LOW CARBON TECHNOLOGY ROAD MAP FOR INDIAN CEMENT INDUSTRY

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INTRODUCTION

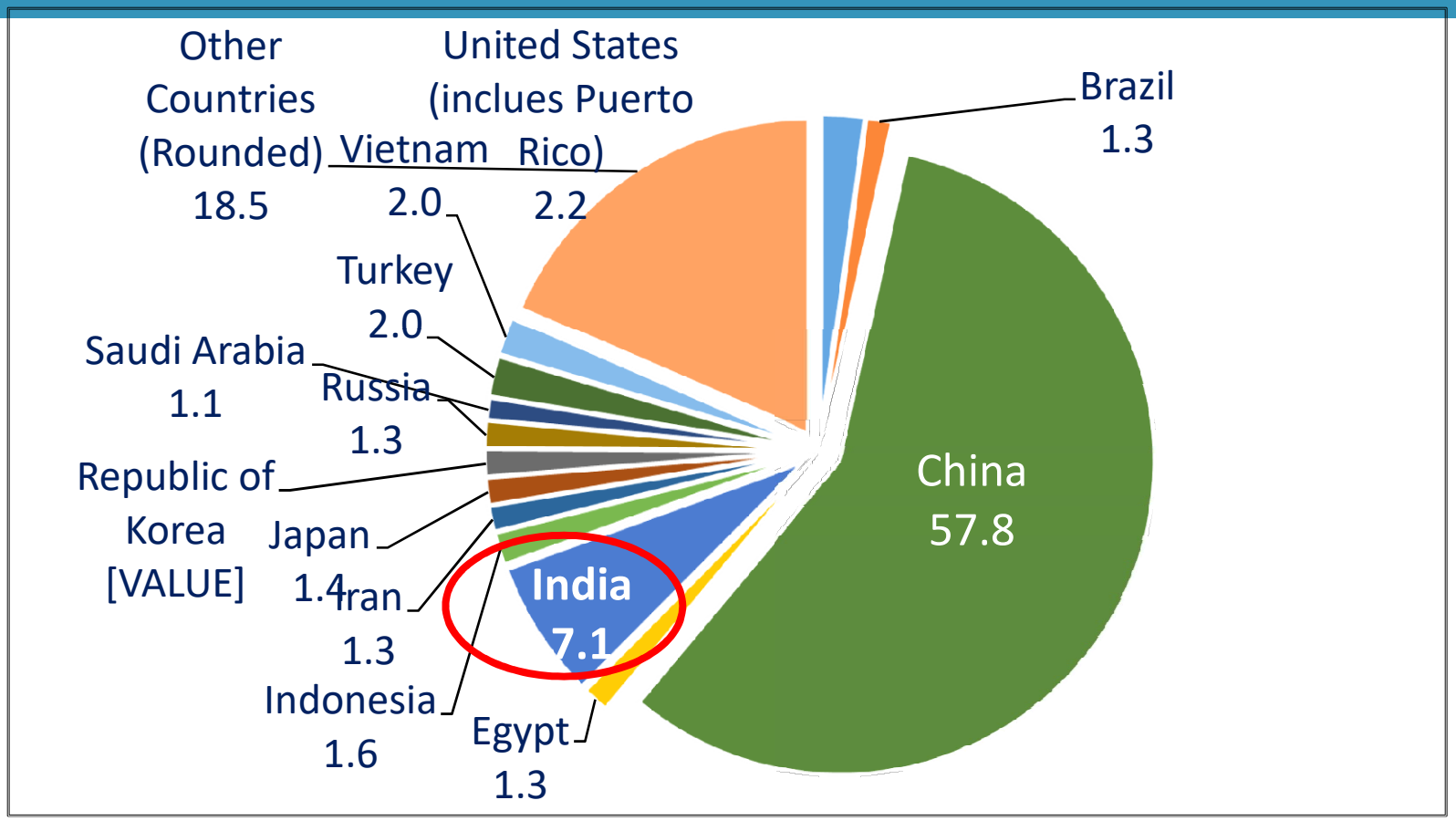
ment is the world's most widely used construction terial

e cement industry has a significant environmental otprint due to the extensive amounts of energy and raw terials used in the process

at Energy is not being utilised to full extent during nker manufacturing in Cement Industries

aste heat from the preheater exhausts and clinker olers can be recovered and used to provide low mperature heating needs in the plant, or used to nerate power

WORLD CEMENT PRODUCTION

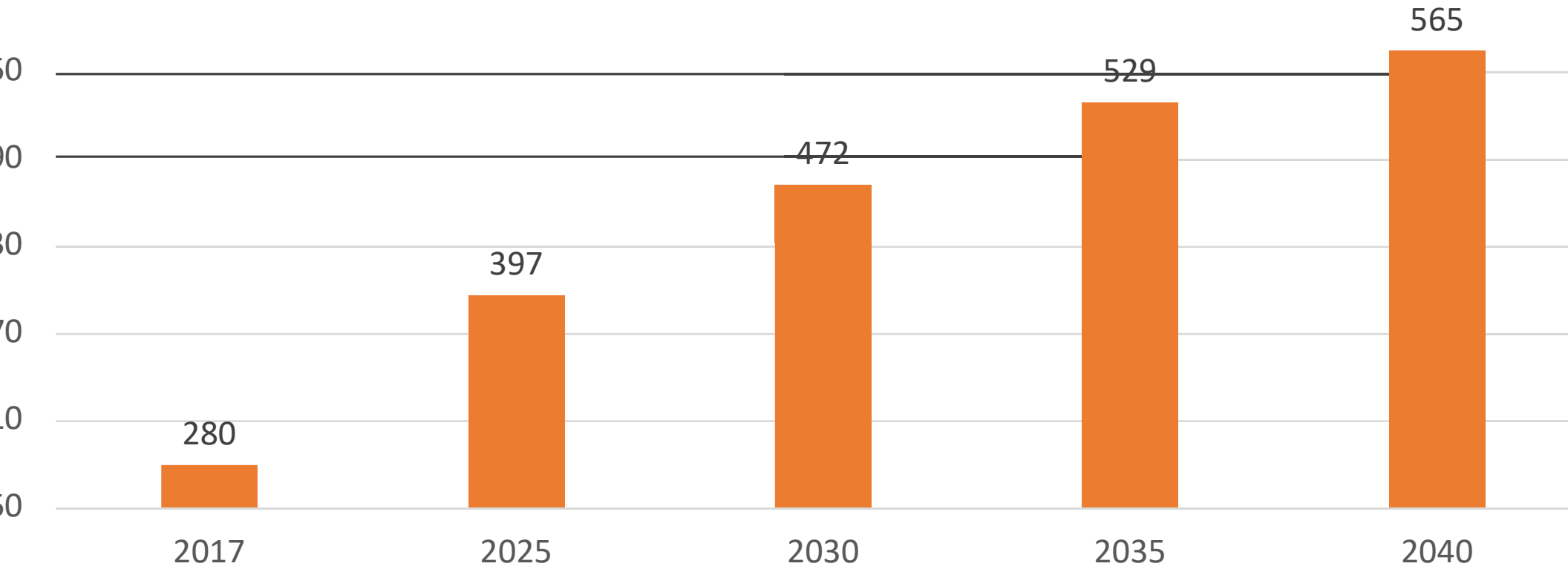


World Cement Production: 4.4 Billion tonnes

INDIAN CEMENT INDUSTRY

- 2nd largest Cement producer in the world.
- Current installed capacity ~ 565 MTPA(2021-2022)
- Current cement production ~ 360 MTPA(2021-2022)
- Biggest consumer of fly ash, 60.02 million tonnes (25.81%) consumed
- Out of 232.32 generated million tonnes during 2020-2021.
- No. of Integrated Cement Plants in India: 168
- No of Clinkerisation units: 04
- No. of Grinding units: 115

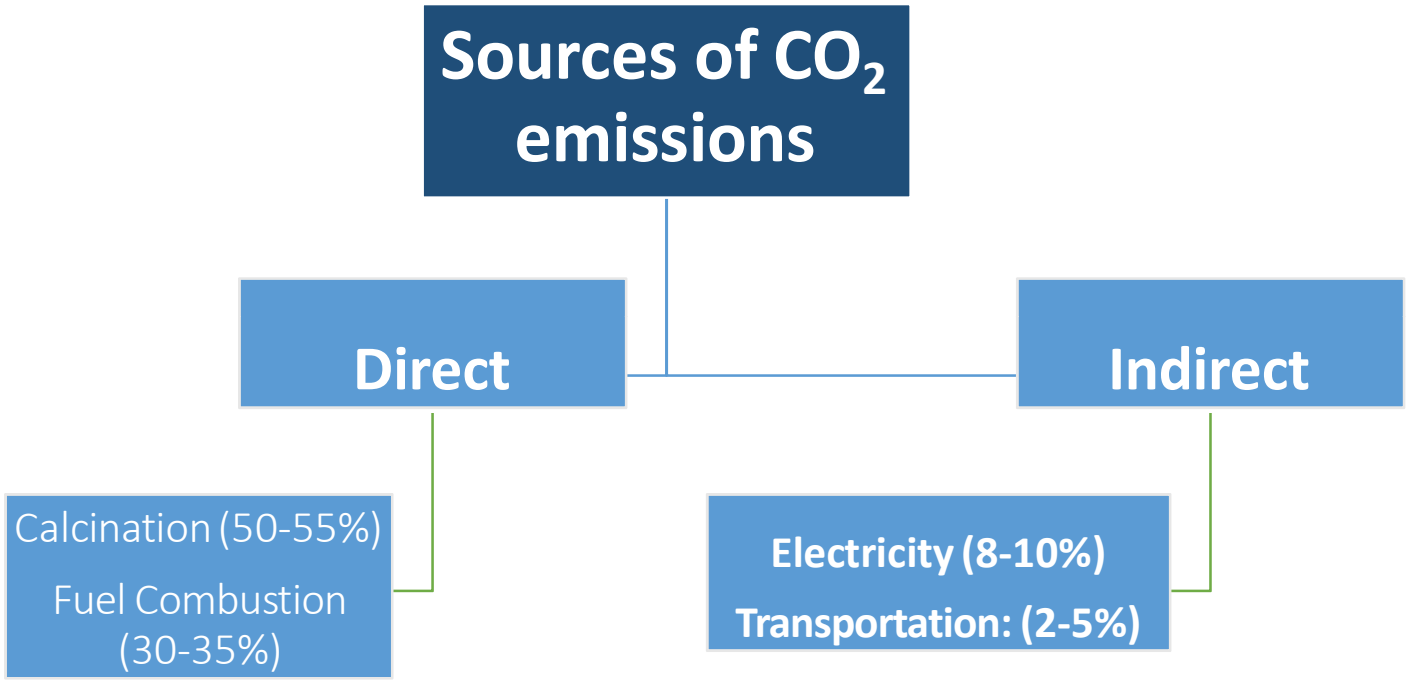
ESTIMATED PROJECTIONS: CEMENT PRODUCTION



Cement production (million tons)

