ERA-NET SMART GRIDS PLUS INITIATIVE

REPORT ON SCOPING WORKSHOP

OCTOBER 28, 2015 IN MALMÖ

VERSION 2.0

(DRAFT VERSION)

02 December 2015

INTERNAL REFERENCE

Deliverable No.:	D 1.6.4
Deliverable Name:	Report on Scoping Workshop
Dissemination Level:	PU
Lead Participant:	B.A.U.M.
Work Package No.:	1
Task No. & Name:	1.6 Support Project
Document (File):	ERA-NET SG PLUS - D1.6.4 Scoping_Workshop_Report - v2.0b.docx
Issue (Save) Date:	2015-12-02

This document was created as part of the ERA-Net Smart Grids Plus Initiative, funded from the European Union's Horizon 2020 research and innovation programme under grant agreement No 646039.

DOCUMENT STATUS

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CONCEPT

Purpose of the Workshop

After successfully closing its first call in the 4th quarter of 2015, ERA-Net Smart Grids Plus (SG+) plans to implement a 2nd call for R&D projects in 2016. It is up to the Management Board (MB), i. e. the 23 participating national research-funding agencies, to decide the scope and content of that call. Connected to its orderly meeting in Malmö, in a so called Scoping Workshop, the MB received in-put from the ERA-Net SG+ Support Team and external experts as to potential research topics for such a call. The team of the Support Project (SP) prepared and moderated this 1-day workshop.

While the overall scope of the future call(s) is open, starting from the ERA-Net SG+ launch event in March 2015 throughout a workshop in the framework of the Austrian Smart Grid Week in May 2015, ERA-Net SG+ has been carefully looking at the topic

Storage and Cross Energy Carrier Synergies

as a potential candidate for part of the scope of the next call. It is important to understand, that in the ERA-Net SG+ 3-layer model not only technology, but also market and adoption topics shall be considered. The latter is a reason why ex-perts in the fields of smart buildings were invited to the workshop to present re-search needs at "the edge of the Smart Grid". All considerations took an empha-sis into account, which the SET-Plan Initiative has recently called

Technologies and Services to provide Smart Solutions to the Energy Customer.

In preparation of the Scoping Workshop, experts of the ERA-Net SG+ Support Team prepared a "gap analysis", i. e. an overview of potential research topics related to storage and multiple energy carriers and their intelligent connection to the grid with respect to customer needs (see below). While the main purpose of that analysis was to structure the discussion, at the Scoping Workshop 6 experts shared their insights in concrete future needs and research demands.

Participants

- ERA-Net SG+ actors
    - Management Board
    - Core Team incl. Support Project
- Potential new candidates for the broadening of the ERA-Net SG+ Initia-tive
- 6 external experts with various backgrounds:
    - academia
    - industry
    - policy.

Goals

As an immediate result of the workshop, the Support Team presented a landscape of potential research areas and questions to be used for the discussion of the Management Board (MB). In the meeting that directly followed the Scoping Workshop the members of the MB discussed their priorities for research topics in the next ERA-Net SG+ call.

MINUTES

ERA-NET SMART GRIDS PLUS SCOPING WORKSHOP, WEDNESDAY OCT. 28, 2015 **Moderation:** *Michele de Nigris, deputy project manager of the Support Project, RSE*	
Introduction *Michele de Nigris, deputy project manager of the Support Project, RSE*	Brief presentation of the gap analysis document as the basis for the workshop identifying research gaps within the area of storage and cross energy carrier synergies
Opening Michael Hübner, *Coordinator of the ERA-Net SG + Initiative, Austrian Ministry for Transport, Innovation and Technology*	Purpose of the scoping workshop: • contributions to the definition of the scope for a second ERA-Net SG+ call • build-up a network and outreach to new partners for the initiative
Experts Hearing: Backgrounds and Research Requirements (Presentations attached)	
Marco Merlo, Politecnico Milano *Storage needs in the future energy system*	Marco Merlo pointed to the following research and development needs: • Adaption of technical regulations and standardisation • Real life applications and interaction with final users • Use the electric distribution grid and subdivide the system in areas • Market adaption and price reductions of batteries • New challenges through the operation of storages / batteries on household / building / community level
Michael Stöhr, B.A.U.M. Consult *Storage at the service of the Energy System: Gaps and RTD*	Michael Stöhr highlighted following research questions: • Exploration of the full potential for low-cost, secure, etc. Li-ion batteries and other storage and demand response technologies • Efficient, flexible and low-cost PtG-converters • Flexible infrastructure (e.g. relocated storage units and 2nd life of existing infrastructures) • Identification of optimum energy transition corridors taking market aspects into account • Appropriate models for cross-carrier energy systems Holistic view of the energy system • Adapting market framework
David Lillienberg, E.ON Sweden, FP7 project FINESCE (trial site Hyllie)	David Lillienberg indicated the following research topics:

