India’s Energy Challenge in an Unequal and Warming World

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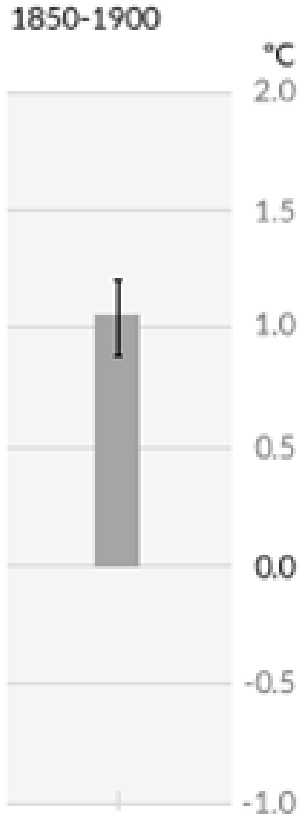
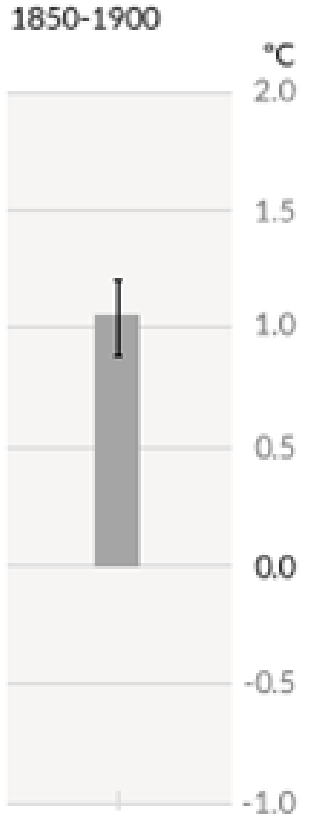
A Warming World



Warming about ~1.07 deg. C from pre-industrial average

IPCC, AR6, WG-I

A Warming World



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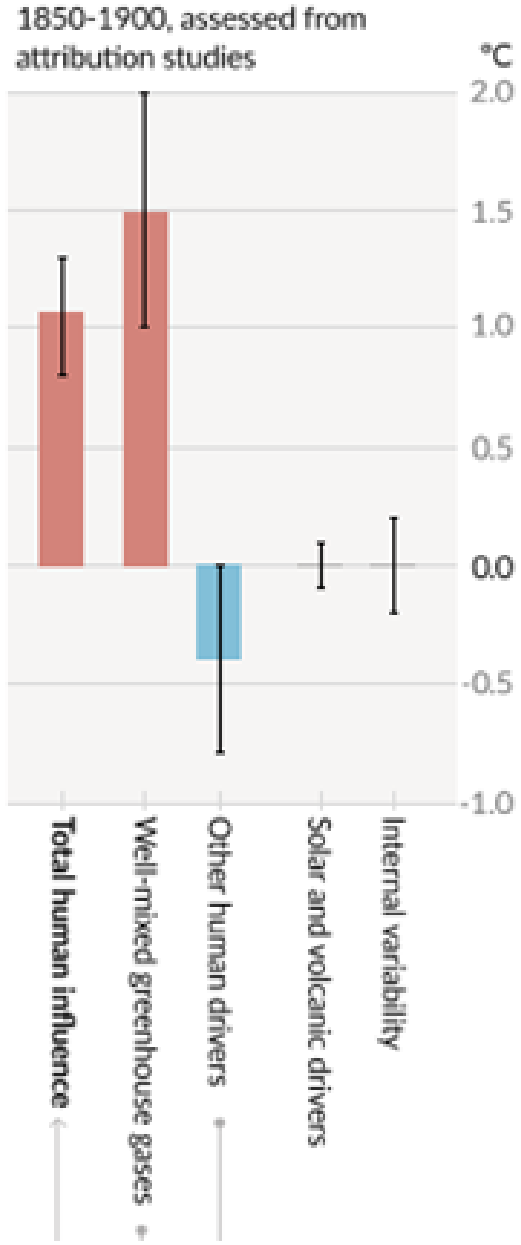

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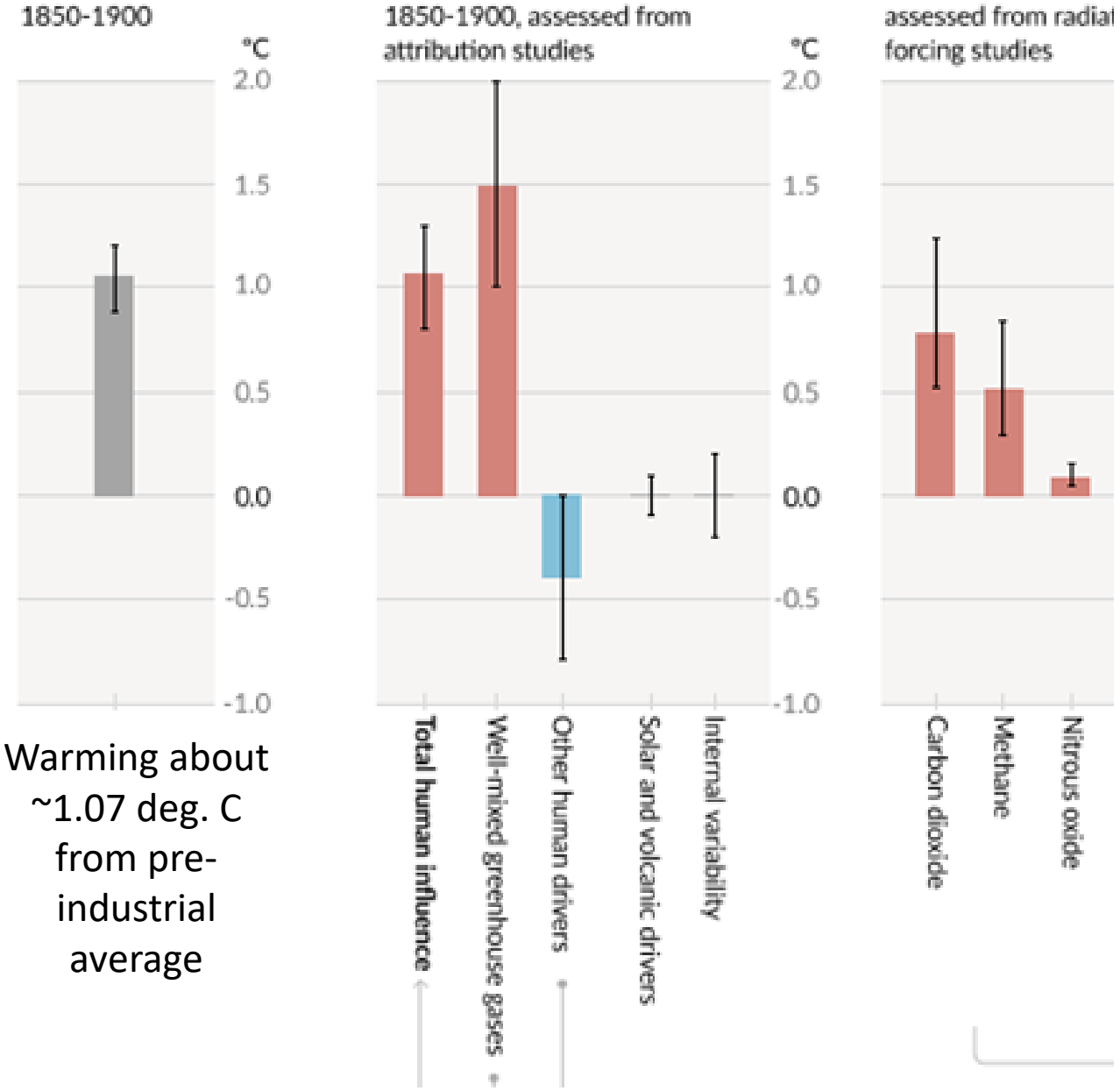

