bridge
HORIZON 2020

Cooperation between Horizon 2020 Projects in the field of Smart Grids and Energy Storage

How the BRIDGE projects are addressing the battery topic?

June 2018

This report has been elaborated by TECHNOFI / DOWEL MANAGEMENT within the INTENSYS4EU Coordination and Support Action (H2020 Grant Agreement n° 731220).

More information at http://www.h2020-bridge.eu/.

DRAFT Executive Summary

Introduction

The use of batteries to support the large-scale integration of renewable energy and a consumer-centred energy transition has been identified as key by the European Commission.

Developing a **sustainable and competitive battery manufacturing sector** in Europe is the main objective of the EU Battery Alliance launched in October 2017.

When it comes to batteries deployment for energy sector use, it is important to better understand how batteries can provide **innovative services**, which battery technologies are the best suited for **each type of application**, what are the **barriers** (for instance regulatory) **faced to deploy batteries**, what could be the role of **electric vehicles' batteries** to support power network management, etc.

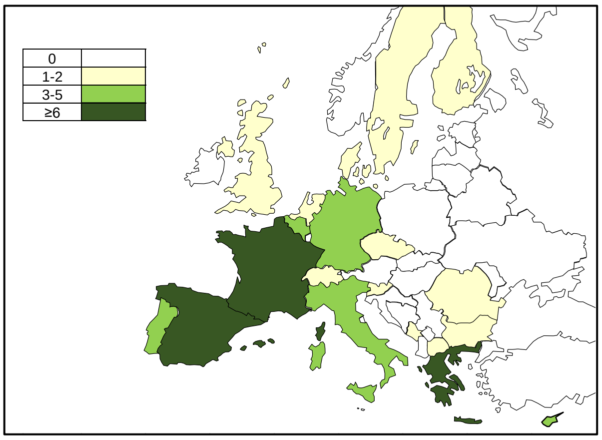
To provide first set of answers to these questions the European Commission asked Intensys4EU project to look into research and innovation (R&I) projects under the **Horizon 2020 program** fostering smart energy systems.

The present report has been elaborated in the framework of the **BRIDGE initiative**, which is the cooperation group of Horizon 2020 projects in the field of Smart Grids and Energy Storage[1]. It is based on **15 ongoing R&I projects** involving battery integration in the energy system. They cover the whole range of scales from cross-border level down to building level. In addition, one project is mostly dealing with battery technology development (see Box 1).

Main findings

Geographical coverage

Most of the demonstrations dealing with batteries within the H2020 projects considered here are located in **Southern Europe**, which tends to confirm that this is where batteries make the highest economic sense, in particular to store excess of solar power. **Islands** (not only Southern) are also very attractive for deployment of batteries in combination with RES given high cost of diesel-based electricity generation.



Technologies

Several battery technologies are tested within H2020 projects. **Lithium-ion batteries** (with different variations of Li-ion technology) are the most widely used: roughly 2/3 of demos.

[1] More information at https://www.h2020-bridge.eu/.

