A solution to the climate and plastic crises

The hydrogen economy requires government involvement

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A SIGNIFICANT transition of the national energy systems is underway, as nations in response to the climate crisis make right on their commitments to urgently decarbonise the economy.

The decarbonisation will mainly be achieved through a concerted push for energy efficiency, as well as a complete shift from fossil fuels to renewable energy. The fluctuating energy production of most renewable energy sources, such as wind and solar power, means that future electric grids must incorporate energy storage systems.

Hydrogen is one of the exciting energy storage technologies, which can be produced from excess renewable electricity production. The hydrogen is produced from electrolysis of water, which is the decomposition of water into oxygen and hydrogen gas by applying an electric current.

Later, the stored hydrogen can be converted into electricity again by reversing the chemical process in a fuel cell. Advantages of hydrogen includes its low energy losses during storage and its clean water vapour emissions when used by fuel cells.

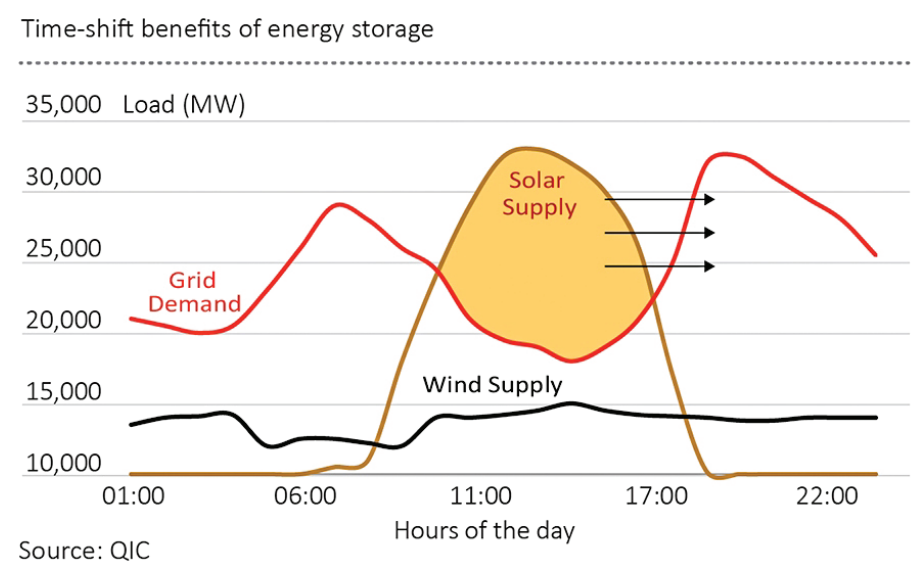

Figure 1: Energy storage needed for fluctuating renewable energy sources

In recent years, political commitments and substantial investments have taken place to spur on the hydrogen economy, with countries like South Korea, Japan and Germany leading the way.

The latter recently announced a €10 billion investment plan with the declared goal of becoming the world leader in the field of hydrogen technologies.

The emerging-market interest for hydrogen is exemplified by the British green hydrogen technology company ITM Power, which has seen its share price increase 15-fold over the last year.

The European Union (EU) predicts that 24 per cent of the world's energy will come from hydrogen by 2050 and identifies "hydrogen [as] a vital missing piece of the puzzle to [achieve] decarbonisation".

In July 2020, the EU presented a hydrogen strategy for a climate-neutral Europe. The long-term plan is to make hydrogen greener and cheaper.

At the moment, 96 per cent of the hydrogen is "grey", as it is produced from fossil fuels, so EU's priority is to develop "green" hydrogen produced entirely from renewable energy sources.

At about twice the price, green renewable hydrogen is not yet commercially competitive with the fossil fuel alternative produced from natural gas.

For renewable hydrogen prices to come down and become commercially competitive, hydrogen technologies such as electrolysers need to mature over the next decade or so.

As such, from 2030 onwards, renewable hydrogen technology expected to be deployed on at a large scale. On the short-term, the EU is supporting the installation of a least 6 GW and 40 GW of renewable hydrogen electrolysers by 2024 and 2030, respectively.