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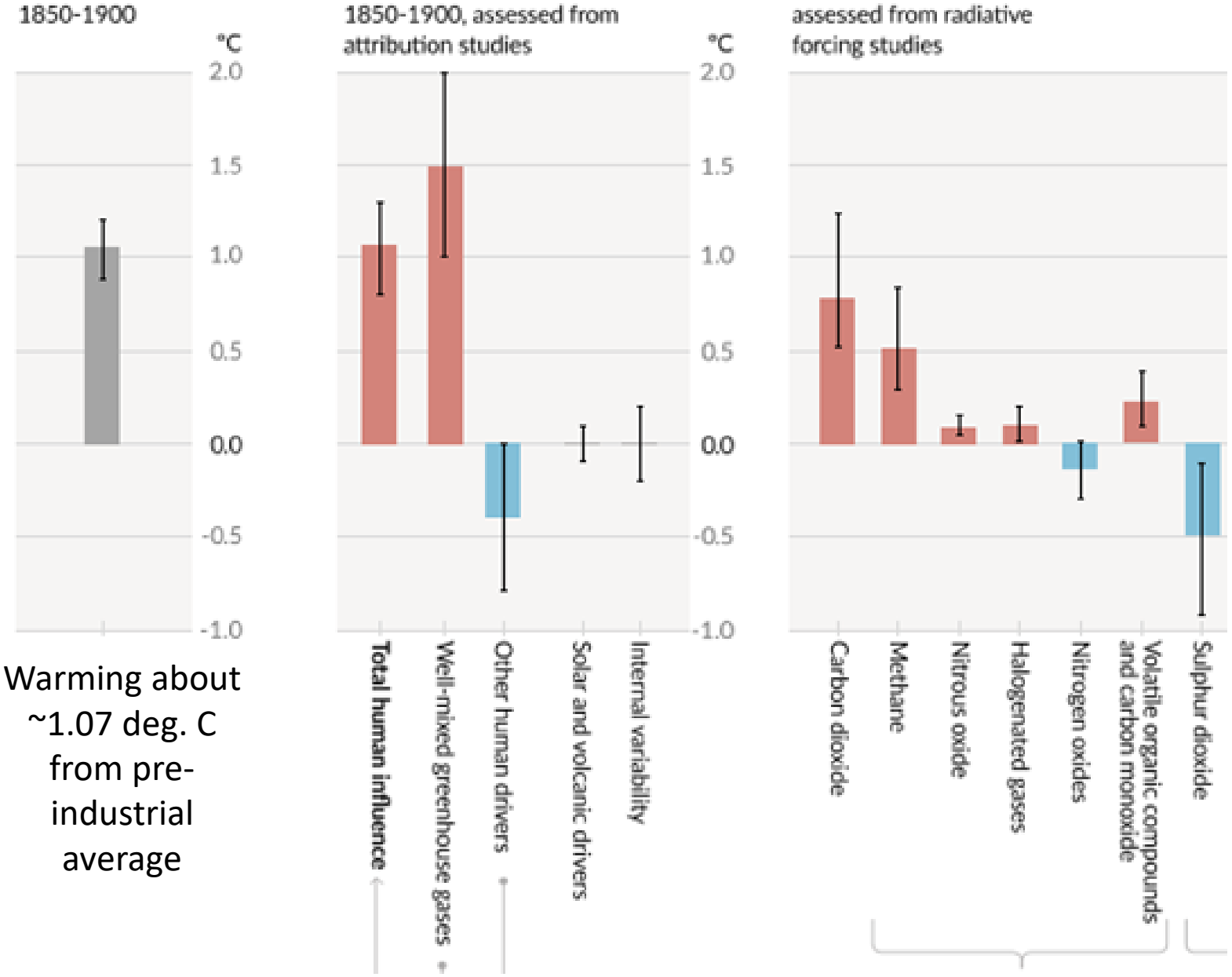

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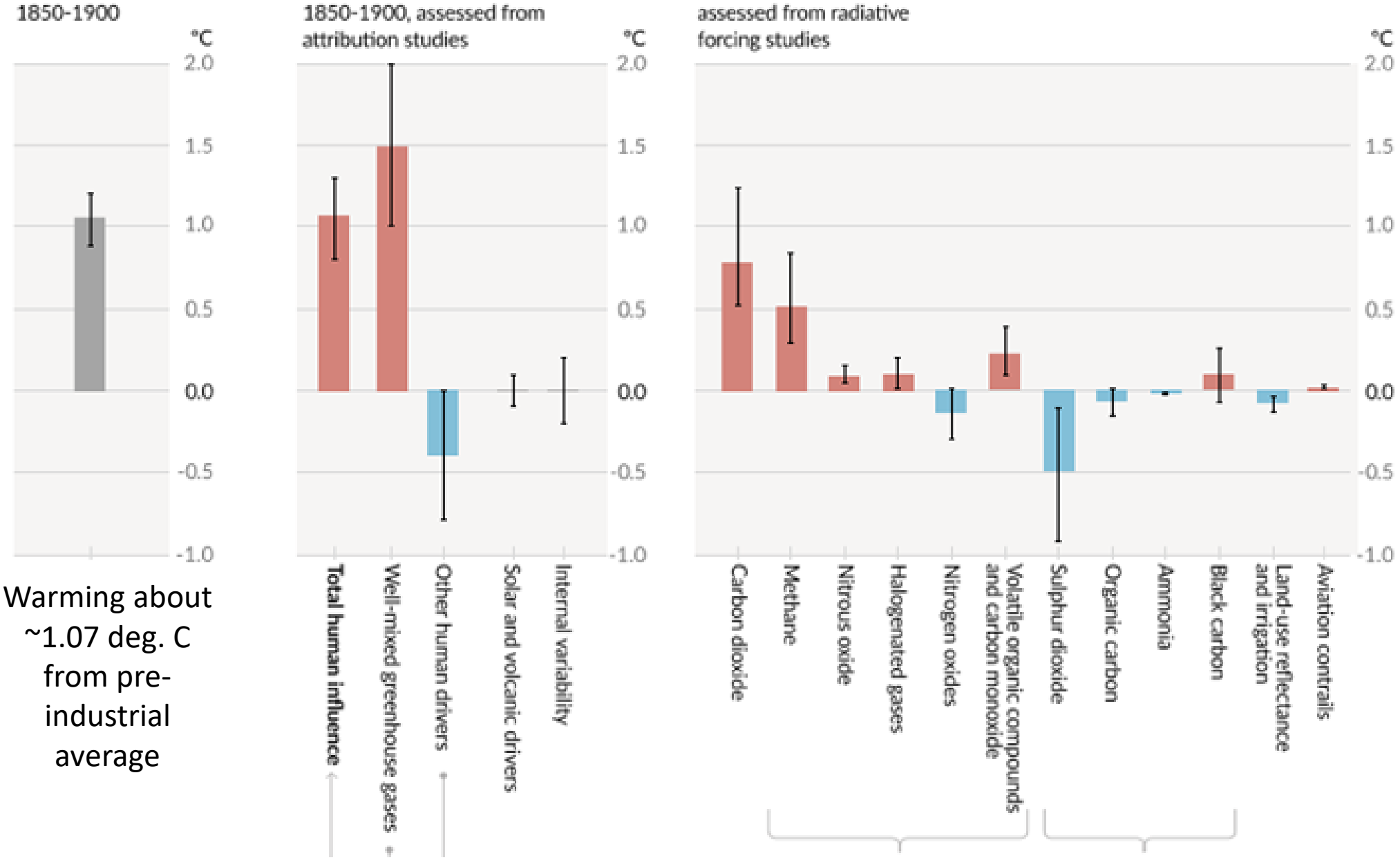
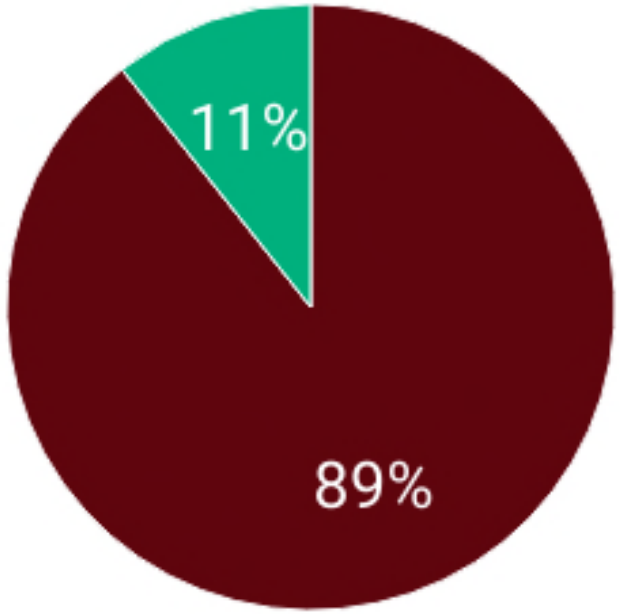