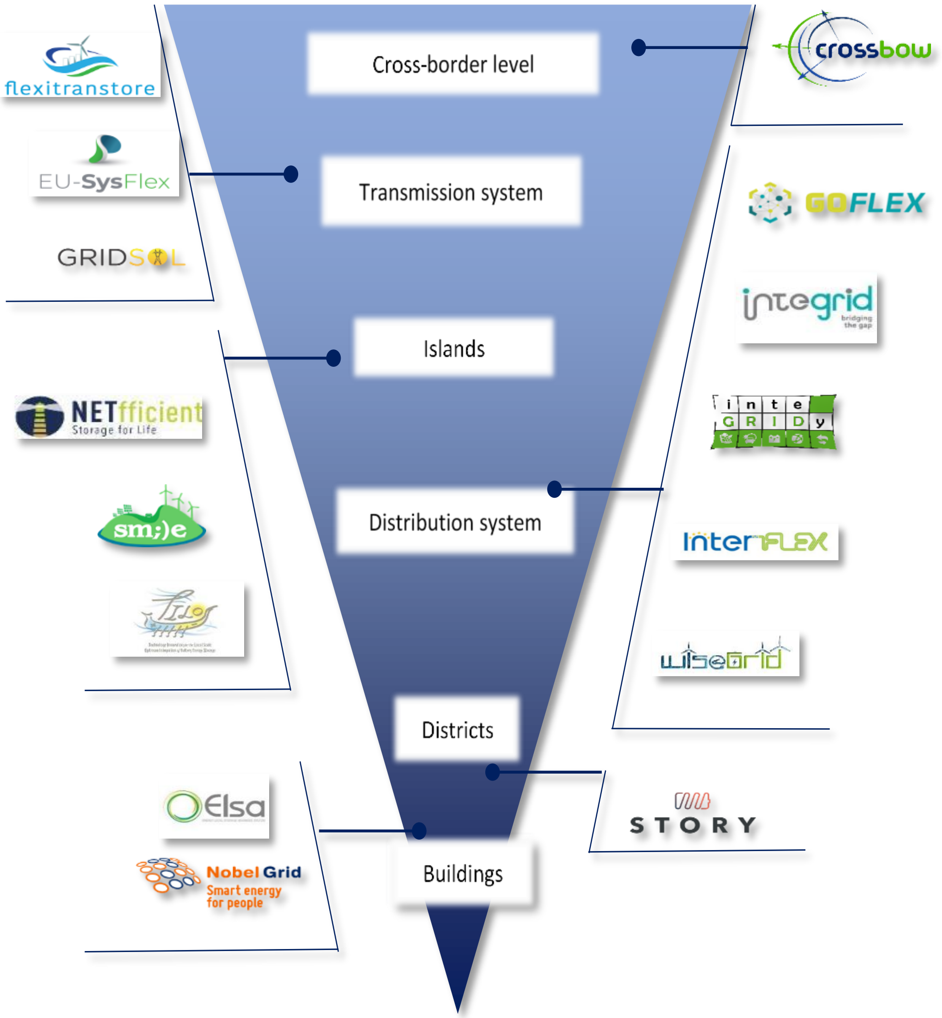
This quickly expanding technology with competitive prices and multiple experience feedbacks provides fast responsiveness, high number of cycles, efficiency and durability. Here it should be stressed that H2020 smart energy system calls are technology neutral: even battery use as such is not prescribed and even less so the use of specific battery chemistry. Calls for proposal are mostly targeting global objectives such as integration of high share of renewables, efficiency and resilience of energy system. Sometimes they target transmission level, sometimes –distribution, etc.

Other battery technologies have been chosen by a few projects, for instance because of their lower cost or for specific applications. Notably a number of projects use long-established lead technology (1/5 of demos). And then there is at least one project using Molten Salt technology (Sodium Nickel Chloride) – TILOS project, Redox flow (GRIDOL project) and Nickel Iron technology (one of technologies used in STORY project).

Valuable feedback from H2020 projects is being provided with regards to possible improvements suggested to battery manufacturers. Some projects are using on purpose a variety of battery technologies in order to conduct a comparative assessment.

One project (NAIADES) is developing **Sodium-ion** technology which could be an alternative in case of shortage or excessive prices of lithium.

Analysed projects cover all energy system levels



Box 1. The 16 Horizon 2020 projects contributing to the present report

Cross-border aspects 	**CROSSBOW** (2017-2021) - CROSS BOrder management of variable renewable energies and storage units enabling a transnational Wholesale market - http://crossbowproject.eu/ - **Involves co-ordinated use of a large number of small battery systems in different countries through Virtual Storage Plant(s) run by aggregators.**
Transmission level: Interactions with distribution level and generation 	**EU-SYSFLEX** (2017-2021) - Pan-European system with an efficient coordinated use of flexibilities for the integration of a large share of RES - http://eu-sysflex.com/ - **Involves batteries connected at low or medium voltage level to deliver services to the energy system; strong communication interface between TSO, retailer and battery system.**
	FLEXITRANSTORE (2017-2021) - An Integrated Platform for Increased FLEXIbility in smart TRANSmission grids with STORage Entities and large penetration of Renewable Energy Sources - http://flexitranstore.eu/ - **Involves big battery system(s) in conventional power plant to increase flexibility, in a substation at the TSO/DSO interface and in a wind plant.**
	GRIDSOL (2016-2019) - Smart Renewable Hubs for flexible generation: Solar Grid Stability - http://www.gridsolproject.eu - **Involves big battery systems integrated in renewable power plants (high voltage level, use of different battery chemistries, etc).**
Island cases 	**NETfficient** (2015-2018) - Energy and economic efficiency for today's smart communities through integrated multi storage technologies - http://netfficient-project.eu/ (Island of Borkum) - **Involves batteries - incl. battery systems using 2nd life EV batteries - for self-consumption of sun energy by households and reaping benefits from ancillary markets. Street lighting based on PVs+batteries. Combined use of batteries and super – capacitors, etc.**
	SMILE (2017-2021) - SMart IsLand Energy systems - http://www.h2020smile.eu/ (Samso and Madeira Islands) - **The Li-ion batteries will be installed at the transformation cabin level or close to the demo PV plants. Also - Installation of batteries at household district level & smart charging EVs/boats. Project at early stage.**
	TILOS (2015-2019) - Technology Innovation for the Local Scale, Optimum Integration of Battery Energy Storage - http://www.tiloshorizon.eu/ (Tilos island) - **Proud winner of 2 EUSEW awards(!) for hybrid power plant combining the use of sun and wind together with big battery systems and introducing mart energy management system on the island.**

