

Cleaner Grid, Higher Emissions?

India is producing a cleaner MWh - but a lot more of them

India's weighted-average grid emission factor declined from 0.774 tCO₂/MWh in FY2013-14 to 0.675 tCO₂/MWh in FY2025-26, while renewable generation rose almost six-fold. The system is clearly getting cleaner per unit of electricity. The harder question is whether carbon intensity is falling quickly enough to overpower demand growth.



0.675

tCO₂/MWh - FY2025-26 weighted-average grid emission factor

310.58 BU

Renewable generation in FY2025-26

1,189 Mt

Power-sector CO₂ in FY2025-26

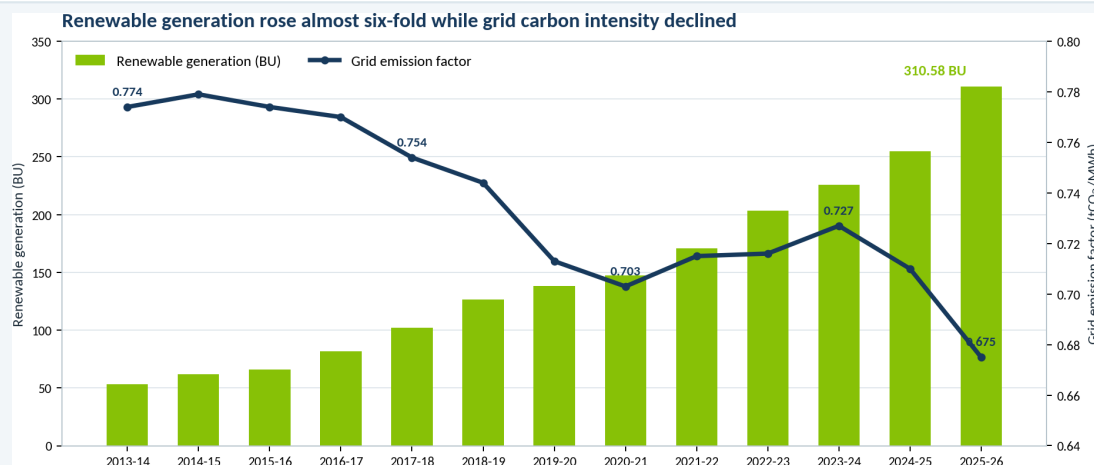


Exhibit 1. Thirteen-year movement in grid emission factor and renewable generation.

The direction of travel is unambiguous: India's electricity is becoming less carbon intensive. Renewable generation has grown from 53.06 BU to 310.58 BU, while the weighted-average emission factor has fallen by about 13%. That is a material structural shift in the power mix. It means every average MWh supplied today carries less CO₂ than it did a decade ago.

But the electricity system has also become much larger. Economic growth, urbanisation, cooling, industrial demand and the early stages of transport electrification are all increasing electricity consumption. The practical decarbonisation question is therefore not whether renewables are working - they are - but whether clean generation is scaling quickly enough to reduce absolute fossil generation as total demand rises.

“Decarbonisation is a race between a falling emission factor and a growing electricity system.”

What changes the story?

Carbon intensity tells us how much CO₂ is emitted per MWh. Absolute emissions depend on that intensity multiplied by the number of MWh generated. A cleaner unit of electricity does not automatically guarantee lower total emissions if the grid is expanding rapidly.

The core test is not only “Is the grid cleaner?” but also “Is it becoming cleaner faster than it is becoming larger?”

Cleaner intensity. Larger system.

Why absolute CO₂ can rise even while every MWh becomes cleaner

The apparent paradox disappears when emissions are decomposed into activity, generation mix and conventional-generation intensity. Demand growth pushes emissions upward; renewable substitution and efficiency improvements pull them down.

01 / THE ARITHMETIC

$$\text{CO}_2 = \text{Electricity generation} \times \text{Grid emission factor}$$

More electricity generation increases the potential emissions base. A lower emission factor reduces the CO₂ attached to each MWh. Both effects occur simultaneously, so a falling grid factor can coexist with higher absolute emissions.

Firstgreen's decomposition separates the growth in activity from changes in generation mix and conventional-plant carbon intensity. This is more useful than asking only whether emissions rose or fell.

METHOD IN BRIEF

The decomposition attributes the observed change analytically. It does not imply that the three components act independently.

1. Activity effect

A larger economy and more electrified end uses increase electricity supplied, raising the emissions baseline unless the grid cleans faster.

