Decarbonization – Way forward to achieve Net Zero Emission

V.P.Bhandarkar -DGM & Head Innovation
Environment SBU
Thermax Limited

Thermax at a Glance

Conserving Resources. Preserving the Future.

THERMAX

6000+ Employees Globally

Installations in
88 Countries

Sales and Service
presence in
30 Countries

USD 750 Million
Revenue

14 Manufacturing Locations
(10 in India, 4 International)

Sustainable Solutions by Thermax

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Clean Air

Air Pollution Control

Clean Water

Water and Waste Solutions

Clean Energy

TBWES | Process Heating | Steam Engineering | Cooling | Project & Energy Solutions | TOESL | First Energy

Offerings

Power

Heating

Cooling

Utilities

Water Treatment

Chemical

Raw Material

Desired Product

Air Pollution Control

Wastewater Treatment

Waste

Hazardous Waste Treatment

Waste To Energy

Enviro At a Glance

40+

Years of experience and expertise in the area of Air Pollution Control

Particulate
&
Gaseous Pollution Control

25+

Industry Presence

Major
- ✓ Cement
- ✓ Power
- ✓ Steel

Some Core sectors include
Chemical | Distillery | Sugar
Oil & Gas | Paper & Pulp | Textile
Refinery & Petrochemical | Rubber

5+

Flagship Products &

- ✓ Electrostatic Precipitator
- ✓ Bag House
- ✓ Flue Gas Desulphurisation system
- ✓ Scrubber
- ✓ ComboFilter®

Value Added Services

- ✓ O&M services
- ✓ Spares parts management
- ✓ Augmentation / Modernisation
- ✓ Health check up of APC equipment
- ✓ Onsite training

- ✓ More than 25,000 Air Pollution Control Systems installed globally

Enviro Product Portfolio

6+ products in Gaseous Segment

01 FGD
- 1.1 Dry Type
- 1.2 Semi-dry Type
- 1.3 Wet Type

02 Scrubbers
- 2.1 Packed Bed
- 2.2 Spray Towers
- 2.3 Plate

7+ products in Particulate Segment

01 ESP
- 2.1 Dry Type
- 2.2 Wet Type

02 Bag House
- 2.1 Pulse Jet
- 2.2 Reverse Air

03 Hybrid System
- 2.1 ComboFilter ®

04 Scrubbers
- 2.1 Venturi
- 2.2 Cyclonic

Decarbonization- The Context

The historic 2015 Paris Climate Agreement – intended to limit global warming below 2°C above pre-industrial levels and pursue efforts to limit it to 1.5°C.

To reach this ambitious goal, countries have to cut GHG emissions rapidly, to reach carbon-neutrality by 2030, and net-zero emissions by 2050.

Unfortunately, the Climate Action Tracker released in May 2021 reveals that current global pledges are insufficient, and the 2°C target could be slipping through our fingers.

Our current policies would, in the best-case scenario, lead to an increase of 2.1 °C and, in the worst-case scenario, to a rise of 3.9 °C.

Time is running out & we need to act fast

Picture says it all

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TIMES CITY | PUNE

'Climate change may dim solar energy 10-15%'

Somit.Sen@timesgroup.com

lumbai: Climate change ould impact the state's solar nd wind energy potential. Vhile solar radiation is ex- ected to decrease by 10-15% n five decades, the wind en- rgy potential could in- rease significantly across tates during the same peri- d, revealed a study by re- earchers at the Indian Insti- ute of Tropical Meteorology IITM), Pune.

Scientist Parthasarathi Iukhopadhyay from IITM aid, "Projections of solar nergy potential for the fu- ure over the western Indian egion including states like

STATE'S RENEWABLE POTENTIAL

- As of June 30, 2022, renewable energy contributes 24.36% to Maharashtra's power mix. This has prompted the state to launch an ambitious initiative to build new solar plants throughout districts to produce 12 gigawatts (GW) of renewable energy over the next six years
- Between 2016 and 2021, the installed solar capacity of Maharashtra increased by 614% from 385.76 MW in 2016 to 2,753.30 MW in 2022, according to the Ministry of New and Renewable Energy (MNRE)
- Maharashtra intends to continue on its leadership track and generate 40% electricity from renewable sources by 2030. The state experiences 250-300 days of bright sunshine annually

year irrespective of the sea- sons."

He said, "The reason for

with a chance of possible im- pact on solar energy produc- tion. The reduction... can be

mentioned, "In case of wind potential, central India, mainly across Maharashtra, Madhya Pradesh and Chhat- tisgarh, shows a positive trend in most climate mod- els. The monsoon months are projected to be windier. The seasonal analysis indicates higher wind speed in the winter and monsoon months when the wind potential is maximum."

The study stated, "Sea- sonal and annual wind speed is likely to decrease over north India and increase along south India and this could increase the wind en- ergy potential in (Maharash- tra) in future."

Monsoon months are pre-

giving a boost to wind energy generation.

Maharashtra currently ranks among the top states in terms of installed renewable energy capacity (10.78 GW) with wind power capacity of 5.01 GW and solar power ca- pacity from all sources/pow- er utilities/sectors of 2.75 GW contributing the most.

The latest study has been authored by TS Anandh, Deepa Gopalakrishnan and Parthasarathi Mukhopad- hyay, researchers from IITM Pune under the Ministry of Earth Sciences as well as Centre for Prototype Climate Modelling, New York Univer- sity, Abu Dhabi, UAE.

Researchers carried out

How do we get there ? What is needed for the Transition ?