Distribution level: Grid services 	**GOFLEX** (2016-2019) - Generalized Operational FLEXibility for Integrating Renewables in the Distribution Grid - http://www.goflex-project.eu/ - **Active use of distributed sources of flexibility (including electric vehicles) to provide grid services and optimize energy consumption and production at the local level.**
	INTEGRID (2017-2020) - Demonstration of INTElligent grid technologies for renewables INTEgration and INTEractive consumer participation enabling INTEroperable market solutions and INTErconnected stakeholders - http://integrid-h2020.eu/ - **Batteries at utility and domestic scale and e-mobility.** Project at initial stage.
	inteGRIDy (2017-2020) - integrated Smart GRID Cross-Functional Solutions for Optimized Synergetic Energy Distribution, Utilization Storage Technologies - http://www.integridy.eu/ - **Some special features: dynamic charging schedules will be demonstrated for a forklift using RES and batteries. EVs will support the grid in case of need (vehicle-to-grid).**
	InterFlex (2017-2019) - Interactions between automated energy systems and Flexibilities brought by energy market players - http://interflex-h2020.com/ - **Main features of the demos: shared batteries storage for collective self-consumption of sun energy; electric vehicle batteries & smart charging.**
	WiseGRID (2016-2020) - Wide scale demonstration of Integrated Solutions and business models for European smartGRID - http://www.wisegrid.eu/ - **Use of batteries, including EV batteries, by aggregators through special tools and platforms to enable prosumers to participate in the balancing market.**
Distribution level: From grid to building & household level 	**ELSA** (2015-2018) - Energy Local Storage Advanced system - http://www.elsa-h2020.eu - **Project is concentrated on development of scalable storage system using 2nd life EV batteries and related ICT and energy management systems to deliver services to buildings, districts and grid.**
	NOBEL GRID (2015-2018) - New cost-effective business models for flexible Smart Grids - http://nobelgrid.eu/ - **Small batteries have been used in the project for demand response tests.**
	STORY (2015-2020) - Added value of STORage in distribution sYstems - http://horizon2020-story.eu/ - **Different battery chemistries tested. Context: development, testing, improving & demonstrating a residential hybrid storage system that can smoothly (without interruption) go from on-grid operation to off-grid operation, inject on demand and consume on demand.**
Technological development 	**NAIADES** (2015-2018) - Na-Ion bAttery Demonstration for Electric Storage - http://www.naiades.eu/ - **Develops and demonstrates the ambient Na-ion battery under realistic conditions as an effective alternative to the Li-ion battery for stationary Electric Energy Storage.**

Link with electric vehicles

Batteries from Electric Vehicles are involved in two main frameworks:

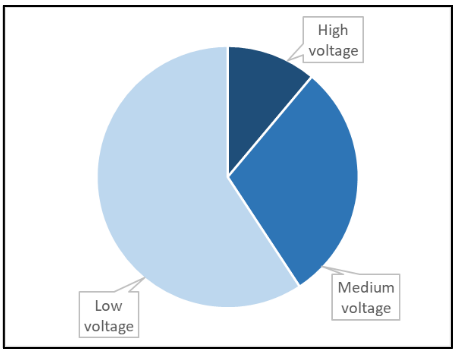
- **Second-life batteries from EVs** are gathered into stationary storage units to provide a range of services to network operators down to buildings (ELSA, NETFFICIENT);
- **Smart charging and Vehicle-to-grid (V2G) applications** are tested within a few demonstrations (INTEGRID, INTERFLEX, SMILE, WISEGRID, etc).