Warming about ~1.07 deg. C from pre-industrial average

IPCC, AR6, WG-I

Historical Cumulative Emissions

~1.07 deg. Warming



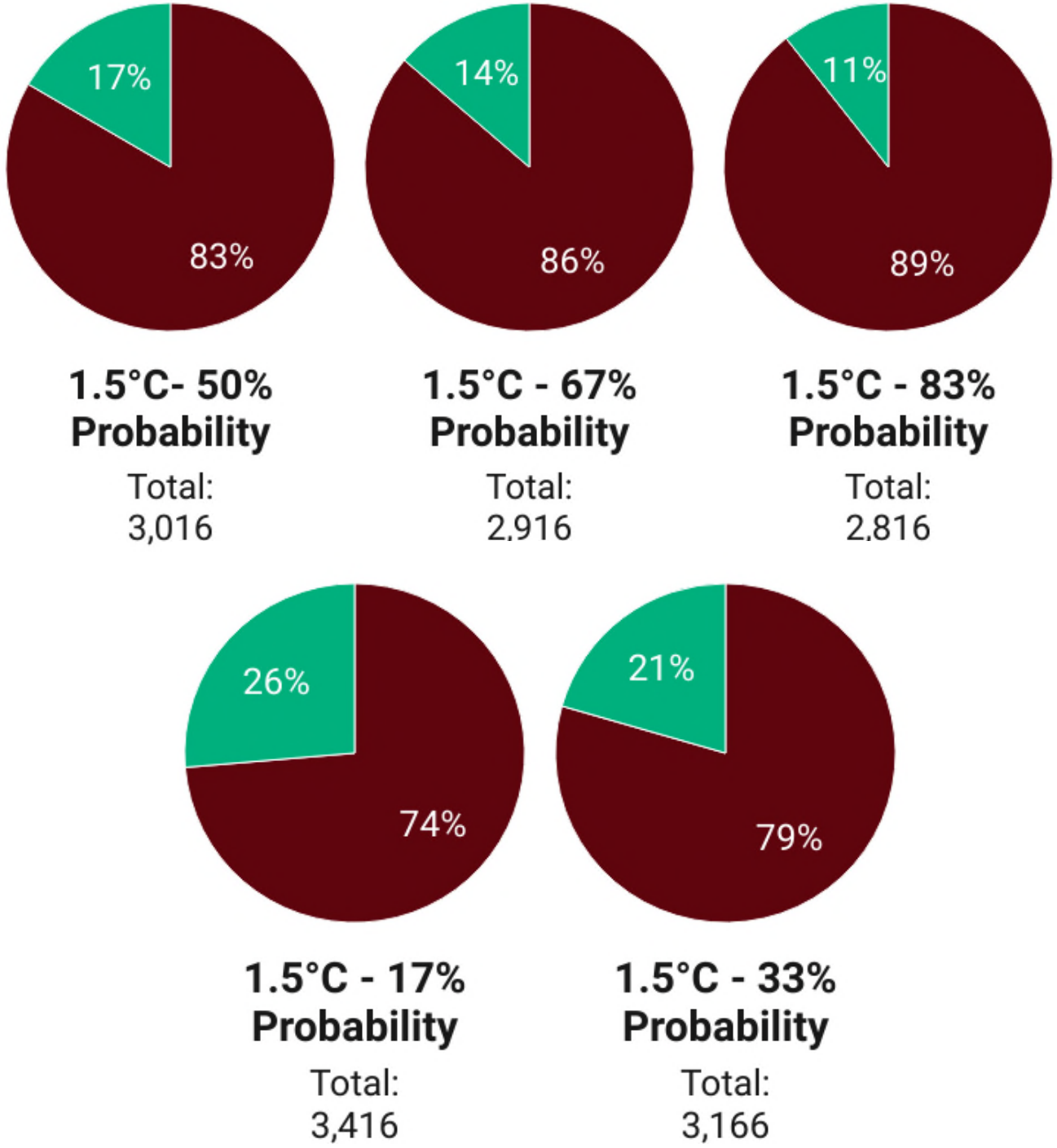
1.5°C - 83% Probability

Total:
2,816

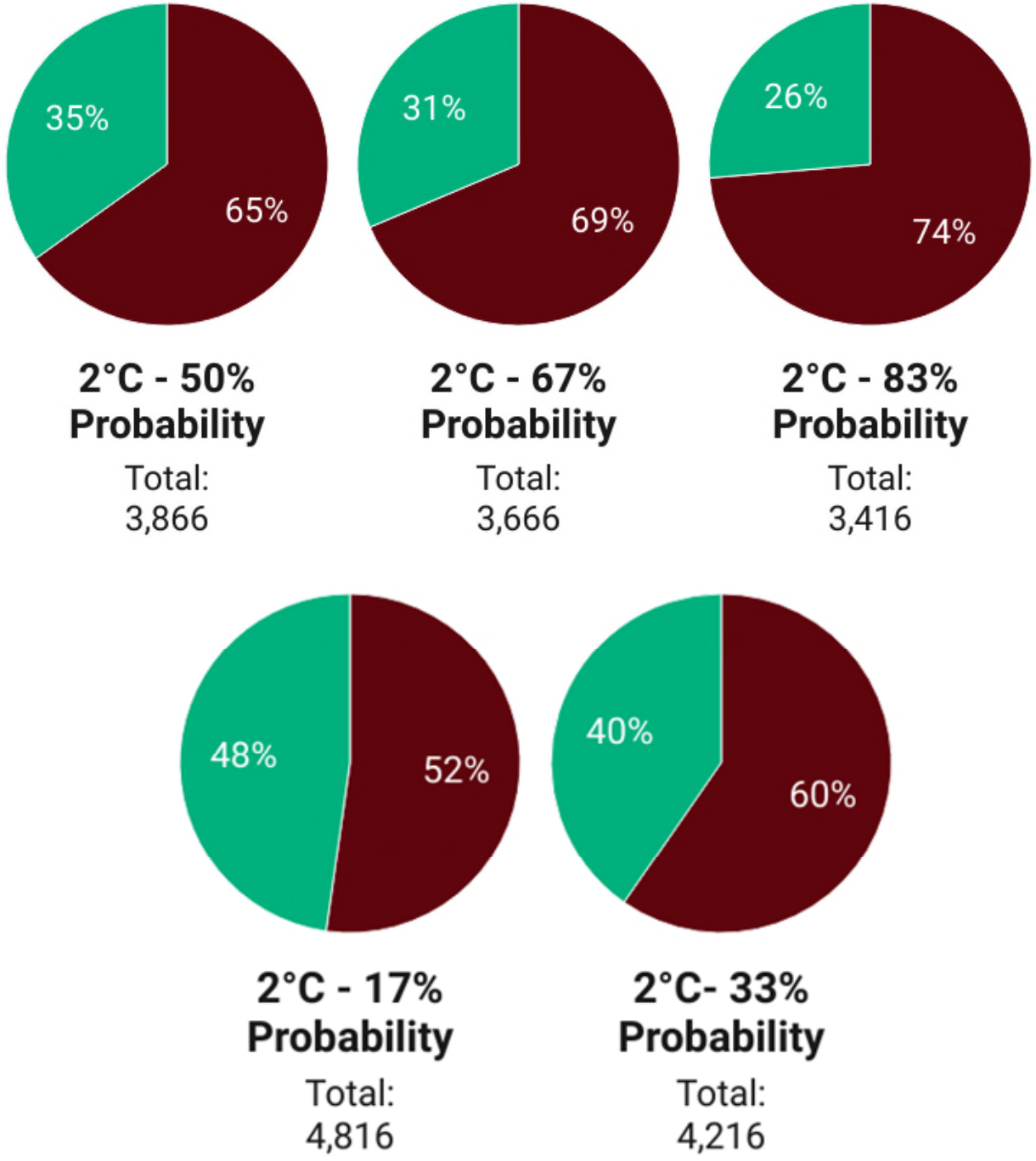
Past Cumulative Emissions (1850-2019)

Remaining Carbon Budget to Limit Temperature Rise below a Specific Target (2020-Global Net Zero)

