Decarbonizing Transport

under a coal-heavy Indian electricity grid

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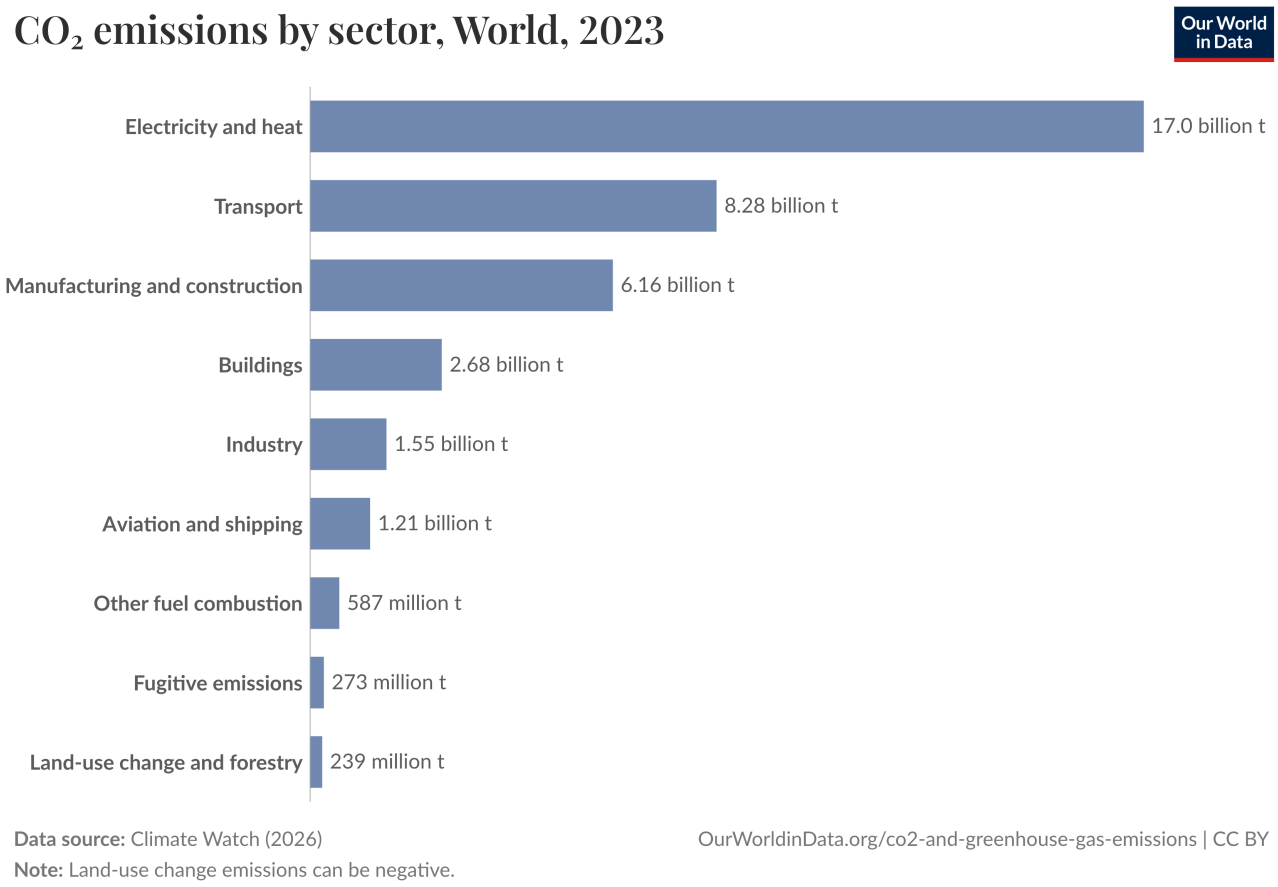
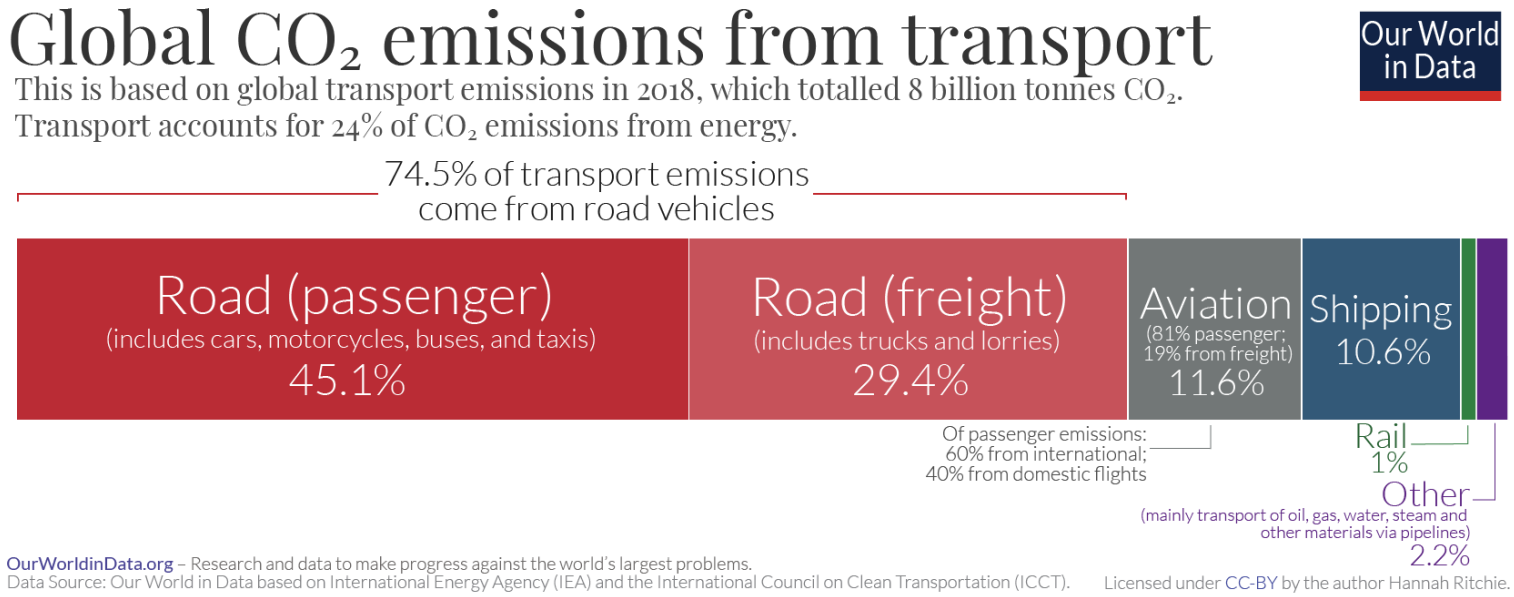
Transport sector is a huge carbon source

