ICE INTELLIGENT COMMUNITY ENERGY

EUROPEAN UNION

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ICE PROJECT OUTPUTS DESCRIPTION

ELECTRIC STORAGE COUPLED TO A TIDAL TURBINE FOR INJECTION ON THE GRID

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BRETAGNE DÉVELOPPEMENT INNOVATION · SDEF · TECHNOPÔLE BREST-IROISE · Technopole Quimper-Cornouaille · PÔLE MER BRETAGNE ATLANTIQUE · UNIVERSITY OF EXETER · PLYMOUTH UNIVERSITY · UEA University of East Anglia · marine

ICE report OUTPUT x:

Electric storage coupled to a tidal turbine for injection on the grid

Background information

The island of Ushant consumes around 6 GWh of electricity annually, almost all produced by generator sets with internal combustion engines using fuel oil. The energy transition in Ouessant is underway and the SDEF has to date deployed three photovoltaic plants on the roofs of the gymnasium, technical workshops and the multipurpose room, for a total installed power of 94 kW.

As part of the ICE project, the SABELLA company has installed a tidal turbine in the Fromveur passage which will develop a maximum power of 250 kW. After a first period of tests, it has been highlighted that the electric signal produced by the tidal, although following a sinus shape behaviour, shows rapid fluctuations that are partly due to the swell on the surface, and the long period harmonic of the waves.

As a results, EDF (electric supplier and grid manager on the island) asked to develop a system that reduces these rapid fluctuations, in order to reach requirements for electricity injection on the grid. These requirements are: Power variation should be below 5 kW/s, with a final aim at below 1 kW/s.

A call for tender has been launched in order to develop a unit that will smooth the tidal power production, in order to allow the injection on the grid.

SYSTEM/TECHNOLOCY SPECIFICATIONS

The solution proposed (figure 1) is to combine a battery rack, a load bank, and a supervision/system to manage the use of each part in order to smooth the signal from the tidal, in order to reach the criteria: Power variation < 5 kW/s.

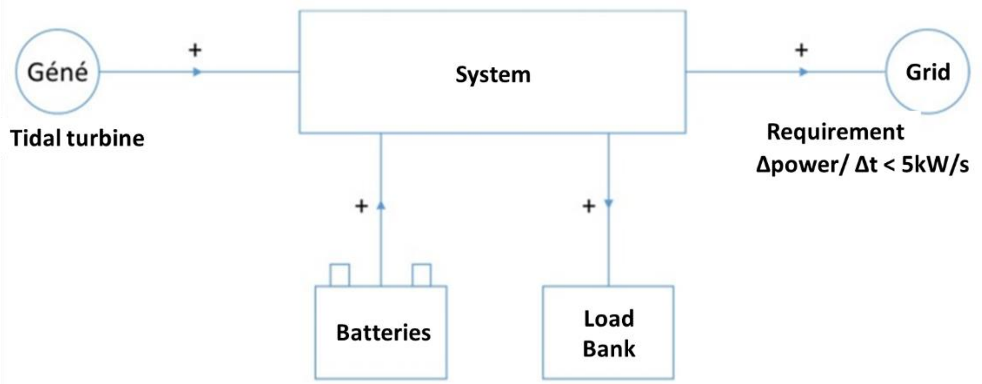

Figure 1 : Schematic view of the storage-smoothening unit

The idea is relatively simple, when the output power of the tidal turbine varies with an amplitude higher than + 5 kW/s, the surplus electricity is load towards the battery rack. If the battery charging level rise to much (while near 80-90%), the surplus electricity is sent toward the load bank (resistance) which dissipate into heat the electricity.

When the output power of the tidal turbine varies with an amplitude smaller than - 5 kW/s, the battery (normally loaded from a previous "surplus" period") counterbalance by providing electricity to reduce the negative variation.

The figure 2 below shows actual data of the raw power output of the tidal turbine (green), as well as simulated output power, after the storage-smoothening unit (red). The actual data are from days with low tides coefficient 40-43, but high swell, resulting in power variations reaching 30kW/s, way to important to be authorized to inject on the grid. The simulated output power after the storage-smoothening unit shows really small power variations, in the range of 550 W/s, or 0.5 kW/s, acceptable to inject electricity on the grid.

