Renewable Energy

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By Channoil Consulting Ltd

A look at the Oil and Gas markets and the future for Renewable Energy.

1. FOSSIL BASED FUELS

Channoil Consulting are experts in the field of fossil fuels and have for many years been advising companies and governments all over the world on the economic use of these fuels. Until recently, our consultancy service has mainly been in the fields of refining, storing, handling, marketing and pricing. However, as we proceed towards a zero-carbon economy the future for the downstream oil industry is changing and Channoil is changing with it. Today we are repositioning ourselves as providers of advice on a holistic energy model.

2. ESG - THE BUZZ WORD (ENVIRONMENTAL, SUSTAINABLE AND GOVERNANCE)

Our contacts in the investment and financial community have made it clear their future investments must meet ESG criteria. This means they will be reducing their involvement in fossil fuel investments in the new era.

We are taking this as fact and believe that without their investment, or even with it, the fossil fuel industry will decline and be replaced by EGS power generating systems. The question is, what is the timeline for the changeover and how will it affect both the oil producing countries and the oil marketing companies? In this paper we look at some of the issues involved.

3. THE MARKETS

The main markets for fuels are:

- Transport (cars, shipping, planes and trains)
- Chemicals (primarily plastics and fertilizers)
- Power (light and heat)
- Agriculture (dairy and agriculture)

Of the above, the main generators of GHGs (greenhouse gases) are transport and power generation. Within the transport sector, we see a two-tier market developing, with the cars on one leading the move to the electrification of transport by switching to EVs and the shipping and aviation sectors potentially leading the move to the development of alternative fuels, as the current batteries technology cannot support their needs for transport energy.

3.1 THE INTERNAL COMBUSTION ENGINE

The solutions being offered to replace the internal combustion engine (ICE) for cars and potentially trucks are primarily focused on the EV (fully electric vehicle), with an interim phase of PHEV (Plug-in Hybrid Vehicle). The batteries in these vehicles put demand straight back to the power generation sector. The PHEV will still need some form of fossil fuel in the medium term and is unlikely to make a big dent in the emissions of GHGs.

The EVs also depend on battery capacity that is reliable and offers a high cycling potential. Currently, the only serious contender in this sector is the lithium-ion battery, which requires cobalt and lithium. Although lithium is readily available, cobalt is expensive and in limited supply. The extraction of both metals is environmentally damaging and cobalt comes from geographically and geopolitically unstable sources. As a result, extensive research is under way at present to try to replace cobalt in the manufacturing process, and no doubt a replacement will eventually be found.

The future growth of EVs seems inevitable. Every manufacturer is driving the EV forward, both in terms of capex and of R & D. Battery technology is moving forward, too, and although it is currently a limited-life option, a breakthrough cannot be far away. Indeed, a Chinese company claims it has developed a long-life battery, which has allegedly been provided to both Tesla and BMW. With Volkswagen and Renault also investing heavily in giga-factories for batteries, the EV is here to stay.

3.2 ALTERNATIVE FUELS

As noted above, a breakthrough in battery technology is on the cards but research and development is also proceeding on alternative fuels for motor vehicles. Those being examined in this context are hydrogen, ammonia and methanol.

All three of these fuels have their problems. Hydrogen is currently too expensive to produce, ranging between US$2,000 and US$3,000 per tonne, given that gasoline trades in the range of $300-$500 per tonne. However, a lot of funding is now going into the production of ’green’ hydrogen by electrolysing water using spare wind or solar power. These and other processes for producing hydrogen do not look to be sustainable as they are predicated on the assumption that cheap power will be available forever. This will clearly not be the case because generators of wind and solar power will not be producing surplus power once economical and effective storage options for electricity are built.

For their part, both ammonia and methanol suffer from a low energy intensity. This means they would both require twice the volume of gasoline and diesel to produce the same power output. Additionally, ‘green’ ammonia relies on hydrogen as the primary feedstock and thus is expensive to produce. The alternative is to use methane as the starting block, which is not a ‘green’ solution.

