



# Minutes of stakeholder debates (lessons learned) for nine knowledge sharing workshops

*Contract ENER C2/2014-642 / S12.698798*

*"Support to R&D strategy in the area of SET Plan activities in  
smart grids and energy storage"*

*Deliverable D4.1*

*by*

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# 1 Introduction

## 1.1 Objectives of knowledge sharing

With the Grid+Storage service contract, knowledge sharing activities are gathered into work package 4 (WP4) "Extracting good practice and support knowledge transfer". The objectives of WP4 are:

- To extract good practices gained in pilots and demonstration activities,
- To support knowledge transfer from these projects to energy network operators, storage players and any other interested stakeholders.

To these objectives, knowledge sharing workshops are organised to emphasise the potential scaling and replication of the experimental or simulation results obtained during the RTD&D projects, and to protect intellectual property rights (IPR) by involving industry in the description of the project results in the existing Knowledge Sharing Platform (KSP) [GridInnovation-online](http://www.gridinnovation-online.eu)<sup>1</sup>.

## 1.2 Organisation of knowledge sharing workshops

### 1.2.1 Regional approach

The initial approach adopted by Grid+Storage consisted in organising nine physical workshops per area of network operator activities (the "clusters" of the existing EEGI roadmap) with a specific focus on energy storage.

In August 2015, it was decided by the Grid+Storage consortium and approved by DG ENER to change this approach per cluster into a regional approach (workshops organised per group of Member States), with the objective of stimulating the participation from local or national projects rather than focusing on European projects.

The workshops are organised according to the schedule presented in Table 1 below.

*Table 1 – Planning for the nine regional first knowledge sharing workshops*

<b>Workshop nr.</b>	<b>Member States</b>	<b>Location</b>	<b>Date</b>
1	Belgium, France, Luxemburg, the Netherlands	Lille (France)	25-26 November 2015
2	Estonia, Latvia, Lithuania	Riga (Latvia)	12-13 January 2016
3	Denmark, Norway, Sweden, Finland	Helsinki (Finland)	26-27 January 2016
4	Bulgaria, Cyprus, Greece, Romania	Athens (Greece)	9 February 2016
5	Portugal, Spain	Madrid (Spain)	15-16 February 2016
6	Austria, Hungary, Slovakia, Czech Republic	Vienna (Austria)	24-25 February 2016
7	Croatia, Italy, Malta, Slovenia, Switzerland	Rome (Italy)	29 February – 1 March 2016
8	Germany, Poland	Munich (Germany)	9-10 March 2016
9	Ireland, UK	London (UK)	15 March 2016

<sup>1</sup> See <http://www.gridinnovation-on-line.eu/>.

The Grid+Storage workshops are organised in cooperation with the [ERA-Net Smart Grids Plus](#) initiative<sup>2</sup> in order to stimulate the participation of local stakeholders.

### 1.2.2 Programme of the knowledge sharing workshops

The nine workshops are held over between one and two days according to the agenda below (adjusted depending on logistical constraints and number of projects presented):

#### **DAY 1**

##### **Morning (9-13:00)**

- Introduction about the new SET Plan organisation
- Introduction about the future integrated R&I activities on Grid + Storage
- Regional Project # 1
- Regional Project # 2
- First round table about lessons learned by the attendees from the projects

##### **Lunch break (13-14:00)**

##### **Afternoon (14-17:00)**

- Presentation of the road-mapping process and the Knowledge Sharing Platform (TECHNOFI)
- Preparing the deployment of innovative solutions with ERA-Net Smart Grids Plus
- Regional Project # 3
- Regional Project # 4
- Second round table about lessons learned by the attendees from the projects

##### **Networking dinner**

#### **DAY 2**

##### **Morning (8:30-11:00)**

- Regional Project # 5
- Regional Project # 6
- Third round table about lessons learnt by the attendees from the projects

##### **Wrap up of the workshop (11:30-13:00)**

- Final round table animated by TECHNOFI with participation of projects representatives and members of EASE, EDSO for Smart Grids and ENTSO-E
  - Impacts of the new knowledge presented by the six projects onto the Grid and Storage roadmap
  - Recommendations for future R&I activities and regional investments about grid and energy storage solutions
  - Options for the tentative deployment plans of the described solutions and barriers to be overcome according to the ERA-Net Smart Grids Plus approach

##### **Lunch break (13-14:00)**

##### **Afternoon**

- Potential demo visit if feasible
- Projects prepare their labelling in direct with ERA-Net Smart Grids Plus and TECHNOFI

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<sup>2</sup> See <http://www.eranet-smartgridsplus.eu/>.

### 1.3 Structure of this report

For each of the nine knowledge sharing workshops, this report gathers the following information:

- List of projects presented, including the link to the slides displayed at the workshop;
- Participants in the different roundtables;
- List of attendees<sup>3</sup>;
- Minutes of the roundtables dedicated to the projects presented, with the main questions raised and topics of discussion;
- Summary of the lessons learned from the workshop (last roundtable).

## 2 Workshop 1 (Belgium, France, The Netherlands)

The first workshop was held in Lille (France) on the 25<sup>th</sup> and 26<sup>th</sup> of November, 2015. The workshop [agenda](#) is available on the [Grid+Storage website](#).

### 2.1 Projects and participants in the workshop

#### 2.1.1 R&I Projects presented

Six R&I projects were presented during the first workshop, as displayed in Table 2 below.

*Table 2 – Projects presented at the first knowledge sharing workshop*

<b>Project</b>	<b>Country</b>	<b>Purpose</b>	<b>Speaker</b>	<b>Link to presentation</b>
<b>LINEAR</b>	Belgium	Large-scale residential demand response project with 250 families in Flanders. The families have washing machines, dishwashers, tumble dryers, electric boilers, EV's and heat pumps. Dynamic pricing, portfolio balancing, voltage control are tested.	Pieter Vingerhoets, Project coordinator smart grids and ICT applications, KU Leuven / EnergyVille	<a href="#">Link</a>
<b>Pampus Project</b>	the Netherlands	Demonstration on the Pampus Island of second life usage by the DSO of used car batteries at households with solar panels.	Haike van de Vegte, Senior Consultant New Energy Technologies, DNV GL Energy	<a href="#">Link</a>

<sup>3</sup> Only the attendees having agreed to have their names listed in the minutes of the workshops are included.

<b>Smart Substation</b>	France	Innovative solutions bringing new functionalities and complete substation digitizing (electrical, mechanical, environmental data)	Thierry Buhagiar, Project coordinator, RTE	<a href="#">Link</a>
<b>GREDDOR</b>	Belgium	Addresses challenges in the management of distribution systems raised by the integration of renewable energy sources and new consumption practices, from investment decisions to real-time control.	Damien Ernst, Professor, Holder of the EDF-Luminus Chair on Smart Grids, Université de Liège	<a href="#">Link</a>
<b>VENTEEA</b>	France	Improve the hosting capacity for renewable energies on the medium voltage network	Didier Colin, VENTEEA Project Manager, ErDF	<a href="#">Link</a>
<b>AES Advancion Energy Storage Array</b>	the Netherlands	Commercial installation of 10 MW Li-ion batteries connected to the transmission network of TenneT NL.	Steve Corwell, AES Europe Vice President, The AES Corporation	<a href="#">Link</a>

### 2.1.2 Roundtables

Four roundtables were held during the workshop, all facilitated by Serge Galant, Chairman of Grid+Storage Steering Board. The first three were mainly devoted to questions for the representatives of the projects presented. The fourth one, gathering also representatives from EASE, EDSO for Smart Grids and ENTSO-E, aimed at summarizing the debates and extracting the lessons learned from the workshop. Table 3 below shows the participants in each roundtable.

