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"The Future of Energy Gases towards the Decarbonisation"

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Energy Transition - Features

- PRESSURE IS MOUNTING as emissions are set to remain stubbornly high until mid- 30s.
- DECARBONIZATION IS ON THE AGENDA of industry and government, but not at the pace or depth to meet the Paris agreement.
- HYDROGEN & CCS have the potential to transform the industry.
- THE WORLD IS MOVING from more oil to cheapest oil as demand declines.
- MULTIPLE ENERGY TRANSITIONS from coal & oil to natural gas, and from fossil fuels to renewables and decarbonized gas.
- In all the scenarios, LNG IS SET TO THRIVE in a strong gas market.

Decarbonization

- Decarbonization is about reducing carbon dioxide emissions resulting from human activity with the target to eventually eliminate them. Decarbonization is the process to reduce the carbon intensity which can be achieved by reducing CO2 emissions in all kind of industrial activities.
- A joint study by EIA & IRENA points out that a 70% reduction in emissions by 2050 is possible by focusing on decarbonization of energy economy. An estimated \$ 29.0 trillion and ' a deep transformation of the way we produce and use energy' would be needed to achieve it.
- Reducing CO2 emissions is not optional anymore and alone may not be sufficient, it is required to be kept at low level and the target is net zero. This would require application of Carbon Capture & Storage (CCS) Technologies. Commercial CCS solutions are today available around US \$ 30 /ton of CO2 capture.

Clean Fuel Gases Initiatives

- Recently in MIT a research group has got unique and encouraging laboratory results in converting CO2 into chemicals which can be used as fuels. While most of the CCS technologies focus on dissolving CO2 the MIT research is directed to convert CO2 to useful cleaner fuels. Such developments have potential to totally change the CCS scenario.
- Synthetic Natural Gas project "Power to Gas" Audi AG & MAN Energy Solutions have set up a 6MW plant at Werlte, Germany uses H2 & CO2 in a methanation reactor to produce Synthetic Natural Gas (SNR). 2800 tons of CO2 is absorbed in this plant. A second plant is being setup in Punta Arenas, Chile which is likely produce 550 million liters of SNG per day by 2026.
- Hydrogen Many challenges production, storage, liquefaction, transportation. Normal process of steam reforming produces about 10 Kg of CO2 for 1 Kg of hydrogen
- Ammonia Ammonia could help with decarbonization in multiple ways. Ammonia can also hold its own as a fuel: not only does it burn CO₂-free like hydrogen, but it has a higher energy density and is easier to store and transport than hydrogen, as it doesn't require cryogenic storage. Ammonia can also act as a storage medium for hydrogen, enabling it to be transported over longer distances more easily. In Japan, it is already considered the most viable carrier for hydrogen. Toyota car to run on ammonia

Global Business Imperatives : Trends

- Electric Vehicles : Governments & Automakers focused on newer, cleaner electric vehicles as a solution to climate change.
 - Will take long time before technology makes it possible
 - Will take long time for existing fossil fuel powered vehicles to reach end of life. Fleet change in US: 2002 – 9.6 yrs, 2021 – 12 yrs
 - To achieve net zero emissions by 2050 would mean stop manufacture of fossil fuel driven cars by 2035
- **New Low emission fuels**: Advanced biofuels and synthetic fuels using H2 and captured CO2 to methanol. Renewable/Synthetic diesel is indistinguishable from diesel produced by refineries and runs on all diesel engines without any modification required and with no blending limits.
 - Exxonmobil (Imperial Oil): 20000 bbl/day renewable diesel by 2024. Successful pilot of 5000bbl/day by conversion of wood waste/ plants.
 - Nextchem/ Saola Energy: renewable diesel
 - Hydrogen:
- Financial institutions, investors are concerned about decarbonization and taking it seriously. In their
 policy shift investors see oil & gas projects with uncertainty and caution and would like to support
 projects based on clean energy only. Chief Executive of World's biggest investor fund BlackRock has
 stated that "climate risk is an investment risk" and 'sustainability' would be in the center of
 company's investment approach

India Decarbonisation Scenario

An overview of the possible decarbonization pathways for India indicates emissions intensity and corresponding timelines until 2070.



India greenhouse-gas emissions,¹ gigatons CO_o equivalent

Reducing emissions intensity

–1.3% per annum, as in 2010–19

Line-of-sight scenario

- Implementation of India's NDC,² existing and currently announced
- Technology advancement as per current trajectory
- · Shift in demand to sustainable alternatives in selected areas

Accelerated scenario

- · Adoption of new policies such as carbon pricing
- Technology breakthroughs (eg, CCUS³ and faster implementation of existing levers)
- Accelerated shift to sustainable consumption (eg, electric vehicles, alternate materials, coarse cereals, green steel)

Source: McKinsey Report October 2023