The major problem with switching the world’s fleet of transport vehicles to EVs is that we would need to build more than twice today’s power generation capability. While this is not impossible, it would take an enormous amount of funding and of course it will take time.

However, if the right sort of policies are put in place - and by this we mean less-restrictive planning rules and an efficient and fair emissions trading system - then the changeover will in due course take place.

Here it should be noted that the role of diesel as a fuel for heavy trucks has not yet been solved, though experimentation is under way to use CNG (compressed natural gas) for these vehicles.

Summarising the above, we come to the billion dollar question: If there is no clear path for replacing diesel and, as we discuss below, kerosene, then refineries and the downstream oil business in general could face a problematical future. How can they exist profitably in a dual-fuelled world and is it possible to do so?

3.3 AVIATION KEROSENE

In the aviation sector the importance of the ratio Watt/kg does not favour electricity. So unless some other major breakthrough happens, we foresee the use of hydrogen as a potential aviation fuel, providing new technologies for storing the hydrogen can be found. At present the steel containers that would be needed to store liquid hydrogen safely would be uneconomic because the passenger load would need to be severely reduced. There are possibilities such as graphene and Kevlar on the horizon that might be adapted to storing hydrogen, but they are still at the research stage.

All the other products and processes, such as used cooking oil conversion (HVO, hydrogenated vegetable oil), that have been given publicity as potential sources of aviation fuels, are limited in scope and lack the volume to make much of a dent in the demand for jet kerosene. Therefore, there is a danger that these may be seen as just publicity stunts.

3.4 MARINE TRANSPORTATION

In the marine transportation sector, we see possibilities for hybrid power systems that could help with decarbonising the fleet. These could be ammonia and turbo sails. Electric power is currently being experimented with on small autonomous vessels, such as tugs and harbour patrol boats. The use of LNG and methanol is also an interim possibility for reducing GHG emissions.

3.5 CHEMICALS

Chemicals are the life blood of the plastics industry and we do not see much opportunity to, for example, replace plastic furniture with wood. To do so would result in a much greater deforestation than we have already seen taking place for agricultural purposes. Chemicals are also used to make fertilizers that are used to create the food that is needed for an ever-growing population. Therefore, we see little possibility to reduce the demand for chemical feedstocks such as ethane and propane as well as for petroleum naphtha for steam crackers.

Lately there has been talk of the electrification of the chemicals manufacturing industry. Two main barriers to this exist. The first is the price of the power required. The second is the source of the carbon - the building block for most of the organic chemicals in use today. If it does not come from oil, where does the carbon come from? One might think CCS (Carbon Capture and Storage) and DAC (Direct Air Carbon capture) would be the answer. However, because of the long lead times needed to develop this technology, and the fact that chemical plant is built to last decades, we are driven to conclude that Power-to-Chemicals technology is some way away and must remain outside the scope of this short dissertation.

3.6 AGRICULTURE

Finally, the agricultural sector. We are told that dairy farming is one of the biggest contributors to global warming because of the methane exhausted by the animals. The only solution here is to reduce the demand for red meat.

In arable farming there is more that can be done. We are aware that well-meaning policies by governments around the world sometimes have unintended consequences. One obvious example is the drive to insist that crop-derived fuels are added to petroleum products to reduce pollution. These remedies have been discredited and should be scrapped as soon as possible.

The use of large swathes of agricultural land to grow rapeseed or corn to produce biodiesel and bioethanol seems to fly in the face of conventional wisdom. In Brazil, large tracts of the rainforest have been cut down to plant sugar cane to produce bioethanol for use in ICE engines. The same goes for Indonesia and Malaysia, where oil palms have been planted for biofuel production. It is a well-known fact that the rain forest is a major absorber of carbon dioxide. By cutting down the rain forest we are robbing ourselves of a major carbon absorber.

