ENERGY TRANSITION OUTLOOK

Global energy demand grew at a compounded annual growth rate of 3% p.a. between 1950 to 2000 mostly spurred by growth in the Western world. The growth rate continued at 2% between 2000 to 2015 on the backdrop of accelerated industrialisation in China. However, during this time, concerns over climate change and adverse impacts due to rising Greenhouse gas (GHG) emissions started to alter the energy vision, leading to the birth of energy transition. A landmark agreement of restricting global temperature rise to less than 2°C above the pre-industrial level by 2050 was adopted in Paris by 190 state parties in 2015. Many countries made a conscious effort to effect changes in the energy mix commensurate with a reduction in carbon-intensive fuel dependence. It is also expected that the growth in global energy demand will fall by less than 1% per year between 2015 to 2030 and further halve to 0.5% per year between 2030 to 2050[1,2].

The Emission Scenario

The energy sector is the most significant contributor to human activity related GHG emissions at 73% of 49.4 Gt CO_2e as of 2016 data. Within this sector, heat and electricity are responsible for 30% (15 Gt CO_2e), transport accounts for 15% (7.9 Gt CO_2e), and manufacturing and construction at 12% (6.1 Gt CO_2e) of total emissions[3]. Figures 1 and 2 show the sector-wise GHG emissions.

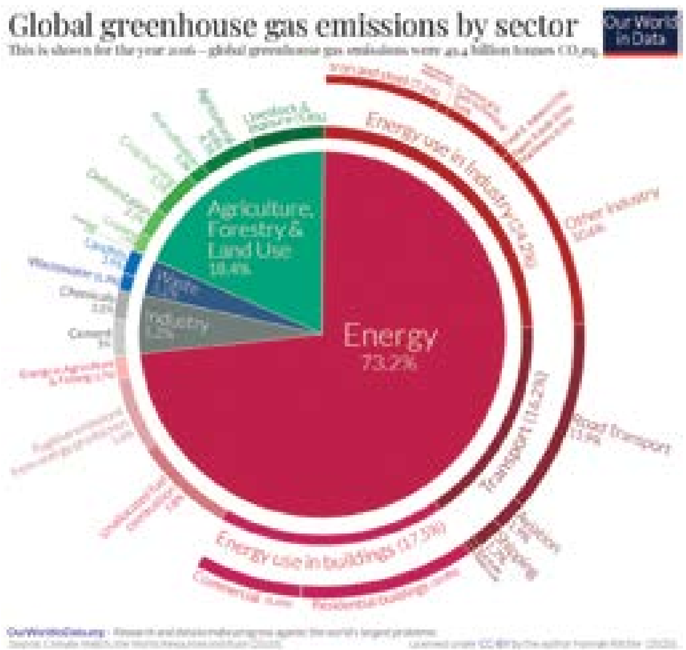

Fig. 1: Sector-wise emission of Greenhouse Gases[4]

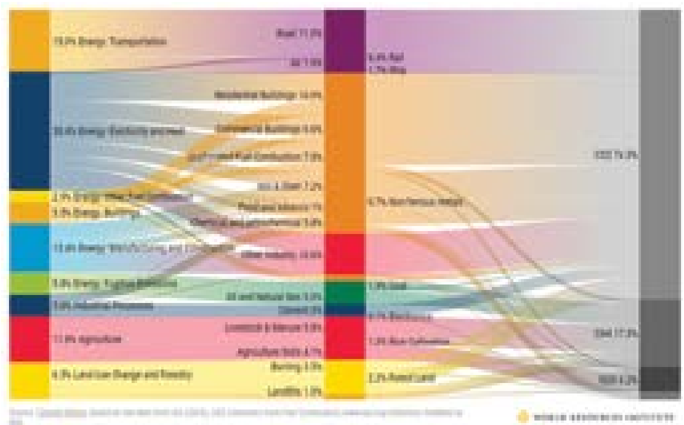

Fig. 2: Greenhouse Gas Emissions in 2016 by sector/ end-use/ gas emission[5]

1 Fueling the energy transition | McKinsey
2 Global Energy Perspective 2021: Energy landscape | McKinsey
3 4 Charts Explain Greenhouse Gas Emissions by Countries and Sectors | World Resources Institute (wri.org)

4 Emissions by sector - Our World in Data
5 https://www.wri.org/resources/data-visualizations/world-greenhouse-gas-emissions-2016

Path to Decarbonisation

To achieve deep decarbonisation of the global economy, it has become imperative to look for alternate energy sources, transitioning to greener sources.

