Analysis of results analysis of hourly coal and solar power dispatch between Maharashtra and Karnataka with sand without solar transmission subsidy

Generator Dispatch (MW) – First 5 Hours

Snapshot	Karnataka Solar	Karnataka Coal	Maharashtra Solar	Maharashtra Coal
With Subsidy	1674.0	7000.0	864.0	1462.0
Without Subsidy	1674.0	3326.0	864.0	5136.0

Transmission Flows (MW)

Snapshot	Ka-Ma Solar Link	Ka-Ma Coal Link
With Subsidy	+1674.0	+2000.0
Without Subsidy	-2000.0	+2000.0

Total System Cost (₹)

- **With Subsidy: ₹ 60,92,64,000**
- **Without Subsidy: ₹ 59,00,64,000**

Insights:

1. Identical Generation but Directional Difference in Solar Flow

- **Karnataka Solar** generates **1674 MW** in both cases.
- The **solar link flow direction** changes:
    - **With Subsidy:** Positive flow (+1674 MW) → means **Karnataka is exporting** to Maharashtra and **Maharashtra pays the transmission fee**.
    - **Without Subsidy:** Negative flow (−2000 MW) → implies **Karnataka is importing** from Maharashtra's solar (hypothetical or modelling quirk depending on network structure or cost).

2. Coal Dispatch Adjusts Based on Subsidy

- **With Subsidy:** Karnataka Coal runs at **maximum capacity** (7000 MW), and Maharashtra Coal is minimized (1462 MW).
- **Without Subsidy:** Karnataka Coal drops to 3326 MW, while Maharashtra Coal ramps up to 5136 MW, likely due to **avoiding costly transmission of solar without subsidy**.

3. System Cost Higher With Subsidy

- Somewhat counterintuitively, **system cost increases** with subsidy.
    - This is because the **subsidy may encourage transmission of solar**, causing **extra flow**, and Karnataka needs to run **more expensive coal** to supply Maharashtra.
    - The model balances **local generation cost** and **transmission tariffs** to minimize total system cost—not just generator marginal costs.

Conclusion:

- **Subsidy encourages solar export**, which alters the power flow direction.
- The **system prefers local coal** in absence of subsidy due to **transmission penalties**.
- The **total system cost is not always lower with subsidies**—because encouraging long-distance solar transfers may require higher coal backup or suboptimal dispatch.

🔍 **Internal Coal Usage (First 5 Hours)**

State	Scenario	Coal Used Internally (MW)	Exported Coal (MW)	Imported Coal (MW)
Karnataka	With Subsidy	7000	**2000 (exported)**	0
	Without Subsidy	3326	**2000 (exported)**	0
Maharashtra	With Subsidy	**1462**	0	**2000 (imported)**
	Without Subsidy	**5136**	0	**2000 (imported)**

What This Means

Karnataka:

- **With Subsidy:**
    - Generates **7000 MW of coal**.
    - Exports **2000 MW** to Maharashtra.
    - Keeps **5000 MW for its own load**, matching its demand.
- **Without Subsidy:**
    - Only runs **3326 MW of coal**.

- Still exports **2000 MW**, implying Karnataka's own solar (1674 MW) + coal (1326 MW after export) is enough to meet its own 5000 MW demand.

Maharashtra:

- **With Subsidy:**
  - Generates **1462 MW of coal**.
  - Imports **2000 MW of coal** from Karnataka.
  - Meets its **total demand of 6000 MW** using:
    - Local solar: 864 MW
    - Local coal: 1462 MW
    - Imports (coal and solar): rest
- **Without Subsidy:**
  - Generates **5136 MW of coal locally** (much higher).
  - Still imports 2000 MW of coal, which might go into balancing due to solar cost structure.
  - This suggests Maharashtra reduces dependency on Karnataka's solar due to **transmission cost increase**, and uses **more local coal** instead.

Summary Insights

- **Subsidy makes Karnataka run coal at full capacity**, helping Maharashtra reduce its own coal use.
- **Without subsidy**, Karnataka reduces its coal generation, and **Maharashtra increases its own coal usage**, likely because **importing solar becomes more expensive**.
- In both cases, **coal flows from Karnataka to Maharashtra**, but **its need varies based on the economic incentive** (i.e., presence of subsidy).
