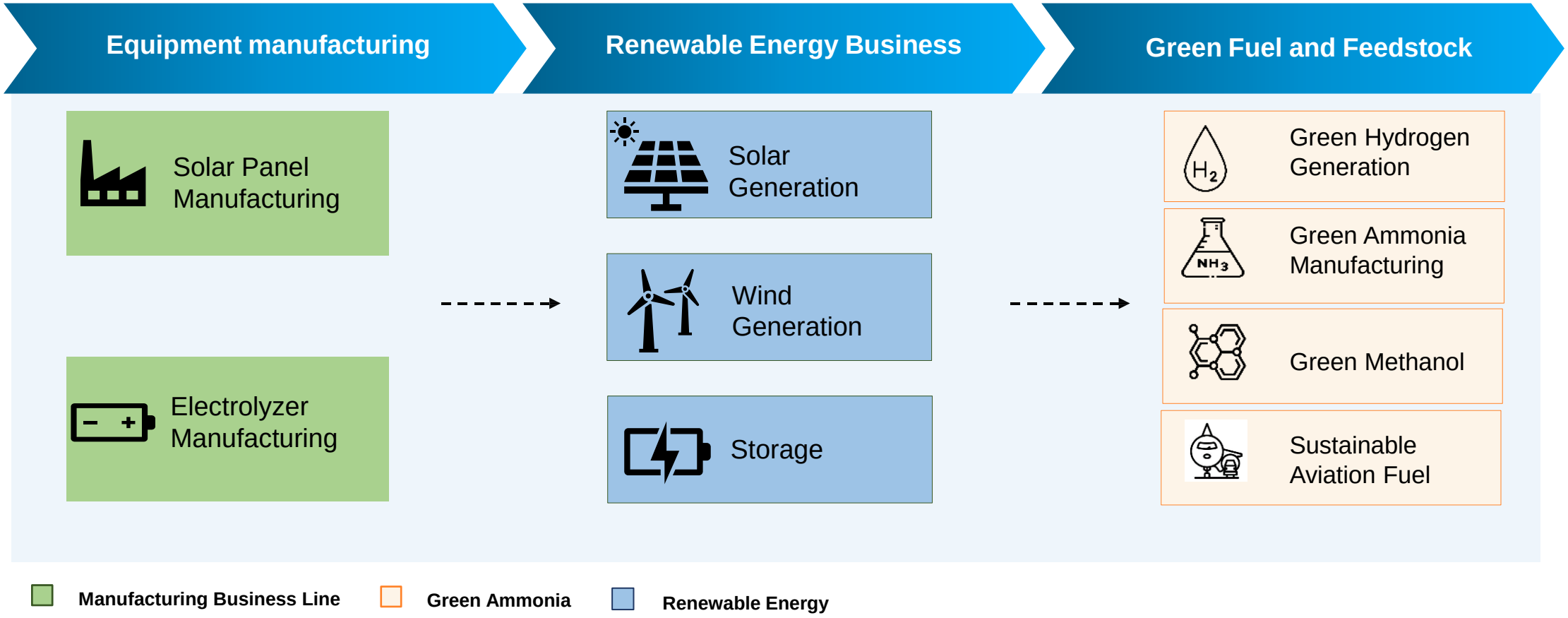
AVAADA

PROMISE OF A SUSTAINABLE FUTURE

International Conference on Green Hydrogen

July 2023

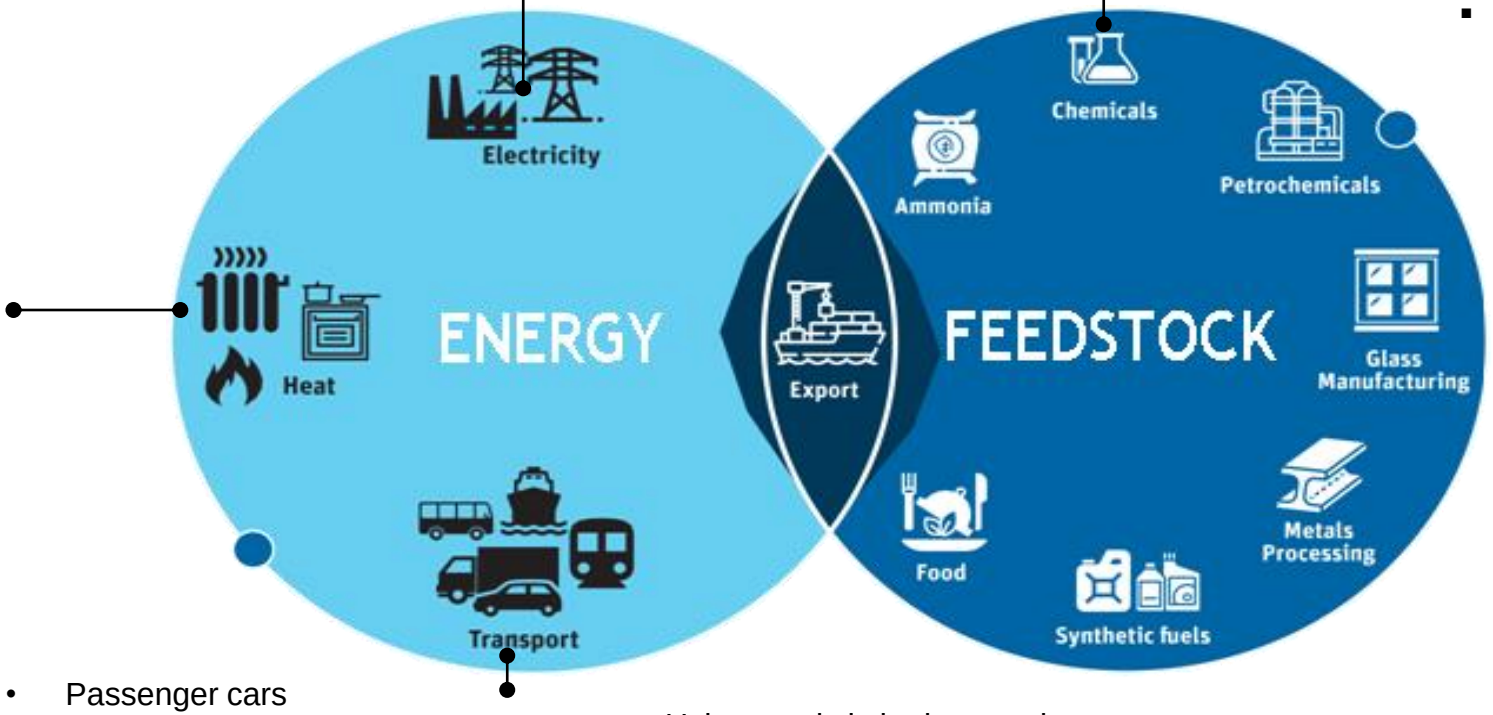
Avaada Group is set to be a leading player in energy transition, built on an integrated business model backed by large renewable energy business



Green Hydrogen and its derivatives offers credible decarbonision solutions to all the carbon emitting sectors..

- Fuel cells,
- Hydrogen Turbines
- Blending in coal-based power plants

- **Hydrogen** is **used** to produce by chemical which are used to remove sulfur, halides, oxygen, metals, and/or nitrogen impurities,



- Residential Heating especially in countries with lower tempratures

- Hydrogen is used in the petrochemical industry for two main purposes, hydrotreating and hydrocracking.
- Hydrogen plays an important role in glass manufacturing, where in combination with nitrogen it is used to provide an atmosphere that prevents oxidation
- Hydrogen can be used in manufacturing of steel