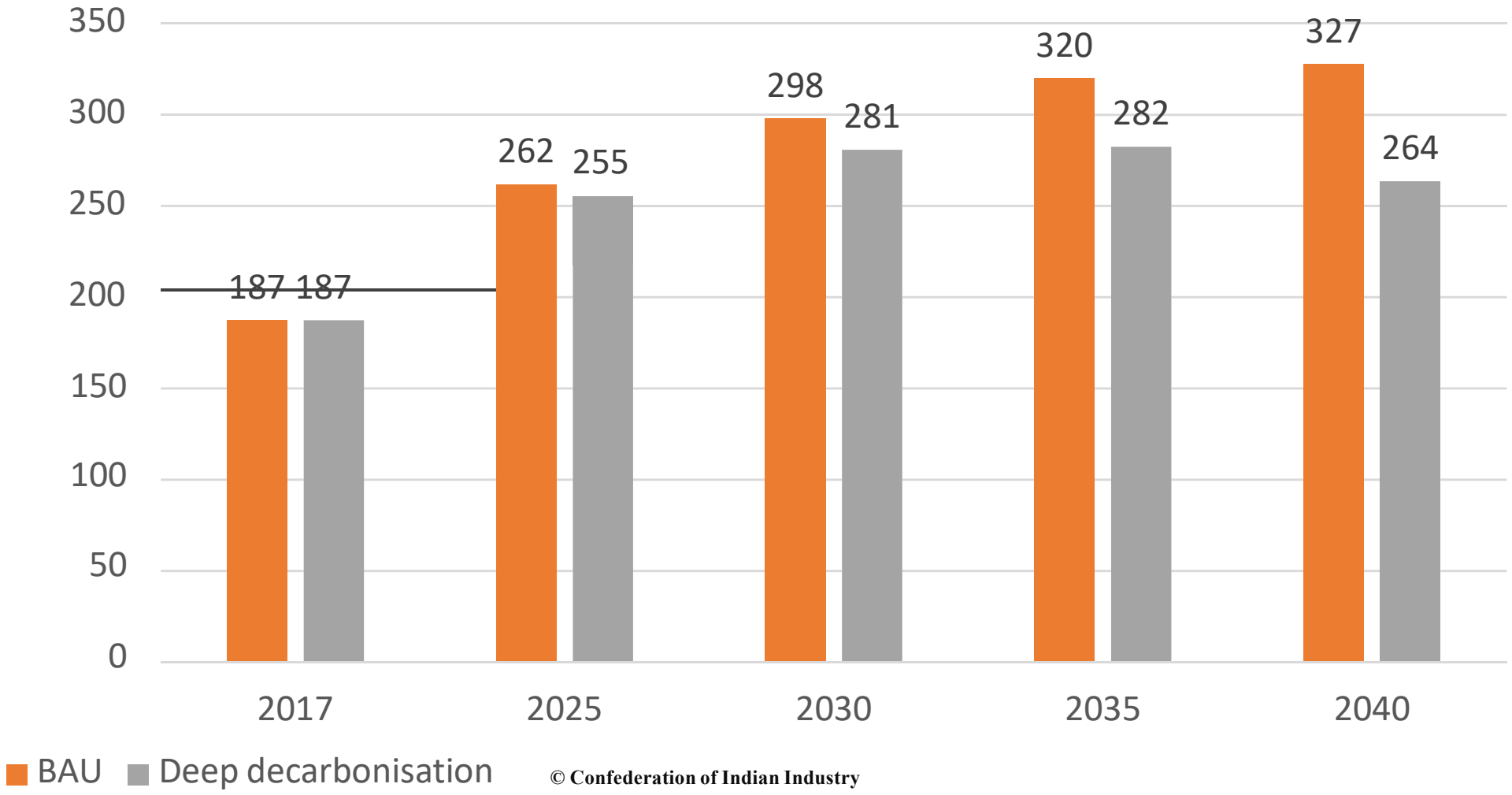
Cement production : Estimates CII Data

SOURCES OF CO2 EMISSIONS IN CEMENT MANUFACTURE (OPC)

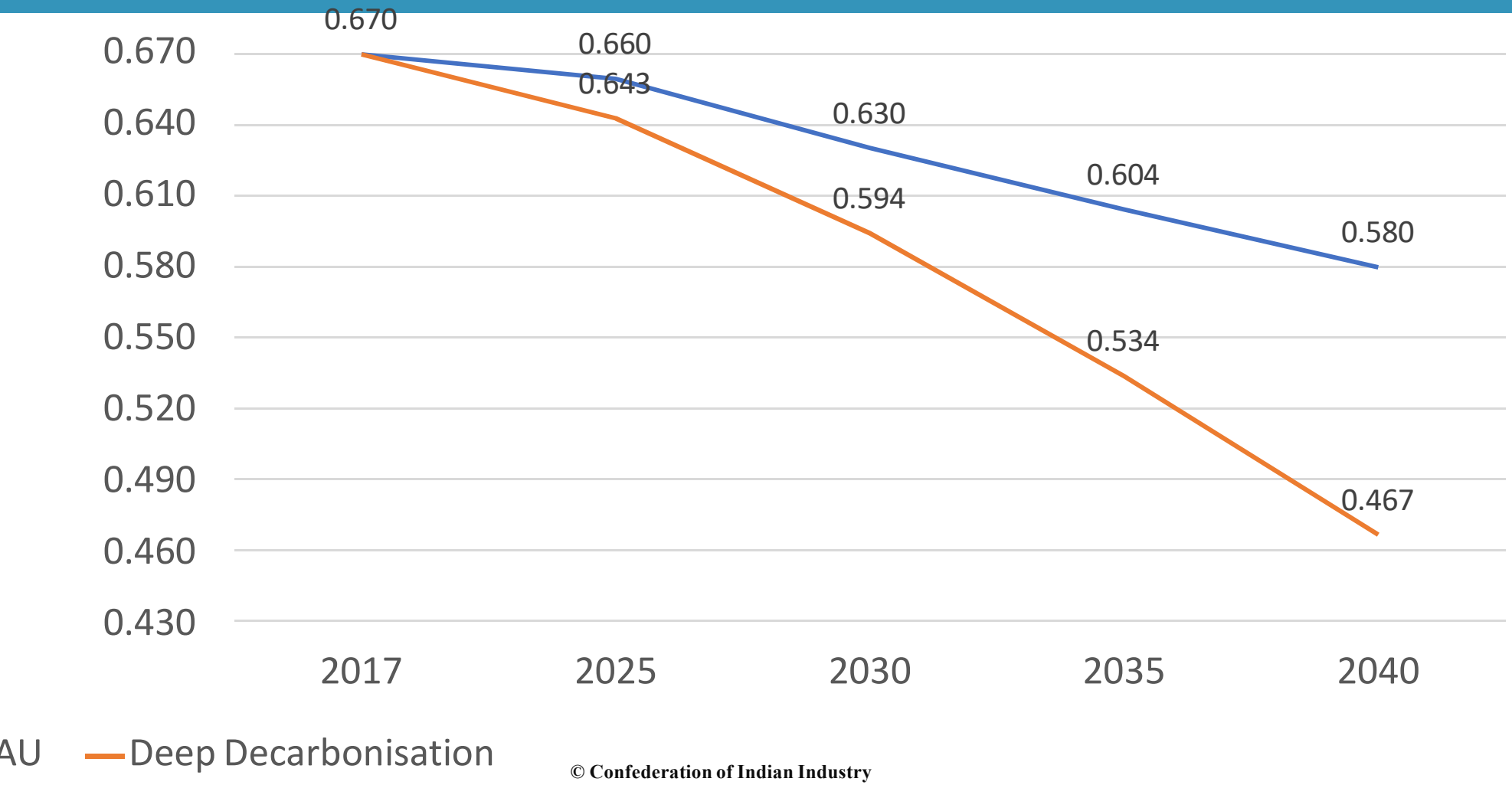


Besides emissions volume, due to the nature of GHG emissions, cement is consi
lard-to-abate sector as it is technologically difficult to reduce the process related
missions emitted due to the calcination of limestone.

ESTIMATED PROJECTIONS: EMISSION (MILLION TONS OF CO2)



ESTIMATED PROJECTIONS: EMISSION INTENSITY (TONS OF CO2/ TON OF CEMENT)



STEPS TAKEN FOR REDUCING CARBON FOOTPRINT BY CEMENT INDUSTRY

The levers identified in the low carbon technology roadmap of Indian cement industry are:

- Reduction in Clinker Factor
- Alternative Fuel and Raw Materials
- Waste Heat Recovery
- Improving Energy Efficiency
- Newer technologies like carbon capture and sequestration

NET ZERO TARGET FOR INDIA

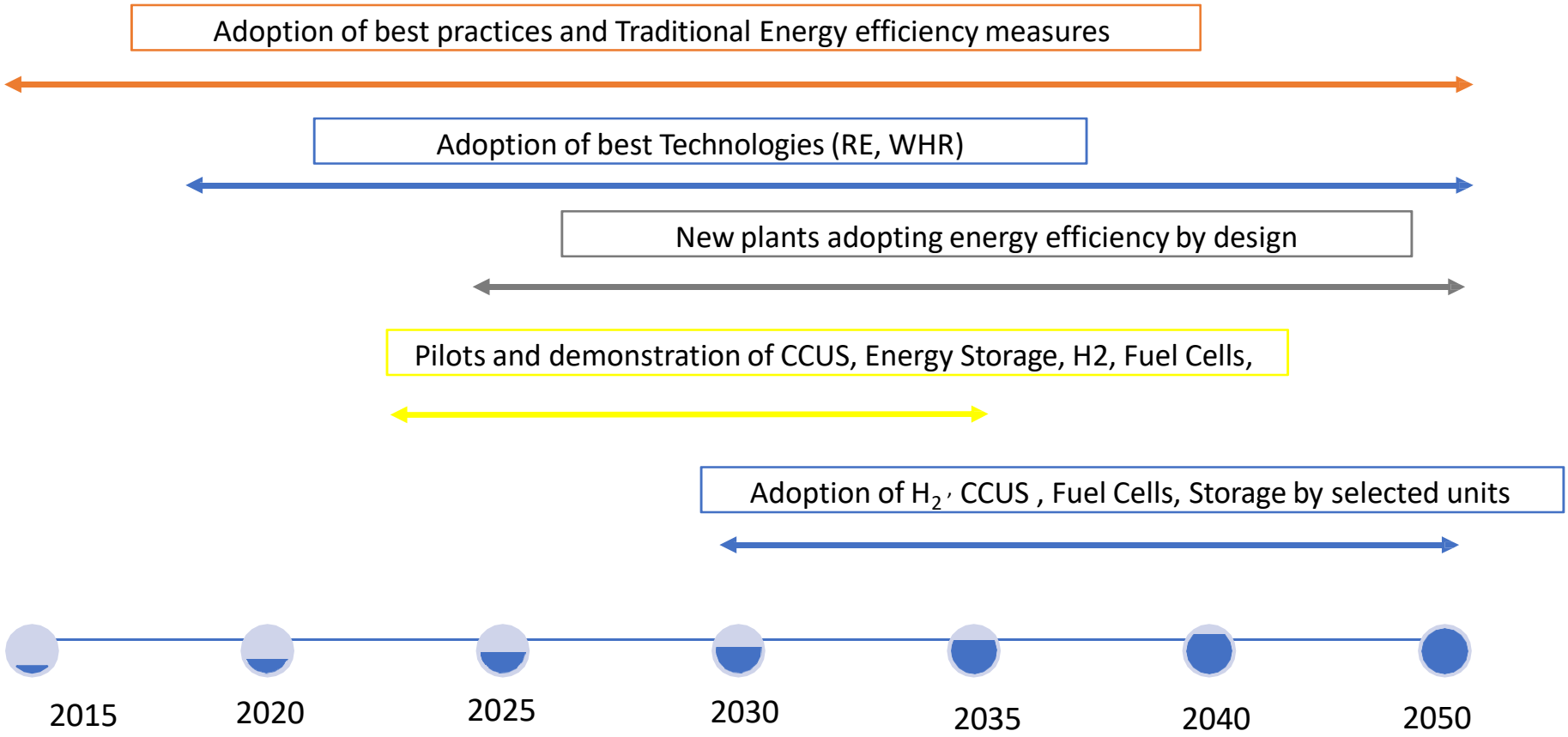
- Our Hon'ble Prime Minister has made the pledge to cut the CO2 emissions in COP 26 summit at Glasgow.
- The new climate action targets "Panchamrit" by India include:
  - A Net Zero target for India by the year 2070
  - Installing non-fossil fuel electricity capacity of 500 GW by 2030
  - Sourcing 50% of energy requirement from renewables by 2030
  - Reducing 1 billion tonnes of projected emissions from now till 2030
  - Achieving carbon intensity reduction of 45% over 2005 levels by 2030
- In Nov 2021, India has reached an emission reduction of 28% and has met th target of non-fossil fuel-based installed power capacity as per COP 21 commit

The proactive steps taken by Indian cement industry has contributed to achieve goal of reduction in carbon intensity.

