in terms of shifting and optimizing the load on the grid, even out the demand with needs and prices, maximizing the use of renewable energy sources.* • *Development of business cases that facilitate "virtual" energy exchange between consumers and producers in the community and thus promote the construction and efficiency of renewable energy sources in the community.*

3 Integrated Vision for ICT supporting Energy Systems for Smart Cities

Figure 8: *Integrated vision for the Smart City (source: D'Appolonia analysis)*

In the global vision for the "ICT-centric context" for energy systems of Smart Cities there are so many interconnected factors, which must work together and be linked to each other, in order to create a clean and useful environment.

This action requires an unprecedented scale of change, which will involve all the stakeholders at all levels: the 4 main urban elements (Citizens, Building sector, Municipality, Energy sector) will guide this transition by expressing the needs (Citizens), while the remaining three elements will act as provider/supplier (Energy Sector), one elements must meet everyday needs and cope with peak demands (Building Sector) and the last actor (Municipality) must manage and guide the transition.
All the elements involved have their peculiarities and priorities, but they must cooperate each other to ensure the fulfilment of the Smart City paradigm.
All these elements will be enabled and supported transversally by the ICT and the Business Processes, which will facilitate the transition towards a harmonised and collaborative city environment.

4 Contingency Actions

4.1 Workshop Organisation and Collection of NEW Inputs for the Vision

Interaction with the SAB as well with the overall project community was very low during the first year of the project due to the difficulties encountered in WP1 for the identification and selection of the experts' member of the Stakeholders Advisory Board (SAB) as well as the definition of the "community of communities".
Taking into account the nature of the project that aims at the interconnection of already available communities bringing together different stakeholders representing different sectors already separately active on smart city innovation activities, the planning of a methodology for community building and management required more effort than the one foreseen at the initial plan.
The consortium was not able to organise a workshop event specifically for the definition of the project vision. We changed our approach and setup an online survey as well as online interviews. The result was better (4 interviews done so far) but it remains unsatisfactory (no reply from the online survey.

The plan is to continue to interact with this SAB (via physical and online/phone meetings) but it is also planned to enlarge the consultation to a circle of "active members" that have or will attend the various events we will be organised or where we will be actively present during the next period. These active members are also identified via the emailing platform or via the LinkedIn group or our Twitter account, as well as via the BuildingSmart ontology group which is under development at AEC3 or through the Sherpa Group 10 "Standardisation" where one of our expert (Simona Costa) plus some of the project partners (VTT, CSTB, POLITO and AIT) are represented.

4.2 Summary of next roadmapping activities

This report summarises the vision for ICT supporting energy systems of smart cities, and is thus the basis of forming the vision for the R4SC road map in the following task T5.3 Innovation and Research Road map. The road map will be structured similarly as here into 4 main categories: citizens, building and energy sectors, and municipality level. The first version of the Innovation and Research Roadmap is available in September 2014 for expert consultations, and its development continues until September 2015 in collaboration with experts.

5 Conclusions

The following Ready4SmartCities vision has been collected by stating the development needs for energy systems of smart cities and especially on how ICT is enabling it. This kind of development is needed to adapt to targets of lowering emissions, increasing energy efficiency and improving the overall performance of energy systems.

The vision is structured into four main categories, which all are aiming towards the same future:

Citizens are taking an active role of a prosumer (energy consumer that also produces energy by themselves). In addition with the increasing use of “connected objects”, citizens become the real actors of their own energy demand by making their own control settings for their use of energy appliances according to various indicators such as energy price levels, carbon foot print, being then also active participators in demand side management They are giving opportunity to decide, how much they are willing to pay for using electricity in different equipment and with what kind of environmental impacts during peak hours.

Building sector has energy efficient, nearly zero, zero, and energy positive buildings with on-site renewable energy production, connected to the energy networks. Buildings have systems and tools for managing the building as an active consumer and producer in the city’s energy system. Building Management Systems enable buildings to be also connected objects that are able to communicate and negotiate with the electricity and heat networks’ systems. As the big producer of data the sector has also the opportunity to learn and fine tune (by developing auto adaptive algorithms) its own energy behaviour and usage for better planning of on-site energy production, e.g. is it better to start a peak power plants to meet the peak load demand, or can energy loads be decreased via demand side management, or are there energy storage available (and dimensioned accordingly) and feasible to use.

