# Landsnet

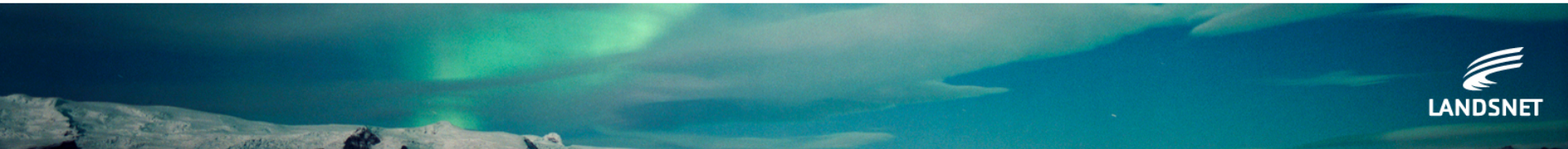
## Five years of synchrophasor use in the control center

NASPI Work Group Meeting
February 2013, Huntington Beach, CA

Ragnar Guðmannsson
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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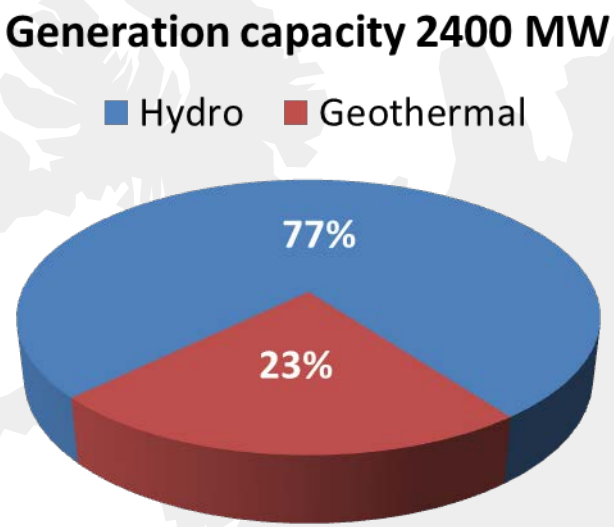
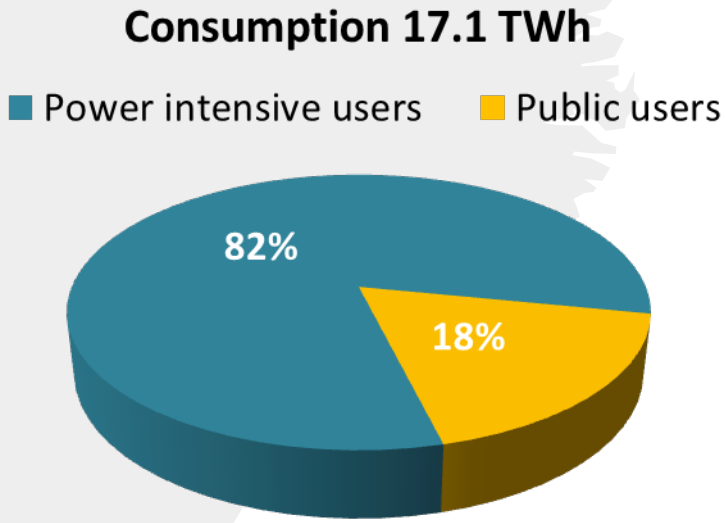
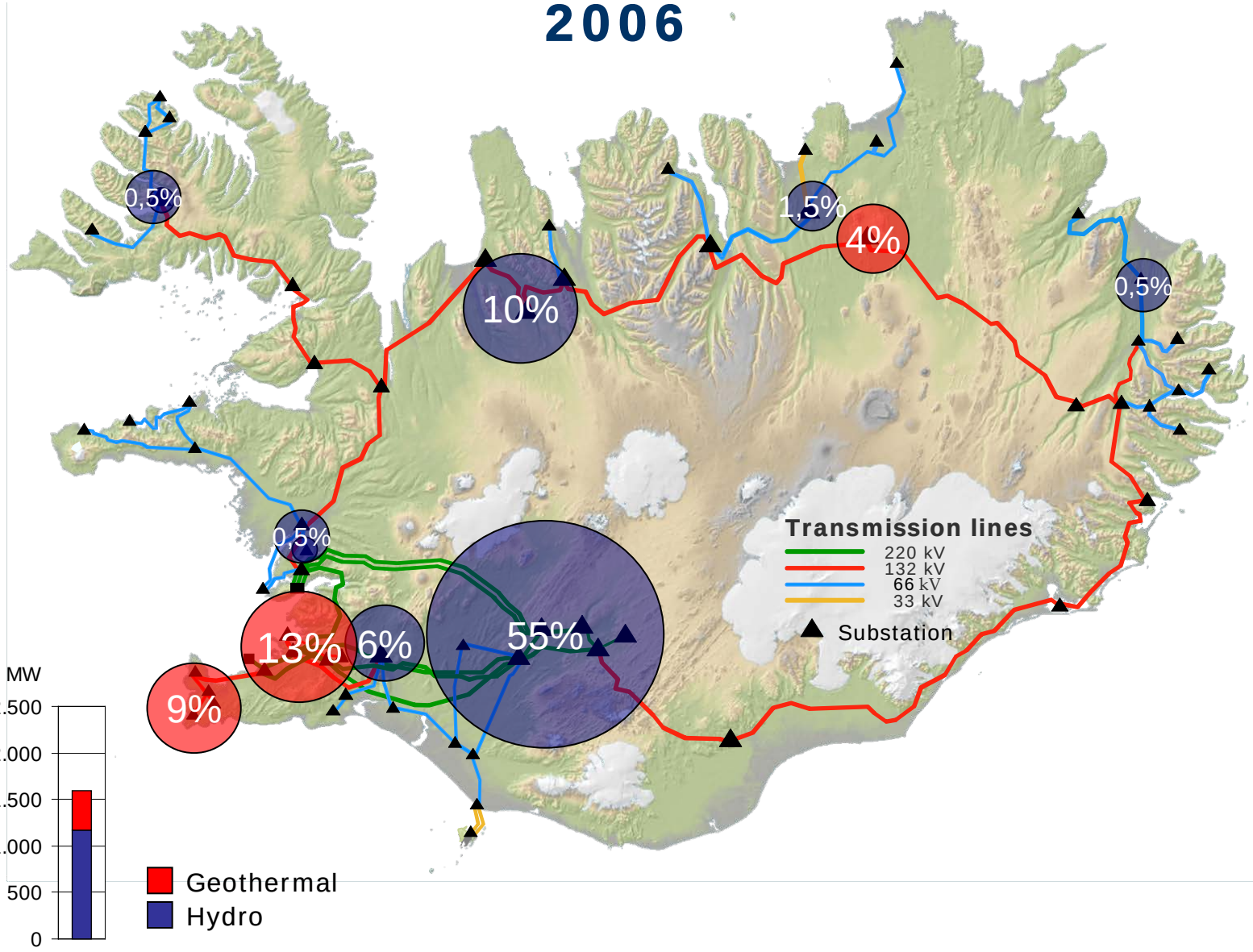
# Generation and Consumption



