Long-duration Storage (LDS): a fundamental step for massive exploitation of Variable Renewable Energies

Long-term storage(LDS), defined for storage time of 10 hours or greater, may have a strong impact to the exploitation and cost reduction of Variable Renewable Energies (VES) as wind or solar electricity systems. If batteries are used primarly for infra-day storage , LDS will be used for inter-season or even multi-years storage making more reliable and affordable electricity system . LDS technologies for VES includes today power-togas-to power(PGP), pumped hydro-storage(PHS) and compressed air energy storage(CAES). Today my short presentation will focus on PGP technologies and use of nanomaterials to improve the affordability and reduce the costs of such a scheme. PGP strategy implies the transformation of electricity (or excess of electricity) into H2 via electrolysis, storage of H2, transformation of H2 to electricity either thermally, via combustion turbines, or electrochemically, via Fuel Cells. The electrochemically way looks particularly interesting through the use of Solid oxide Electrolizers (SOEL) and solid oxide Fuel Cells (SOFC), although there is a need to develop a proper heat storage strategy in order to increase the energy efficiency of SOFC/SOEL system to a level of 65-70%. In an alternative process architecture, H2 could also be transformed into methane via a methanation unit using concentrated CO2. Methane could be stored as natural gas is routinely stored today and later combusted into a gas turbine upon demand , with CO2 captured, concentrated , stored and recycled. Although this latter scheme my seen easier to implement from a technological point of view , we need to consider the costs associated with CO2 capture and methanation. In any of the above scheme there is anyhow a need to storage large quantity of H2. Together with gas storage up to 700 bar, with an energy consumption of 2-3 KWh per kg of H2 or liquid H2 storage with an energy consumption of10-12 KWh per kg of H2, with a major issue of the boil-off occurring 3 days after a vessel is charged, new solutions are gaining importance , achieving higher volumetric efficiency above 100 kg H2 per m3 : metal hydride(MH) and carbon nanotubes . In MH , H2 is chemically bonded with metals or alloys to form hydrides, here the major issue is agian the heat management. In Carbon nanotubes adsorption , temperature is the key factor and operation is quite effective under O degree C.

A proper definition of all components of the PGP architecture is then essential to reduce the costs of VES, in such quest of process optimization, nanotechnology may play a role in all the components.