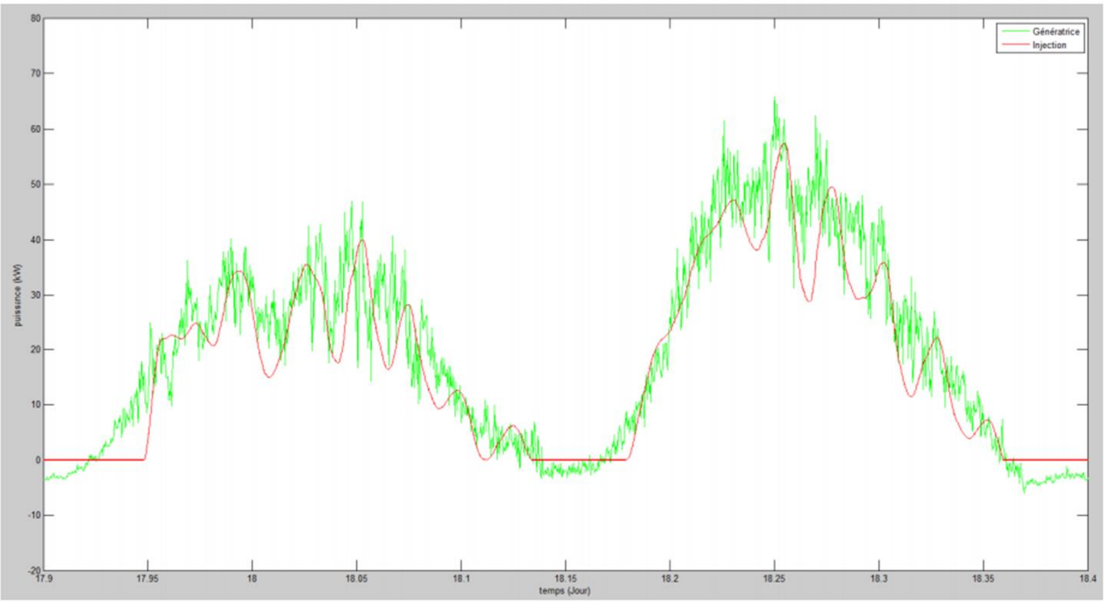

Figure 2 : Raw output power of the tidal turbine (green) and simulated output power after storage-smoothening unit (red) – 2 tides with coef 43 and 40 and HIGH swell.

The state of charge of the battery is targeting to remain around 50%. This configuration is the best compromise between the most capacity of the battery to absorb electricity surplus, and the most capacity of the battery to counterbalance electricity “default” in the raw output.

The simulation (figure 3) shows that the state-of-charge (SoC) rapidly varies, however still remaining around the value of 50% charge.

Moreover, the state-of-charge seems to remains within the range 49-51% during the actual production of the tidal turbine.

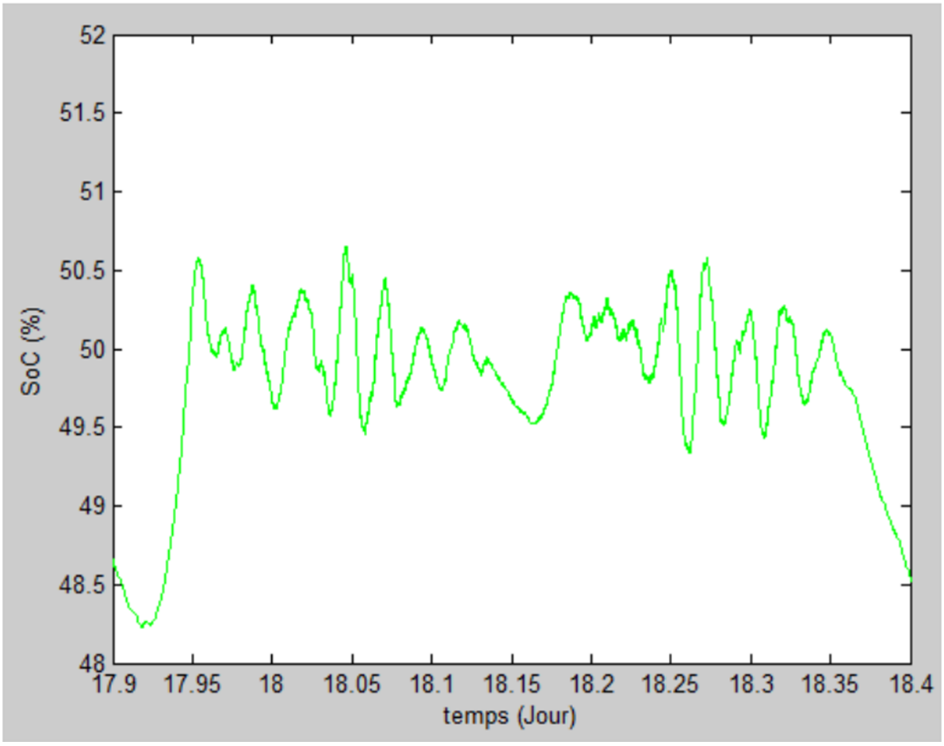

Figure 3 : Simulated evolution of the state-of-charge of the battery rack - 2 tides with coef 43 and 40 and HIGH swell

ANTICIPATED AND/OR RECORDED IMPACTS/ BENEFITS

The impacts of this objects are based on two aspects:

1) The first benefit is the increase of electricity infected on the grid, and therefore the increase of renewable electricity share of Ushant energy consumed.

2) The second impact is on the global renewable marine energy sector, with the development of this new technical bricks that should increase the development of renewable marine energy, which is particularly important for islands and coastal area.

ANTICIPATED AND/OR RECORDED CHALLENGES

One main challenge of this solution is that it depends on the tidal turbine technology, which is for now not completely mature. The testing and improvement of the storage-smoothening unit requires the tidal turbine function normally.