2. Generation-mix effect

Renewable generation displaces part of conventional output. The more clean generation is delivered at fossil-heavy hours, the larger the carbon benefit.

3. Conventional intensity

Plant efficiency, dispatch, fuel mix and utilisation determine the emissions of the remaining fossil MWh.

02 / EMISSIONS BRIDGE

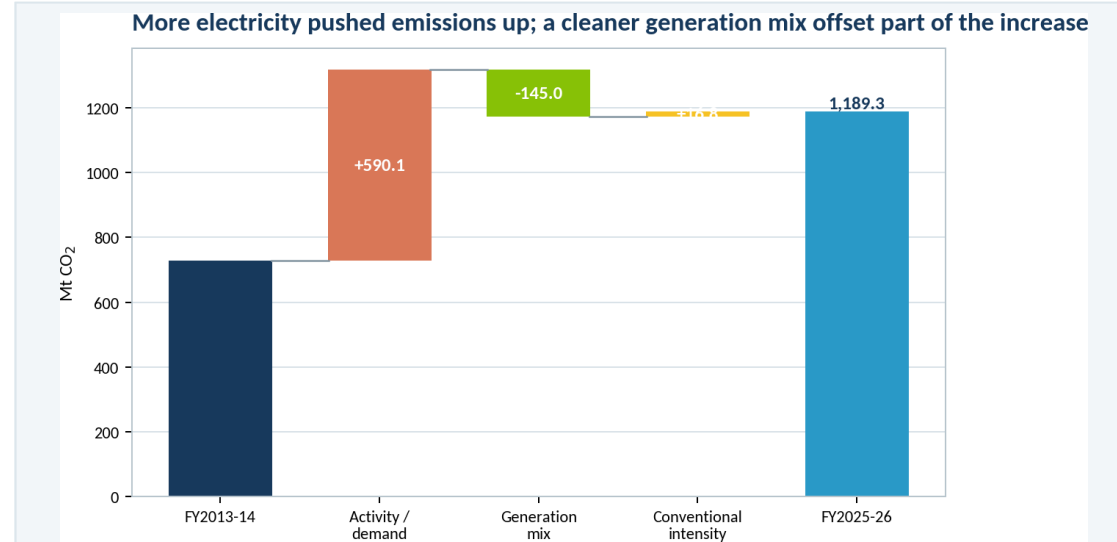
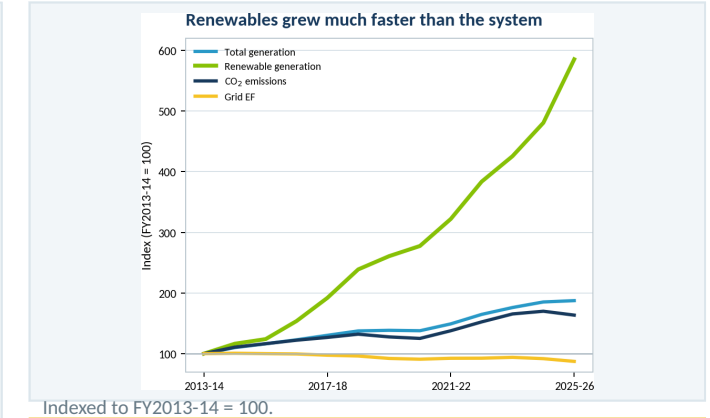


Exhibit 2. Firstgreen decomposition of the change in power-sector CO₂.

03 / WHAT GREW FASTEST?



Renewables are working. Demand growth is simply working in the opposite direction.

India's power-sector decarbonisation challenge is increasingly about **netting two opposing forces**: demand growth and carbon-intensity decline.

The emissions that did not happen

What India's renewable build-out may already have avoided

A historical trend shows what happened. A counterfactual asks what emissions might have been if the same electricity demand had been served by a more carbon-intensive grid. The answer reveals the value of the intensity improvement already achieved.