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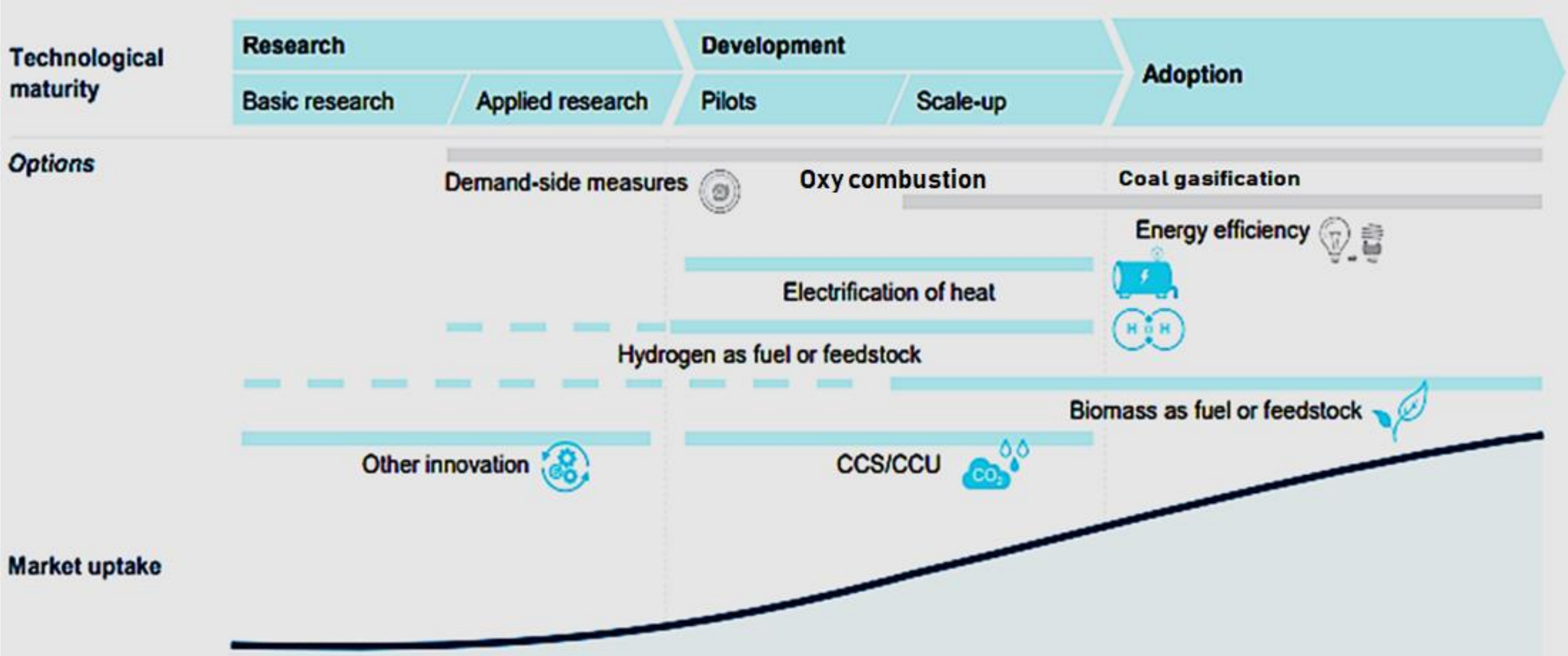
India's CO_2 emission is 7% of global emissions and is increasing at 4.5% per annum.

India's clean energy future is at a critical juncture. India navigates the intriguing challenge of delivering an unprecedented expansion of energy supplies to satisfy its rapidly growing economy and to do so in a way that satisfies the government's 2070 net-zero emissions pledge.

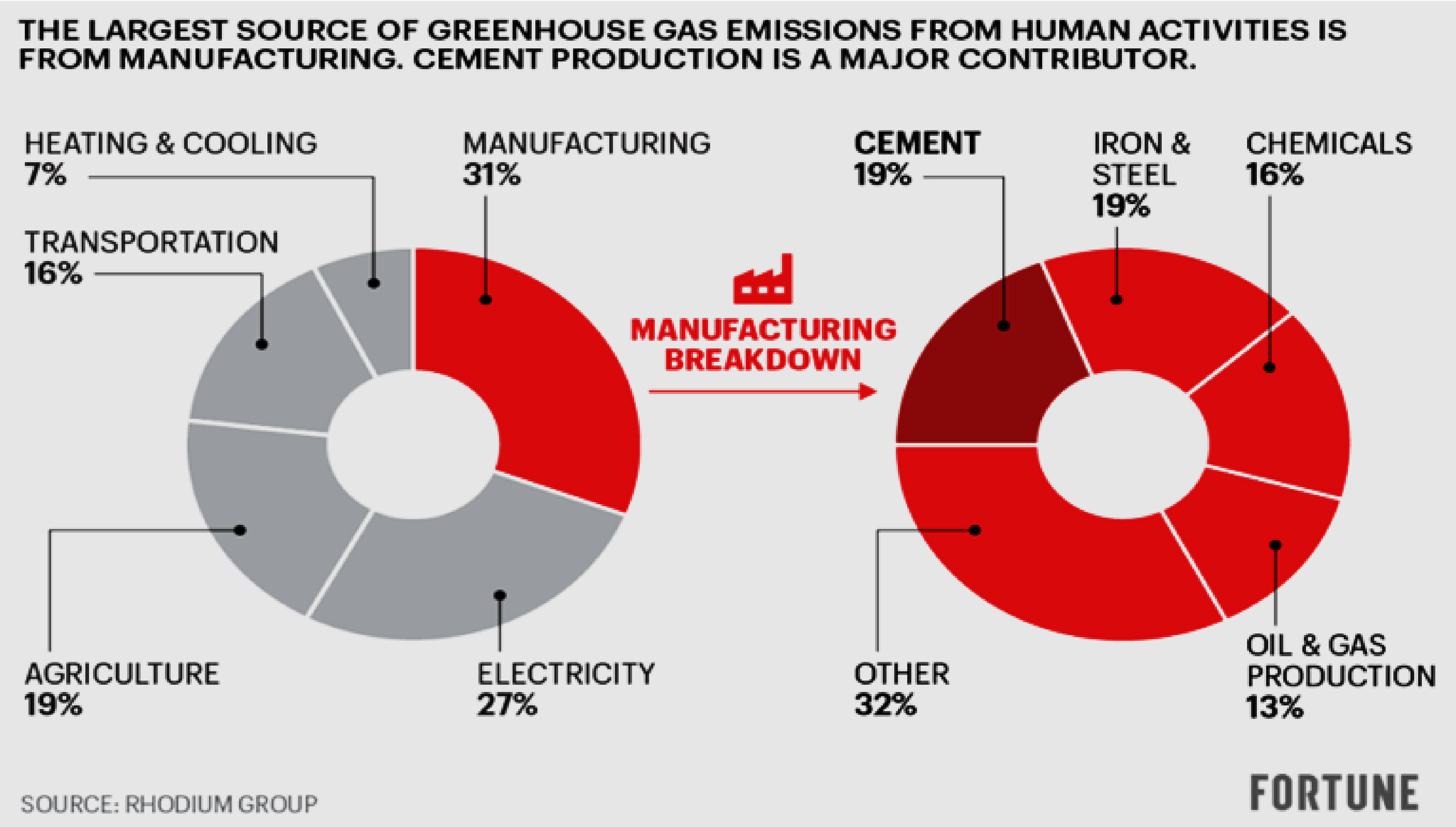
Of course, we cannot drop the old ways of producing and consuming energy overnight. But the emergency of the situation mandates that we drastically accelerate our zero carbon emission transition.