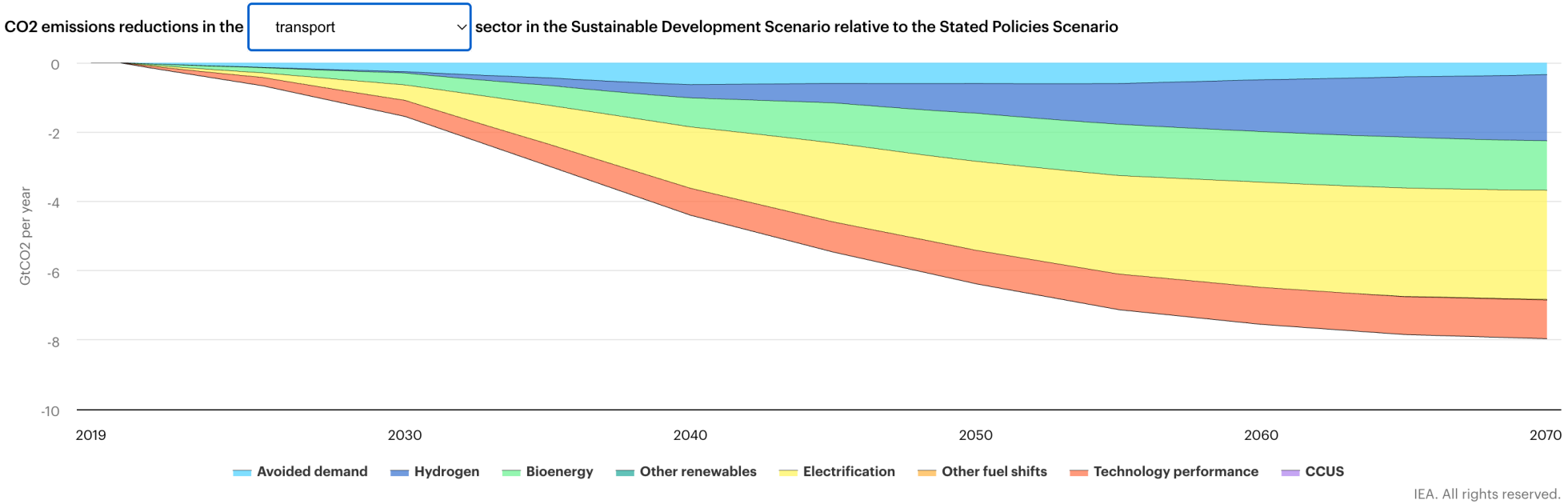


Where do transport emissions come from?



