Council of Enviro Excellence

3rd NATIONAL POWER-GEN ENVIRONMENT EXCELLENCE SUMMIT & AWARDS 2024

Topic :-

The evolving thermal power generation portfolio with a focus on cleaner fuel options, including gas, and reassessing the role of coal in the long-term energy mix

Speakers :-

Mr Rajesh Ranjan,
Deputy General Manager, BHEL

Hearty Welcome!

Evolving Thermal Power Generation Portfolio Focus on Cleaner Fuel Options & Reassessing the Role of Coal in Long-term Energy Mix

PROJECT ENGINEERING MANAGEMENT
HRDI & ESI COMPLEX, NOIDA

By: RAJESH RANJAN, BHEL-PEM

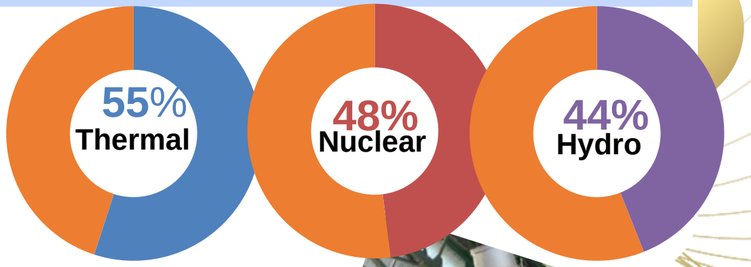
About BHEL

India's Flagship Engineering & Manufacturing Company

PROJECT ENGINEERING MANAGEMENT | NOIDA | HRD | COM

- Making in India **since 1964**; supplying products & services globally
- India's **largest engineering and manufacturing enterprise** in energy and infrastructure sectors
- **Maharatna PSU**; Government of India holding of **~63%**
- Only company associated with all **3 stages** of Indian **Nuclear Power** Program
- Sole Indian supplier of **Li-ion batteries** of next generation fighter aircraft

BHEL's Share in Nation's Total Installed Power Generation Capacity



PAN India Presence

Manufacturing Units	Service Centers	Regional Marketing Centers	Projects Sites in India & abroad	Regional Offices	Repair Units
16	08	15	140+	04	02

About PEM

Started operations in 1974 as Consultancy Services Division

Rechristened as Project Engineering Management in 1984

PROJECT ENGINEERING MANAGEMENT

HRDI & ESI COMPLEX, NOIDA

SYSTEM INTEGRATOR

ENGINEERING CENTRE

PEM

BHEL

Profit Centre

Member of 14 BIS Committees

50 years
Engineering Excellence

500+ sets
Project Engineering Experience

100+
EPC Projects executed

Human Capital
450+ Employees
370+ Engineers

Intellectual Capital
Patents granted – 1
Patents filed - 2
Copyrights – 151

450+
Registered Suppliers

BHEL'S INTERVENTIONS FOR SUSTAINABLE DEVELOPMENT GOALS

COP-26: India's 5-point action plan **'Panchamrit',** includes commitment for Net Zero target by 2070.

हरित बीएचईएल (Harit BHEL) Initiative

- **To position itself as a Green Company**

Adopted a three-pronged strategy:

1. Setting Target to Achieve Net Zero by 2047
2. Green Company Rating for Manufacturing Units
3. Nine Focused Sustainability Initiatives

Our Vision

To be a Net Zero and Water Neutral Company with minimal Environmental Impact.

Our Target

- ✔ To be a Net Zero Company by 2047.#
- ✔ Achieving highest Green Company Rating for all BHEL Units.

Net Zero wrt scope 1 & Scope 2 emission.

BHEL - An environment conscious organization right from its inception

Power Generation in India

All India Installed Capacity (in MW) of Power Stations (as on 31.05.2024), Source: CEA