*Table 3 – Participants in roundtables at the first knowledge sharing workshop*

Roundtable nr.	Participants
1	<ul style="list-style-type: none"> <li>Henrik Dam, Policy Officer New energy technologies and clean coal, DG ENER, European Commission</li> <li>Pieter Vingerhoets, Project coordinator smart grids and ICT applications, KU Leuven</li> <li>Haike van de Vegte, Senior Consultant New Energy Technologies, DNV GL Energy</li> <li>Eric Peirano, Grid+Storage Project Manager, TECHNOFI</li> </ul>
2	<ul style="list-style-type: none"> <li>Thierry Buhagiar, Project coordinator, RTE</li> <li>Damien Ernst, Professor, Holder of the EDF-Luminus Chair on Smart Grids, Université de Liège</li> <li>Eric Peirano, Grid+Storage Project Manager, TECHNOFI</li> </ul>

3	<ul style="list-style-type: none"> <li>• Didier Colin, VENTEEA Project Manager, ErDF</li> <li>• Steve Corwell, AES Europe Vice President, The AES Corporation</li> <li>• Eric Peirano, Grid+Storage Project Manager, TECHNOFI</li> </ul>
4	<ul style="list-style-type: none"> <li>• Maria-Laura Trifiletti, EASE</li> <li>• Steve Corwell, The AES Corporation, representing EASE</li> <li>• Victoria Gerus, EDSO for Smart Grids</li> <li>• Norela Constantinescu, ENTSO-E</li> <li>• Iva Gianinoni, RSE, representing also ERA-Net Smart Grids Plus Support Team</li> <li>• Bart Mantels, VITO / EnergyVille</li> </ul>

### 2.1.3 List of attendees

In total the workshop was attended by 36 participants, listed in Table 4 below.<sup>4</sup>

*Table 4 – Attendees in the first knowledge sharing workshop*

<b>Name</b>	<b>Company</b>
Antoine Besson	Bouygues Energies & Services
Christian-Eric Bruzek	Nexans France
Thierry Buhagiar	RTE
Claude Campion	3C Projects
Didier Colin	ErDF
Norela Constantinescu	ENTSO-E
Bertrand Cornélusse	Université de Liège
Steve Corwell	AES EUROPE / EASE
Henrik Dam	European Commission
Bart De Meyer	Eandis
Sophie Dourlens-Quaranta	TECHNOFI
Damien Ernst	Université de Liège
Bruno Francois	Ecole Centrale de Lille - L2EP
Serge Galant	Technofi
Victoria Gerus	EDSO for Smart Grids
Iva Maria Gianinoni	RSE
Victor Gomes	ENERCON GmbH
Cristina Gómez	REE
Vassilis Iliadis	AES Technologies
Bart Mantels	VITO / EnergyVille
Marcel Meeus	Sustesco bvba
Alexandre Parisot	RTE
Eric Peirano	Technofi
Benoit Robyns	Hautes Etudes d'Ingénieur
Janailson Rodrigues	SuperGrid Institute
Johan Steimes	Université Libre de Bruxelles

<sup>4</sup> Only the attendees having agreed to have their names listed in the minutes of the workshops are included.



Marion Steward	EDF
Cédric Thoma	French Ministry of Energy
Gilles Tihon	SPF - Public Service of Wallonia
Maria Laura Trifiletti	EASE
Ruud Van de Meeberg	Enexis BV
Haike Van de Vegte	DNV GL Energy
Gérald Vignal	RTE
Pieter Vingerhoets	ENERGYVILLE - KU Leuven
Conor Wilson	Gaelectric Energy Storage

## 2.2 Minutes of the debates

### 2.2.1 Roundtable 1

#### Questions about the Grid+Storage process to Eric Peirano (TECHNOFI)

- The change in approach between the existing EEGI roadmap and the upcoming Grid+Storage integrated R&I roadmap (RIR) was questioned. It was made clear that the main change is the focus on R&I activities relative to energy storage integration in the power system. An additional change will be the structure of the RIR which should improve readability.
- A question was raised about how to address dissent between stakeholders during the consultations process. The example of micro-grids was taken to illustrate diverging views amongst the smart grids and energy storage community. It is also the role of monitoring and knowledge sharing to provide experience feedback about each type of approaches and technologies. No option shall be discarded for R&I activities except if it has been proven that it is not promising. The project's partners have proposed a dissent management methodology (Deliverable 1.1).
- Clarification was requested since the Grid+Storage contract is supposed not to address batteries. It was made clear that Grid+Storage addresses the integration to the grid of all types of energy storage solutions (including batteries and also power to gas technologies which allow to connect gas and electricity networks); but it does not address R&I activities about battery (or power to gas) technologies such as new materials to improve performances (efficiency, ageing, etc.).
- About the knowledge sharing platform (KSP), it was asked whether data sets could be uploaded to it. It was answered that even though the KSP has not been designed to that purpose, this could be possible. It is currently under discussion in the framework of the eHighway2050 project for a data base relative to transmission technologies (cost and performances).

#### Questions to Henrik Dam (EC, DG ENER)

- It was asked whether grid operators would be allowed to operate energy storage facilities in the future. Henrik Dam said that the matter is being considered by the European Commission in the context of the energy market design consultation and the proposals for the revision of the Third Energy Package expected by Dec. 2016. In his opinion, the probable scheme would be that grid operators buy services to energy storage operators. For some specific purposes (for instance black-start capabilities), allowing TSOS/DSOs to own the energy storage assets has yet to be decided yet.

- The need for research about regulation to reach the objective of a single energy market covering the 28 Member States (MS) was pointed out. Henrik Dam replied that this is an ongoing process: for instance, MS have to share their development plans; a regional approach to balancing is currently under discussion. In general, R&I projects could challenge existing regulations. For example, in some demonstration projects, DSOs are owning storage assets. The only regulations which cannot be disregarded are the safety regulations.
- Another question was raised about the standards for manufacturers.

**Questions to Haike van de Vegte (DNV GL Energy) about the Pampus project**

- With the main difference between centralised and decentralised storage being the maintenance costs, it was asked if maintenance costs have been evaluated for the Pampus project; and if these costs are increased because of the second-life use of batteries. More generally, life cycle costs of batteries have to be assessed.
- The status of primary reserve granularity was raised (between 15 and 60 minutes).
- The replicability of the Pampus project was questioned. Is it limited by the supply of second-life batteries? Haike van de Vegte replied that the fleet of electric vehicles (EV) is growing fast. The market for batteries from cars that can be used for second life application shall become serious in 2020 in DNV GL's predictions. In addition, second-life batteries are one of the solutions amongst other storage technologies (including new batteries).
- What about the security aspects of the battery? It is built in containers and a safety protocol developed in the STALLION project<sup>5</sup> is applied.
- The battery management system (BMS) needed to address different types of batteries, with different ages, was discussed.
- How to ensure the capacity of batteries was questioned.
- The issue of the ownership of second-life batteries was raised. In principle the car manufacturer is responsible for recycling the batteries. This legal responsibility can be transferred for a demo project.

**Questions to Pieter Vingerhoets (KU Leuven) about the LINEAR project**

- Recommendations about regulation were discussed.
- It was asked whether specific R&I activities about demand response (DR) in large industries would be included in the roadmap, complementing residential DR.
- How storage for hot water tanks can be taken into account was discussed. The RealValue project (Ireland) was mentioned.
- The need for automated activation of DR was pointed out, because consumers on the long run cannot realistically be active in a manual manner.
- The motivation of consumers to participate in DR out of a demonstration project was questioned. Pieter Vingerhoets said that 3 main motivations exist: 1) enthusiastic to help; 2) comfort; and 3) money: but for the moment the business case is not here; cost of smart appliances need to decrease.
- The competition between energy efficiency and active consumption was discussed: the more the devices are energy-efficient, the less there is an interest in demand response. More generally, market-based solutions vs. obligations for DR were discussed.
- It was asked whether residential DR could participate in voltage control in Europe. Pieter Vingerhoets answered positively but said that it would not be the main driver.

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<sup>5</sup> "Safety Testing Approaches for Large Lithium Ion battery systems".