Global passenger-km to double, car ownership up 60% by 2070 (IEA, 2020)

We seem to have a solution in electrification!

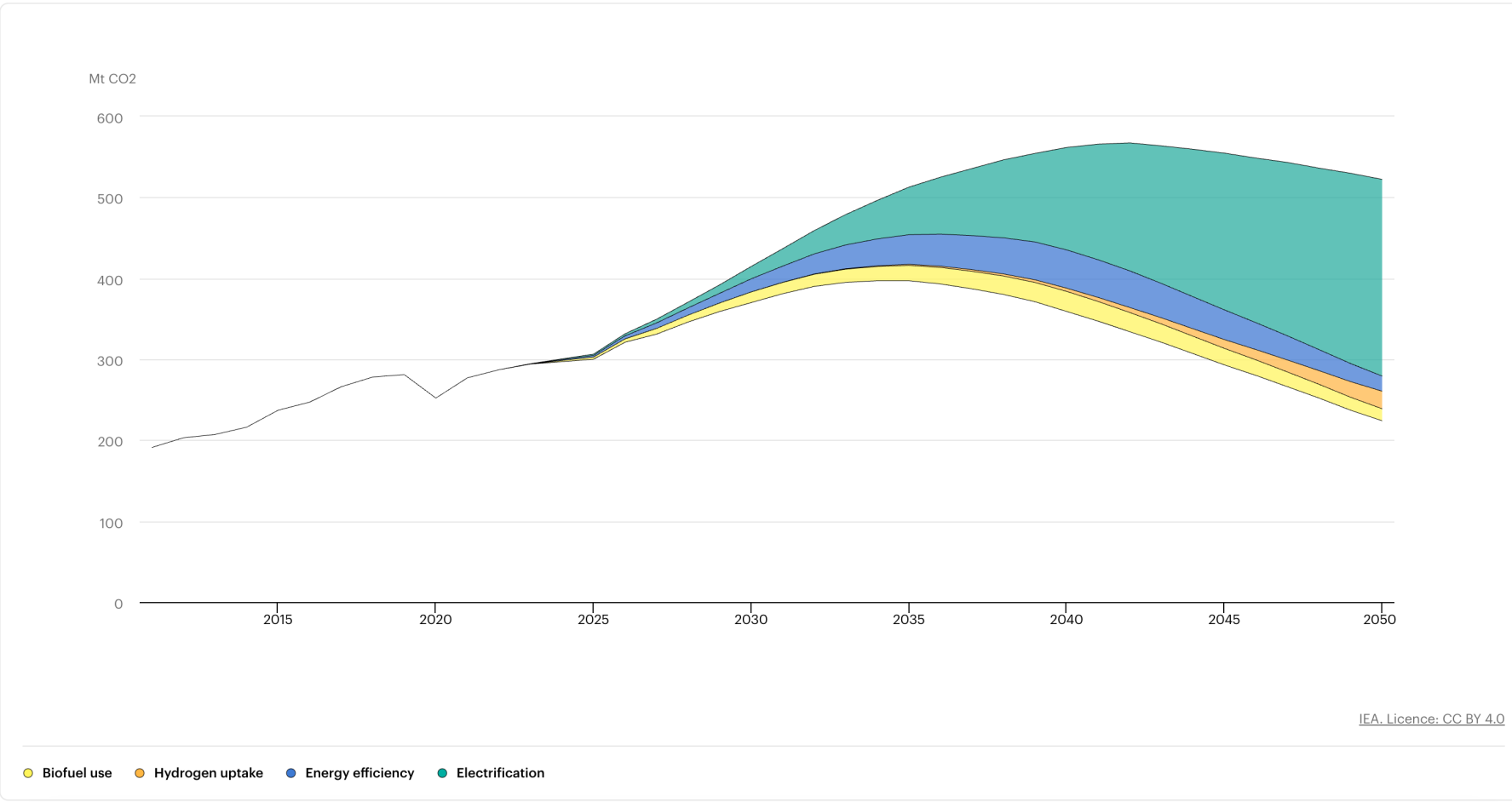


Cumulative emissions reductions, 2020-2070

In the sustainable development scenario, operational and technical innovations unlock energy efficiency gains in the short to medium term, while switching to low-carbon fuels and electric powertrains drives emissions reductions in the long term.

