The Oil Storage Industry - Future Options

by Charles Daly, Channoil Energy

June 2022

Based on the current theory, that the life of the fossil fuel industry is less than 30 years or so, to take us beyond the current 2050 target for eliminating fossil fuels from the world, then we must look at what potential alternative uses these large areas of primarily waterfront locations can be turned to.

The current thinking is that about a third of storage terminals that are currently employed storing chemicals will continue in use. Those storing vegetable extracted oils will also continue in use but may be under capacity pressure.

The results will be that current transportation fuels terminals storing gasoline, diesel, kerosine and bunker fuels should become more or less redundant. That is the theory. However, once we remove the political rhetoric, what is a most likely scenario? The developed world, primarily the G6 countries plus the EU 27 might be able to achieve their stated targets of Net Zero by 2050. The stated Net Zero targets will be a struggle to achieve. What exactly is meant by Net Zero? Will it be achieved?

The history in this respect is not good. When it came to environmental clean-up, waste was exported from these (G6 + EU) countries to the developing world in order to achieve their own targets. The same occurred with the first-generation biofuels. In this case swathes of land were turned to palm oil and sugar cane to create so called clean fuels. Then it was realised that when land use change was considered, these biofuels were no better than fossil-based ones in terms of carbon emissions.

Could the same happen with Net Zero? Net Zero implies that for every tonne of carbon emitted by the G6 +EU 27, a tonne of carbon needs to be eliminated elsewhere on the planet. Maybe this can be achieved by planting trees in the developing world and using this argument to offset ongoing fossil fuel use but still achieving Net Zero.

Nonetheless, efforts are being made to decarbonise power through the furious pace of building offshore wind and desert based solar farms. This, coupled with nuclear generation, will eliminate a substantial amount of the carbon emitted by the power generation industry.

Now the world is moving towards a major conversion of the transport fleet to electricity. The case for this change has been pushed by political rhetoric but has not yet been made or fully researched. The scarcity of the battery building metals and the damage to the environment created by the energy and human effort needed to mine them, has not been sufficiently explained to the general population and if and when the message gets through, there will be a massive outcry and could result in a slowdown in take-up or even rejection of the EV.

How does this bear on the oil terminal? The reality is that those oil terminals that are sea fed and have lengths of waterfront, can shift their business to other waterborne trades, albeit with some investment. The first is the container trade. If the growth forecasts for international trade are to be believed, then an increase in container traffic is to be expected.

The next change would be driven by the fact that oil storage is only one form of energy storage and therefore other forms of power storage should be considered as potential use for the redundant tank farms. At this stage of this revolutionary change to energy supply, it is impossible to guess which technology will win out and what will be the game changer.

In this paper we will try and review the diverse options currently being proposed as the future storage of power options.

Li-Ion Grid scale batteries

The most obvious is the Li-Ion battery. There are currently many grid scale batteries being built around the world, especially in those countries that already have surplus wind and solar power.

These batteries can store surplus cheap power when the grid is overloaded, at night for example or on extremely sunny periods. One of the arguments against Li-I is the one stated above of the damaging impact to the environment in those countries where the basic metals are mined. These metals are lithium, cobalt and manganese. These rare earths are so called because they are not abundant. They occur in conflicted areas and are subject to human exploitation. Think of countries such as the Congo, Mali, Senegal and China.

There is another reason to be cautious about these large Li-I batteries. They are known to have the propensity to self-combust and once the fire takes hold it is almost impossible to put out, as it is a chemical reaction. Recent cases resulted in a battery fire in a car on a car carrier in the mid-Atlantic that resulted in the ship sinking with the loss of its cargo of luxury cars.

Therefore, placing of these storage batteries needs to be away from population centres and hazardous materials, which seems to defeat the object of the exercise in the first place.

Another problem not clearly publicised is that the weight of the EV is much more than a conventional one and this creates more tyre and road surface wear. All these need energy to produce and repair. These considerations need to be taken into consideration when evaluating the potential damage to the environment in a 'mine to wheel' analysis.