# Generation Capacity 2006

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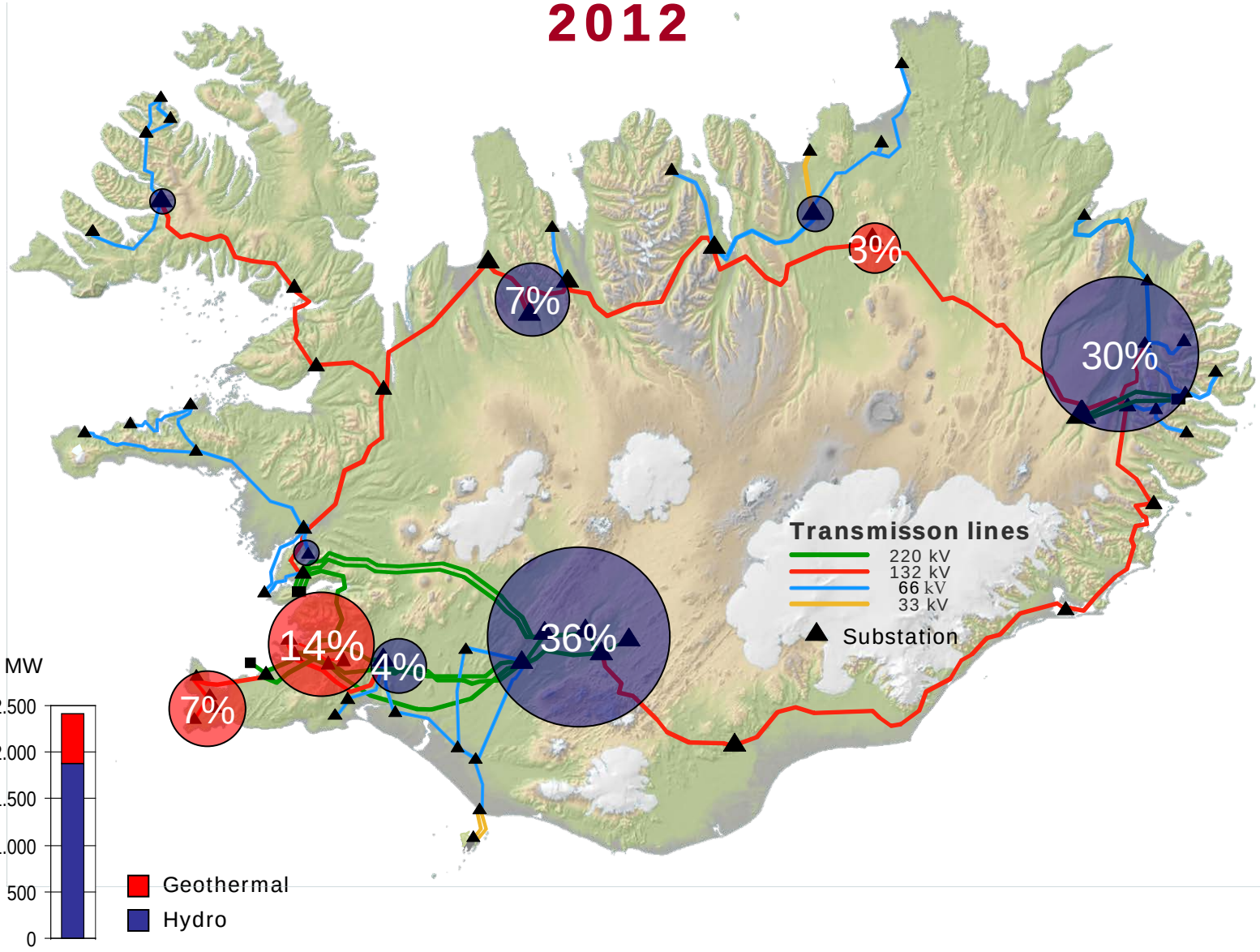
# Generation Capacity
## 2012

