‘The business case for energy transition in Indian industries’

ENERGY TRANSITIONS COMMISSION INDIA

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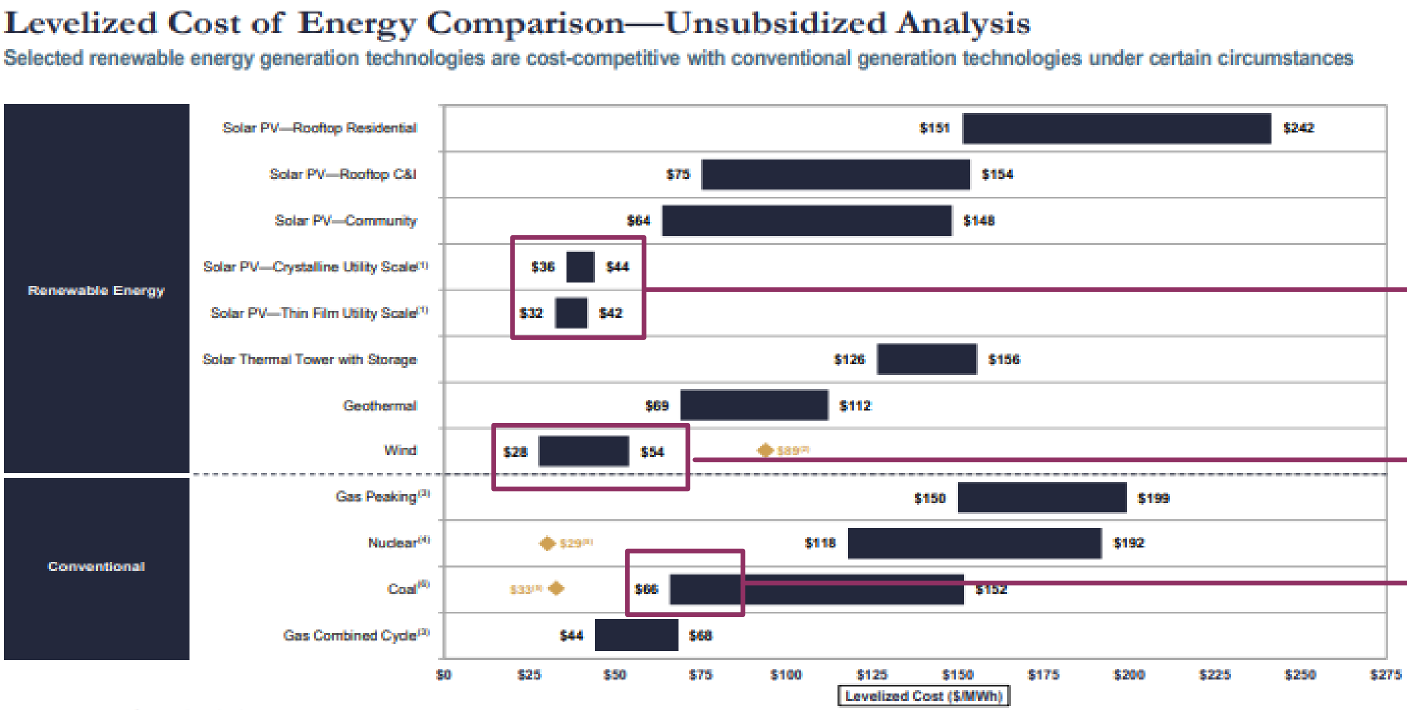
IMPLICATIONS OF COST DECLINES IN THE COST OF STORAGE AND RE

RENEWABLES ARE NOW CHEAPER THAN CONVENTIONAL GENERATION IN ALMOST ALL GLOBAL MARKETS, INCLUDING INDIA



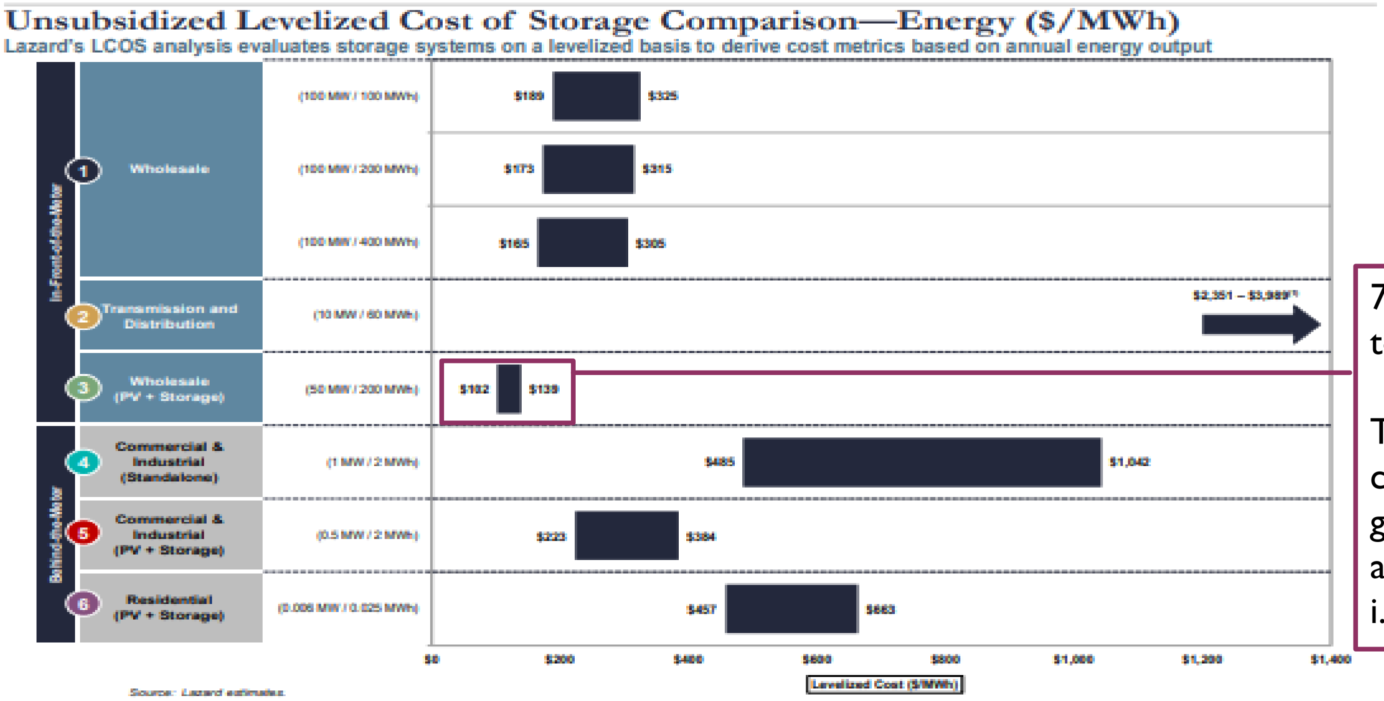
2.52 – 3.08 Rs/kWh consistent with what we see in India

