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Briefing Note: BESCOM's CARBON EMISSIONS AND ENERGY MIX: TRENDS AND INSIGHTS (FY18-FY24)

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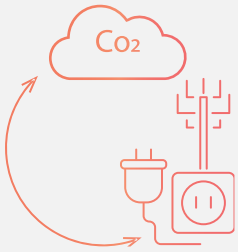

Introduction

This report establishes a distribution licensee-specific CO2 emission tracking methodology, leveraging the Central Electricity Authority's power plant-wise CO2 database for fiscal years 2017-18 to 2023-24. By aggregating and allocating emissions based on power procurement and distribution patterns, this analysis provides a granular view of Scope 2 emissions associated with individual licensees. The resulting dataset aims to serve as a standardized and readily accessible resource for policymakers, grid operators, and entities mandated to report their environmental footprint, facilitating informed decision-making and accurate emissions disclosure.

Key Findings

- In FY 2023-24, BESCOM's weighted average emission factor of 0.71 tCO_2/MWh was close to the national average (0.72 tCO_2/MWh), highlighting the need for further emission reduction efforts.
- BESCOM experienced a 29.66% rise in absolute annual CO_2 emissions from FY 2017-18 to FY 2023-24, primarily due to increased coal consumption.
- In FY 2023-24, fossil fuel-derived energy sources constituted 70% of BESCOM's overall energy supply.
- BESCOM's thermal capacity fluctuated from 4,827 MW in FY 2017-18 to a peak of 6,246 MW in FY 2019-20, before settling at 5,623 MW in FY 2023-24.
- Hydro procurement fell sharply from 5,506.35 GWh in FY 2021-22 to 1,956.36 GWh in FY 2023-24, with available hydro capacity dropping from 1,695 MW to 824 MW.
- Renewable energy procurement increased from 19% in FY 2017-18 to 25% in FY 2023-24, with solar and wind playing a key role.
- During the COVID-19 pandemic, BESCOM experienced a significant reduction in its emissions, with an approximate 25% decrease in FY 2020-21. This decline was primarily attributed to lower electricity consumption and a greater incorporation of renewable energy sources during the pandemic-related restrictions. However in FY 2022-23, emissions saw an approximate 47% increase, largely due to an increased reliance on coal-based power generation to satisfy the growing electricity demand post-pandemic.

Energy Sources

Fossil-based energy procurement has consistently been the primary energy source for BESCOM, accounting for approximately 61% of its total procurement across all five years.

The energy generation portfolio of BESCOM over the years reflects a gradual yet significant transition towards renewable energy, while maintaining a substantial reliance on fossil fuels such as coal and lignite. The analysis highlights evolving trends and challenges, emphasizing BESCOM's strides in diversifying its energy mix.

Authors: Ria Jain
Reviewer: Akanksha Galagali, Raghav Nandakumar, Santhosh Velu
Designer: Vimal Bhojraj
Auroville Consulting

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Transition in Energy Mix

Analysis of BESCOM's energy procurement data from FY 2017-18 to 2023-24 indicates a clear shift toward renewables. While fossil fuels dominated at 75% in FY 2017-18, renewable energy, particularly solar, steadily grew from 19% to 27% by FY 2023-24. This shift underscores BESCOM's consistent efforts to integrate cleaner energy sources while addressing the growing energy demands of Karnataka.

Thermal Energy Trends

Thermal capacity and procurement trends highlight the continued importance of thermal energy for BESCOM, with coal contributing an average of 55% and lignite 5% to the energy mix from FY18 to FY24. These trends are shaped by factors such as plant capacities, policy shifts, and the integration of renewable energy sources. In FY 2017-18, with an available capacity of 4,827.30 MW, coal based energy procurement procurement stood at 18,670.33 GWh, and lignite based energy procurement at 2,202.33 GWh. Available capacity rose to 6,246.6 MW in FY 2019-20, but coal procurement dropped to 16,562.61 GWh, reflecting reduced thermal utilization amidst growing renewable energy adoption. During FY 2020-21, a decline in thermal plant capacity by 5,401.1 MW, driven by the pandemic, led to reduced procurement of coal (13,565.86 GWh) and lignite (1,355.19 GWh). By FY 2023-24, available thermal capacity increased to 5,623.00 MW (4.10%), with coal procurement peaking at 27,049.59 GWh (99.41%) and lignite at 1,964.58 GWh (44.94%), driven by delayed renewable integration and economic factors.