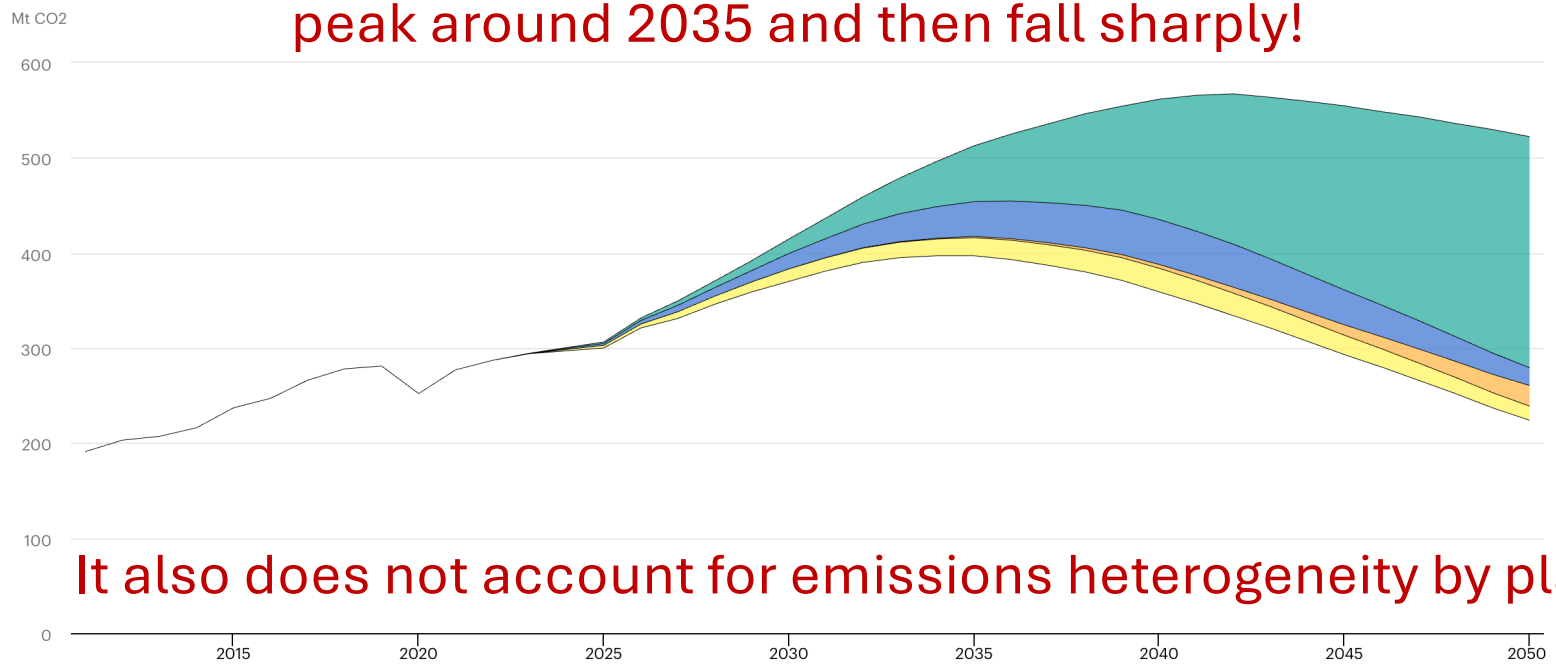
Transport emissions reductions in IEA optimistic scenario

India (IEA Transitioning India's Road Transport Sector Report, 2023)



But do we really have a solution?

This graphic assumes indirect power sector emissions peak around 2035 and then fall sharply!