### 2.2.2 Roundtable 2

#### **Questions to Thierry Buhagiar (RTE) about the smart substation project and to Damien Ernst (Université de Liège) about the GREDOR project**

- A question was raised on the possible roll out of smart substations both at the TSO and DSO levels, and more especially how to use the RTE concept in the GREDOR approach for DSOs? Damien Ernst said that the historical split between TSOs (well monitored and controlled part of the system) and DSOs (part of the system with less monitoring and control capabilities) was not valid anymore, because today we need the DSOs to be equipped with smart substations. Thierry Buhagiar pointed out that many issues needed to be solved before the complete roll out of smart substations in the network: first the level of decentralised control (functions which are completely automated versus functions which remain in the hands of the operators) and the control of the system seen from the TSO (how the different automated systems could interact and generate dynamics that the operators cannot handle). If such issues can be solved, the next challenge would be to share data and have a common model since the TSOs could need to communicate with distributed power generation and large pools of consumers through DSOs: a real-time communication system would need to be created.
- Questions were raised on the profitability of the wide roll out of storage devices in distribution networks. According to Damien Ernst, storage investments would make the distribution system more efficient by avoiding too sophisticated solutions and reinforcement.
- Discussions focussed on the overall profitability of storage in the power system. Many remarks were made arguing that, except for the projects advertised by some companies such as AES, it is still difficult to find profitable applications, except when addressing multiservice applications as recommended by some players. It was pointed out that pumped hydro storage (PHS) in Germany is no longer profitable since the daily market spread has decreased because of PV production. Some attendees pointed out that beyond the perspective offered by integrators such as AES, the domestic battery marketed by Tesla (power wall) should also change the storage market: PV systems with batteries should be competitive shortly. This point opened the debate for the costs that should be charged by network operators in the case of a wide roll out of self-consumption schemes.

### 2.2.3 Roundtable 3

#### **Questions to Didier Colin (ErDF) about the VENTEEA project and to Steve Corwell (AES Europe) about the AES project**

- TSOs and DSOs should seek for the lowest cost for society of storage solutions compared to grid upgrade; it was asked how far we are today (in years or in euros) from this minimal cost. Didier Colin said that such study has been done: there is no advantage for storage except for some cases in substations for multiservice applications (in general for a few hours, and in urban areas). In addition, TSOs/DSOs shall call upon the market to provide services. Steve Corwell (SC) said however, that regulators base their decisions upon cost-benefit analyses (CBA): if storage is cheaper, regulators will allow it.

- Following several questions regarding the profitability of the AES systems, Steve Corwell replied that the company had found at least three business applications: PCR (primary control reserves), replacement reserves (in lieu of power plant derates) and longer duration flexible peaking. SC pointed out that the company is investigating other applications that are now competitive and will become even more so since the cost of batteries should continue to decrease in the coming years due to a significant increase of the manufacturing capacities in the world to meet EV demand. SC explained that AES has developed an integration approach which allows the scaling (up and down) of the systems to accommodate various grid needs and with different batteries and battery providers.
- About the real electrical efficiency of the batteries, Didier Colin said that it was difficult to assess, since it depends on the services provided (ErDF promotes a multiservice business model). Steve Corwell added that there are some issues about the building codes (isolation is mandatory in buildings hosting the batteries while cooling is necessary for the batteries to maintain their performances in time).
- The comparison between batteries and power-to-gas solutions was discussed. It was explained that these two technologies provide different services to the power system at different scales. Power to gas are conversion technologies (from electricity to gas) which allow to store electricity in the form of chemical energy which in turn is easy to store in large quantities (natural gas network). This gas can be used for heating (connection with heating networks), electricity generation in gas turbines, in industry, in the transport sector for instance. Batteries are used for electricity to electricity applications.
- A comment was made regarding the fast penetration of power electronics on the network which could cause stability problems (frequency control for instance) following a discussion on the possible large scale deployment of batteries in the power system.

## 2.3 Lessons learned from the workshop

These lessons and recommendations have been discussed and agreed upon during the 4<sup>th</sup> roundtable.

### 2.3.1 Impacts of the new knowledge presented by the six projects onto the GRID+STORAGE roadmap

The projects presented covered a large range of maturity levels for network operators, from TRL 5 for some applications to TRL 9 for some others.

Storage as a flexibility option will impact the following TSO and DSO clusters in the roadmap:

- Planning,
- Operations,
- Asset management,
- Market design.

### 2.3.2 Recommendations for future R&I activities and regional investments about grid and energy storage solutions

One first recommendation is that “clean” large scale demonstrations are needed, involving cost-benefit analyses and life cycle assessments. Such demonstrations should involve regulatory bodies and address small scale dispersed storage functionalities.

At DSO level, there is a clear need for support tools for decision making on flexibility management.

### 2.3.3 Options for the tentative deployment plans of the described solutions and barriers to be overcome

The following topics need to be addressed in the future roadmap:

1. Regulatory harmonisation on storage,
2. Knowledge sharing on demonstrations,
3. Business good practices (from product specification to competitive procurement) to turn energy storage and other demonstration technologies into viable business activities,
4. Valuation of storage as a multi-service solution,
5. Ownership of storage,
6. Standardisation of grid connected energy storage,
7. Clean CBA including LCA approaches,
8. Taxes and fees that puts pressure on the real value of energy storage solutions.

### 2.4 Projects willing to join the Knowledge Sharing Platform

The following stakeholders have expressed willingness to join the knowledge sharing platform [GridInnovation-online](#).

- CAES (Ireland),
- Université Libre de Bruxelles,
- Université de Liège for the GREDOR project,
- AES energy storage arrays,
- EnergyVille for the LINEAR project (with updated results).

## 3 Workshop 2 (Estonia, Latvia, Lithuania)

The second workshop was held in Riga (Latvia) on the 12<sup>th</sup> and 13<sup>th</sup> of January, 2016. The workshop [agenda](#) is available on the [Grid+Storage website](#).

### 3.1 Projects and participants in the workshop

#### 3.1.1 R&I projects presented

Seven R&I projects were presented during the first workshop, as displayed in Table 5 below.

*Table 5 – Projects presented at the first knowledge sharing workshop*

Project	Country	Purpose	Speaker	Link to presentation
<b>DSM Platform for Optimal Energy Management Strategies Development</b>	Latvia	Experimental rational use of energy with aim to demonstrate and simulate the potential of smart meters and home area network automation implementation and their interoperability with energy management strategies	Artjoms Obushevs, Researcher, Institute of Physical Energetics	Link

<b>Energy Storage Application in Urban Electric Transport</b>	Latvia	Recuperation of tramway braking energy by equipping substations with reversible rectifiers and installing energy storage devices	Linards Grigans, Researcher, Institute of Physical Energetic	<a href="#">Link</a>
<b>Smart Energy Management System with Energy Storages</b>	Estonia	Overview of two different pilot systems in Tallinn University of Technology: 1. Smart Energy systems - AC/DC Link Based Microgrid System for Research and Study Purposes, and 2. Load Management System – Day-Ahead Electricity Price Based Energy Management System	Argo Rosin, Senior Research Scientist / Vice-Dean for Research, Department of Electrical Engineering / Faculty of Power Engineering, Tallinn University of Technology	<a href="#">Link</a>
<b>Development of a Li-Ion Energy Storage System for Electrical Microgrids</b>	Estonia	Design and construction of a 150 kW Li-Ion energy storage system (ESS) prototype; development of control algorithms and methodology	Tarmo Korõtko, PhD student, Department of Electrical Engineering, Tallinn University of Technology	<a href="#">Link</a>
<b>Smart Electric Thermal Storage (RealValue project)</b>	Latvia	Deployment of Smart Electric Thermal Storage (SETS) at 50 locations in Latvia (homes and commercial buildings); cost-benefit analysis and business plan development	Zane Broka, PhD student, Riga Technical University	<a href="#">Link</a>
<b>Large-Scale Electrical Energy Storage Potential in the Baltic States</b>	Latvia	Analysis of the potential demand for energy storage in the Baltic States; large- and small-scale technologies comparison	Karlis Baltputnis, PhD student, Riga Technical University	<a href="#">Link</a>

<b>Estfeed data sharing platform</b>	Estonia	Software platform capable to integrate many data sources and to provide appropriate services to convert these data into valuable information for energy flexibility management, energy efficiency, audit and benchmarking	Kalle Kukk, Strategy Manager, Elering	Link
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### 3.1.2 Roundtables

Four roundtables were held during the workshop. The first three were mainly devoted to questions for the Speakers and interactions with the audience about the lessons learnt by the projects and the new knowledge needs to better integrate energy storage into the electricity system. The fourth roundtable, gathering also representatives from the ERA-Net Smart Grids Plus support team, EASE and ENTSO-E, aimed at measuring the impacts of the new knowledge presented by the seven projects onto the Grid and Storage roadmap and summarizing the recommendations for future R&I activities and regional investments about grid and energy storage solutions.. Table 6 below shows the participants in each roundtable.

