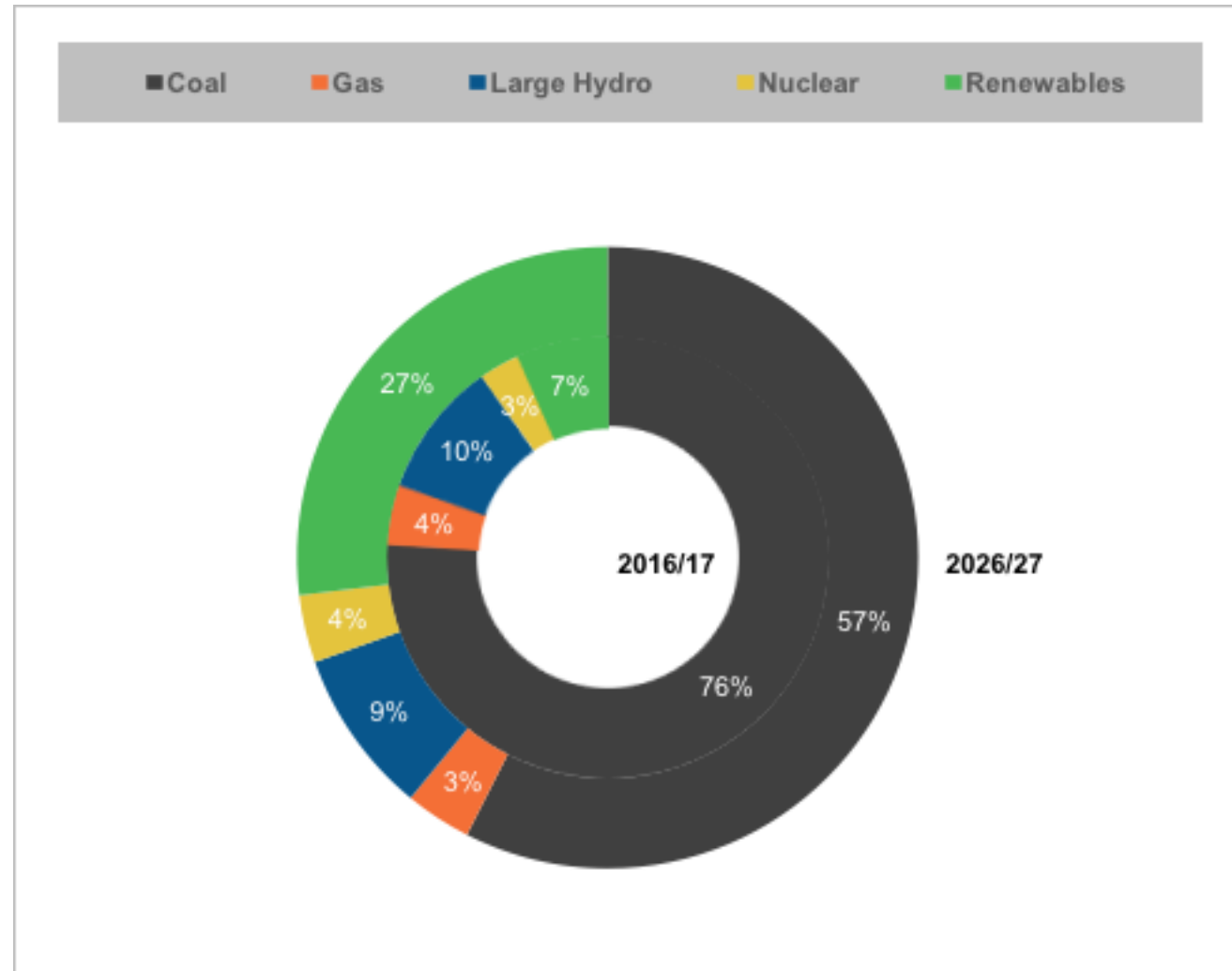


Challenges of Integrating 175 GW of Renewable Energy in India and Policy Options



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Overview of Power Generation

