Deep Decarbonization Pathways (DDP): Status and Way Forward for India

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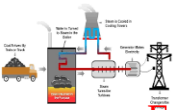
Context: India

2nd largest producer of coal, 2nd largest consumer of coal in the world. Employs ~15 million people directly and in connected businesses, 4 populated states' revenues depend on coal royalties.

- High direct/indirect levy on coal (?) - Clean energy tax/GST compensation cess ~@30% of coal pithead price, high coal transport rates cross-subsidize cheaper passenger travel
- Thermal coal (91%), Metallurgical coal (9%), Surface mining (>94%), Underground mining (<6%) >220 million ton imported each year

Energy security concerns drive many decisions: 3rd largest consumer of energy (56% coal, 25% oil), but only ~1000 kWh/capita/year. Energy imports – 85% crude, 45% natural gas, 20% coal. Over $ 130 billion/year. All social programmes ~ $ 85 billion/year



Energy affordability concerns: High imports expose to higher prices. Farmers, lower middle-class rates (<3 cents/unit). Domestic coal projected to remain major source of electricity generation in India for some years, 54% generation capacity, ~ 72% generation share. No phase out possible – phase down (by when?), IEA (2021) puts 215 Mtce by India under most strict scenario in 2050. ~20 GW coal de-commissioned in 5 years. 39 GW under construction (68% supercritical, 20% ultra-supercritical).

- Gasoline and diesel highly taxed ~ 130-150% over basic costs.
- Transitions to renewable energy (RE) and green hydrogen promoted simultaneously. 500 GW RE target by 2030 (~5 times current capacity). 1$/kg green hydrogen in one decade (currently $4-5)

Around 750 million people have gained access since 2000. 100% Village (600 thousand total) completely electrified by 2019. Higher access of electricity at reasonable price to all is a major issue. Critical to meet SDGs.

Agriculture sector is difficult to mitigate for India. Main source of non-CO_2 emission (CH_4 and N_2O) (*19-20% of total national GHG emissions*). Sub sustenance nature, widely dispersed, poor and marginal farmers.

15% of CO2 emissions in 2016 were removed by the LULUCF sector (forestland, cropland, settlements)

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Context India (contd.)

- 2.87 trillion USD/year GDP (2020-21), annual growth rate (2009-2018) ~7%

- Sectoral Gross Value Added (GVA) contributions to GDP
  - Agriculture (~14%), industry (~30%), services (~55%)
  - Electricity, gas, water supply and other utilities ~2.2%
  - Financial services ~ 6.1%
  - Real estate and professional services ~15.6%
  - Transport ~ 4.9%
  - Construction ~7.8%

- 1.35 billion people (17% of global population)

- GHG emissions in 2019 ~ 3.3 billion tons, likely peak 4.5 billion tons around 2040-45, 2.5 billion tons in 2050 (steep action)
- National GHG emissions (2019) - 40% coal for power generation, 8.5% road transport, 4.75% Iron & steel, 2.5% waste
- **<u>Below 5% cumulative GHG emissions during 1850-2019.</u>**
  - **Right to develop and SDGs, carbon space allocation globally**

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Climate Action perspective

- Over **450 plus GHG mitigation related policies** (direct and indirect)
  - Energy efficiency (PAT, standards and labeling, green buildings)
  - Renewable energy (500 GW by 2030, first NDC 175 GW, current 145 GW)
  - 30:30 EV (30% of all new vehicles to be EV by 2030)
  - Smart grids and grid upgradation for system flexibility – storage (cost and material)
  - Infrastructure development and Energy transitions are big ticket items for India
- **Each policy has market connect and support @ federal, state and local levels**
- Some examples of investment possibilities in the **next 5 years (~230 billion USD) e.g.**
  - Solar PV ~ 180 billion USD
  - Municipal Solid Waste projects ~ 5 billion USD
  - Hydrogen economy ~ 5 billion USD (and will grow)
  - Ethanol economy ~ 2 billion USD
  - Grid flexibility ~ 15 billion USD (by 2030)
  - Batteries for power (solid state?) ~ 5 billion USD (by 2030)
- So, India is a **huge market** for climate positive actions.
- High risks? Projects could be made bankable with joint efforts. Returns are attractive.
- Movement towards deep decarbonization is happening in India - continuously. Net Zero 2070 announced. Global investments are required at reasonable terms.
- **Come and be our business partner in low carbon and climate resilient development.**

Foreign Direct Investment: Limits enhanced

No	Sector	Detail	Automatic	Government
1	Auto Components	A manufacturer is permitted to sell its products manufactured in India through wholesale and/or retail, including through e-commerce, without Government approval.	100%	-
2	Automobile		100%	-
3	Airports	Air Transport services, Airports, Other services	49% (scheduled services), 100%	49% (scheduled services), 100%
4	Chemicals	subject to applicable laws/regulations; security and other conditionality.	100%	-
5	Construction	Construction Development: Townships, Housing, Built-up Infrastructure (real estate not included)	100%	-
6	Defense Manufacturing	Special Conditions	74%	74%
7	Healthcare	Construction of Hospitals	100%	-
		Healthcare (Brownfield)	74%	74%
		Healthcare (Greenfield)	100%	-
8	Ports and Shipping	subject to applicable laws/regulations; security and other conditionality.	100%	-
9	Railways		100%	-
10	Renewable Energy		100%	-
11	Roads and Highways		100%	-
12	Thermal Power		100%	-

Source: Invest India 2020

Business and Industry Involvement

- More than 80+ **Indian corporates** have voluntarily announced to implement Paris Agreement targets (global target 2C, well below 2C, 1.5C)
- More than 15+ **Indian corporates** announced **Net Zero** targets in the last 2 years including
  - Reliance Industries (RIL) to become net carbon zero by 2035
  - Adani Group RE for all data centers by 2030, Ports by 2025
  - Tata Power by 2050
  - Wipro (IT services major) by 2040
  - Dalmia Cement carbon negative by 2040
  - Mahindra & Mahindra by 2040
  - ITC only RE by 2030
  - Birla Carbon by 2050
  - Pepsico (India operations) by 2040
  - JSW Energy before 2050
- **20+ Indian corporates** have also announced **Internal carbon pricing** ranging $10/tCO2e (Tech Mahindra) to $120/tCO2e (Wipro)

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India's Climate Commitments @ COP26 (2005-2030)

1. To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
2. To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.

3. **To reduce the emissions intensity of its GDP by 45 per cent by 2030 from 2005 level (current status – 31%)**

4. **To have 500 GW of renewable power generation capacity by 2030 (current status – 145 GW).**

5. **To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030. WIP**

6. **To achieve about 50 per cent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 with the help of transfer of technology and low-cost international finance including from Green Climate Fund (GCF). Current status – 39%**

7. **To Mitigate 1 billion tonnes of CO_2 equivalent by 2030. WIP**

8. **Indian railways to become Net Zero by 2030. Current status: emits ~30 million ton/year, likely to double. WIP**
9. **India to become Net Zero by 2070. WIP**

Climate Finance should be enhanced from US$ 100 billion 2020-2025 to a trillion US$ by developed countries. Climate Finance commitments should be monitored.