Managing electricity self consumption with ICT to meet the needs of people and grid operators	• Design, scope as well as regulatory and market conditions of the ICT layer needed to connect all energy systems • Customers integration (also by incentive structures) • Integration of sensor technologies and meters • demand-response standard • Different use areas for storage • Reduction of storage costs necessary • more openness regarding data needed • Pilots and demonstrations much more powerful than pre-studies
Marcus Voß, DAI-Labor, TU Berlin *Managing power, heat and comfort in Smart Buildings*	Marcus Voß suggested the following research areas: • Electricity oriented control of a CHP through smart EMS (Energy Management System) • Opportunities and barriers to buildings as a short time storage to provide ancillary services for the grid • Planning of optimal energy supply and components sizing • Flexibilized building energy supply • Potentials, data needs and connected issues for saving through automation • Interoperability of smart home and smart building platforms • Integration of EV into the building
Michael Stöhr, B.A.U.M. Consult (Replacing Frederic Malefant, Renault Group, General Manager - Head of Smart Charging, V2G and Stationary Storage Projects, H2020 project ELSA) *Second life use of electric vehicle batteries in buildings and districts*	In his second presentation, Michael Stöhr indicated the following research gaps: • Dimensioning of battery systems • Use of second-life components • More life-cycle assessments for storage solutions necessary
Matthias Müller-Mienack, GridLab, founded by and cooperating closely with 50Hertz Transmission *System, grid and market relevance of stationary and mobile storage services*	Matthias Müller-Mienack highlighted the following research topics: • Applications • pooling concepts for control power push into the market
Michele de Nigris, RSE, H2020 project Grid Plus Storage *European research on Storage and Cross Energy Carrier Synergies*	Michele de Nigris indicated the following research needs: • role of storage solutions and active demand in defence plans

	• Role of storage solution in system restoration • Network planning tools involving storage (interfaces) • procedures to involve DSOs in control zones with high share of DER including storage
The research landscape	See Gap Analysis below
Towards new ERA-Net Smart Grids Plus Calls Moderated session to develop a research agenda	Additional and partly cross-cutting to the gap analysis, more research is needed with regard to: • interaction with and involvement of final users / end consumers • holistic concept of the energy system • adaption of regulatory and market framework • different usage areas for storage • standardisation • ICT / data management and security • More applied research, pilots and demonstrations
	In the final discussion moderated by Michael Hübner to address expectations from the funding agencies for the 2nd ERA-Net SG+ call, the following topics/questions were highlighted as well: • scope of the call should be very broad, but at the same time ask specific questions • Data Platforms for an innovative Energy Ecosystem and openness of / data sharing through such platforms (potentially join forces with ICT funding programmes) • Inclusion of customer / community driven initiatives and the role of DSOs in the future energy system • For the next top-up funding by the EU, challenging and very up-to-date topics for the call needed • results of the first call important for decision on topics for the second call

GAP ANALYSIS

The following “landscape of research topics” relates to the part of a potential scope that deals with “storage”, “cross energy carrier synergies” and “services for the end customer”. It describes “use cases” in which the relevant research questions will show up. All use cases are structure according to the following “usage areas”:

- Developing a Holistic View of the Energy System in Transition
- Bulk Storage at the Service of the Energy System
- Closing the Gaps in the Cross-energy Carrier System
- Managing Buildings as Intelligent Objects on Grids
- Managing Industrial Areas as Intelligent Objects on Grids
- Electric Vehicles as Elements of Smart Grids

These symbols depict a qualitative assessment of the research need for this use case. Green shall show how much one knows already and dark yellow depicts the research need. They express the impression of the Support Team built on the analysis done before and during the Scoping Workshop.

Developing a Holistic View of the Energy System in Transition

use case	*technology*	*marketplace*	*adoption*	*comments*
Holistic Physical View of the Energy System for Achieving Societal Consensus	Develop a holistic model of the energy system at the different scales that integrates different energy carriers.	Integrating cost and benefits aspects in the holistic energy system approach.	Sensitivity analysis of the models developed to the final user reaction (adoption)	Focus should be on integrating different models with specific strengths in a single powerful model.
	Which is the best mix of flexibilities at different scales and in different geographical areas?	How do the costs of different flexibilities affect different stake-holders and how can they be allocated at best? How can the provision of electricity system flexibility be remune-rated in a fair manner, thereby encouraging the provision of sufficient flexibility?	Can prosumers/ final users make business out of its generation/ load flexibility or otherwise find it attractive to provide flexibility?	Depending on the scale at which the energy system is looked at (single building/enterprise, local area, country, EU), a different mix of storage, demand response and generation management might be the best. The best mix further depends on the concrete geographical area which is looked at.
	Which is the optimum mix of central/ decentralised generation and storage, and grid extension and how sharp is the optimum, i.e. how robust are optimum solutions?	Remuneration of cross-energy flexibility: Who makes a business out of it? Are new market models needed?	How can prosumers/ final users be informed about their potential of, and mo-tivated to act for the over-all optimisation of the enti-re energy system (combin-ing the use of electricity, heat, cool, water etc.).	Little is known at this stage about the optimum trade-off of grid extension and flexibilities for different geographical areas.