1.96 – 3.75 Rs/kWh, due to different quality wind resource

4.6 Rs/kWh, a little higher than in India (about 3.5 – 4.5 Rs/kWh depending on transport costs)

Source: Lazard Investment Bank, Levelized Cost of Energy, Version 13

SOLAR PLUS STORAGE IS NOW COMPETITIVE WITH FOSSIL BASED PEAKING PLANTS

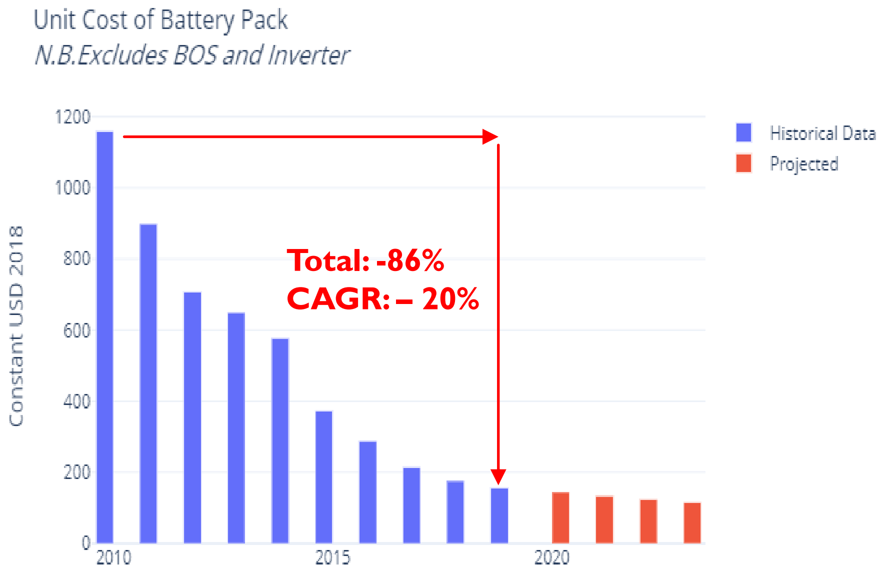


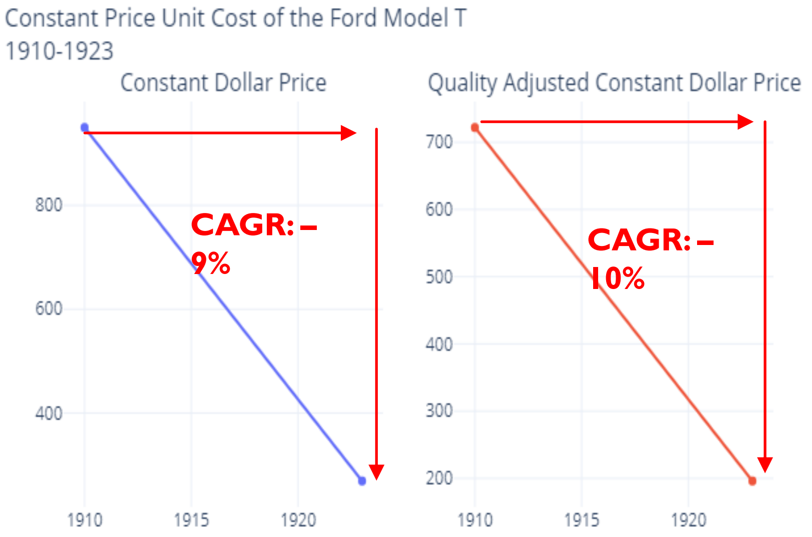
7.14 – 9.73 Rs/kWh today.

This is already competitive with gas and coal at low annual load factors, i.e. peaking plants.

Source: Lazard Investment Bank, Levelized Cost of Storage, Version 5

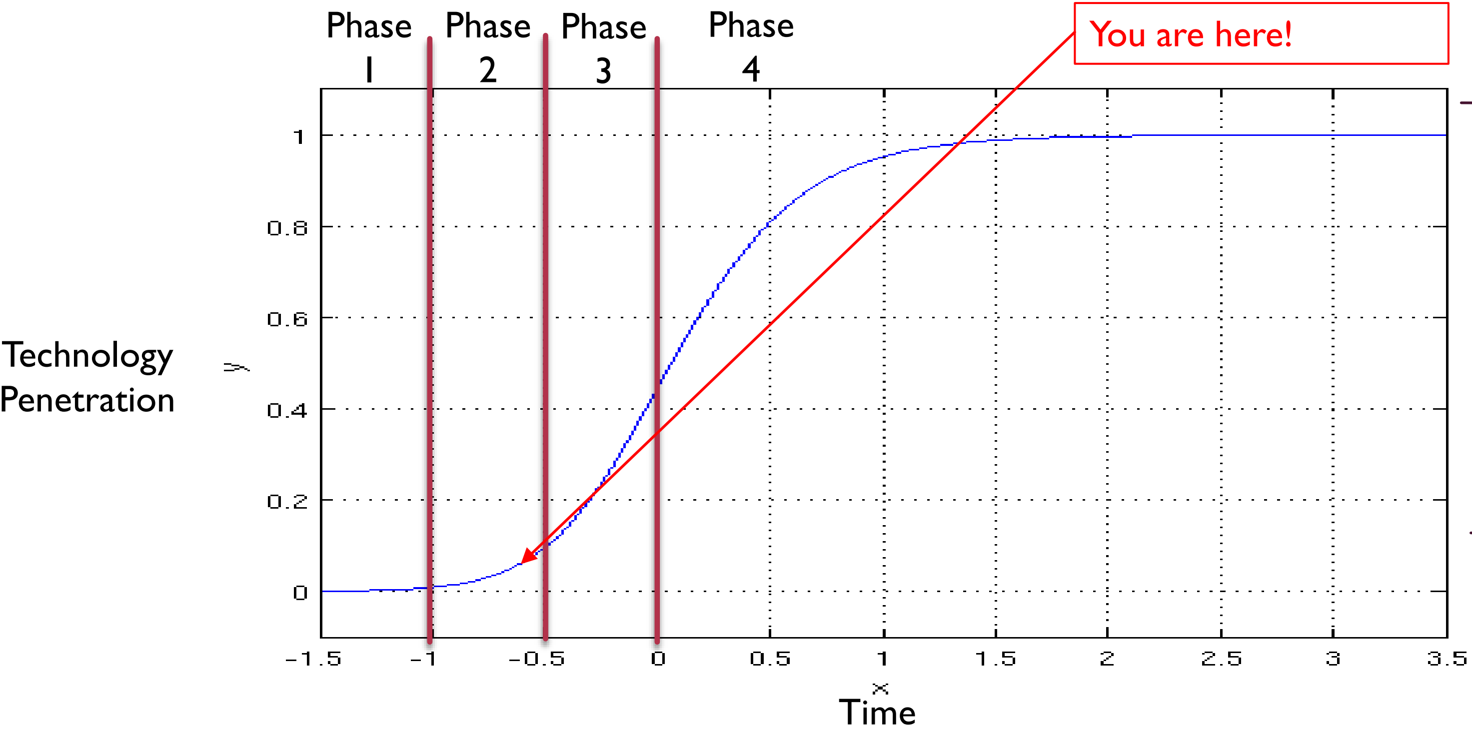
COST LEARNING IN LI-ION BATTERIES IS AMONG THE FASTEST OBSERVED IN ENERGY TECHNOLOGIES