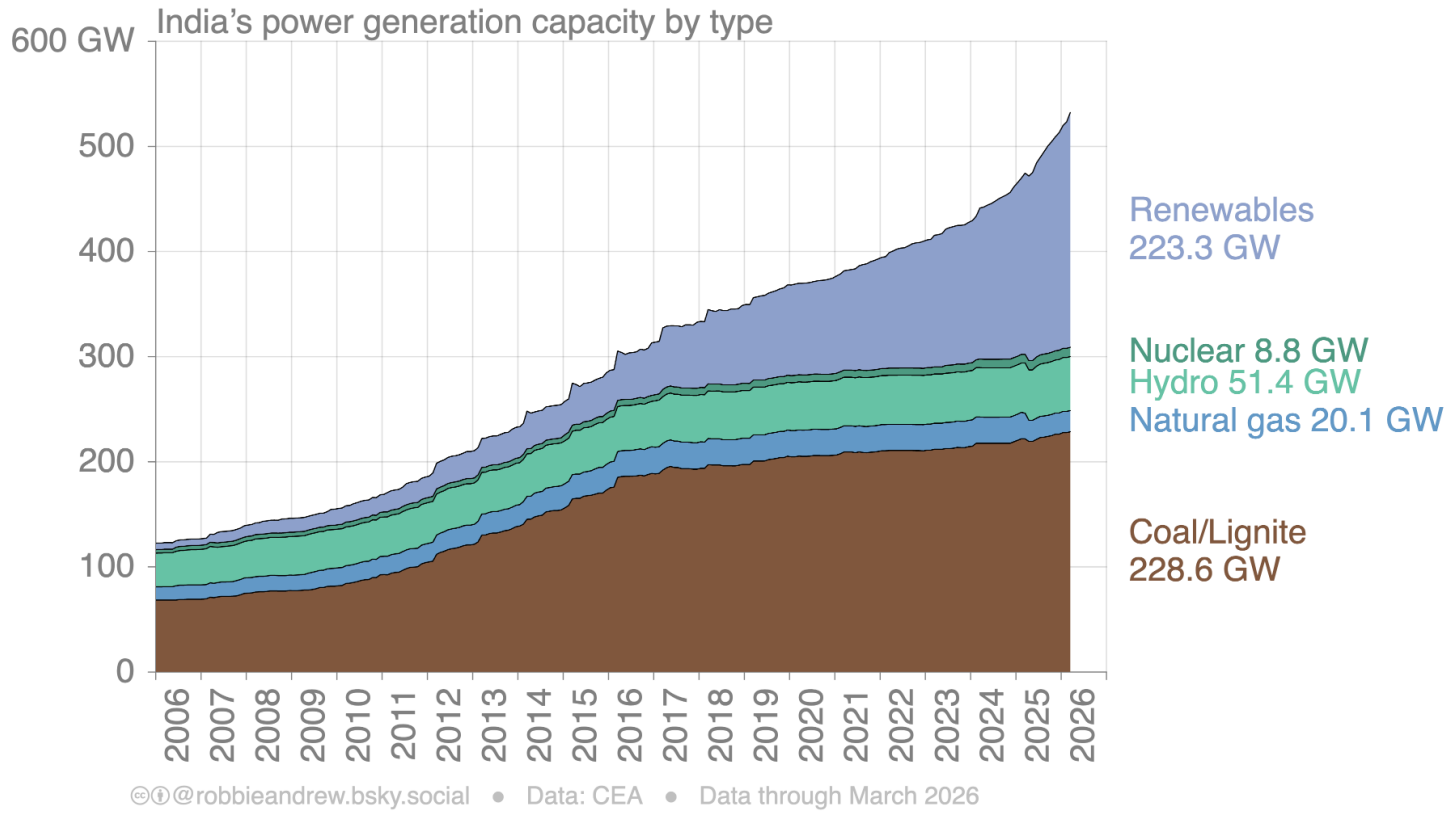


It also does not account for emissions heterogeneity by plant!