4 CLIMATE CHANGE

Although a lot of agitation on short term issues can result in misplaced political action, the best way to curb the rise in the planet's temperature is through market-related strategies. Punitive action, such as closing industries because they are contributing to global warming, is no solution.

Instead, a carrot is always better than a stick. A solid financial return is therefore needed to encourage investment by industry to clean up polluting industries and to change the amount of GHGs emitted into the atmosphere.

This requires investment in new technologies. Technologies currently available, in addition to the known renewables, are Carbon Capture and Storage and Direct Air Carbon Capture and re-use. Cryogenic batteries using air or hydrogen, micro-hydro power from fast flowing rivers, and many other research projects such as solid-state fuel cells are all potential sources of energy. And on a major scale, we have tidal power that could be invested in at national level in those countries blessed with high tidal ranges.

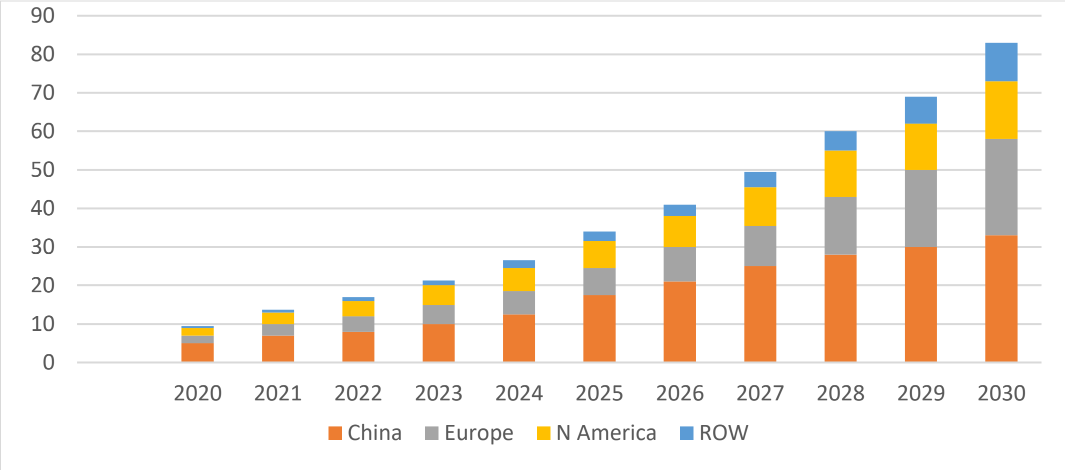
The technologies can quickly be brought into commission if the right financial incentive is available. We have seen figures suggesting a carbon tax of $50/tonne would be sufficient to ensure that investment in CCS and other technologies took place.

This can only come about if there is a global agreement on the price of emissions. There are currently 51 carbon pricing initiatives (25 Emissions Trading Systems and 26 Carbon Tax Systems) in the world but these cover just 20% of global emissions. If we are to achieve anything like the GHG reductions needed to stop global warming then we need to increase coverage of ETS substantially. Carbon pricing in these systems varies from US$1/tonne of carbon equivalent to $139 per tonne. Even within the EU, prices vary, ranging from Portugal at $8.00 to the UK at $25 per tonne. However, these prices are nowhere near the $50-$100 per tonne needed to incentivise investment in capacity and R & D. If the 'climate warriors' want to make a worthwhile impact, we believe they would be better served by directing their protests at the UN level, calling for a proper carbon emissions trading system. This is what lobbyists should also be asking for at COP 26.

5 POWER GENERATION

If the EV market is going to take off, and most forecasters agree that it will, increasing amounts of power generating capacity will be required. Based on the cumulative growth shown in Figure 1 below and the fact that the car fleet is renewed approximately every seven years, we would expect to see 360 million EVs on the road by 2030. We do not think the EV will see the same rates of growth in Africa as we foresee in China, Europe and North America. Even in N America the rate of growth for EVs will be slower because American motorists are still wedded to their large gas guzzlers. (See Figure 1 below.)

