

## In-Depth Analysis: CO<sub>2</sub> Emissions from Buildings

### 1. Full-Series Trend (1970–2024): The Story of a Sleeping Giant Awakening

For decades, CO<sub>2</sub> emissions from India's building sector followed a remarkably stable and predictable path. Growing from ~34 Mt CO<sub>2</sub>eq in 1970 to ~210 Mt CO<sub>2</sub>eq in 2024, the sector's emissions footprint has expanded six-fold. However, the most compelling part of this story is not the long-term growth, but the dramatic shift that has occurred in the post-pandemic era. This is the story of a "sleeping giant"—a historically steady, slow-growing sector that has suddenly awokened and entered a new phase of accelerated emissions.

### 2. Breakpoint Detection: A Tale of Two Very Different Eras

The analysis identifies only two breakpoints, **1975** and **2020**, which starkly divide the sector's history into two distinct eras. The model fits the data with high precision (Adjusted R<sup>2</sup> of 0.986).

The slopes of the regimes are [-0.4, 3.3, 7.3].

#### Regime 1 & 2: 1970–2019 (The Long Stability)

- **Slopes: -0.4 and 3.3**
- After a brief, noisy start, the sector entered a **45-year period of remarkably stable, linear growth**. The consistent slope of **3.3** from 1975 to 2019 reflects a steady, predictable increase in energy consumption tied to gradual urbanization, population growth, and the slow but steady adoption of electrical appliances and LPG for cooking. During this long period, the building sector was a reliable but not explosive source of emissions.

#### Regime 3: 2020–2024 (The Great Acceleration)

- **Slope: 7.3**
- The 2020 breakpoint, confirmed as **statistically significant (p-value approx 0.009)** by the Chow test, marks a dramatic shift. The growth rate of emissions has **more than doubled** in the post-COVID era.
- **Inference:** This "Great Acceleration" is a critical new development. It suggests that the pandemic and its aftermath have fundamentally altered energy consumption patterns in buildings. Likely drivers include:
  - **Increased Residential Use:** A surge in "work from home" and more time spent at home has increased residential electricity consumption.
  - **The Rise of Cooling:** This acceleration may be the first clear sign in the data of a non-linear increase in air conditioning adoption, a long-anticipated driver of emissions.
  - **A Construction Rebound:** A post-pandemic boom in real estate and construction activity would also contribute directly to this trend.

### **3. Piecewise & ARIMA Insights: A New Growth Paradigm**

The doubling of the slope post-2020 is the key takeaway. The final regime is modeled with an **ARIMA(2, 2, 0)** process. The second-order differencing ( $d=2$ ) confirms that this new, higher growth rate has strong momentum and is characteristic of an accelerating trend, not a temporary spike.

### **4. Forecast & Future Implications**

The forecast, driven by this new, higher-growth regime, projects that emissions will reach **~296 Mt CO<sub>2</sub>eq by 2034**. This represents a **~41% increase** over the next decade. While the absolute number is smaller than for Power or Industry, this *rate* of growth is a major cause for concern.

### **5. Core Data-Backed Conclusions**

- **A Paradigm Shift is Underway:** The building sector is no longer a “slow and steady” emitter. The post-2020 era has kicked off a new phase of accelerated growth.
- **The Post-COVID effect is real and significant:** Unlike a simple recovery, the pandemic appears to have triggered a lasting change in energy use, leading to a steeper emissions trajectory.
- **A New Emissions Frontier:** This acceleration is a warning sign. As demand for space cooling and electricity in buildings continues to rise, this sector is poised to become a much more significant driver of India’s total emissions. The “sleeping giant” has awoken.