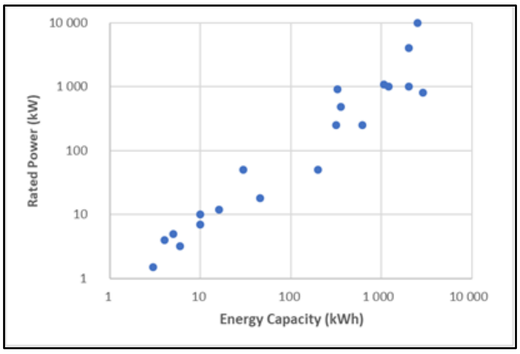
Battery size and voltage level

Batteries, as any energy generation or consumption devices, can be connected at three different levels:

- **Low voltage** (lower than 400 V): this covers residential cases as well as district level installations;
- **Medium voltage** (between 1 kV and 50 kV): in this case, batteries are connected to distribution grid or are part of medium-size generation facilities;
- **High voltage** (higher than 110 kV): in this case, batteries are connected to transmission network or operated together with big generation capacities.

Most of the batteries in H2020 projects are connected to the low voltage level. Furthermore, a wide range of battery sizes (both in terms of energy and of capacity) are tested by H2020 projects.

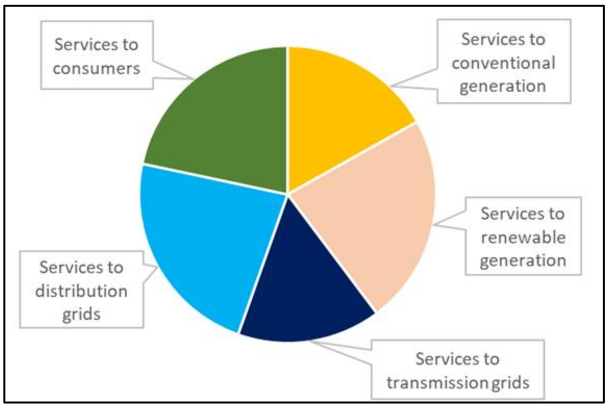




Services provided by the batteries

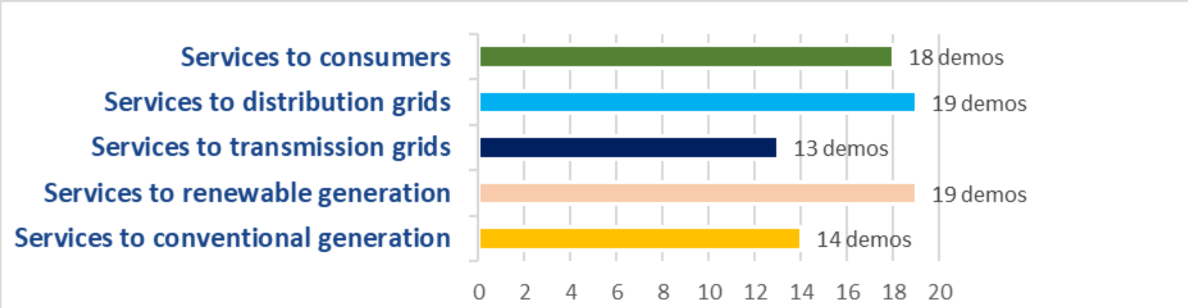
Energy storage in general, and batteries in particular, can provide services to all energy system stakeholders, namely:

- Conventional generation,
- Renewable generation,
- Transmission grids,
- Distribution grids,
- Customer services.



All types of services are demonstrated within the H2020 projects considered in the present report. Most projects actually demonstrate several types of services, which reflects the reality of the storage business model: a battery must provide a range of services in order to be profitable enough.

