Design the Sustainable Future of Manufacturing

Call for Innovation

Scope of Work: IMC: Call For Innovation

Background Information & Problem Statement (Why is it important for us)

The objective of this call for innovation is to identify breakthrough and disruptive next-generation Renewable Power to X solutions that would help reduce CO2 emissions of PM MTB. PMI is fully committed to fighting climate change and it has released its Low-Carbon Transition Plan (LCTP), showcasing the ambitious new sustainability targets and setting the scene for how the company will operate in the future. PMI plans to go Carbon Neutral (Scope 1 & 2) by 2025, MTB would be a leading example of this transition with a portfolio of solutions to decarbonize the value chain.

One of the focal points of this effort is towards increased penetration of renewable electricity (solar and wind) to replace the existing electricity sources which are predominantly from fossil-based fuels. Along the same lines, the MTB is exploring the case of setting up a behind-the-meter renewable energy power plant to decarbonize the electricity sources whilst also looking at electrification of the heating. The heating is presently dominated by natural gas and the electricity is procured via the grid.

It must be noted that PM MTB has a substantial consumption of Natural gas required for producing steam and district heating, this is the major contributor to CO2 emissions of the factory. Approximately 50% of the total CO2 equivalent emissions of the factory (linked to Natural Gas) are considered hard to abate and remain at the focus of the MTB to be reduced with innovative technologies. The call for innovation is aligned to reduce the hard-to-abate CO2 emissions while linking renewable energy generation with round the clock supply of energy. Since steam (maximum of 200 °C) is the energy vector for the majority of heating for the factory, an emphasis shall be given to technologies that help bridge the gap between renewable electricity and steam production via various innovations. This does not however limit this call for innovation to only thermal storage but any other vector of energy that would decouple generation and utilization of renewables for round the clock energy supply.

The challenge is that the renewable energy sources remain intermittent and linked to the availability of the sun and wind resources, this makes it difficult to have a round-the-clock supply of clean energy and also causes issues in the operation of an industry. To overcome such a challenge, this call for innovation is looking for breakthrough technologies from Italian companies/start-ups which support the theme of round-the-clock energy via renewable Power to X. The core motivation would be to utilize the excess solar and wind to be stored in an energy vector, which could be energy storage or conversion to molecules like hydrogen, that can be later utilized to fill the gap between generation and demand. These technologies shall be evaluated scientifically with the best ones being selected for potential pilot opportunities.

Main Theme 'Power to X':

The overarching theme of the call for innovation shall be focused on converting the excess generation from the renewables to a new vector that can be later utilized back either in form of electricity or heat or as a new molecule (like Hydrogen). The theme can be further juxtaposed to what is called as Long-Duration Energy Storage (LDES) solutions, these include various forms of converting excess energy for storing it to provide a round-the-clock supply of energy. In general, these can be categorized into four main zones (these are not exhaustive lists of technologies but some examples):

1) Electrochemical: Electrochemical energy storage refers to batteries of different chemistries that store energy. E.g., air-metal batteries or electrochemical. Some examples:

- Aqueous flow batteries
- Metal anode batteries
- Hybrid flow batteries

2) Thermal: Thermal energy storage systems use thermal energy to store and release electricity and heat. E.g., heating a solid or liquid medium and then using this heat to power generators at a later date.

- Sensible heat
- Latent heat
- Thermochemical heat

3) Mechanical: Mechanical systems store potential or kinetic energy in systems for future use. E.g., raising a weight with surplus energy and then dropping it when energy is needed.

- Novel Pumped Hydro
- Gravity based
- Compressed Air Energy Storage
- Liquified Air Energy Storage
- Liquid CO2

4) Chemical: Chemical energy storage systems store electricity through the creation of chemical bonds or creation of a new chemical (like Green Hydrogen) E.g., using power to create syngas, which can subsequently be used to generate power or heat.

- Power-to-gas-to-power
- Green Hydrogen

For Green Hydrogen: Specifically for technology providers focused on providing green hydrogen, the call does not limit the end utilization of the hydrogen thus produced. The focus of this stream would be on not just the generation of green hydrogen but also various innovative applications like CHPs, mobility, heating from green H2 to replace natural gas, etc. In general, the application of Hydrogen could be either to replace natural gas for steam production or used as a fuel for supply chain trucks, or even as combined heat & power. Furthermore, novel forms of storing Hydrogen are also invited in this call, this would also include new methods of efficiently storing Hydrogen (like metal hydrides, liquid Hydrogen carriers, etc.). An integrated end-to-end solution for the generation of hydrogen and its utilization for the industries like PMI would also be very well accepted.

State of the Art:

The state of the art includes electrochemical batteries (predominantly Lithium-Ion), which are today utilized for peak shifting and energy arbitrage-related applications. These batteries are very effective for short duration storage applications for 2 to 3 hours of energy storage, as the hours of storage increase they also lead to substantial capital cost increments for the batteries. Furthermore, Lithium-Ion is best suited for many other applications and is limited in resource-based supply (i.e. the Lithium reserves). It also has the use of materials that can be classified as rare earth or toxic (based on chemistries like NMC). For coupling with renewable energy power plants, short-duration energy storage does not make a substantial impact as industries demand round-the-clock supply of energy which would require longer duration forms of storage or conversion of excess energy from the renewable power plant to a molecule that would be acting as an energy vector.

In the context of green hydrogen production, the state of the art includes traditional alkaline electrolyzers and the standard PEM electrolyzers. The traditional alkaline systems suffer from the inability to react to a sudden change in power (due to lower current densities) from renewable sources and hence require energy storage to buffer the intermittent nature of renewables, these electrolyzers also have issues with liquid and reactive electrolytes that may cause issues by decay in the system. The standard PEM systems are able to cater to the fluctuation in the loads but are rather CAPEX intensive with the use of significant rare materials. There have however been a lot of innovations in these types of electrolyzers that overcome the stated weakness and the call is open to innovations in all forms of electrolyzers or hydrogen generation systems.

Objectives/Expected Outputs:

Over-arching Theme:

- To identify breakthrough and disruptive next-generation Power to X solutions that would help reduce CO_2 emissions of PM MTB, with the focus of coupling with renewable energy plants to offer round-the-clock balancing.
- Technical benchmark of the technology against the state of the art with various techno-commercial benefits highlighted.
- Understand the technical and commercial maturity of solutions with a potential pathway for pilot projects at the MTB.
- High-level techno-economic cases of the innovations that shall be identified for potential applications.
- Levelized cost of energy reductions versus the state of the art and technical benefits compared to the existing technologies.

What is that we are not searching (technologies, solutions, partners that we want to avoid):

- Technologies that offer 2 to 3 hours of energy storage.
- Technologies with toxic metals being utilized and no form of recycling available.
- Technologies that are considered commercially mature.
- Technologies that shift the scope of emissions from one zone to another (e.g. from scope 1 to scope 2 etc.)
- Hydrogen technologies that are utilizing carbon capture (i.e. blue hydrogen).

- Systems that are not modular can only be done at utility scale (+100 MW).
- Systems requiring geological changes like drilling deep inside the surfaces of the premises (like Geothermal).
- Hydrogen innovations focused on reduction reactions for steel and reforming sectors.
- Hydrogen applications for very high temperature reactions like concrete or cement.

APPENDIX

Background info-graphics for Long Duration Energy Storage Technologies and Power-to-X

Source: Long Duration Energy Council (Home | LDES Council)