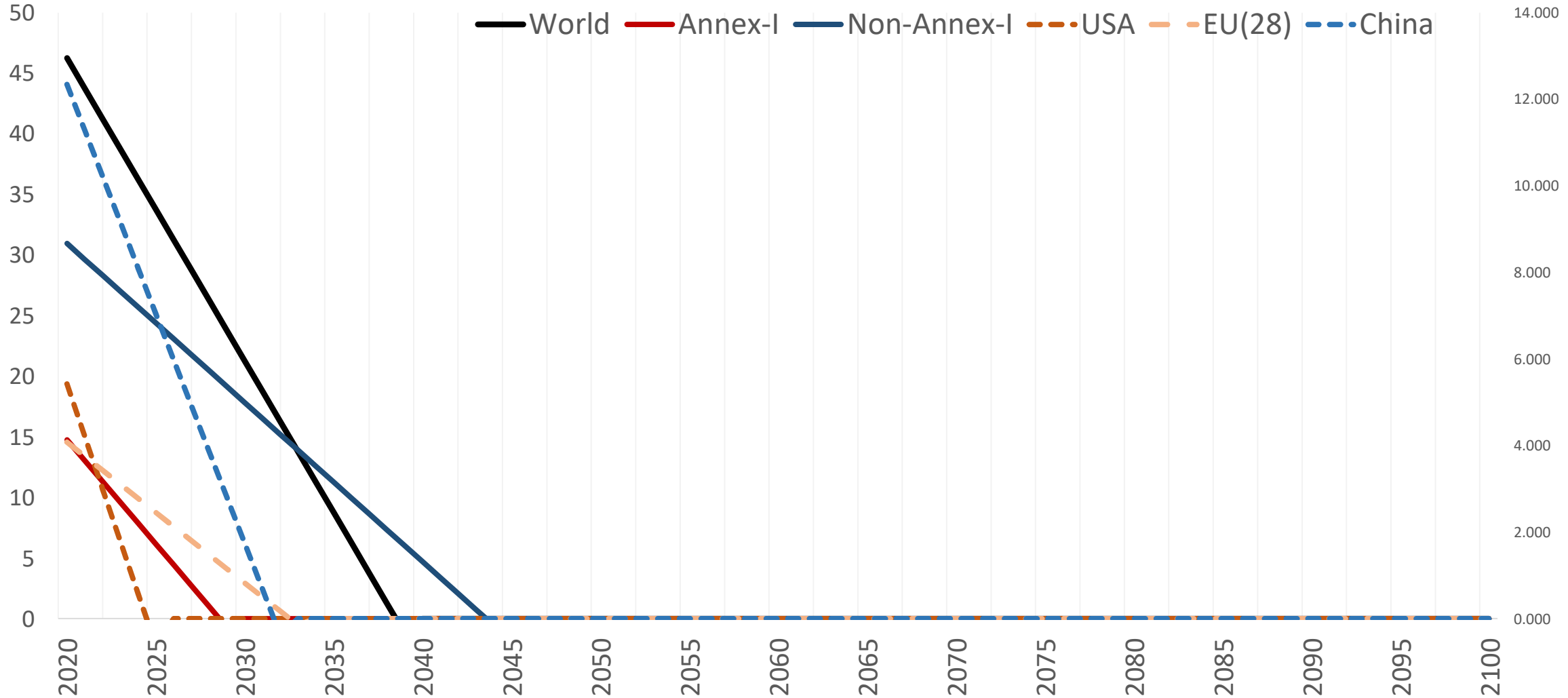
Historical Cumulative Emissions → 1.07 deg. Warming



Historical Cumulative Emissions → 1.07 deg. Warming

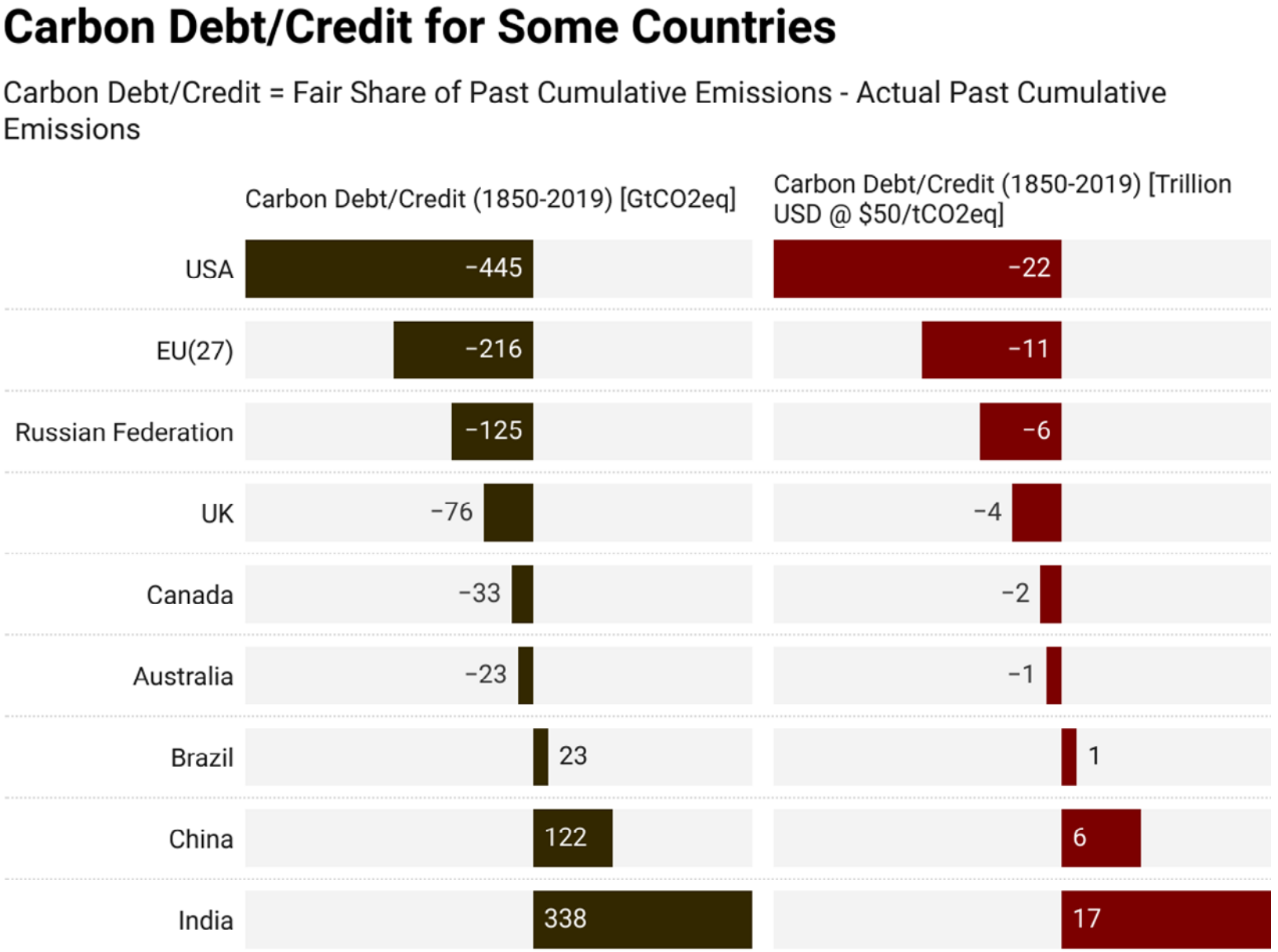


The Hot Air of Net0 → 1.5 deg --- No longer alive



Very little carbon space left for the future

- Historical Emissions by Developed countries
- 71% of cumulative emissions up to 1990
- 61% of cumulative emissions up to 2019
- India's contribution → ~5%



With Current Pledges even 2 deg. C is barely "alive"

- For an 83% probability of limiting temperature rise to below 2 deg C.
- And a 17% probability of limiting temperature rise to below 1.5 deg. C
- Remaining Carbon Budget of ~900 GtCO2

	Year to Reach Net-Zero Emissions – Full Historical Responsibility
USA	2020. Negative emissions needed from 2020 onwards
EU (27) + UK	
Australia	
Canada	
Japan	
Other Annex-I Countries	
Annex-I as a Group	

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	Year to Reach Net-Zero Emissions – Full Historical Responsibility	**Year to Reach Net-Zero Emissions if Grandfathering**
USA	2020. Negative emissions needed from 2020 onwards	**2031**
EU (27) + UK		2046
Australia		**2030**
Canada		**2031**
Japan		2044
Other Annex-I Countries		2046
Annex-I as a Group		**2039**

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	Year to Reach Net-Zero Emissions – Full Historical Responsibility	Year to Reach Net-Zero Emissions if Grandfathering	Year to Reach Net-Zero if Fair Share Weighted with Historical Responsibility
USA	2020. Negative emissions needed from 2020 onwards	2031	2023
EU (27) + UK		2046	2033
Australia		2030	2025
Canada		2031	2026
Japan		2044	2033
Other Annex-I Countries		2046	2035
Annex-I as a Group		2039	2029

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	Year to Reach Net-Zero Emissions – Full Historical Responsibility	Year to Reach Net-Zero Emissions if Grandfathering	Year to Reach Net-Zero if Fair Share Weighted with Historical Responsibility	Proposed year of Net Zero
USA	2020. Negative emissions needed from 2020 onwards	2031	2023	2050
EU (27) + UK		2046	2033	2050 (some 2045)
Australia		2030	2025	None
Canada		2031	2026	2050
Japan		2044	2033	2050
Other Annex-I Countries		2046	2035	~2050
Annex-I as a Group		2039	2029	2050

