2 Publishable summary

2.1 Summary description of project context and objectives

The objective of eStorage is to develop cost-effective solutions for the widespread deployment of flexible, reliable, GWh-scale storage across the EU, and to enhance grid management systems to allow the integration of large share of renewable.

The key issue we plan to address is the need for power regulation during low demand periods, when only inflexible baseload generation and intermittent renewable generation are operating. In contrast to conventional generation, a storage plant able to regulate its consumption could help to avoid curtailing wind.

Conventional Pumped Storage Hydro Plants (PSP) can only regulate their power in generation mode; variable speed technology for PSP can bring additional flexibility in pumping mode as well. Developing technically and economically feasible solutions in eStorage will allow upgrading a significant part of European PSP capacity to variable speed, providing up to 10 GW of additional regulation capability with no environmental impact and little administrative burden, all at a much lower cost than required for developing new plants.

We will also develop and demonstrate solutions for coupling the dispatch of storage plants with renewable generation using advanced Energy Management Systems. This will enable storage plants to maximise their value in the balancing markets. From simulation studies, demonstration results and storage potential analysis we will evaluate the system-level benefits of storage. We will also identify development barriers in order to draw recommendations for efficient market and regulatory framework to maximise the impact of project outcomes.

eStorage gathers major stakeholders from the entire value chain across EU (Elia – TSO, EDF – Generation Company, Imperial College – Academic Institution, DNV KEMA - Energy Consultancy and Alstom – Equipment Manufacturer).

2.2 Description of the work performed since the beginning of the project and the main results achieved

2.2.1 Demonstration (WP1/WP2)

The overall goal of WP1 is to demonstrate the technical and economic feasibility of converting an existing PSP in France (Le Cheylas PSP) to variable speed technology.

During the second period of the project, the main objectives have been to finalise the technico economic feasibility of the project, to validate the basic design of the operation, and to launch the conversion itself.

Main achievements for this period of WP1 are the following:

- Validation of the basic design of the operation by EDF, leading to the signature of the execution order of the equipment purchase contract covering the procurement, fabrication and commissioning of Le Cheylas Unit 2 conversion between Alstom and EDF. This validation means

that acceptable technical solutions have now been identified to mitigate industrial risks, which took more time than anticipated;
- Finalisation of the new hydraulic design of the turbine and launch of the detail design studies;
- Continuation of the basic design of the generator;
- Finalisation of the simulations related to the Voltage Source Invertor (subcontracted to its supplier ABB);
- Launch of the procurement process for the elements to be changed in Le Cheylas PSP, and not covered by the contract between Alstom and EDF (busbars, transformer, additional buildings...).

Main achievements of the WP2 for the second reporting period are the following:

- The release of a high-level specification project note describing the scope, the proposed optimization tool and development methodology, as well as the expected results;
- The implementation and integration of a PSP model in the Demonstrator;
- The design and implementation of a functional testing framework and a test book for the Demonstrator;
- A meeting with EDF on July 22nd 2014 to discuss IPSO added value for a generation company through a set of use cases : wind curtailment, Pumping-to-Generation and Generation-to-Pumping mode switching, and PSP operation mode relaxation;
- A performance and modularity improvement of the Optimization Engine Framework on which IPSO is built upon;
- The implementation of a first balancing market clearing engine with basic commodities (high level specification and prototype);
- The description of the first energy storage valorisation use-cases on the balancing market.

2.2.2 RTD (WP3)

Main achievements in WP3 during Year 2 include:

- Finalisation of four interim reports providing a basis for scenario development (D3.1), covering the topics of scenario assessment, electricity demand development, fuel availability and price development and technological development;
- Conducting a comprehensive literature survey to identify the most relevant recent studies looking at scenarios for EU electricity system development;
- Organisation of breakout sessions during the 1st eStorage Annual Workshop in Arnhem, 30 October 2013, to discuss the preliminary results and the approach to scenario development with project partners and a broad range of external stakeholders;
- Elaboration of the approach to carrying out a grid study and qualitative assessment of the need for flexibility and role of storage in decarbonised European electricity system;
- Delivery of D3.1 “Feasible development scenarios for the future EU electricity system”, which describes the methodology applied to scenario development and selection;
- Establishing a close interaction with the eHighway2050 FP7 project in order to exchange scenario-related information, in particular with respect to transmission grid considerations;
- Exchange of input data spreadsheets between the scenario development activity (Task 3.1) and the storage value assessment (Task 3.2);
- Further refinement of analytical tools for assessing the value of energy storage in Task 3.2, as well as development of a complementary analytical approach based on stochastic system scheduling;
- Preliminary analysis of gaps and barriers for EU-wide rollout of grid-scale storage in Task 3.3.

