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Cryogenics for Power and Energy: A Winning Ticket?

Pierre Crespi

Air Liquide Advanced Technologies, Paris, France

E-mail: pierre.crespi@airliquide.com

***Abstract*—For 60 years, the Air Liquide Group has been working on major international industrial and scientific programs using cryogenics, which have enabled the development of technologies and competencies today serving the energy transition. For example, the Ariane rocket program has developed a mode of space transport using liquid Hydrogen as an energy vector, for which more than 800 Hydrogen, Oxygen and Helium tanks have been produced and flown successfully over 45 years. This mastery naturally led us to get involved in other sectors of mobility, such as Hydrogen charging stations for land transport and liquid Hydrogen tanks for trucks, planes and ships.**

"Big Science" is also a strong enabler for this energy transition, with facilities like the LHC at CERN or the ITER fusion reactor, which use numerous superconducting magnets cooled with liquid Helium, working in the so-called Low Temperature Superconductivity domain, or LTS. A direct spin-off of cryogenics for Big Sciences, the large Hydrogen liquefiers necessary for the energy transition are now directly derived from these Helium liquefiers, while the use of superconductivity at higher temperatures or HTS, which stands for High Temperature Superconductivity, appears more and more attractive to generate and transport electrical energy in an increasingly electrified society.

This plenary conference will present several examples of the latest cutting-edge cryogenic technologies used for space, aeronautics, terrestrial mobility and large scientific experiments. It will also provide an insight on potential medium and long-term markets for the use of high temperature superconductivity for fusion reactors and energy transportation, as well as various uses of liquid Hydrogen. The industry is now on the path to carbon neutrality and cryogenics will play an important role in energy production, transport and storage. The global cryogenics community is nowadays able to provide practical, efficient and reliable industrial cooling systems over a wide power and temperature range that are game changing. This will pave the way to a more sustainable industry and great scientific experiments.

Keywords (Index Terms)—Cryogenics, superconductivity, energy transition, hydrogen, windpower, CO2 capture, hydrogen mobility, large cryogenic refrigerators. turbo-Brayton

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