Hydro Energy Procurement

Hydro procurement has shown significant impact, with hydropower contributing an average of 8% to BESCOM's energy mix between FY18 and FY24. Notably, this share surged to 17% during FY 21-22. In FY 2020-21, hydro procurement saw a significant increase to 4,607.41 GWh, supported by an available capacity of 1,266.43 MW, which marked a substantial rebound after earlier fluctuations. Favourable monsoon conditions in FY 2021-22 further boosted hydro procurement to 5,506.35 GWh, with an expanded available capacity of 1,695.52 MW, representing the peak of hydro performance during the period under review. However, subsequent years experienced a downward trend, driven by reduced water availability and capacity cuts. By FY 2023-24, hydro procurement had dropped sharply to 1,956.36 GWh, with the available capacity reduced to 824.71 MW, emphasizing the challenges in maintaining stable hydro generation amid fluctuating environmental and operational factors.

Renewable Energy Adoption

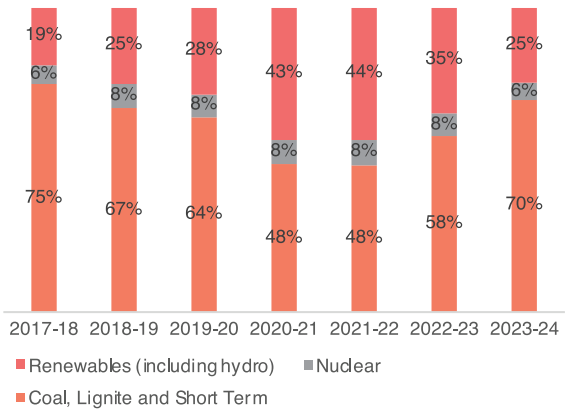
BESCOM'S commitment to renewable energy is evident in its Renewable Purchase Obligation (RPO) achievements, reflecting substantial investments in solar and wind energy. Between FY 2018-19 and FY 2022-23, solar procurement consistently surpassed targets. For instance, in FY 2019-20, BESCOM was required to procure 7.25% solar energy and 12% non-solar energy, but it exceeded these targets, achieving 15.25% and 13.18%, respectively.

BESCOM has also diversified its portfolio with nuclear energy and short-term procurement to meet demand fluctuations, ensuring grid stability. However, challenges in storage capacity, grid integration, and transmission infrastructure remain. Strategic interventions in these areas will be critical for accelerating the shift towards a low-carbon energy mix and aligning BESCOM's operations with national and global climate goals.

Table 1: Procurement by fuel type (GWh/year)

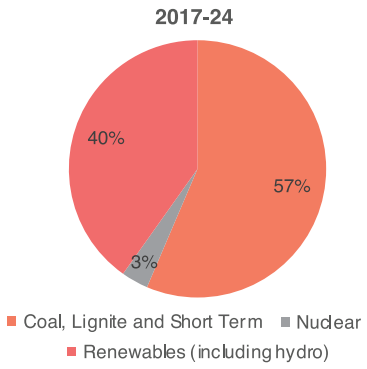
By fuel type	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Coal	18,670	18,874	16,563	13,566	16,882	20,163	27,050
Short term/others	2,433	1,722	2,612	-437	-3,465	-2,080	1,140
Lignite	2,202	1,424	1,532	1,355	1,863	1,647	1,965
Nuclear	1,992	2,649	2,458	2,485	2,591	2,623	2,404
Hydro	1,796	789	1,097	4,607	5,506	3,059	1,956
Wind	2,851	3,402	3,235	3,053	3,118	3,035	2,764
Solar	1,209	3,402	4,826	5,242	5,074	5,759	6,044
Biomass	63.88	892.60	70.32	91.59	101.35	64.59	30.28
Total	31,217	32,960	32,393	29,963	31,670	34,271	43,352

Figure1: Procurment by fuel category (%)



From 2018-19 to 2023-24, the total change in electricity generation by fuel type has varied significantly. The cumulative change in generation across all sources during this period is 12,135.29 GWh. The share of different fuel types in this total change is as follows: Coal, Lignite, and Short-Term sources contributed 6,847.68 GWh (56.4%), Nuclear contributed 412.56 GWh (3.4%), and Renewables (including hydro) contributed 4,875.05 GWh (40.2%).

Figure 2: Increase in power demand by fuel source (%)



CO2 Emissions By Fuel Type

BESCOM's emissions have rebounded sharply post-pandemic, with coal and lignite surpassing pre-COVID-19 levels, signaling a renewed dependence on fossil fuels.