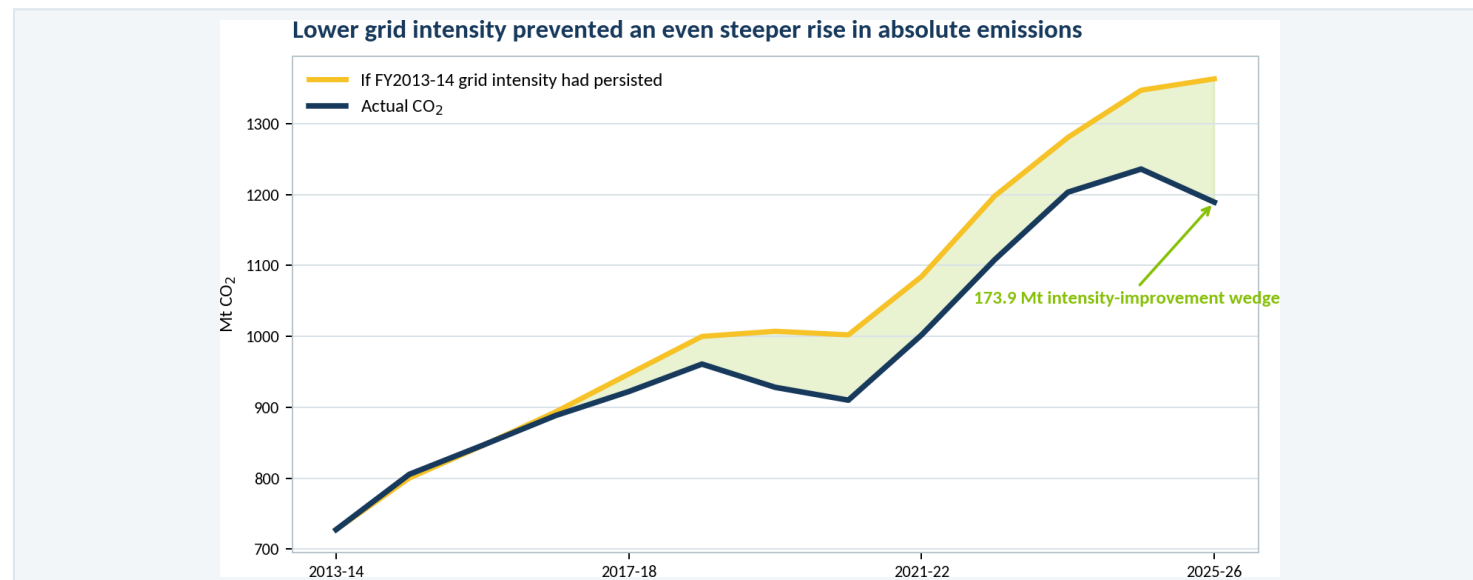
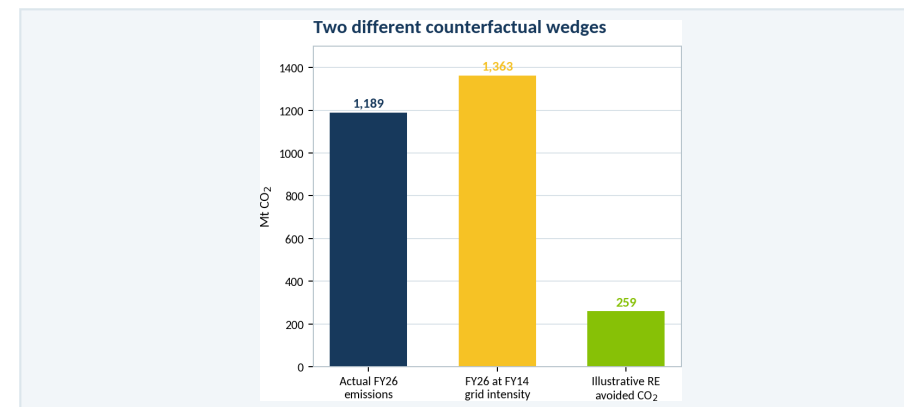


Exhibit 3. FY2025-26 actual emissions compared with a constant-FY2013-14-intensity counterfactual. If FY2025-26 generation had carried the FY2013-14 grid emission factor of 0.774 tCO₂/MWh, total emissions would have been materially higher than observed. The difference is the carbon-intensity improvement wedge. It captures the combined influence of cleaner generation mix, fossil-plant efficiency and dispatch changes.

This wedge should not be labelled entirely as “renewable avoided emissions”. Renewable generation is a major contributor, but the average grid factor also reflects efficiency, dispatch and fuel-mix changes across the conventional fleet.



Illustrative renewable displacement range.

Why a range?

Avoided emissions depend on which conventional plant is displaced, at what hour, and with what losses or curtailment. Average and marginal emission factors answer different questions.

The next renewable MWh is most valuable when it displaces a high-carbon MWh.

This is why the value of storage, transmission and demand flexibility increases as renewable penetration rises: they improve the timing and location of clean generation, not merely its annual volume.

Renewable growth has already created a large carbon benefit; the next step is to maximise **fossil displacement per clean MWh**.

The next 100 BU matters more

How fast must the grid clean up to outrun electricity-demand growth?