Source: Lazard Investment Bank, Levelized Cost of Energy, Version 13

CONCEPTUALIZING TRANSITION



Phase 4: PV + BESS competitive in a generalized manner

Phase 3: PV+BESS competitive in some applications

Phase 2: PV competitive, grid integration constraint

Phase 1: PV not competitive, policy push

Introduction to ETC HTA

Background

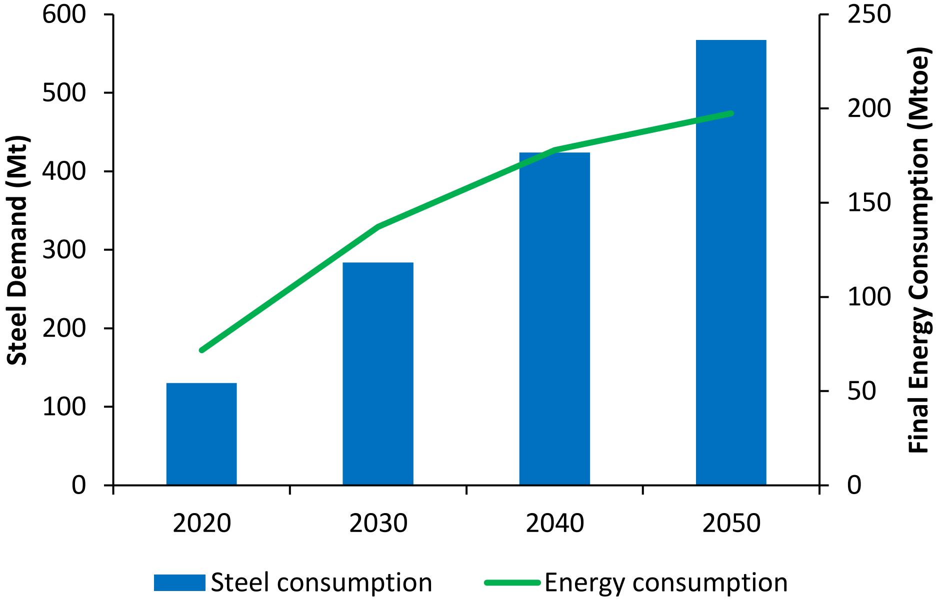
- The Energy Transitions Commission (ETC) brings together a diverse group of leaders from across the energy sector to accelerate the transition towards a low carbon energy system.
- ETC India, with TERI as secretariat, aims to foster the adoption of low-carbon pathways in India through discussions between various stakeholders.
- Decarbonising the ‘hard-to-abate’ sectors is a particular challenge, given the higher incremental costs of zero carbon technologies, impact on international competitiveness and the requirement for high temperature heat and or presence of process emissions.
- ETC India is taking forward work in these sectors to develop plausible decarbonisation pathways out to 2050.

Harder to abate sectors

- The HTA sectors supply the Indian economy with the majority of the materials it needs to support rapid economic development.

- These include iron & steel, cement, petrochemicals, aluminium, fertilisers and bricks. Demand for these materials is set to rapidly expand as India develops.

- Steel demand, for example, is set to more than quadruple between 2020 and 2050, with energy and emissions also increasing accordingly.



TERI analysis, 2019

Technology solutions

- Sectors need scalable, cost-effective solutions to drive decarbonisation, whilst still facilitating economic growth. Some of the potential solutions for India , which require further research, development and deployment include:

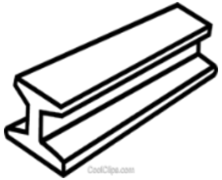
- **Hydrogen**

- **Electrification**

- **CCU**

- **Bio and synthetic chemistry**

- **New materials**



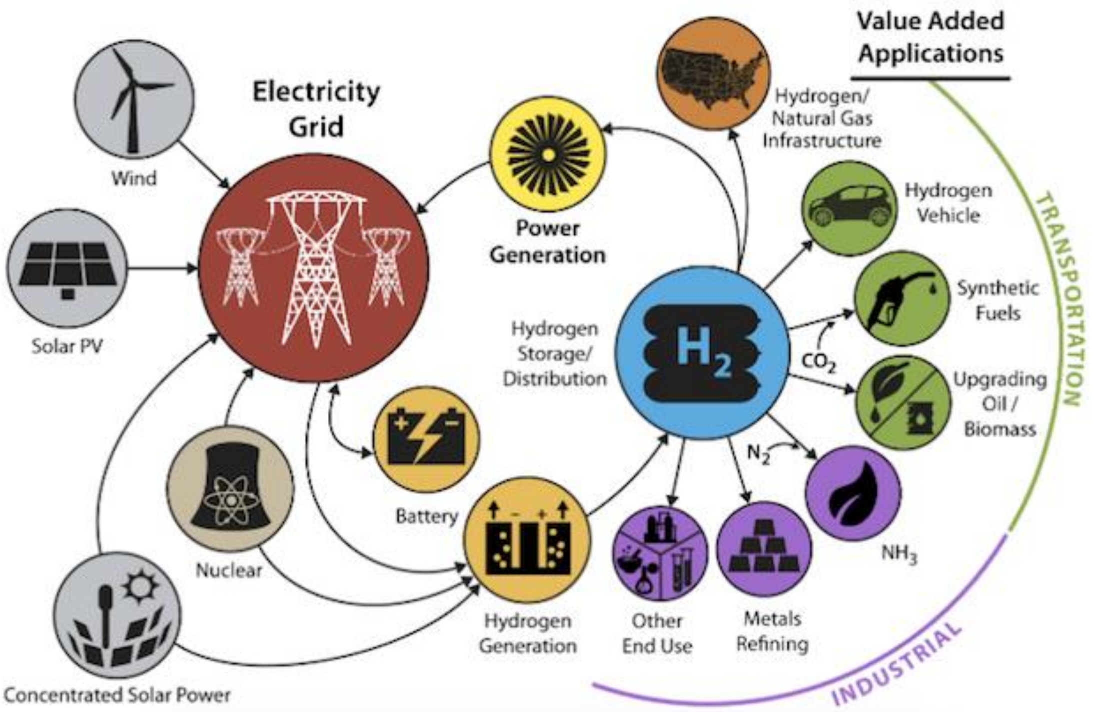
- **Greater efficiency and circularity**

EXAMPLE: Potential role of hydrogen in India

- Hydrogen is a **cross-sector solution**, and will be most cost-effective when infrastructure is shared between different industries.

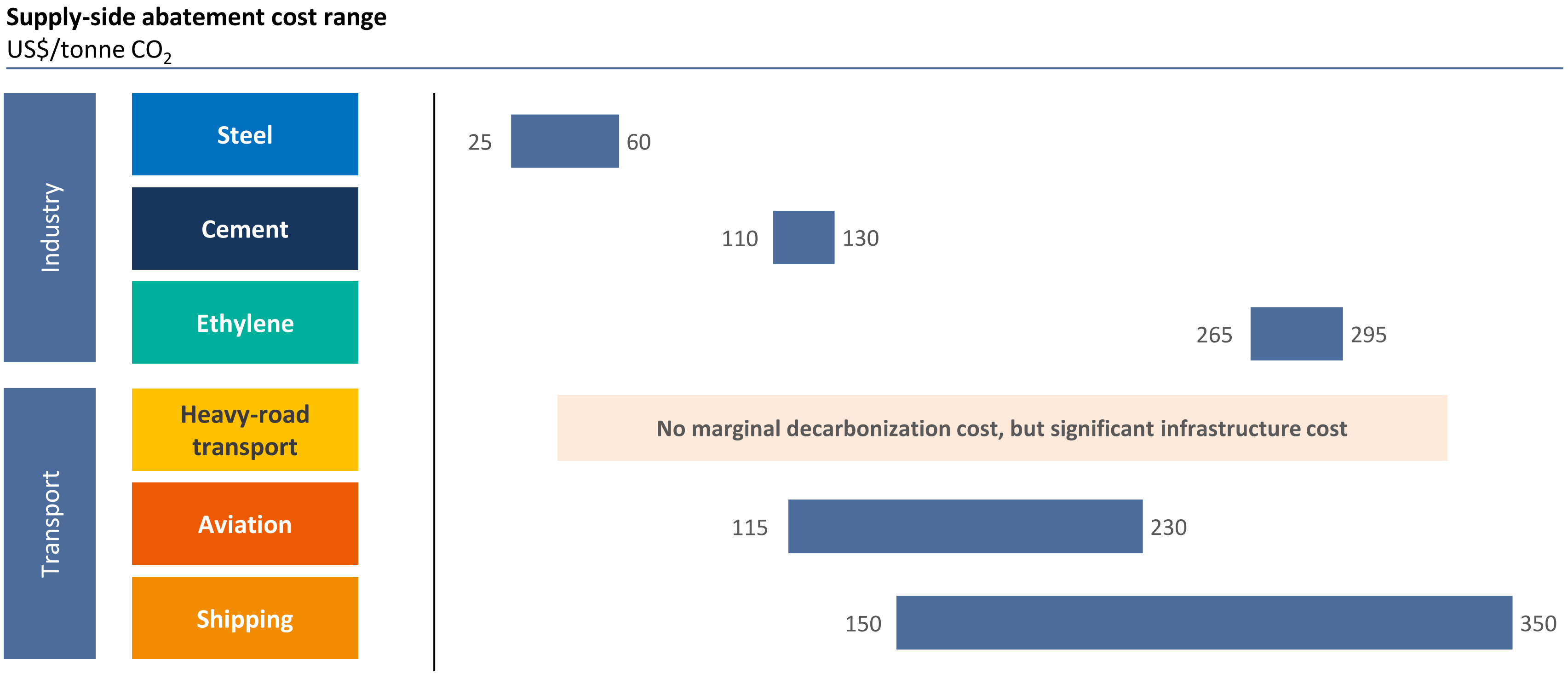
- Applications include **transport**, **power** generation and storage and high-temperature heat processes in heavy **industry** .

- India has potential to develop a strong **hydrogen economy**, making use of low power prices to produce electrolytic hydrogen at scale.