FIGURE 1 CUMULATIVE SALES OF EVS (MILLIONS)



Source: Wood Mackenzie

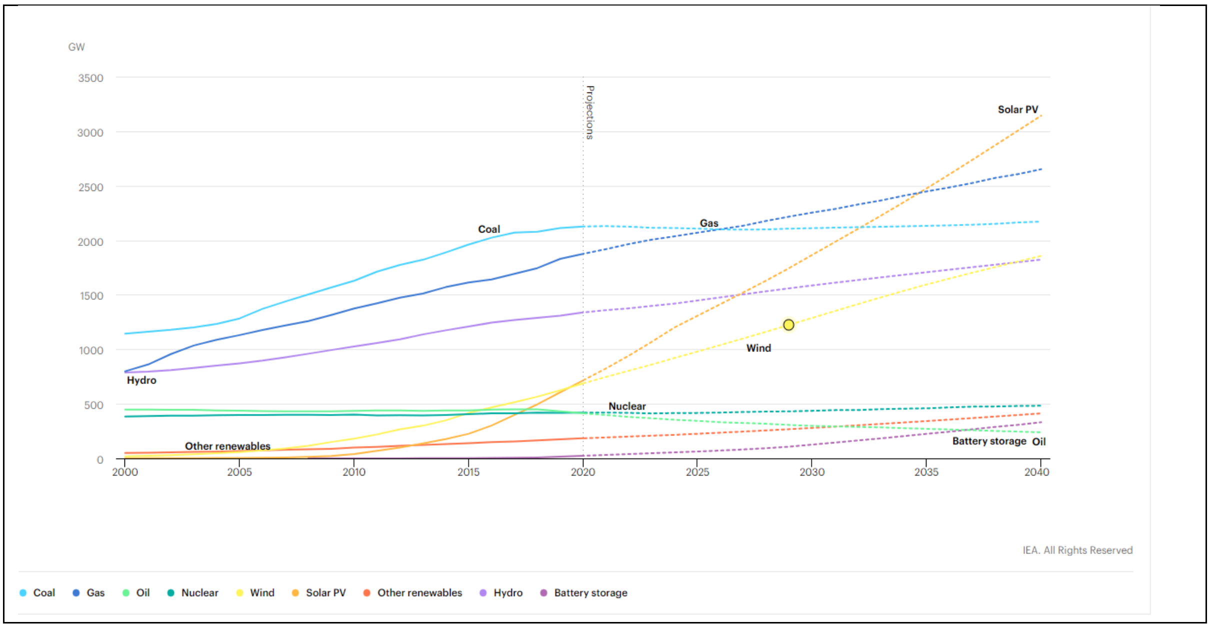
Furthermore, that capacity should be primarily in the form of sustainable energy. However, most outlooks to 2030 and beyond still show coal as one of the predominant sources of power, with 30% of primary energy produced by coal-fired power plants. This is a scenario that we believe is unsustainable and as pressure is put on the coal producing countries by the UN and other world political bodies, they will have to invest in EGS systems.

The following graph (Figure 2) from the IEA shows the projected impact of renewables that are likely to be seen beyond 2030. Solar PV is the fastest growing source of power. The impact of solar PV will mostly be felt in Africa, where energy growth is expected to outstrip China and India.

Our experience in Africa is that governments are nowadays being much more proactive in developing structures and legislation that incentivise the development of renewable power.

The major growth in solar power will be to provide lighting and heating but it will also be used to power industry.

FIGURE 2



Source: IEA

The cost of renewable power is now so low that subsidies are no longer required to incentivise investors to build Solar PV and Offshore Wind projects. Onshore Wind, however, is still problematical as it is considered environmentally damaging and it raises objections from local communities.

Figure 3 gives a range of Levelised Cost of Electricity (LCOE) for each of the competitive alternatives in 2020 and 2030. The data are an aggregation from a few sources and are only meant as a guidance. LCOE varies by country or region.