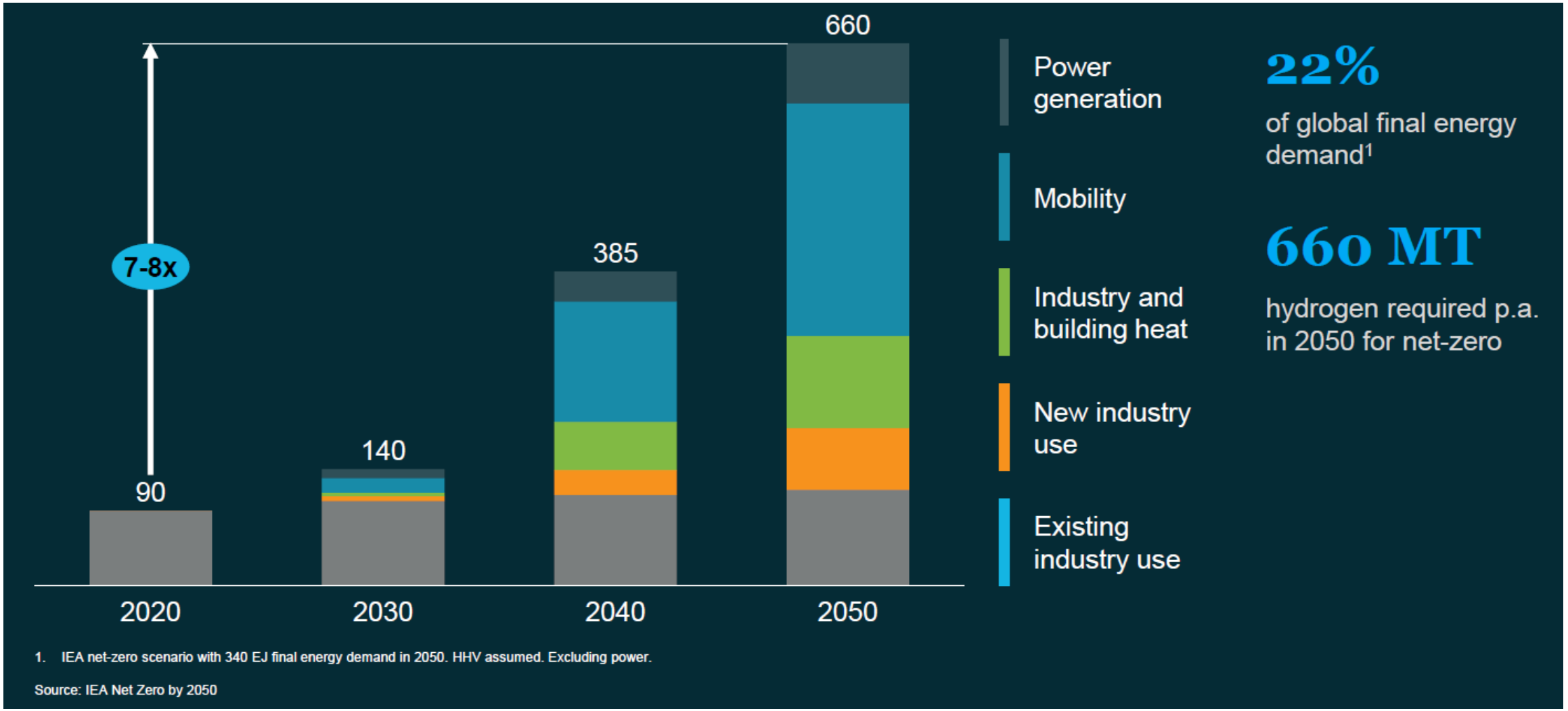
- Passenger cars
- Heavy Mobility including trucks
- Trains
- Marine
- Aviation

- Using catalytic hydrogenation, hydrogen can be used to harden oil to produce margarines and other semi- solid fats

- Synthetic fuels are derived from ‘syngas’ and traditionally produced via steam methane reforming

According to estimates, for achieving net zero targets by 2050, Green Hydrogen required will be 660 Million Tons by 2050 (equivalent to ~3700 Million Tons of Green Ammonia)

Green Hydrogen Demand for Net Zero (Million Tons)



1. IEA net-zero scenario with 340 EJ final energy demand in 2050. HHV assumed. Excluding power.

Source: IEA Net Zero by 2050

Key demand centers for exports

Japan

- Japanese Govt. has defined a Hydrogen Strategy Road map in which it has committed very ambitious targets
- Govt. intends to blend 50% ammonia is coal-based power plants
- By 2030 it targets to import **3 million tons (~17 Million Tons Ammonia)** of Green Hydrogen, with demand rising to **30 million tons (168 Million Tons of Green Ammonia)** by 2050, demand coming from usage in power plants