The transportation sector is a significant contributor (16%) towards GHG emissions. These emissions are primarily due to burning fossil fuel for cars, ships, trucks, planes, trains, etc. Conventionally, over 90% of the transportation fuel is derived from petroleum resources – mainly Kerosene, Gasoline and Diesel. The energy transition must prioritise decarbonising transportation sector. Electric battery vehicles or Hydrogen fuel cell-based vehicles are the hot alternatives being actively considered by world economies.

Electricity production is another large (28.2% per cent of 2018 GHG emissions) contributor to the GHG emissions. Approximately 63% of the electricity is obtained by burning fossil fuels, mostly natural gas or coal. Study shows that the electricity demand is increasing seven times faster than demand growth of other fuels and in 2050 the total demand is expected to be double that of all other fuels put together1. Figure 3 depicts the rising electricity demand.

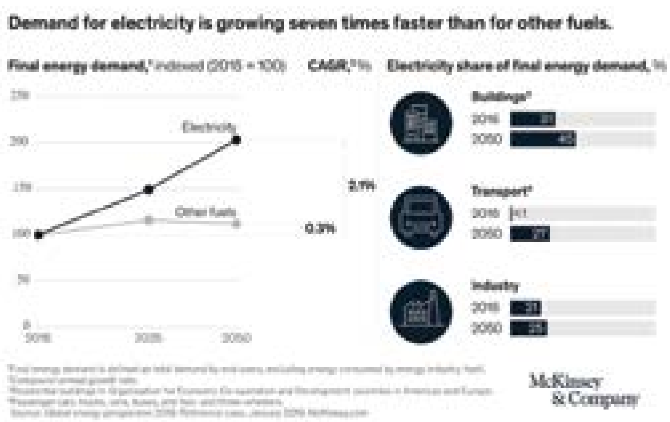

Fig. 3: Rise in Electricity demand

The growth of electricity demand will be driven by fuel mix changes in transport, industry and construction sectors, with renewables replacing oil and gas. Digitisation of industries would further increase electric power demand for handling increased demand from data capture, storage and processing. With the current efficiency improvement of energy generation, it is unlikely that the goal of 1.5°C temperature reduction looks achievable; GHG emissions are likely to reduce from current levels by 25% till 2050 reaching a 3.5°C pathway, refer Figure 4.

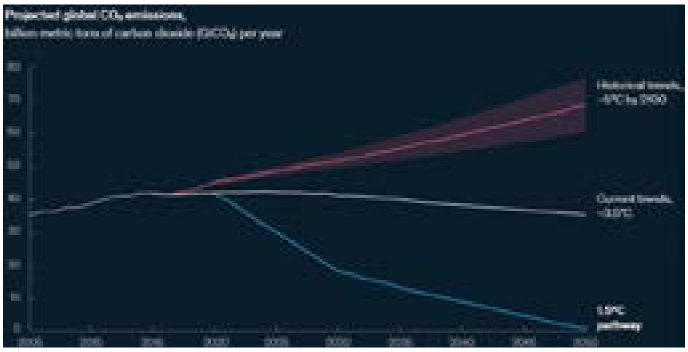

Fig. 4: Projected CO_2 emissions[6]

Another large share of GHG emissions is attributed to the industry (24%). Industrial GHG emissions primarily arise due to fossil fuels' combustion used as an energy source and greenhouse gas emissions from specific chemical reactions necessary to produce goods from raw materials. The industry sector is mainly considered ***'hard sector'*** to decarbonise because several large GHG contributors in the industrial (Eg. Steel, Cement, Petrochemicals, etc.) need a high temperature. Further, specific process requirements must be satisfied, making the switch to renewables difficult; moreover, a fifth of the industrial sector's carbon dioxide emissions are solely from the processes itself rather than the type of energy used. Slow progress in research and innovation on alternate approaches towards decarbonising the industrial sector also hamper progress.