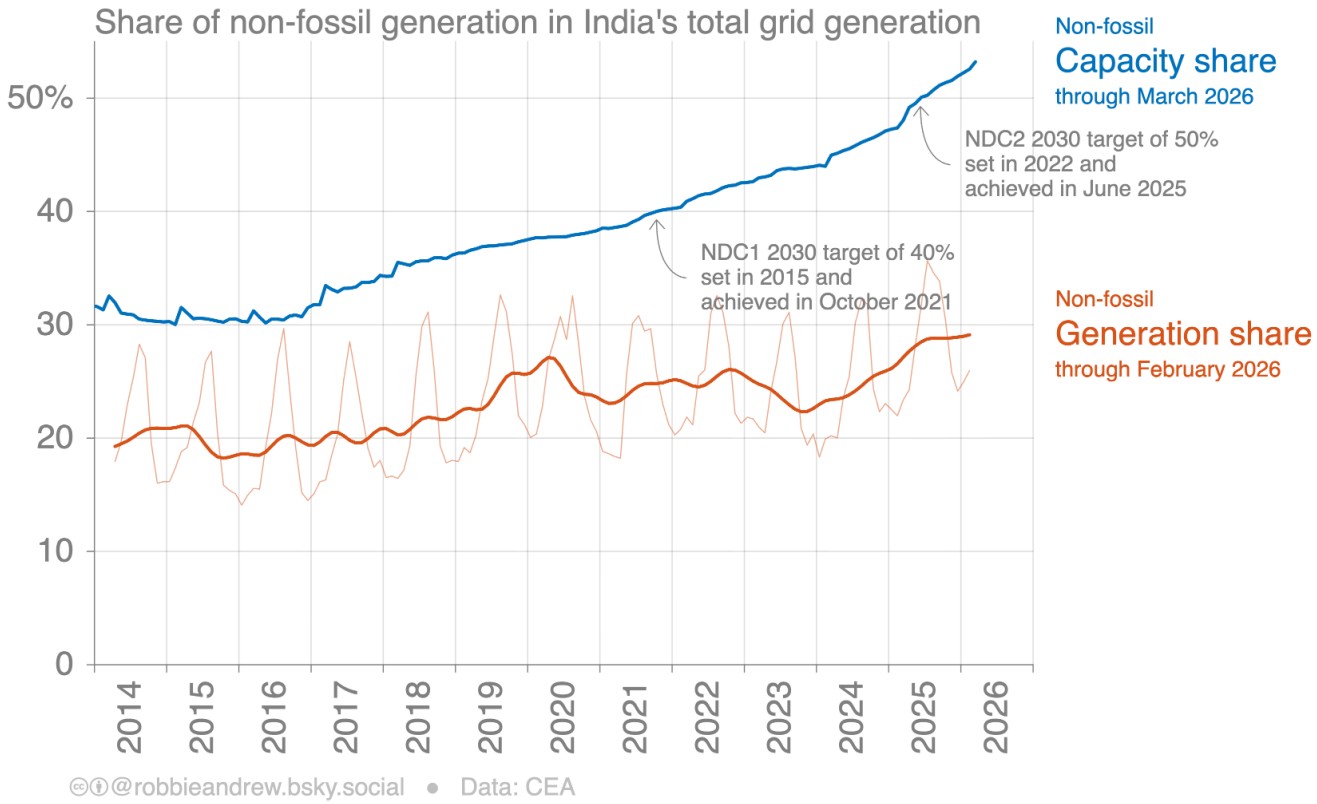
IEA. Licence: CC BY 4.0

Biofuel use · Hydrogen uptake · Energy efficiency · Electrification

Renewable capacity has increased dramatically

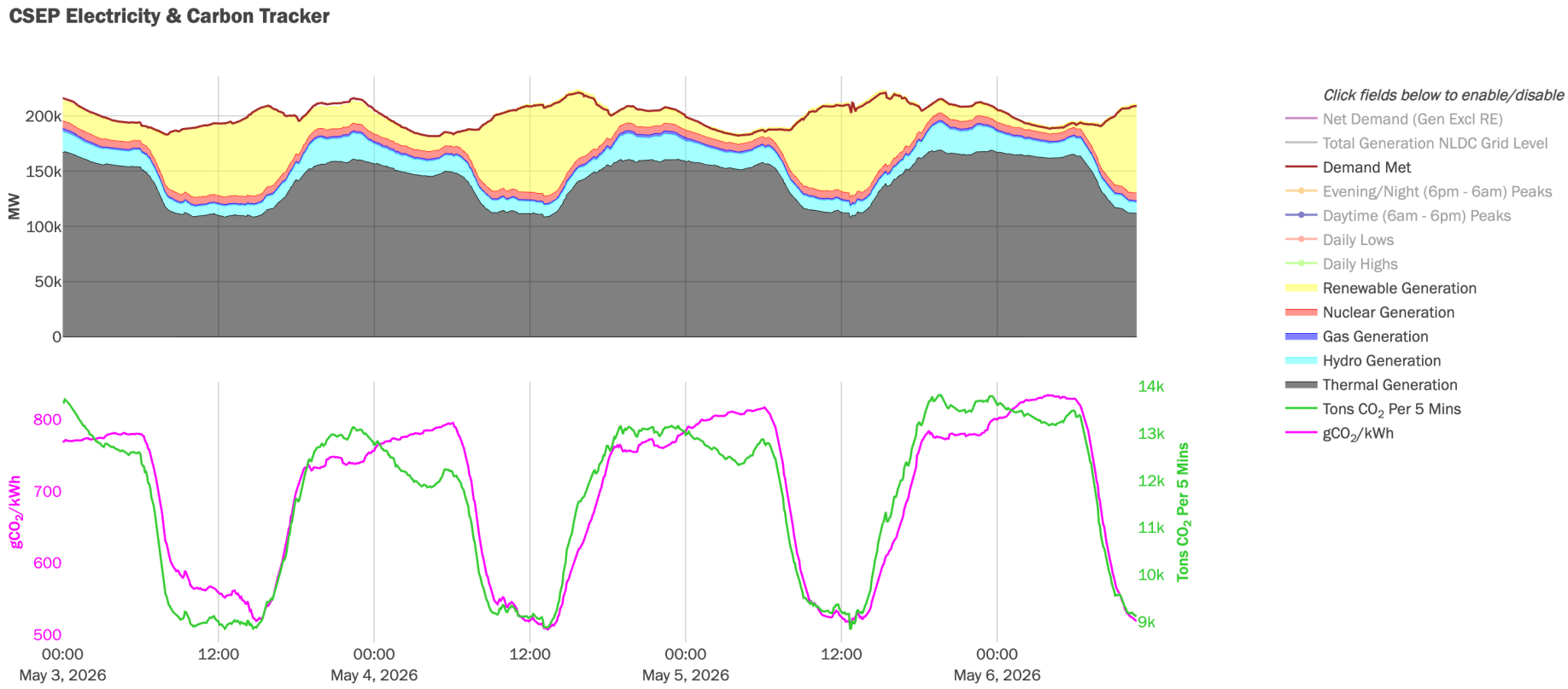


But penetration does not equate generation