NREL, 2017

Costs of transition varies greatly by sector



Source: Industry: McKinsey & Company (2018), *Decarbonization of industrial sectors: the next frontier* / Shipping: UMAS analysis for the Energy Transitions Commission (2018) / Other transport sectors: SYSTEMIQ analysis for the Energy Transitions Commission (2018)

Decarbonizing the harder-to-abate sectors would have minimal impact on most end consumer prices …

Impact on final product cost (US$ / % price increase)

Industry	**Plastics**	+$0.01 on a bottle of soda	**<1%**
Industry	**Steel**	+$180 on the price of a car	**+1%**
Industry	**Cement**	+$15,000 on a $500,000 house	**+3%**
Transport	**Heavy-road transport**	No price impact	**None**
Transport	**Shipping**	+$0.03 per kilogram of imported sugar	**<1%**
Transport	**Aviation**	+$40-80 on a 6,500-km economy class flight	**+10-20%**

Source: SYSTEMIQ analysis for the Energy Transitions Commission (2018)

… but a very significant impact on the price of some intermediate products

Impact on intermediate product cost (US$ / % price increase)

			% price increase
Industry	**Cement**	+$100 per tonne of cement (+$30 per tonne of concrete)	**+100% (+30%)**
Industry	**Steel**	+$120 per tonne of steel	**+20%**
Industry	**Plastics**	+$500 per tonne of ethylene	**+50%***
Transport	**Heavy-road transport**	No price impact	**None**
Transport	**Shipping**	+$4 million on typical bulk carrier voyage call per annum	**+110%**
Transport	**Aviation**	+$0.3-0.6 per liter of jet fuel equivalent	**+50-100%**

*Assuming an initial price of US$1000/tonne for ethylene, although the price of ethylene is very volatile.
Source: SYSTEMIQ analysis for the Energy Transitions Commission (2018)

Towards a Low Carbon Steel Sector

Overview of the Changing Market, Technology, and Policy Context for Indian Steel

SHAKTI SUSTAINABLE ENERGY FOUNDATION

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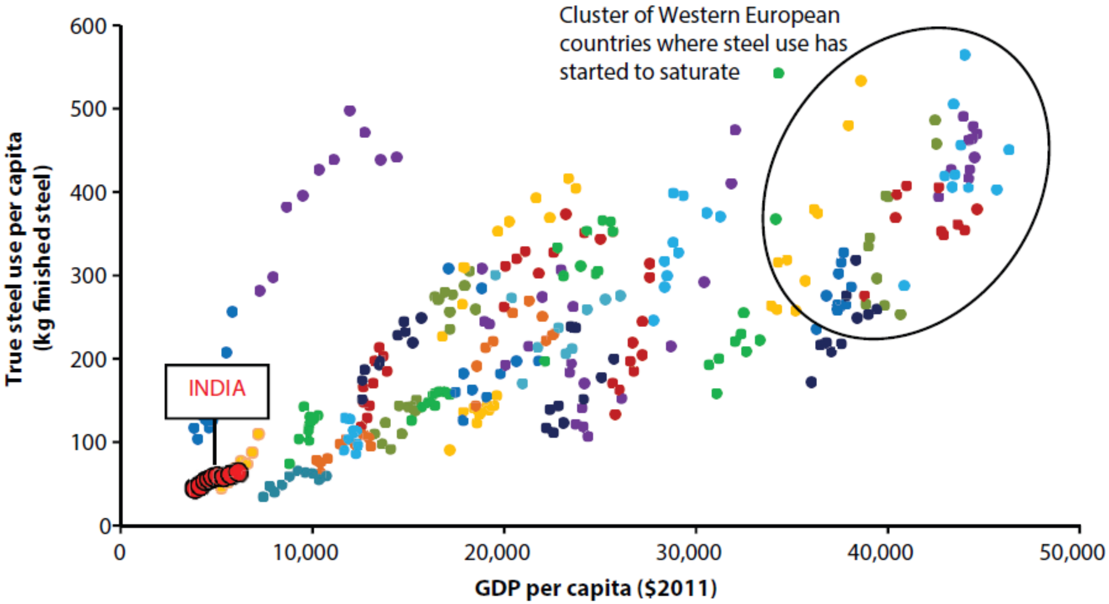
Demand Growth and Structure: *Top-down modelling*

Our econometric model projects steel demand in India out to 2050, based on assumptions around the country's economic growth, levels of capital investment and structure of the economy.

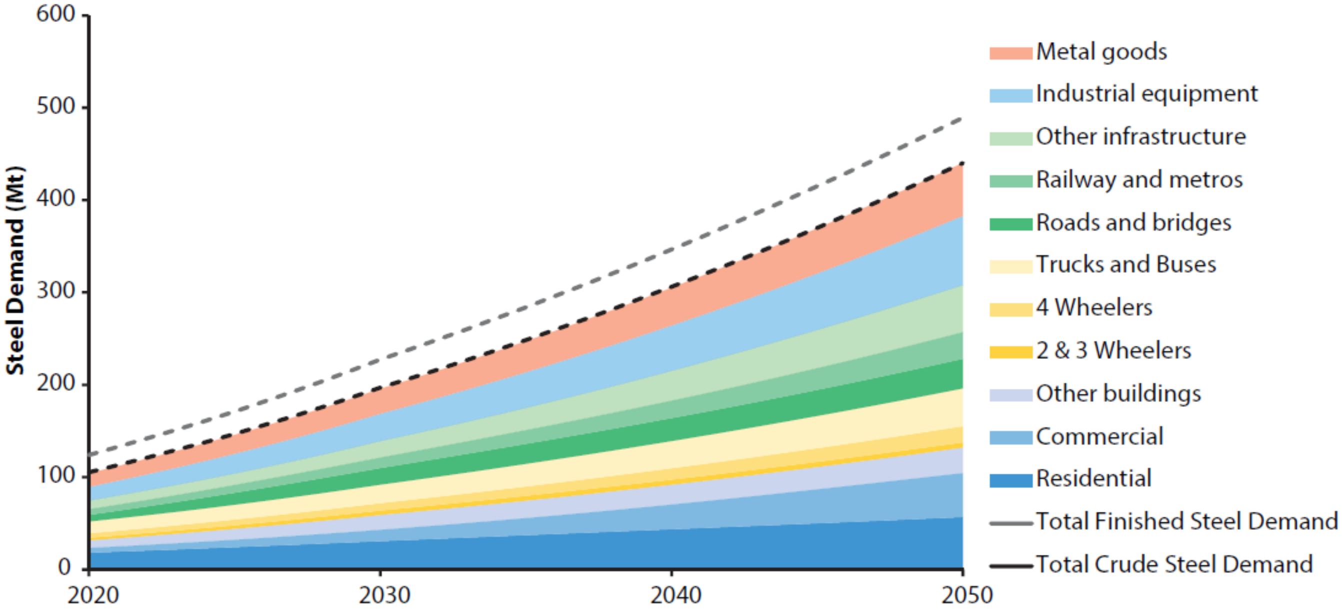


Source: TERI analysis based on data from WSA (2018b); World Bank (2017)

We have derived a relationship between steel demand and these macroeconomic indicators through the observation of data from 34 other countries between 2006 and 2016.