FIGURE 3

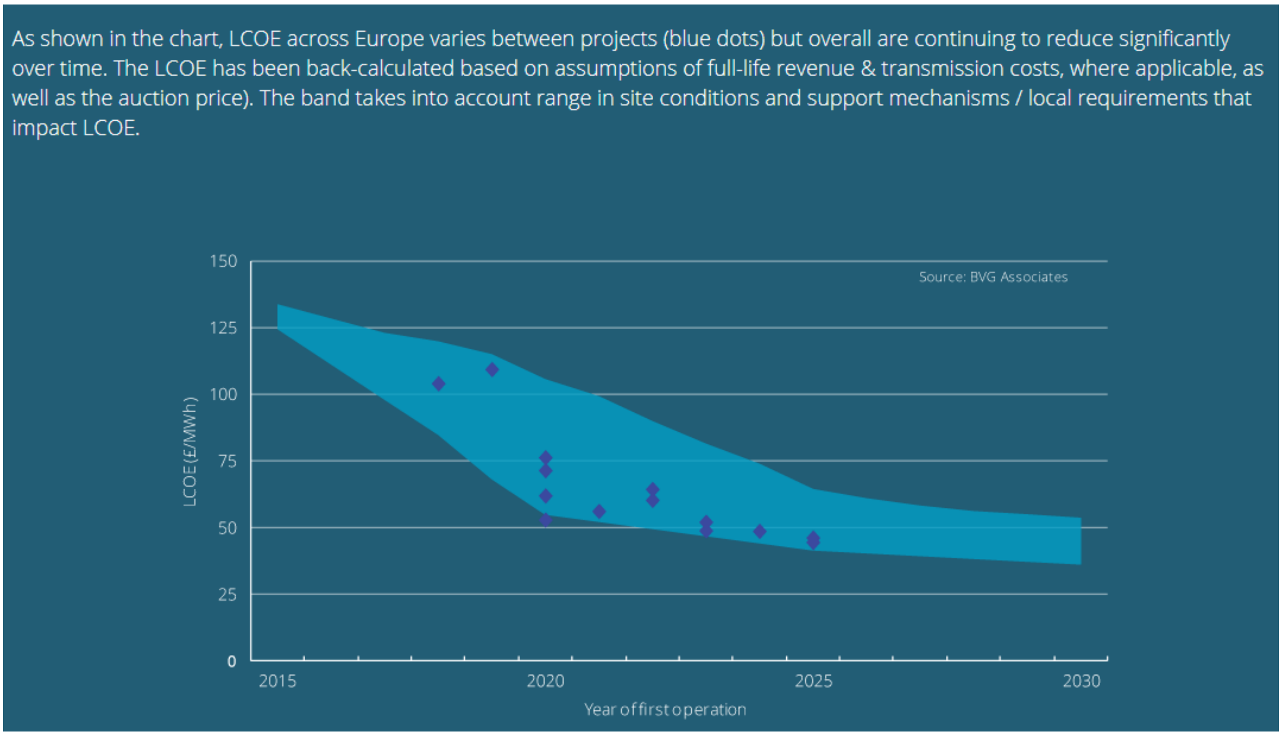
	2020	2030
LCOE	$US/MW	
Nuclear	116.5	118
Offshore Wind *	133	51
Solar PV	75	45
Gas CC	100	45
Coal	60	59

Source Channoil

*Offshore Wind offers in May 2020 to the UK grid from the Dogger Bank wind farm have been US$57-63 per MWh

As an example, the following chart (Figure 4) from BVG Associates shows the various LCOEs for European countries. What is noticeable is that they all show a falling trend.

FIGURE 4



Source: BVG Associates

In the USA, costs are slightly different, as this EIA table (Figure 5) shows.