Decarbonization Options



Innovation is required to ensure full menu of decarbonization options is available

Sources of Green House Gases



Industrial Decarbonization Challenges

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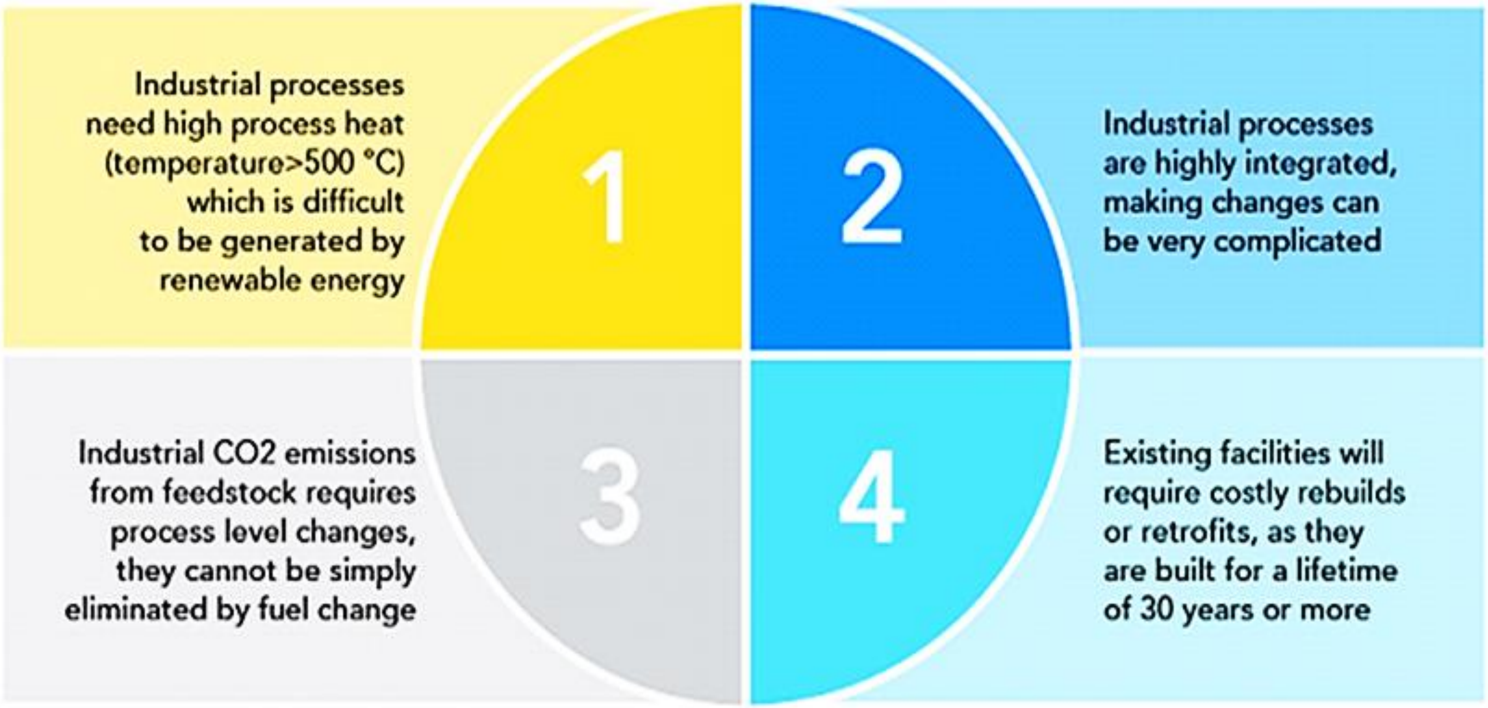
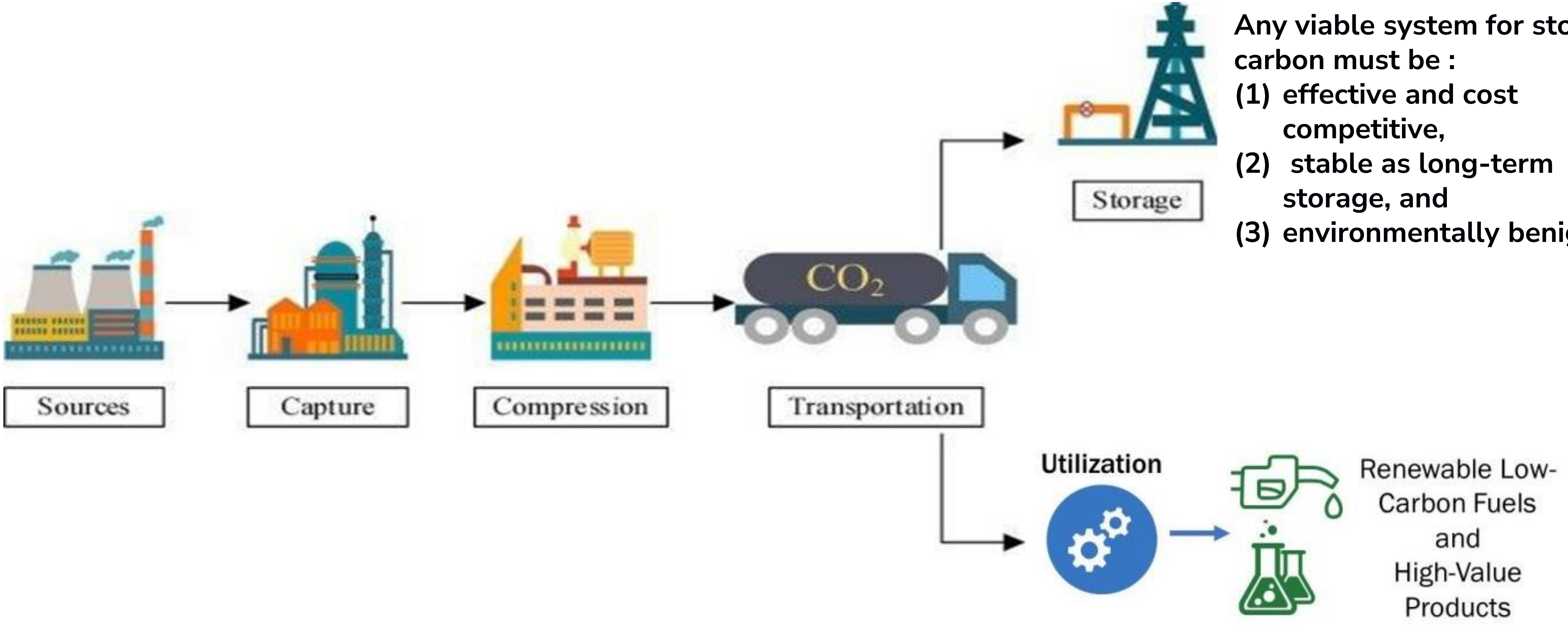


Each company must establish a decarbonisation strategy in line with its industry. It is essential for a company to evaluate the number of emissions it is directly or indirectly responsible for as a result of its business operations, and to then identify the options for reducing them.

Decarbonization can be converted into business opportunity by converting captured CO_2 into useful products / carbon credits.

CCUS – Complete value chain



Any viable system for storing carbon must be :

(1) effective and cost competitive,
(2) stable as long-term storage, and
(3) environmentally benign.