Implications for India

~18% of the global population

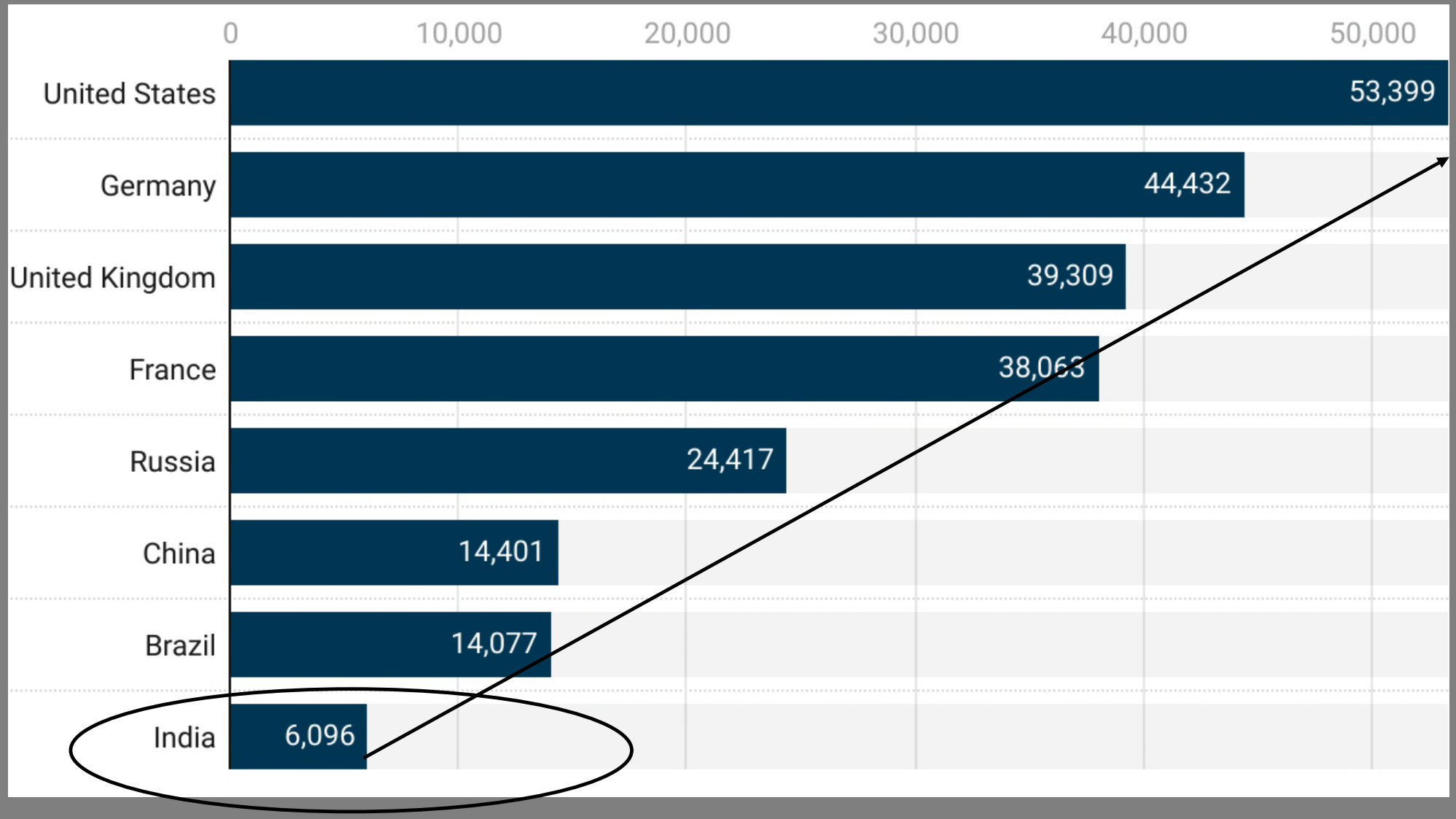
~4.5% of global emissions so far (1850-2019)

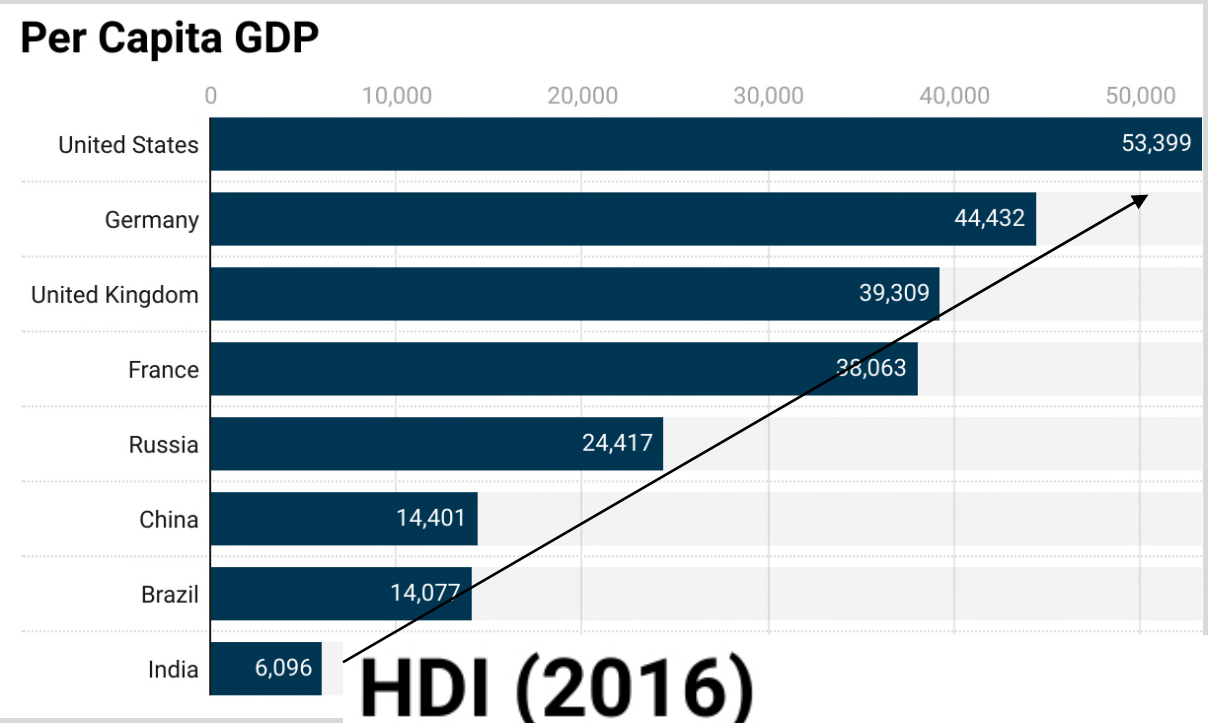
Yet….

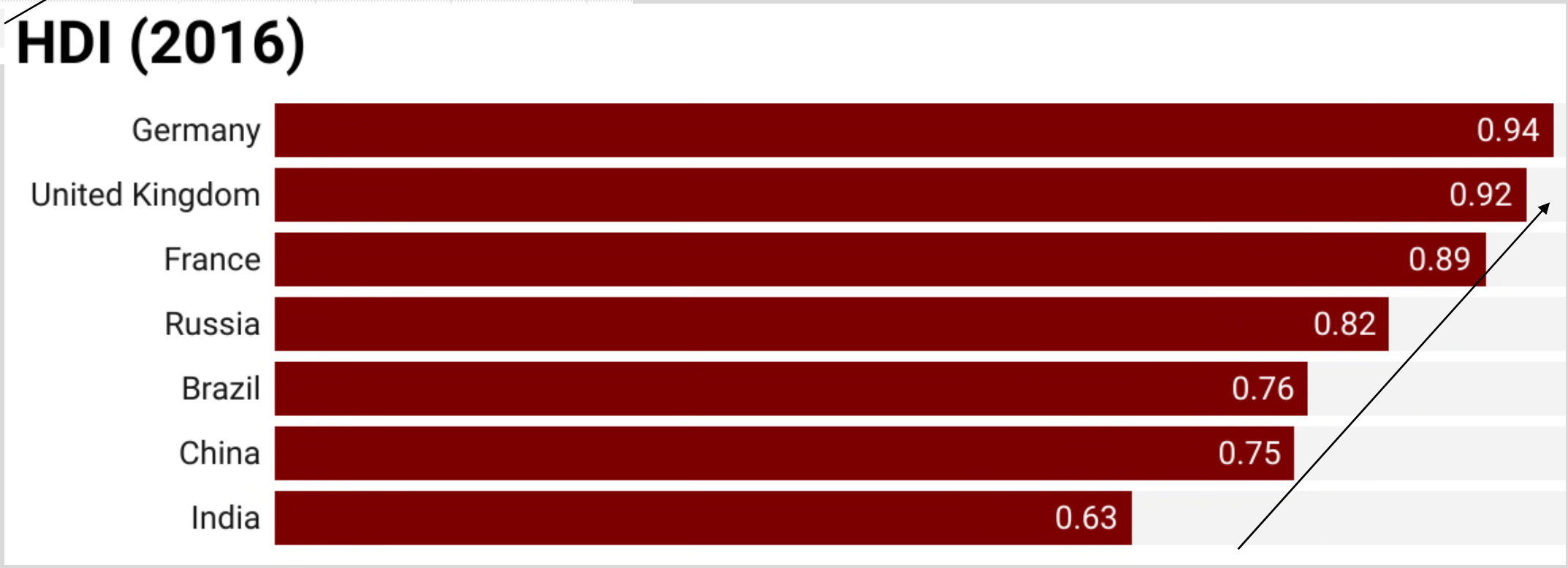
- **Pressure to do more**
- **Declare net-zero…… by….?**
- **Enhance NDCs…..**