Volvo recently produced an interesting report on this subject. This report presents the carbon footprint of the new fully electric Volvo C40 Recharge, in comparison with a Volvo XC40 ICE. The major finding was that the accumulated emissions from the materials production and refining, Li-ion battery modules and Volvo Cars manufacturing phases of C40 Recharge are nearly 70% higher than for XC40

ICE. However, the savings in carbon emission during the running of the two vehicles shows that carbon emission break-even occurs at round the 110,000 km when utilising global electricity production mix. https://www.volvocars.com/images/v/-/media/Market-Assets/INTL/Applications/DotCom/PDF/C40/Volvo-C40-Recharge-LCA-report.pdf

Hydrogen

Storing energy in the form of hydrogen appears to be gaining attraction in the current climate. Hydrogen made by the electrolysis of water seems so easy to produce and the revolutionary fuel slips off a politician's tongue like ice. What is electrolysis and if it is so easy, why has it not been done at scale to date?

Electrolysis is the splitting of a molecule by the use of two electrodes and requires lots of electricity. A molecule of water H_2O holds two atoms of hydrogen and one atom of oxygen. Splitting this molecule will give you the hydrogen and the oxygen, simple! If this hydrogen is being used as a store of energy, then why consume so much energy to produce it? The ratio of production is as follows: 50KWH is needed to electrolyse 9 litres of water to produce 1 kg of H_2 (99.9% purity).

A further constraint is that hydrogen is a very light gas and to store it requires cooling it to below minus 240 ^{0}C. This in itself requires considerable amount of energy. As an example, a liquefier for hydrogen production of 27,000 Kg per day will have a capital cost of around $US 100 million and a power demand of 8-10 KWH/Kg.

The other problem with hydrogen is that it is a tiny molecule and it escapes easily, therefore storing it costs a lot of depending on the form of storage. Underground storage (the cheapist) could be $1.80 per Kg or $1,800 per tonne. Compare this with current fossil fuel storag rates of $3.00 per tonne.

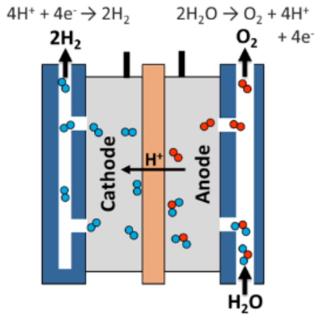
However, hydrogen can be useful in high cost single consumer applications, such as the manufacture of steel or fertilizer. When comparing hydrogen as a fuel against cheaper and better alternatives, the case fails. Politicians are very glib about this new wonder fuel, but are burying their heads in the sand when it comes to the practicalities - they are for someone else to solve. Professor Sir Dieter Helm, in a recent asessment of the UK Government's Energy policy paper calls it a 'Lobbyist's Utopia'. I think this is an astute observation.

For instance there is no mention of the enormous cost of converting domestic heating and cooking systems wholly to hydrogen. This exercise will require changing the current grid and every boiler and cooker in the world. The limitation of injecting hydrogen into natrual gas without change in infrastructure is 20%. This constraint will place great strains on households that will need to be driven by electric cooking inorder to completely eliminate fossil fuels. This also implies a massive write off of the gas grid infrastructure.

How Does it Work?

Like fuel cells, electrolyzers consist of an anode and a cathode separated by an electrolyte. Different electrolyzers function in different ways, mainly due to the different type of electrolyte material involved and the ionic species it conducts.

Polymer Electrolyte Membrane Electrolyzers



Source US Energy Dept.

From the storage industry point of view there is no case to pioneer building storage for pure hydrogen until the economic case for its use is made.

Hydrogen in chemical carrier composition

The other case is that hydrogen can be carried within chemical compounds that are easier to handle and store. These routes are already well known as is the case for most hydrocarbons. However, if we want to eliminate carbon we need non-carbon compounds.