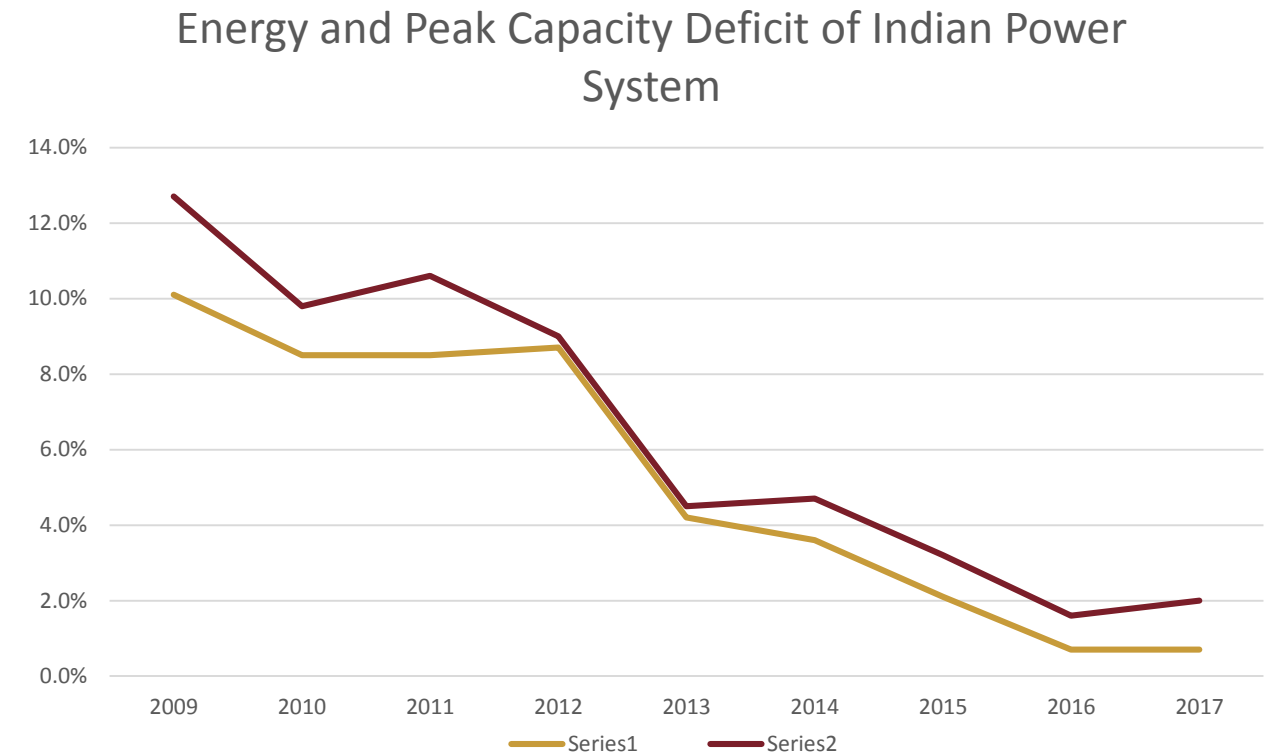
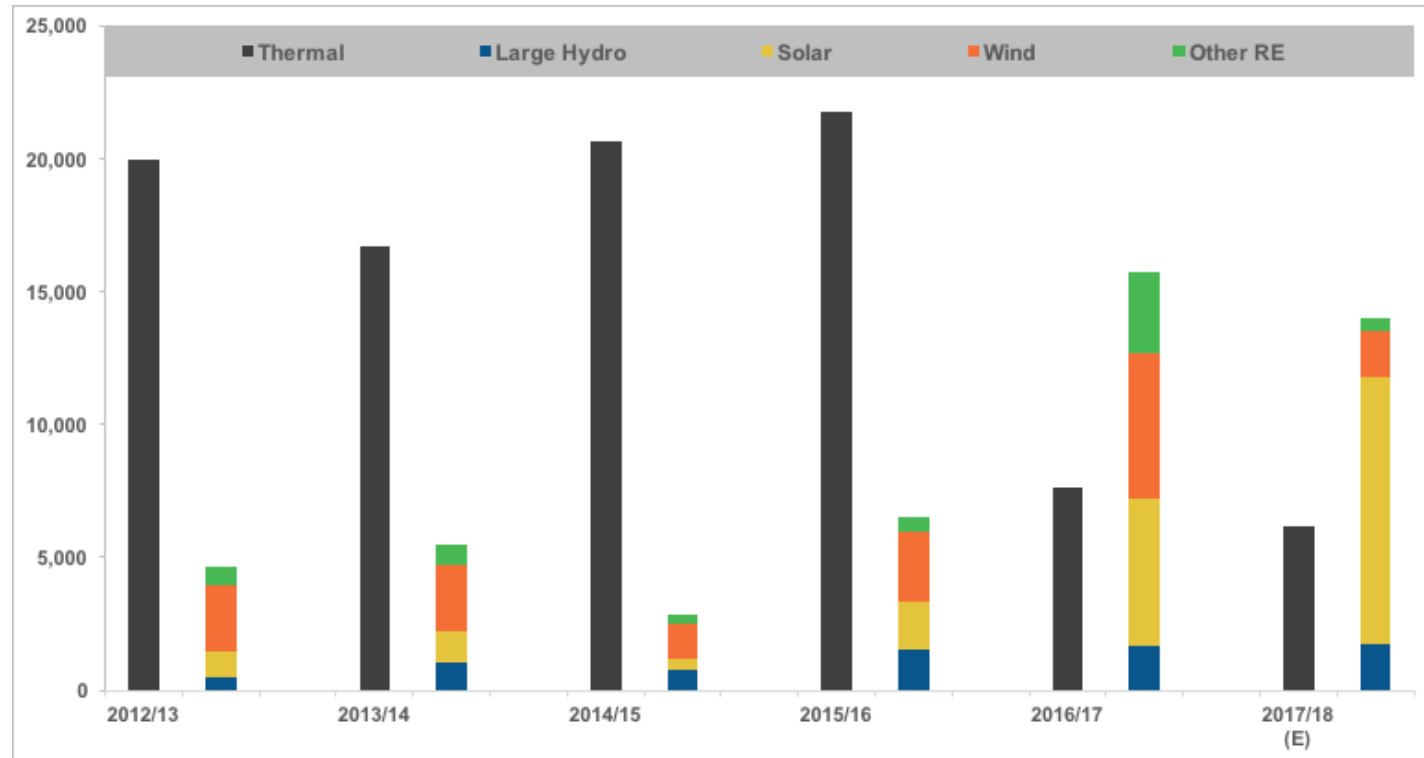