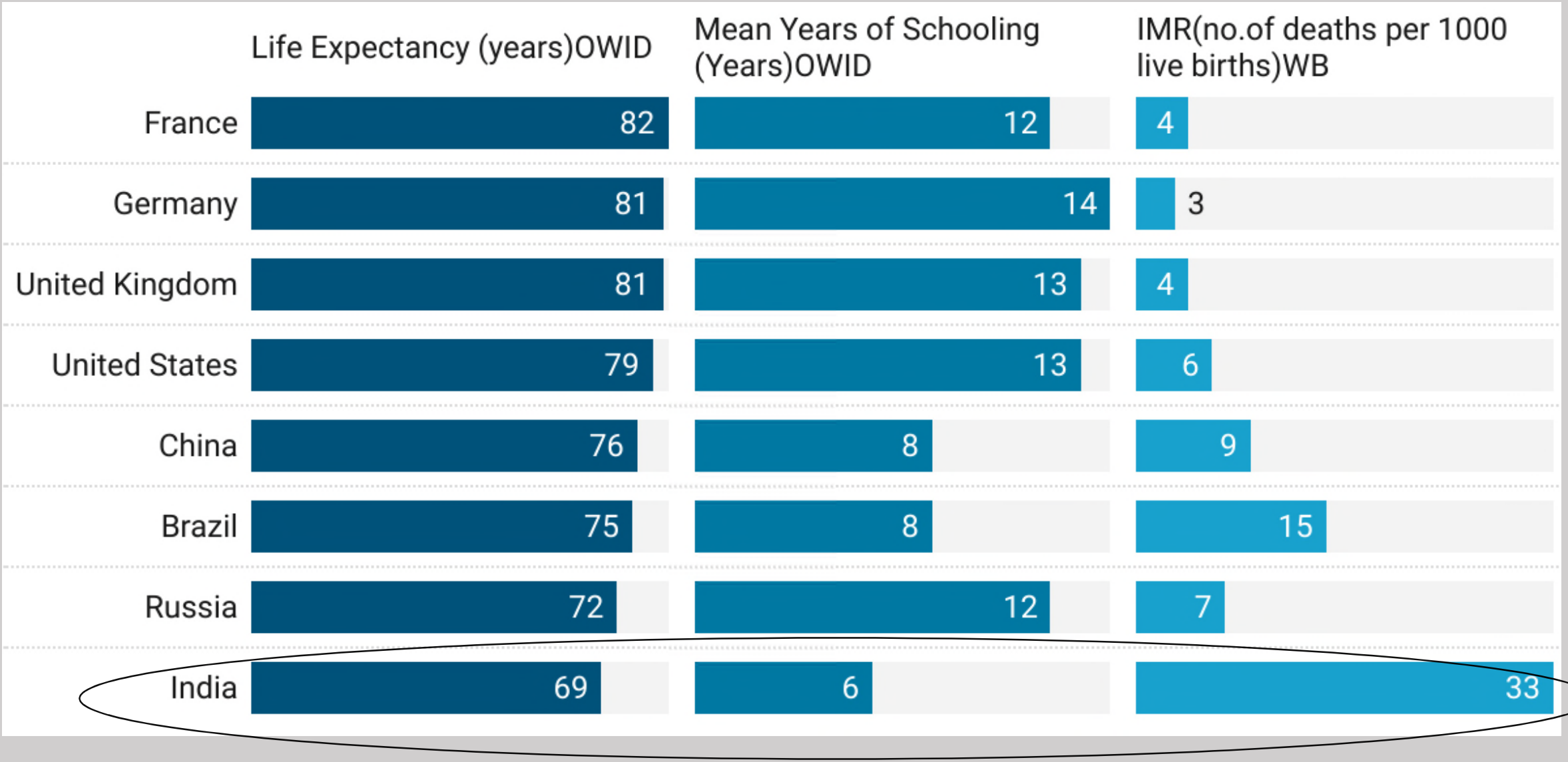
What are the challenges?

Per Capita GDP (2016 - $ PPP)




Per Capita GDP
0
10,000
20,000
30,000
40,000
50,000
United States
53,399
Germany
44,432
United Kingdom
39,309
France
38,063
Russia
24,417
China
14,401
Brazil
14,077
India
6,096

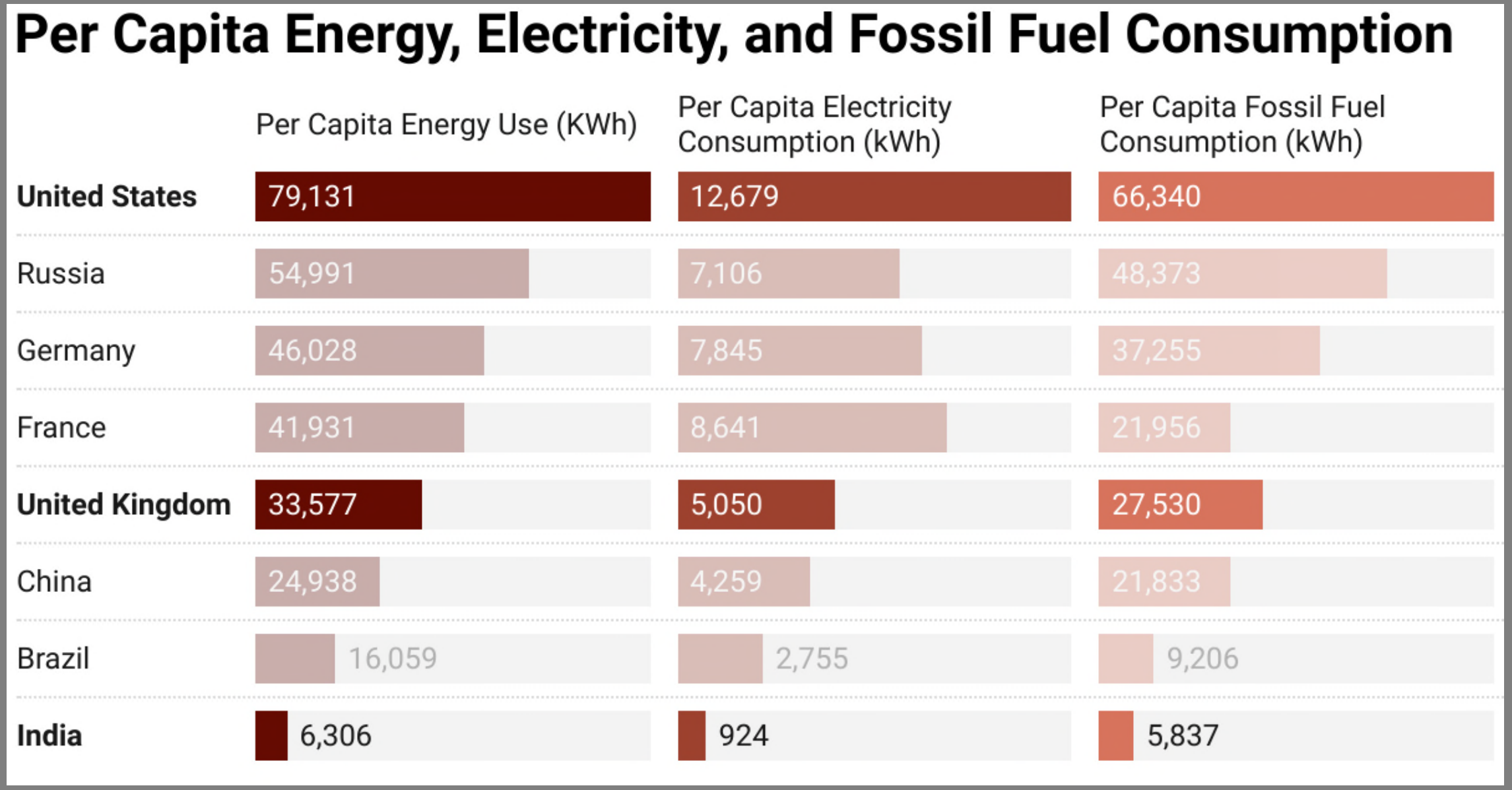

HDI (2016)
Germany
0.94
United Kingdom
0.92
France
0.89
Russia
0.82
Brazil
0.76
China
0.75
India
0.63



Developmental Challenge is significant.