Region	Ownership/ Sector	Mode wise breakup									Grand Total
		Thermal					Nuclear	Renewable			
		Coal	Lignite	Gas	Diesel	Total		Hydro	RES*(MNRE)	Total	
Northern Region	State	18985.00	250.00	2878.90	0.00	22113.90	0.00	6008.25	747.70	6755.95	28869.85
	Private	22624.33	1080.00	772.00	0.00	24476.33	0.00	3241.00	38378.62	41619.62	66095.95
	Central	15048.62	250.00	2344.06	0.00	17642.68	1620.00	11580.51	379.00	11959.51	31222.19
	Sub Total	**56657.95**	**1580.00**	**5994.96**	**0.00**	**64232.91**	**1620.00**	**20829.76**	**39505.32**	**60335.08**	**126187.99**
Western Region	State	21290.00	900.00	2849.82	0.00	25039.82	0.00	5446.50	604.23	6050.73	31090.55
	Private	31762.17	500.00	4676.00	0.00	36938.17	0.00	481.00	48398.84	48879.84	85818.01
	Central	21610.47	0.00	3280.67	0.00	24891.14	3240.00	1635.00	666.30	2301.30	30432.44
	Sub Total	**74662.64**	**1400.00**	**10806.49**	**0.00**	**86869.13**	**3240.00**	**7562.50**	**49669.37**	**57231.87**	**147341.00**
Southern Region	State	22192.50	0.00	791.98	159.96	23144.44	0.00	11827.48	633.08	12460.56	35605.00
	Private	13572.50	250.00	5120.24	273.70	19216.45	0.00	0.00	53653.25	53653.25	72869.70
	Central	13952.38	3390.00	359.58	0.00	17701.96	3320.00	0.00	541.90	541.90	21563.86
	Sub Total	**49717.38**	**3640.00**	**6271.80**	**433.66**	**60062.85**	**3320.00**	**11827.48**	**54828.23**	**66655.71**	**130038.56**
Eastern Region	State	6970.00	0.00	80.00	0.00	7050.00	0.00	3550.22	278.11	3828.33	10878.33
	Private	5553.00	0.00	0.00	0.00	5553.00	0.00	209.00	1723.75	1932.75	7485.75
	Central	16166.51	0.00	0.00	0.00	16166.51	0.00	1005.20	10.00	1015.20	17181.71
	Sub Total	**28689.51**	**0.00**	**80.00**	**0.00**	**28769.51**	**0.00**	**4764.42**	**2011.86**	**6776.28**	**35545.79**
North Eastern Region	State	0.00	0.00	411.36	36.00	447.36	0.00	422.00	268.75	690.75	1138.10
	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	298.13	298.13	298.13
	Central	1242.02	0.00	1253.60	0.00	2495.62	0.00	1522.01	30.00	1552.01	4047.63
	Sub Total	**1242.02**	**0.00**	**1664.96**	**36.00**	**2942.98**	**0.00**	**1944.01**	**596.88**	**2540.89**	**5483.86**
Islands	State	0.00	0.00	0.00	84.35	84.35	0.00	0.00	5.25	5.25	89.60
	Private	0.00	0.00	0.00	35.19	35.19	0.00	0.00	29.78	29.78	64.97
	Central	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.10	5.10	5.10
	Sub Total	**0.00**	**0.00**	**0.00**	**119.54**	**119.54**	**0.00**	**0.00**	**40.13**	**40.13**	**159.67**
ALL INDIA	State	69437.50	1150.00	7012.06	280.31	77879.87	0.00	27254.45	2537.11	29791.56	107671.43
	Private	73512.00	1830.00	10568.24	308.89	86219.14	0.00	3931.00	142482.37	146413.37	232632.51
	Central	68020.00	3640.00	7237.91	0.00	78897.91	8180.00	15742.72	1632.30	17375.02	104452.93
	Total	**210969.50**	**6620.00**	**24818.21**	**589.20**	**242996.91**	**8180.00**	**46928.17**	**146651.79**	**193579.96**	**444756.87**

Power Generation in India

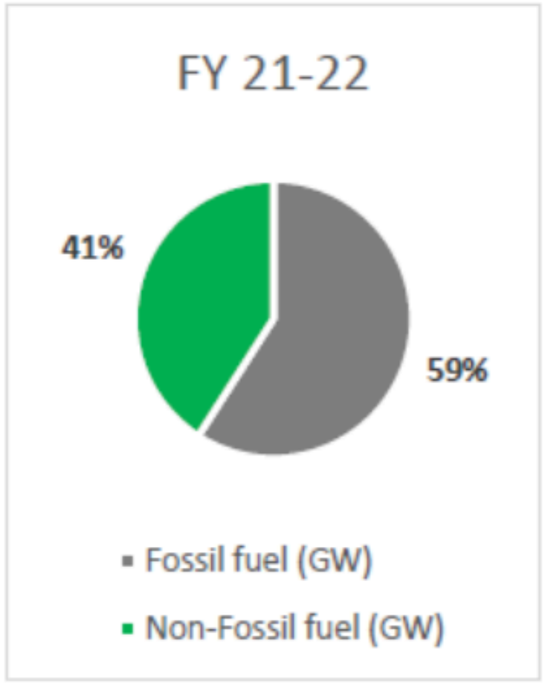
Peak demand for 2021-22, 2026-27 and 2031-32 as per 20th EPS Report, Source: CEA - NEP