South Korea

- Govt. plan to blend 30% hydrogen at all its gas-fired power plants by 2035, and 20% ammonia at more than half of its coal power stations by 2030
- Due to limited available land for RE generation, South Korea believes that it can only reach net-zero emissions by importing vast quantities of clean hydrogen
- Demand for Green Hydrogen is expected to be **27.9 Million Tons (156 Million Tons of Green Ammonia)** by 2050

European Union

- EU Commission adopted a set of **legislative proposals to decarbonise its gas market** by facilitating the uptake of RE and low carbon gases, including hydrogen - inline with climate targets to reduce GHG emissions by at least 55% by 2030 and become climate-neutral by 2050
- EU Commission has projected a demand of **20 mtpa of Green Hydrogen (equivalent of 112 mtpa of Green Ammonia)** by 2030 of which 50% will be imports. This is expected to increase to 100 Million Tons **(561 Million Tons of Green Ammonia) by 2050**

Singapore

- To meet net zero targets by 2025, it has targeted to meet half of its power through Hydrogen
- It has come out with comprehensive strategy on Hydrogen adoption and will be major demand center
- Singapore also aims to become Green Hydrogen Bunkering Hub and invited bids for the same

Collective demand for Green Ammonia from these 4 geographies will contribute significantly to the demand

EVs have found limited penetration in heavy mobility –H_2 based vehicles are well positioned to provide feasible solution to replace fossil fuel based Heavy Mobility

Parameters	Diesel Truck	Electric Truck	Hydrogen Fuel Cell Truck
Deadweight / Curb Weight (kg)	15,000	20,500	9,795
Gross Weight (kg)	40,000	40,000	36,000
Range (km)	640	440	400
Tank/Battery Capacity	400 litres	600 kWh	31 kg
Operating Cost ($/km)	1.02	0.35	0.15 @ US $ 2 / kg of Hydrogen

With an expectation of a sharp decline in prices of Hydrogen, Hydrogen powered Trucks will gain traction over time and will replace diesel trucks in large quantums

Hydrogen price – 2 USD/kg
Electricity charging price: 0.1USD/kWh
Fuel price: 1 USD/Litre

Green methanol is another fuel/feedstock, the usage of which is expected to grow significantly - Automotive and construction industries will be biggest drivers of market growth