What kind of energy requirements for the future does this imply?

Per Capita Energy, Electricity, and Fossil Fuel Consumption



	Number of Countries	Proportion of Global Population	Per Capita GDP ($-PPP)	HDI	Per Capita Energy Use (GJ)
High Development	**41**	**18%**	**43,272**	**0.900**	**241**
UK		1%	39,309	0.924	123
USA		4%	53,399	0.920	338

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UK		1%	39,309	0.924	123
USA		4%	53,399	0.920	338
Medium Development	**52**	**45%**	**15,039**	**0.750**	**88**
China		18%	14,401	0.746	104
Mexico		2%	17,207	0.751	74

	Number of Countries	Proportion of Global Population	Per Capita GDP ($-PPP)	HDI	Per Capita Energy Use (GJ)
High Development	41	18%	43,272	0.900	241
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Medium Development	52	45%	15,039	0.750	88
China		18%	14,401	0.746	104
Mexico		2%	17,207	0.751	74
Low Development	41	37%	3,488	0.550	21
India		18%	6,096	0.630	23
Kenya		1%	2,927	0.591	11

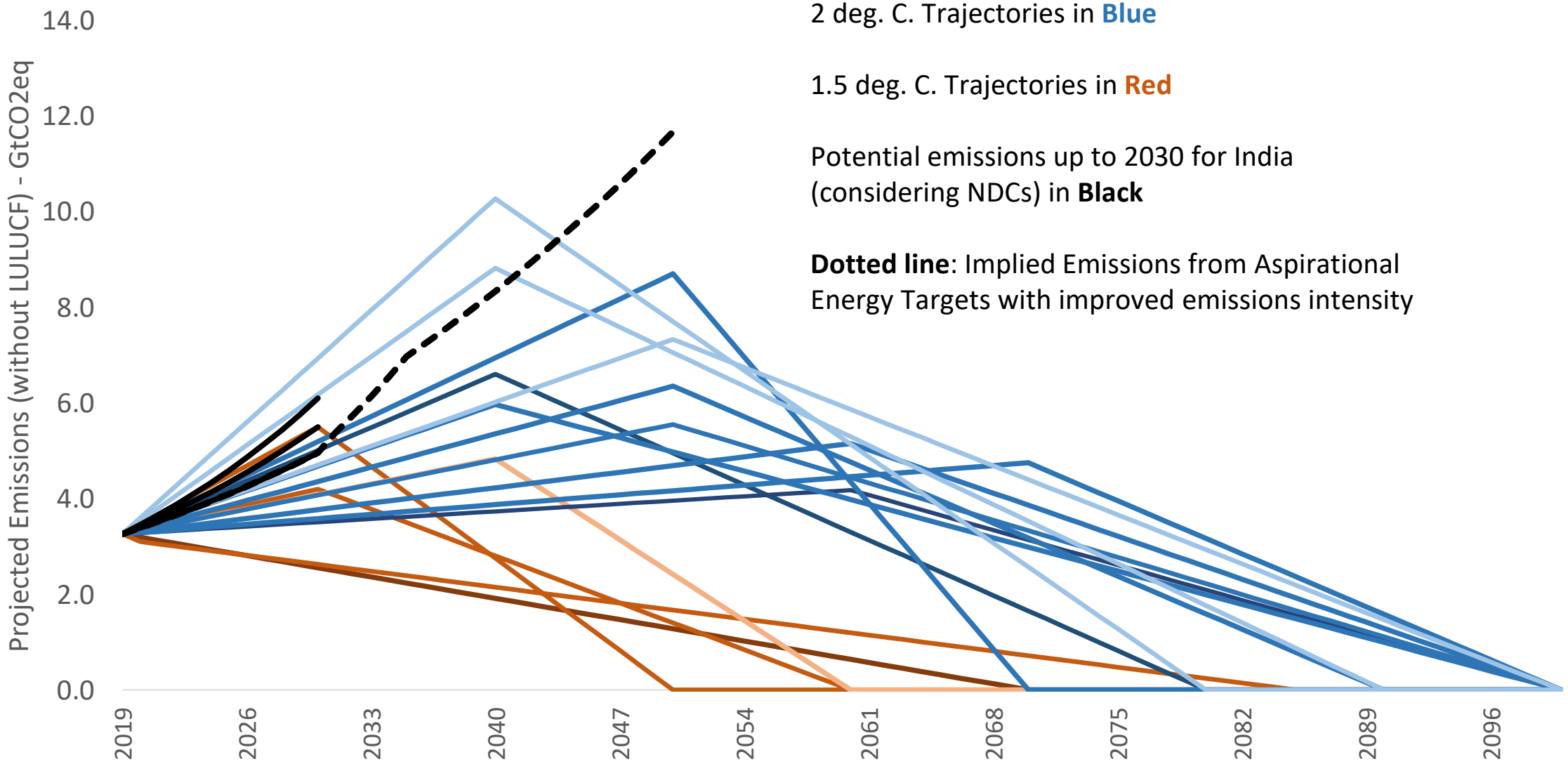
Energy – Some Basic Scenarios

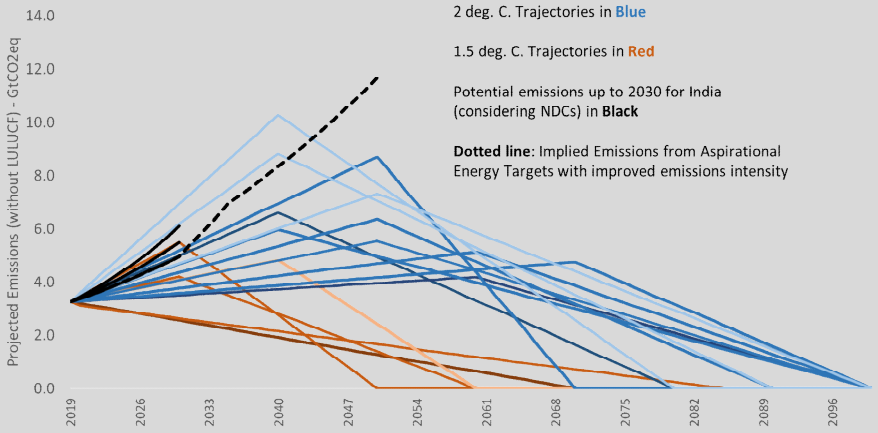
- Current per capita energy use = 23 GJ

- Aspirational goals for 2035 and 2050 (not just eradication of poverty but well-being and decent work for all)

2016	2035	2050
23	70	120
23	85	240
23	100	320

- Even if we take the lower end….
  - 23 → 70 → 120


2 deg. C. Trajectories in Blue
1.5 deg. C. Trajectories in Red
Potential emissions up to 2030 for India (considering NDCs) in Black
Dotted line: Implied Emissions from Aspirational Energy Targets with improved emissions intensity
Projected Emissions (without LULUCF) - GtCO2eq
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
2019
2026
2033
2040
2047
2054
2061
2068
2075
2082
2089
2096



All Values in GtCO2	Considering full historical responsibility	Considering only what is remaining for the future (Grandfathering)	Future availability weighted with historical responsibility
India's Fair Share of the Remaining Global Carbon Budget (83% probability of 2 deg. C, 33% probability of 1.5 deg. C	503	166	241
India's Emissions for an Aspiration energy target of 120 GJ per person by 2050	220-236		

The challenge is significant….