FIGURE 5 ESTIMATED LEVELISED COST OF ELECTRICITY (LCOE, UNWEIGHTED) FOR NEW RESOURCES ENTERING SERVICE IN 2025 (2019 $US PER MEGAWATTHOUR)

Plant type	Capacity factor (percent)	Levelized capital cost	Levelized fixed O&M[1]	Levelized variable O&M	Levelized transmis-sion cost	Total system LCOE	Levelized tax credit[2]	Total LCOE including tax credit
Dispatchable technologies								
Ultra-supercritical coal	85	47.57	5.43	22.27	1.17	76.44	*NA*	76.44
Combined cycle	87	8.40	1.59	26.88	1.20	38.07	*NA*	38.07
Combustion turbine	30	16.17	2.65	44.33	3.47	66.62	*NA*	66.62
Advanced nuclear	90	56.12	15.36	9.06	1.10	81.65	-6.76	74.88
Geothermal	90	20.38	14.48	1.16	1.45	37.47	-2.04	35.43
Biomass	83	39.92	17.22	36.44	1.25	94.83	*NA*	94.83
Non-dispatchable technologies								
Wind, onshore	40	29.63	7.52	0.00	2.80	39.95	*NA*	39.95
Wind, offshore	44	90.95	28.65	0.00	2.65	122.25	*NA*	122.25
Solar photovoltaic[3]	29	26.14	6.00	0.00	3.59	35.74	-2.61	33.12
Hydroelectric[4,5]	59	37.28	10.57	3.07	1.87	52.79	*NA*	52.79

[1]O&M = operations and maintenance.
[2]The tax credit component is based on targeted federal tax credits such as the production tax credit (PTC) or investment tax credit (ITC) available for some technologies. It reflects tax credits available only for plants entering service in 2025 and the substantial phaseout of both the PTC and ITC as scheduled under current law. Technologies not eligible for PTC or ITC are indicated as *NA*, or not available. The results are based on a regional model, and state or local incentives are not included in LCOE calculations. See text box on page 2 for details on how the tax credits are represented in the model.
[3]Costs are expressed in terms of net AC (alternating current) power available to the grid for the installed capacity.
[4]As modeled, EIA assumes that hydroelectric generation has seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.
[5]Costs are for 2023 online year. See page 6 for details on the exception.
Source: U.S. Energy Information Administration, *Annual Energy Outlook 2020*

Source: EIA

As can readily be seen, Wind, Gas and Solar will all beat fossil fuel and nuclear generated power by 2030.

Therefore, we think the optimistic forecasts for oil and coal demand projected by the major oil companies will not be sustainable and we are of the view that political and environmental pressures will relegate coal to the bottom of the league by 2030.

6 ENERGY STORAGE

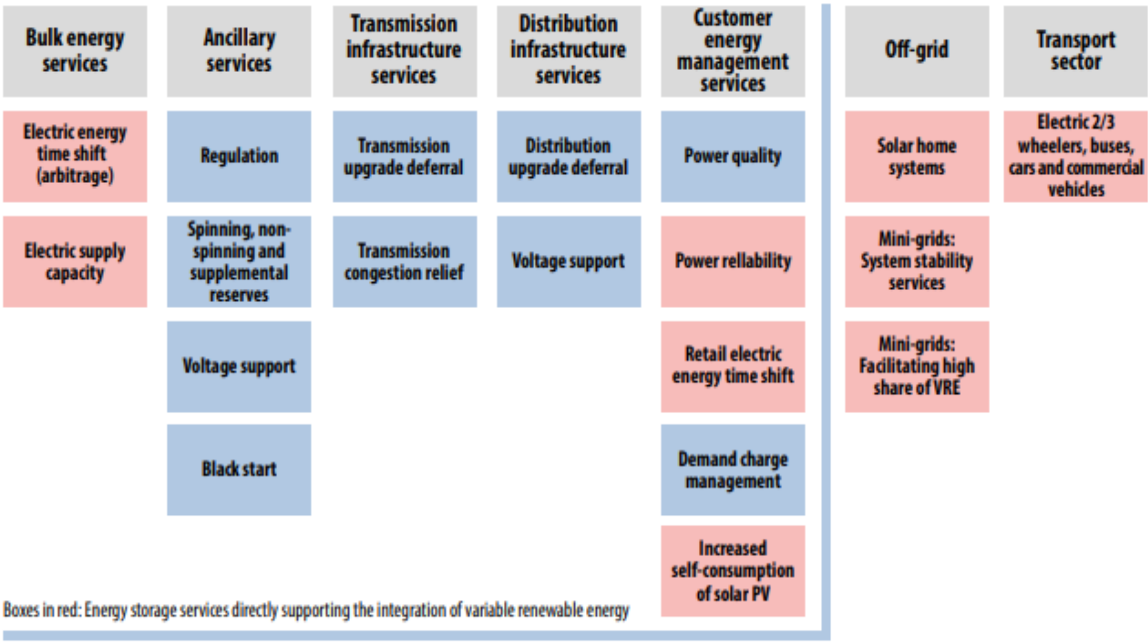
The one game-changer for renewable power will be the emergence of a capability to store power effectively. This can be done with current knowledge and technology, but the pressure for environmentally acceptable power storage will bring on new technology at an ever-increasing pace.