Initiatives already launched by India – ISA (with France), CDRI, One Sun-One World-One Grid (with UK)

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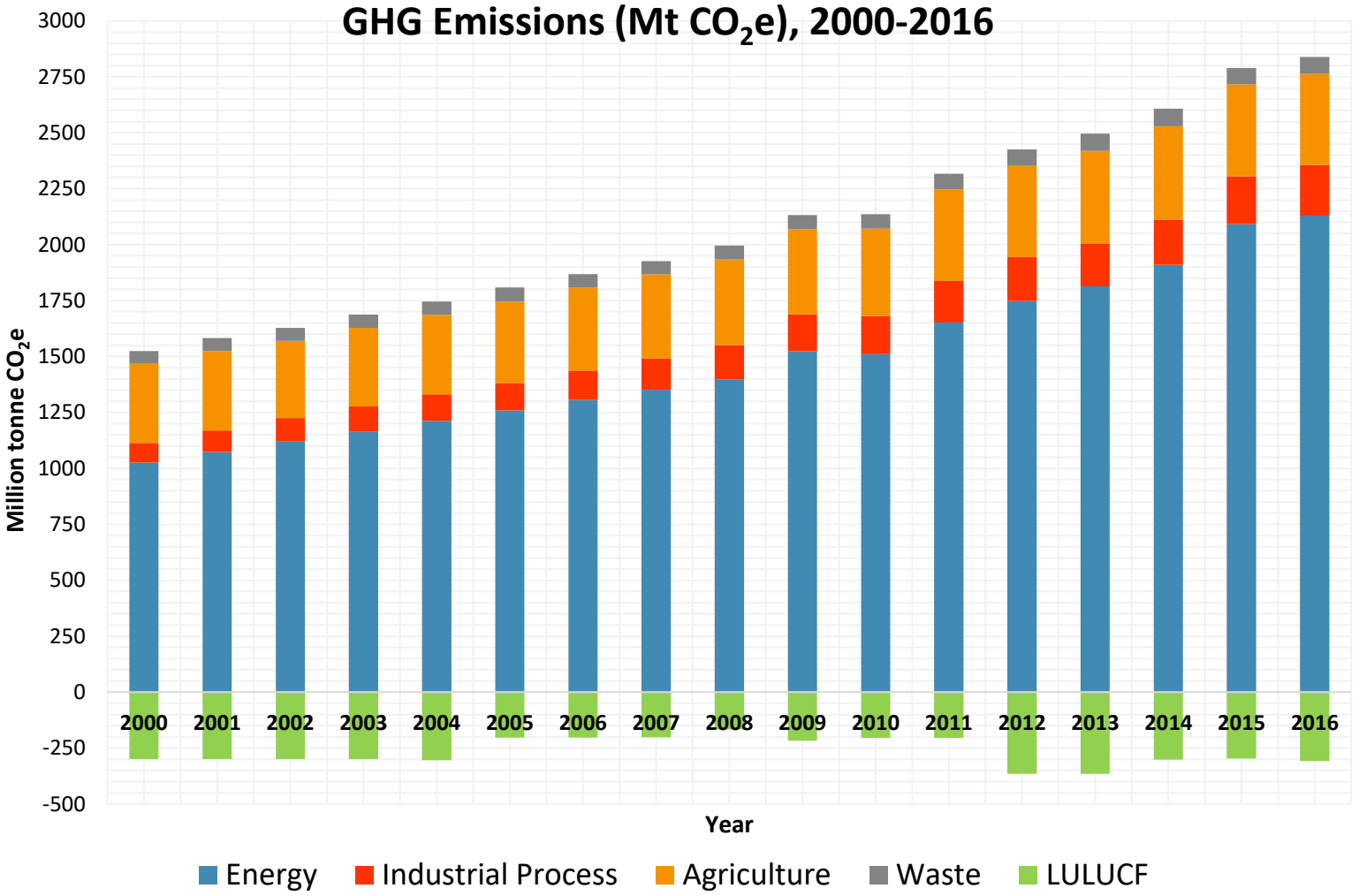
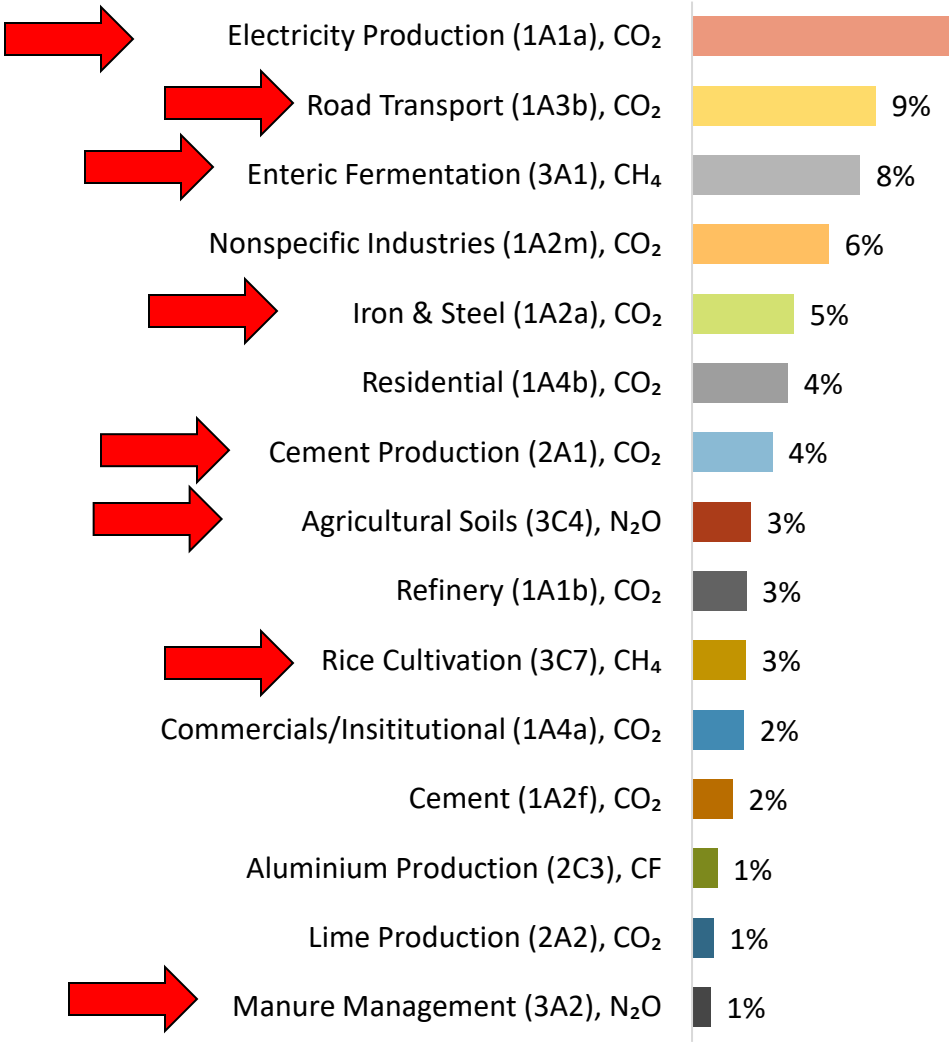
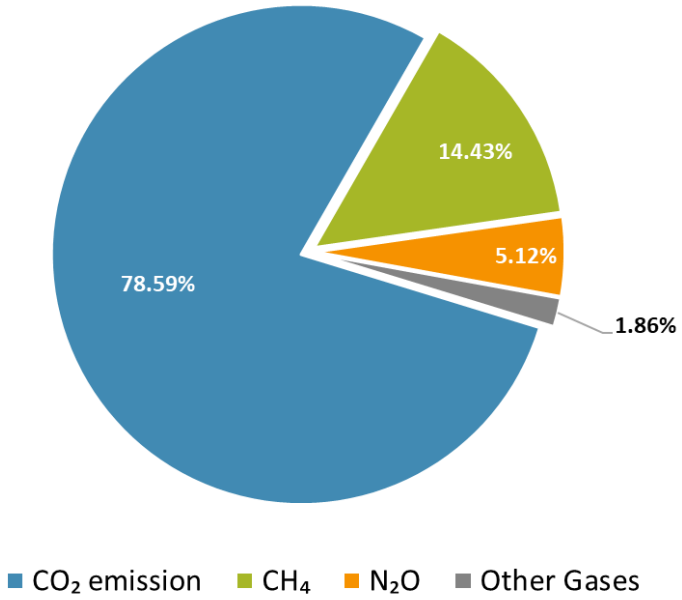
Sector wise GHG Emission (Mt CO_2e)