IPCC REPORT ON GLOBAL WARMING

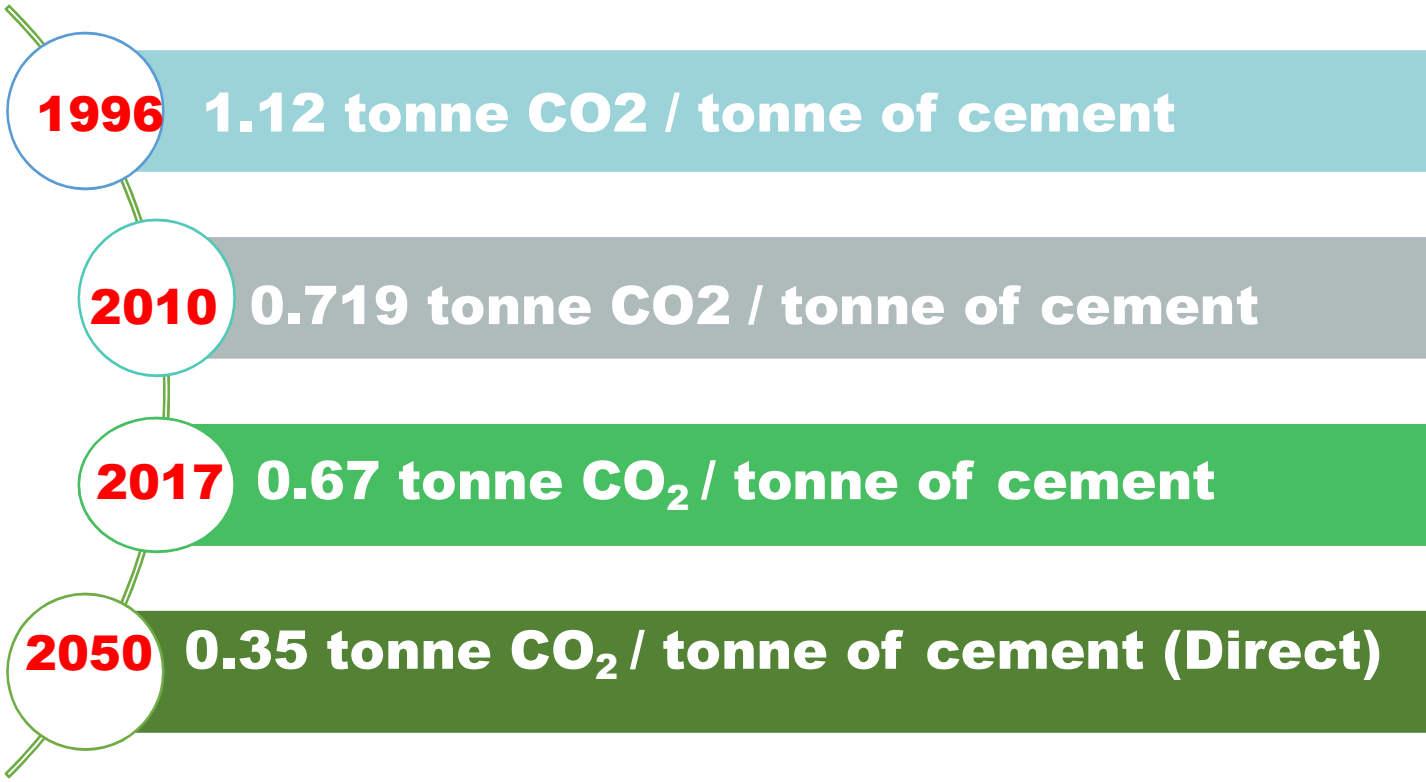
- For limiting the increase in global temperature to 1.5°C, requires achieving net zero carbon dioxide emissions globally in the early 2050s.
- As per IPCC report, major transitions in the energy and industrial sector will be required to limit global warming such as:
  - substantial reduction in fossil fuel use,
  - widespread electrification,
  - improved energy efficiency,
  - use of alternative fuels (such as hydrogen),
  - using materials more efficiently,
  - reusing and recycling products and
  - minimising waste.

TECHNOLOGICAL ROAD MAP FOR DECARBONIZATIO



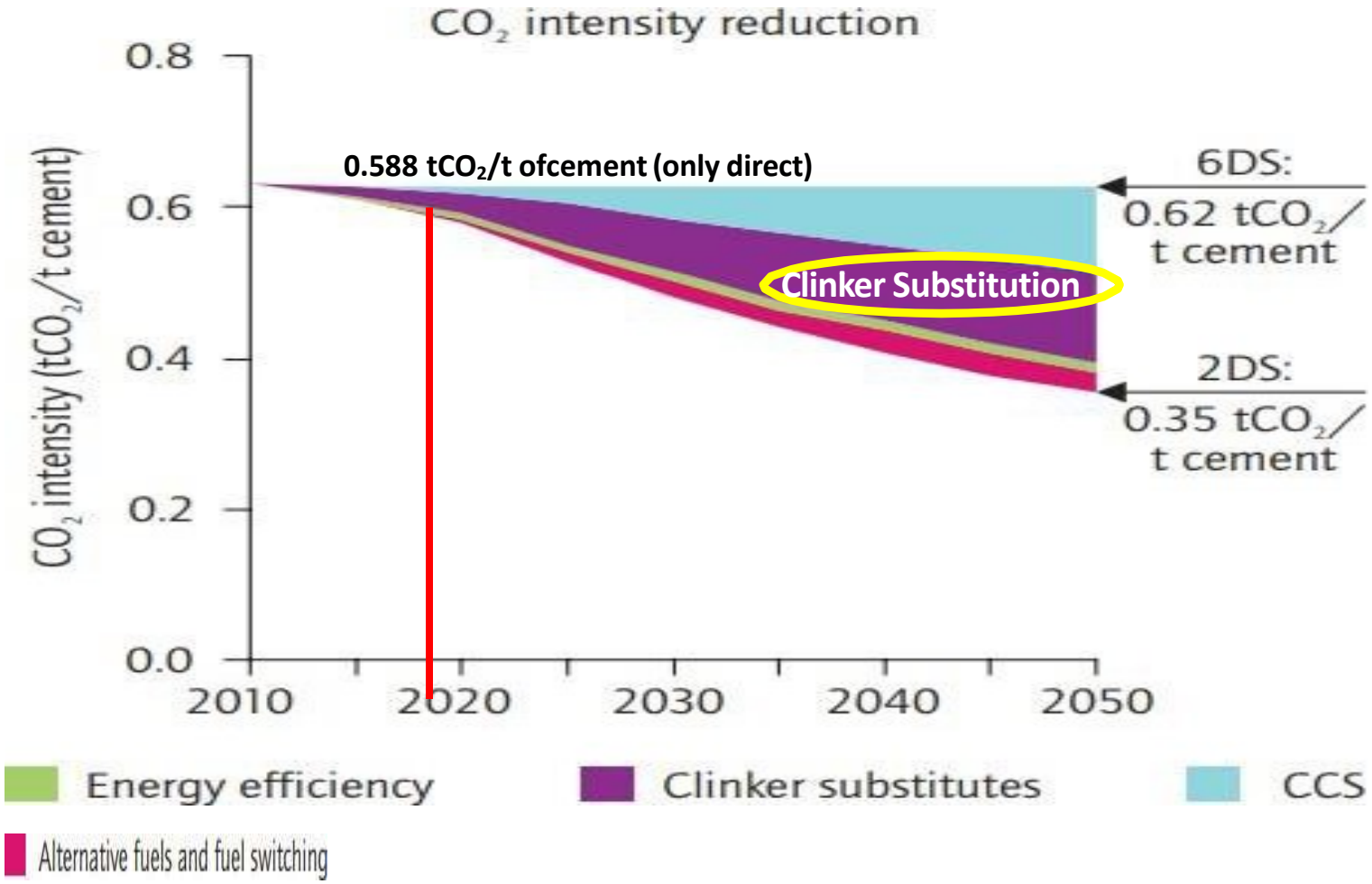
STATUS OF CO2 EMISSIONS FROM INDIAN CEMENT INDUSTRY

As per the IEA estimates, global cement sector generates nearly 2.8 billion tonnes of CO_2, equivalent to 7% of the total anthropogenic emissions

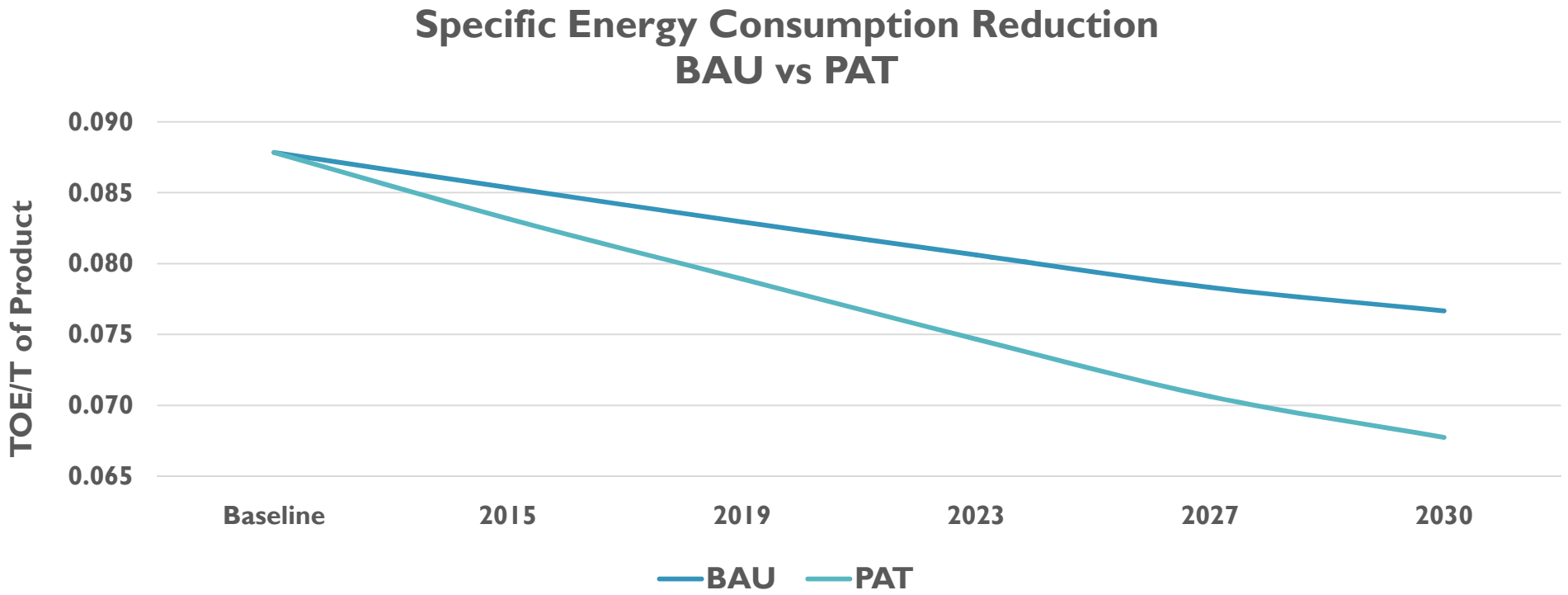


Source: Technology Roadmap, World Business Council for Sustainable Development (WBCSD