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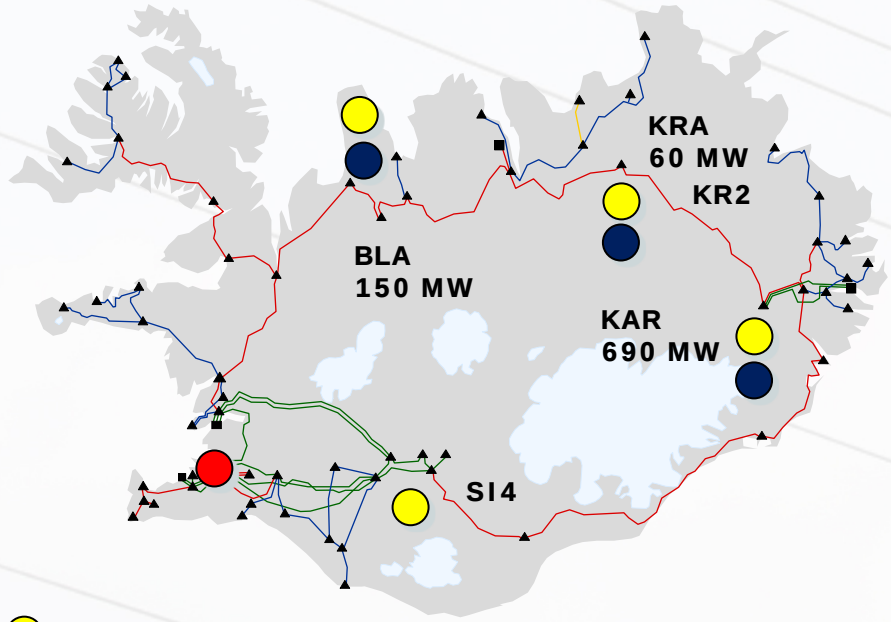
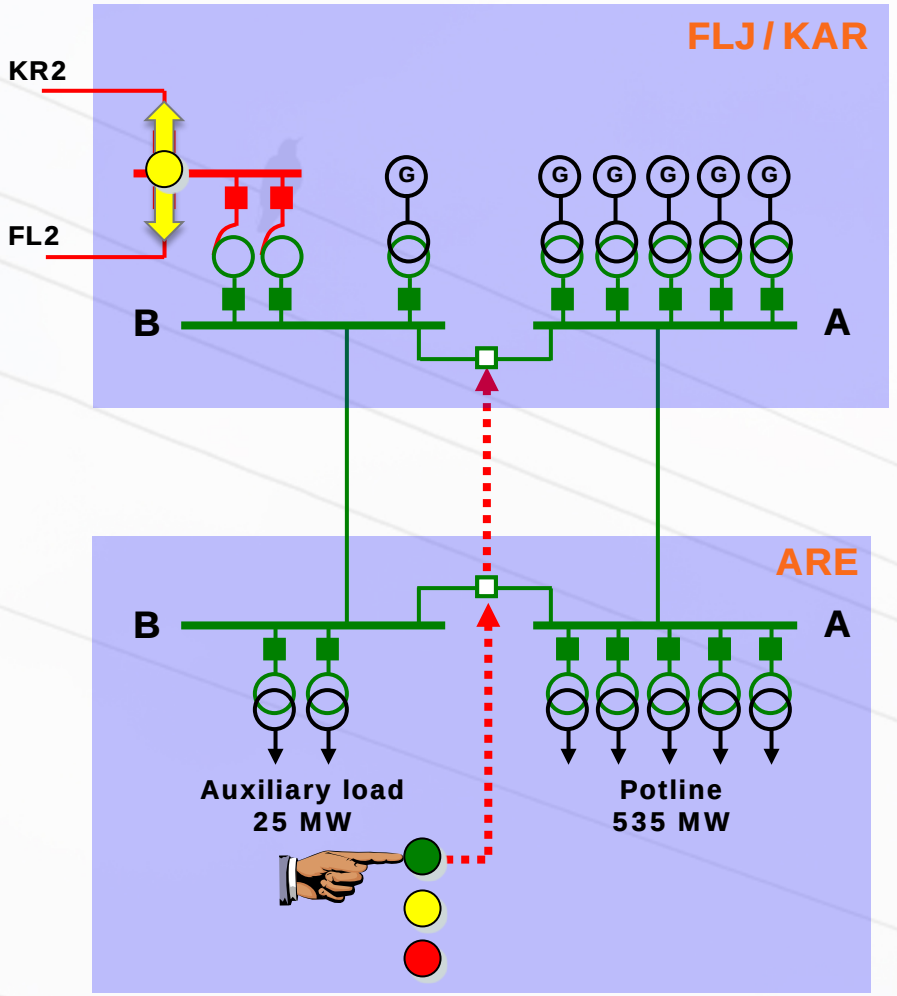
# WAMS and tuning of PSS to improve stability in relation to commissioning of 690 MW generation and load in 2007