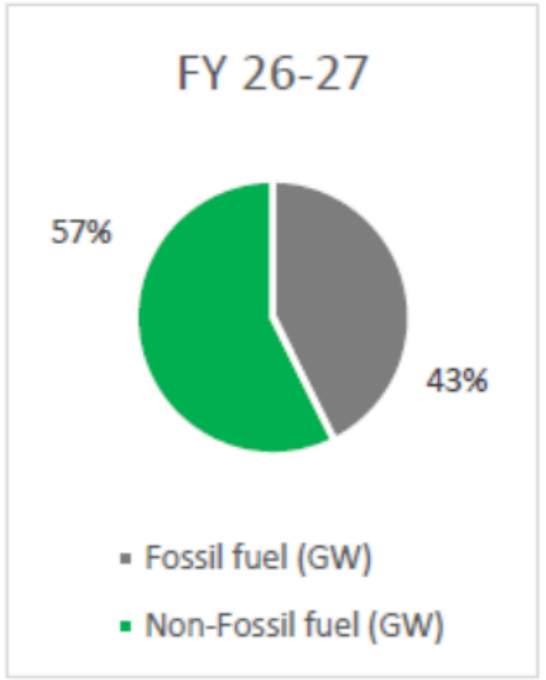
ion	Energy Requirement (in MU)			Peak Demand (in MW)		
	2021-22	2026-27	2031-32	2021-22	2026-27	203
thern Region	4,18,188	5,92,312	7,73,545	73,367	97,898	1,27
tern Region	4,28,994	5,96,793	7,63,198	65,437	89,457	1,14
thern Region	3,51,611	4,60,853	5,96,557	61,165	80,864	1,07
tern Region	1,64,542	2,32,971	3,08,103	26,043	37,265	50
th Eastern Region	18,312	24,904	32,373	3,437	4,855	6
India	13,81,646	19,07,835	24,73,776	2,03,115	2,77,201	3,66

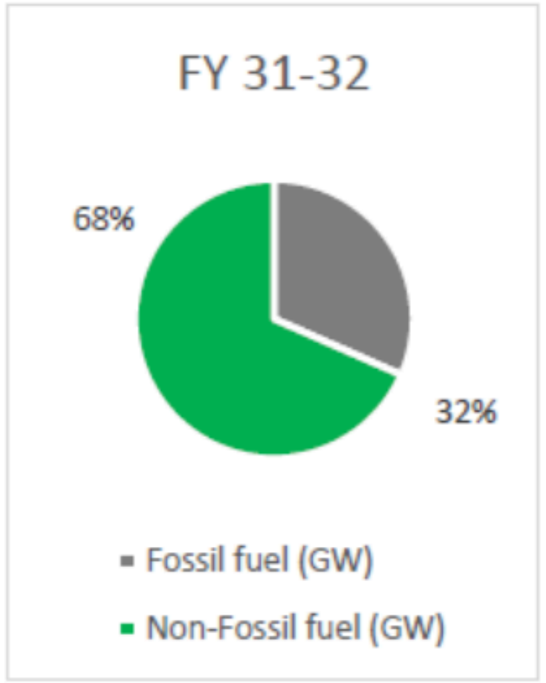
Note: The electricity demand projection carried out by the Electric Power Survey Committee, covers electricity demand only for the utility system. The projections do not include the portion of electricity demand of Industries and other consumers that would be met from captive power plants.

Power Generation in India

Share of Fossil and Non-Fossil fuel based plants in Total Installed Capacity, Source: CEA







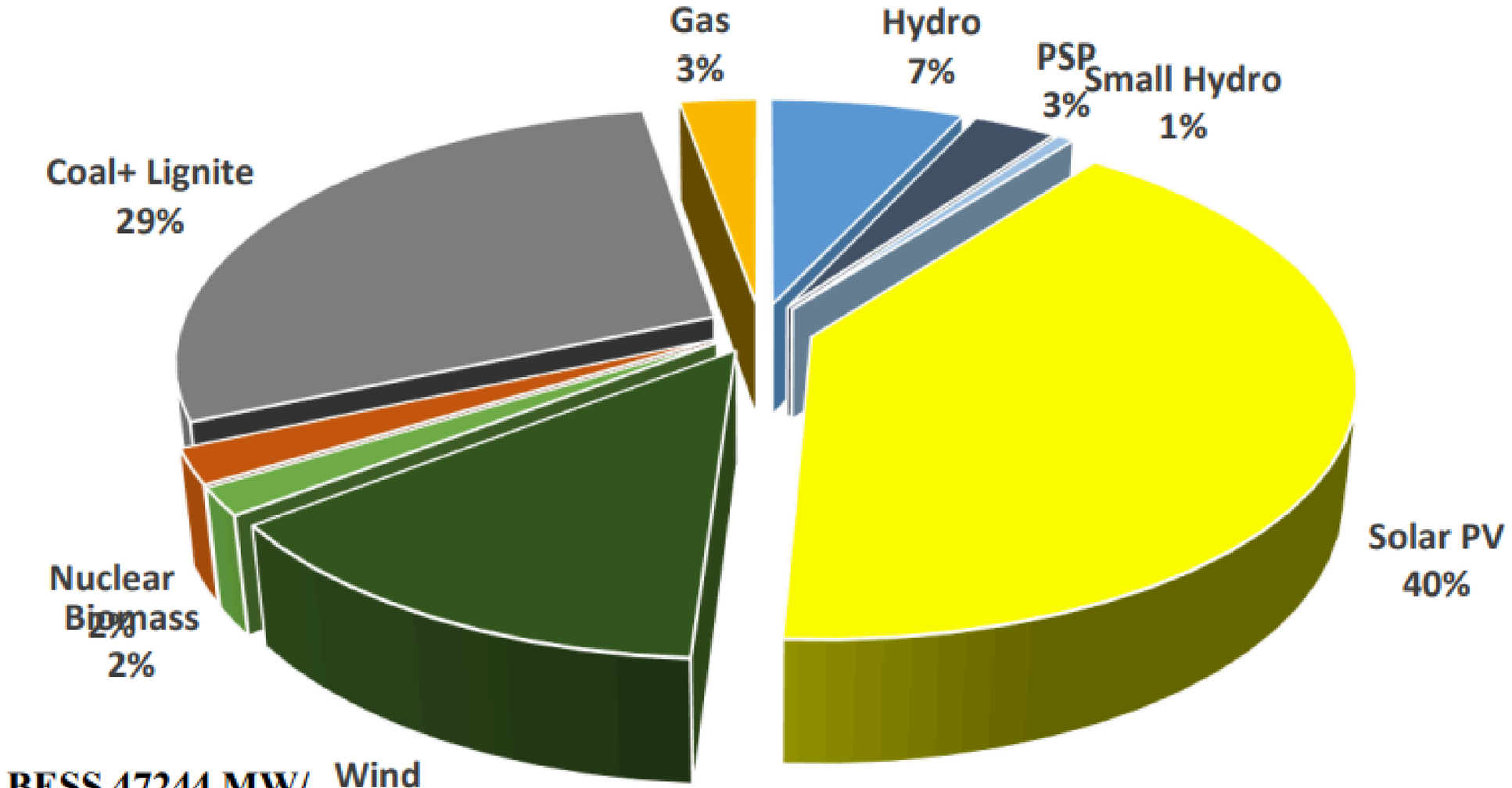
Note: The actual % may change to the extent of the quantum of capacity materialising and actual retirement taking place during 2022-27 & 2027-32.