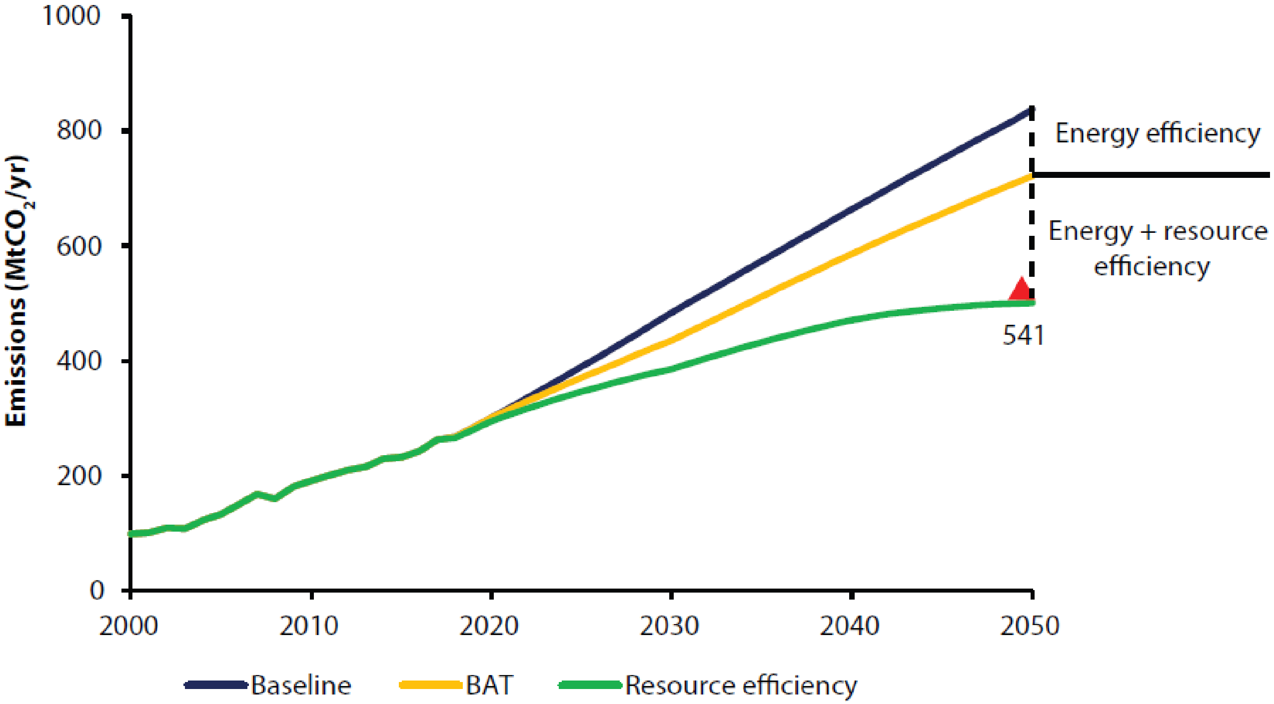
To select these countries, we chose those that were above a minimum geographical size, above a minimum level of industrial sector activity, and that spanned a broad range of GDP per capita

Demand Growth and Structure: *Bottom-up modelling*



Complementary bottom-up modelling to allow us to conduct material flow analysis.

Resources Supply and Environmental Footprint

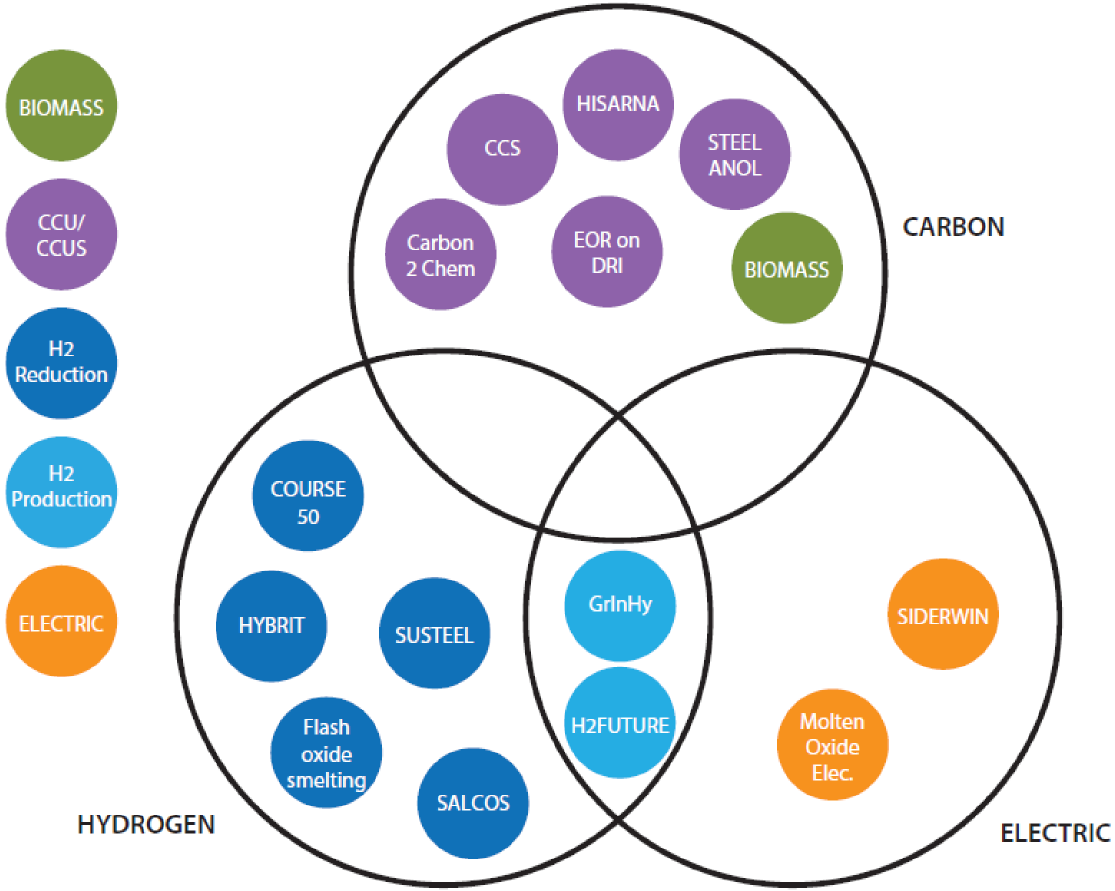


Source: TERI analysis based on data from MoS (2017)

We first conducted analysis to assess the impact of energy efficiency measures – moving to best available technologies – as well as resource efficiency measures. In combination, these reduce emissions by nearly 40%.