*Table 6 – Participants in roundtables at the first knowledge sharing workshop*

<b>Roundtable nr.</b>	<b>Participants</b>
1	<ul style="list-style-type: none"> <li>• Artjoms Obushevs, Institute of Physical Energetics</li> <li>• Linards Grigans, Institute of Physical Energetic</li> <li>• Eric Peirano, TECHNOFI (moderator)</li> </ul>
2	<ul style="list-style-type: none"> <li>• Argo Rosin, Tallinn University of Technology</li> <li>• Tarmo Korõtko, Tallinn University of Technology</li> <li>• Eric Peirano, TECHNOFI (moderator)</li> </ul>
3	<ul style="list-style-type: none"> <li>• Zane Broka, Riga Technical University</li> <li>• Karlis Baltputnis, Riga Technical University</li> <li>• Kalle Kukk, Elering</li> <li>• Eric Peirano, TECHNOFI (moderator)</li> </ul>
4	<ul style="list-style-type: none"> <li>• Zane Broka, Riga Technical University</li> <li>• Karlis Baltputnis, Riga Technical University</li> <li>• Kalle Kukk, Strategy Manager, Elering</li> <li>• Norela Constantinescu, ENTSO-E</li> <li>• Allan Schrøder Pedersen, EASE</li> <li>• Eric Peirano, TECHNOFI (moderator)</li> </ul>

### 3.1.3 List of attendees

In total the workshop was attended by 40 participants, listed in Table 7 below. <sup>6</sup>

*Table 7 – Attendees in the second knowledge sharing workshop*

<b>Name</b>	<b>Company</b>
Triin Aavik	Eesti Energia As
Ott Antsmaa	Elektrilevi OÜ
Karlis Baltputnis	Riga Technical University
Viesturs Brazis	Riga Technical University
Zane Broka	Riga Technical University
Jānis Černovs	AS "Sadales tīkls"
Vladimir Chuvychin	Riga Technical University
Norela Constantinescu	ENTSO-E
Laimonas Dapsys	Modus Energija
Sophie Dourlens Quaranta	TECHNOFI
Dainis Dravnieks	Ministry of Economics
Juris Flugins	AS "Sadales tīkls"
Helena Geissler	B.A.U.M. Consult
Juris Golunovs	Riga Energy Agency
Larisa Grackova	Institute of Physical Energetics
Ervins Grebesh	Institute of Physical Energetics
Linards Grigans	Institute of Physical Energetics
Ivo Grinbergs	AS "Sadales tīkls"
Polina Ivanova	AS Latvernergo
Leo Jansons	WEC LMC
Tarmo Korõtko	Tallinn University of Technology
Kalle Kukk	Elering AS
Olegs Linkevics	Latvernergo
Bart Mantels	VITO / EnergyVille
Anna Mutule	Institute of Physical Energetics
Artjoms Obusevs	Institute of Physical Energetics
Irina Oleinikova	Institute of Physical Energetics
Eric Peirano	TECHNOFI
Andrejs Roscins	Energokomplecss
Argo Rosin	Tallinn University of Technology
Ivars Rozenštrauhs	AS "Sadales tīkls"
Allan Schroeder Pedersen	Technical University of Denmark
Antanas Sauhats	Riga Technical University
Gunta Šlihta	IPE
Girt Stana	Riga Technical University

<sup>6</sup> Only the attendees having agreed to have their names listed in the minutes of the workshops are included.



Diana Zalostiba	Riga Technical University
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## 3.2 Minutes of the debates

### 3.2.1 Roundtable 1

#### **Questions about the Grid+Storage process to Eric Peirano (Technofi)**

- Following a question raised by an attendee, it was made clear that all types of energy storage technologies are considered in the roadmap (not only electrochemical storage). The focus indeed is on the integration of energy storage to the grid whatever the storage technologies are.
- It was also asked whether power plants capable to adapt their running regime to market conditions could be considered as energy storage. It was made clear that this shall be considered as a flexibility source, but this is not the main focus of the roadmap.

#### **Questions to Artjoms Obushevs (Institute of Physical Energetics) about the DSM Platform**

- The relation between DSM profitability and sufficient market price differentials was discussed, as well as automated activation of DSM versus active (manual) participation of consumers.
- Disconnection of load in case of high market prices was considered: it should be done locally and not at substation level.
- The concrete impacts of DSM in Latvia were discussed. For the moment, such impacts are difficult to assess: Latvia's consumption being quite low it is difficult to find a business case for DSM and only consumers with a yearly consumption higher than 2,500 kWh could provide DSM. However, the development of the Internet of Things (IoT) and consequently the decrease in the price of technologies to connect e.g. home appliances should foster the deployment of DSM. In addition, by 2023, 100% of Latvian consumers will be equipped with a smart meter and will have access to real-time consumption data. The participants agreed that DSM for industrial consumers should be addressed first.
- Combination of DSM, storage and auto-consumption was discussed: still, in Latvia, PV is not booming because prices of PV systems remain too high which make it difficult to find a business case for auto-consumption

#### **Questions to Linards Grigans (Institute of Physical Energetic) about Energy Storage Application in Urban Electric Transport**

- Benefits of the recuperation of tramway braking energy were highlighted not only for efficient operation purposes but also because it limits the need for building new substations when extending the tramway network.
- The replication value of the proposed solution was discussed and collaboration with other cities was suggested. So far only a tens of cities in Europe are equipped with such solution in urban electric transport, and some projects exist for railway.
- Storing the braking energy in the substation connecting the DSO and the tramway electric network (with a dedicated storage device such as batteries) and injecting it back to the distribution system may be beneficial, for instance for frequency control purposes. However, there would be some issues in terms of permitting (the system operator of the tramway electric network would be considered as a power generator), as well as in terms of power quality (harmonics) and hardware (bidirectional flows in the substation).

- Further research is needed, in particular regarding supercapacitor aging models (supercapacitors and batteries would be a suitable solution for the envisaged system services). The impact of temperature on the performance (life cycle analysis) is also a topic.

### 3.2.2 Roundtable 2

#### **Questions to Argo Rosin (Tallinn University of Technology) about Smart Energy Management System with Energy Storages**

- Profitability of storage systems with regards to price differentials was discussed. In particular, transmission costs avoided thanks to local storage should be taken into account to improve profitability.
- It was highlighted that price differentials are not sufficient to assess profitability: the whole trajectory of the spot price must be taken into account.
- It was mentioned that the increase of stochastic power generation could cause higher and more frequent spot price fluctuations. Increased stochastic power generation will also influence the power quality in the grid, which means higher demand and cost for balancing (or other ancillary) services. This could also increase the feasibility of storage systems.
- Combination of storage systems with load management systems could increase the cyclic lifetime (and feasibility) of storage devices.

#### **Questions to Tarmo Korõtko (Tallinn University of Technology) about the Development of a Li-Ion Energy Storage System for Electrical Microgrids**

- It appears that a “universal use case” (applicable to households, factories, etc.) is infeasible within today’s market conditions.
- The multiservice business model of batteries was discussed: they could be used for stabilizing power coming from RES generators but also for frequency control, fast reserve, etc. A multiservice business model (as discussed during the first workshop in Lille) would help to find a competitive business case for electrochemical storage. According to Elering, this type of storage clearly has a role to play for TSOs (new products, mFRR, etc.) and should be operated by other stakeholders.
- The use of second life batteries was identified as a promising solution to keep costs down.
- The impact on network tariffs of storage and auto-consumption deployment has been discussed, in particular for distribution network operators. New remuneration schemes for DSOs (based on capacity rather than on energy) may have to be found.