Future emissions are determined jointly by electricity growth and the speed of grid decarbonisation. The same renewable programme can deliver very different carbon outcomes depending on how quickly total demand expands.

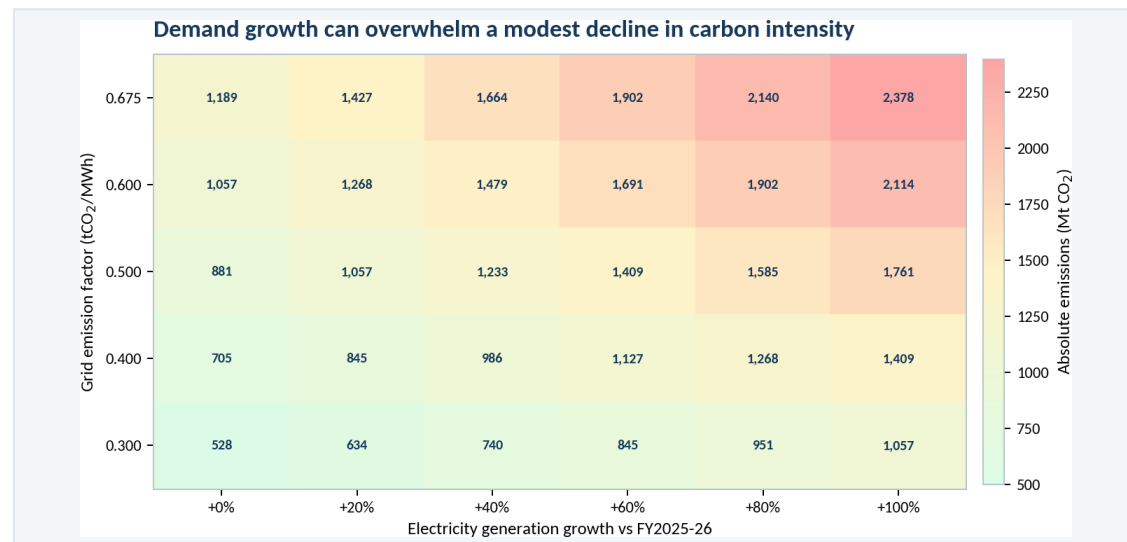
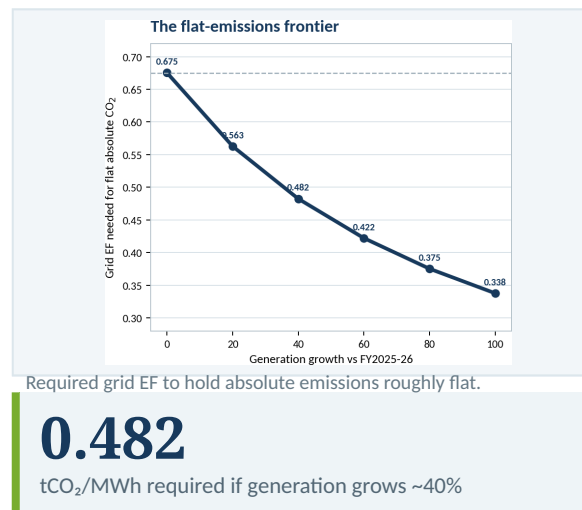


Exhibit 4. Absolute CO₂ under alternative demand-growth and grid-intensity combinations. The sensitivity matrix converts decarbonisation into a physical constraint. If FY2025-26 generation grows by 40% while the grid factor remains at 0.675 tCO₂/MWh, absolute emissions rise sharply. To keep total power-sector CO₂ roughly flat, the average grid factor needs to fall to around 0.482 tCO₂/MWh. At 60% generation growth the threshold falls further, to roughly 0.422.

This relationship becomes more important as electricity takes a larger role in mobility, buildings and industry. Electrification can reduce economy-wide fossil use, but it also moves more energy services onto the power system. A faster-growing electric economy therefore raises the value of faster grid decarbonisation.



What planners should watch

- Clean generation delivered, not only capacity commissioned.
- Fossil generation displaced in energy and peak hours.
- Transmission access and storage that reduce curtailment.
- Demand flexibility that shifts load toward clean supply.
- Grid EF trajectory alongside electrification growth.

Capacity is potential.

Generation is actual output. Carbon reduction ultimately depends on what fossil MWh is no longer produced.

The practical implication is that renewable targets should increasingly be paired with outcome metrics: renewable BU delivered, carbon intensity of the grid, peak fossil requirement and avoided conventional generation. The next 100 BU of clean electricity matters most when it reaches the system at the hour and location where fossil generation would otherwise run.