INDIAN SCENARIO FOR CO2 EMISSIONS



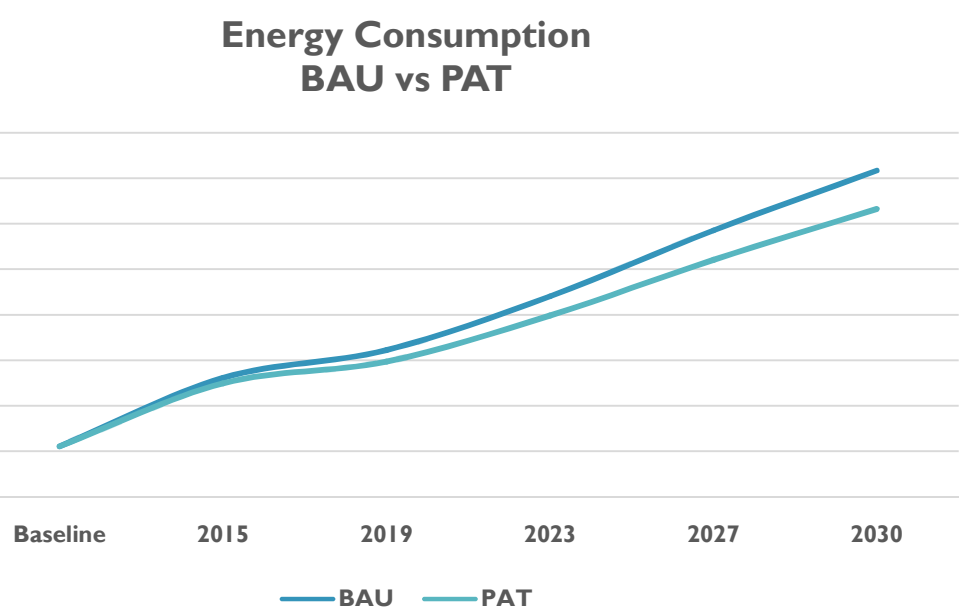
SEC – CEMENT SECTOR

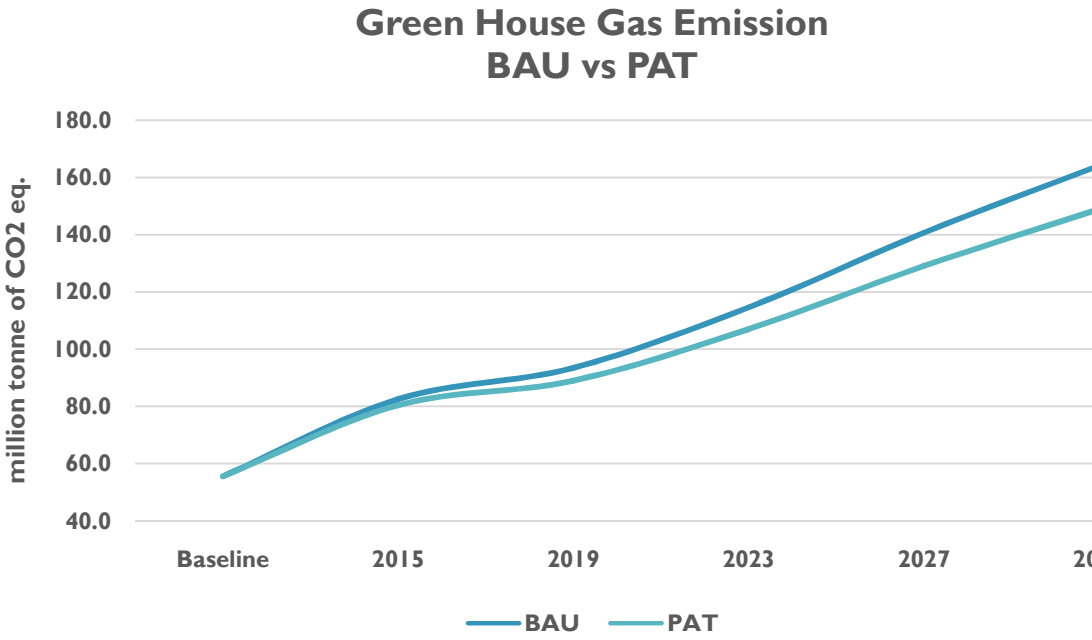


EC improvement under PAT would be better than the Business as Usual and by 203

r would see additional 9% improvement in SEC over BAU

ENERGY AND GHG – PAT VS BAU





ough subsequent PAT cycles by 2030 the annual energy savings possible in Cement

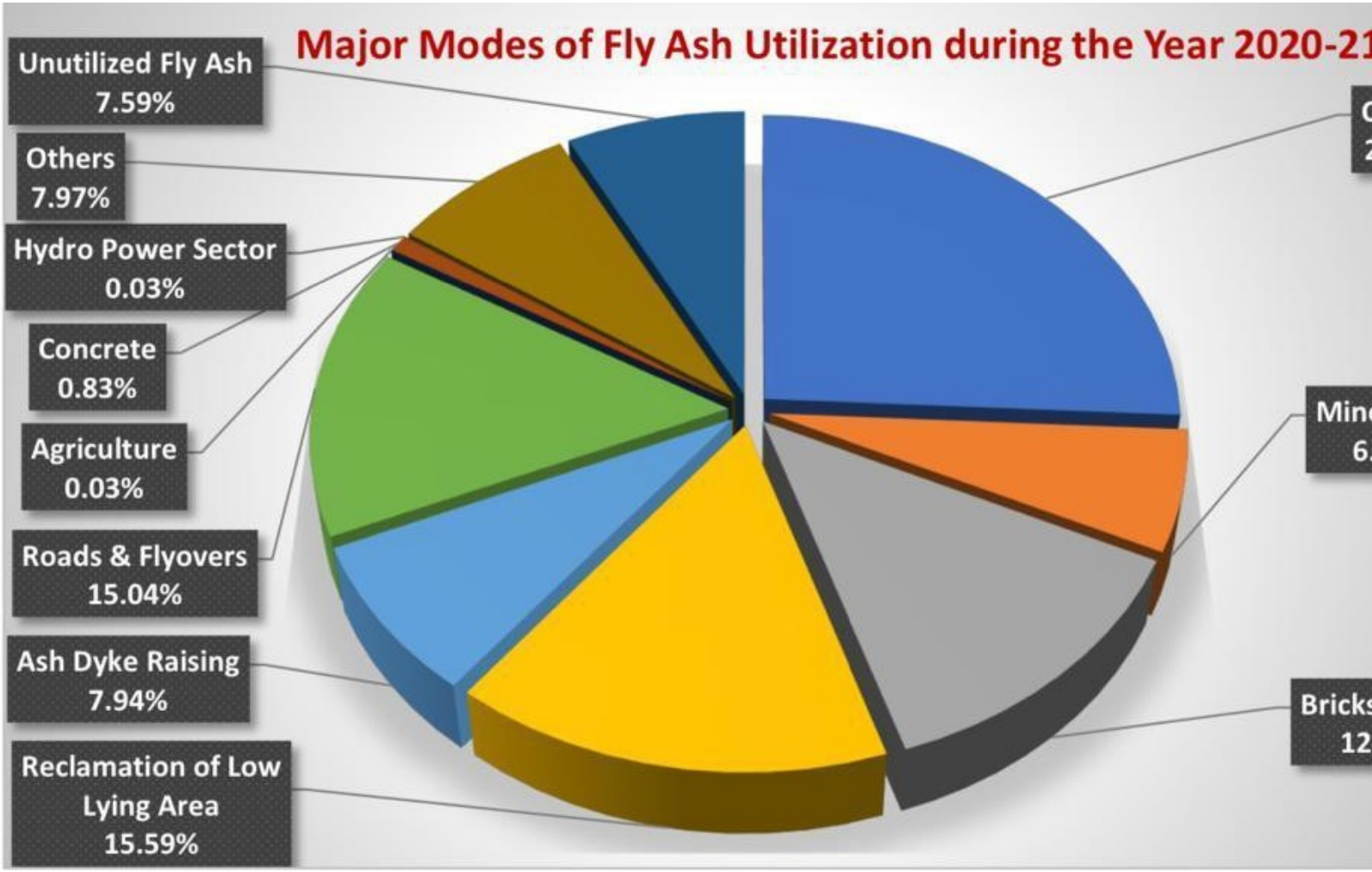
or is 33.86 mMTOE which is equivalent to 121 million T CO2 eq avoided emission1

ed on difference between PAT and BAU

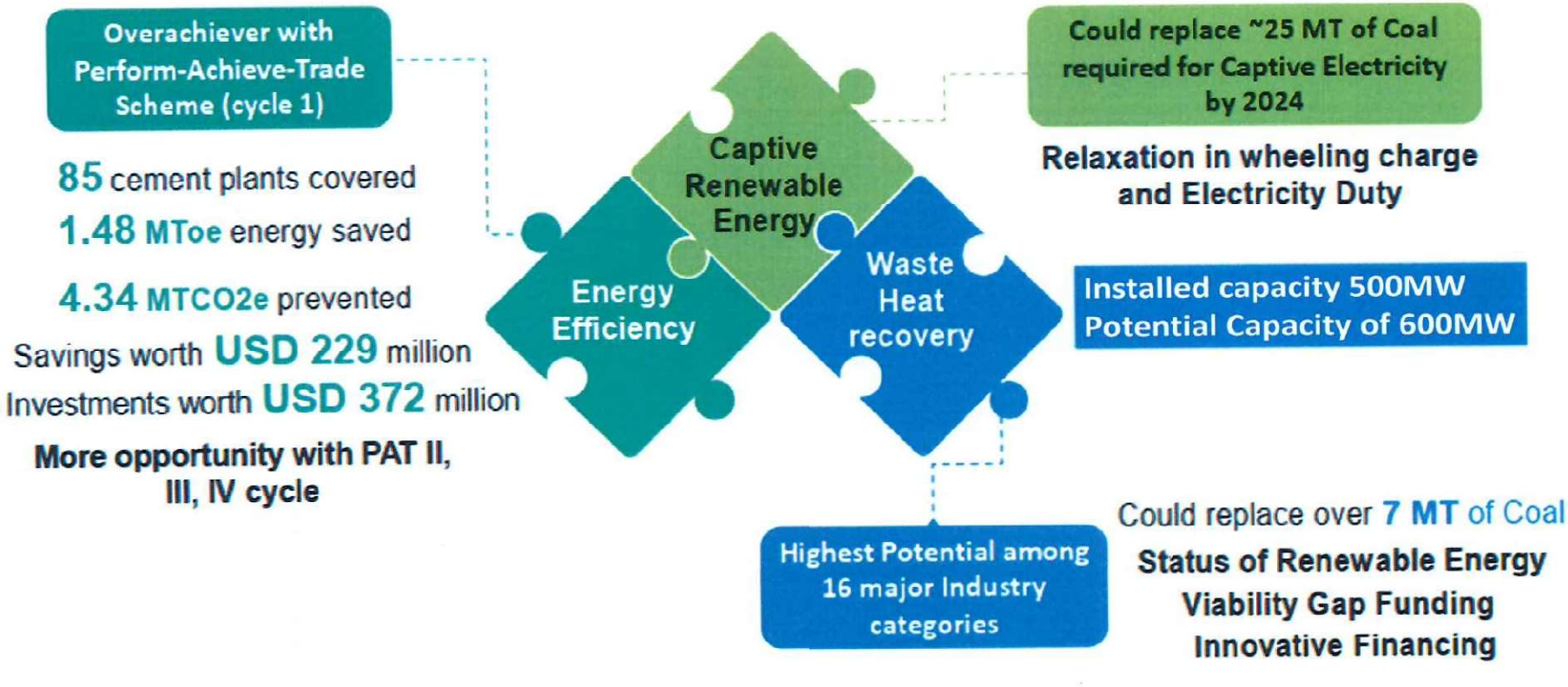
FLY ASH GENERATION & UTILIZATION IN INDIA