### 3.2.3 Roundtable 3

#### **Questions to Zane Broka (Riga Technical University) about Smart Electric Thermal Storage (SETS)**

- Profitability of sophisticated solutions like SETS and aggregation was questioned mainly by DSOs, compared to simple day/night signals sent to usual water boilers. It was highlighted that today, SETS are more profitable than other storage technologies. Automated activation is an important feature to guarantee the profitability.
- The role of the aggregator, and the possible impact of aggregated storage devices on congestion management were discussed (both in terms of volume and spatial distribution).
- Upscaling potential was questioned: simulation of SETS deployment with different energy scenarios is to be done both for planning and operation purposes, as well as behavioural studies.

**Questions to Karlis Baltputnis (Riga Technical University) about Storage Potential in the Baltic States**

- Modelling of weather correlation between Nordic and Baltic regions was identified as a key issue for smooth market integration.
- Suitable market incentives to develop storage were discussed. They could be similar to Feed-in-Tariffs for RES to ensure enough revenues for storage owners. Not only investment costs should be considered but also operation costs (for example efficiency of PHS is 70%: it is profitable only if price differentials are greater than 30%). To increase revenues of storage owners, price arbitrage must be complemented by provision of reserves.
- The question of central vs. decentralised accumulation was discussed: actually both would be useful and complementary.

**Questions to Kalle Kukke (Elering) about the Estfeed platform**

- Realistic deployment of DSM for households was questioned, since their consumption is considered as quite inelastic. Dynamic pricing would be a prerequisite.
- Legal issues may be raised for aggregators accessing the platform: they need to be authorized by the consumers. An important feature for the platform is to be operated by a neutral player (the TSO).

### 3.3 Lessons learned from the workshop

These lessons and recommendations have been discussed and agreed upon during the 4<sup>th</sup> roundtable.

#### 3.3.1 Impacts of the new knowledge presented by the six projects onto the GRID+STORAGE roadmap

The projects presented cover a large range of maturity levels for network operators, from TRL 4-5 for some applications to TRL 9 for some others

Storage as a flexibility option will impact the following TSO and DSO clusters in the roadmap:

- Operations,
- Asset management,
- Market design.

#### 3.3.2 Recommendations for future R&I activities and regional investments about grid and energy storage solutions

The following R&I activities must be considered in the roadmap:

- Business model for storage with multiple services;
- Second-hand automotive battery for stationary applications;
- Storage in transport electricity network located in substations to provide system services to DSOs;
- Home area network monitoring and control as a mean to promote DSM (price of automation and control expected to strongly decrease);
- Use of automated local thermal energy storage devices (consumer level) by aggregators so as to provide system services for network operators;
- Design market incentives together with taxes and fees for the integration of medium to large-scale storage (price signals);
- Dynamic price signals as a mean to stimulate demand response;
- Network reinforcement (interconnections) as a way to ease market integration

### 3.3.3 Options for the tentative deployment plans of the described solutions and barriers to be overcome

The following topics need to be addressed in the future roadmap:

- Open source software and open hardware;
- Interdependence of gas and electricity networks, i.e. for heating (not only heat networks but also decentralised Power-to-Heat devices);
- Services provided by DSM and storage to not only to DSOs but also TSOs;
- Data sharing and availability, use of ICT tools

### 3.4 Projects willing to join the Knowledge Sharing Platform

The following stakeholders have expressed willingness to join the knowledge sharing platform [GridInnovation-online](#).

- Estfeed project (Estonia).

## 4 Workshop 3 (Denmark, Norway, Sweden, Finland)

The third workshop was held in Helsinki (Finland) on the 26th and 27th of January, 2016. The workshop [agenda](#) is available on the [Grid+Storage website](#).

### 4.1 Projects and participants in the workshop

#### 4.1.1 R&I projects presented

Six R&I projects were presented during the third workshop, as displayed in Table 8 below.

*Table 8 – Projects presented at the third knowledge sharing workshop*

Project	Country	Purpose	Speaker	Link to presentation
<b>Smart Integrated Energy Storage</b>	Sweden	Present the EnergyHub solution, a patented, market ready, 4-quadrant inverter for PV, storage, small scale wind and EV charging which adds value through a cloud business platform enabling savings.	Björn Jernström, CEO, Ferroamp	Link
<b>Helen Ltd 1 MW storage in the Kalasatama-area</b>	Finland	Present a large BESS system for network applications (primary / secondary frequency regulation, peak power shaving and voltage support).	Janne Huvilinna, Smat Grid Team, Helen Ltd	Link

<b>Power-to-Gas via Biological Catalysis (P2G-BioCat)</b>	Denmark	Present the BioCat power2gas pilot based upon an alkaline electrolysis and a biological methanation.	Markus Forstmeier, VP Business Development, Electrochaea	Link
<b>Energy Storage – Storage related grid integration work in national projects in Finland</b>	Finland	A presentation by VTT about the main nationally-funded smart-grid projects in Finland with a storage integration component.	Hannele Holttinen, Principal Scientist, VTT	Link
<b>Large battery systems to stabilize frequency output from wind farms and for provision of primary reserve power</b>	Denmark	Feedback from Vestas on field experience with storage to provide primary reserve for wind power farms.	Rasmus Lærke, Plant Control Systems Manager, Vestas.	Link
<b>Large scale balancing from Norwegian hydropower</b>	Norway	Explain to the audience the large-scale balancing opportunities offered by the Norwegian hydropower energy storage facilities.	Atle Harby, CEDREN Director, SINTEF Energy Research	Link

#### 4.1.2 Roundtables

The first three roundtables were mainly devoted to questions for the representatives of the presented projects. The fourth one, gathering also representatives from EASE and EDSO aimed at summarizing the debates and analysing the impacts of the six presented projects onto the R&I topics to be selected in the integrated roadmap.

Table 9 below shows the participants in each roundtable.

*Table 9 – Participants in roundtables at the third knowledge sharing workshop*

Roundtable nr.	Participants
1	<ul style="list-style-type: none"> <li>• Björn Jernström, CEO, Ferroamp</li> <li>• Janne Huvilinna, Smat Grid Team, Helen Ltd</li> <li>• Eric Peirano, Project Manager of Grid+Storage, TECHNOFI</li> </ul>
2	<ul style="list-style-type: none"> <li>• Markus Forstmeier, VP Business Development, Electrochaea</li> <li>• Hannele Holttinen, Principal Scientist, VTT</li> </ul>

	<ul style="list-style-type: none"> <li>Rasmus Lærke, Plant Control Systems Manager, Vestas</li> <li>Eric Peirano, Project Manager of Grid+Storage, TECHNOFI</li> </ul>
3	<ul style="list-style-type: none"> <li>Atle Harby, CEDREN Director, SINTEF Energy Research</li> <li>Eric Peirano, Project Manager of Grid+Storage, TECHNOFI</li> </ul>
4	<ul style="list-style-type: none"> <li>All participants (plenary discussion)</li> <li>Eric Peirano, Project Manager of Grid+Storage, TECHNOFI</li> </ul>

#### 4.1.3 List of attendees

In total, the workshop was attended by 37 participants, listed in Table 10 – below.<sup>7</sup>

*Table 10 – Attendees in the third knowledge sharing workshop*

NAME	COMPANY
Satu Paiho	VTT Ltd
Eric Peirano	TECHNOFI
Daniel Hernández Maldonado	TECHNOFI
Janne Huvilinna	Helen Ltd.
Bart Mantels	VITO / EnergyVille
Rasmus Laerke	Vestas Wind Systems
Teija Laitinen	CLIC Innovation
Hannu-Pekka Hellman	Helen Electricity Network Ltd
Tomas Qvickström	Fortum Power and Heat Oy / Production Optimization and Trading
Ville Tikka	Lappeenranta University of Technology
Kari Maki	VTT
Aira Hast	Aalto University
Sirpa Repo	Elenia Oy
Olli Huotari	Empower IM
Atle Harby	SINTEF Energy Research
Sebastian Johansen	Fortum
Jukka Rinta-Luoma	University of Vaasa
Marja Englund	Fortum Oyj
Hannele Holttinen	VTT
Behnam Zakeri	Aalto University
Conor Wilson	Gaelectric Energy Storage
Michael Child	Lappeenranta University of Technology
Kauko Leiviskä	University of Oulu
Juha Ulvinen	Eaton Power Quality
Juha Kuuluvainen	Eaton Power Quality
Allan Schroeder Pedersen	Technical University of Denmark
Nosizwe Dlengezele	Hitachi Chemical Europe
Alexander von Jagwitz	B.A.U.M. Consult GmbH
Iva Maria Gianinoni	RSE
Antti Keskinen	Caruna
Björn Jernström	Ferroamp Elektronik AB
Juha Forsström	VTT

<sup>7</sup> Only the attendees having agreed to have their names listed in the minutes of the workshops are included.

