Ancillary Services Facilitating Large Scale Integration of Renewable Energy in India

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Introduction

- Basic services - electricity generation, transmission and distribution
- Support services - frequency control, voltage control, generation reserves, black-start etc.
- Same infrastructure to supply basic and support services.
- Increasing penetration of renewables - Increased requirement for ancillary services.

Types of Ancillary Services and Duration

Source: Brendan Kirby, Ancillary Services: Technical and commercial insights, WARTSILA, July’07
Renewables – Technological Advantage

- Renewables - capable of acting as ‘suppliers’ of ancillary services as well
- Power electronics equipment
  - Capability to provide many of the ancillary services
- Indian Context
  - 175 GW of renewables by 2022

Types of Ancillary Services

- Ramping capability
  - Regulation up/down
- Controllable reactive power support
- Fast frequency response
- Voltage regulation
- Flicker control
- Harmonic cancellation
- Active power filtering.
Ancillary Services Framework

Ministry of Power
- Tariff Policy
- Technical Committee on Renewables

CERC
- Indian Electricity Grid Code
- Ancillary Services Operations Regulations, 2015

Nodal Agency
- Detailed Procedures
- Feedback
### Salient Features

<table>
<thead>
<tr>
<th>RRAS Providers</th>
<th>• All the regional entity generators whose tariff for the full capacity is determined or adopted by the CERC - Mandatory Provision</th>
</tr>
</thead>
</table>
| Designated Nodal Agency                                                        | • NLDC, through the RLDCs.  
  • Preparation of the merit order stack                                          |
| Triggering criteria                                                            | • Extreme weather /special day, outages, load and frequency profile, abnormal events loop flows, regional Area Control Error (ACE) and recall by the original beneficiary. |
| “Virtual Ancillary Entity (VAE)”                                                | • Acts as counterparty for scheduling and accounting in the regional pool.  
  • Instruction directly incorporated in the schedule of respective RRAS providers. |
| Handling Deviations                                                            | • CERC Deviation Settlement Mechanism (DSM) Regulations.  
  • The energy despatched under RRAS is deemed delivered ex-bus. |
| RRAS Energy Accounting                                                          | • Respective Regional Power Committee (RPC) on weekly basis  
  • Based on data from interface meters and the implemented schedules.  
  • Separate RRAS statement issued by RPC along with Regional DSM Account.  
  • Any post-facto revision in rates/charges by RRAS providers is not permitted. |
| Compensation Mechanism                                                          | • RRAS Up - fixed and variable charges paid from the regional pool along with Markup  
  • RRAS Down - 75% of the variable charges are payable by RRAS providers to pool and fixed charges are reimbursed to beneficiaries  
  • No commitment charges - Penalties for persistent failure |
RRAS Despatch Mechanism
### Key Statistics

- **Number of RRAS Providers and Installed Capacity**: 49 Nos. totaling around 52.5 GW
- **Variable Charges** [Assumption: 1 US $ = ₹ 60]
  - Lowest Variable Charge (Pit Head Coal Fired Plant) @ 123 Paisa (US$ 0.02)/ kWh
  - Highest Variable Charge (Gas Power Project (Liquid Fuel)) @ 793 Paisa (US$ 0.13)/ kWh

<table>
<thead>
<tr>
<th>Period: April 2016 to June 2017</th>
<th>Regulation Up</th>
<th>Regulation Down</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Instructions Issued</strong></td>
<td>2390 Nos.</td>
<td>442 Nos.</td>
</tr>
<tr>
<td><strong>Energy Despatched</strong></td>
<td>2767 MU</td>
<td>336 MU</td>
</tr>
<tr>
<td><strong>Average Energy Despatched per Day</strong></td>
<td>7 MU</td>
<td>1 MU</td>
</tr>
<tr>
<td><strong>Maximum Power Despatched in a Time-block</strong></td>
<td>3746 MW</td>
<td>2366 MW</td>
</tr>
</tbody>
</table>
Case Study (1)

Improved Frequency Profile

Improved Frequency Profile - Achieved FVI of 0.023

Ancillary Services was dispatched to maintain grid frequency and to provide high evening load ramp

Dadri one unit was dispatched under RRAS to maintain hot spinning reserve
Case Study (2)
Ramp Management

Trend of Load met: Date- 07th-June-17
RRAS Instruction during Evening Peak

The maximum demand met was 143939 MW and Regulation Up of 2300 MW was applied to meet the demand in evening peak.
Case Study (3)

Grid Resilience – Handling Variability

Grid Resilience - Ancillary Services- handling variation of Wind generation (03.04.2017)

- Total All India Wind generation was around 2200 MW.
- Wind generation started reducing at 17:40 Hrs and came down to around 1700 MW.
- Regulation Up was implemented to compensate the wind generation.
Case Study (4)
Real Time Congestion Management

Real Time Congestion Management

SR Import ATC was reduced due to outage of HVDC Talcher-Kolar Ploe-I on 1st-May-17

For managing congestion in SR Regulation Up was implemented in SR RRAS providers

Regulation Up was withdrawn after restoration of HVDC Talcher-Kolar Ploe-I
Case Study (5)
Reliability Support

Reliability Support: S/D of 765kV Agra-Gwalior -1

Regulation Up of 1000 MW in NR was implemented to facilitate S/D of 76kV Agra-Gwalior -1

Regulation Down of 600 MW in WR was implemented to facilitate S/D of 765kV Agra-Gwalior -1
Case Study (6)

Extreme Weather Conditions

- Load crash in Northern Region on 07th June-17 due to Extreme weather conditions
- Northern Region demand met on 06th June-17
- Regulation Up was implemented in all regions during increase in demand of Northern region
- Regulation Down was implemented in all regions during low demand period of Northern region
Key Learnings from Indian Experience

- Layer of Centralized Ancillary Despatch over Decentralized Layer of Scheduling Process
- Improved Frequency Profile.
- Ramp Management - Evening Peak / Morning Peak
- Real Time Congestion Management
- Grid Resilience – Handling Low Probability High Impact Events
- Availability of Variable charges for first time in public domain
  - Better Despatch Decisions
  - Changing Merit Order month on month
- Handling impact of extreme weather conditions on the grid
- Reliability Support
- Information Dissemination
- Benefits to stakeholders – Generators & State Utilities
- Freedom and Choice available to states retained
Challenges

• Better Load & Renewable generation forecasting
• Reserves Quantum Available for despatch
• Hydro Scheduling under Ancillary Services
• Gate Closure for Scheduling Process
• Automation, IT Infrastructure and Manpower
• Metrics for Performance Monitoring
Future Roadmap of Ancillary Services

- Energy Limited Resource (Hydro)
- Harnessing Pumped Storage Plants (PSP)
- Participation of Merchant/IPP
- Reactive Power & Voltage Control Ancillary Services
- Black Start Ancillary Services (BSAS)
- National Pool Account Operationalization
- Replication at State level