Technological innovations provide a rational approach to achieving a low carbon economy. Technical solutions are always leading part of the puzzle in energy transition approaches. These could include use of zero-carbon or renewable energy sources, Adopting to the new alternate pathway, CO_2 capture from significant industries such as power, steel, cement, etc. in addition to efficiency improvements. However, technological advancements must be supplemented by proper policy support from the states, which can accelerate deployment of the emerging technology. Strategically designed policies incentivise faster adoption of emerging low carbon technologies and make more investments in such cleaner technologies more feasible or profitable.

The present policies for decarbonisation would only be able to keep emissions stable till 2050. Reductions in developed economies would be offset by industry growth in developing economies leading to increased use of coal, oil and gas-based power for transport and power generation[1].

6 The 1.5-degree challenge | McKinsey

Amongst the conventional carbon-based fuels coal demand peaked in 2014 and is declining by 40% from 2019 to 2050; oil demand is expected to peak in 2029 and gas demand in 2037, as shown in Figure 5.

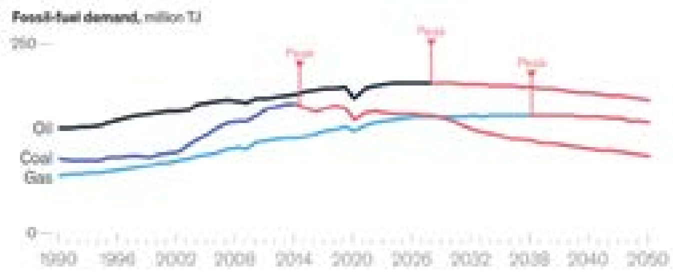

Fig. 5: Demand for Fossil fuels and peaking of demand[2]

The New Energy Scenario

Figure 6 shows the current mix of the global energy system and the contribution to CO2 emission from each sector. Fossil fuels dominate the energy system, and these are also a significant contributor to carbon emissions.

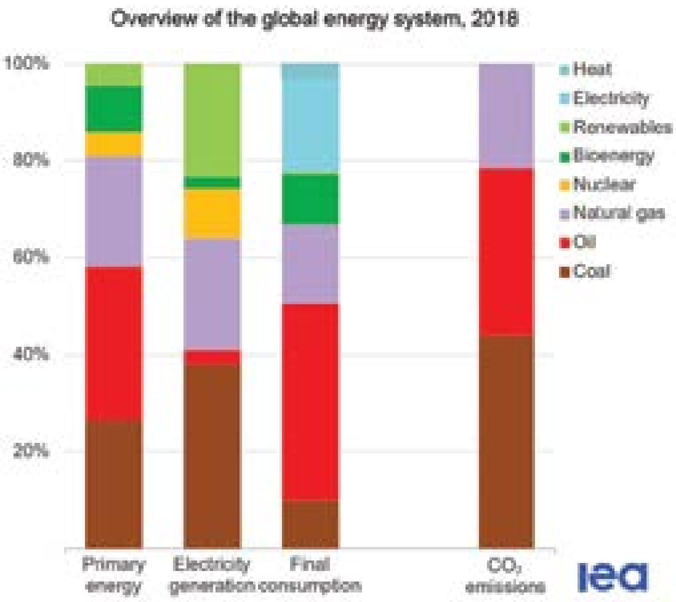

Fig. 6: Overview of Global Energy Mix and CO_2 emissions[7]