Ludwig Karg	B.A.U.M.
Robert Weiss	VTT Technical Research Centre of Finland
Jussi Matilainen	Fingrid Oyj
Pekka Koponen	VTT technical Research Centre of Finland
Markus Forstmeier	Electrochaea

## 4.2 Minutes of the debates

### 4.2.1 Session 1

#### **Questions/discussions following the presentation of Björn Jernström, CEO, Ferroamp**

- The regulation relative to storage projects at LV level in Sweden (and Finland) were discussed: there are numerous limitations and Björn Jernström considered that companies must advertise the benefits of distributed storage systems, for instance the increase of grid flexibility.
- The aggregation of distributed storage to participate in frequency regulation markets was debated. Major challenges identified are relative to business plan opening opportunities for multiservice models, such as as voltage control, and data security when implementing large-scale deployment. Regarding possible revenues for storage solutions, it was argued that wind and PV power integration would increase the volatility of electricity prices in the future, thus making it more difficult to build business models on price trajectories.

#### **Questions/discussions following the presentation of Janne Huvilinna, Smat Grid Team, Helen Ltd**

- Technical performances of the Toshiba batteries were discussed (theoretical maximum number of cycles versus the investment costs). It was argued that if the lifespan of the batteries were not as specified by the vendor, it would be very difficult to find profitable business opportunities.
- Janne Huvilinna explained that the purpose of the project is to test different business opportunities for such systems, for instance primary/secondary frequency regulation, peak power shaving and voltage support. It was explained that such a system could be used in a portfolio of generation means to strengthen their bidding strategy on the market even though the most likely applications would be systems services. More generally, Helen Ltd is working on a long-term evaluation of these systems and a collaboration with DSOs is envisaged.

### 4.2.2 Roundtable 1

- During this session, business cases for (small-scale to medium scale) BESS were commented: there was a broad consensus around the multiservice business case of BESS, i.e. several applications should be combined in order to be reach profitability in competitive market conditions. Such applications should focus on the technical specificities of batteries (fast response) which call for a participation in frequency regulation. It was also pointed out that the scale of the systems and their spatial distribution in the network is a key point to optimise possible revenues.
- Investment and O&M costs fees were commented: it was suggested that a multiple owner scheme could help to enhance the integration of storage. It was suggested to put some R&D effort on BoS (including integration components) since they tend

to be as expensive as the batteries. Another way to lower investment costs could be to resort to second-life batteries: the participants stressed that a major issue is to evaluate with great accuracy the SoH (state of health). Most participants agreed to say that with the massive deployment of EVs, the price of the cells would probably drop to a price level that would make first-hand BESS profitable.

- Along with R&D activities to lower the costs of integration, the experts pointed out the need to incentivise the use of storage as it was done during the two last decades for wind and PV power. Moreover, regulations related to the ownership of such systems by regulated and market players should be rapidly clarified.

#### 4.2.3 Session 2

##### **Questions/discussions following the presentation of Markus Forstmeier, VP Business Development, Electrochaea**

- Most of the discussions were related to the technical performances of the process and the scalability: how to valorise the wasted heat (low enthalpy) imposed by the optimal working temperature for the microorganisms? Markus Forstmeier explained that one very positive aspect of this technology is the handling of hydrogen which is consumed during the electrochemical process and not stored. Maintenance and operations of such processes were questioned: the technology has indeed a very high CAPEX but the OPEX expenses should be low, which should make it a competitive power2gas technology.

##### **Questions/discussions following the presentation of Hannele Holttinen, Principal Scientist, VTT**

- Most discussions focussed on the relative value of flexibility sources (slide 4 in the presentation). Hannele Holttinen mentioned that pump hydro current prices were taken into account in the calculations. Incentives to promote storage integration were proposed based on the available models.
- The flexibility provided by the Norwegian hydro facilities was discussed. It was stressed that the necessary reinforcements of the Norwegian transmission network so as to supply the new links to Holland, Germany, Denmark and the UK start to meet public acceptance issues in Norway. Moreover, it was argued that today there is no proven profitability for demand-response (only in few particular cases for industrial customers).

##### **Questions/discussions following the presentation of Rasmus Lærke, Plant Control Systems Manager, Vestas.**

- Storage life-time issues were discussed, i.e. how the patten of the different discharging and charging cycles would affect the batteries' lifespan since the number of cycles is a critical factor for profitability and therefore business models. Vestas mentioned that they currently base their investment decisions on the lifespan specified by the manufacturers.
- Rasmus Lærke explained that wind power and storage coupling is still not profitable in Europe because of the insufficient spread.

#### 4.2.4 Roundtable 2

- The main messages were relative to regulations which should be changed to stimulate the development of BESS in the same way as it was done during the two last decades for renewables (feed-in tariffs). This would foster the creation of new



companies with innovative business models. All experts expect a strong reduction in the investment cost of batteries with the foreseeable development of EVs and the large-scale factories planned in China.

- The participants stressed that grid flexibility can be brought by other solutions than storage: network reinforcement, fast gas turbines, demand response, etc., and coupling with other energy networks where power2gas can provide a way to store large quantities of energy which can be used in other sectors such as transport, and possibly electricity and heat production in CHPs (but with a quite low electricity to electricity efficiency). Some participants argued that with the current prices of fossil fuels (gas), it could be difficult to find a market for power2gas technologies even with negative electricity prices.

#### 4.2.5 Session 3 and roundtable 3

##### **Questions/discussions following the presentation of Atle Harby, CEDREN Director, SINTEF Energy Research**

- A study estimating the potential of the Norwegian hydropower for balancing and providing energy storage to the pan-European power system was presented (different scenarios depending of the penetration of renewables). It was shown that Norway alone could not provide all the necessary storage and flexibility (estimated to 150 TWh storage capacity in 2050 by IEA), but it could be a major player especially at time scales of several hours to a couple of weeks. It was stressed that more coordination between European TSOs would be required to use such resources: today, Nordic TSOs perform balancing activities for a single merged network. The Norwegian hydro and storage capacity was further discussed: Norway has few pumped hydro stations (seven up to now), but a large flexibility in storage hydro with 85 TWh in storage capacity. Studies have shown the potential to extend from current 30 GW to 50 GW of capacity by linking the different reservoirs. Norway could at least double its hydro capacity in the future with reliable business models. Atle Harby pointed out that social acceptance and environmental impact is now a major issue for hydro projects in Norway, but using only existing reservoirs would not cause large environmental impacts.
- The production costs of pumped hydro were discussed: it was concluded that Norwegian hydro power using existing reservoirs could be less costly than other technologies, even when costs for interconnectors across the North Sea to continental Europe and UK are included in addition to investments costs to link the reservoirs with new tunnels and power plants.

#### 4.3 Lessons learned from the workshop

These lessons and recommendations have been discussed and agreed upon during the final roundtable.