PMU

PSS

Data center

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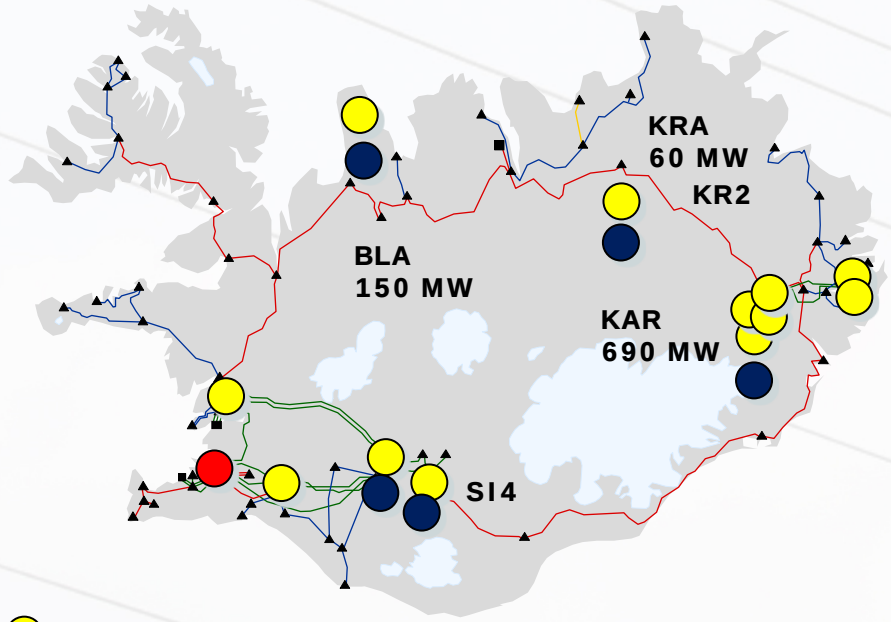
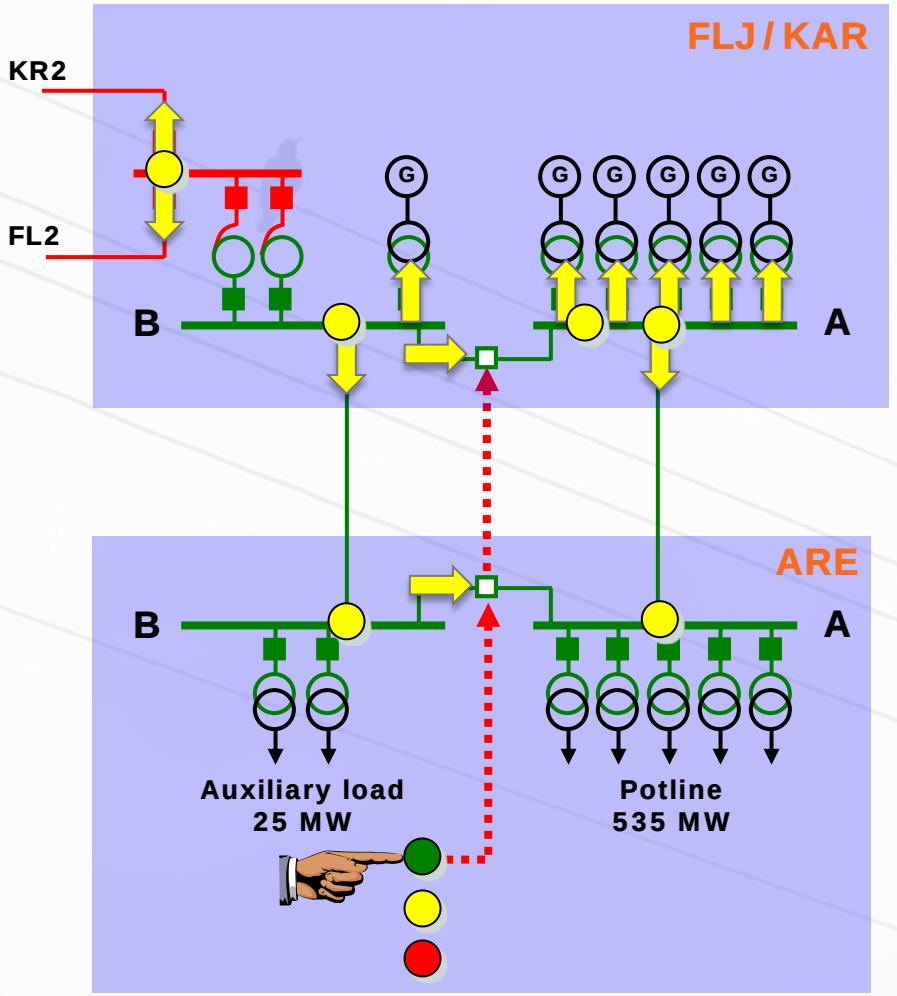
# Now 12 PMUs installed, with detail of Eastern 220kV AC system (DC to follow) for co-ordinating control