New technologies

We then conducted an assessment of new technologies, which could help drive deep decarbonisation in the Indian iron and steel sector.



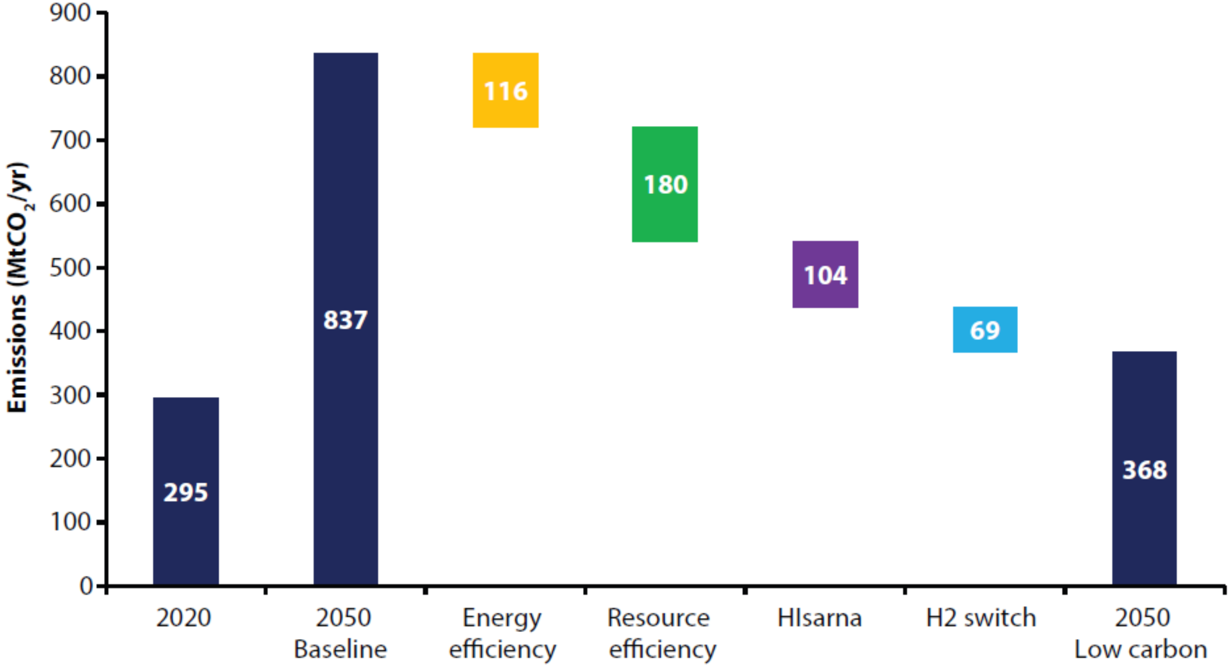
New technologies: *Deep Decarbonisation Pathway*

Based on the assessment of emerging technologies in the previous section, as well as the other characteristics of the Indian steel sector, we have devised a deep decarbonization scenario. This is an illustrative scenario, showing the impact of a mix of technology solutions that we think could be well suited to the Indian context.

Measure	2020s	2030s	2040s	2050
BAT energy efficiency	■	■	■	■
Moderate ambition resource efficiency	■	■	■	■
Maximise domestic scrap	■	■	■	■
Adoption of HIsarna technology		■	■	■
Addition of CCUS to HIsarna plants			■	■
H_2-DR for new primary capacity			■	■
H_2 blend in old blast furnaces			■	■