The International Energy Agency Assessment indicates that ***global energy demand is set to drop by 5% in 2020, energy-related CO_2 emissions by 7%, and energy investment by 18%. The impacts vary by fuel. The estimated falls of 8% in oil demand and 7% in coal use stand in sharp contrast to a slight rise in renewables' contribution. The reduction in natural gas demand is around 3%, while global electricity demand looks set down by a relatively modest 2% for the year.***

The global megatrends indicate wind and photovoltaic together will meet more than half of the world's electricity demand by 2050. All countries would also substantially increase the proportion of renewable energy in their total energy use by 2050. Renewables and batteries would form 80% of the market in new power capacity. It is expected that oil demand would continue to increase until 2035 and gradually decrease until 2050 to match and stabilise the current levels. Hydrogen economy would start gaining market share slowly from 2030 onwards.

The Energy Transition Path

There are three pillars to energy transition – generation, storage and efficiency; the related technologies converge to provide an integrated solution. The road to achieving climate change goals on the energy transition pathway essentially adopts the following tracks[8]:

- Electrification of transport – 15% of CO_2 emissions each year are from vehicle exhausts, and a reduction will require a widespread shift to electric vehicles
- Electrification of buildings – 7% CO_2 emissions come from cooking and heating in buildings and 20% from space and water heating, as shown in Figure 7.

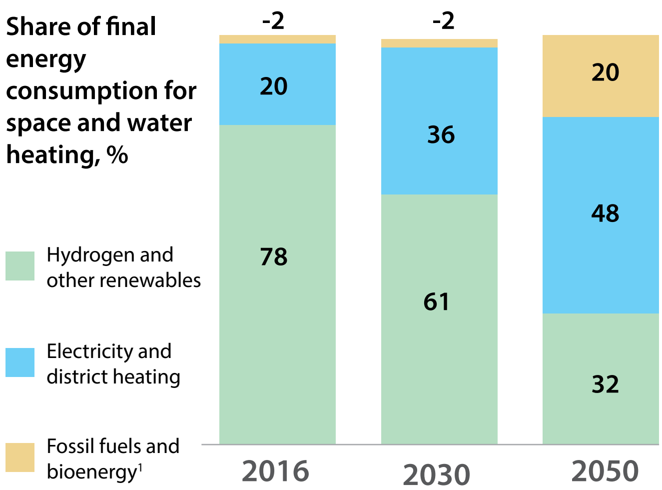

Fig. 7: Energy for Buildings[6]

- Reduce methane emissions – oil, gas and coal mining generates most methane, the second most potent GHG making up 40% of annual emissions. Reduction in demand, gas leakages and improving gas recovery are some measures that can be adopted to achieve fugitive methane emission of 40% of the current level in 2030 and 10% in 2050.

7 The Oil and Gas Industry in Energy Transitions – Analysis - IEA

8 The 1.5-degree challenge | McKinsey

- Improvements in industrial processes – 40% emission from metals, mining, chemical, and other processes need to be reduced to 2/3rd of 2016 levels by 2050. This can be achieved by adopting a circular economy, improving efficiency and optimising operations.
- Electrifying industrial processes – the most considerable emission reduction will come from the electrification of industrial heat process that can reduce 65% of the fossil fuel caused CO2 emissions. This is mostly applicable for low and medium temperature-based industries like construction, food, textiles, and manufacturing.

Decarbonisation of Power and Fuel:

Renewables – Approximately two-thirds of the current global power generation is from fossil fuel sources of coal and natural gas, generating 40% of the total CO2 emissions. Increase in wind power to five times and solar power to eight times the current levels would be required to achieve decarbonisation targets by 2030.

Hydrogen – Electrification alone may prove inadequate for decarbonising industries like steel making. These industries would require the use of low-carbon hydrogen generated from renewable power sources ("green" hydrogen) or by using natural gas with carbon capture ("blue" hydrogen). Figure 8 shows the increasing role of hydrogen.