Clean aviation fuel

The rapidly growing transportation sector accounts for 16.5 per cent of the total greenhouse gas emissions. Decarbonising the transport sector has so far proven difficult, though there are promising signs that electric vehicles might someday become mainstream.

However, for the aviation industry, heavy batteries are not a feasible solution, particularly not for long-haul flights. Hydrogen, which contains 236 times more energy per kilogramme than lithium-ion batteries, is looking like a promising option as future aviation fuel.

And with the EU starting to create legislation that forces airlines to use zero-emission fuels, the hydrogen aviation fuel option is being seriously looked at – also by the shipping and truck sectors.

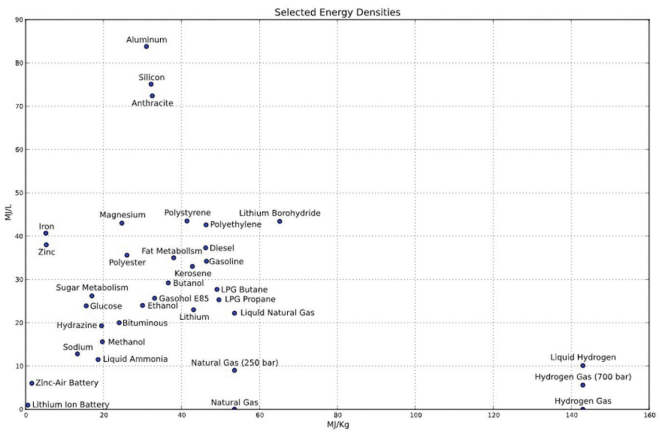

Figure 2: Energy storage densities plotted per weight along the x-axis and per volume along the y-axis

Hydrogen is a gas and takes up a lot of space. For practical purposes in the aviation industry, hydrogen needs to be compressed, either as a liquid or as compressed gas.

While liquid hydrogen has a very high energy density per weight, it still has a relatively low energy density per volume.

Even when compressed as liquid hydrogen gas, its energy density is still 3.5 times lower than that of gasoline. It is also worth mentioning that compressing hydrogen comes with a 35 per cent energy penalty.

Reuse of all plastics

Despite decades of efforts to recycle plastic, only about 10 per cent of global plastics are recycled, while 80 per cent end up on the landfill or in Nature. One reason is that sorting out the hundreds of different types of plastic is difficult and/or uneconomical.

The pervasive plastic pollution of our environment, including the micro-plastics, ingested/inhaled by all animals and humans alike, is cause for significant concern.