Year	Installed Capacity (GW)	Installed Capacity of Fossil fuel (GW)	Installed Capacity of Non-Fossil** fuel (GW)	%of Non-fossil fuel in Installed Capacity
FY 2021-22	399.5	236.1	163.4	40.9%
FY 2026-27	609.6	259.9	349.7	57.37%
FY 2031-32	900.4	284.4	616	68.41%

** Non Fossil Fuel – Nuclear and Renewable Energy Sources

Power Generation in India

Projected All India Installed capacity by the end of 2031-32, Source: CEA - NEP



BESS 47244 MW/
236220 MWh

TOTAL IC 900,422 MW

Power Generation in India

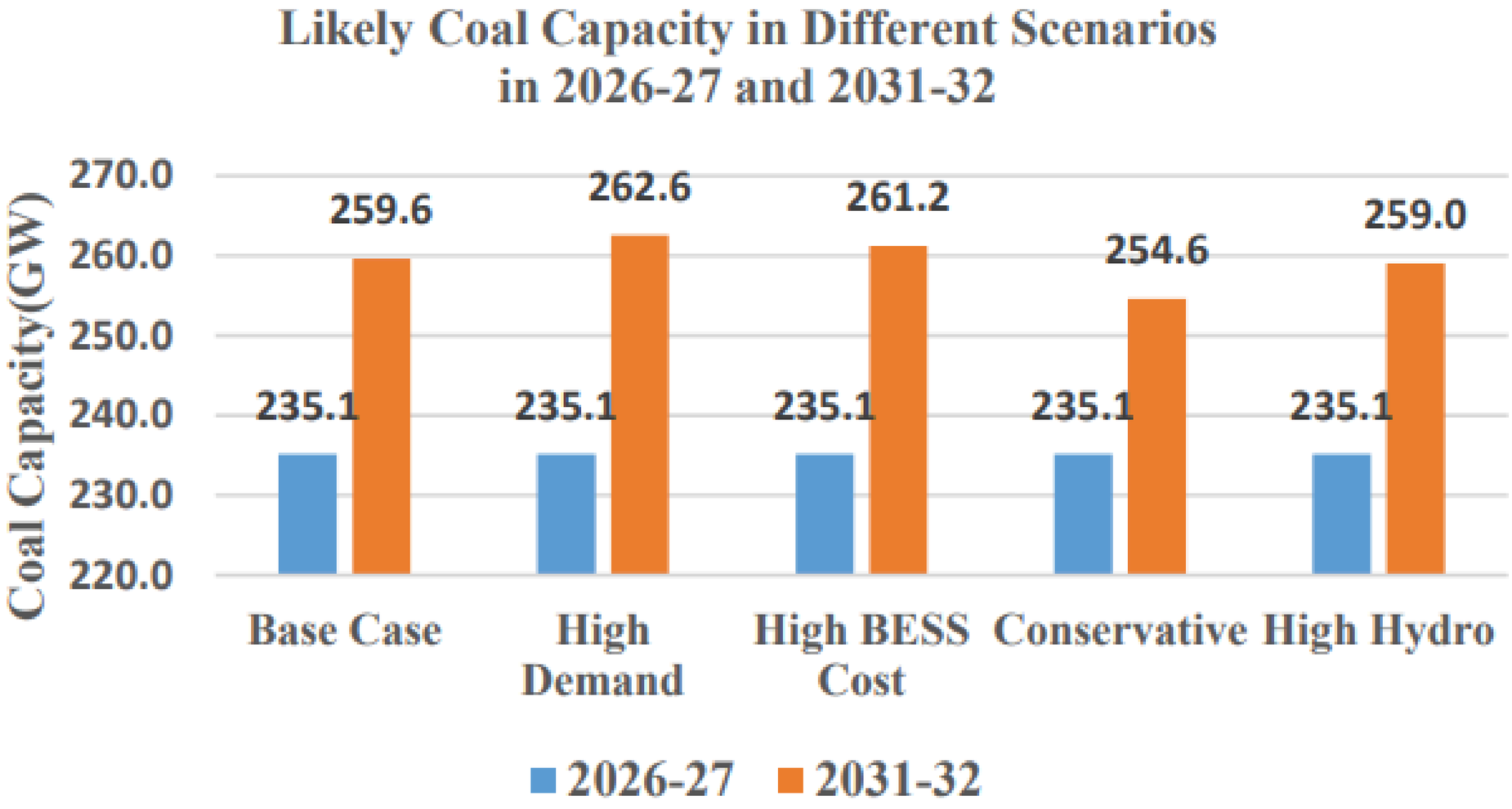
Projected All India Installed capacity by the end of 2031-32, Source: CEA - NEP