Final global demand for hydrogen on 1.5ºC pathway, exajoules

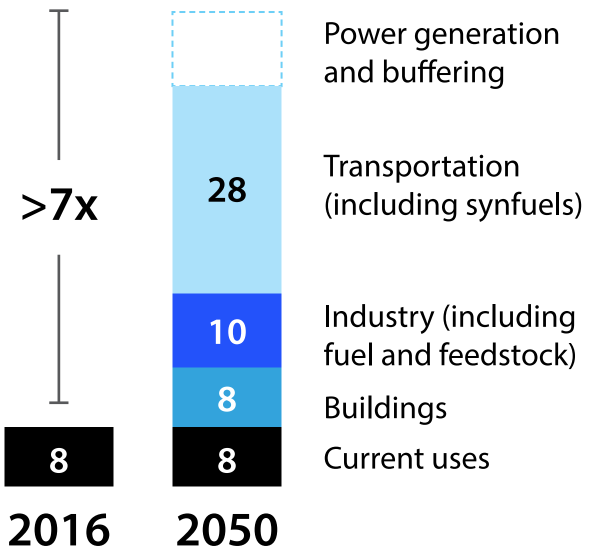

Fig. 8: Hydrogen demand growth[6]

Bioenergy – Industries like aviation, marine transport, and cement manufacturing are challenging to decarbonise through electrification or hydrogen. In these sectors, fossil fuels can be replaced with bioenergy using a sustainable conversion of biomass or waste to energy and feedstock, contributing 3% of total CO2 reduction by 2050. Figure 9 shows the growth of bioenergy in the mix.

Top uses of bioenergy by 2050, % of each industry's 2016 CO_2 emissions reduced via bioenergy

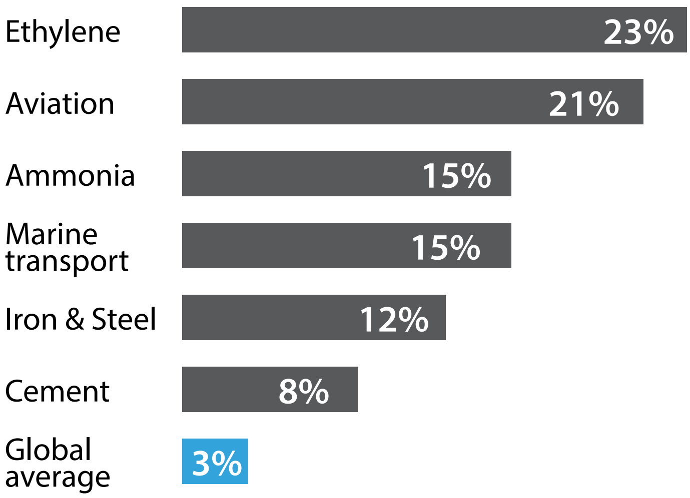

Fig. 9: Demand growth for Bioenergy[6]

The overall picture of energy transition is shown in Figure 10. The overall consumption increases two-fold by 2050, mostly through electrification and green hydrogen in the mix. Renewables are projected to become cheaper than fossil fuel-powered plants in the coming decade.

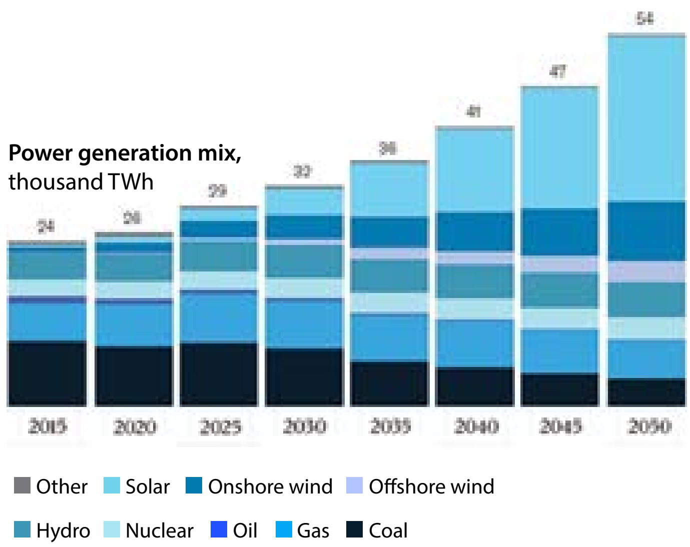

Fig. 10: Change in the power generation Mix[2]