Fly Ash Generation in 2020-21: 232.56 Million Tonnes

Fly Ash Consumption in Cement Industry in 2020-21: 60.02 Million Tonnes i.e. 25.81%



CLEAN AND RENEWABLE SOURCE OF ENERGY & EFFICIENCY

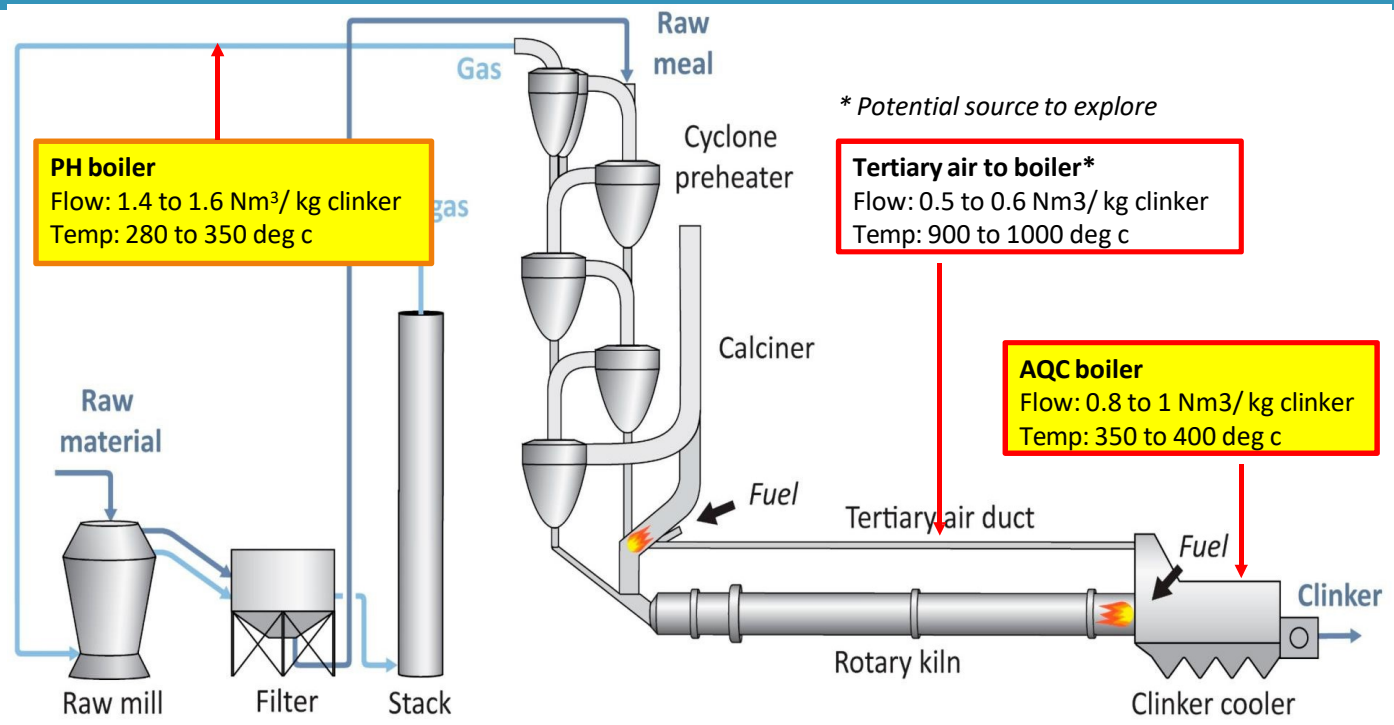


Source: CMA
Source : CMA

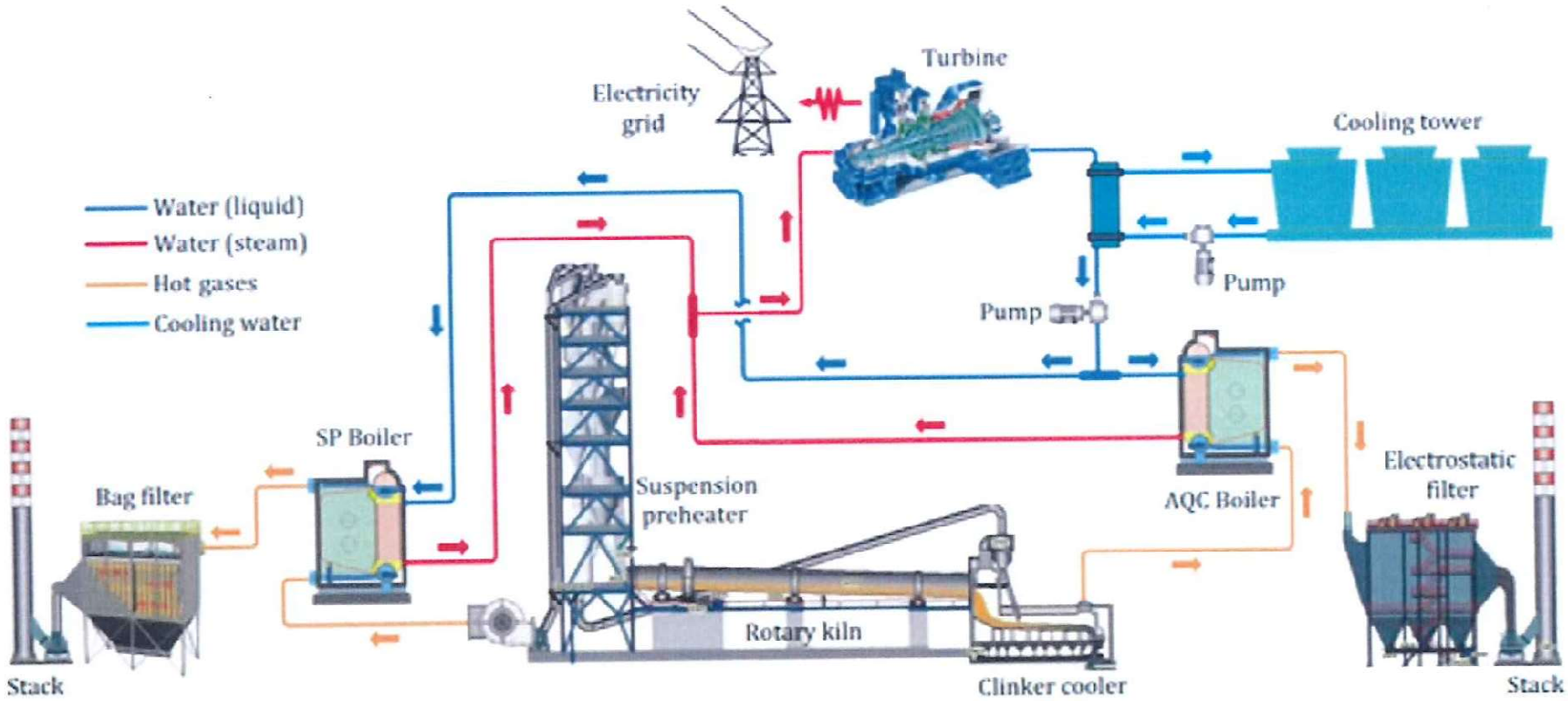
WASTE HEAT SOURCE IN CEMENT PLANT

ecoverable waste heat

- heoretically heat required 390 - 20 kcal/kg of clinker.
- verage practical heat consumption 20 kcal / kg of clinker
- seful heat 58 %
- navoidable loss:
  - Radiation
  - Fuel and raw meal moisture evaporation
  - Clinker heat
- ecoverable:
  - Cooler exhaust
  - Preheater exhaust.



TYPICAL SCHEMATIC OF CEMENT WHR POWER PLAN



BENEFITS OF WHR POWER PLANTS OF CEMENT INDUSTRY

01 Meet up-to 30% of Power needs of Cement Plant (Approx. 3 MW for 1MTPA)

02 High Energy efficiency

03 Reliable source of power

04 Reduce CO_2 emission (1.2 to 1.4 Kg CO_2/KWhr)

05 Generate Green Power without burning fossil fuel (0.8 Kg/KWhr)

06 Enhance plant economics

07 Mitigates the impact of future electric price increase

08 Other benefits like RPPO, PAT etc.,.

CHALLENGES - ECONOMICAL

01

High Capital cost

(Rs. ~ 9 Crore / MW compared with Rs.4.5 crore / MW for conventional power plant)

Reasons:

- Low steam parameters (Pressure and temperatures)
- Higher requirement of water

02

RPO benefits not extended to WHRPP uniformly across the country

03

No Special Incentives, allowances and promotion considered so far for WHRPP

04

Cost reduction by optimisation of

- steam parameters
- Layout
- Boiler configuration & MOC
- Procurement / Construction schedule
- Water System design
- And use of Advance Model Predictive Control software

WHR - RENEWABLE ENERGY

Waste Heat Recovery Power is actually Renewable Energy as it

A. Does not burn any Fossil Fuel

B. Promote Energy conservation

C. Reduce Green House Emission

D. In the larger interest of the environment including climate change

IMPORTANT MESSAGE WAY FORWARD

Explore every option to Maximise the efficiency of Cement Pyro process and to minimise waste heat to the lowest possible.

With the available waste heat from pyro process system, try to maximise the WHRS potential with best suitable WHRS technology, So that WHR Cost economics will be optimum

WHRS installations, which is already a proven technology worldwide for Cement Industry, should be declared eligible for RPO offsetting benefits without any electricity duty (or similar tariffs) to encourage its adoption by Cement Industry.

Globally, especially in United States and European Union, WHRS qualifies for benefits at par with renewable energy projects. The same could be considered in India.

CONCLUSION

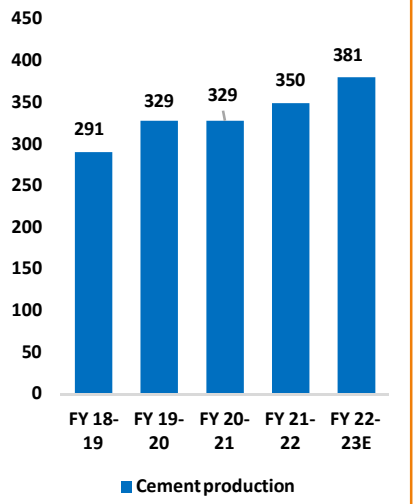
Power Generation by Waste Heat Recovery Power Plant without Auxiliary fuel firing requires substantial capital investment and therefore requires maximum encouragement :

- By giving Renewable Energy Status
- Allowing to meet Renewable Purchase Obligations
- Providing incentives by Government Agencies

CEMENT PRODUCTION & WHR POTENTIAL

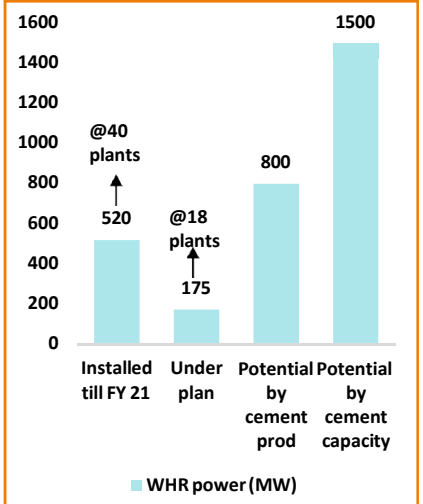
CEMENT PRODUCTION

Million Tonnes



WHRS POWER GENERATION POTENTIAL

Potential in MW



DOMINATED BY COST OF GENERATION

Generation cost

- WHRS power generation cost Rs 0.5-1.4/kWh.
- Captive power plant generation cost Rs 4.5-7/kWh.
- WHRS power generation: 20-25% of total cement plant consumption
- Power cost reduction: 14-18%.