Indian grid is projected to remain coal-dominated for a few decades

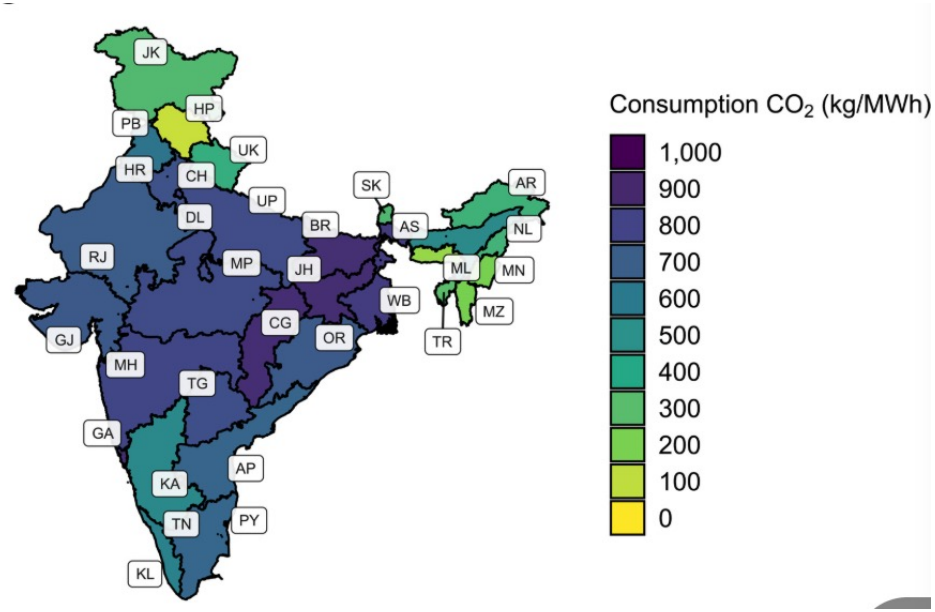
Marginal emissions vary a lot within day

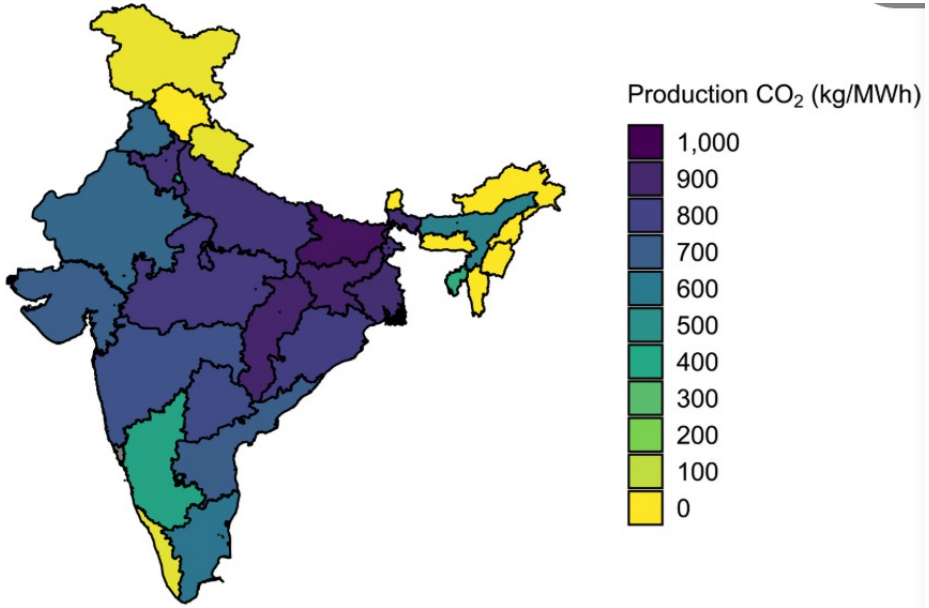


Using average emissions factors can understate emissions!!