Source: India's BUR-3 (MOEFCC 2021)

Category-Gas wise GHG Emission (2016)

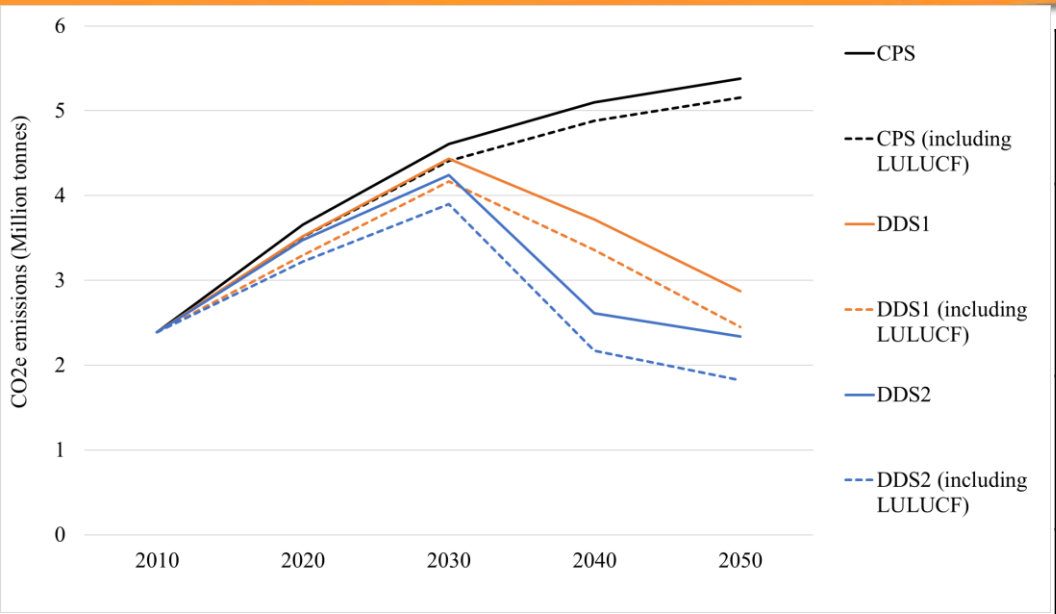




Difficult and challenging to abate

Source: India's BUR-3 (MOEFCC 2021)

GHG Emissions: Net zero by 2065-75?



Scenario	Cumulative Budget, billion tons CO2e (2020-2050)	CO2/capita tons (2050)
CPS (including LULUCF)	142 136	3.1
DDS1 (including LULUCF)	114 104	1.66
DDS2 (including LULUCF)	98 86	1.35

Notes: Carbon budget 2020-2050 in billion ton-CO_2e
Ton CO_2e/capita is for year 2050

Cumulative CO2 budget reduction 2020-2050:

CPS to DDS1 transition mitigates up to **28 bt-CO_2**
including LULUCF, it will be up to **32 bt-CO_2**

CPS to DDS2 transition mitigates up to **44 bt-CO_2**
including LULUCF, it will be up to **50 bt-CO_2**

Cumulative CO2 budget: India needs room for development, results within range of global models.