Resource	Installed Capacity (MW)	Percentage (%)
Hydro#	62,178	6.9%
PSP	26,686	3.0%
Small Hydro	5,450	0.6%
Solar PV	3,64,566	40.5%
Wind	1,21,895	13.5%
Biomass	15,500	1.7%
Nuclear	19,680	2.2%
Coal + Lignite	2,59,643	28.8%
Gas	24,824	2.8%
Total	**9,00,422**	100.0%
BESS(MW/MWh)	47,244/236,220	

Excluding 5856 MW of Hydro Imports from Nepal and Bhutan

Likely Coal Capacity in Different Scenarios in 2026-27 and 2031-32, Source: CEA - NEP

Exhibit 5.5a



Some of the Best Practices to be Adopted in Thermal Power Plant Design

- **Improved Heat Rate**: It is a common measure of system efficiency in a steam power plant.
- **Pollution Control Equipments**: SOx emission control thru' Flue Gas Desulphurization (FGD), Containment of NOx emissions, Suspended Particulate Matter (SPM), Mercury, and Specific Water Consumption.
- **Civil Aspects**: Opting for the best combination of RCC & Steel.
- **Predictive Maintenance**: Smart tools for better Operation & Maintenance (real-time monitoring) of the Plants.
- Carbon Capture, Utilization and Storage (CCUS),
- Co-firing with Biomass
- Rooftop Solar Plant
- Green Buildings
- Energy Efficient Drives
- Suitability for Flexible Operations

Flexible operation of TPPs to support Renewable Energy (RE) integration for increasing Green Energy utilization

Flexible operation allows power plants to operate at part load operation. Plant can fast ramp up and down as per the load demand in the grid thereby reducing heat and energy losses associated with constant full-load operation.

- BHEL implemented indigenously developed Flexible Operation solution at 1X600 MW REGL Raigarh & 1X500MW Sagardighi.
- Achieved a ramp rate of 3% per minute keeping all major parameters within stable and deviation limits.
- Other Projects:
  - WBPDCL : 1X210MW Bakreswar & 1X250MW Santaldih
  - TATA: Trombay U#8 (1X250 MW)
  - ADANI: Mahan Energen Limited Singrauli (U#2) (1X600 MW)

Enabling power stations to facilitate RE integration and ensuring energy security

Evolution of India's Environment Protection Rules

India enacted Environment (Protection) Amendment Rules 2015 on 7 Dec '15:

Sr.	Pollutant	Pre 31-Dec '03	B/w 1-Jan '04 & 31- Dec '16	Post 1-Jan '17
1	SOx (mg/Nm³)	600 for Unit Size <500 MW		
		200 for Unit Size ≥500 MW		100
2	NOx (mg/Nm³)	600	450	100
3	SPM (mg/Nm³)	100	50	30
4	Hg (mg/Nm³)	0.03 for ≥500 MW	0.03	0.03

Technology Particulars	Wet Limestone	Seawater	DSI
Type	Spray, DCFS	Scrubbing & Aeration	Injecting Dry Alkaline Mineral
Reagent	Limestone Slurry	Seawater	Sodium Bicarbonate
Byproduct	Gypsum	-	
Suitability	All	Coastal	Low Sulphur, <300 MW
Costing	Base	Low capex, High variable	Low capex, High opex
Footprint	Base	Larger	Smaller
Installations	Highest	Fewer	Emerging

Environment (Protection) Second Amendment Rules, 2022 (5th Sept, 2022)

Sl. No.	Category	Location/area	Timelines for compliance (Non-retiring units)		Last date for retirement units for exemption fro compliance	
			parameters other than SO_2 emissions	SO_2 emissions	parameters other than SO_2 emissions	SO_2 emissio
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Category A	With 10 km radius of National Capital Region or cities having million plus population[1].	Up to 31st December 2022	Up to 31st December 2024	Up to 31st December 2022	Up to 31st December 2027
2	Category B	With 10 km radius of Critically Polluted Areas[2] or Non-attainment cities[2]	Up to 31st December 2023	Up to 31st December 2025	Up to 31st December 2025	
3	Category C	Other than those included in category A and B	Up to 31st December 2024	Up to 31st December 2026	Up to 31st December 2025	

[1] As per 2011 census of India.