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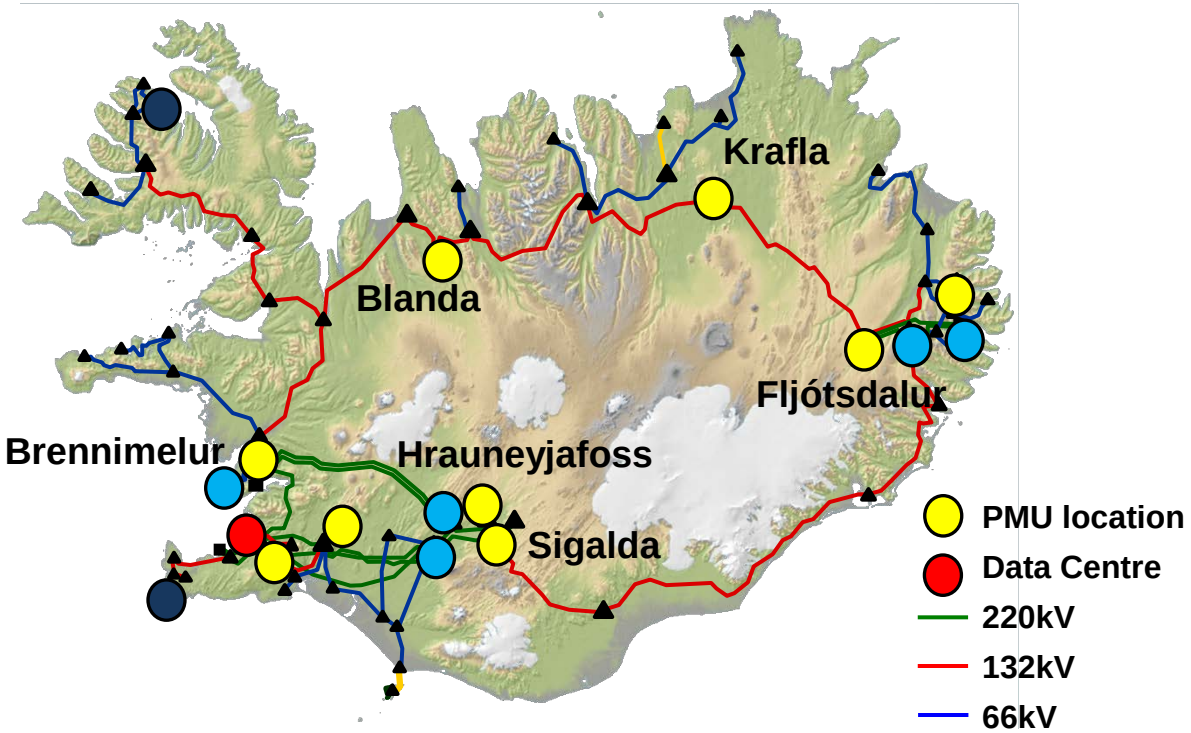
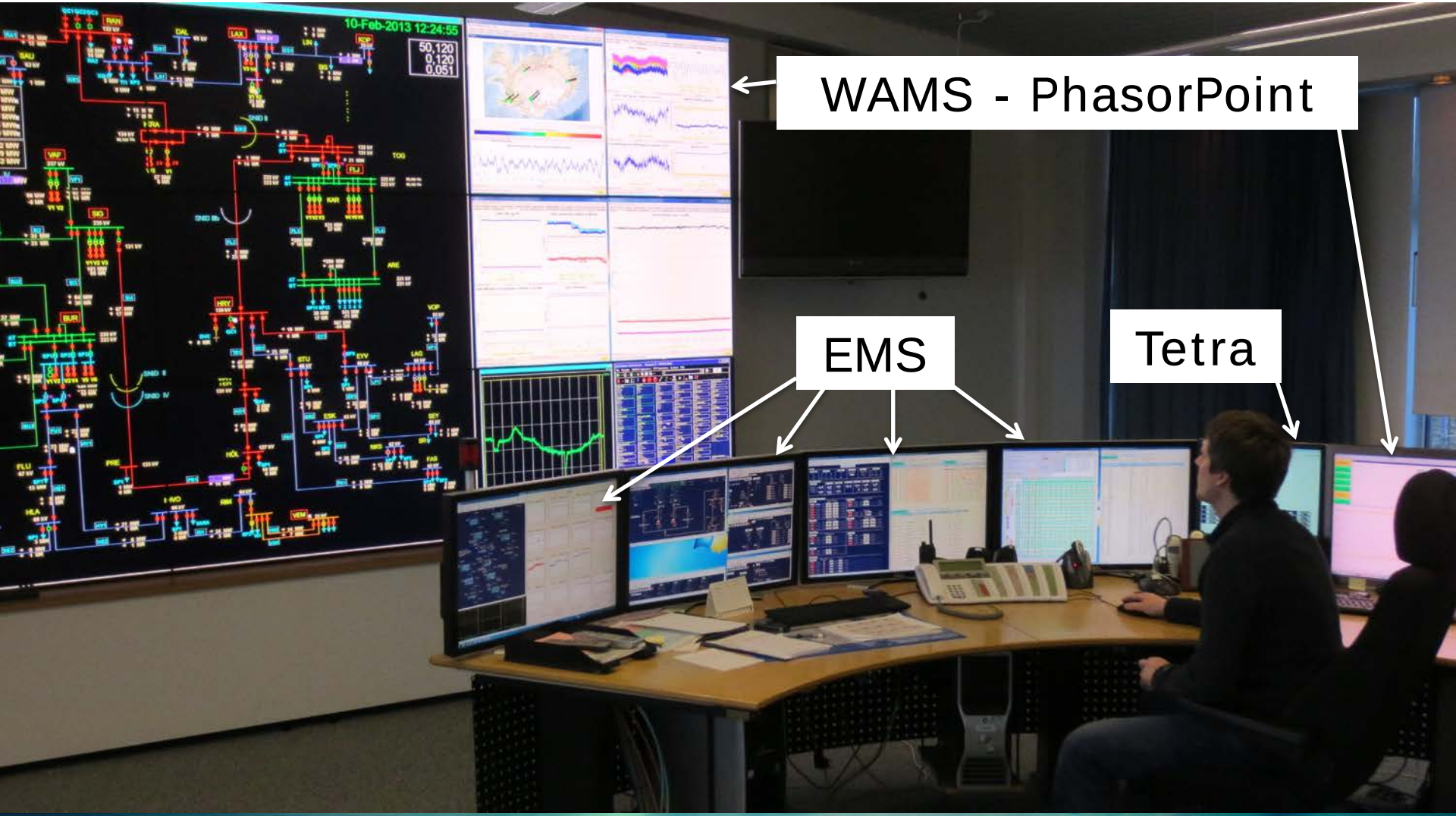
# WAMS in Landsnet´s control room