India's power generation capacity has been dominated by thermal mainly coal.

Coal contributes to 57% of installed capacity and 76% of generation.

Renewables contributes to 17% of installed capacity but only 7% of generation.

Improving Generation Capacity Deficit



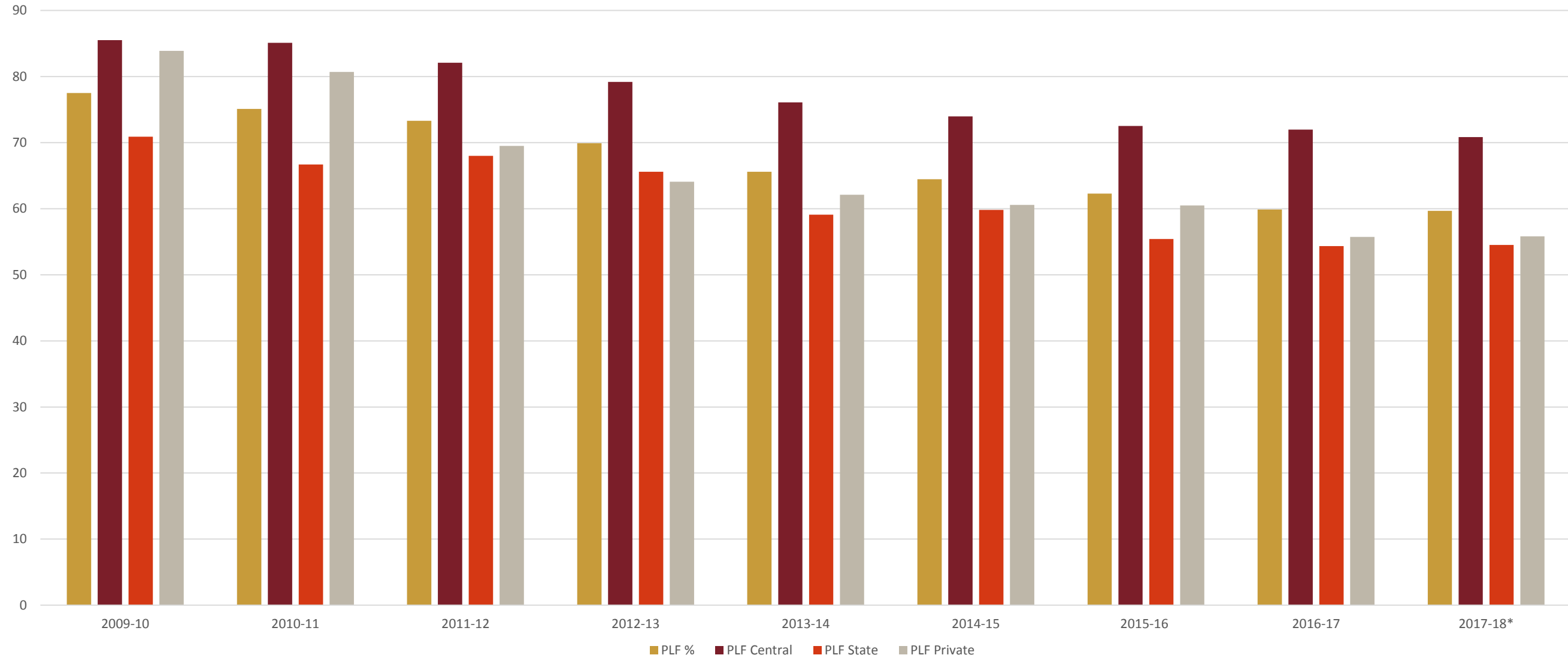
However, there has been rapid take up of energy capacity.

During FY 2016/17 renewable energy capacity additions exceeded thermal capacity additions.

The energy and peak capacity deficit of Indian power system has been largely eliminated.