Market is expected to register a CAGR of 6%

Market is currently valued in 2021 at $ 3.1 Billion

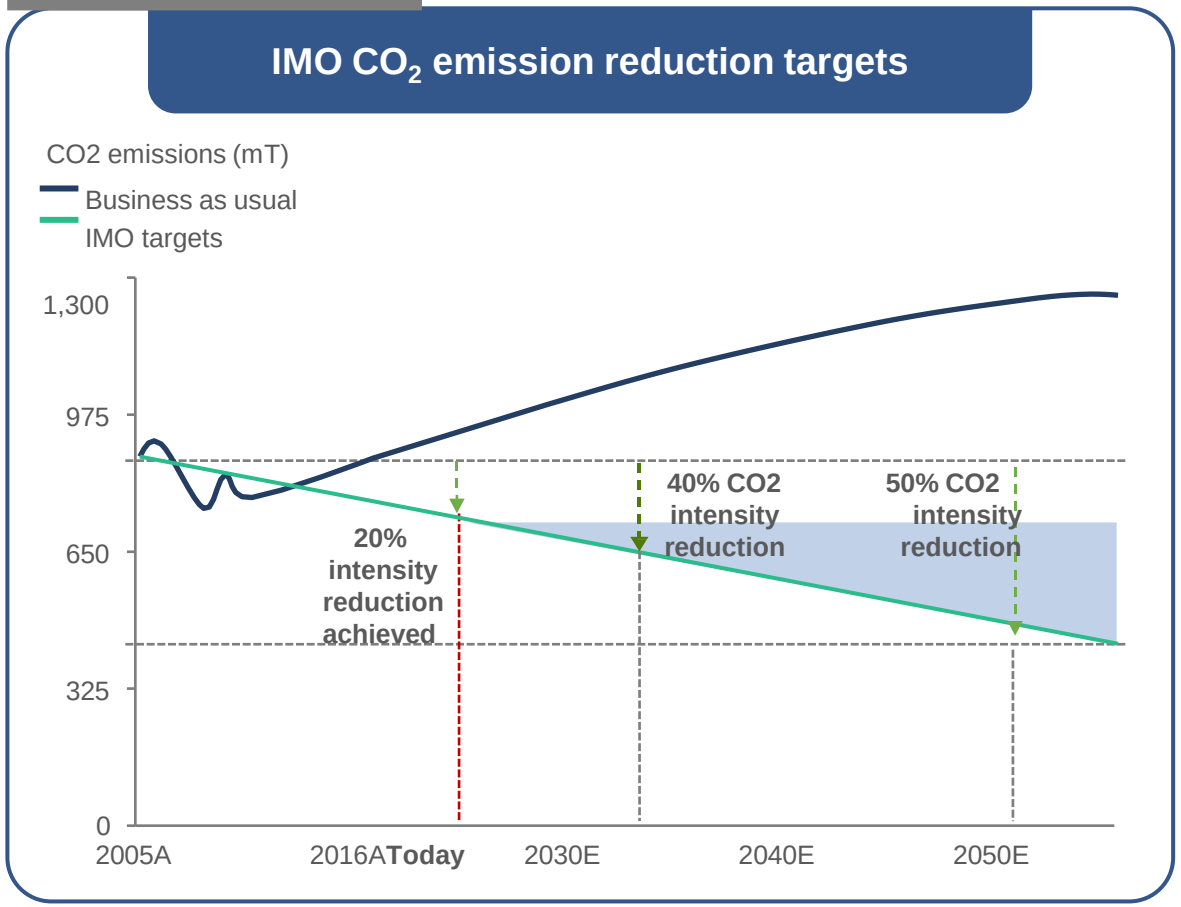
34% of global market revenue in 2021 was accounted for by Asia pacific

- Methanol demand is expected to continue increasing to reach more than 120 Mt by 2025 and 500 Mt by 2050 in IRENA's Transforming Energy Scenario
- Most of the growth will come from production of olefins, with a smaller share for gasoline blending, formaldehyde, acetic acid etc..