The essential uses of power storage are shown in Figure 6 below. In Africa and other developing economies, the development of off-grid or mini-grid storage already provides more efficient lighting and heating than conventional kerosene-driven light and heat.

In a recent auction by the UK Grid for power storage, 225MW of capacity was offered. In Australia, TESLA Corp has installed a 100MW battery for stabilising the grid for the city of Melbourne.

The forecast growth of storage capacity is directly linked to the growth of VRE (variable renewable energy) but on the basis that forecasts for VRE are set to double by 2030, storage demand will grow from 4.67 TWh in 2017 to a range of 12-16 TWh by 2020 *(source IRENA October 2017 report).* A substantial part of this will be standby batteries, pumped hydro and mechanical flywheel or turbine systems.

FIGURE 6: THE RANGE OF SERVICES THAT CAN BE PROVIDED BY ELECTRICITY STORAGE



Source: IRENA October 2017 report on electricity storage and renewables

7. THE RENEWABLES STORY

The first chapter in the renewables story can be considered to be the advent of the first generation of renewable fuels through the esterification of vegetable oils. Initially, palm oil and then rapeseed oil were used and later other oil seeds entered the picture. Old technology, admittedly, but it fitted the political narrative, and the governments of the countries involved mandated a certain minimum quantity (7% by volume) to be added to the diesel mix.

The gasoline market was treated to a bioethanol admixture. This came from sugar and corn and was also subject to a mandate, initially at 7% vol and now increasing to 10% vol. In Europe, where the EU RED II comes into force this year, we expect very little annual growth in biofuels consumption to 2030, as we expect the growth in EVs to subsume the need to increase biofuels usage.

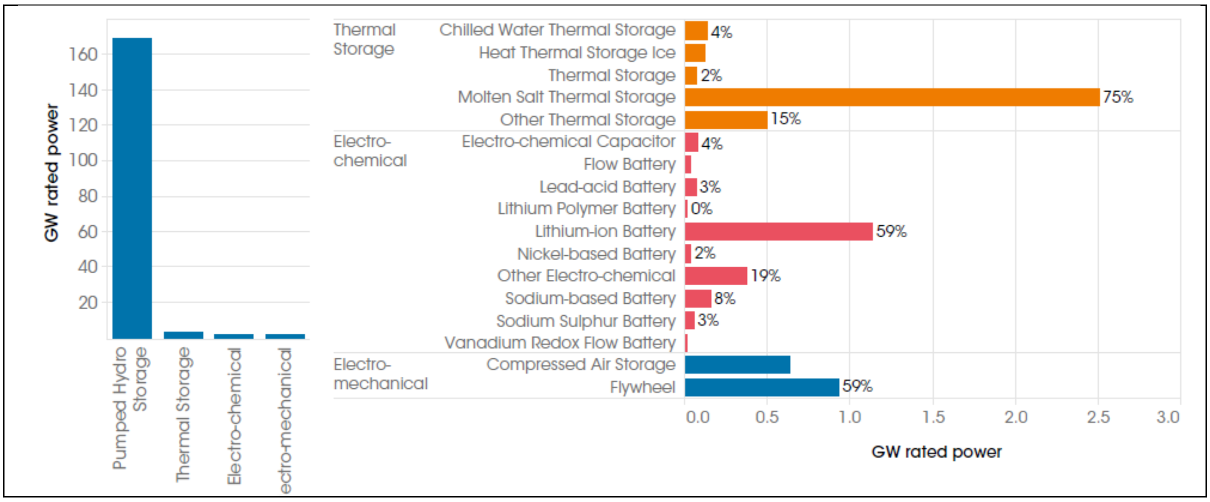
The next chapter of the renewables story came in the power sector via Solar PV and Wind (initially onshore). These were costly new technologies and needed a feed-in tariff to attract investment. However, the price of these technologies has now come down to the point where subsidies are no longer needed, and they can compete on their own strengths with the alternative fossil-fuel derived power.