Options for Decarbonizing ‘Hard to Abate Sectors’

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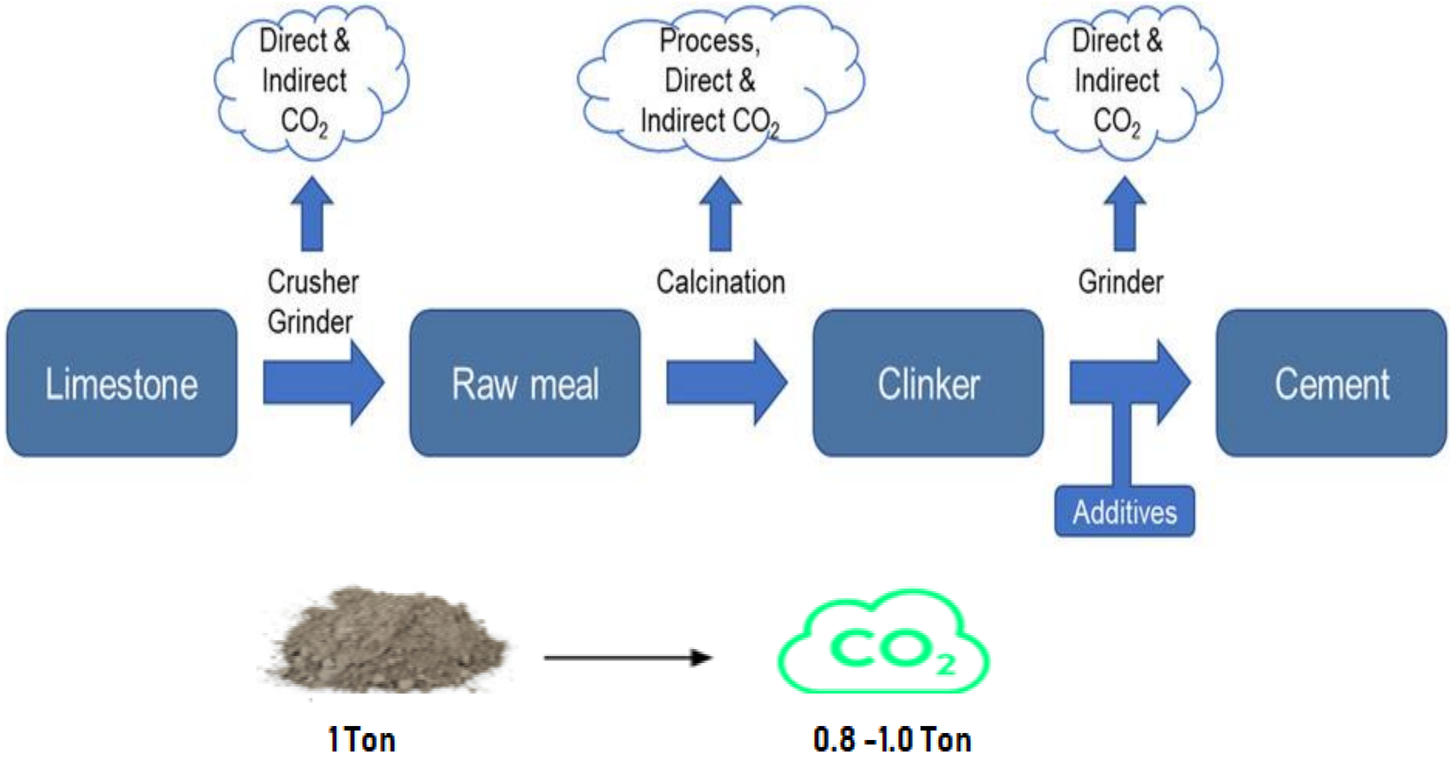
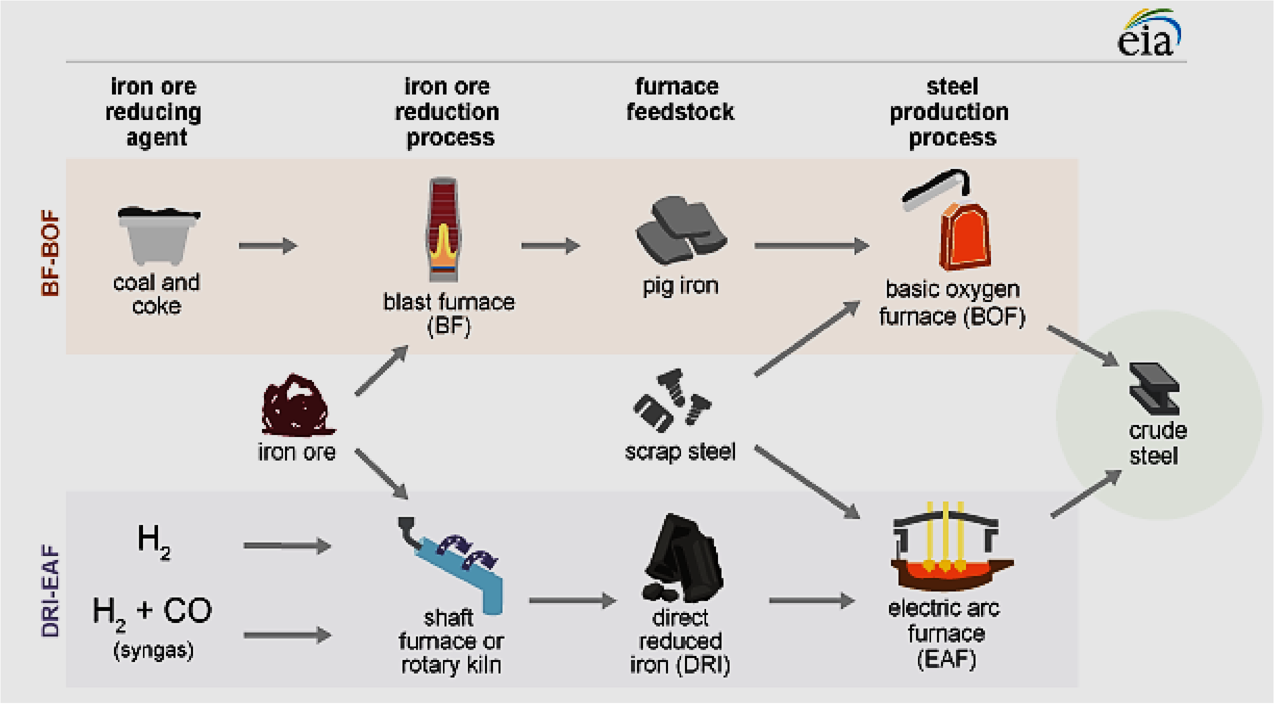
Cement Sector

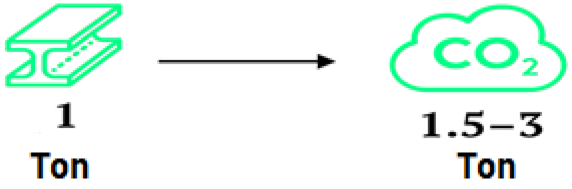


- ✓ Changing to biogas or biomass would require a modest retrofit of the kiln.
- ✓ Capturing CO2 to the exhaust gases of cement kilns would prevent CO2 emissions resulting from both fuel combustion and limestone calcination.
- ✓ Utilizing CO2 gas produced in the process in the concrete that is produced from cement.