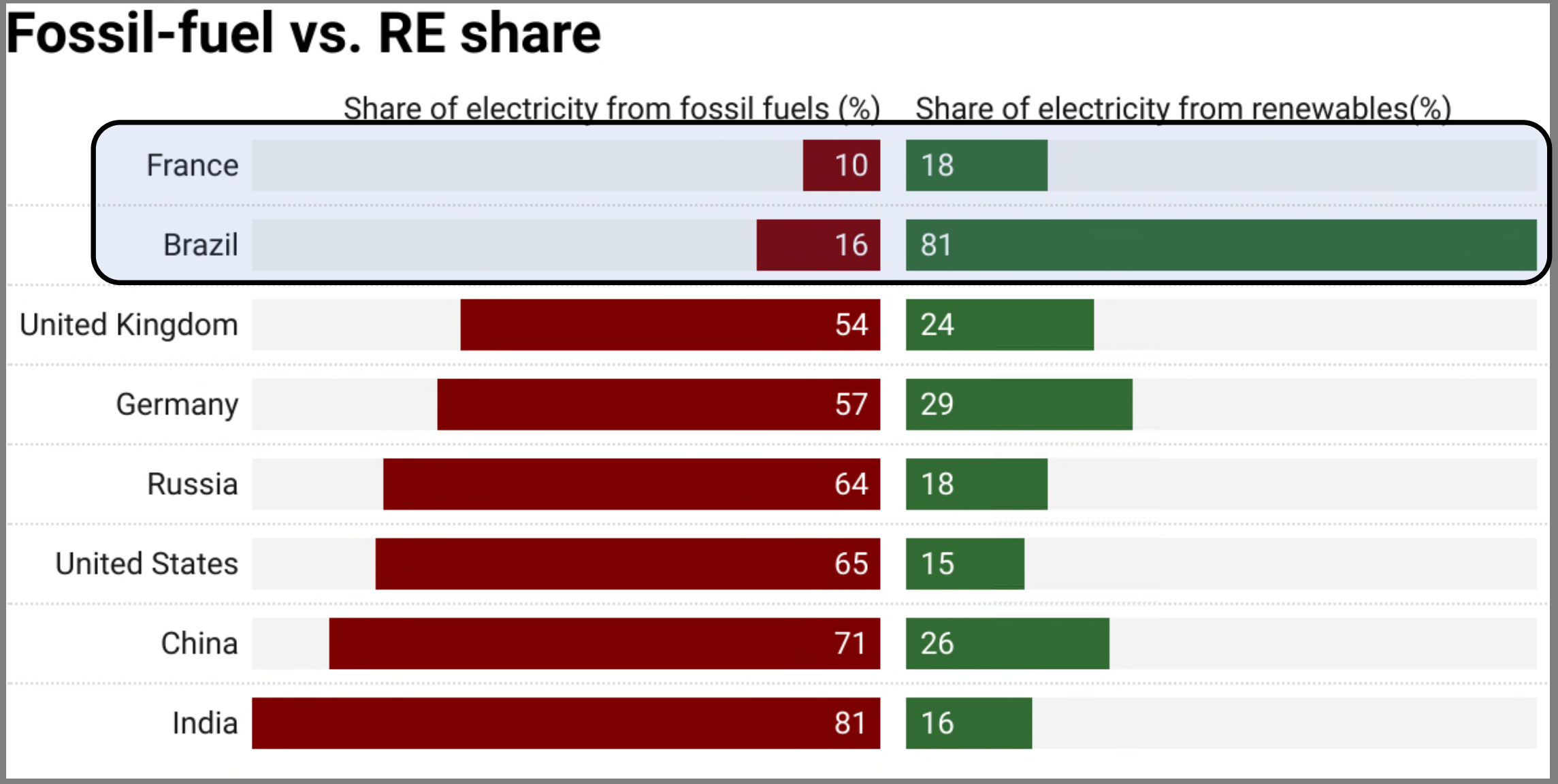
Ambitious targets for RE currently

- 175 GW from RE (without large hydro) by 2022
  - 100 GW from solar
  - 60 GW from wind

450 GW by 2030 – domestic target for now

- COVID-19 impact
- Storage? Energy security?

Fossil-fuel vs. RE share



RE Generation

As of 31 May 2021

Total RE capacity - ~95 GW

- **Solar → 40.5**
- Wind → 39.4
- Biomass → 10.3
- SHP → 4.8

- Developed countries transition from coal to gas
- India installed more RE in 2018 than Germany

2018 Capacity [GW]	Total Installed Capacity	Solar PV	Wind
India	364	32	35
Germany	198	45	59

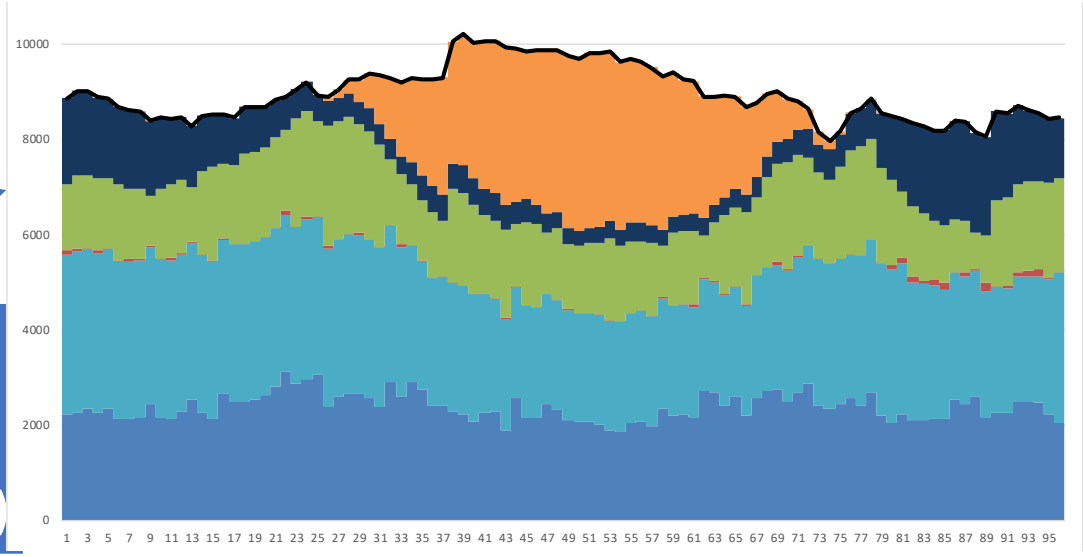
New RE Addition in 2018:

India = 12 GW (10 Solar and 2 Wind)

Germany = 6 GW (3 Solar and 3 Wind)

Not without Cost

Southern India (50% of RE installed capacity)	Avoided Cost of Carbon ($/ton)	Total Financial Burden (Million USD)
Karnataka	1.91	227
Telangana	4.51	200
Tamil Nadu	1.92	286
Andhra Pradesh	2.92	350



Over and above a carbon tax (coal cess) of ~ $ 4.5/tCO2

Additional burden of grid integration of VRE
→ ¢ 1.11/kWh: balancing cost
→ ¢1.5/kWh: stranded capacity cost
→ Totaling: ¢ 3.04/ kWh

High cost of energy

	Average Per Capita GNI ($/person/year)	Residential Electricity Charge (¢/kWh)	Industrial (¢/kWh)	Commercial (¢/kWh)
California (USA)	35046	19	12	15
Texas (USA)	29525	12	5	8
Karnataka(India)	2500	9 - 10	7 - 10	6 - 15
Tamil Nadu (India)	2800	6.5 - 9	6 - 9	6 - 11

Will new (cheaper) RE reduce costs?

Cost of RE

- RE costs have reduced… but
  - System costs, storage costs, required system inertia
    - PH storage vs. BESS, coal for balancing
  - Manufacturing capacity for RE, storage?
    - High import dependence (In 2019-20, India imported 796 million solar cells, panels, and modules, worth Rs. 11,899 crore in 2019-20, 78% from China)
  - Constraints on gas, hydro, nuclear
    - Gas unavailable, hydro is multipurpose
    - Nuclear -- financial and other constraints

Near term future of the power sector

- Clean coal
  - Progressive retirement of older plants: based on performance parameters (including environmental)
  - New investment focus on clean coal (SC, USC, AUSC)
  - Focus on air pollution (more than mitigation)
- RE capacity phased increase based on capacity to absorb while enhancing manufacturing capabilities
- Storage and balancing → domestically available resources (hydro can play a key role)

Why Equity is Important for India…and other developing countries ….. As we head to COP 26

The challenge is huge (cannot be emphasized enough)

Pressurizing India to do more– inequitable and unjust

India urgently needs to focus on development -- Important for adaptation (>1.5 deg. C world)

Not enough to say more needed by low-income countries conditional on finance (What is the record on this? Will it lead to green debt?)

Differentiation still relevant – less developed countries some flexibility (with adequate action). Track record of developed country inaction on multiple fronts

Measure action using equity as the basis. Only possible way forward that does not put the burden of saving the world disproportionately on the backs of the poor.