



## Digital Energy

### Case Study: Wide Area Control System (WACS) in Iceland

GE's WAMS grid stability solutions address challenges in the Icelandic grid

#### REAL-TIME WIDE AREA MONITORING AND CONTROL TO ENHANCE NETWORK SECURITY AND RELIABILITY

An extensive network of synchrophasor measurements underpins control room monitoring and analysis. The measurement network also supports direct response-based control for fast frequency response and islanding management.

#### ICELAND, THE RENEWABLE ENERGY POWERHOUSE



The Icelandic energy transition has its roots in the 1970s with an extensive renewable energy initiative to harness plentiful hydropower and geothermal energy resources. Today, all electricity in Iceland is produced using renewable energy sources, with 73% of electricity provided by hydropower plants and 27% from geothermal energy.

#### KEY BENEFITS

- Real time monitoring of the dynamics of the power system
- Improved capability to analyze disturbances
- Fast and accurate detection of islanding and operator support for resynchronization
- Supports PSS tuning process
- Dynamic modelling and control tuning improving security of supply
- Locational fast frequency control improves frequency and islanding performance
- On-going collaboration for expanding the use of the Wide Area Control system

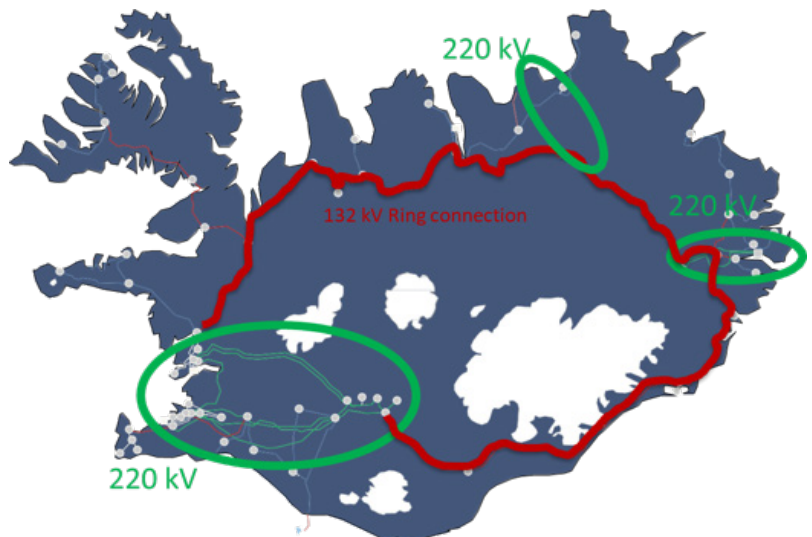
#### CUSTOMER CHALLENGE

##### Long Transmission Lines and Weak Connections

There is potential for harnessing more renewable energy resources, but there are inherent stability limitations on connections in the Icelandic grid. The transmission system consists of three major clusters of loads and generators in the south-west, east and north. Under normal operation these clusters are connected through a 132 kV ring around the island.

Landsnet, the Icelandic transmission system operator, has seen major expansion in generation and load connections, but network reinforcements have been limited due to environmental sensitivity. Partnership between Landsnet and GE started with power system stabiliser (PSS) tuning at plants in the 132kV ring in preparation for commissioning the 690MW Kárahnjúkar hydro plant. The PSS tuning methodology using WAMS became standard procedure for all new plants and refurbishments and has enabled the ring to be operated stably without major reinforcement.

As further load and generation growth progressed, the angle stability during disturbances led to increasing risks of islanding and associated outages. These dynamic issues have been addressed by fast location-sensitive balancing control that reduces the number and impact of islanding events.





## THE SOLUTION

GE installed Phasorpoint, a Wide Area Monitoring System (WAMS) to collect, analyze and visualize real-time phasor data across the Icelandic transmission system. GE and Landsnet used the dynamic monitoring to baselined dynamic performance, prior to commissioning and PSS tuning at key points in the network. The WAMS system provides both real-time observations of system testing and a resource for analyzing the results of the various tests. The PhasorPoint system enables practical assessment of the controllability of oscillations throughout the network, and measures of the contribution of the plant to oscillation damping with and without the PSS. It also provides longer-term review and comparison data for stability before and after PSS tuning.

Over 13 years, the installed base of PMUs has grown to over 50, with over 70% of transmission circuits monitored and several generators monitored at unit level. WAMS is used extensively in the control room for operational monitoring of stability during operational procedures, particularly related to large dispatch operations, disturbances, islanding and resynchronization.

### Islanding & Resynchronization: Resolving Instability in Disturbances

Phasorpoint Applications include:

- Real-time system condition monitoring
- Oscillatory Stability Management (OSM)
- Islanding, Resynchronization, and Blackstart (IRB)
- System Disturbance Management (SDM)

GE continue works closely with Landsnet to further expand the use of WAMS & WACS. Several Smart Grid projects using wide area control have been deployed in operational service using GE's PhasorController. Systems in service now and in the near future include;

- **Discrete load control** Fast triggered load step up or down – West Iceland Smelter Load Controls
- **Discrete load trip** Fast triggered load disconnection e.g. East Iceland Load Shed
- **Fast ramp control** Fast triggered gen/load ramp e.g. Hrauneyjafoss Hydro fast ramp
- **Intelligent splitting** Split choice for island balance e.g. Sigalda Hydro Splitting Logic



Landsnet control room, showing PhasorPoint in use.



**n PhasorController**  
20ms Real-Time PMU-based logic control with specialist WACS function block library



**n Operational now**   **n Planned**

Images provided with permission of Landsnet and Landsvirkjun.



- 1 Control Center**
- Data concentrator for PMU data
  - Control Room visualization
  - Administration of PhasorControllers
  - Testing & Trials



- 2 East Iceland Fish Factory Load Shed (x6 plants)**  
Co-ordinated trip of 1-6 units for local FFR and east Iceland network limits



- 6 Hrauneyjafoss (HRA) Fast Ramp**  
Governor control mode switch to wicket gate control & fast downramp, 60MW

- 3 ISAL Smelter Load Control**  
2 up & 2 down load step stages, +20MW, -50MW



- 7 Geothermal governor control**  
Controlled fast ramp down & islanding control

- 4 NAL Smelter Load Control**  
2 up & 2 down load step stages, +20MW, -50MW



- 5 Sigalda (SIG) Intelligent Split**

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