Options for Decarbonizing 'Hard to Abate Sectors'

Steel Sector





- ✓ Using biogas instead of natural gas in DRI production can reduce CO2 emissions.
- ✓ Using zero-carbon electricity in an EAF would eliminate the CO2 emissions associated with generating electricity to power EAFs for production of either recycled steel or virgin steel.
- ✓ Capturing CO2 at existing BF-BOF production sites does not necessarily require altering the conventional production process.

Options for Decarbonizing ‘Hard to Abate Sectors’

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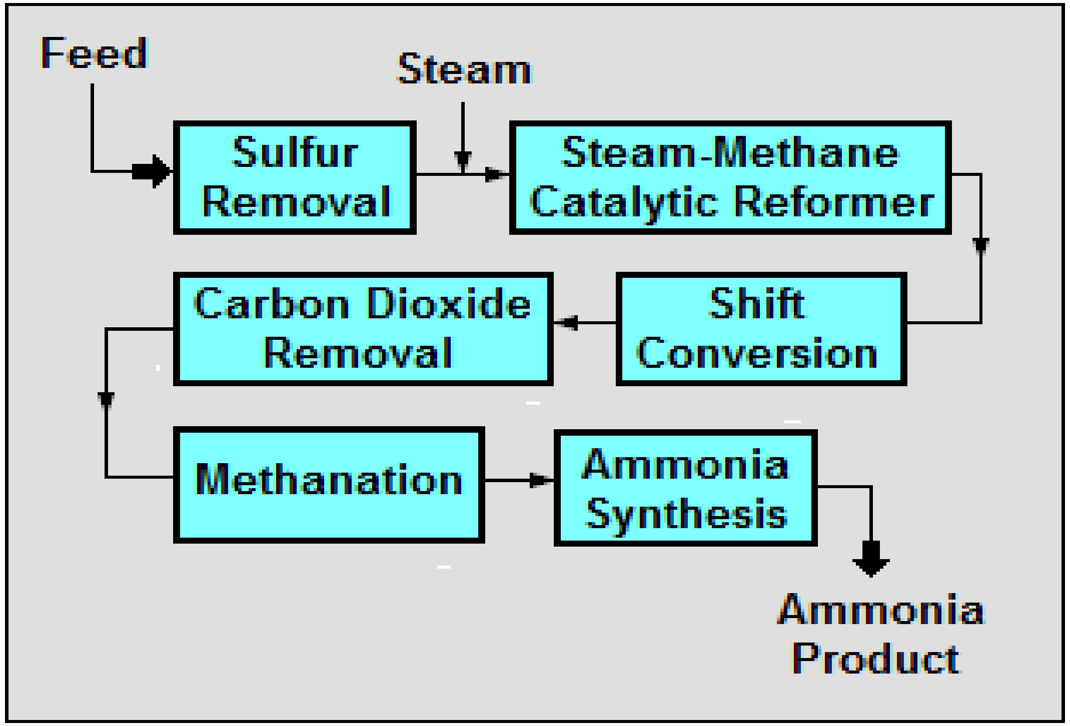
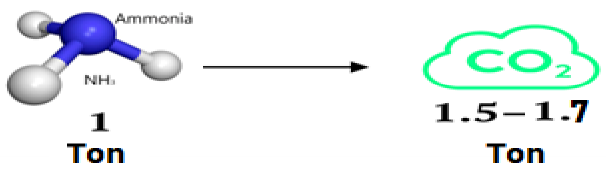
Ammonia Synthesis





Capturing CO2 from WGS process could reduce emissions.

The nearly pure stream of CO2 from the water gas shift reaction can be captured at low cost. The emissions from the natural gas used for heat in the conventional process have a low percentage of CO2 and so they cost more to capture.

Ammonia producers may therefore benefit from switching to autothermal reforming (ATR) of natural gas to produce hydrogen. This would ensure that all emissions consist of pure CO2 , which can be captured at low cost.

Options for Decarbonizing 'Hard to Abate Sectors'