Nuclear Power has also been considered a form of renewable power by some, as it has no CO2 emissions. In Channoil we do not agree with this classification as the technology still extinguishes a fuel source and we are sceptical about the future of nuclear power generation, as we do not believe it will ever compete after the Chernobyl and Fukushima disasters. The safety regulations that came in after these disasters have pushed capital costs so high that only long-term state investments can make them work. The Hinkley Point nuclear power plant being built by EDF and the Chinese company (CNG) in the UK, needed a government guaranteed take-or-pay price of £92.5 per MWh to attract sufficient finance for it to go ahead. Two further plants have been proposed in the UK, at Sizewell and Bradwell on the East Coast but we do not believe these will ever achieve Final Investment Decision status.

The penetration of more renewable power in the power mix has posed stability challenges for the electricity grid. The transition to full renewable energy will occur when proper storage, with the necessary guarantee of inertia is available. This could be via cryogenic battery technology and, subject to this technology working and proving its sustainability, it could be the final winner in the race. In the meantime, Lithium-ion technology has major problems to overcome as a storage system. There have been a few cases of batteries overheating and catching fire, and as we pointed out earlier, the rare metals needed are finite and mined in some unstable countries.

Figure 7 below shows the amount of power storage by type and capacity in 2017. We expect total battery capability to increase threefold by 2030. We also think it likely that the mix of technologies will change dramatically as new research and the development of cleaner and cheaper alternative storage systems are brought to industrial scale.

FIGURE 7: GLOBAL OPERATIONAL ELECTRICITY STORAGE POWER CAPACITY BY TECHNOLOGY, MID-2017



Source: IRENA

8. CONCLUSIONS

In this review we have tried to capture the known, and sometimes unknown, issues the fossil fuel industry is going to have to face. Already, the scale of the layoffs being made by the conventional oil industry are truly frightening.

We have covered the options that need to be considered when making the strategic decisions upon which the very survival of the oil business could depend.

Most, if not all, members of the industry have committed themselves to a net-zero policy by 2040. To reach that target they will need to invest in change; and to achieve the transition successfully, they are going to have to make drastic changes to their thinking and develop new skills.

The oil storage businesses are also going to have to think about where their future revenue stream will come from. The changes needed must start being thought through now and be implemented within the next five years. We see this as an area for crossover from the international oil storage business and one that must be taken seriously if the industry is not going to be left with empty rusting mild steel tanks.

There is some similarity between storing energy in liquid form (hydrocarbons) to storing electric power in some liquid form. So, with its experience and knowledge of storing pressurised liquid gases, the storage industry should find the transition to storing power via hydrogen, ammonia or other liquids relatively easy to make.

Channoil Consulting has put together a great team of experienced consultants with in-depth knowledge of the oil and gas industry. We ourselves have already made the transition to power markets and this allows us to offer our clients solutions that suit their specific needs and can help them safely navigate the journey from the old oil and gas world to the new holistic energy model.

If you want to know more please contact us at:

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