BESCOM's greenhouse gas (GHG) emissions, measured in tonnes of CO_2 equivalent (tCO_2e), reflect significant changes between FY 2017-18 and FY 2023-24, shaped by evolving energy procurement patterns and the energy mix.

In FY 2017-18, total emissions stood at 23.59 million tCO_2e, with coal-based energy procurement contributing 18.55 million tCO_2e (79% of total emissions). Over the next two years, emissions declined to 20.63 million tCO_2e (12% of total emissions) by FY 2019-20, driven by reduced reliance on coal and increased adoption of renewable energy.

During the COVID-19 period in FY 2020-21, CO_2 emissions dropped upto 27% reaching 15.03 million tCO2e. This decline was primarily driven by decreased electricity demand and an increased share of renewable energy in BESCOM's energy mix.

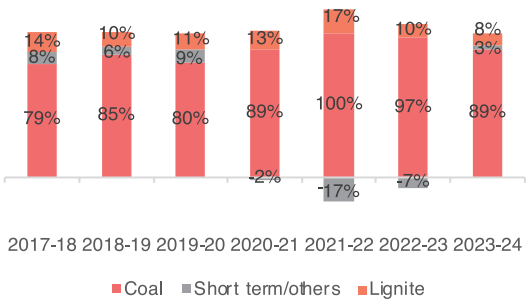
Post-pandemic recovery saw a resurgence in emissions, with total emissions reaching 21.25 million tCO_2e in FY 2022-23 and peaking at 30.60 million tCO_2e in FY 2023-24, the highest recorded during the period. Coal remained the dominant contributor, accounting for 27.22 million tCO_2e (89% of total emissions) in FY 2023-24, while lignite emissions rose to 2.56 million tCO_2e from a pandemic low of 2.03 million tCO_2e in FY 2020-21.

Table 2: CO2 emissions by fuel type (Million tonnes CO2/year)

By fuel type	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Coal	18.55	18.57	16.51	13.32	14.50	20.52	27.22
Short term/others	1.83	1.28	1.86	-0.31	-2.48	-1.49	0.83
Lignite	3.22	2.11	2.29	2.03	2.44	2.22	2.56
Nuclear	0	0	0	0	0	0	0
Hydro	0	0	0	0	0	0	0
Wind	0	0	0	0	0	0	0
Solar	0	0	0	0	0	0	0
Biomass	0	0	0	0	0	0	0
Total	23.60	21.96	20.66	15.04	14.46	21.26	30.60

The negative values observed in BESCOM's "Short term/others" emissions category during FY 2020-21 (-2.04%), FY 2021-22 (-17.14%), and FY 2022-23 (-7.00%) indicate a net reduction in emissions from these sources. This trend can be attributed to BESCOM's evolving power procurement strategy, which involved decreased reliance on high-emission short-term power purchases and adjustments such as power buybacks or reduced procurement from costly thermal sources. Additionally, BESCOM growing renewable energy capacity, particularly in solar and wind, played a significant role in offsetting fossil fuel-based power during these years. Regulatory policies, grid stability measures, and fluctuations in electricity demand also influenced power scheduling, reducing dependence on short-term thermal power. These factors collectively contributed to the observed negative emission values reflected in Figure 3, highlighting BESCOM's shift toward cleaner enery sources

Figure 3: Share of CO2 emissions by fuel source (%)



CO2 Emissions Intensity

Fossil-based energy continues to be the predominant energy source

The weighted average emission factor for BESCOM's power supply has exhibited a dynamic trend over the years. In FY 2017-18, the emission factor stood at 0.76 tCO_2/MWh, gradually declining to 0.67 tCO_2/MWh in 2018-19 and 0.64 tCO_2/MWh in 2019-20, indicating initial progress in reducing emissions. A sharper decline was observed in 2020-21 (0.50 tCO_2/MWh) and further in 2021-22 (0.46 tCO_2/MWh), driven by increased renewable energy adoption.

However, from 2022-23 onwards, the emission factor began rising again, reaching 0.62 tCO_2/MWh and further climbing to 0.71 tCO_2/MWh in 2023-24. This shift was due to an increased reliance on coal-based generation and reduced availability of renewables. Despite an overall 6.58% reduction in emission intensity from 2017-18 to 2023-24, BESCOM's latest emission factor (0.71 tCO_2/MWh) is now approaching the national weighted average of 0.727 tCO_2/MWh (CEA, 2022).

