FLEXILIZATION ISSUES OF THERMAL POWER PLANTS

Anjan Kumar Sinha
NTPC Ltd

Conserving Now, Preserving Future
India’s Present Installed /Renewable Capacity

Total Installed Capacity = 331 GW

(As on 30.10.2017, source: CEA)

- Hydro; 45; 14%
- Coal; 194; 59%
- Nuclear; 7; 2%
- Gas; 25; 8%
- Diesel; 0.91 GW
- [RES], 60; 18%
- Biomass; 8; 14%
- [Solar PV], 15; 22%
- Small hydro; 4; 8%

Installed RES = 60 GW
(As on 31.10.2017)

- Small hydro
- Wind
- Biomass
- Solar PV
India’s Intended Nationally Determined Contribution (INDC) aims to base 40% of the total installed power generation capacity on non-fossil fuel resources by 2030 with international support on technology transfer and financing. This includes Government of India’s ambitious target of achieving 175GW of RE by the year 2022.

Future Renewable Integration Plan

175 GW Renewable Integration Plan by 2022

- Biomass: 10GW
- Small Hydro<25MW: 5GW
- Wind: 60 GW
- Solar PV: 100 GW
Peculiarities of Variable Renewable power

- Difficulty in load frequency control
- Difficulty in scheduling of tertiary reserves
- Requirement of enhanced transmission network and its under utilisation
- Increase in requirement of ancillary services and hence increased system operation cost
- Increase in transmission cost due to all above factors
- Lower PLF due to ducking of load curve
- High ramping requirement
- Two shifting and cycling of plants
- Increased forced outage and O&M cost
- Equipments life time reduction
- Poor heat rate and high Aux. Power

Impact on System

Impact on existing Plant
Today’s Scenario: Cycling without Renewable Integration

- In last five years, conventional capacity was added rapidly but in same proportion electricity demand did not rise, which caused lower PLF and lower peak to installed capacity ratio.

- It is likely to fall further due to rapid addition of RE.
Installed capacity ~ 523 GW *

Peak hour ramp rate is 247 MW/min.

Ramping down rate with sun rise is highest i.e. 368 MW/ min.

Duck belly demand to peak demand ratio is 61% which will lead to partial loading and two shifting i.e. cycling of fossil based power plants and hence low PLF.
Flexibilization: Need for Benchmarking

Defining
- Defining from different perspectives

Measuring
- Metrics
- Quantifying

Operationalisation
- Sources, Options
- Preparedness for Coal based plants

Compensation/Incentivisation
- Regulatory framework
- Market structure and mechanisms

International Energy Agency
Characteristics of Flexibility

- Quantity (MW) which is required to be kept in reserves
- Turndown
  - Minimum boiler load:
- Cycling capability
  (start-up to full load best achieved time taken)
  - Very hot start-up: <1h
  - Hot start-up: 1.5–2.5 h
  - Warm start-up: 3-5 h
  - Cold start-up: 6-7 h
- Ramp rate
  - 30-50% load: %/min
  - 50-90% load: %/min
  - 90-100% load: %/min

We can assign a flexibility index for each unit based on the above parameters

- 4-8% Flexible
- <4% Inflexible

- 2-5 Hour Flexible
- 5-7 Hour Inflexible

- 20-40% MCR Flexible
- 40-60% Inflexible
Steps to Operationalisation of flexibility

- Frequency Droop (RGMO/FGMO)
- Spinning reserves
- DSM
- Tertiary reserve
- Ancillary Service
- Operating reserves
- Operation till Tech. Min.
- Capacity reserves
- RSD

0-10 seconds
5 min to 30 min
15 min to hrs

- Very Hot
- Hot Start
- Warm Start
- Cold Start

Studies carried out at NTPC Dadri (490 MW) for: Flexible control Retrofitting” - Condenser Throttling
- The ramp rates achieved: 3.6% at lower load ramp size of 10%, and 5% at higher loads

Pilot successfully completed at NTPC Dadri (490 MW) for on AGC for operationalisation of Spinning Reserves
- Another Pilot to be carried out at NTPC Simhadri

Ancillary Service Regulation
- Technical Minimum at 55%
- Part Load compensation based on Heat Rate, APC & Sp. Oil
- Forecasting

Fleet wide monitoring
- Reducing stresses during start-up
- Reducing the level of minimum loads
- Part Load optimization
- Structured APC Reduction Programme
- Tuning of auto-control loops
- Sliding Pressure Operation

Capacity Building
Capability Evaluation of NTPC Units for Flexibility

• Dadri 210 MW & Simhadri 500 MW has been studied by VGB Power Tech, Germany Under Special Task Force, IGEF.

• Key Findings are
  – Proper Coal Quality maintenance is Vital
  – Low Load Stable operation with 2 Mills is possible but requires boiler safety systems modification to allow continuous two mill operation’
  – Considering minimum load below 50%, the provision of 5% Frequency control power becomes nearly impossible
  – Advanced C&I solutions with automatic start-up, more ambitious set points and optimized underlying control loops would gently enhance flexibility

• Present Capability of NTPC Units
  – Units are capable of sustaining Technical minimum load of 55% MCR with out oil support
  – Ramp rate of 500 MW units varies between 1-1.5 %
  – Ramp rate of 200 Mw Units varies between 1.5-2%

• Main Concerns
  – Varying Coal quality, specially low VM coal is a major concern for flame stability at low load
  – SH/RH Steam Temperature variations & Boiler Tube metal temperature excursions during Ramp-up/Down
Flexible Operation – Road Map (Short Term)

**Identification of Units for Flexible operations**

- Units having high Energy Charges are likely to undergo maximum load variation
- The units situated near RE rich region may also require to undergo load variations due to areas balancing issues
- Going for addition of 100% Supercritical Coal Fired Plants with 4-5% efficiency gain, and each 1% efficiency gain shall reduce the CO₂ emissions by 2.5%, but running them on part load will undermine the gains
- Old Units and lesser efficient Units to run on flexible mode with lesser running hours.

**Short term Action Plan**

- Test Runs by OEMs at Technical Minimum Loads
- Base line data to be captured
- Optimisation of Operational practices
- Optimisation of control loops
- Capacity Building
Flexible Operation – Road Map (Medium Term/Long Term)

**Medium Term**

- Modification / Retrofitting for enhanced flexible operation
- Pilot Project taken up at Dadri 490 MW Unit with Siemens by retrofitting Flexible Control module “SPPA-T3000”
  - Enhanced ramp rate of 3.6%
  - 7% Primary response by condensate Throttling

**Long Term**

- Study of Two NTPC Stations (Ramagundam & Unchahar) Under USAID
- Study for cost and impact of Cyclic loading by International Consultant
- Flexibilisation study at VSTPS by Jcoal
- Study by BHEL & GE (OEMs)
- Policy framework implementation based on report for adequate compensation for part load and Start-up compensation
Conclusion

Integration of variable renewable energy (VRE) impacts both grid stability as well as other generating units connected to grid, thus increases cost of transmission and generation and finally cost to consumer.

However, these cost can be reduced by adopting suitable operation practices, mitigation technologies, a better policy in picture, though it can not be eliminated totally. After all, we have to pay for better environment.

Thank You