What are Energy Vectors?

One of the consequential challenges facing society today is to ensure that everyone has access to reliable energy while also protecting and preserving the natural environment. The Government's undertaking for eminently all gross energy consumed to be from renewable, zero-carbon sources continues to drive change in the energy system apace with European and international targets.
In 2018, the EU agreed upon a climate and energy framework setting clean energy targets and policy objectives for the period from 2021 to 2030. On that count, abatement of greenhouse gas emissions by at least 40 percent below 1990 levels, renewables to deliver 32 percent of energy and further, efficiency ought to improve by 32.5 percent. What do these targets really imply? How will Europe's energy system assemble in 2030? Which elements of the energy transition are particularly pertinent?

As we transition to a more sustainable energy system, that dispenses secure, affordable and low-carbon energy usage, new energy vectors metamorphose. Recent precedents include unconventional gas supplant to natural gas in the system and CO_2 schemed as a tradable and transportable commodity. The inception of new energy vectors in the system requires approaches that rationalise their interdependences and the roles and interactions of the collaborators who partake within the network.

Energy vectors, aptly described as the human made energy that is not directly usable, but which must be extracted or produced before being transported and stored in appropriate quantities for a prolonged use over time, in applications that are not always calculable in advance. The use of renewable energy resources with integration of energy vectors into the flow chain is pivotal for promoting sustainable energy systems. The cost, volume, energy density and environmental compatibility of alternative energy vectors are of critical importance.

The momentous energy vectors with plentiful potential for realisation of a global comprehensive energy system include:

- Hydrogen
- Electricity
- Synthetic Fuels
- Heat-Transfer Fluids

Hydrogen is a clean energy vector and an effective medium for storing energy. Often seen as an eco-friendly ideal energy vector owing to its low environmental impact and dependable traits, hydrogen can be produced from many sources that are accessible in enormous quantities i.e., natural gas, water and electricity, biomass, biogas etc. Hydrogen is a sustainable alternative to natural gas. When separated from natural gas, the carbon dioxide released by the process is captured and either stored below the surface or utilised in chemicals manufacturing. This yields what is known as blue hydrogen. Another way to produce hydrogen is by separating water molecules (H_2O) into H_2 and O with the aid of renewable electric power, referred to as the green hydrogen. Ammonia—one nitrogen atom bonded to three hydrogen atoms—is the highest carrier of hydrogen, which has a significant energy density in contrast. Ammonia has almost twice as much energy as liquid hydrogen by weight.

Renewable electricity generation is an essential part of a sustainable energy future. Hydroelectric power, using the potential energy of rivers, is by far the best-established means of large-scale electricity generation from renewable sources. In contrast to wind and solar generation, hydro plants have considerable mechanical inertia and are synchronous, helping with grid stability. A significant proportion of electricity can be provided from wind, photovoltaic systems, solar thermal systems, geothermal energy, ocean energy and biomass.

Synthetic fuels are carbon based liquid fuels produced using chemical conversion processes from carbon rich sources such as captured carbon dioxide streams from the exhausts of industrial processes, coal, natural gas, biomass or biogas. Major synthetic fuels include ethanol, methanol, biodiesel, biogas and syngas. Sustainable synthetic fuels (either liquid or gaseous) can be used as a like-for-like replacements for fossil jet fuel, diesel and fuel oil.

Heat Transfer Fluids are a viable medium to store energy for power generation and heating and cooling applications. Thermal fluids are normally low-viscosity mineral oils that are chemically stable at the higher operating temperatures. Concentrated Solar Power generates electricity by focusing solar radiation to heat the fluid thereby used to generate steam (or to heat a different working fluid such as air) to drive a turbine-generator arranged in the power block.

The far-reaching riddle for the energy sector in the expanding era of energy vectors is perhaps the identification of vectors most suited for utilisation in innovative multi-energy vector integration opportunities. From an energy perspective, energy vectors can be sifted for the economic, energy and technological investment in bringing forth their synthesis, transportation, storage and final use. The screening for the energy expenditure in whetting the development of energy vectors will also help reduce the associated waste and extend the energy available for end consumption compared to the primary source.