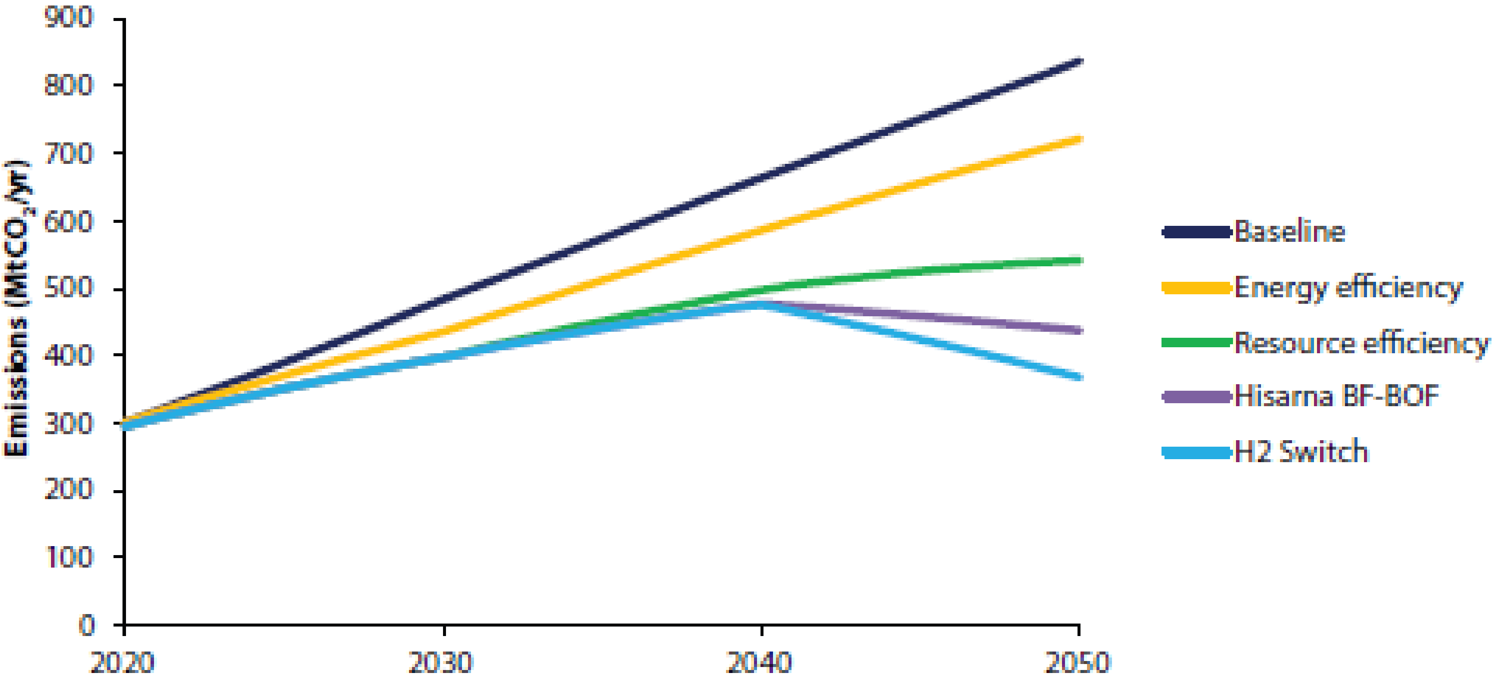
Source: TERI analysis

New technologies: *Deep Decarbonisation Pathway*

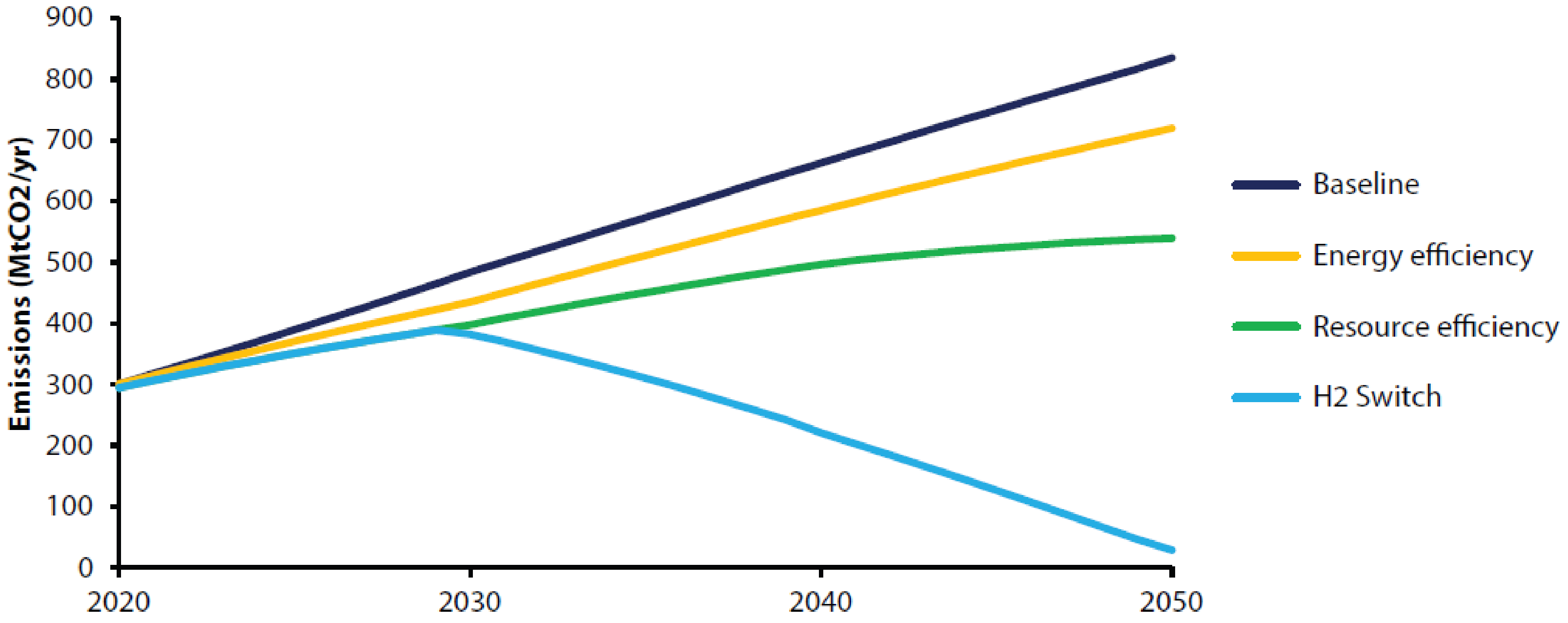


This pathway results in a greater than 50% reduction in emissions, when compared with the Baseline scenario, putting the sector on track for net zero emissions by 2060.

New technologies: *Deep Decarbonisation Pathway*



New technologies: *Optimistic Hydrogen Scenario*



Recommendations

1. Make maximum use of domestic scrap
2. Maximise energy efficiency
3. Facilitate greater resource efficiency throughout the economy
4. Establish pilot and demonstration plants to test low carbon technologies
5. Stimulate demand for low carbon steel
6. From 2030, introduce policy measures to constrain emissions

Future work

- The potential role of natural gas and coal gasification as transition fuels
- Scenarios on the cost and availability of steel scrap
- Finance and technology requirements for improving energy efficiency in the Indian steel sector (larger steel plants)
- Identifying energy efficiency opportunities in the secondary steel sector and in downstream units, including rolling mills, wire drawing, industrial furnaces, forging and foundries.
- Developing sectoral guidelines for energy conservation
- The use of biomass as a partial replacement of coking coal in the BF-BOF route
- Environmental impact of mining key resources, such as iron ore and coal
- Understanding the interactions of different emissions reduction policies and technologies between the heavy industry sectors, and the rest of the Indian economy
- Understanding the role of finance in delivering the transition to low carbon technologies, including total levels of investment required
- Developing an improved understanding of the pathway to a net-zero steel sector, beyond 2050

TERI / ETC India work plan

ETC India, which is based in TERI, has started a program of work to understand plausible decarbonisation pathways for the ‘hard-to-abate’ sectors in India.

The entire work program will cover a broad range of heavy industry sectors, including iron & steel, cement, aluminium, petrochemicals, fertilisers and bricks. The first sectors being covered are iron & steel and cement, with cross-cutting technology reports on the role of hydrogen and CCUS.

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