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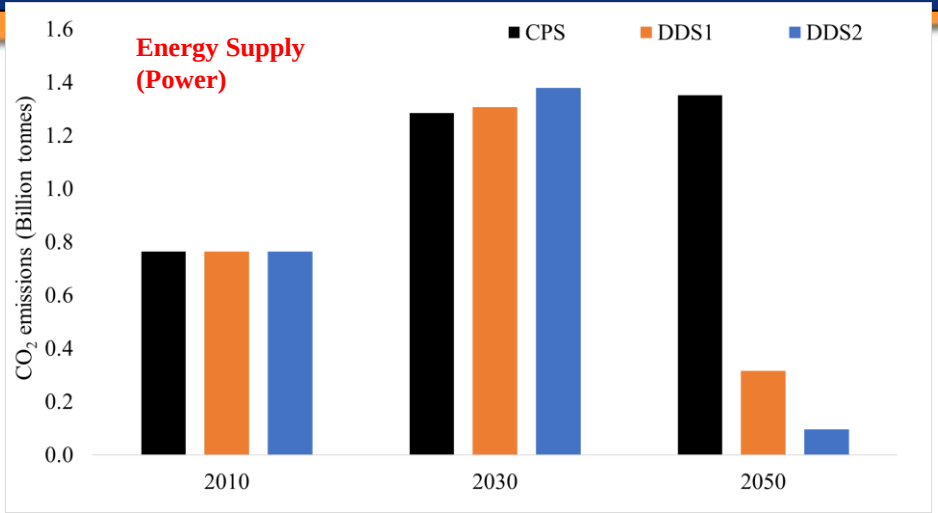
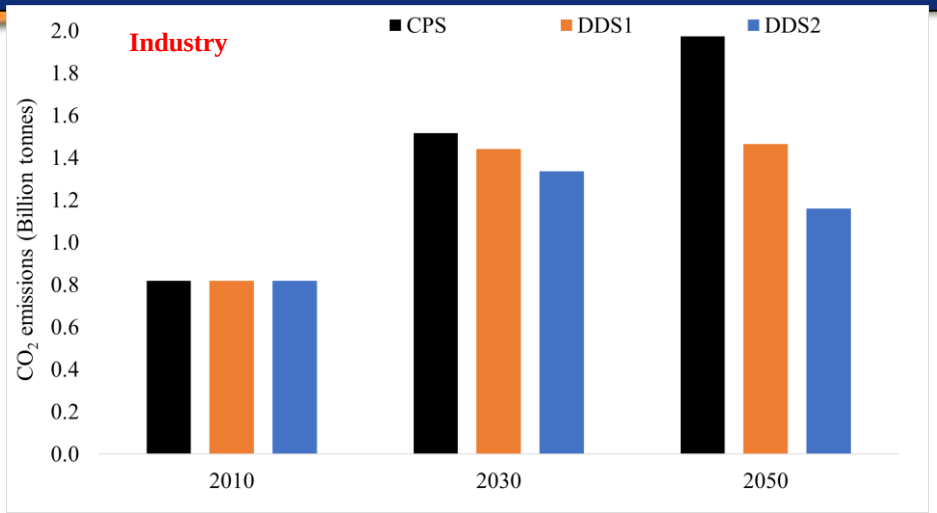
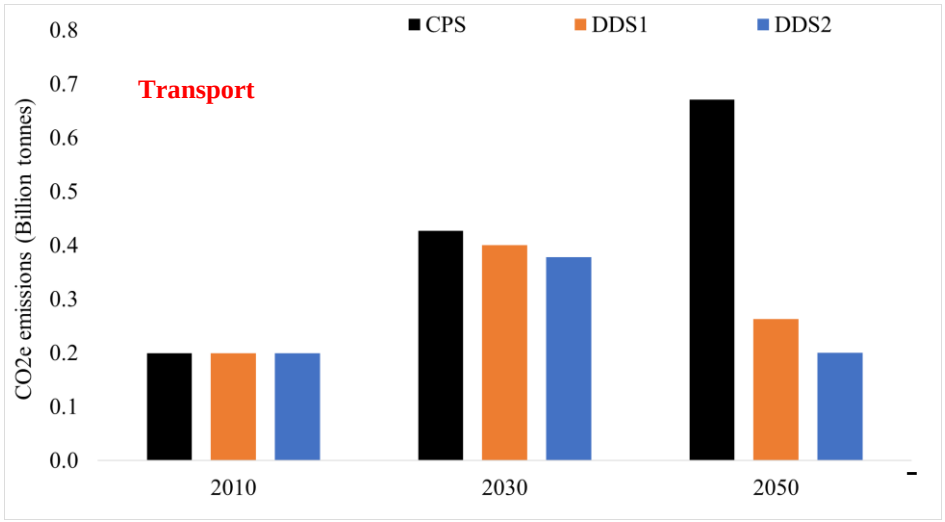
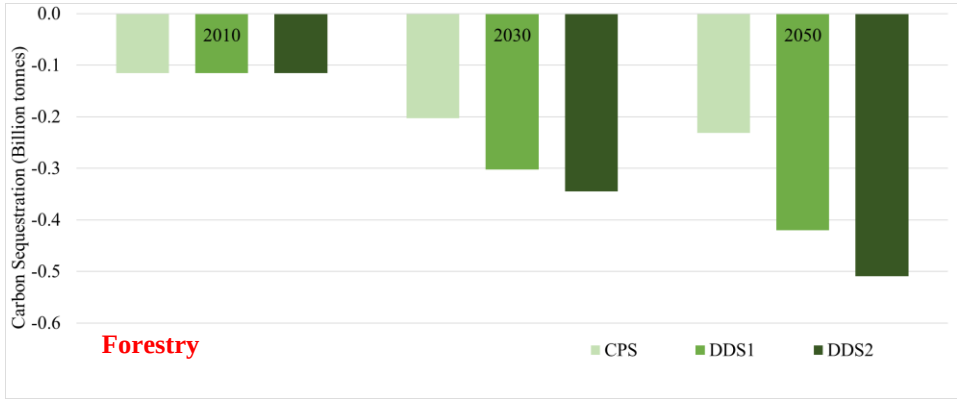
Sectoral Emissions and Carbon Sinks