- 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

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# WAMS in Landsnet´s control room


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# WAMS – Operator view

## Normal operating condition

- High resolution measurment [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 af production and influence on damping
  - better view of angle condition when closeing

# WAMS – Operator reponse

## 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 Issus → Predefined  actions

## Operator response

- Active power control of Hydro units → GOV - AGC – PSO
- Voltage control → units, capacitor banks
- System spilt to prevent power ocillations
- Reduction of smelter load

# WAMS – trip of line on 132 kV ring


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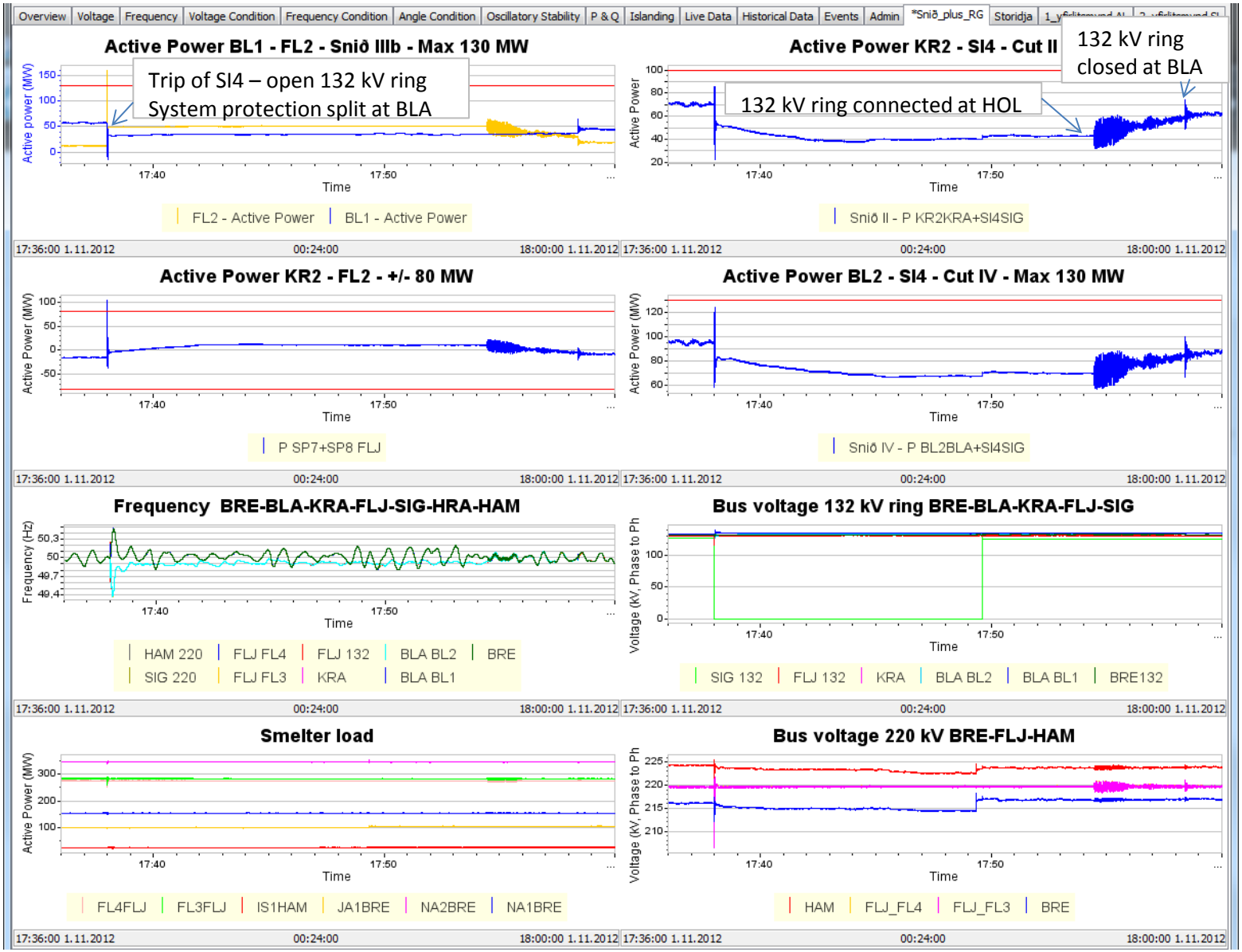
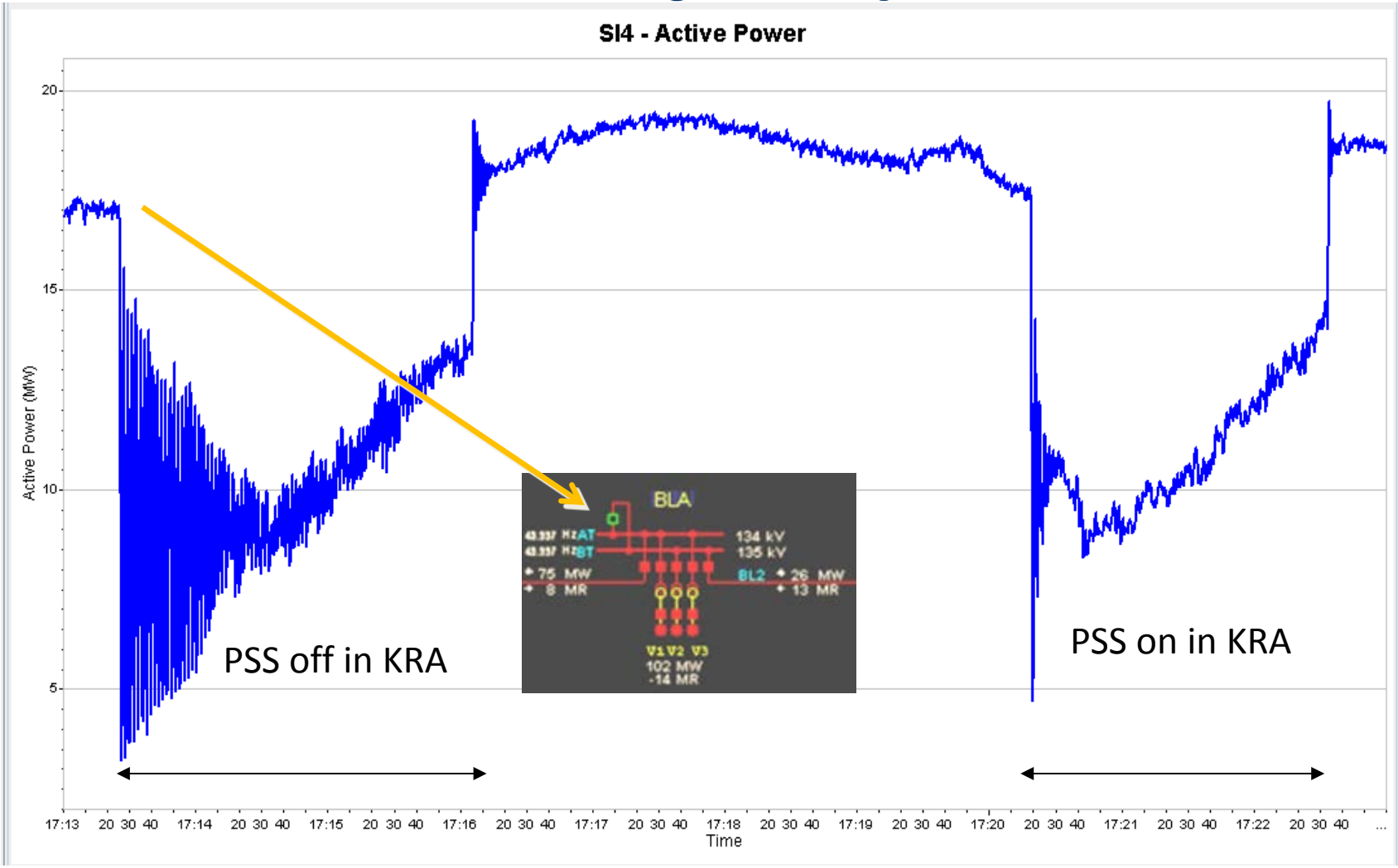
# WAMS – trip and reconnection of 132 kV ring