use case	*technology*	*marketplace*	*adoption*	*comments*
	Which transition paths are robust and which measures are hardly regretable?	How can the market framework be designed to encourage desirable trends/ fully sustainable developments from the outset? E.g. how can local generation and use/ local trade of energy generation (electricity and heat) be encouraged?	Which trends would be erroneous? How can the final user sell his energy production to his neigh-bours, thus directly partici-pating to the energy market?	Measure which can be modified with little effort and costs are less regretable.
	How can spatially distributed storage devices avoid grid reinforcements and/or new grid lines?	How can the provision of local storage (electricity, heat, cool) be remunerated, thus encouraging sufficient provision of local storage? How expensive is taking public resistance against new grid lines into account compared to alternative flexibilities?	How acceptable are different flexibility options for the society?	
Adapting Market Frameworks for Optimum Course Setting of Energy Transition		How do different market frameworks impact on the energy transition?		
		Which are optimum corridors for cost-effective energy transition paths?	What are the costs and benefits of implementing new services and products that lead the customers to a more active role?	"Optimum" means best with regard to overall costs, environmental/ climate impact, and social balance.
		Which market rules do best suit optimum		

use case	technology	marketplace	adoption	comments
		energy transition paths?		
Integrated IT Platforms for Multiple Usage Areas	Which is a suitable ICT infrastructure allowing system operators with stringent requirements to ensure network security?	Which is a suitable ICT infrastructure allowing growing exchanges between market players (including consumers through aggregators)?	How to develop ICT structures (APPs) to facilitate user adoption?	
	Which approach for data acquisition and data management (updates, storing/ archiving and cleaning methodologies, data security) should be developed to manage the increasing amount of data?		How to develop data interfaces with the user?	
			Develop common and easy to use protocols – e.g. green button.	
Attractive User Interfaces	Develop ata management layer for development of APPs in view of the implementation of all types of energy services.		Data interfaces with the user. Common and easy to use protocols – e.g. green button.	
	Data privacy issues – technologies and solutions	Data privacy issues – regulation and remuneration	Data privacy issues – user information and adoption	
Standardisation and Legislation		Recommendations for energy legislation facilitating the integration of fluctuating generation.	Common and easy to use protocols – e.g. green button.	
			Which de facto standards can influence the development of innovative energy	Such standards are de facto set in the telecom field or wide-spread platforms such

use case	technology	marketplace	adoption	comments
			related products and services?	as google or facebook.
Data handling	Which interoperability issues need to be addressed?	How does data handling procedures affect the cost-effectiveness?	Which data handling procedures are the most convenient to all actors involved?	
	Data security: which technologies and solutions can be proposed?	Which data are necessary for market transactions involving many users?	Which data security measures are needed from the point of view of different actors involved?	

Relevant Projects

project title and acronym	*lead organisation*	*start / end date*	*countries involved*	*website*	*project scope (abstract*
ADDRESS	Enel Distribuzione S.p.A	January, 2008 to December, 2013	Belgium, Switzerland, Germany, Spain, Finland, Italy,France;United Kingdom; Netherlands, Sweden	http://www.addressfp7.org/	To enable the active participation (i.e. active demand) of domestic and small commercial consumers to electricity system markets and the provision of services to the different market players.
LINEAR	Vlaamse Instelling voor Technologisch Onderzoek N.V.	January, 2011 to December, 2014	Belgium	http://www.linear-smartgrid.be/	To design a demand response architecture supporting multiple aggregators and multiple energy management system providers as well as the development and integration of smart grid ready appliances.
evolvDSO - Development of methodologies and tools for new and evolving DSO roles for efficient DRES integration in distribution networks	Enel Distribuzione S.p.A	January, 2013 to December, 2016	Austria, Belgium, Germany, Denmark, France, Ireland, Italy, Portugal	*www.evolvdso.eu*	To define future roles of DSOs on the basis of scenarios driven by different DRES penetration levels, various degrees of technological progress, and differing customer acceptance patterns.
NETFFICIENT73 - Energy and economic efficiency for today's smart communities	AYESA ADVANCED TECHNOLOGIES SA	January, 2015 to January, 2019	Spain, UK, Germany, Italy, Sweden, France, Belgium	http://cordis.europa.eu/prject/rcn/194443_en.html	To deploy and demonstrate local storage technologies which have reached TRL 5-6 in a real electrical grid, and will develop ICT tools to exploit the synergies between them, the smart grid and the citizens. The demonstration in this real environment will

project title and acronym	*lead organisation*	*start / end date*	*countries involved*	*website*	*project scope (abstract*
through integrated multi-storage technologies					be driven by five use cases covering low voltage and medium voltage scenarios and a wide range of applications and functionalities. Viable business models will be defined for the cases.
GREEN2STORE - Integrative usage of storage capacity in the 'cloud' for developing renewable energies	EWE AG	November, 2012 to October 2016	Germany	http://www.green2store.de/	To ensure that a greater proportion of renewable energy generation can be integrated into the distribution networks by the integrative usage of local storage units centrally managed.

Bulk Storage at the Service of the Energy System

use case	*technology*	*marketplace*	*adoption*	*comments*
Bulk Short-Term Storage and Storage-Based Grid Services	Which sort of storage (capacity, reaction time, etc.) does best serve the grid in which situation?	Which is respectively the best remuneration schems?	How can safety and other acceptance aspects be best dealt with?	Bulk short-term storage can be large batteries, compressed air, cryogenic storage, pumped-hydro or others, including combinations of different storage technologies.
	Which is the role of energy storage in the future grid defence and restoration plans?	How compare local and centralised solutions economically?	How compare local and centralised solutions with regard to societal acceptance?	
		Develop market models for the user/ system/ he utilities/ aggregators.	How differ market models with regard to their potential of being adopted by the actors involved?	
Cross-energy Synergies and Long-Term Storage	To which extent can existing natural gas infrastructure manage hydrogen feed-in?	Which are regulatory and economic impacts and opportunities for storage facilities compared to other available flexibility solutions?	Which regulatory framework adaptions are needed to deal with hydrogen feed-in?	In the transistion phase, hydrogen might be used instead of methane.
	How compare cross-energy synergies of very distributed short-term heat stores with long-term heat storage at district level?	Which potential exists for cost-savings due to synergies and which stakeholders can profit from it?	Who will own and/or operate storage facilities?	
	Demonstrate under real operating conditions and on large-scale new advanced network operation and energy	How can energy storage systems take part in different energy market segments, e.g. capacity markets?	Which barriers hinder the adoption of cross-energy synergy and long-term storage use?	