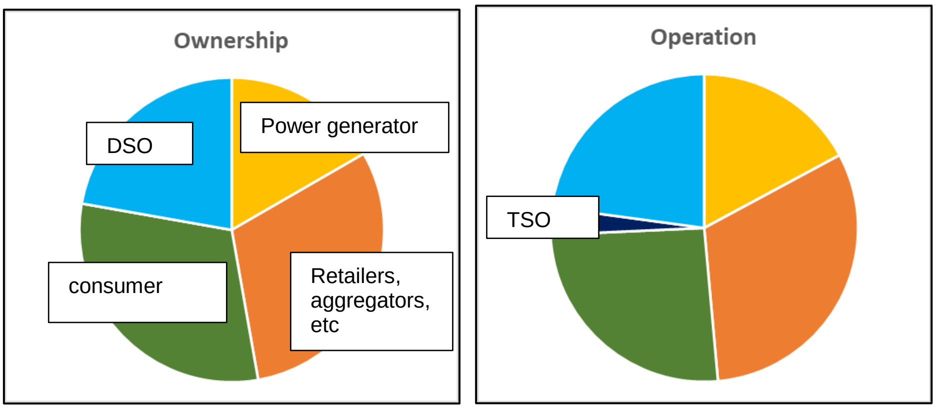
The allocation of the projects' demonstrations within the different services are illustrated below:



Ownership and operation of the batteries

In terms of ownership of the batteries and of who should operate them, H2020 projects have diverse views. **Ownership by prosumers** (possibly aggregated) is favoured to support self-consumption and to provide services to the DSOs. Batteries might also be integrated in **a production site** (CCGT or RES): in that case ownership and operation by power generators make sense. Nevertheless, network operators are still pleading for the right to own or operate batteries especially when batteries are used to relieve grid constraints.

It is to be noted that currently there are no common EU rules as to storage ownership. The rules which are proposed in the recast of the Electricity Market Directive are constructed around the basic principle that normally storage services should be provided by free market operators rather than network operators. However, ownership possibilities by network operators are possible in market failure situations.



Future deployment of the innovative solutions demonstrated within H2020 projects

Exploitation plans

Altogether, the R&I projects considered in this report plan to deliver **practical solutions** contributing to the deployment of services provided by batteries to energy system stakeholders:

- Batteries connected at distribution level will support the system operators, locally up to cross-border level, to ensure the **security and quality of electricity supply** and to support the **system balancing**, while keeping **operation costs under control**.
- Batteries integrated into **renewable power plants** will help **limiting the intermittency** of renewable power generation.

- Batteries integrated into **conventional power plants** will allow those to be **even more flexible**. This is a must with increase in renewables generation.

- Batteries will support both **individual and collective self-consumption** of renewable production.

- Batteries installed in **hybrid power plants** will support the smooth functioning of **geographical islands'** energy systems and help limiting the use of CO_2-intensive power generation. Use of batteries in **boats** will contribute to cleaner connectivity of islands; smart charging envisaged.

- Solutions will be provided in order to manage the impact on the grid of the increasing number of **electric vehicles** ("smart charging"), and even to use such storage capacity in order to provide grid services ("vehicle-to-grid"). At the same time, increasingly available **second-life batteries** will be reused for stationary storage to serve building, district or grid needs.

New market designs and business models are being elaborated by the H2020 projects in order to make these new services economically viable.

Need for regulatory adaptation

Several projects mention regulatory aspects that deserve to be considered in order to facilitate the deployment of battery services. For instance:

- **Lack of regulation for the development of hybrid plants in most EU countries.** Notably variable renewable power plants integrated with Battery Energy Storage Systems should be able to sell they output as a single product. Renewable energy support schemes should take into account *pros* and *cons* of storage integration. This is especially needed in island systems.
- **Lack of regulation to drive demand for flexibility services provided by storage systems:** in some Member States, self-consumption regulatory framework allows only charging the energy storage systems from the renewable energy generated on-site, and energy excess cannot be fed into the grid. This is detrimental to the cost-effectiveness of the solution. In other Member States, if prosumers equipped with rooftop PV panels subsequently install batteries, they usually lose their preferential Feed-in-Tariffs. This makes batteries combined with a rooftop PV at household level economically unattractive.
- **Barriers to the participation of distributed resources in wholesale energy markets and ancillary markets services**: participation in wholesale market should be possible with low amounts of generation/storage (in aggregation).

When the Clean Energy Package is adopted and enforced, the regulatory environment for storage/ batteries will substantially improve.