Declining Plant Load factor of thermal plants

Plant Load Factor of Thermal Power Plants

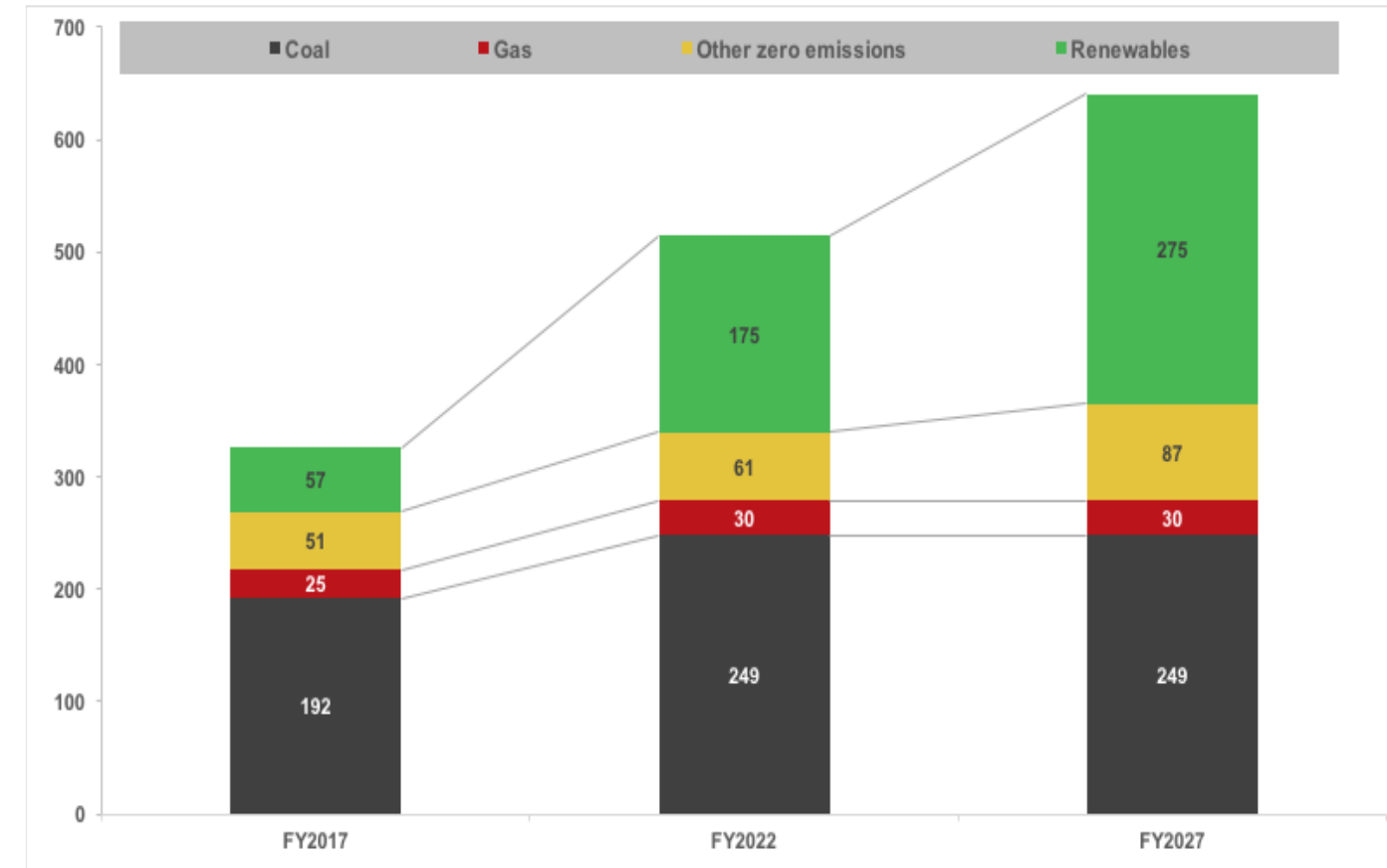
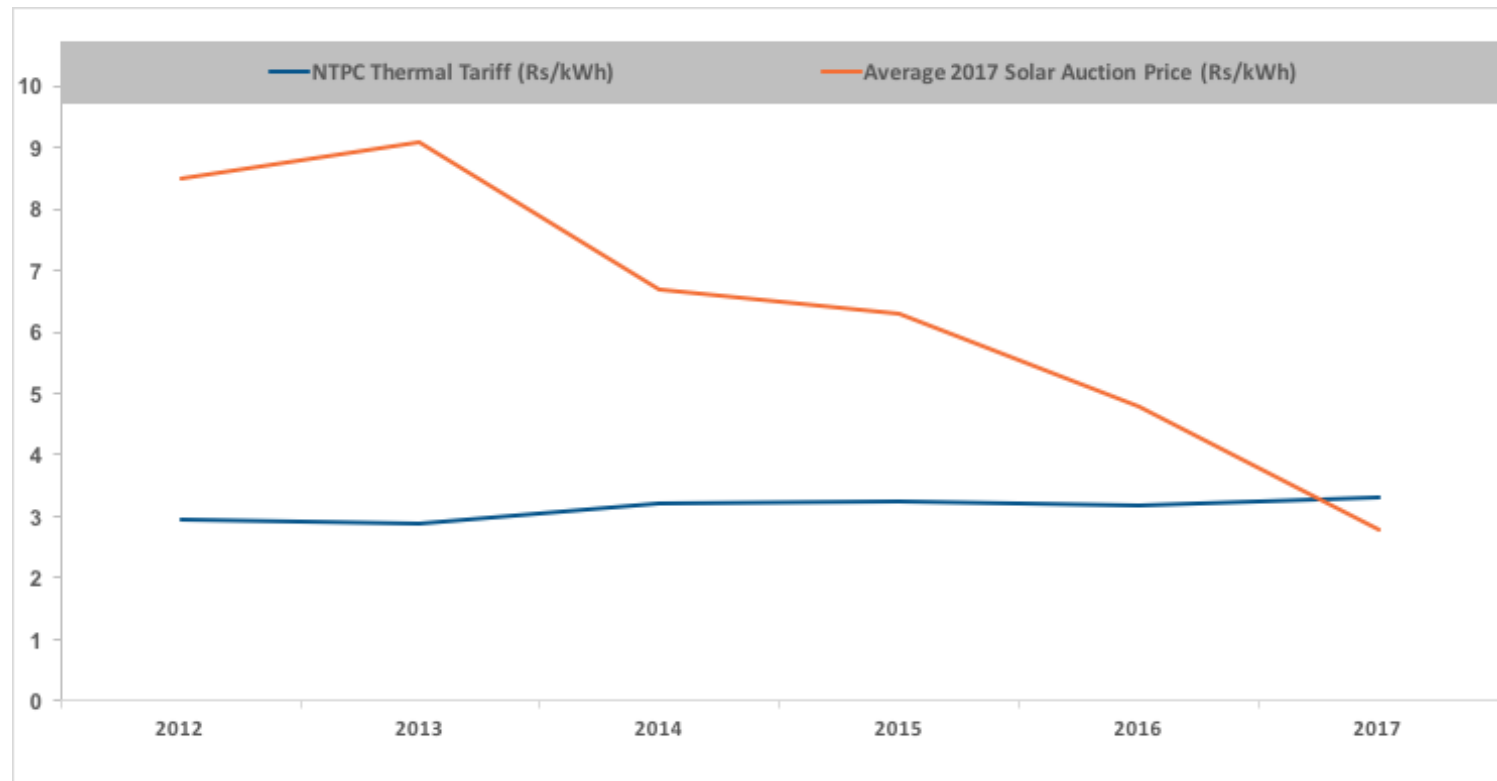


