

In-Depth Analysis: CO₂ Emissions from Transport

1. Full-Series Trend (1970–2024): The Rise and “Bending” of the Curve

Emissions from the Transport sector have grown nearly eight-fold, from ~44 Mt CO₂eq in 1970 to ~344 Mt CO₂eq in 2024. This rise is a direct proxy for India’s story of expanding mobility, vehicle ownership, and freight. However, unlike other major sectors, the transport story is not one of endless acceleration. Instead, it is a more hopeful narrative of peak growth followed by a significant, policy-driven “bending” of the growth curve.

2. Breakpoint Detection: The Rise and Fall of Peak Growth

The analysis identifies three critical breakpoints—1987, 2004, and 2017—that chart the sector’s course. The piecewise model fits the data extremely well (Adjusted R² of 0.994), and the resulting slopes [0.7, 2.9, 13.9, 6.8] reveal a fascinating arc of growth and moderation.

Regimes 1 & 2: 1970–2003 (The Awakening)

- **Slopes: 0.7 and 2.9**
- The first two regimes show the sector awakening. The 1987 break marks the beginning of accelerated growth, likely tied to the expansion of domestic automotive manufacturing and a growing consumer base in the post-liberalization economy.

Regime 3: 2004–2016 (The Golden Age of Vehicle Growth)

- **Slope: 13.9**
- The 2004 break kicks off an era of explosive growth, with the slope increasing by an incredible 380%. This was the golden age for vehicle sales in India, fueled by a booming economy, rising middle-class aspirations, and massive investment in road infrastructure (like the Golden Quadrilateral). This 13-year period represents the peak of carbon-intensive mobility growth.

Regime 4: 2017–2024 (The Deceleration)

- **Slope: 6.8**
- This is the most crucial insight for the transport sector. The 2017 break marks a **major structural deceleration**, with the growth rate of emissions being **cut in half** compared to the prior regime. This slowdown is significant and sustained.
- **Inference:** This is likely the result of a confluence of powerful factors:
 - **Policy Impact:** The transition to stricter fuel efficiency norms (BS-IV to BS-VI) has had a measurable effect.

- **Economic Factors:** Events like the 2016 demonetisation and subsequent shifts in the automotive market may have tempered peak growth.
- **Infrastructure Shift:** The expansion of metro rail networks in major cities and the initial, though small, penetration of electric vehicles are beginning to make a dent.
- The 2020 break is also statistically significant, but the post-COVID rebound, while strong, has settled onto this new, lower-growth trajectory rather than returning to the pre-2017 boom.

3. Piecewise & ARIMA Insights: Statistical Confirmation of a Slowdown

The dramatic drop in the slope from 13.9 to 6.8 is the clearest statistical evidence of a structural change. While the final regime's **ARIMA(0, 2, 1)** model still indicates a strong underlying trend ($d=2$), the *magnitude* of this trend has been successfully curtailed.

4. Forecast & Future Implications

The forecast, based on this moderated final regime, projects emissions will reach **~420 Mt CO₂eq by 2034**. This is a **~22% increase** over the next decade. While still a significant rise in absolute terms, this rate of growth is substantially lower than that projected for the Power and Industrial sectors, reflecting the impact of the post-2017 slowdown. The wide confidence intervals on the forecast also suggest higher uncertainty, reflecting the recent volatility and the ongoing transition in the sector.

5. Core Data-Backed Conclusions

- **Peak growth is likely over:** Unlike other heavy sectors, the transport sector's emissions growth appears to have peaked in the 2004–2016 period.
- **Policy and market forces are working:** The significant deceleration since 2017 is a strong sign that fuel efficiency standards, public transport infrastructure, and economic factors are successfully “bending the curve” and tempering emissions growth.
- **The post-COVID rebound was moderate:** The sector did not snap back to its old, high-growth trajectory, providing further evidence that the post-2017 slowdown is a real structural change.
- **A qualified success story:** While absolute emissions are still rising and remain a challenge, the transport sector is a prime example of how a combination of policy, technology, and market forces can successfully decouple growth from emissions growth, offering a potential roadmap for other sectors.