Implementation of Automatic Generation Control at Hydro Power Plants in Southern India

Chandrasekhar Reddy Atla
Nagaraja Ramappa
PRDC, Bangalore, India

Satish Kumar Singh
Deloitte Touche Tohmatsu India LLP, India

Pradeep M
Karnataka Power Corporation Ltd, India
Outline

Introduction

Reserves required for high RE integration

Simulation Studies

Pilot Implementation Progress

Conclusions
Introduction

Renewable Integration and Sustainable Energy (RISE)
Introduction

Operational Challenges with high Renewables

- Scheduling,
- System control and dispatch;
- Reactive power supply and voltage control;
- Regulation and frequency response reserve;
- Energy imbalance service;
- Operating synchronized reserve;
- Operating supplemental reserve.
The objective of the AGC pilot is to support the system operation during high ramping of renewables by enabling secondary reserves by AGC.

At present, most of the power plants in India are enabled for one way communication where actual generation of the generation units is communicated to SLDC (State Load Dispatch Center).

However power plants are not enabled to receive any signals from SLDC and respond accordingly.
Reserves required for high RE integration

System reserves are the most important services among all ancillary services when RE penetration is high in the system.

- Primary reserves
- Secondary reserves
- Tertiary reserves

Reserves required for high RE integration

Two methods can be adopted for system reserve calculation,

Deterministic and Probabilistic calculations

Primary Reserves:
- Largest Unit/s
- Largest Line/s

Secondary Reserves:
- Wind Variation Mean & Std deviation
- Solar Variation Mean & Std deviation
- Conventional Generation Capability
- Load Variation Mean & Std deviation
- Net-Load Ramps Mean & Std deviation
Reserves required for high RE integration

Two methods can be adopted for system reserve calculation,

Simulation method using power system transient/dynamic models
Simulation Studies: AGC Model
Simulation Studies: Sample System

- GEN UNIT A
  - (210 MW x 7)
  - (250 MW x 1)
- GEN UNIT B
  - (500 MW x 2)
  - (700 MW x 1)
- GEN UNIT C
  - (103.50 MW x 10)
  - Participation factor: 0.6 (60%)
  - Scheduled: 750 MW
- GEN UNIT D
  - (115 MW x 4)
  - Participation factor: 0.4 (40%)
  - Scheduled: 260 MW
Simulation Studies: Sample System

Frequency response with and without AGC

Generation Unit Responses
AGC Pilot Implementation

AGC pilot implementation

- **Stage 1**: Configuration of existing AGC module in EMS system at SLDC to generate AGC control signals
- **Stage 2**: Enhance the facilities at hydro power plants to implement AGC control
AGC Pilot Implementation @ SLDC

AGC Module

Unit Power and status feedback

Channel Equipment

G1
G2
Gn

Generating units on AGC

Ramp rate limiters

AGC Set Points

Channel Equipment

G1
G2
Gn

AGC Algorithm

Filter

PI controller

Filtered ACE

Filtered ACE

ACE

+ +

+ +

ΔPtie

scheduled net interchange

Δf

measured f

+ +

BΔf

AGC Module

Telemetered tie flows
## AGC Pilot Implementation @ Hydro Power Plants

### Selection of Generation Plants for AGC pilot

- **Water Availability**
- **Plant Operation**
- **Turbine Technologies**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Hydro Plant Name</th>
<th>Installed Capacity (MW)</th>
<th>Reservoir type</th>
<th>Turbine type</th>
<th>AGC control (MW)</th>
<th>Selected Yes/No</th>
<th>Remarks</th>
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<td>Sharavathi</td>
<td>10x130.5</td>
<td>Dam based</td>
<td>Pelton</td>
<td>Approx. 100 MW</td>
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<td>Varahi</td>
<td>4x115</td>
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<td>Yes</td>
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<td>3</td>
<td>Nagjhari</td>
<td>5x150+ 1x135</td>
<td>Dam based</td>
<td>Francis</td>
<td>---</td>
<td>No</td>
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</table>
AGC Pilot Implementation @ Sharavathi hydro power plant

Parameters (Unit Wise):
1. Real unit capacity (MW),
2. Unit ON/OFF Status
3. Set points in auto mode
4. One-way communication exist
5. Two-way Communication for every 4 secs

Part 1: Software requirement
The present software needs to be enabled for automatic from LDC control center in with two-way communication.

Part 2: Communication requirement

Satellite communication, VSAT (104 protocol)
AGC signal for every 4 seconds
AGC Pilot Implementation @ Varahi hydro power plant

Satellite communication, VSAT (104 protocol) AGC signal for every 4 seconds

Part 1: Software requirement
The present software needs to be enabled for automatic from LDC control center in with two-way communication.

Parameters (Unit Wise):
1. Real unit capacity (MW),
2. Unit ON/OFF Status
3. Set points in auto mode
4. Two-way Communication for every 4 secs

Part 2: Communication requirement

LDC, Bangalore
KPTCL RTU

Varahi 220 kV S/S

Varahi plant panel

Fiber communication (104 protocol)

Plant DCS
Varahi Hydro plant
Conclusions

The reserves in the system (primary and secondary reserves) can be calculated for state or regional system by using dynamic simulation studies.

Under the AGC pilot, the detailed requirements at power plants and Load Dispatch center are presented. This will help the utilities to draft the technical requirements to implement AGC facilities.

At present most of the power plants in India are enabled for one way communication where actual generation of the generation units is communicated to SLDC. Hence, two communication requirements are highlighted to enable AGC operation.

The outcomes of the pilot will be analysed to develop the frame work guidelines for ancillary markets focused on secondary reserves in India.
THANK YOU