A cleaner grid is not enough. It must become **cleaner faster than demand becomes larger**.

Electrification changes the equation

The carbon benefit of moving from molecules to electrons compounds as the grid decarbonises

Firstgreen's sectoral analysis indicates that electricity can take a substantially larger role across transport, buildings, agriculture and industry. That makes the carbon quality of every incremental MWh increasingly important.

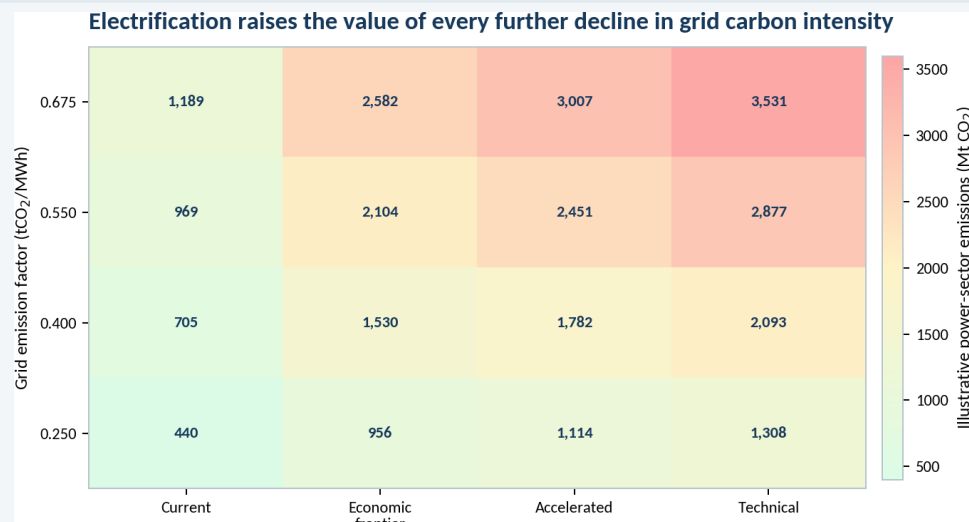
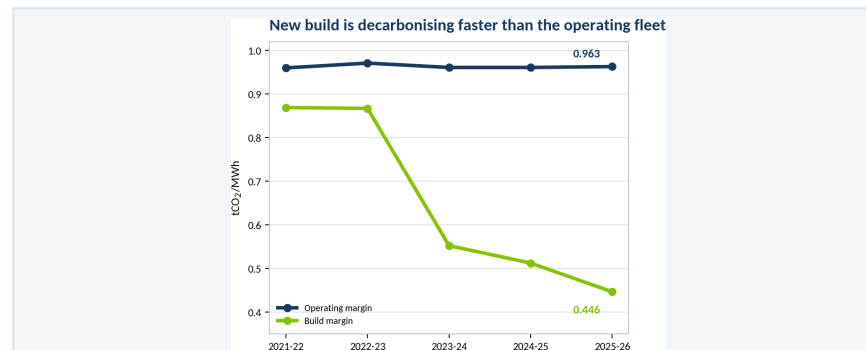


Exhibit 5. Power-sector emissions under alternative electrification and grid-intensity pathways.

Firstgreen's sectoral electrification analysis suggests an economic electrification frontier of about 63.5%, rising toward 75.2% in an accelerated case, with a technical ceiling near 88%. The important result is not a single national percentage, but the sectoral sequence: light mobility and pumping move first; cooking and low-temperature heat follow; heavy freight and high-temperature industry remain more difficult.

Electrification also changes the denominator. At the economic frontier, roughly 304 Mtoe of non-electric final energy is displaced while only about 177 Mtoe of additional electricity is required in the model. Efficient electric technologies therefore raise electricity demand while reducing total final-energy demand.

The emissions outcome increasingly depends on the grid. Every EV, electric pump, heat pump and industrial electric process becomes cleaner as the grid factor falls. Electrification and grid decarbonisation are reinforcing transitions, not separate policy tracks.



Build margin is decarbonising faster than the operating fleet.

Light mobility

High readiness and strong efficiency gain from EV drivetrains.

Industry

Motors and low-temperature heat move first; high-temperature processes remain harder.

Buildings

Cooking and low-temperature heat have substantial potential.

Agriculture

Electric pumping can displace direct diesel use efficiently.



Two transitions at once

Clean the electrons - and move more of the economy onto them.

India's next decarbonisation phase is two transitions at once: **clean the electrons - and move more of the economy onto them.**