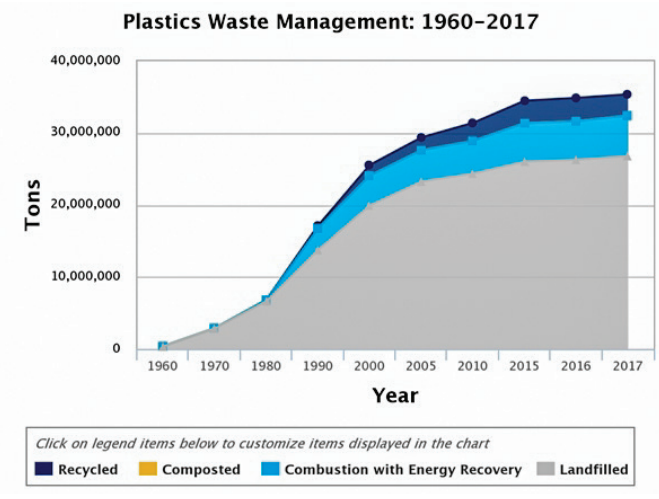

Figure 3: Plastic waste management since 1960

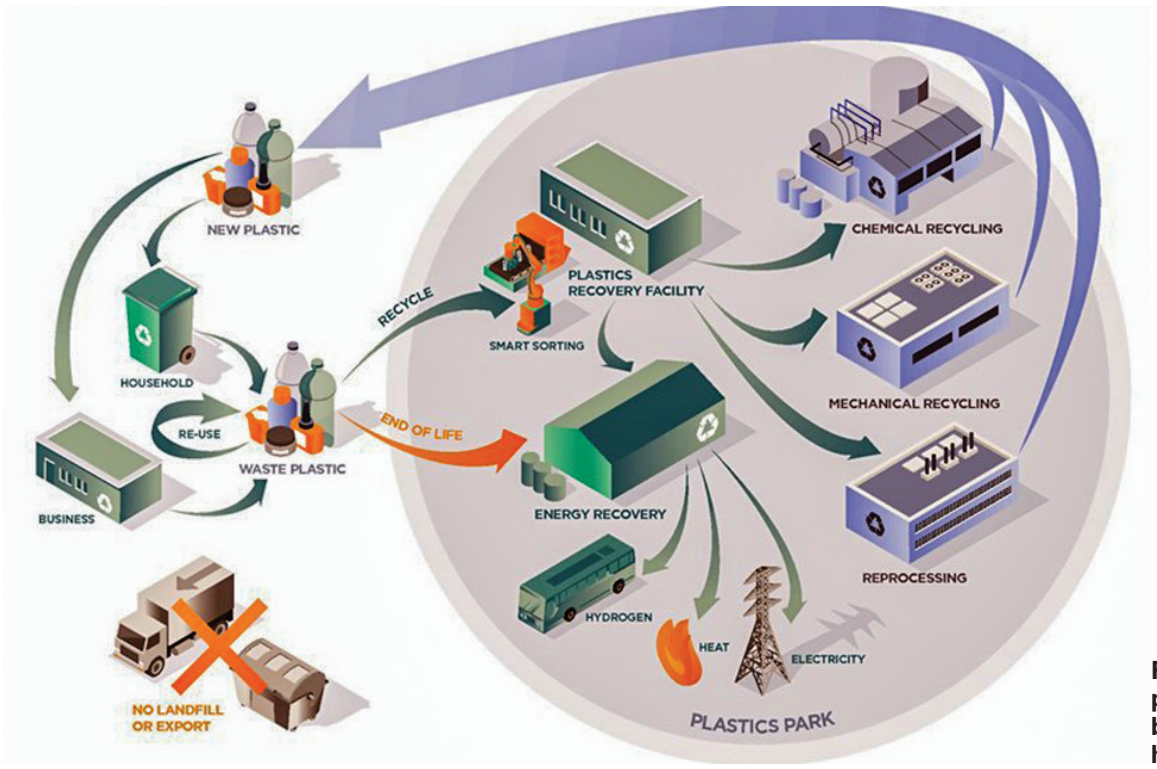

Figure 4: All plastics can be made into hydrogen fuel

All plastics can be pyrolysed at 430°C and be made into hydrogen as well as other byproducts. Interestingly, the hydrogen economy can therefore help to rid the world of the plastic pollution problem because it allows all plastics to be converted into hydrogen fuel.

The Hydrogen Economy

There are a growing understanding and acceptance that the hydrogen economy requires government involvement. Having strong government involvement, including substantial government investment, gives confidence and attracts other investors.

Moreover, the hydrogen economy requires planning on a regional and/or national level.

As such, the government must be a vital driver of the hydrogen economy by bringing the key stakeholders together and through discussions, deliberation and targeted policies and incentives ensuring that there will both be a hydrogen demand and supply.

Creating a hydrogen economy from scratch will not happen by itself.

At the most fundamental level, the hydrogen economic planning must identify the big hydrogen produces and big hydrogen consumers/exporters.

This includes identifying the location of the big renewable energy production areas such as large scale solar and windmill parks.

The hydrogen energy storage and hydrogen power station locations must also be identified to ensure uninterrupted power supply for the existing power grid during periods of low renewable electricity production.

Proximity to heavy energy-intense industry, such as chemical production and steelmaking, should also be planned.

Moreover, integrated planning that taps waste heat from the hydrogen processes for use in other industrial processes, district heating or district cooling should be implemented.