Source: Emergen research

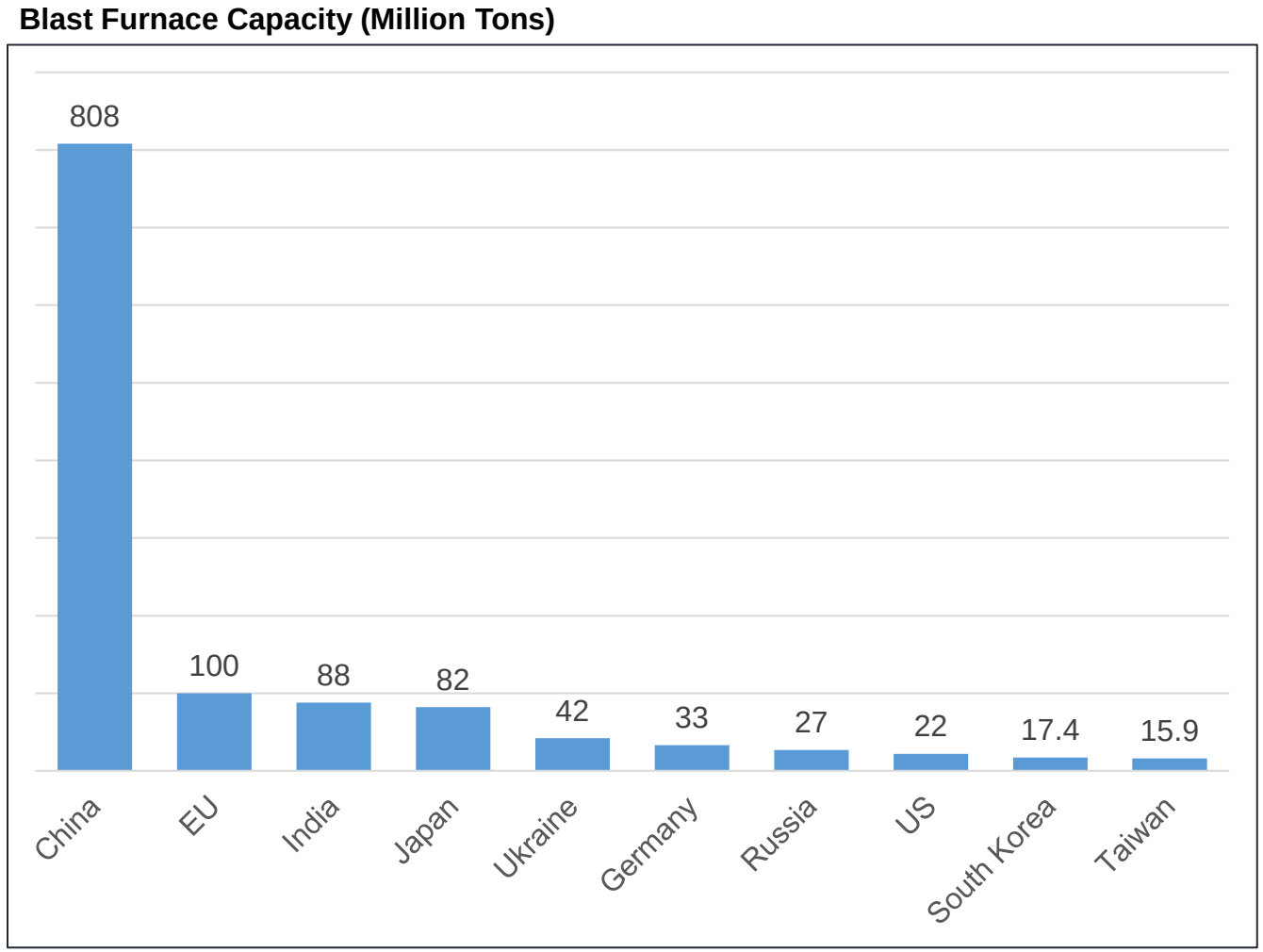
Another driver for increased usage of Green Methanol will be International Marine Organization (IMO) targets to reduce GHG emissions by 40% and 50% by 2030 and 2050, respectively

Shipping Fuel



- Shipping industry contributes 3% to the total global emissions
- **Compelled by IMO targets, shipping industry is expected to move to Green Methanol and Green Ammonia powered ships** – engines have been developed by MAN and first ships expected to get into commercial operation by 2026
- If all the present fleet is converted into Green methanol powered ships, Green Methonal demand is estimated to be in **range of 500-600 Million Tons**

Steel is another candidate which will transition to usage of Green Hydrogen as EU imposes CBAM on all steel imports



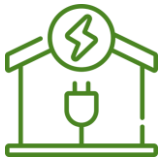
- Japan and India have significant exposure to EU in terms of steel exports and will be significantly impacted
- Blast Furnace can be converted into DRI furnace in which Green Hydrogen can be fired and used a reducing agent
- Steel manufacturing industry is expected to become large user of Green Hydrogen in coming decade
- Some of leading steel manufacturers like Arcelor Mittal, Liberty Steel etc. have started working on usage of Green Hydrogen and usage is expected to increase going forward

While India has the potential to become the center of the global hydrogen revolution, multiple barriers stand in the way of its realization

India's advantageous position

India is a renewable-rich land with high solar and wind potential and a mature industry to harness it

India is well known globally for its skilled personnel in the STEM sector, vital to the development of the Hydrogen economy in India



While in most countries its cheaper to produce electricity conventionally, renewable power tariffs in India are much lower than that produced using coal and gas

India also has a long coastline which can be used to supply green hydrogen to both the EU and to East Asia

Barriers to hydrogen economy

India needs to establish bilateral arrangements under Article 6.2, similar to those being penned by Australia and the middle east to enhance the competitiveness of Indian firms

India needs to improve its electrical transmission and evacuation infrastructure, especially near ports, and encourage states to facilitate energy banking

India needs to revamp its infrastructure to support the industry e.g., the development of ports to handle ammonia, and the development of hydrogen hubs

While the Indian government through its hydrogen policy has announced incentives, It needs to provide support to cultivate demand, reduce production costs, develop guarantee of origin frameworks

THANK YOU

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