INVESTMENT FOR WHR SYSTEM

Installation cost

- For WHR - INR 8-10 crore /MW
- For CPP - INR 4-5 crore/MW

WASTE HEAT RECOVERY (WHR)-PRESENT STATUS

- Total installed capacity : approx. 660 MW (50 plant locations)
- WHR under installation by 2022-23 : approx. 100 MW
- WHR installation announced by companies to be installed in future
- approx. 150 MW
- WHR capacity by 2030 - around 1550 MW with following assumptions for 20
- Cement production capacity – 726 Million tons
- Clinker production : 508 million tons with 0.70 clinker factor
- Considering WHR potential in 70% production i.e. 356 million tons
- WHR generation @35kWh/MT clinker

ROLE OF GREEN HYDROGEN IN DECARBONIZATION OF CEMENT

- Replacing fossil fuels with hydrogen / blended with the other gaseous fuels to reduce the carbon foot print of the fuel part the cement kiln.
- Green Hydrogen based electricity for the cement production
- Green Hydrogen / Hydrogen blended gaseous fuels for the logistics

HOW TO MAKE GREEN HYDROGEN COMMERCIALLY VIABLE

- Green Hydrogen is viable if the policy announced in Feb, 202 implemented vigorously.
- Economy of scale of renewable energy generation (400 GW of So PV, wind power, banked RE, bio mass power generation) by 2030 and ra increase of hydrogen production capacity will reduce the hydrog manufacturing cost.
- Creating enabling policy environment for increasing Green Hydrogen dem
- Anticipated demand for Green Hydrogen will raise to 32 Million Tones by 2
- The expected hydrogen cost will come down to Rs.80/- per kg by 2050 or earlier through electrolysis of water with use of solar energy. *Promote transition to Green Hydrogen & Green Ammonia*
- The government policy should encourage fertilisers, steel and refineries to to green hydrogen / ammonia with suitable incentives

MEASURES ANNOUNCED IN THE GREEN HYDROGEN POLICY BY GOVT. OF INDIA

Interstate Transmission charges waiver for next 25 years for producers fo
projects commissioned before 30th June 2025

Open Access RE approval for Green Hydrogen projects will be provided v
15 days of application;

30 days Banking of RE used for making Green Hydrogen/Ammonia

Fair Banking charges will be fixed by State Commission.

Priority connectivity of RE & Green Hydrogen & Ammonia

Land allocation in existing RE parks for establishing Green Hydrogen & Ammonia
(GHA).

Establishing manufacturing units for GHA in five states from the land ban
created (*Maharashtra, AP, UP, Rajasthan and Gujarat)*

Creating GHA storage facilities (bunkers near ports for export / used by

MEASURES ANNOUNCED IN THE GREEN HYDROGEN POLICY BY GOVT. OF INDIA (CONT....)

- RE used for producing GHA will be accounted for RPO of consuming entity.
- MNRE will establish 1 portal for all statutory clearances and permission required for:
  - Manufacturing, Transport, Storage, Distribution of GHA
  - All clearance to be given by concerned agencies in 30 days
- MNRE may aggregate demand from all sectors (consumers of GHA)
- Consolidated bids to be conducted for procurement of GHA through designated implementing agencies

GREEN HYDROGEN – IN CONCLUSION

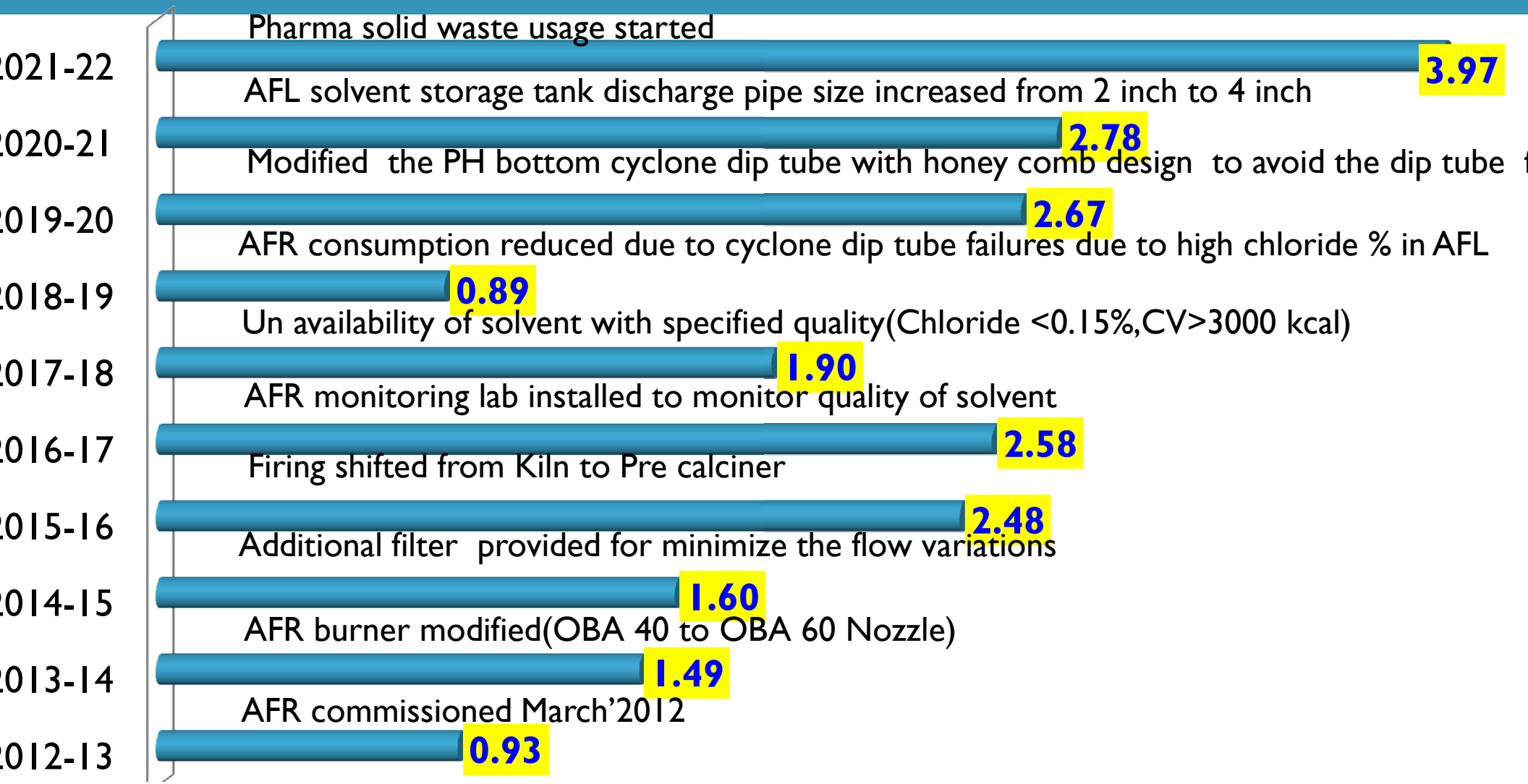
- This technology is already established and proven.
- To apply Green H plus its O2 effectively on a Cement Plant will need an electrolyser and a source of Green Electricity.
- Co benefits of Green H in kiln will help the following :-
  - Drop the NOx and SO3 cycles
  - Allow use of high S petcoke if AFR and Green Hydrogen availability is
  - Allow higher use of AFR
  - Use of 100% Biofuel if available
- White H form Plastics will allow countries to make good use of their waste plastics, produce White H and graphene and hence not only reduce CO2 combustion in cemer plant but also the CO2 from raw materials

MY HOME PRESENT PRODUCTION CAPACITIES

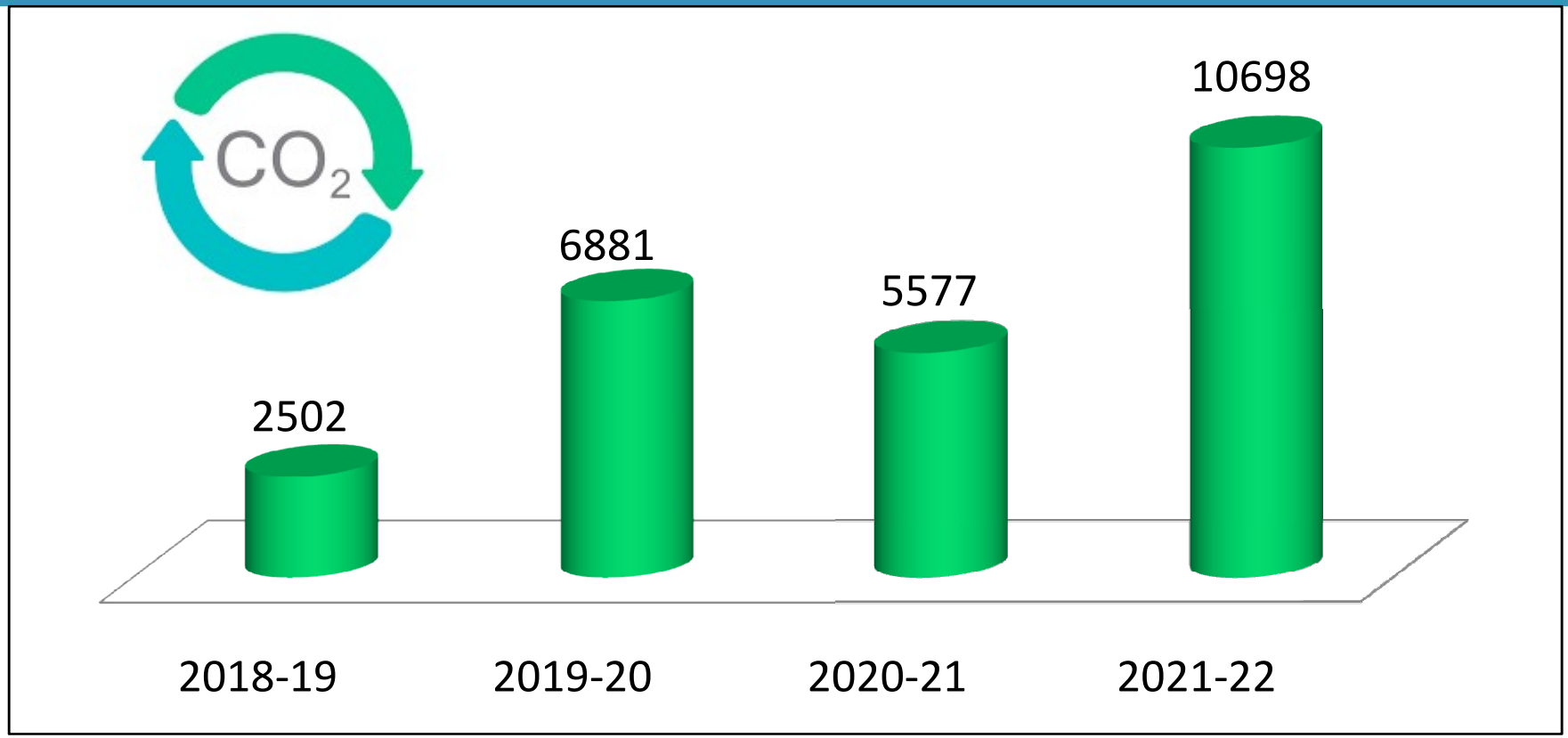
Details	Particulars	Unit-I	Unit-II	Unit –III
Present capacity	Clinker	0.80	1.30	1.40
	Cement	0.792	1.108	2.00

- Three units with state-of-the-art technology from Walchand Industries, FLSmidth Denmark and KHD Germany. Total cement capacity is 3.5 Million MTPA
- Two Captive Power Plants of 75 MW total capacity
- Waste Heat Recovery System (WHRS) 12.5 MW