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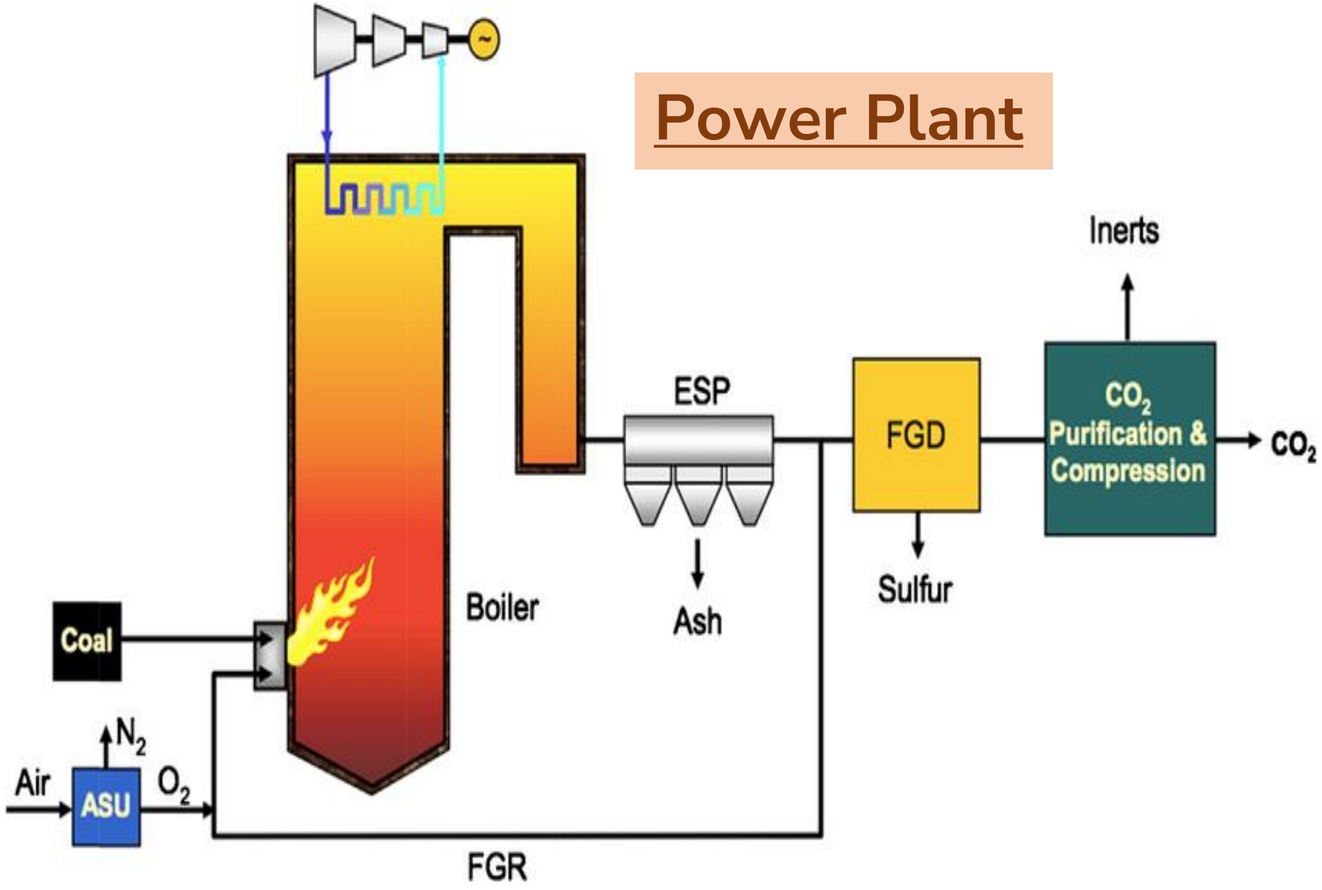
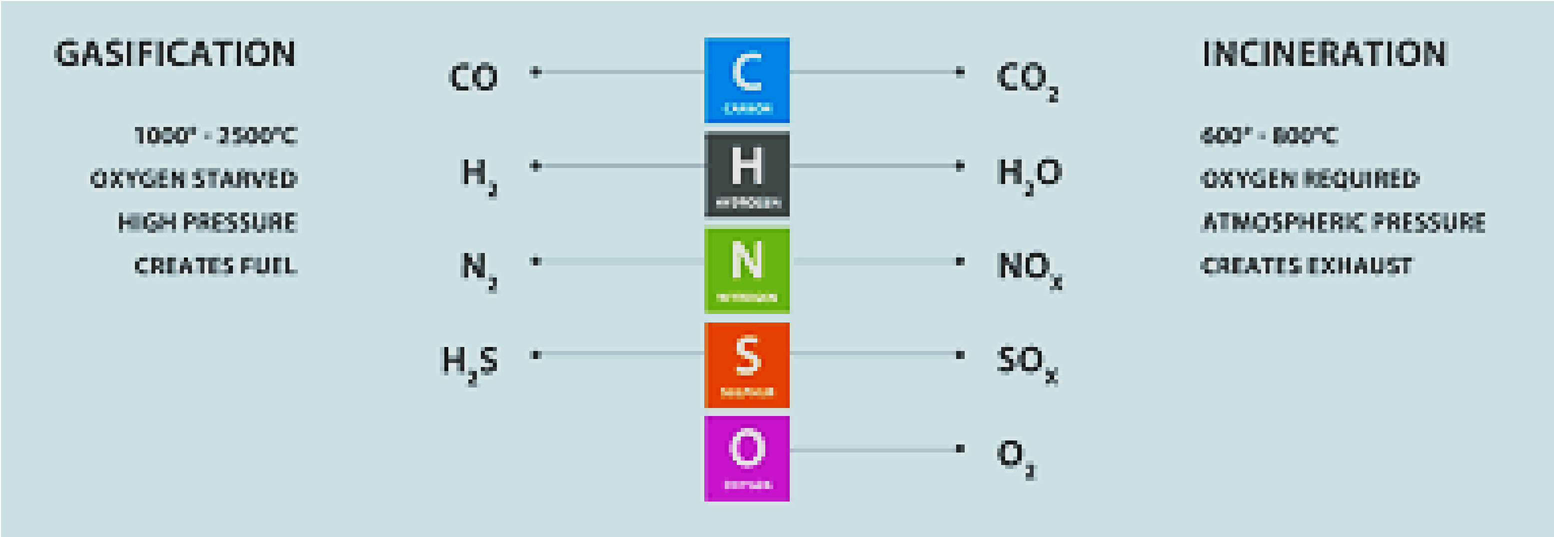
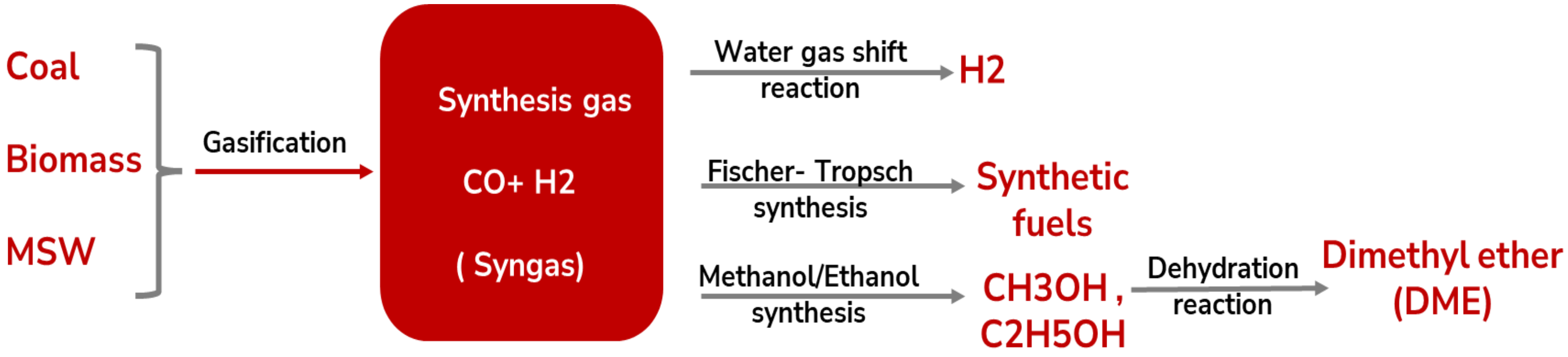


	Pulverised Coal	NG Combined Cycle	IGCC
Energy penalty	15-28%	15-16%	5- 20%
Efficiency penalty	8-15%	6-11%	5-10%