##### 4.3.1 Impacts of the new knowledge presented by the six projects onto the GRID+STORAGE roadmap

The projects presented during this workshop cover a high maturity level for network operators (TRL 7-9).

Storage as a flexibility option will impact the following TSO and DSO clusters in the roadmap:

- Operations,
- Asset management,

- Market design.

#### 4.3.2 Recommendations for future R&I activities and regional investments about grid and energy storage solutions

The following R&I activities must be considered in the roadmap:

- 1) *Batteries: multiple services should be considered and demonstrated at different scales together with adapted business models and regulations.*
  - More business cases should be studied and evaluated.
  - Regulations have to evolve rapidly (incentives for example).
- 2) *Batteries and retail markets (access to flexibility markets).*
- 3) *Batteries: Social value for end users should be studied.*
  - Promote the social consciousness and provide high-quality services to end-users (auto consumption devices in Germany and the NEST thermostat in US)
  - Marketing and branding could be important tools to influence customer behaviour in order to help European decarbonisation.
- 4) *Data privacy issue for small scale storage.*
- 5) *New grid architectures integrated in the energy system and maximizing social welfare.*
  - Storage and local generation could challenge the TSO and DSO revenue models in the future.
  - TSOs and DSOs cooperation is fundamental for grid planning.
- 6) *Second-hand automotive battery for stationary applications: cost of BoS to be considered*
- 7) *Large-scale battery systems can be used for frequency controls (ancillary services) but business models and regulations must be adapted.*
- 8) *Power to gas of interest to couple grids with other energy (gas) networks for transport and heating applications. Power2gas technologies are still an issue.*
- 9) *Flexibility: DSM vs storage to be developed depending on cost trajectories.*
  - Important monetary costs for the transmission and distribution system.
- 10) *LV DC grids of interest to lower costs of BoS when coupling PV and storage (and other DC devices)*
  - Both economic and technical interests.
- 11) *Coupling wind power and battery systems: no obvious business models in well-meshed networks. Export potential for weak or isolated grids.*
- 12) *Good match between large-hydro in Norway and European wind production at affordable costs but transmission studies needed.*
  - Transmission constraints: stability, congestion, etc.
- 13) *Power2heat for balancing and storage*
  - Balancing power capacity (Germany and Austria examples)
  - Dynamic compensation between heat and electricity (heat with electricity when it is cheaper to do so).

#### 4.4 Projects willing to join the Knowledge Sharing Platform

A general invitation to join the [GridInnovation-online](#) community and submit their respective projects was proposed to all the speakers and the workshop participants.

## 5 Workshop 4 (Bulgaria, Cyprus, Greece, Romania)

The fourth workshop was held in Athens (Greece) on the 9<sup>th</sup> of February, 2016. The workshop [agenda](#) is available on the [Grid+Storage website](#).

### 5.1 Projects and participants in the workshop

#### 5.1.1 R&I projects presented

Eight R&I projects were presented during the fourth workshop, as displayed in Table 11 below.

*Table 11 – Projects presented at the fourth knowledge sharing workshop*

Project	Country	Purpose	Speaker	Link to presentation
<b>Hybrid stations: legal framework and regulatory aspects</b>	Greece	Isolated island systems, a particularly favorable case for the application of storage through Hybrid Power Station (HPS): combination of RES units & energy storage devices with controllable generating units	Stavros Papathanasiou, Associate Professor, NTUA	<a href="#">Link</a>
<b>Lessons learned from the Ikaria hybrid station</b>	Greece	Hybrid energy project on the Ikaria island combining wind generation and pumped hydro storage	Elias Spanos, Project Manager, ENET	<a href="#">Link</a>
<b>The Kythnos hybrid station</b>	Greece	First worldwide bidirectional inverter installed and tested in the wind and solar PV hybrid system of Kythnos	John Chadjivassiliadis, Chairman of IENE (Institute of Energy for South-East Europe)	<a href="#">Link</a>

<p><b>Grid and Market Integration activities in Cyprus and the need for storage</b></p>	<p>Cyprus</p>	<p>Presentation of several projects in Cyprus including active demand management, distributed energy resources and energy storage</p>	<p>Ioannis Koumparou, Research Associate, PV Technology, FOSS Research Centre for Sustainable Energy, University of Cyprus</p>	<p><a href="#">Link</a></p>
<p><b>FCH-JU Energy Storage Commercialization Study</b></p>	<p>Greece</p>	<p>Assessment of the role and commercial viability of energy storage (both power-to-power and conversion of electricity to heat and hydrogen) in light of the projected development of the European electric power system towards 2030 with an outlook to 2050</p>	<p>Christina Papadimitriou, Senior Researcher, NTUA</p>	<p><a href="#">Link</a></p>
<p><b>Meltemi: microgrid concept in a holiday district</b></p>	<p>Greece</p>	<p>Video about the development of a microgrid</p>	<p>Aris Dimeas, Senior Researcher, NTUA</p>	<p><a href="#">Link</a></p>
<p><b>Smart Islands networks with very high penetration of renewables</b></p>	<p>Greece</p>	<p>Demonstration of a new concept for islands: Hybrid station with oversized RES and small capacity of storage to increase the RES penetration beyond 60% while ensuring power supply</p>	<p>Aris Dimeas, Senior Researcher, NTUA</p>	<p><a href="#">Link</a></p>
<p><b>Developing tools to increase RES penetration in smart grids</b></p>	<p>Greece</p>	<p>Proposition of control schemes with optimized network operation, active management of LV distribution networks and mitigation of overvoltage and of voltage imbalances</p>	<p>Grigoris Papagiannis, Professor, AUTH</p>	<p><a href="#">Link</a></p>

### 5.1.2 Roundtables

The first two roundtables were mainly devoted to questions for the representatives of the presented projects. The third one aimed at summarizing the debates and analysing the impacts of the eight presented projects onto the R&I topics to be selected in the integrated roadmap.

Table 12 below shows the participants in each roundtable.

*Table 12 – Participants in roundtables at the fourth knowledge sharing workshop*

Roundtable nr.	Participants
1	<ul style="list-style-type: none"> <li>• Stavros Papathanasiou, Associate Professor, NTUA</li> <li>• Elias Spanos, Project Manager, ENET</li> <li>• John Chadjivassiliadis, Chairman of IENE (Institute of Energy for South-East Europe)</li> <li>• Ioannis Koumparou, Research Associate, PV Technology, FOSS Research Centre for Sustainable Energy, University of Cyprus</li> <li>• Eric Peirano, Project Manager of Grid+Storage, TECHNOFI</li> </ul>
2	<ul style="list-style-type: none"> <li>• Christina Papadimitriou, Senior Researcher, NTUA</li> <li>• Aris Dimeas, Senior Researcher, NTUA</li> <li>• Grigoris Papagiannis, Professor, AUTH</li> <li>• Eric Peirano, Project Manager of Grid+Storage, TECHNOFI</li> </ul>
3	<ul style="list-style-type: none"> <li>• All participants (plenary discussion)</li> <li>• Sophie Dourlens-Quaranta, Consultation coordinator for Grid+Storage, TECHNOFI</li> </ul>

### 5.1.3 List of attendees

In total, the workshop was attended by 56 participants, listed in Table 13 below.<sup>8</sup>

*Table 13 – Attendees in the fourth knowledge sharing workshop*

NAME	COMPANY
Kostis Andreadis	HEDNO
Sofia Apostolopoulou	HEDNO
NIKOLAOS ARGYROS	INTRACOM Defense Electronics
Dionysia-Theodora Avgerinopoulou	European Institute of Law, Science and Technology
Anastasios Bakirtzis	Aristotle University of Thessaloniki
John Chadjivassiliadis	IENE (Institute of Energy for South-East Europe)
Markos Champakis	HEDNO
Dikeados Chris	IPTO
NICK CONSTANTOPOULOS	MINISTRY OF DEVELOPMENT
Spiros Corcokios	GREEN SA
Loukas Daoutis	HEDNO

<sup>8</sup> Only the attendees having agreed to have their names listed in the minutes of the workshops are included.