Energy sector is closely interconnected with the building sector at its city scale systems and is participating to the local energy production and distribution, and as such, their systems are able to communicate and negotiate with Building Management Systems that are also considered as distributed energy suppliers interconnected with the rest via the energy networks. There are systems and tools for management and optimisation of the use of energy supply, storage and demand, based on better predicting of energy profiles and forecasting based on weather forecasts.

Energy sector operates in heat and cooling, and electricity supply, which have differing characteristics, and thus also differing ICT needs. Heat and cooling networks are operated at the local and city level, and their systems vary in different cities. For heat and cooling networks, the more efficient use of low temperature levels is possible and increases the overall sustainability and efficiency of district heating system. On the other hand, electricity supply does not have actual or clear city level systems or networks, but they work on national and international levels with various electricity distribution companies for different areas; and separately centralised large electricity producers. Electricity markets continue to globalise, e.g. European level electricity markets are foreseen. Energy brokers operating in the middle of global electricity grid and a group of consumers are common. However, there are some linkages between electricity and heat networks, such as combined heat and power production (CHP), which operation and their better optimisation for different situations is easier via coordinated management of energy systems. New opportunities are rising for new actors in the local energy markets.

Municipality plays a role in energy efficient and sustainable city planning, smarter controlling of street lighting, sponsor to boost the development of cheaper electricity storages, and other city infrastructures such as waste and water management. Transportation planning and use of electrical cars is included in the coordinated and optimised operation of city's energy systems.

In order for such futuristic scenarios to emerge, the ICTs as a set of pervasive enabling technologies have to play a major role especially in the following areas:

- Cyber security: The data exchanged could be private data (citizen behaviour) or strategic ones especially when smart grids are concerned. Thus the security and privacy of the exchanges is of key importance to prevent from any breach or leak;
- Internet of Things: All these systems will rely on sensors and actuators coupled to decision making mechanisms. These systems to be largely deployed must be easy to use and to interconnect to each other. It means the interoperability issues have to be solved from the hardware level up to the semantic level;
- Big Data / Linked Data: In order to optimise the use of energy, to balance such complex/ ramified networks the processing of the huge amount of corresponding data is also of key importance.

Open data policy was not discussed at all and it is perhaps the most important thing when we are aiming at a network of Smart Cities (replicating and learning from each other). It is very important to keep in mind that every country within the EU has different legislations according their data privacy and data collection policies. For example, in Germany privacy is a very important issue when it comes to data and their use. Therefore, interoperability does not have only to do with use and interconnection on a smart city level, but also to use and interconnection on a wider – European level.

The last aspect will be treated in the updated version of the present report that will be provided by M19 by the partner responsible DAPP for feeding the final roadmap that will be released by partner VTT in D5.6 and improved accordingly.

REFERENCES

[1] EU Project Smart Cities Stakeholder Platform, *Using EU funding mechanism for Smart Cities* 2013, (http://eu-smartcities.eu/publications);

[2] Hitachi Ltd, *Hitachi's Vision for smarter Cities*, Social Innovation Business Project Division 2013;

[3] C. Gurdgiev, S. Dirks, M. Keeling, *Smarter cities for smarter growth*, IBM Institute for Business Value 2010;

[4] M. Keeling, S. Dirks, *A vision of smarter cities*, IBM Institute for Business Value 2009;

[5] TelefÓnica, *Smart Cities m2m technologies*, (https://m2m.telefonica.com/discover-m2m/smart-cities);

[6] D7.2.3 - *Dissemination Plan*, EU Project DIMMER 2013

[7] EU Project iURBAN 2013, http://www.iurban-project.eu;

[8] EU Project ODYSSEUS 2013, (http://www.odysseus-project.eu/);

[9] D1.3 - *Demand and Behaviour Survey*, EU Project ORIGIN 2013;

[10] D. Schwabeneder, H. Auer, TUW-EEG, WP2 - *Technical, Economical and social patterns of Energy Service Provision*, EU Project ORPHEUS 2014;

[11] REEB Consosrtium and High-Level Advisory Group, European Commission "ICT for a Low Carbon Economy", *Smart Buildings*, July 2009.