use case	technology	marketplace	adoption	comments
	management capabilities based on the use and integration of electricity storage technologies.			

Relevant Projects

project title and acro-nym	lead organisation	start / end date	countries involved	website	project scope (abstract
Electricity storage for short term power system service	Technical University of Denmark	January, 2010 to December, 2010	Denmark	http://stateofgreen.com/en/profiles/energy-2008-forskel/solutions/electricity-storage-for-short-term-power-system-service	To evaluate and compare – technically and economically – the available options for using dedicated electricity storage units to provide short term system services at transmission system level in the Danish power system.
Opportunities to use Compressed air energy storage for storage of electricity in the electricity system of the future	Technical University of Denmark	January, 2005 to December, 2010	Denmark		To determine whether Compressed Air Energy Storage (CAES) will be a sound alternative in financial and energy terms to other types of electricity storage (hydrogen. battery. pumped storage power stations abroad) and regulation methods in connection with electricity overflow and other regulation needs in the electricity system of the future.
Adiabatic compressed-air energy storage (CAES) for electricity supply - ADELE	RWE Power AG	January, 2009 to December, 2013	Germany	http://www.rwe.com/web/cms/mediablob/en/391748/data/364260/1/rwe-power-ag/innovations/Brochure-ADELE.pdf	To examine the techno-economic feasibility of the AA-CAES technology, focusing on three key components: turbo-machines (compressors operating at pressures over 100 bars with temperatures exceeding 600 °C), heat exchangers (heat accumulator operating at high internal pressures and temperatures and subject to stresses resulting from the cyclic pressure and temperature loads due to the storage and production cycles), and caverns.
RealValue - Realising Value from Local Electricity Markets with Smart Electric Thermal Storage Technology	GLEN DIMPLEX IRELAND	January, 2015 to January, 2019	Ireland, UK, Germany, Finland, Latvia	http://cordis.europa.eu/project/rcn/196841_en.html	To demonstrate how local small-scale energy storage, optimised with advanced ICT (i.e., a cloud hosted aggregation platform to allow consumer engagement through development of apps and Internet of Things), could bring benefits to market participants throughout the EU. Smart Electric Thermal Storage (SETS) will be deployed, but the analysis will also consider other storage technologies and energy vectors, including integration with district heating and micro-generation.

Closing the Gaps in the Cross-energy Carrier System

use case	*technology*	*marketplace*	*adoption*	*comments*
Power-to-Gas Conversion Chain	Develop low-cost electrolysers dealing efficiently with fluctuating input power.	Which are the first markets for flexible electrolysers?	Where is flexible operation of electroly-sers acceptable for operators today?	First market-ready applications might be in the off-grid, island grid and UPS sector.
	Which methanation route is most promising, chemical or biological?	How do chemical and biological methanation compare with regard to costs and prospective cost decrease and synergies?	Which carbon-dioxide sources can be made available for P2G quickly?	The biological route is more robust with regard to purity of hydrogen, but less developed at this stage.
	Develop efficient low-cost methanation units.	Which market and regulation framework can effectively prevent greenwashing of heavy climate polluters and other non-stainable application of P2G at different stages of the technology deployment?	Which early adopters might pave the way for methanation units which will not needed and not be cost-effective in the short-term, but will be crucuial in the long-term?	A non-sustainable application of P2G would be for instance greenwashing of lignite power stations by using the exhaust carbon dioxide for producing synthetic methane or liquid fuels which are then considered as green or renewable fuels.
	Redesign processes and plants, which usually operate under constrained conditions, in order to integrate P2X technologies.	Which cost-benefits can P2X technologies offer?	In which sectors will P2X technologies most likely be accepted?	
			Which regulatory or legal limitations to P2G exist and how can they	

use case	*technology*	*marketplace*	*adoption*	*comments*
			be overcome?	
Power-to-Heat Conversion Chain	Optimise heat stores: high energy density, low short and medium-term losses, high charge and discharge rates.		Validate compact electricity-grid connected heat and cold storage systems with enhanced performance.	
	How do P2H systems need to be designed to ensure that only surplus electricity is converted to heat?	Which market and regulatory framework can ensure that only surplus electricity is converted to heat?	How must P2H systems be designed to refrain users from using them as mainly or exclusively electric heating systems?	In the long-term, renewable electricity might provide also a significant part of the heat supply, because PV and wind are very area-efficient conversion technologies. However, electric heating is not sustainable as long as the major part of energy is not yet covered from renewable resources. At least until this is the case, direct renewable heat generation and heat pumps are better solutions than direct electric heating.
		Which regulatory or legal limitations to P2H exist and how can they be overcome?	How can municipalities and other players support the implementation of P2H?	
	Develop new concepts for heating supply (e.g., "Cold district heating") and interaction with electricity grid (e.g. load shifting of related heat pumps).			

