Landsnet

Five years of synchrophasor use in the control center

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System Operation
Overview

1. The Icelandic Transmission System and challenges in System Operation
2. WAMS in Landsnet’s control room
3. WACS project’s
4. Results and future development
Location of Iceland with distances over the Atlantic Ocean
Generation and Consumption

Generation capacity 2400 MW
- Hydro: 77%
- Geothermal: 23%

Consumption 17.1 TWh
- Power intensive users: 82%
- Public users: 18%
WAMS and tuning of PSS to improve stability in relation to commissioning of 690 MW generation and load in 2007
Now 12 PMUs installed, with detail of Eastern 220kV AC system (DC to follow) for co-ordinating control.
WAMS in Landsnet’s control room

- Psymetrix - PhasorPoint – RT monitoring of system stability
- PMU installation 2013 ARE, HRY, BUR, BUD, KLA
- PMU installation 2014 REY, ISA
- Data center is located at Landsnet control center Gylfaflöt
WAMS in Landsnet’s control room
WAMS – Operator view

Normal operating condition
- High resolution measurement [Hz, MW, kV, MVAR]
  - observation window 15 min (was 1-2 hr)
  - oscillation not seen by conventional EMS
  - damping, frequency bands (new)

Maintenance
- Security assessment
  - predefined graph for better monitoring of system conditions
- Open 132 kV ring
  - interarea mode (0.3 to 0.5 Hz)
  - variation of production and influence on damping
  - better view of angle condition when closing
WAMS – Operator response

Critical events or operating condition
- Opening of 132 kV ring (inter area mode)
- Trip of smelter load (large proportion of total load)
- Trip of generation (at high transport between areas)

Operator training
- EMS training simulator (3 days in 6 months interval)
- WAMS → Known Issues → Predefined actions

Operator response
- Active power control of Hydro units → GOV - AGC - PSO
- Voltage control → units, capacitor banks
- System spilt to prevent power oscillations
- Reduction of smelter load
WAMS – trip of line on 132 kV ring

PSO opens bustie CB at BLA
FL2 CB closed at FLJ
trip again
Trip of FL2
open 132 kV ring
FL2 CB closed at FLJ
trip again
WAMS – trip and reconnection of 132 kV ring

- Trip of SI4 – open 132 kV ring
- System protection split at BLA

132 kV ring connected at HOL

132 kV ring closed at BLA
WAMS – PSS tuning and system tests

Sl4 - Active Power

PSS off in KRA

PSS on in KRA
WAMS – PSS tuning and long-term tests

1.2Hz Mode

Mode Amplitude (MW)

Mode Decay Time Constant (sec)

Before PSS tuning
After PSS tuning

0.8Hz Mode

Mode Amplitude (MW)

Mode Decay Time Constant (sec)

Improved Performance

1st through 20th February
3rd through 9th March
WAMS – PSS testing at HRA

Unit without PSS and above normal operating limits [70 MW]

Test during PSS commissioning to check PSS damping performance
WAMS - KR2 out → production changes
WACS – Project overview → Psymetrix

Wide Area Defence Scheme – started 2011
- Power balance of areas
- Prevent system split
- Increased system security

Secondary Load Shedding – started 2013
- Increased power flow on 132 kV ring
- Faster shedding after system split
- More focus on lower voltage levels (smart grid)
- Increased system security
- PMU – PDC – Tetra modem → trip of load
WACS - dynamics related to 132 kV ring

132kV ring power flow

Load

Production area
WACS - Trip of 500 MW smelter load in SouthWest

Active Power – 132 kV ring

Active Power – 132 kV ring to KAR/ARE

Frequency

Voltage angle between FLJ and SIG
WADS - Wide Area Defence Scheme

• Emergency control to maintain system stability
  ✓ seen as grid service, similar to underfrequency load shed
  ✓ targeted, controlled action to reduce overall impact

• Uses measurements from PhasorPoint
  - frequency, voltage angle

• Trips generation in an area where a large proportion of load has tripped

• Proportionate response to angle stability condition

• Increased system security with connected system
Results

- Knowledge of system dynamics has increased
- PSO’s response time shorter and more affective
- Improved capability to analyse disturbances
- Important for testing and monitoring of regulation equipment – GOV, AVR, PSS
- Knowledge of system dynamics has increased
- Stability has significantly increased with successful PSS tuning
Future: Improved damping

- PSS tuning of all hydro and geothermal units
- SVC POD commissioning and tuning
- Tunning of smelter load regulation equipment
Future: Governor design and tuning

- New governor design for Geothermal → Island operation
- Geothermal units in AGC for emergency control
- Optimal settings for Hydro units in island operation to deal with smelter load variation after long outage
Future: WACS and smart grid solutions

- Emergency control of smelter load to reduce impact of disturbances
- Control of all secondary load from EMS and WACS (0-120 s)
- Intelligent system design to ensure secure system split depending on operating conditions