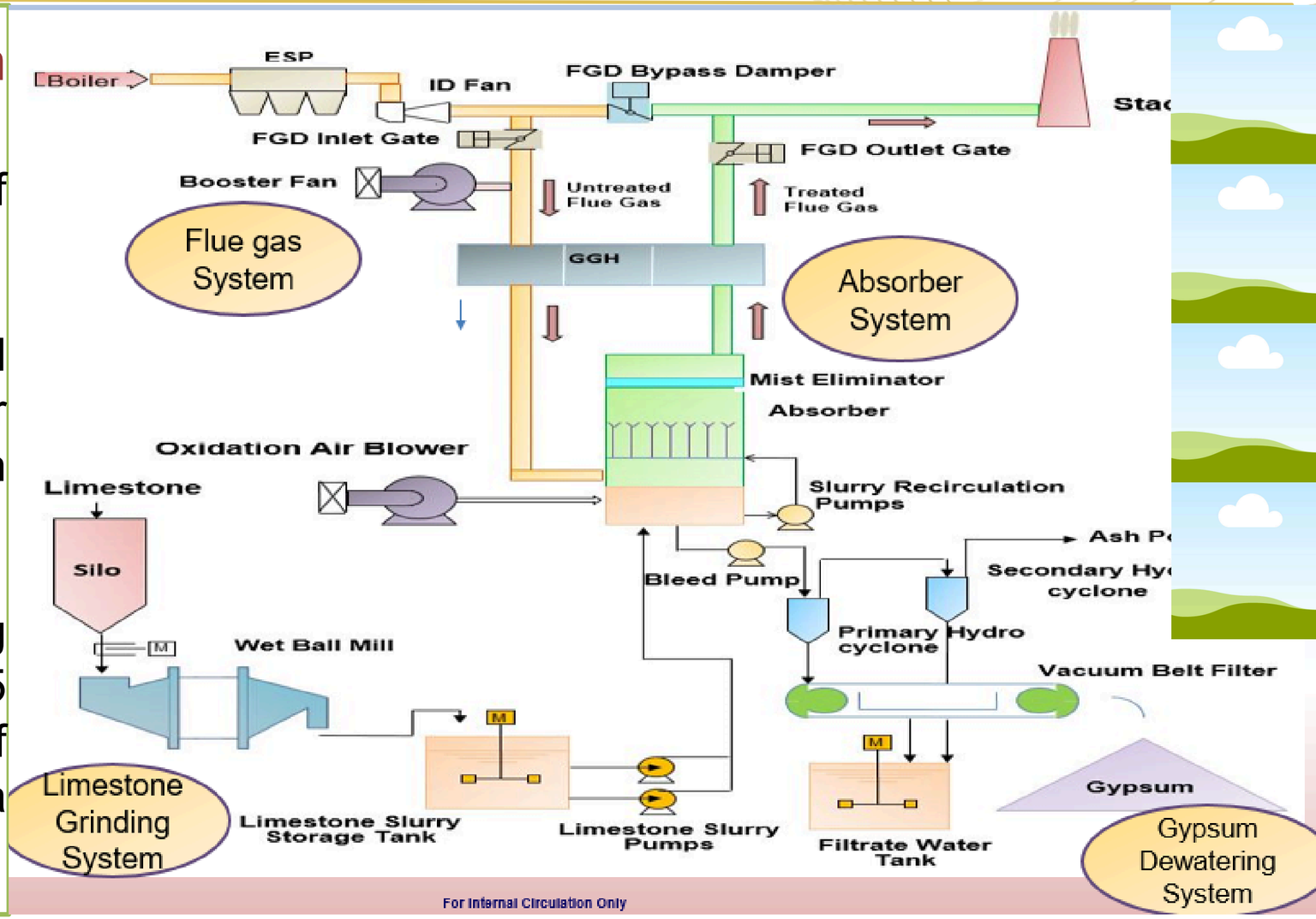
[2] as defined by CPCB.

REDUCING POLLUTANT FOOTPRINTS : PROVIDING SUSTAINABLE SOLUTIONS

PROJECT ENGINEERING MANAGEMENT
HRDI & ESI COMPLEX, NOIDA

Flue Gas Desulphurization (FGD)

- India is contributing ~15% of global SOx emissions.
- Minimizing SOx emission limited to 100 mg/Nm_3 (earlier, 600 for <500 MW & 200 for >500 MW) in existing thermal power plant.
- BHEL is currently executing orders aggregating more than 35 GW for 65 Absorbers sets of various power utilities including a 1320 MW project overseas.