Gasification





Pilot Coal To Methanol Plant at R&D Centre

Hydrogen Economy

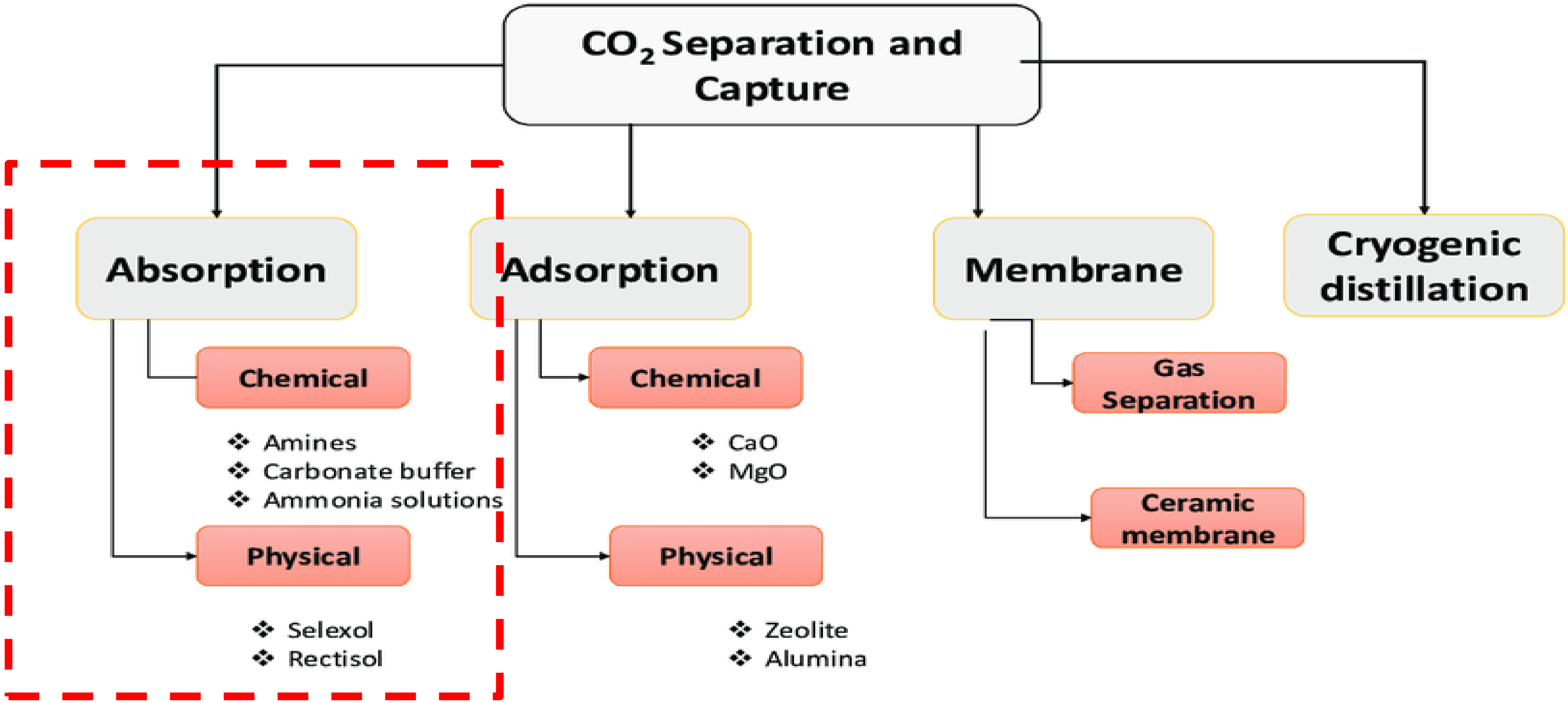
Grey hydrogen	Blue hydrogen	Green hydrogen
Split natural gas into hydrogen and CO_2	Split natural gas into hydrogen and CO_2	Split water into hydrogen by electrolysis powered by water or wind
CO_2 emitted in the atmosphere	CO_2 stored or reused	No CO_2 emitted

Indian Government has made a good start via its National Hydrogen Mission.

The first phase focuses on incentivizing clean energy supplies to service expected demand for green hydrogen.

The next phase is likely to prioritize demand signals via mandates in fertilizers, refining and city gas distribution.

CO2 Mitigation Technologies from Source



A) Pre-combustion carbon capture

Gasification of coal, coke, waste biomass, and or residual oil or steam reforming/partial oxidation of natural gas to produce syngas.

B) Post combustion carbon capture

Consists of treating exhaust gases on the output side of the various industries such as Power, Steel , Cement , Refineries, Fertilizer etc.

Choice of Solvent

- **The choice of the absorbent (Physical/Chemical) for CO_2 capture is guided by the partial pressure of CO_2 in the gas to be treated.**
- **Chemical solvents - Can be used for both pre & post combustion, however they are more appropriate for post-combustion CO_2 capture method due to low partial pressure.**
- **Physical solvents - For precombustion CO_2 capture because of high partial pressure of CO_2.**

Advantages / Barriers for Chemical/Physical solvents

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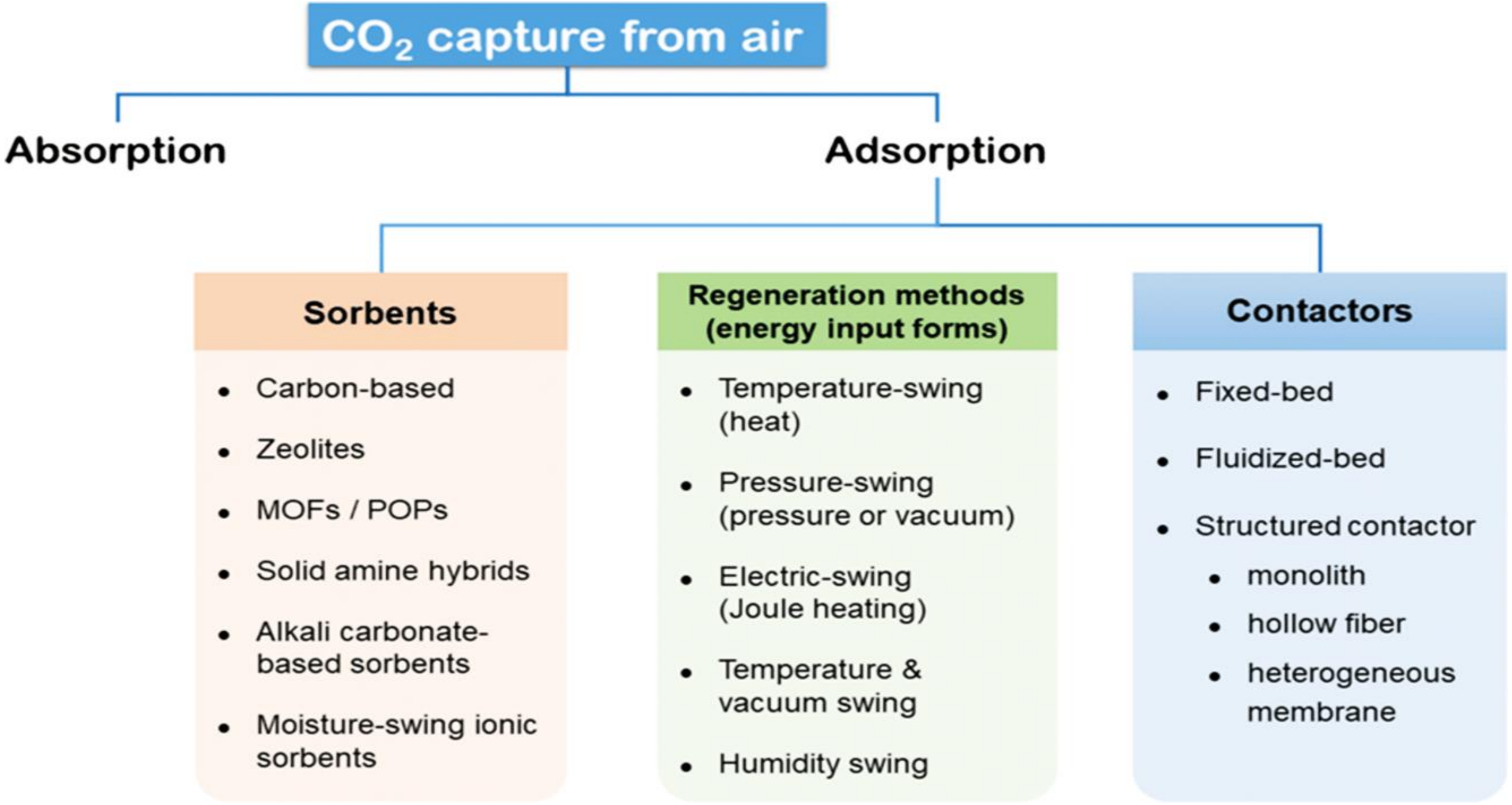
Chemical solvents