Hybrid Conversion Chain Networks	Which are the most promising technologies for the implementation of hybrid networks?	What are regulatory or legal limitations to P2X and how can they be overcome?	How can municipalities and other players support the implementation of P2X?	
	Analyse potential of other municipal infrastructures (e.g. wastewater treatment plants, water networks, etc.), for synergies (e.g. for electrical load shifting).		What are best practices in cross-energy carrier synergies at European level and under which conditions have they been implemented?	
	Develop cross-energy carrier mid-scale storage projects, in particular in the P2H area.			

Relevant Projects

project title and acro-nym	*lead organisation*	*start / end date*	*countries involved*	*website*	*project scope (abstract*
Increased energy supply flexibility and efficiency by using decentralised heat pumps in CHP stations	Technical University of Denmark	January, 2007 to December, 2010	Denmark		To test a number of ideas concerning the integration of compression heat pumps in the energy system.
TILOS - Technology Innovation for the Local Scale Optimum Integration of Battery Energy Storage	Piraeus University of Applied Sciences	January, 2015 to January, 2019	Greece	www.tiloshorizon.eu	To demonstrate the optimal integration of local scale battery energy storage devices in small grids (islands) when performing multiple services. A prototype battery system will support both stand-alone and grid-connected operation, while proving its interoperability with the rest of the grid components, including demand side management aspects and distributed, residential heat storage in the form of domestic hot water.

project title and acro-nym	*lead organisation*	*start / end date*	*countries involved*	*website*	*project scope (abstract*
E-gas project	Audi	Ongoing	Germany	http://www.audi.com/com/brand/en/vorsprung_durch_technik/content/2013/10/energy-turnaround-in-the-tank.html	To develop and test a pilot prototype for the production of methane as substitution of natural gas as car fuelutilising electricity for hydrogen production and CO2 from a biogas plant.
MefCO2 project - Methanol fuel from CO2	i-deals	December, 2014 to November, 2018	Spain, Slovenia, Germany, UK, Iceland, Italy, Belgium,	http://www.spire2030.eu/mefco2/	To develop an innovative green chemical production technology which contributes significantly to the European objectives of decreasing CO_2 emissions and increasing renewable energy usage, by producing methanol from the utilisation of CO2 captured from coal power plants and hydrogen produced from electricity.

Managing Buildings as Intelligent Objects on Grids

use case	*technology*	*marketplace*	*adoption*	*comments*
Power and Heat and other Cross-Energy Carrier Management According to Inhabitants' Needs		Which business cases exist for combined power and heat management and other cross-energy carrier synergies? Which are the costs and benefits for users?	What are best practices of combined power and heat management and other cross-energy carrier synergies at European level and under which conditions have they been implemented?	Other energy carriers are notably gas and cold. Further, heat at different temperatures might be distinguished, e.g. 120 °C for sterilisation (in hospitals) and other processes, 60 °C for hot water preparation, 30 °C for room heating.
	Which are the technical limits for flexibility of energy use in buildings?	Which are the marketplace limits for flexibility of energy use in buildings?	Which are the limits for the adoption of flexibility of energy use in buildings?	Final limits might be determined by maximum deviations of temperature from set values, legislation on health and safety at work, etc.
	Which overall flexibility can be achieved by combining individual flexibilities in buildings and districts?	Which are the best market models for combining individual flexibilities into marketable packages?	How can end users profit from building and district flexibility systems?	
Optimization of Self-Generation and Power Feed-In	Which contribution can control mechanisms provide to stabilizing the grid that are based on grid frequency and voltage only without making use of further ICT?	How is the trade-off between costs of ICT and benefits derived from its use?	Which regulation schemes for self generation do best serve overall societal benefits and sustainable development?	
	Do grid codes need to be adapted for self generation? If yes, how?			

use case	*technology*	*marketplace*	*adoption*	*comments*
	Do specific ICT needs exist for self generation?			
System Service Provision to Electricity Grids Using Storage and other Flexibilities	Can the massive use of small-scale local energy storage devices (in micro and smart grids) provide ancillary services at large-scale, i.e. in primary and secondary reserve markets?	Which market solutions enable small-scale consumers (with heat appliances) to offer TSOs additional and more efficient balancing services?		
	Develop scalable P2G units for combination with biogas plants.		Under which conditions is a shift from electricity feed-in to gas feed-in favourable.	P2G-biogas plants could significantly shift electricity feed-in to gas feed-in in rural areas with high renewable generation and weak electric grids.
	How much flexibility do buildings add to the energy system at the lowest level? How does the flexibility differ for different building energy supplies?	What are possible incentives for each of the actors (building owners, administrators, contractors, tenants) to provide flexibility? What are incentives to install larger storage (to increase flexibility)?		
	How much flexibility can the building mass provide under which conditions (e.g., insulation)?		Will end-users accept if temperatures deviate slightly from their set-points and how much?	