Evaluating New Technologies for Energy Transition

International Energy Agency (IEA)[9] has developed different methods and tools to assess the various technologies' effectiveness for an energy transition based on scenario analysis. The Sustainable Development Scenario (SDS) targets rise in global temperature of 1.8°C in 2070 with a probability of CO_2 emission reaching net-zero as 66%. Negative CO_2 emissions after 2070 would enable reaching the target of restricting temperature rise target of 1.5°C by 2100. Such negative emissions have also been studied in 88 scenarios by the Intergovernmental Panel on Climate Change (IPCC).

The Energy Technology Perspectives Model 2020 (ETP 2020) by IEA uses a combination of scenario techniques to evaluate the energy sector's performance in the long term. The technologies that have been studied and developed have advanced to extensive prototype testing with known performance and cost parameters. The ETP model has four parts covering energy conversion, industry, transport and buildings. Using this model, outcomes can be studied for use cases of construction, industry, and transport against variations in energy supply.

In the SDS, electrification of transport, industry and building sectors would reduce emissions in 2070 by 40%. Adopting hydrogen, bioenergy and synthetic fuels derived from hydrogen would result in further 20% reduction and deploying carbon capture utilisation and storage (CCUS) systems can contribute 15%. Innovation in new and existing technologies can bring about the implementation of these strategies for decarbonisation. The technology readiness is shown in Figures 11 and 12.

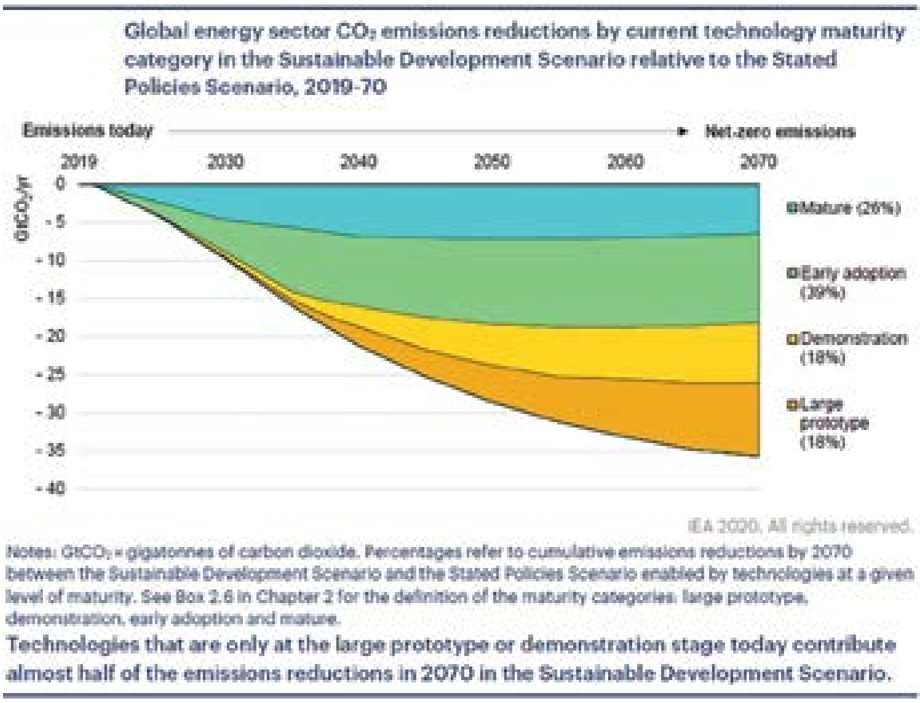

Fig. 11: Technology readiness for CO_2 emission reduction[9]

Fig. 12: Maturity of Technology for Energy Transition[9]

9 Making the transition to clean energy – Energy Technology Perspectives 2020 – Analysis - IEA

Records show that implementing new energy technologies has taken between 20 to 70 years to progress from prototype to commercialisation and gain at least 1% of the national market, refer Figure 13. However, with the stiff targets for decarbonisation in a relatively shorter span of three decades, the entire cycle of technology maturation, commercialisation and market adoption must be operated on a much faster time scale. This will require strong policy support, more generous sharing of knowledge and improving synergy between different agencies.