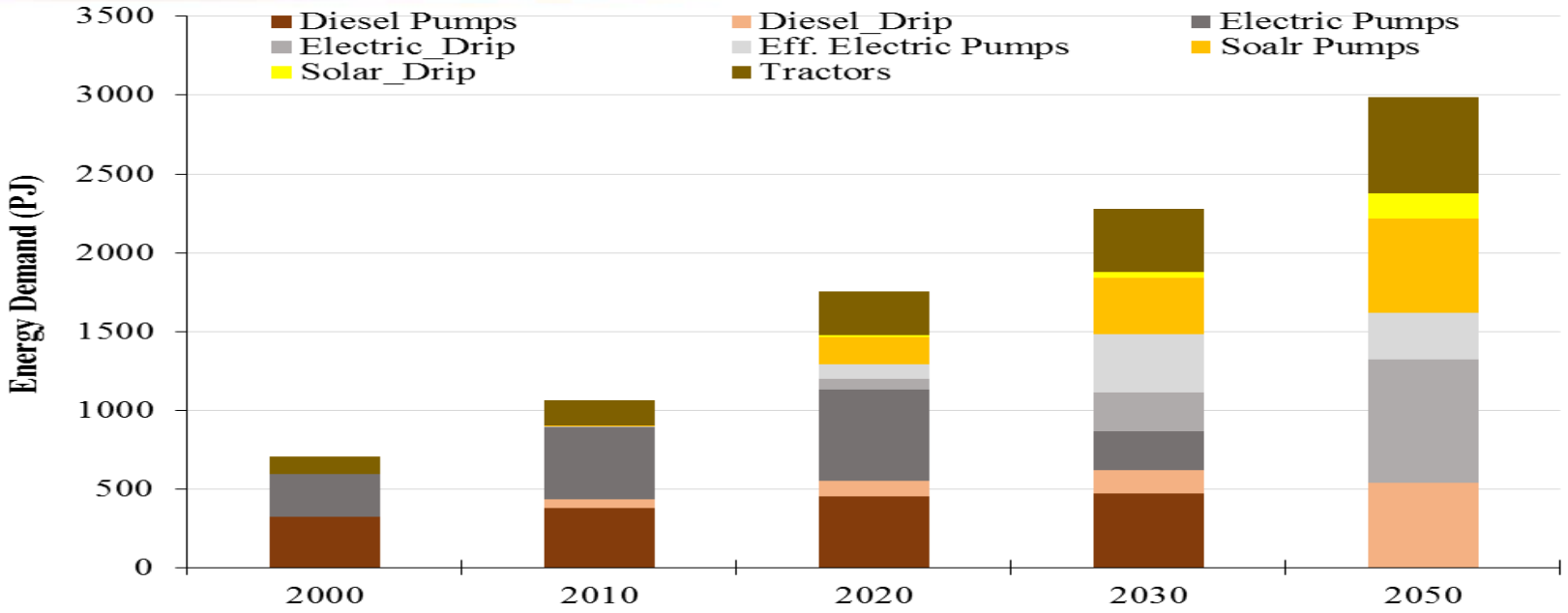


Forestry: Afforestation, reforestation, TOF, Increase in density of existing forests, soil carbon sequestration

- **Power sector :** Responsible for maximum reduction due to EE (advanced technologies), renewables and CCS
- **Industry**: EE is responsible for reduction; demand reduction and CCS in cement, steel responsible for reduction in 1.5 °C
- **Transport**: Technology substitution, fuel switch, modal shift, behaviour change (public transport, WFH), multimodal logistics

Reference: Vishwanathan et al. 2021 (under review)

Aggressive Net Zero? 2060-2065

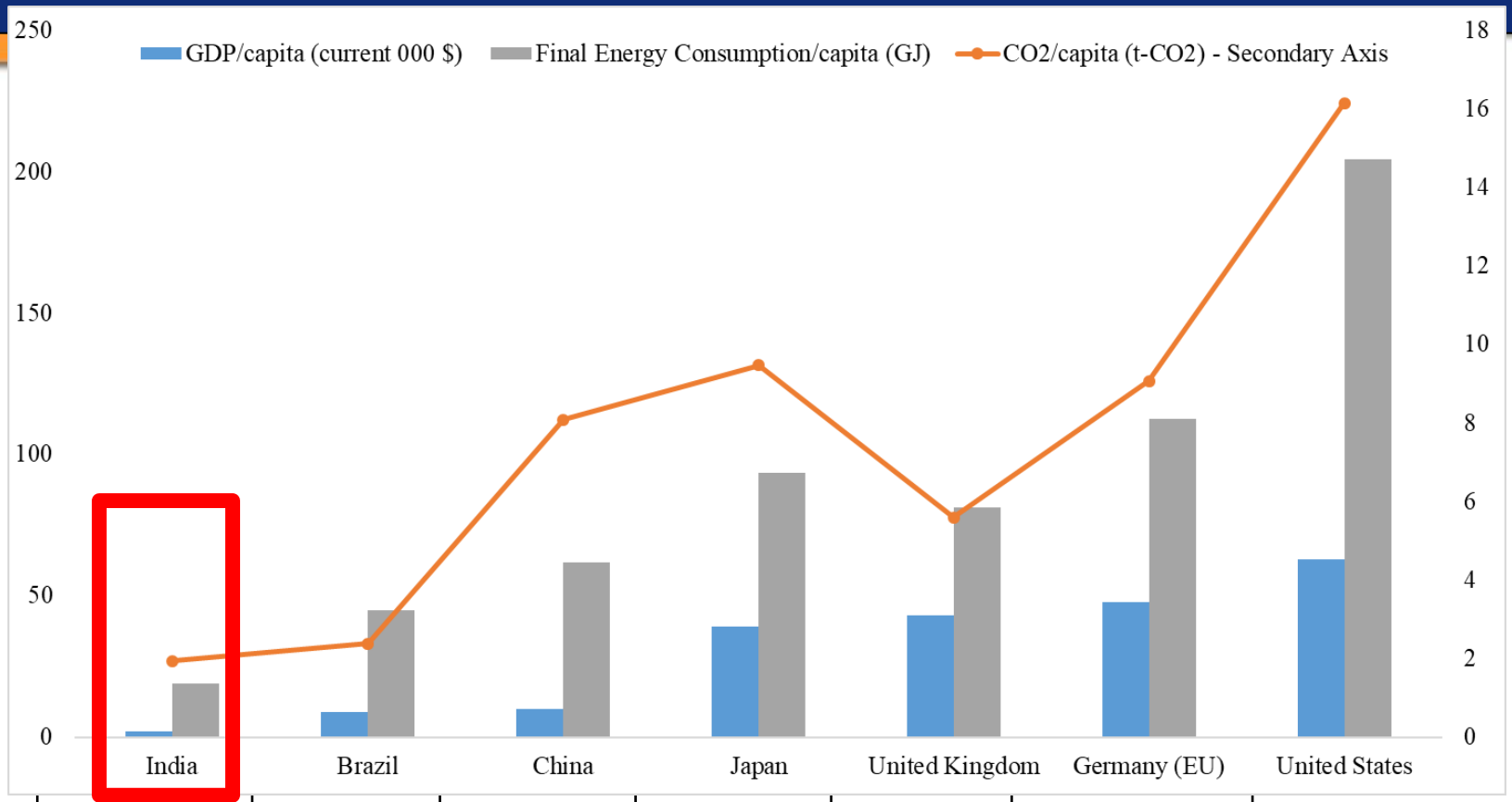


Source: Work in progress. Under Embargo. Please do not cite.

	Cumulative CO_2 Budget (Billion ton)	CO_2/capita at 2050 (ton)
NDC	147	2.7
Current Policy (with LULUCF)	136 (125)	2.4 (2.2)
Synchronizing development and Net-zero (with LULUCF)	116 (100)	1.3 (1.01)
Aggressive Push for Net-Zero (with LULUCF)	104 (87)	1.2 (< 1.0)

Reference: Vishwanathan and Garg (2020), India's BUR (2021)

Net-zero : Where do we stand internationally



	India	Brazil	China	Japan	UK	Germany	USA
Net-zero announced in	Not yet made	2020	2020	2020	2019	2019	2021
Net-zero Target Year (tentative)	**2070-2080**	**2060**	**2060**	**2050**	**2050**	**2050**	**2050**
Coverage	Not announced yet	CO_2, Conditional on finance	CO_2	All GHGs	All GHGs	All GHGs	Not announced yet

India's developmental needs should influence our commitment to peaking and net-zero emissions

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Development and Climate Goals

Make in India would increase industrial production (than service sectors), so relatively higher GHG emissions

National Infrastructure Vision 2025 ($5 trillion economy)