use case	*technology*	*marketplace*	*adoption*	*comments*
Planning of optimal energy supply and components sizing	Develop tools to support planning of optimal mix and size of building energy supply and storage components. Survey more typical consumption data beyond standard profiles are needed to improve such tools.	What are business cases and operator models for building energy supply systems?	Planning of optimal energy supply and components sizing according to specific inhabitants needs.	
	How does the planning differ among (European) countries with different electricity consumption pattern, different heating supply systems, …)?	How do business cases differ among European countries (different incentives, regulations, …)?		
Saving potentials through smart automation	What data is needed where in the building/district to optimize the building energy supply?	What are the saving potentials through intelligent automation? What are break-even points for automation technology?	Will people accept sensors and actors in their apartments? Will they use Energy Management System (EMS) user interfaces appropriately?	
	What is the benefit of forecasts and improving forecasting accuracy in building energy management? How do they improve commitment to ancillary services?		How can the tenants' privacy be respected and preserved as much as possible?	

use case	*technology*	*marketplace*	*adoption*	*comments*
Interoperability of smart home and smart building platforms	How can EMS platform architectures be extended through valued-adding services (e.g., for forecasts, AAL functionality, integration of building administration, etc.)?	Can value-added services be used to make better business-cases for building EMS?	Do users accept value-adding services connected to/provided by the building administration?	How can EMS platform architectures be extended through valued-adding services (e.g., for forecasts, AAL functionality, integration of building administration, etc.)?
	How can embedded EMS architectures cope with different actors in the system and ensure priorities in controlling components and ensure data access control?			How can embedded EMS architectures cope with different actors in the system and ensure priorities in controlling components and ensure data access control?
Integration of EV in building EMS		What are business cases for integration electric vehicles (EV) charging stations in building EMS?	Would tenants accept if their EV is used for EMS flexibility through intelligent charging or even V2G?	

Relevant Projects

project title and acro-nym	*lead organisation*	*start / end date*	*countries involved*	*website*	*project scope (abstract*
SGSM- Smart Heat Networks	Salzburg AG	January, 2010 to December, 2013	Austria		To evaluate the potential of Smart Grid concepts for district heating systems in the model region of Salzburg and to investigate intelligent operation strategies and control mechanisms for the reduction of peak loads.
TILOS - Technology Innovation for the Local Scale Optimum	Piraeus University of Applied Sciences	January, 2015 to January, 2019	Greece	www.tiloshorizon.eu	To demonstrate the optimal integration of local scale battery energy storage devices in small grids (islands) when performing multiple services. A prototype battery system will support both

project title and acro-nym	lead organisation	start / end date	countries involved	website	project scope (abstract
Integration of Battery Energy Storage					stand-alone and grid-connected operation, while proving its interoperability with the rest of the grid components, including demand side management aspects and distributed, residential heat storage in the form of domestic hot water.
Resilient - REnewable, Storage and ICTs, for Low carbon Intelligent Energy maNagemenT at district level	D'Appolonia S.p.A.	Septenber, 2012 to August, 2016	Belgium, Spain, France, Italy, United Kingdom	http://www.resilient-project.eu/home	to design, develop, install and assess the energy and environmental benefits of a new integrated concept of interconnectivity between buildings, DER, grids and other networks at a district level, by combining different innovative technologies including smart ICT components, optimized energy generation (including RES) and storage technologies, all integrated to provide real-time accounts of energy demand and supply at a district level and assist in decision-making process.
Smart neighboring heat supply based on ground heat pumps	Municipality of Solrod	January, 2011 to December, 2012	Denmark		To develop and demonstrate the concept of 'neighboring heating' (i.e. heat supply to a cluster of 10-20 individual houses from a central plant) based on smart control of a heat pump in a combination with a hot water storage. where the possibilities of 'tapping' cheap electricity from the grid in periods with low electricity demand or/and high wind production are analyzed and demonstrated.
Hybrid Energy project of Ikaria: Energy Sustainable island for real life community		January, 2007 to December, 2012	Greece	http://www.ppcr.gr/Energy.aspx?C=55	To build an integrated renewable energy network on Ikaria Island (Greece), allowing renewables to become the backbone of public power supplies.
IGREENGrid IntegratinG Renewables in the EuropEaN electricity Grid	Iberdrola Distribución Eléctrica S.A.	January, 2013 to December, 2015	Austria, Germany, Greece, Spain, France, Italy	http://www.igreengrid-fp7.eu/	To produce a set of recommendations identifying most promising solutions for an appropriate integration of small and medium size variable renewable resources in distribution grids (both in medium and low-voltage networks), considering the impact of other technologies (storage, active demand, etc.).
SOPRIS - Stochastic Optimal Planning for Renewable energy sources Integration in power Systems	Eidgenössische Technische Hochschule Zürich	May, 2015 to May, 2018	Switzerland	http://cordis.europa.eu/project/rcn/189926_en.html	to provide algorithms and tools for optimal scheduling decision in power systems in the presence of uncertainty while ensuring system reliability and to develop stochastic and optimization based techniques to address the problem of unit commitment, reserve provision and energy scheduling both on the generation and the demand side, while taking the network and reliability constraints into account.
S3C	VITO	December, 2012 to December, 2015	Belgium, Germany, Italy, Portugal, Slovenia, Sweden, The Netherlands	www.s3c-project.eu	To foster 'smart' energy behaviour of households and SMEs in Europe via active user participation. Best practices are identified, which most efficiently impact the behaviour of users and can give guidance to the design of novel technical and social user-interaction schemes. Guidelines and a toolkit are developed.