Most discussed at present is ammonia (NH_3). This is a liquid at Standard Temperature and Pressure (STP) and can be handled by most systems, except that it easily combines with water to produce $NH_4(OH)$. This product is commonly known as ammonia water and is used as a domestic bleach. In concentrations above 40% ammonia it causes burns to the skin and its vapours cause irritation to the eyes. It is corrosive to copper and zinc and can explode in an exothermic reaction when in contact with strong acids such as Sulphuric Acid. It has a boiling point of 38^0C, which implies a need for cooling in warm climates.

Therefore its use as a carrier for hydrogen has certain limitations and will require investment in current mild steel terminals for it to be handled at scale.

Nonetheless ammonia is expected to be the prevailing option for long-distance hydrogen transport as it is already known how to handle it and it is just a question of scaling up. It will be used to transport hydrogen from sunny producer countries to cold consumer countries

Other methods of carrying hydrogen includes the use of hydrides. However the problems with non carbon based hydrides is that they require a lot of heat to release or bond the hydrogen atom and most of the stable ones are metallic. These can be handled as powders. Therefore their use will be very industy specific. One for the silo rather than the oil tank.

Liquid Air-Cryogenic battery

The development of liquid air cryogenic batteries is currently being tested at pilot and commercial scale in the UK, Spain and the USA. This technology is well known and should represent a simple solution to the power storage issue. Air is liquified overnight when power cost is low and stored in liquid form. A synchronous turbine is coupled to the tanks and runs in slow rotation. When the grid calls for additional power the turbine can be spooled up to provide grid based power by releasing the air from its liquid state. The only issue with this technology is that it is not long duration power.

The liquid alternative fuels

Methanol

There is an argument in favour of methanol, particuraly cellulose derived. Sustainable production of methanol is already being used in powering the transport sector but can also be used in clean cooking.

Sustainable methanol (CH_3OH) can be produced from biomass, timber or by fusing captured CO2 and hydrogen produced from cheap offshore wind powered electrolysis. Although a caution here from the paragraph on Pure Hydrogen above.

Nonetheless, if the economics of methanol as a fuel are proven and carbon emissions pricing is the key to this, then storage terminals can certainly handle it. It is a light colourless liquid with a density at 15^0C of 0.786 and a Flash point of 11^0C. Therefore very similar to the lighter petroleum fractions that are regularly stored.

There are already a number of ships curently operating methanol powered engines and it is the author's belief that a substantial number of newbuilds will be delivered into the fleet in the future. This is one for the bunker industry to think about, since they have not been traditionally used to handling low flash material.

Crop Based Biofuels

These are currently being used and stored in oil terminals where blending occurs to meet the various road transport fuel obligatiuons imposed by Governments. They are the solution only in the short term if the drive to EVs remains as positive as it is now and whilst the future ban of sales of conventional ICE vehicles stays in place.

Therefore they are not likely to be a long term solution. They cannot continue to compete with food demand as the planet's population continues to grow.

Liquified Natural Gas (LNG) - Liquified Petroleum Gas (LPG)

Thus far we have seen LNG used in ships and LPG in cars as autogas. However, as these are derived from fossil fuels they do not have a long term future. In reality they will probably be around for a long time as they can be classified as lower emission fuels with respect to carbon emission when compared to the alternatives.

Conclusions

From the foregoing it is clear that Oil Storage Terminals will need to change their functionality. They will need to invest in diversity and handling capability.

The future is not sufficiently clear at the moment and brave pioneers may or may not get it right.

The panaceas of liquid hydrogen as the fuel of the future is not proven.

Alternative uses can include battery storage or other forms of liquid power alternatives to fossil fuels.

Timing is going to be critical as we observe the development of clear thinking on carbon emissions valuations and the derivative markets that are needed to facilitate investment decisions.

The technology of the future is not known and a number of game changers could be just over the horizon.

Clarity on CCUS and Nuclear power is sorely needed by industry in order to cause a wave of serious investment in realigning the storage terminal industry.

For further detailed studies in the sector contact consult@channoilenergy.com

Charles L Daly

Channoil Energy – www.channoilenergy.com

June 2022