Affordable and clean energy
24X7 Clean power for all
175 GW Renewable capacity
LPG connection for all

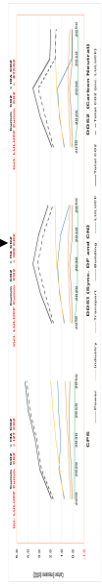
Convenient and efficient transportation and logistics
Roads (national and rural)
Railways (national, intermodal, metros)
Airways and Ports

Housing and water supply for all
Zero slums, housing with piped water supply
Waste water recycling

Doubling farmer income
Increased irrigation(83%) with storage, processing and marketing infrastructure

Digital services for all
100% population coverage for telecom and high quality broadband services

Education and Health
Quality institutions and infrastructure



Technology and Investment Needs for Future Energy transitions and security

- Coal phase out?: reduce the share in electricity mix, alternative energy for industrial production, just transitions for people and coal producing states, stranded assets, CCS
- Oil & Gas: Reduce imports (EV, biofuels, EOR)
- Renewables: Increase share of intermittent sources like solar and wind, storage critical
- More bioenergy (biofuels, bio-CNG etc)
- Smart grids and electricity storage
- Electrification of Industries, Transport and Cooking
- Energy Efficient Devices and Technologies
- Hydrogen (green) and nuclear

2020 2025 2030 2050

Year

Source: Authors' Illustration based on Make in India, https://www.makeinindia.com/national-infrastructure-pipeline-building-india

Ballpark Investments?

- **Enhanced NDC:** Averaging around US$ 246 billion per year during 2021-2030 (Total ~ US$ 2.46 trillion)
- **1.5 ºC compliant**: Average projected to be US$ 224 - 364 billion per year during 2021-2030 (Total ~ US$ 2.2 - 3.6 trillion)
- **Net-Zero by 2060:** Average projected to be US$ 168 - 196 billion per year during 2021-2030 (Total ~ US$ 1.7 - 2 trillion)
- **Net-Zero by 2070**: Average projected to be US$ 140 - 168 billion per year during 2021-2030 (Total ~ US$ 1.4 - 1.7 trillion)
- **All other sectors have almost similar numbers. So double these for economy wide (total 7-8 trillion US$)**
- Main investment opportunities: Solar, wind (including offshore), EV (including charging I/S), batteries (including flow batteries for power), grid flexibility, Energy efficiency all sectors, green hydrogen, bioenergy, Nuclear ($350-450 Billion), agriculture and water, FTA (Forests, Trees outside forests, and agroforestry)
- Who pays for these? Some grants, mostly as business investments – leverage finance
- IFSCA (International Financial Services Centres Authority) – India to become a sustainable finance hub in next 5 years?
- CDRI – to become adaptation finance hub for developing countries?

Total investments between 2021-2030 in all sectors (Trillion USD)

	Power	Other Sectors	Total
NDC	2.4	3.4	5.8
2 °C_early action (High)	4.3	3.7	8.0
2 °C_early action (Low)	3.9	3.7	7.6
2 °C_late action (High)	3.2	3.6	6.8
2 °C_late action (Low)	3.3	3.6	6.9
well below 2 °C	3.1	3.9	7.0

Investments for Power and Other sectors (Billion USD)

Power Sector

2021-2030	Biomass	Coal with CCS	Gas with CCS	Hydro	Nuclear	Solar with Storage	Wind	Cumulative Total	Avg. Annual
NDC	254	471	331	471	209	642	7	2385	239
2 °C_early action (High)	416	694	366	157	158	2191	298	4281	428
2 °C_early action (Low)	380	634	335	143	144	2002	272	3910	391
2 °C_late action (High)	308	514	271	116	117	1622	221	3168	317
2 °C_late action (Low)	324	541	286	122	123	1709	233	3338	334
well below 2 °C	302	505	266	114	115	1594	217	3113	311

Main Enduse Sectors

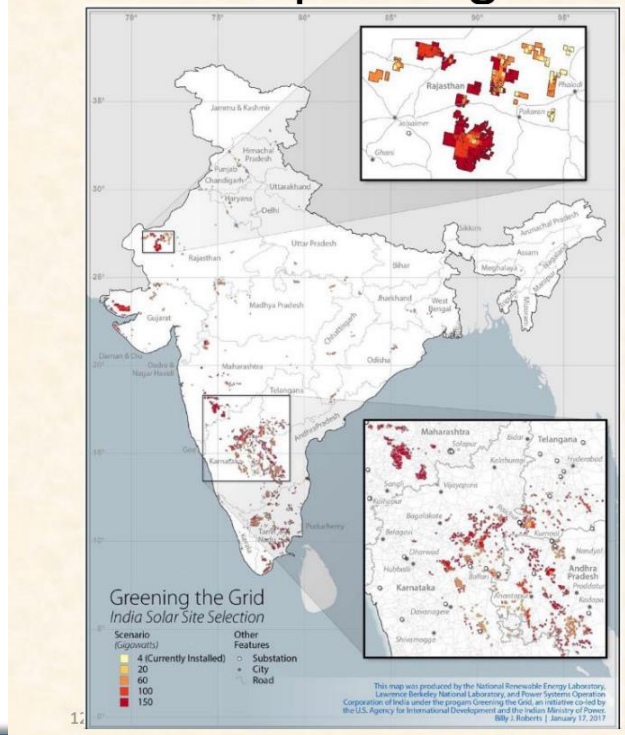
2021-2030	Agriculture	Industry	Buildings	Transport	Cumulative Total	Avg. Annual
NDC	299	1390	810	949	3449	345
2 °C_early action (High)	325	1485	864	1010	3684	368
2 °C_early action (Low)	322	1474	857	1002	3656	366
2 °C_late action (High)	320	1464	851	995	3630	363
2 °C_late action (Low)	315	1443	839	981	3578	358
well below 2 °C	343	1571	914	1069	3897	390

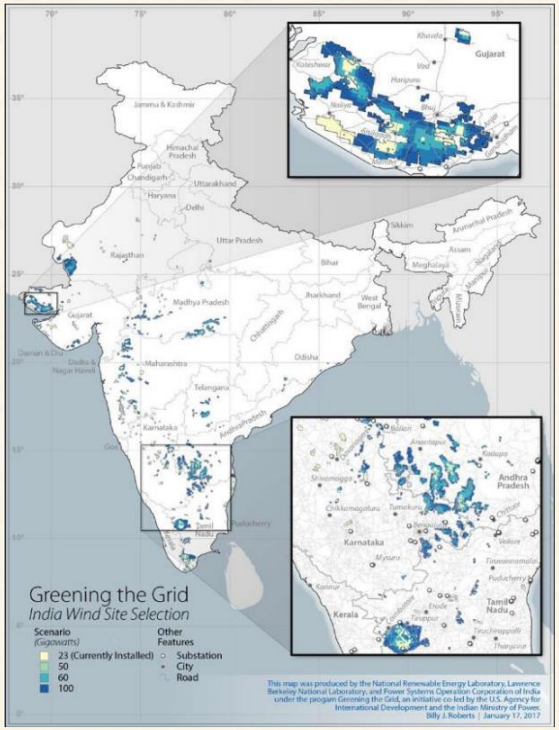
Reference: Vishwanathan, S. S. and Garg, A. (2020)