Managing Industrial Areas as Intelligent Objects on Grids

use case	*technology*	*marketplace*	*adoption*	*comments*
Managing Power-Driven Heating and Cooling Systems with Respect to Grid Requirements	Validate electrochemical and other storage technologies that are connected with low voltage substations or variable distributed electricity generation.	Which market and regulatory framework is suitable for triggering large-scale exploitation of grid services provided with heating and cooling systems?	How can the transaction costs be fairly allocated?	Managing power-driven heating and cooling systems in a grid-serving manner requires, similar to demand response, very low costs compared to storage systems. However, the paradigm change that this represents leads to significant transaction costs (information and acquisition of potential operators, etc.). These costs are not covered by profits that can presently gained from flexibility.
			Under which conditions can bulk flexibility and energy efficiency in industry be made available?	Industrial loads can provide by far the largest flexibility to the electricity system.
		Which regulation and incentives are needed for exploring flexibility services from the commercial sector and industry?		E.g. supermarkets are potential actors providing flexibility to the electricity system thanks to inherent large thermal masses.
System Service Provision to Electricity Grids Using Storage	At which scale (building, city quarter, district, etc.) are which system services (balancing and reactive power, black start-up capacity, etc.) best provided from a	Which new and different electricity generation schemes, including aggregators and storage systems, should be developed in order to allow DSOs to provide ancillary services to		New characteristics loads (more capacitive and ohmic, less inductive) and distributed generation lead to new and locally varying demand for system services. Technically, they can be provided by a broad range of means at any scale of the

use case	technology	marketplace	adoption	comments
	technical point of view?	TSOs?		system. The open question is which mix of system service provision is technically adequate, economic, quickly adaptable to new generation and demand patterns, and adoptable by potential operators.
		Which business models could be attractive for all parties involved in the provision of ancillary services through small scale storage units?		
Facilitating bulk demand response	Develop appropriate ICT for comprehensive demand response at industrial sites.	Which business cases can be developed for "smart energy commercial districts" or geographically concentrated aggregations of SME?	Which are the optimum market models for demand response to make customers willing to accept alternative consumption schemes which allow different delivery patterns according to actual grid condition?	
	How can different storage technologies best be combined in order to meet a broad range of required characteristics?			
	Which margins for demand response exist in the different industrial sectors (food, paper, manufacturing	Which business cases can be developed for bulk demand response in transport (railways, trams, electrical and	Which APPs are suitable for the management of demand response in the commercial or	

use case	technology	marketplace	adoption	comments
	etc.)	conventional busses)?	transport sector?	

Relevant Projects

project title and acronym	lead organisation	start / end date	countries involved	website	project scope (abstract
ELSA - Energy Local Storage Advanced System.	BOUYGUES ENERGIES & SERVICES	April, 2015 to April, 2018	France, Germany, Ireland, Italy, UK	http://cordis.europa.eu/project/rcn/194415_en.html	To implement and demonstrate an innovative solution integrating low-cost second-life EV Li-ion batteries and other direct and indirect storage options, including heat storage, demand-side management, as well as use of intermittent RES. The project will integrate close-to-mature (TRL>=5) storage technologies and related ICT-based energy management systems for the management and control of local loads, generation and single or aggregated real or virtual storage resources, including demand response in buildings, districts and distribution grids.
SOPRIS - Stochastic Optimal Planning for Renewable energy sources Integration in power Systems	Eidgenössische Technische Hochschule Zürich	May, 2015 to May, 2018	Switzerland	http://cordis.europa.eu/project/rcn/189926_en.html	To provide algorithms and tools for optimal scheduling decision in power systems in the presence of uncertainty while ensuring system reliability: stochastic and optimization based techniques to address the problem of unit commitment, reserve provision and energy scheduling both on the generation and the demand side will be developed, while taking the network and reliability constraints into account.
INGRID - High-capacity hydrogen-based green-energy storage solutions for grid balancing	Computer science Engineering	July, 2012 to June, 2016	Italy, Spain, France, Belgium, Canada	http://www.ingridproject.eu/	To demonstrating the effective usage of safe, high-density, solid-state hydrogen storage systems for power supply and demand balancing within active power distribution grids with high penetration of intermittent distributed generation (RES in particular). The hydrogen solid-storage systems with cutting-edge ICT-based active network control technologies will be used for balancing highly variable power supply and demand. This will also allow a seamless integration among different energy carriers (electricity, gas, heating systems).
DON QUICHOTE - Demonstration of new qualitative innovative concept of hydrogen out of wind turbine electricity	HYDROGENICS EUROPE NV	October, 2012 to September, 2017	Netherlands, Belgium, Germany, Iceland, Italy	http://www.don-quichote.eu/	To demonstrate in the long-term the readiness of combining renewable electricity (wind) and hydrogen storage and the feasibility of grid balancing services using a fuel cell.
iLAND (Belgium) - (2014/2021).	DEME	From 2014 to 2021	Belgium		To construct a massive new offshore hydroelectric energy storage project to help Belgium wean itself off nuclear power by

project title and acro-nym	*lead organisation*	*start / end date*	*countries involved*	*website*	*project scope (abstract*
					2025, in order to balance fluctuations on the electricity network which are caused, amongst others, by wind parks.