EFFORTS MADE FOR INCREASE AFR TSR%

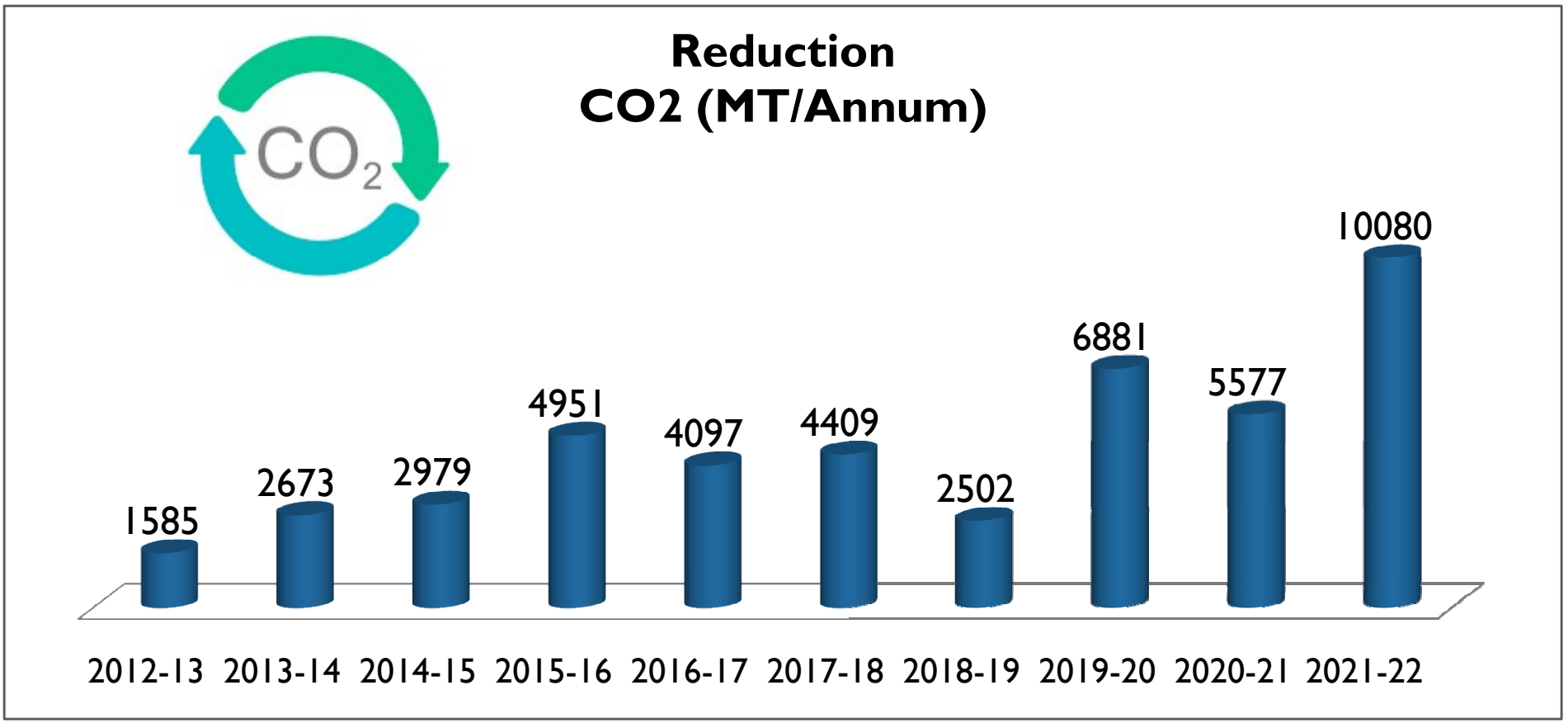


REDUCTION IN CO2 EMISSIONS DUE TO AFR USAGE



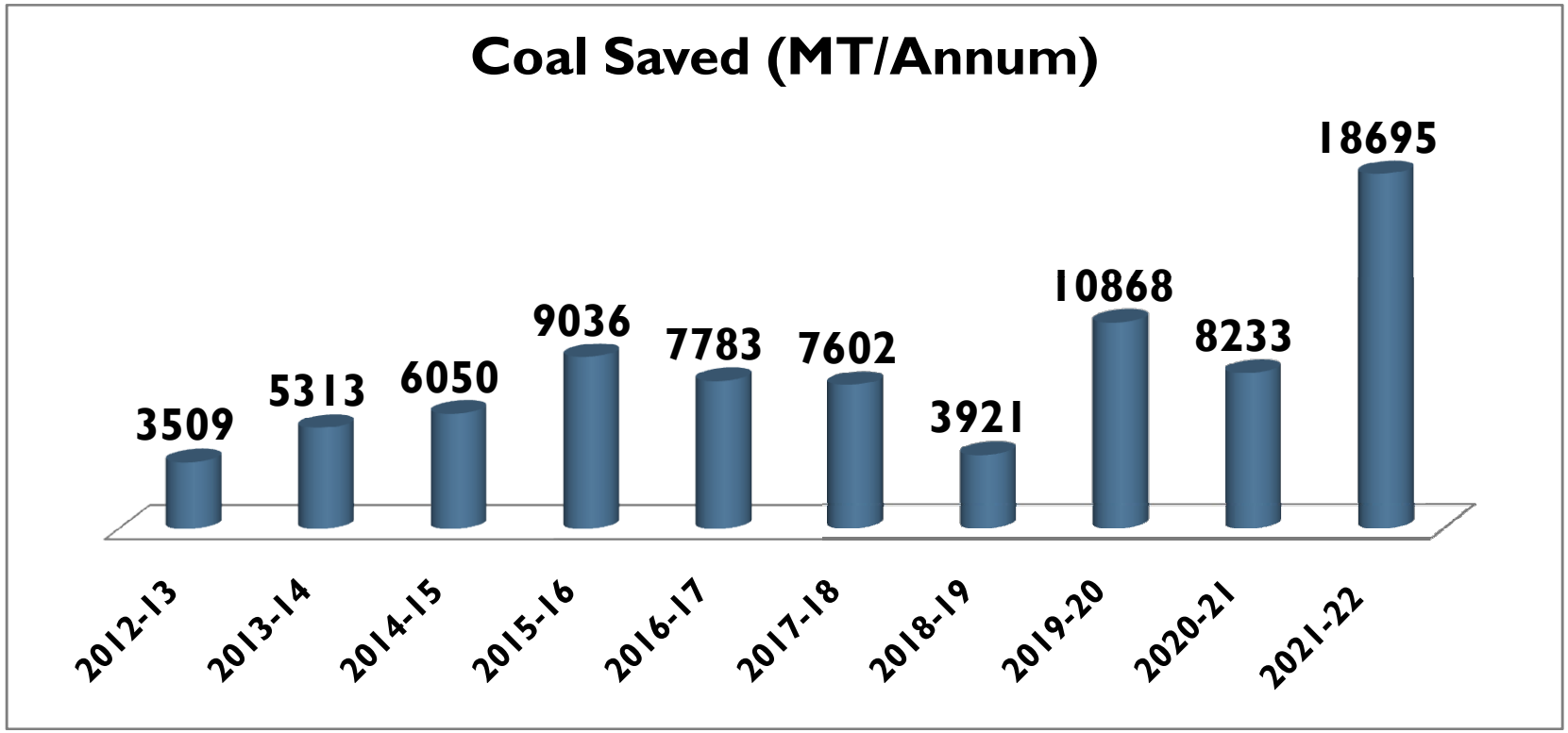
GHG emissions reduced by **10698** MT CO2 during the year 2021-22

REDUCTION IN CO2 EMISSIONS DUE TO AFR USAGE



GHG emissions reduced by **10080** MT CO2 during the year 2021-22

REDUCTION IN NATURAL RESOURCES(COAL) DUE TO AFR USAGE



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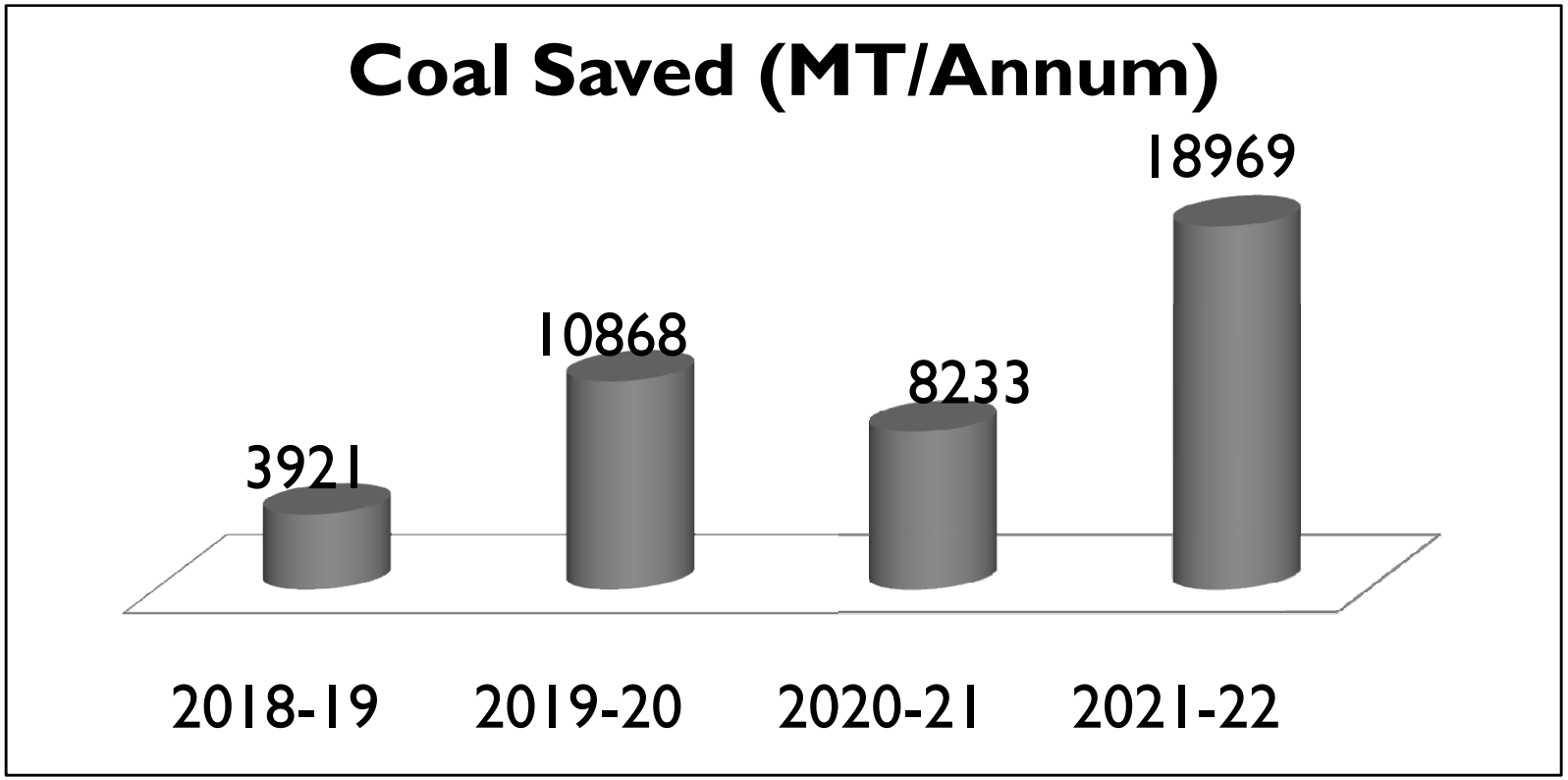
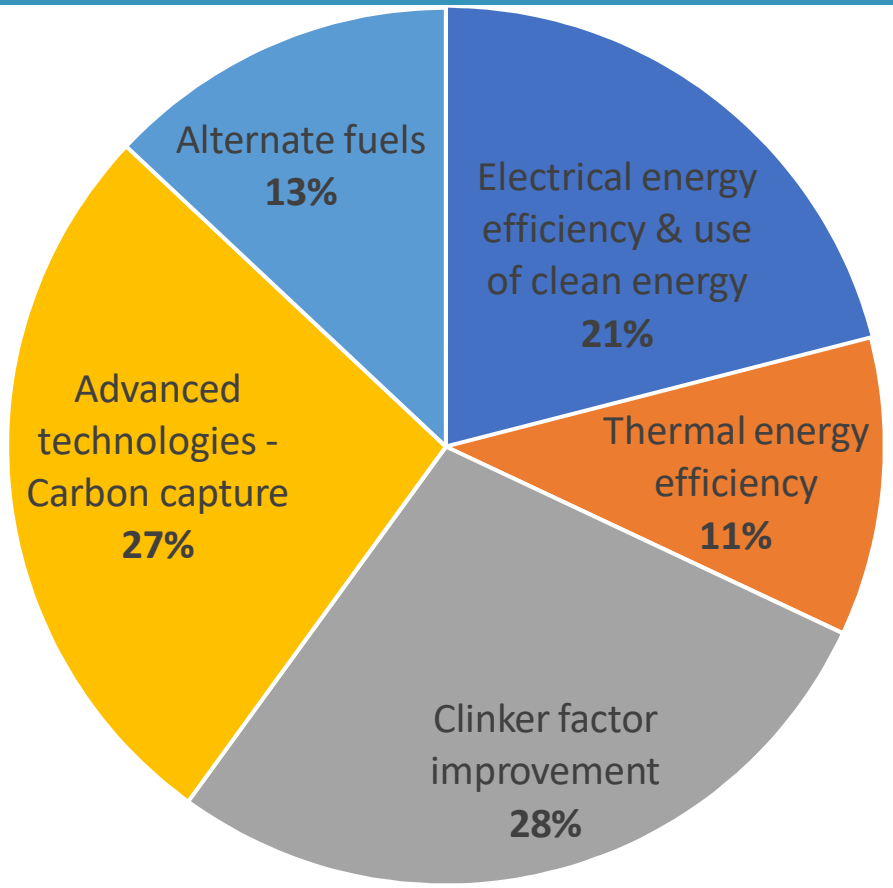