Opportunities in Renewable Energy

- As of Sept 15, 2021, the total installed capacity for Renewables is 150+ GW (39.24 GW wind, 40 GW solar, 10.3 GW biopower, 4.8 GW small hydro, 46 GW large hydro)
- India's share of non-fossil fuels in the total installed capacity is projected to increase from 30% in 2015 to approximately 39% now. (50% target by 2030)
- One of the most ambitious renewable energy targets: 500 GW by 2030
- 4th largest wind power capacity in the world: Offshore could be explored (90 GW potential) – TN and Gujarat coasts
- 5th largest solar power capacity in the world
- Transmission direction has to change due to RE transitions (from East present, TO from west and south)

Present & upcoming Grid level Solar and Wind Location





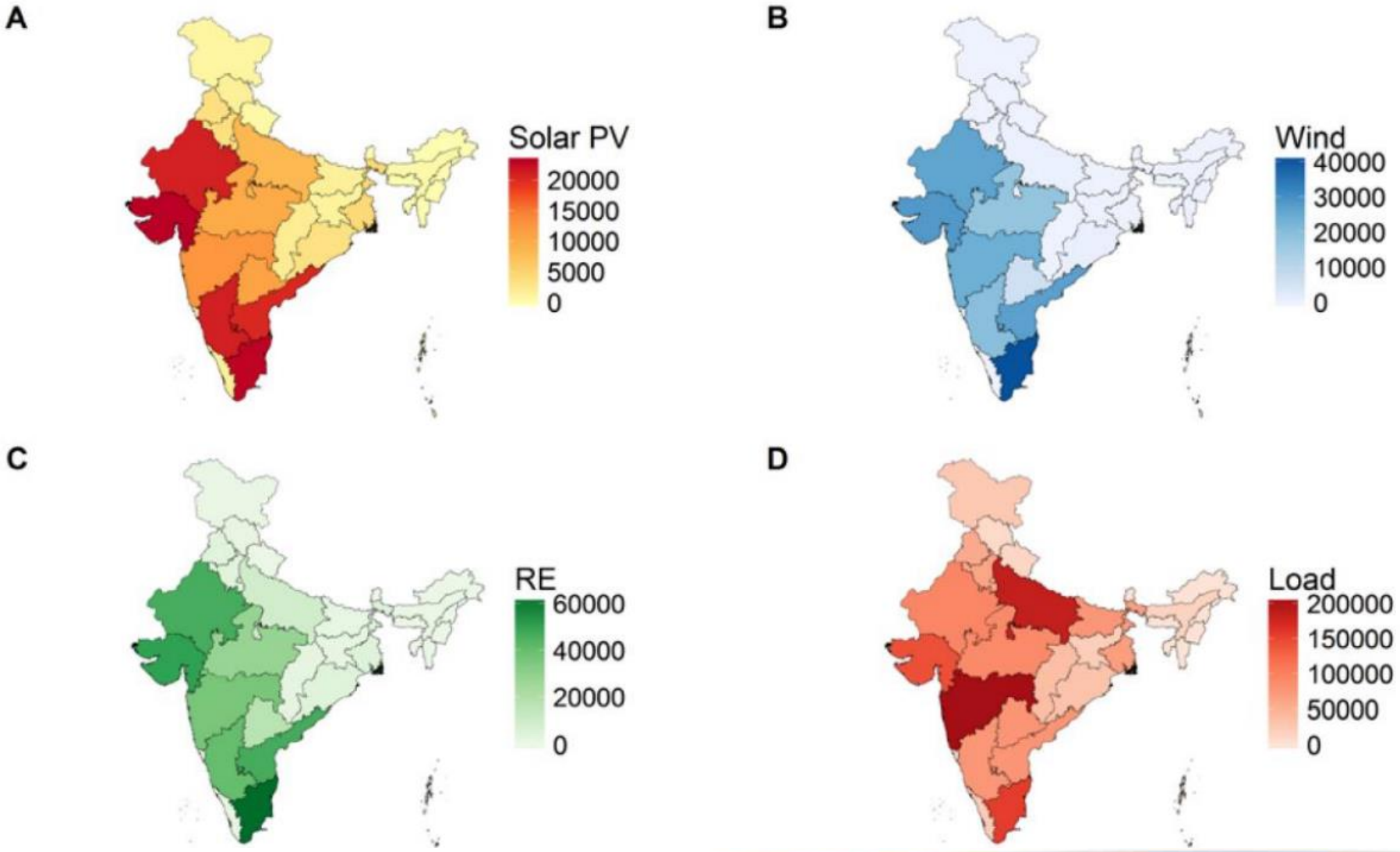
Source: Ministry of New and Renewable Energy, Invest India 2020

Drivers: 100 smart cities (provision of solar and 10% renewable mandatory), green energy corridor (12600 km)

Opportunities: battery storage, grid integration, RE to be under Make in India programme, Green Hydrogen

Be our partners in RE and clean businesses

Opportunities in Renewable Energy



Source: NLDC studies

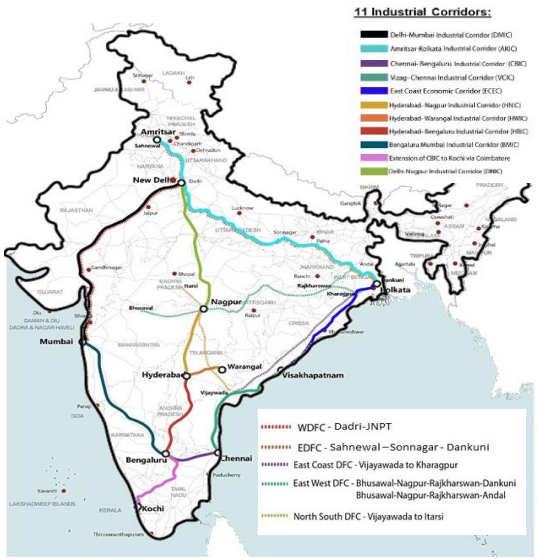
Opportunities in Transport Infrastructure

Railways

- India Railways is the largest network in Asia
- India is projected to account for 40% of the total global share of rail activity by 2050
- Government has allowed 100% FDI in the railway sector.
- Government investment of **USD 715 Bn USD** by 2030 on railway infrastructure.
- Drivers:
  - Indian railways to increase the modal share in freight by 45% from existing 27% by 2030.
  - Dedicated freight corridor and Diamond quadrilateral network
  - Atmanirbhar Bharat Abhiyan – Self Reliant India