Impact of COVID19 on Energy Transition

The COVID19 crisis has overshadowed the world economy in much of 2020 and continues into 2021, showing an appreciable downfall in energy demand curves. Studies project that growth to pre-COVID19 levels may resume in one to four years, but the growth path would change. Demand for electricity and gas would register higher growth; oil demand would rise at a slower rate while coal demand would continue to fall further. The increase of remote working and travel reduction can reduce oil demand by 2 million barrels per day by 2035.

The response to the pandemic crisis has shown hope for a decarbonised future for energy. Healthcare and economic stimulus support has been swift, and the present scenario points towards a contained spread of the virus and returns to a growth path. The agile response to this black swan event shows that appreciation of the catastrophic scenario and supportive policy decisions can implement new technology on an accelerated track. Applying this same concept to the cause of energy transition can achieve the desired decarbonisation targets and meet the agreed demand for climate change.

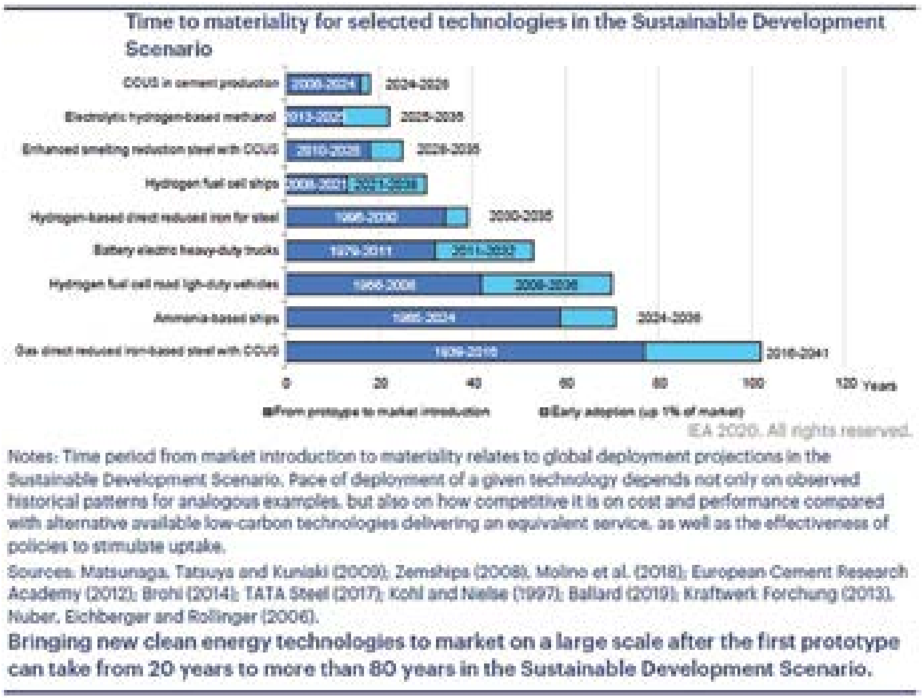

Figure – 13: Timespan for technologies to achieve market share[9]

Concluding Remarks

In response to the Paris 2015 agreement, rapid changes are being witnessed globally, especially the way energy is used. Technology can deliver solutions to combat global warming; however, the approach requires careful selection and policy support. Engineering companies and expertise would help the industries in conducting detail energy transition studies and framing suitable roadmap for adopting select technologies to meet the given industrial process's specific goals.

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