Description	Advantages	Barriers
Solvents react reversibly with CO_2, often forming a salt; it is regenerated by heating (temperature swing), which reverses the absorption reaction (normally exothermic)	It provides fast kinetics to allow capture from streams with low CO_2 partial pressure	▪ A large amount of steam required for solvent regeneration that de-rates the power plant significantly ▪ The energy required to heat, cool, and pump non-reactive carrier liquid (usual water) is often high

Physical solvents

Description	Advantages	Barriers
The solubility of solvent is directly proportional to CO_2 partial pressure and inversely proportional to temperature, thus making physical solvents more applicable to low temperature and high-pressure applications (Syngas)	CO_2 recovery does not require heat to reverse a chemical reaction	▪ Low solubility can require circulating large volumes of solvent, which increases energy needs for pumping ▪ CO_2 pressure is lost during flash recovery

Direct Air Capture (DAC)



It is always going to be easier to pull CO2 out of an exhaust stream at source , where it is concentrated (roughly 1 molecule out of every 10), than out of the air, where it is highly dispersed (roughly 1 molecule out of every 2,500). Presently the cost of CO2 capture from air is around $ 600/ton.

Schematic of CO2 capture Process

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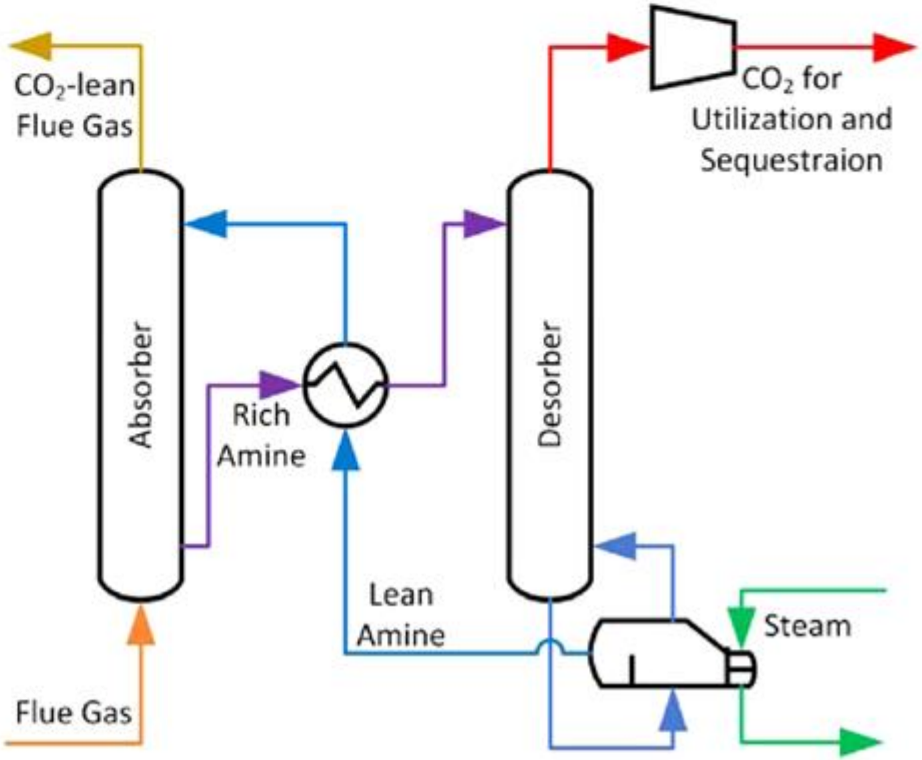
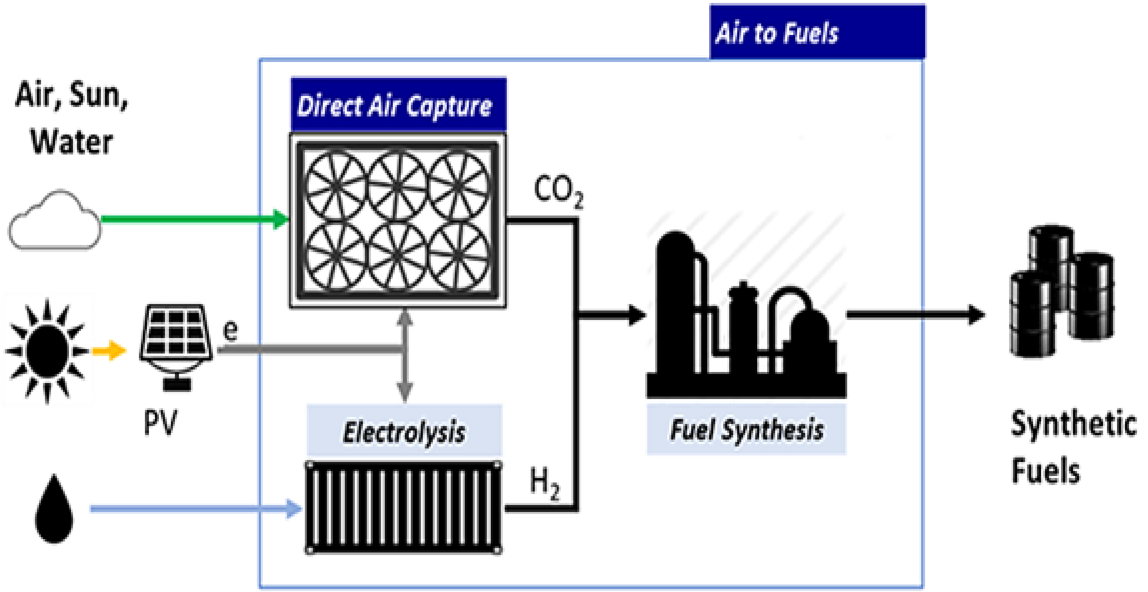
Amine based system



The cost of CO2 capture can range from USD 30 /ton CO2 to USD 60/ton CO2 , depending upon the CO2 source and nature of contaminants.

Adsorption based system



Since CO2 is in dilute form the cost of capture is around USD 400 to USD 600/ ton .

Way forward for decarbonizing Industrial sector

A) Clear road map with sector- specific targets (specially for hard to abate sectors)

B) Expanding the decarbonization umbrella (cover complete industrial sector including MSMEs through policy interventions)

C) Technology Transfer (Key enabler is availability of cost effective & proven technology, alongside resource and knowledge sharing)

D) Promoting circular economy

E) Need for comprehensive National study on geological storage

F) Development of CO_2 transport infrastructure

G) A carbon market that would suit India to fight climate change

In Conclusion..

This century has to be the "Century of Decarbonization" in order to protect and handover the planet to next generation.

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Thank You!