12.5 MW WASTE HEAT RECOVERY POWER PLANT

THANK YOU

IMPACT OF VARIOUS LEVERS…

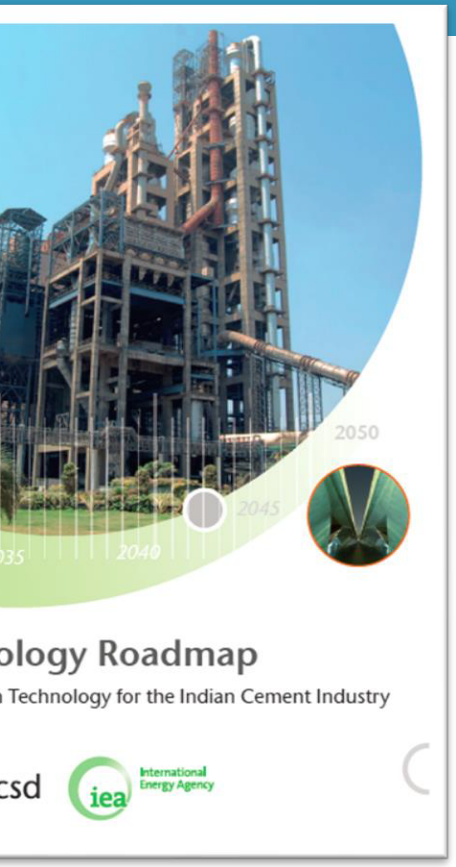
deep decarbonization
enario – carbon
mission intensity will
educe by 30% to 0.467
CO_2/T cement



WHAT ARE LEVERS TO REDUCE CARBON FOOTPRINT OF CEMENT

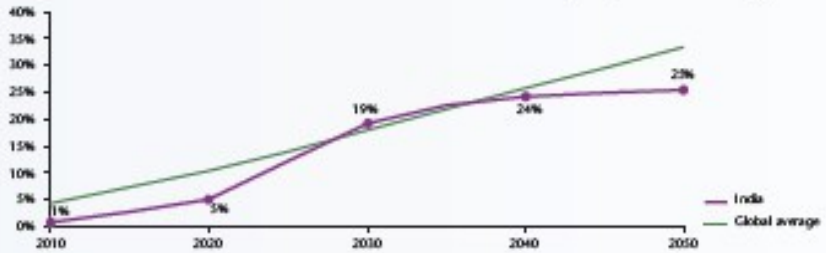
- Reduction of thermal energy intensity
- Clinker factor
- Low / No carbon Alternative Fuels and raw materials
- Waste Heat Recovery
- Carbon capture and storage, use
- Electrification of kiln using renewable energy
- Green Hydrogen
- Recarbonisation
- Oxy rich fuel and other new technologies
- Newer low carbon cements (LC3, lime stone cement, geo polymer cement etc)

OW CARBON TECHNOLOGY ROADMAP

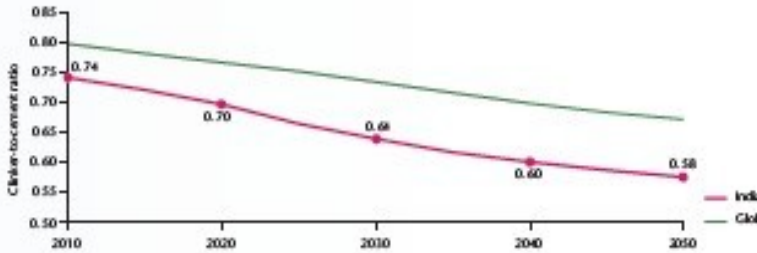


Key indicators for Indian cement industry to reach 2DS

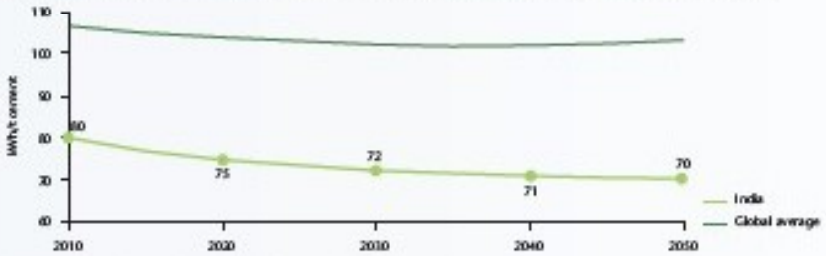
Progress indicator for share of alternative fuels and raw materials (AFR) in thermal energy use



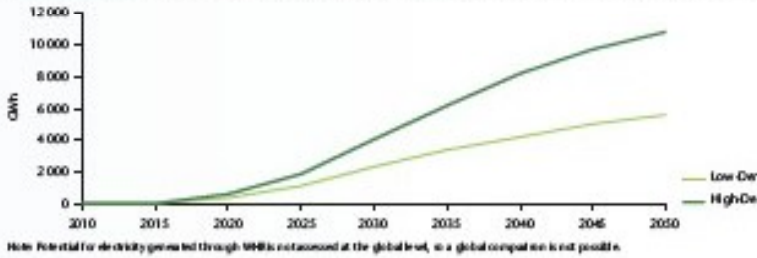
Progress indicator for clinker-to-cement ratio



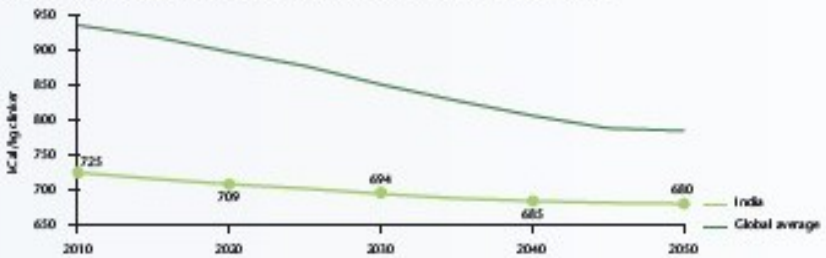
Progress indicator for specific intensity of electrical requirements (excl. potential from WHR)



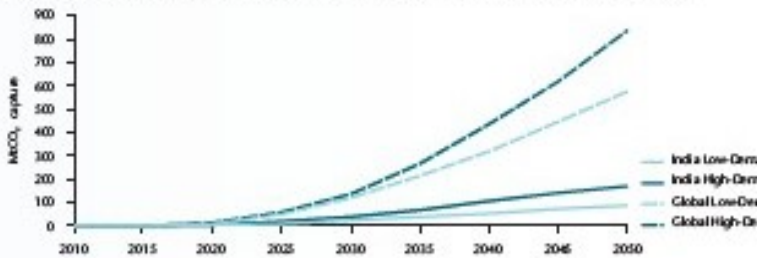
Progress indicator for additional electricity generated through WHR at cement plant



Progress indicator for specific intensity of thermal heat requirements



Progress indicator for carbon captured by global and Indian cement industry



PPROACH I: LOW CARBON TECHNOLOGY ROADMAP

	2020		2030
	LCTR roadmap	Cement Group	LCTR roadmap
HG emission (kg O_2/MT cement)*	580	519	480
linker factor	0.70	0.629	0.64
lectrical SEC kWh/MT cement)	76	66.9	73
hermal SEC (kcal/kg inker)	709	720	694
FR TSR (%)	5	2.7	19

Direct emissions from cement manufacturing process. Does not include indirect emissions from the roduction of electricity

PPROACH 2: GHG EMISSION TARGET – MAJOR PLAYERS

ompany	Current GHG emission (2019-20)	Target	Initiatives /action planned
almia ement	492 net CO_2/ton of cementitious material	Carbon negative by 2040	• 100% blended cement production by • 100% renewable power by 2030 • EV transition by 2030 • Use of AF to fully replace fossil fuel b • Adoption of CCU and other advanced technologies by 2035
ltratech ement	613 kg/ton of cementitious product (Scope 1&2)	462 kg net CO_2/ton of cementitious product by 2032 (27% reduction as compared to 2017)	• WHR installation and energy efficienc improvement • Clinker factor reduction • AF utilization • Increasing usage of RE (34% - RE + WH
CC & Ambuja	ACC – 506 kg CO_2/ton cement – net emission (2018) Ambuja – 557 kg Net CO_2/ton cementitious product (scope 1&2) – gross 2019	40% reduction (with 1990 base) by 2030 – 480 kg Net CO_2 40% reduction (with 1990 base) by 2030 – 463 kg Net	• Clinker factor reduction, blended cem production • Use of waste derived fuel and biomas • Energy efficiency improvement in kiln CPP • RE and WHR

EVERS

Sr. No.	Levers	Existing	Target	Indicator	Reduction emission intensity (k CO_2/MT ec cement)
1	Clinker factor	0.628	10% reduction in clinker factor	0.57	51.4
2	Alternate fuel TSR	2.70%	10% TSR	10% TSR	35.4
3	Electrical & Thermal energy efficiency	700 kcal/kg clinker (only fossil fuel) 66.9 kWh/MT cement	50 kcal/kg reduction 5% reduction	650 kcal/kg clinker 63.5 kWh/MT cement	15.9
4	CPP heat rate	3225 kcal/kWh	50 kcal/kWh reduction	3175 kcal/kWh	0.52
5	Renewable energy	0.14% (1.2 MW)	5% share	48 MW Solar PV installed capacity or 58000 MWh Green power	4
				Total reduction	107.

ROGRESSIVE UTILIZATION OF FLYASH IN EMENT MANUFACTURING & CONCRETE DURING HE PERIOD 1998-99 TO 2020-21