2.2.3 Others (WP4/WP5)

Main achievements in WP4 during Year 2 include:

- Completing the database for existing PSP plants in Europe;
- Identification of several sites to perform a detailed study of plant conversions in order to draft a number of conversion business cases to cover the installed PSP fleet in Europe;
- A first business case has been identified and the analysis has begun. The other business cases will be launched once the first will be finalised and the same methodology will be applied;
- Finalization of the selection criteria for potential new PSP sites and finalization of the GIS computer model used to identify new PSP sites;
- Performing the assessment for new potential PSP sites for the EU-15, Norway and Switzerland using the GIS computer model, including validation of the results (and thereby the model);
- Manual down selection with national/local expert for France and Germany.

Main achievements in WP5 during Year 2 include:

- The organization of the first annual workshop (D5.4) in Arnhem (Netherlands) was the first deliverable that could help raising awareness about eStorage;
- The participation in various significant conferences and presentation of the technical co-works, which exhibits the professional expertise in energy storage as well as the friendly partnership within the organization.

2.2.4 Management (WP6)

Main achievements in WP6 during the 2nd period of the project :

- Participation to the Steering Committee and General Assembly in Arnhem (Netherlands) and the presentation of the work achieved in the 1st Period and the pending issues ;
- Regular monitoring meetings and completion of follow-up documents ;
- Realisation and submission to the EC of the 1st periodic reporting ;
- Preparation and submission to the EC of the amendment n°1 ;
- Review and submission of Deliverables in line with the process and due dates agreed in the contractual documents;
- Meeting with the Commission regarding both Periodic reporting 1 and Amendment 1 ;
- Regular updates (every 3 months) of the Monitoring and Action Management board and of the Action list to address work progress and actions to be done;
- Update of the Risk register at the beginning of the period;
- Cost control and resources management to ensure a coherence between both prevision and real achievements.

2.3 The expected final results and their potential impact and use

The general project scope is to develop a global system solution by connecting the intermittent generation to the storage resources through an efficient electricity market, and by maximising the bulk storage resources flexibility. By optimising the global chain value and making recommendations to adapt the regulatory framework to incentivise the adequate bulk storage development maximising the global system value, one expect to maximise the end consumer value and minimise the electricity cost and/or minimise the intermittent generation integration cost impact.

With a typical availability factor above 90% and response time below the minute Hydro-Electric plants are amongst the most reliable generation resources to provide base load or peak power. The variable speed technology applied on Pumped Hydro Storage Plants pushes the flexibility of such plants one step further. With their flywheel capability and a reaction time for large power variation below the second, variable speed PSP can provide power quality service as well as frequency regulation in pumping and generation mode and time shift. They are the ideal partner of intermittent generation. However the investment cost for new plants and the topology constraints limit the diffusion of the technology. By developing solutions to upgrade existing plants we provide cost-effective way to disseminate this technology all through Europe.

The eStorage project will indeed demonstrate in WP1 the economic and technical feasibility to upgrade existing conventional Pumped Hydro storage plants into variable speed ones by upgrading a 240 MW PSP. This upgrade will allow to increase the plant frequency regulation capacity and to improve its cycle efficiency and therefore provide economic benefit to the plant owner. The project includes also a R&D phase whose objective is to develop solutions that will it make possible and economically viable to upgrade in variable speed more than 75% of the 40,000 MW installed base.

IT tools encompassing new market regulatory framework geared to closer to intraday and real-time capabilities and dealing with network congestion management will help reducing the impact of disturbances introduced by ever growing penetration of variable energy resources like wind. Studying and assessing new market design will likely help both system operators and Balance responsible Parties to achieve system and portfolio balancing by introducing closer to real-time products and opportunities to trade energy and reserves. New IT tools will not only consider the point of view of the central grid or market operator but will also help other actors such as generation companies to adjust and optimize their revenue streams by having new energy or reserves trading opportunities.

Several international studies indicate that bulk storage can provide many benefits to electricity grids and markets in addition to facilitating the integration of renewable energy. These include increased efficiency of existing plant and of the transmission system as a whole, enhanced security of energy supply. Thus, PSP can contribute to a reduction of overall generation and transmission system costs and electricity prices.

Variable speed Hydro Storage probably has the shortest reaction time amongst the transmission scale generation resource.

Bulk storage will reduce the need to curtail wind. Curtailment is already occurring in grid systems having integrated large intermittent generation (Ireland, Spain,…) and predicted levels of wind congestion on transmission lines are of concern to System Operators. Thus PSP could provide valuable wind management services to the TSO and command a new payment consistent with market consultation by the Regulators for “new ancillary services” to reward such grid services.

PSP have the potential to provide ancillary services, including operating reserve, reactive power, black start, automatic generation control and system support services. The challenge of integrating increased renewables onto the grid adds greater complexity to balancing of the system and introduces greater risks (e.g. frequency fluctuations) and costs for all stakeholders - existing plants, utilities, the system operator, potential investors and the consumer. PSP have the potential to provide what may be termed Advanced Ancillary Services in providing a powerful and flexible balancing component for systems with high wind penetration.

2.4 The address of the project public website

http://estorage-project.eu/