Source: Underlying Data from MERIT India

Marginal emissions vary a lot across plants





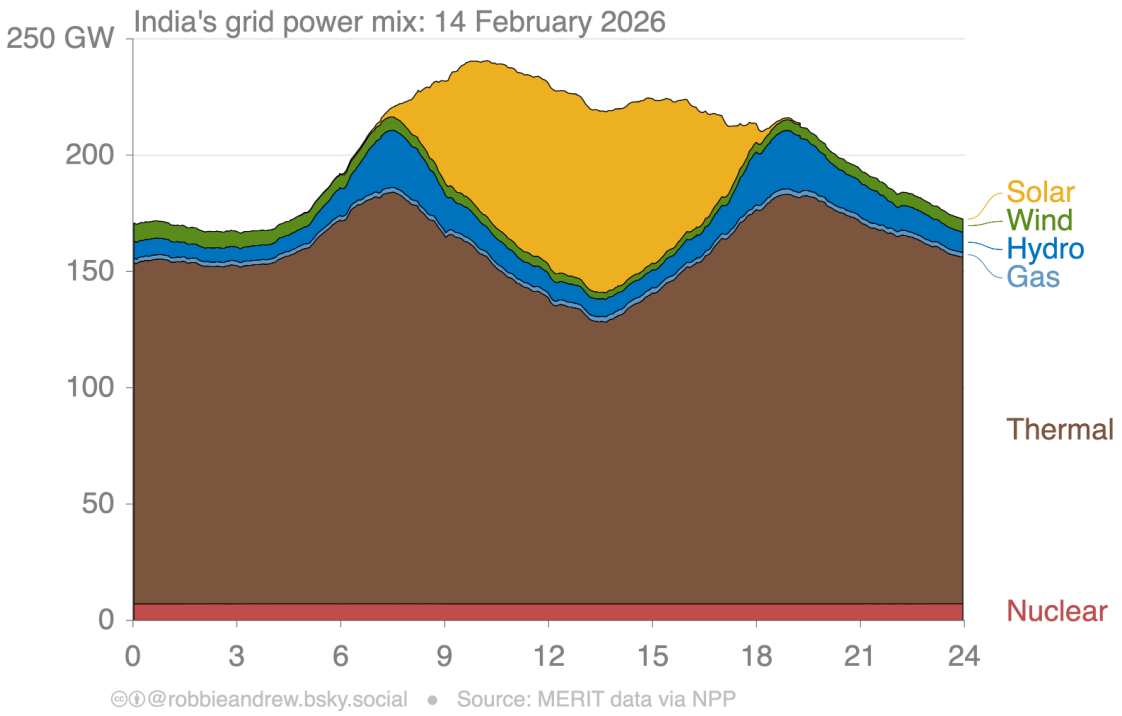
If EVs made up 30% of pkm today => 1000–2000 annual pollution-related additional deaths
(Peshin et al 2024, who do not fully account for marginal emissions heterogeneity)

EVs will not deliver decarbonization anytime soon

- Highest EV charging load is at night, when coal dominates
- Difficult to change power systems to keep pace with EV adoption
- By 2035, EVs are predicted to consume 6-9% of India's total electricity

- Demand response (DR): shifting load away from peak
- Our proposal: incentivize shift of some EV charging toward midday using time-of-day tariffs.

Can EVs utilize within-day solar peak?



Research questions:

1. Can subsidizing EV charging during peak solar hours shift when consumers charge?
2. What are the decarbonization / pollution co-benefits?

RCT to measure elasticity of EV charging demand by time-of-day

- (1) Work with Charging Point Operators (CPOs) to subsidize EV charging prices
  - EV adoption has been fastest in 2W/3W, but we will largely get 4W
  - Recruit repeat sample of users for deeper dive into DR behavior
  - Can inform EV ToD tariffs that some discoms have proposed

- (2) Measure decarbonization (“additionality”) through modeling

- Conduct parallel survey of EV users to understand baseline behavior (income, charging behavior etc.)

Future agenda

Battery swapping

- Commercial 2/3-wheelers can swap batteries during day
- We may need to focus on when batteries are charged

Public transport (EV buses)

- New EV bus acquisitions in recent years: Delhi (2,800), Bengaluru (4,500), Hyderabad (2,000), and Ahmedabad (1,000)
- Huge operational challenge to decarbonize

Long-distance trucking/aviation/shipping

- Technological challenges exist