Electric Vehicles as Elements of Smart Grids

use case	*technology*	*marketplace*	*adoption*	*comments*
Grid Balancing with Controlled Charging of EVs		Which are the optimum rules and incentives vs possible overloads and power quality issues promoting the possible services provided by EV charging to the grid?	Develop an understanding of consumer willingness and fear to participate to grid balancing with his own EV.	
			Which APPs linked to load balancing through EV charging flexibility are needed?	
		Can bidirectional use of EV batteries be profitable compared to EV battery use as flexible loads and other demand response?	Can bidirectional use of EV batteries be accepted by users? By which user groups?	
		Which are the adequate market mechanisms for V2G - vehicle-to-grid operation (for load shaping and ancillary services) that could provide incentives to promote optimized EV charging?		
	V2G technologies: different application schemes (position and control of the inverters, centalised vs. local control of the fleet etc.)	How impacts the V2G functionality on the market of EVs?	Can V2G be a driver to motivate the adoption of electric mobility? How can the user find his interest in this? MMI for V2G?	

use case	*technology*	*marketplace*	*adoption*	*comments*
Large-Scale EV Charging Stations	Which novel control techniques in charging technologies (smart EV charging management) can be developed in order to optimise the integration of volatile power from renewable sources by aggregating the EV power demand?	Can EV charging stations become a business? Within which market framework? Deploy common standards in use and billing of EV charging.	How impacts the availability of large-scale EV charging stations on the dynamics of electric mobility adoption?	
		Business models for large-scale EV charging stations: who pays for the infrastructure ? Who pays for the supply network and the network integration?	How develops urban mobility (public-private) in presence of large-scale EV charging station deployment?	
		Regulatory aspects of large-scale EV charging stations: DSO model, single supplier model? Open market model?		
Second Life EV Batteries for Grid Management	How much additional control do second-life batteries need?	Are the costs of additional control and risk of failure balanced by the lower cost of second-life batteries?	Is the higher risk of failure of second-life batteries acceptable for users?	
	Develop pilot vehicle second-life EV battery storage programs, ag-gregating multiple used batteries to develop a bulk, commercial-scale energy storage system.	How can cost competitiveness of second life EV batteries with conventional technologies be achieved?	Which opportunities exist for a second life market for batteries as an incentive for the adoption of EVs?	

use case	*technology*	*marketplace*	*adoption*	*comments*
	Which is the optimum size and location in the LV network of a BESS (Battery Energy Storage System) based on second life EV batteries for the provision of grid services, such as for instance peak shaving and upgrade deferral?	Carry out more than one ancillary service with any particular BESS based on second life EV batteries.	Use of second EV life type batteries for home application (in conjunction to PV panels).	
	Testing second life EV batteries for local stationary use and definition of performance criteria.			

Relevant Projects

project title and acro-nym	*lead organisation*	*start / end date*	*countries involved*	*website*	*project scope (abstract*
COTEVOS - Developing Capacities for Interoperability Assessment	Tecnalia	September, 2013 to February, 2016	Spain, Italy, Austria, Denmark, Germany, Slovenia, The Netherlands, Poland	http://cotevos.eu/the-project/	To establish the optimal structure and capacities to test the conformance, interoperability and performance of all systems comprising the infrastructure for Electrical Vehicles (EV) charg-ing, to verify the functionalities that different systems require to manage EV charging including the associated smart grid infrastructure and to assess new systems and applications for the electricity grid in order to allow grid operators to host a larger penetration of EVs within their management procedures.
MERGE Mobile Energy Resources in Grids of Electricity	PUBLIC POWER CORPORATION	January, 2010 to December 2011	Greece, Portugal, UK, Germany, Spain, Belgium, Ireland, Norway	http://www.ev-merge.eu/	To evaluate the impacts that EVs may have on the European electric grids from the perspective of planning, operation and market design and to address concepts such as EV control and aggregation as VPP (virtual power plants) i.e. EV batteries as decentralized storage devices (V2G applications).

project title and acro-nym	*lead organisation*	*start / end date*	*countries involved*	*website*	*project scope (abstract*
Green eMotion	Siemens	March 2011 to February 2015	Germany, Denmark, Spain, France, Italy, UK, Greece, Hungary, Ireland, Sweden	http://www.greenemotion-project.eu/	To propose standardised, interoperable electro-mobility solutions to allow convenient travel with electric vehicles (EV) throughout Europe and to specify a pan-European ICT architecture which ensures the involvement of all market participants and which allows open and convenient access for EV drivers to the charging infrastructure.
ELSA - Energy Local Storage Advanced System.	BOUYGUES ENERGIES & SERVICES	April, 2015 to April, 2018	France, Germany, Ireland, Italy, UK	http://cordis.europa.eu/project/rcn/194415_en.html	To implement and demonstrate an innovative solution integrating low-cost second-life EV Li-ion batteries and other direct and indirect storage options, including heat storage, demand-side management, as well as use of intermittent RES. The project will integrate close-to-mature (TRL>=5) storage technologies and related ICT-based energy management systems for the management and control of local loads, generation and single or aggregated real or virtual storage resources, including demand response in buildings, districts and distribution grids.

ERA-Net SG+ funding partners

ERA-Net Smart Grids Plus will be supported by funding from the European Union's Horizon 2020 research and innovation programme.