The overall PLF has dropped to 60% in 2017 from 77% in 2010. Private sector plants have experienced a drop from 84% to 56%.

Conventional Generation – Key concern areas

- Consistently decreasing PLFs is major concern
 - *PLFs dipped from 64.5% in fiscal 2015 to 59.88% in fiscal 2017*
 - *Domestic coal production could not keep pace with thermal power capacity addition.*
 - *Other factors include lower off-take by Discoms, increased share of renewables in installed capacity, and financial stress of Discoms*
- Increase in non-performing assets (NPAs) in the thermal segment
 - *~51 GW of stressed assets (thermal and gas)*
 - *Another ~23 GW of under-construction projects may become stressed, endangering \$ 20 billion investments*
 - *\$ 60 billion of debt is likely to become NPA if prevailing issues are not resolved*
- Fuel non-availability, aggressive bids, lack of fresh PPA, and offtake risk
 - *~13.5 GW of projects with coal source but no PPA*
 - *~ 6 GW of projects with no coal source and no PPA*

Increasing Share of Renewable Capacity in Indian Power System



Large Utility scale solar projects have achieved cost parity with coal power in 2017.

However, there are system wide costs that need to be taken into account. These includes, cost of additional reserve, energy storage and higher O&M cost of thermal plants due to rapid ramping.

However, India will add more renewable capacity (175 GW by 2022 and 275 GW by 2027).