For hydrogen fuel infrastructure, this must for starters be put in place for fueling of aeroplanes, ships, and trucks.

With the hydrogen market projected to reach €630 billion by 2050, infrastructure for hydrogen as an energy commodity – not unlike crude oil today – for import and export needs to be planned.

In other words, a system's thinking approach is needed for the successful implementation of the hydrogen economy, allowing for the emergence of a decarbonised economy.

Climate Crisis

In a global perspective, most countries in the world have de facto committed to transitioning to a low-carbon economy when they signed on to the Paris Climate Agreement.

The hydrogen economy is an essential piece in the puzzle of achieving this goal and in abating the climate crisis – and potentially also the plastic pollution crisis. **– @*green***

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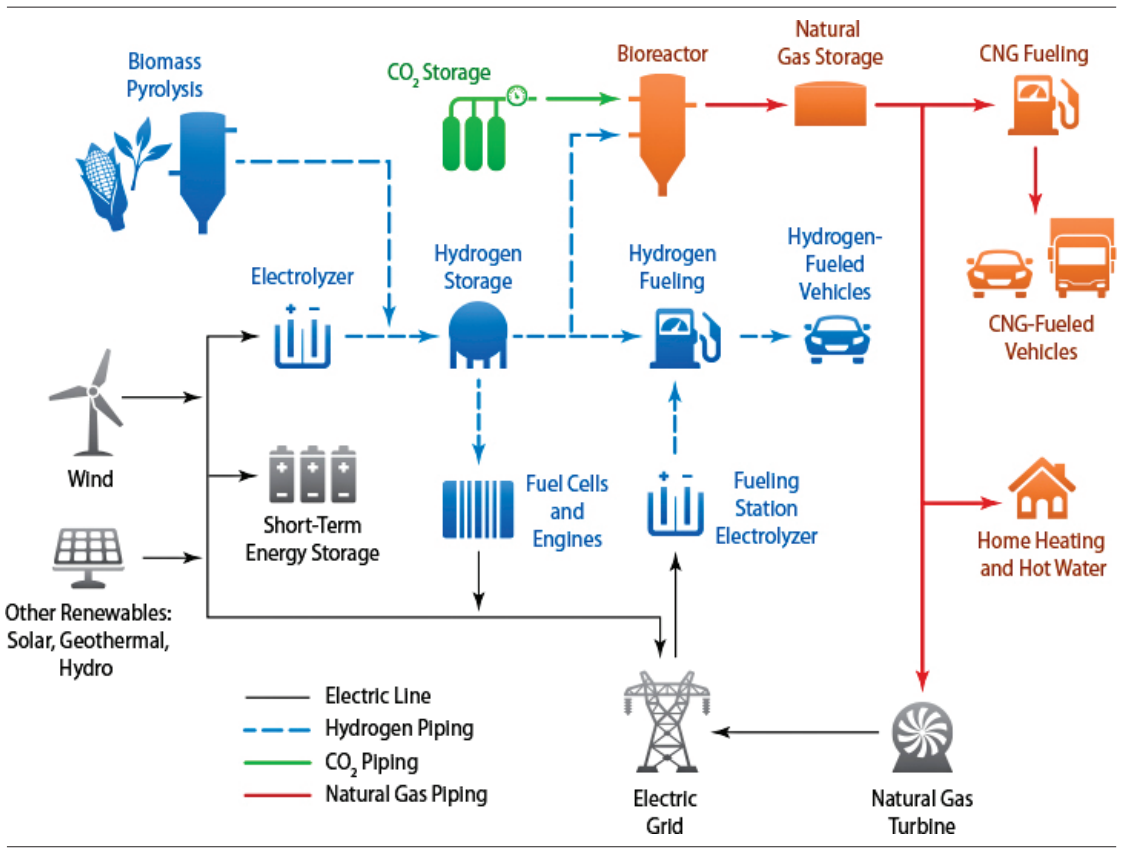

Figure 5: The future decarbonised energy system with integration of renewables and hydrogen

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