Figure 4: BESCOM weighted average emission factor (tCO2/MWh)

Among the three fuel types in BESCOM's portfolio, lignite consistently exhibits the highest specific consumption, primarily due to its lower calorific value, which necessitates greater fuel input for the same amount of electricity generation. Lignite's specific consumption ranged from 1.30 tCO_2/MWh in FY 2023-24 to 1.50 tCO_2/MWh in FY 2019-20, significantly surpassing that of coal and short-term/other sources. Coal's specific consumption ranged between 0.86 tCO_2/MWh in FY 2021-22 to 1.02 tCO_2/MWh in FY 2022-23, while short-term/other sources demonstrated relatively lower values, ranging from 0.72 tCO_2/MWh in FY 2020-21 to 0.75 tCO_2/MWh in FY 2017-18. These patterns highlight lignite's higher fuel requirements compared to coal and other procurement sources, emphasizing its impact on BESCOM's emissions.

While coal-based power remains relatively stable, with slight fluctuations influenced by supply conditions and efficiency improvements, and short-term sources show minimal variation, lignite consumption has gradually decreased from its peak of 1.50 tCO_2/MWh in 2019-20 to 1.30 tCO_2/MWh In FY 2019-20, renewable energy procurement averaged 36.75%, reflecting a shift toward cleaner energy sources. Despite this decline, lignite remained the least efficient fuel, requiring the highest input per unit of electricity generated.

Table 3: Emission factor by fuel source (tCO2/MWh)

By fuel type	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Coal	0.99	0.98	1.00	0.98	0.86	1.02	1.01
Short term / others	0.75	0.74	0.71	0.70	0.72	0.72	0.73
Lignite	1.46	1.48	1.50	1.49	1.31	1.35	1.30

Table 4: Comparison of weighted average emission factor (tCo2/MWh)

By fuel type	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
India	0.75	0.74	0.71	0.70	0.72	0.72	0.72
BESCOM	0.76	0.67	0.64	0.50	0.46	0.62	0.71

Core Insights for BESCOM

BESCOM's energy procurement trends highlight the dynamic shifts in its energy mix, influenced by capacity changes, policy mandates, and economic factors. Hydro capacity has shown significant fluctuations, peaking in FY21-22 at 1,695.52 MW but declining sharply in FY23-24 to 824.71 MW, largely due to reduced water availability and capacity cuts. Similarly, thermal capacity has experienced variations, starting at 4,827.30 MW in FY17-18, peaking at 6,246.6 MW in FY19-20, and later fluctuating, reaching 5,623.00 MW in FY23-24. The decline in hydro capacity, coupled with shifts in thermal availability, has necessitated adjustments in procurement strategies to ensure grid stability. As BESCOM continues its renewable energy transition, addressing infrastructure challenges, optimizing thermal efficiency, and integrating energy storage solutions will be critical in balancing energy security and sustainability.

Recommendations

Mandate CO2 Emission Disclosure for BESCOM.

To reach our net-zero goals at both the local and national levels, it's vital that BESCOM publicly shares and reports its carbon dioxide emissions. This transparency will give consumers, policymakers, and investors the information they need to make smart choices. The state Energy Department should mandate that BESCOM uses a reporting system similar to what the Central Electricity Authority (CEA) uses in its CO2 Baseline Database for the Indian Power Sector. This would allow for more accurate reporting BESCOM's progress and easily compare it to other power distribution companies.

Set emission reduction targets for distribution licensees

Policymakers equipped with precise data on emission sources, volumes, and intensities can develop targeted regulations and incentives to accelerate the shift to a low-carbon future. Setting emission reduction targets for electricity utilities is crucial in addressing climate change, as these targets establish a clear pathway toward net-zero emissions. Ambitious goals push utilities to prioritize renewable energy adoption, driving transformative change across the sector.

Phase out the most polluting power plants

The coal-based power capacity of 2.1 GW and lignite-based capacity of 1.368 GW, sourced by BESCOM from power plants, have been in operation for over 20 years and are nearing the end of their useful life. These aging facilities, marked by low efficiency and high emissions, fail to meet the air and water quality standards set by the Ministry of Environment, Forests, and Climate Change. Retrofitting them to comply with these regulations would require significant investment, potentially leading to higher electricity tariffs. A comprehensive cost-benefit analysis, evaluating

alternatives such as repurposing or retrofitting both old and new coal power plants, is essential to assess feasibility and costs. Such an analysis would also help chart a strategic roadmap for phasing out the most polluting power plants while ensuring a sustainable energy transition.

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