Aris Dimeas	NTUA
Telaki Dimitre	HEDNO
Sophie Dourlens Quaranta	TECHNOFI
Housos E	Upatras
Chalkia Eleni	CERTH
ALEXANDRA GEORGANTI NTALIAPE	independent
Rebekka Gkogkou	ICCS / NTUA
VIVI GOURIOTI	DESFA
Nikos Hatziargyriou	HEDNO
Vassilis Iliadis	AES Technologies
Mantzaris Ioannis	HDNO
Vasileios Ioannitis	Seabriz
Svisceva Irina	
Emmanouil Kakaras	Mitsubishi Hitachi Power Systems Europe GmbH
DIMITRIOS KANELLOPOULOS	PPC RENEWABLES S.A.
Kostas Kaousias	HEDNO
Evangelos Karfopoulos	Ntua
Vasiliki Katsiki	SYSTEMS SUNLIGHT S.A.
Stefanos Kokkinelis	HEDNO
Ioannis Koumparou	University of Cyprus
Pantelis Kourelis	HEDNO
DIONYSIOS KOUTSOUVELIS	INTRACOM DEFENSE ELECTRONICS
PANAGIOTIS KTENIDIS	TEI PIRAEUS - SEALAB
Ilias LAMPRINOS	Intracom Telecom
Panagiotis Maniatis	Greek Environmental & Energy Network
Marios Maniatopoulos	NTUA
Kelly Mavrogenou	ICCS/NTUA
Nikolaos Nikolopoulos	Centre for Research and Technology Hellas / Chemical Process and Energy Resources Institute
Christina Papadimitriou	ICCS
Stefanos Papaefthymiou	HEDNO
Grigoris Papagiannis	Aristotle University of Thessaloniki
DIMITRI PAPAKONSTANTINOU	HEDNO, HELLENIC ELECTRICITY DISTRIBUTION NETWORK OPERATOR S.A.
Apostolos Papakonstantinou	HEDNO
Stavros Papathanassiou	NTUA
Eric Peirano	TECHNOFI
Nikos Pomonis	SYSTEMS SUNLIGHT SA
VILLY REPOUSI	independent
Elias Spanos	ENET S.A.
Stathis Tselepis	CRES
Isidoros Vitellas	HEDNO
Alexander von Jagwitz	B.A.U.M. Consult GmbH
Spyros Voutetakis	Centre for Research and Technology Hellas (CERTH)
ΑΛΕΞΑΝΔΡΟΣ ΖΩΤΟΣ	INTRACOM DEFENSE ELECTRONICS (IDE)

## 5.2 Minutes of the debates

### 5.2.1 Session 1

- The economic feasibility of storage was discussed in relation with the price differential (spread) between peak and off-peak hours: at least 80€/MWh are needed in general. Still, island systems are a good business case for storage since generation prices are in general quite high (up to 300 €/MWh in the example mentioned), and capacity payments are implemented. To have more than 30% of RES on an island, dispatchable RES units such as Hybrid Power Stations (HPS) are needed.
- The issue of stand-alone storage vs. HPS was discussed: actually storage is viable only if there is a high level of RES curtailments. If RES and storage are owned by two different players, then storage would not be viable, as the simultaneous implementation of high RES capacity and storage facilities to handle their curtailments could not be easily coordinated in practice. A single investor for both RES and storage is needed.
- The issues of environmental constraints, permitting and communication to local people were discussed: they indeed occur for all projects. Still, the issue is not about the permits themselves but the complexity of the processes, which results in long durations and extra costs for investors.
- Comparison between storage in islands and on the mainland was debated: only if system services provided by storage are properly remunerated, storage can be viable on the mainland. So far in Greece, such services are not compensated sufficiently either for thermal units or for HPS. Also, the contribution of storage to security of supply should be valued.
- Centralized storage such as pumped hydro storage (PHS) is economically viable for the pan-European transmission grid under current market conditions (sufficient spread). For example, the Norwegian hydro provides services to the pan-European system (new HVDC links with Germany, the UK, Belgium, Denmark) are under construction. However, the issue of local opposition remains (both for the overhead lines and the water levels in impacted rivers and reservoirs).
- Residential storage (storage for auto-consumption in private homes or buildings) can be an option, but the beneficiaries should be identified. Still, benefits other than economic can be an incentive for households: for example in Germany, residential storage develops even if there is no business case; some people indeed like being self-sufficient in terms of energy supply.
- A paradox is raised: storage is needed to integrate more RES; but, under current market conditions, integrating more RES flattens market prices (spot price curve) and reduces the profitability of storage (for business models based upon the spread). Therefore innovations are needed in terms of market design and regulation to value the system services which can be brought by storage.
- It was reminded that energy storage is not the only flexibility means. Flexibility can come from the network (e.g. reinforcements such as cross-border interconnections and power electronics), generation (fast gas turbines for instance and variable speed machines for PHS), demand side management, and the connection with other energy networks.

### 5.2.2 Session 2

- Again conditions for energy storage viability are discussed. Islands combining high fossil fuel costs and high RES penetration are identified as the sole cases in which storage is viable under current regulations and market conditions. The issue of the sensitivity to fossil fuel price is raised: if the oil barrel remains cheap for a long period, it would be detrimental to the profitability of energy storage when installed in island networks where generation costs are high. Still, storage would remain necessary to compensate RES intermittency whatever the market prices are.
- The new HVDC link planned between Greece (mainland), Crete, Cyprus and Israel (EuroAsia interconnector) could change the business models for storage on the Greek islands.
- In general, one of the barriers to storage development is the double fee storage units have to pay, being considered both as producers and consumers.
- The issue of fully automated network management was raised, with the example of digitalized substations. Some consider that full automation is not realistic, for example for safety reasons. On the contrary, it was debated that multiple stakeholder schemes complicates the reliable operations of the power system. A possible way to combine an optimized level and automation and the involvement of several stakeholder was presented for distribution networks. This proposal remains to be tested and validated in real distribution networks.
- Cost of storage components are compared to the cost for the integration of storage into the grid. Cost reductions are expected during the upcoming years; still, incentives are needed to get to an early market.

### 5.3 Lessons learned from the workshop

These lessons and recommendations have been discussed and agreed upon during the final roundtable.

#### 5.3.1 Impacts of the new knowledge presented by the six projects onto the GRID+STORAGE roadmap

The projects presented cover a large range of maturity levels for network operators, from TRL 4-5 for some applications to TRL 9 for some others

Storage as a flexibility option will impact the following TSO and DSO clusters in the roadmap:

- Operations,
- Market design.

#### 5.3.2 Recommendations for future R&I activities and regional investments about grid and energy storage solutions

The following statements must be considered in the selection of the R&I activities for the future integrated roadmap:

- Hybrid stations, i.e. storage systems in a generation portfolio, are a suitable model for storage integration in systems where generation costs are very high and renewable penetration is saturated (typically islands).
- Multiservice business models for storage integration might be a solution provided that the system services brought by storage are fairly valued (regulations and market mechanisms).



- Power converter technologies bring new horizons in terms of control of the future smart grids, including storage integration. More R&I activities are needed to understand the complex system dynamics of power systems with large power electronics penetration.
- Permitting (duration and number of bodies) is still an issue for large-scale storage projects.
- Flexibility cannot be ensured only by storage technologies: R&I activities are needed for other flexibility means (interconnections and power electronics, flexible generation, demand management, connections with other energy networks, etc.).
- There is a need to design market incentives for the integration of small to large-scale storage (price signals, ownership, etc.) in an appropriate regulatory environment.
- Middleware layers (with multi-agent systems) are a possible alternative for the management of LV networks hosting large share of renewables (including prosumers and storage)

#### 5.4 Projects willing to join the Knowledge Sharing Platform

A general invitation to join the [GridInnovation-online](#) community and submit articles was proposed to all the speakers and the workshop participants. Several were keen to submit articles. Some participants pointed out that the European Commission should make the platform more visible and suggest that each EC-funded project provides articles.