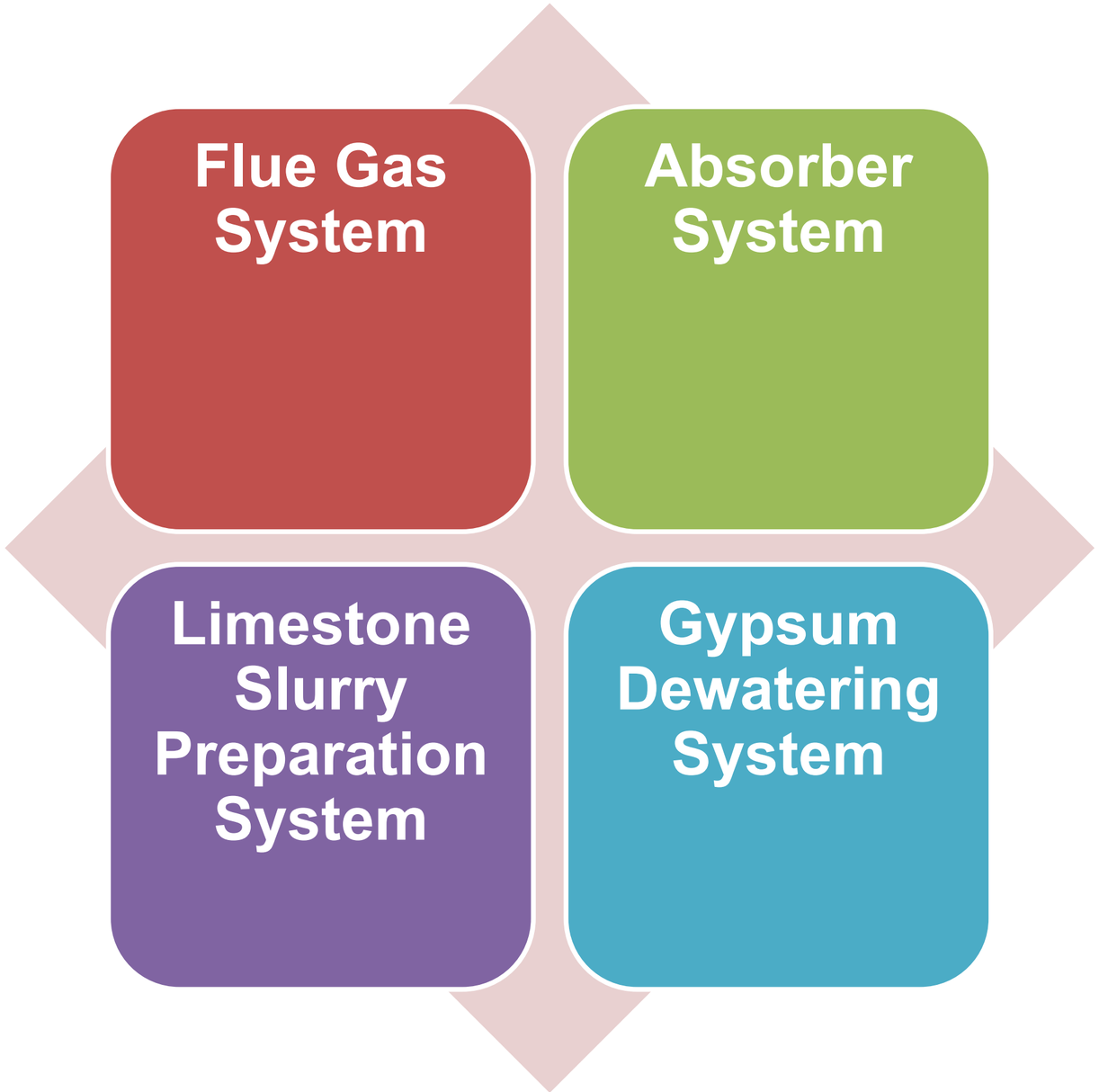


Reduction in SOx emission of 0.1 million metric tons per year

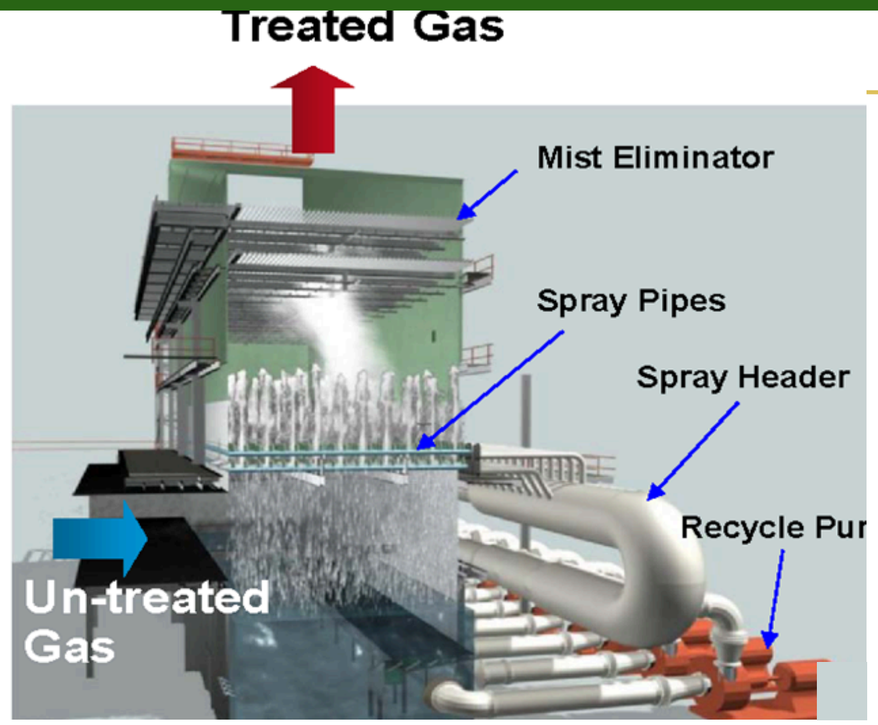
DESIGN CONDITIONS FOR FLUE GAS DESULPHURIZATION SYSTEM

Input	Output	Remarks
SO2 Concentration	SO2 Concentration	Removal Efficiency of absorber
Flue Gas Flow Rate & Temperature and Layout	Flue Gas Flow Rate & Temperature and Layout	Size of Absorber, Boost-up Fan and Stack (Chimney)
Limestone Purity	Gypsum Purity	Sizing of Absorber, LHP, LGS, GDS, GHP and Layout
Utility Requirement (Air & Water)	Plant Operations	Sizing of Auxiliary Systems
Soil Condition, Tech Spec. and Layout	Equipment & Facilities	Civil Foundation & Structural Design
Electrical Systems	Plant Operations	APC, Cabling, Transformer and Layout etc.
Redundancy (2x100% or 3x50%, etc.)	Plant Operations	Equipment Sizing, Building Sizing and Layout
Layout & Interface	Equipment & Facilities	Brownfield installation

MAJOR SYSTEMS & EQUIPMENTS IN A WET LIMESTONE FGD



MAJOR SYSTEMS & EQUIPMENTS IN A WET LIMESTONE FGD



JOURNEY & CHALLENGES OF FGD IMPLEMENTATION

- About 525 (199 GW) out of the total 596 (209 GW) TPPs are yet to install the Flue Gas Desulphurization (FGD) System to comply with new emission norms.
- The capacity of TPPs complying with this rule is below 20 GW capacity, including CFBC units.
- FGD installation is in progress at ~25 GW capacity.
- The progress achieved in 8.5 years indicates that a lot more has to happen on various fronts (Rising Cost, Low Vendor base, Supply-Chain implications due to Make in India, Uncertain Execution in Brown field Sites, etc.) for Indian TPPs to become fully compliant.

Source: CEA Report

ALTERNATE USAGE OF COAL – HYDROGEN ECONOMY

TABLE 1 COMPARISON OF HYDROGEN PRODUCTION METHODS