Status of Renewable Energy in Southern Region

	2017	2022
Total Installed Capacity (GW)	91.8	144.9
Renewable Installed Capacity (GW)	26.1	59.7
	2017	2022
Total Generation (BU)	241.3	420.7
Renewable Generation (BU)	33.1	101.2

Presently share of **Renewable Installed Capacity** in the region is **28%** which will become **41%** in 2022.

Presently share of **Renewable Generation** in the region is **12%** which will become **24%** in 2022.

Source: Central Electricity Agen

Initiatives Taken by the Government to Promote Renewable Energy

- Established a separate ministry with clear mandate for promoting RE. (i.e. Ministry of New & Renewable Energy)
- Dedicated financial institution (IREDA).
- Setting a target of 175 GW RE capacity to be achieved by 2022 .
- Setting Renewable Portfolio Standards (RPO) for DISCOMs and large consumers.
- Separate RPO carve outs for solar (2.5% in FY 2017 to 8% by FY 2022) and gradual increasing of RPO (11.5% in 2017 to 17% by FY 19).
- Dedicated Inter-state transmission infrastructure (Green Corridor with a total investment of \$ 5.6 billion).
- Waiver if Inter state transmission tariffs for RE plants

Initiatives Taken by the Government to Promote Renewable Energy

- Adaption of reverse auction for wind and solar capacity additions resulted in price discovery.
- Managing off-taker risk in the context of poor credit worthiness of DISCOMS.
 - Central agencies such as SECI and NTPC acting as a counterparty provides additional comfort to the investors for centrally bided capacity.
 - MNRE guarantee of payments.
- Establishing Gigawatt range solar parks with supporting infrastructure plus for off-take arrangements for plug and play investments by private sector.
- Availability of accelerated depreciation for taxation purposes.
- Must run status for Renewables in generation capacity.
- Establishment of state of the art Renewable Management Centers (REMC) with forecasting and fully visibility of RE plants
- Priority lending status for RE sector

Issues–RE Integration and Grid stability

- Curtailment of RE power during RE peak generation to avoid overloading/ tripping .
- Transmission line evacuating RE power not compliant to n-1 criteria.
- Old RE generating plants are not compliant to LVRT (Low Voltage Right Through).
- Old RE Plants signed with high Tariff PPA are not demanded by DISCOMS during their peak generation period due to availability of cheaper power in the market.
- DISCOMS needs to back down cheaper conventional sources of power, adding to their losses.
- States like Andhra Pradesh, Punjab and Rajasthan
 - *Unplanned shut down or lower PLF while bearing their Fixed cost.*
- Long standing PPAs with conventional power developers.
- Large scale consumers setting their own captive solar plants for RPO compliance
 - *Problem for DISCOMs as they loose high end consumers*

Recent Power Market Initiatives to address RE integration

- Coordination for Scheduling and dispatch with neighbor States for better access of least cost generation.
- Adoption of state-of-art automated load and RE forecasting systems.
- Scheduling and dispatch could be upgraded to 5 minutes from current 15 minute basis.
- CERC guidelines for coal flexibility, reducing minimum operating levels for coal plants.
- New tariff structure that specifies performance criterion (ramping), and that addresses the value of coal as PLF decline.
- Creation of model PPAs for RE that move away from must-run status and employ alternative approaches to limit financial risks.
- Address integration issues at the distribution grid, including rooftop PV and utility-scale wind and solar that is connected to low voltage lines.
- RE generators to provide grid services such as automatic generation control and operational data.

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- Creating a market for substantial flexible generation that can ramp-up very quickly.
 - Creating market storage devices as reserve.
 - Transparent procurement mechanism of flexible generation in assuring grid stability.
 - Fair price discovery and compensation of flexible resource providers.
 - Expand balancing areas to reduce variability by offering more balancing resources/demand.
 - Evacuation of power through Green Energy Corridors from the regions having high concentration of RES.
 - Upgrade Grid operational protocols to ensure that renewable energy does not affect the grid.