- Opportunities: Net Zero Railways by 2030 – $75 billion investments in electrification, RE capacity installation reqd (~60 GW), Green financing

Dedicated Freight Corridor

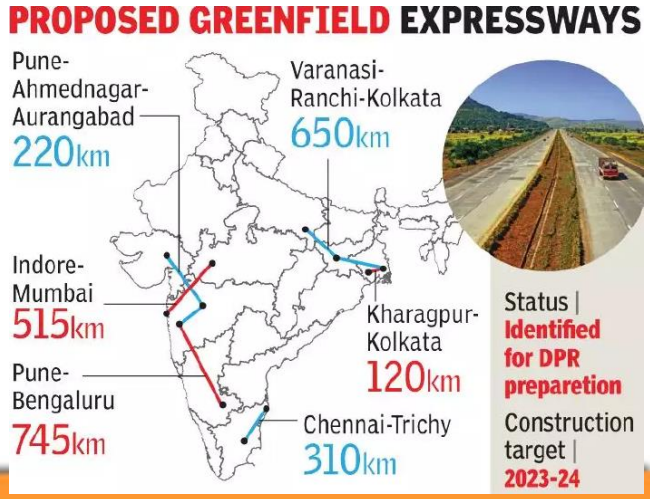


Roads and Highways

- Second largest network in the world. Transport 64% goods traffic and 90% of passenger traffic.
- Bharatmala (Highways): Aims to build 66,100 km of economic corridors, border and coastal roads, and expressways to boost the highway network. This programme aims to grow 50 corridors (from current 6), increase freight share to 70-80% and connect 550 districts
- Bharatmala (Highways) and Sagarmala (Coastal roads): $**421 Billion by 2030**

- Opportunities: Expansion of roads in PPP modes (Investment: $82 billion), Rural roads connected to towns and cities, multi-modal logistics, Freight electrification, Bharatmala ($421 billion)

Bharat Mala 2.0: National Highways



Source: Ministry of Railways, Ministry of Road Transport and Highways, Invest India 2020

Opportunities in Electric Mobility

- 300 million vehicles (75% are 2-wheelers)
- World's largest two-wheeler and three-wheeler manufacturer
- World's second largest bus manufacturer
- World's largest tractor manufacturer
- World's third largest heavy truck manufacturer and fourth largest car manufacturer
- Current value chain: USD 100 Billion
- Employment: 32 Million (direct and indirect)

- **Central Policies**

  National Auto Policy (2018)
  Automotive Mission Plan (2016-2026)
  National Electric Mobility Mission Plan (2020)
  FAME India Phase II (2019-2022)
  Budget: $ 1.3 Billion

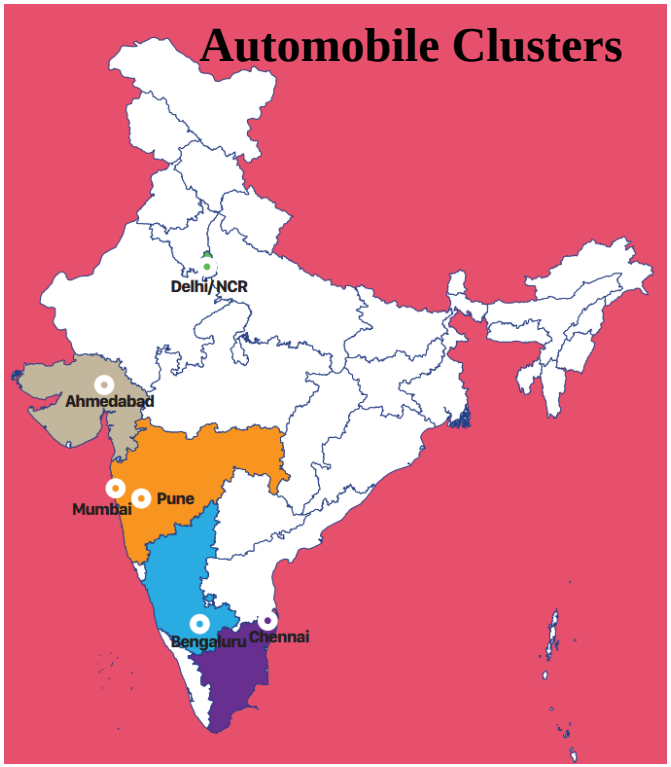
- **Favorable State Policies**

  Maharashtra, Karnataka, Uttar Pradesh, Uttarakhand, Delhi, Telangana, Andhra Pradesh, Kerala, Odisha

EV market CAGR : 44% between 2020-2027
Market size: $50 Billion in 2030

Infrastructure

National Mission on Transformative Mobility and battery storage (2020)



Source: Invest India 2020

Opportunities in Urban and Housing Infrastructure

- 100 Smart cities (**Investment : $ 30 Billion**) – tier 1 cities

  (adequate water supply, assured electricity supply, sanitation, including solid waste management, efficient urban mobility and public transport, affordable housing, especially for the poor, robust IT connectivity and digitalization, good governance, especially e-Governance and citizen participation, sustainable environment, safety and security of citizens, particularly women, children and the elderly, and health and education)

- 500 Atal Mission for Rejuvenation and Urban Transformation (AMRUT) (**Investment : $ 10 Billion**) – tier 2 cities

  (provide basic civic amenities like water supply, sewerage, urban transport, parks as to improve the quality of life for all especially the poor and the disadvantaged)

Making these climate resilient and low carbon SMART and AMRUT cities

- Housing for All by 2022 (Investment: $ 50 Billion)

- Real Estate Market size to increase to $ 1000 Billion by 2030

- Swachh Bharat Mission (SBM) – Cleanliness campaign (Investment: $ 30 Million)

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Summary

1. **India is well on track to meet its Paris commitments**

2. **India has commited to be Net Zero by 2070**. For the world to be Net Zero by 2050, the developed countries need to have ambitious plans to be Net-Negative.
   - Continue with GHG/GDP Intensity targets until 2035 (~45% during 2005-2030)
   - Peaking GHG during 2040-2045? (and plateau until 2045 before declining)
   - Earlier may be possible but investments increase

3. **Multiple transitions**, required to phase down coal and oil, and each of these transitions will take minimum 20-25 years for a country like India. So,
   - Acknowledge that climate action needs financing
   - Create a common technology development pool in which industrialized and developing countries are equal partners
   - Net-zero is for the basket of all six GHGs and not CO2 alone
   - Bring back the adaptation discussion to the table along with net-zero

4. Climate Equity, Climate justice, and lifestyles are very important at a global level

5. **INVOLVE Investors, Businesses and Industry** in climate change discussions and actions

Thank You

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