	Coal gasification with CCUS	SMR with CCUS	Water electrolysis
Energy intensity, kWh/kgH_2 (Zapantis, 2021; Patonia and Poudineh, 2020)	3.48	1.91	52.5–70.1
Life cycle GHG emissions, gCO_{2eq}/MJ (HHV) (IEA, 2021b)	24*	23*	5–1
Water consumption, kgH_2O/kgH_2 (Coertzen and others, 2021)	70	18-44	60–90
Land use†, km^2 (Zapantis, 2021)	17	14	5750
Production cost, $\$/kgH_2$ (USDOE, 2020)	1.6	1.5–2.3	6–9.3

* with 95% CO_2 capture rate; † land requirement (excludes mining area) of a hydrogen plant with a capacity of 1.76 MtH_2/y

Excerpt of report by Dr. Qian Zhu (March ’23) by the International Centre for Sustainable Carbon (ICSC) for the International Energy Agency’s (IEA) Coal Industry Advisory Board (CIAB).

ALTERNATE USAGE OF COAL – GASIFICATION - CHEMICAL

- India has a reserve of 307 billion Tons of thermal coal and about 80% of coal produced is used in coal-fired power plants.
- In line with the objective of ammonia for fertilizers and petro-chemicals among other clean-coal usage, Ministry of Coal has undertaken initiative of National Coal Gasification Mission to achieve 100 MT coal gasification by year 2030.
- BHEL and CIL formed a Joint Venture Company "Bharat Coal Gasification and Chemicals Limited" to undertake Coal to Chemicals business, majorly:

(i) Gasification of Coal to produce Syngas (a mixture of carbon monoxide (CO) & Hydrogen (H2)] – utilizing in-house developed **Clean Coal Technology with Pressurized Fluidized Bed Gasifier (PFBG).**
(ii) Syngas clean-up to suite Ammonia synthesis requirements and
(iii) Ammonia, Nitric Acid and Ammonium Nitrate synthesis.

Utilization of high ash Indian coal through clean coal technology

Welcome Suggestions on Email: errr@bhel.in, Cell: 84990 84114

Thanking You on Behalf of !

Council of Enviro Excellence