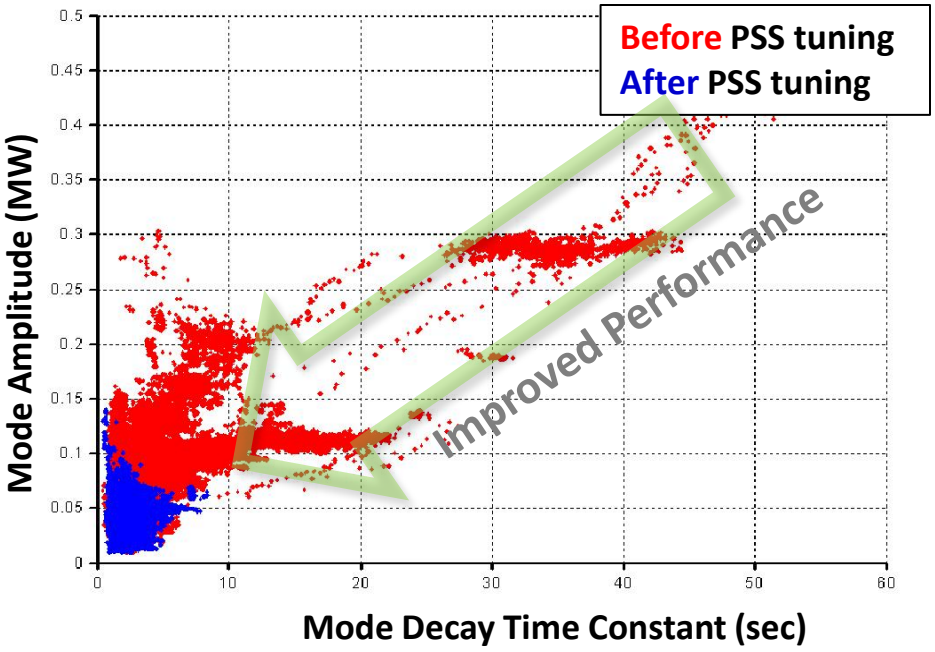


# WAMS – PSS tuning and system tests

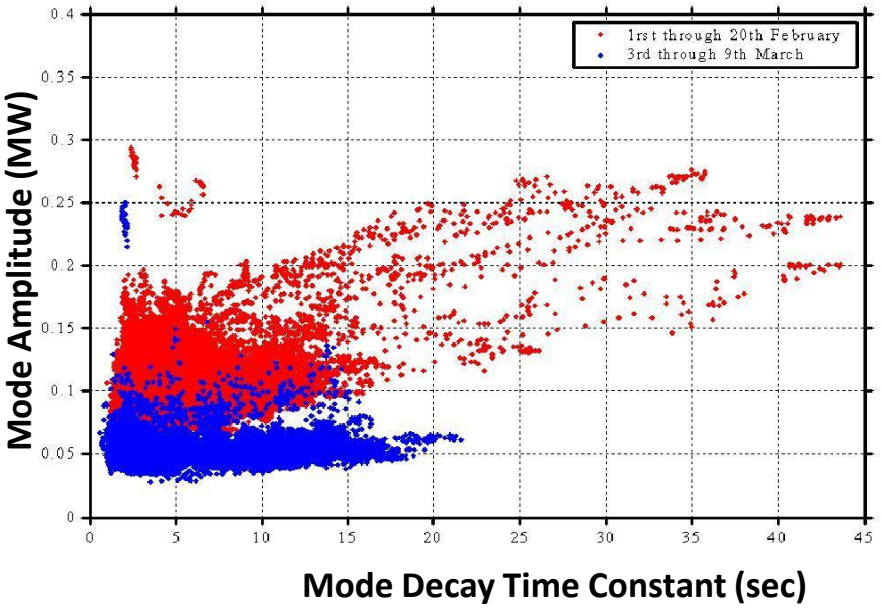


# WAMS – PSS tuning and long-term tests

**1.2Hz Mode**




**0.8Hz Mode**

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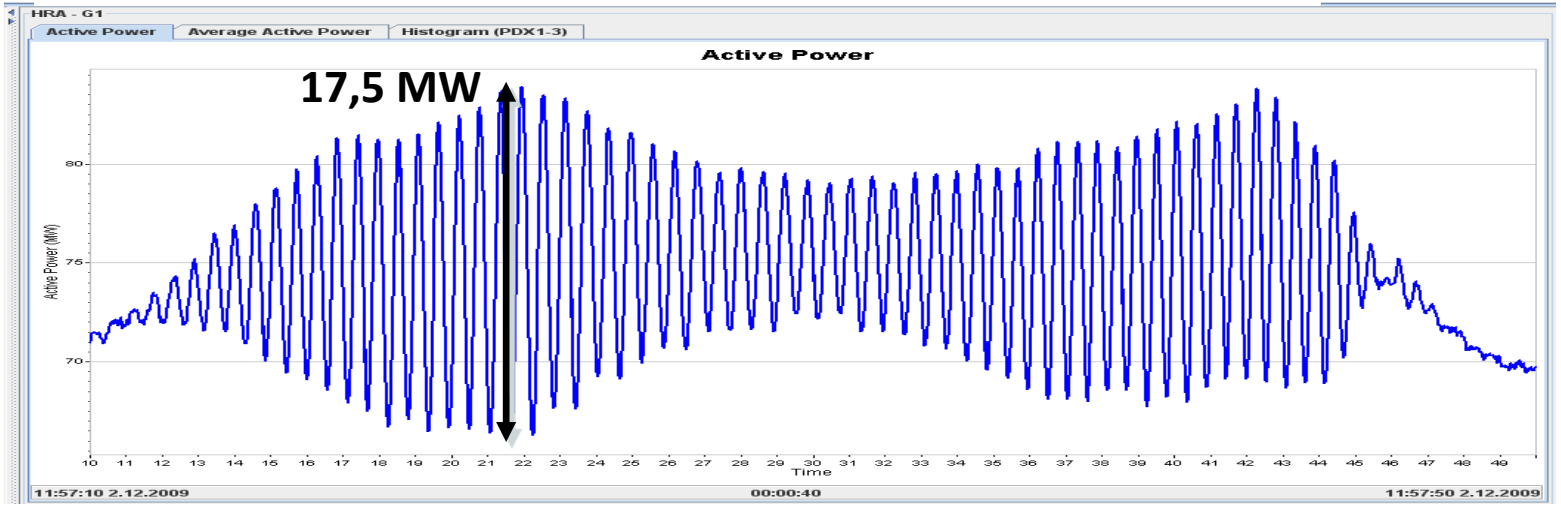
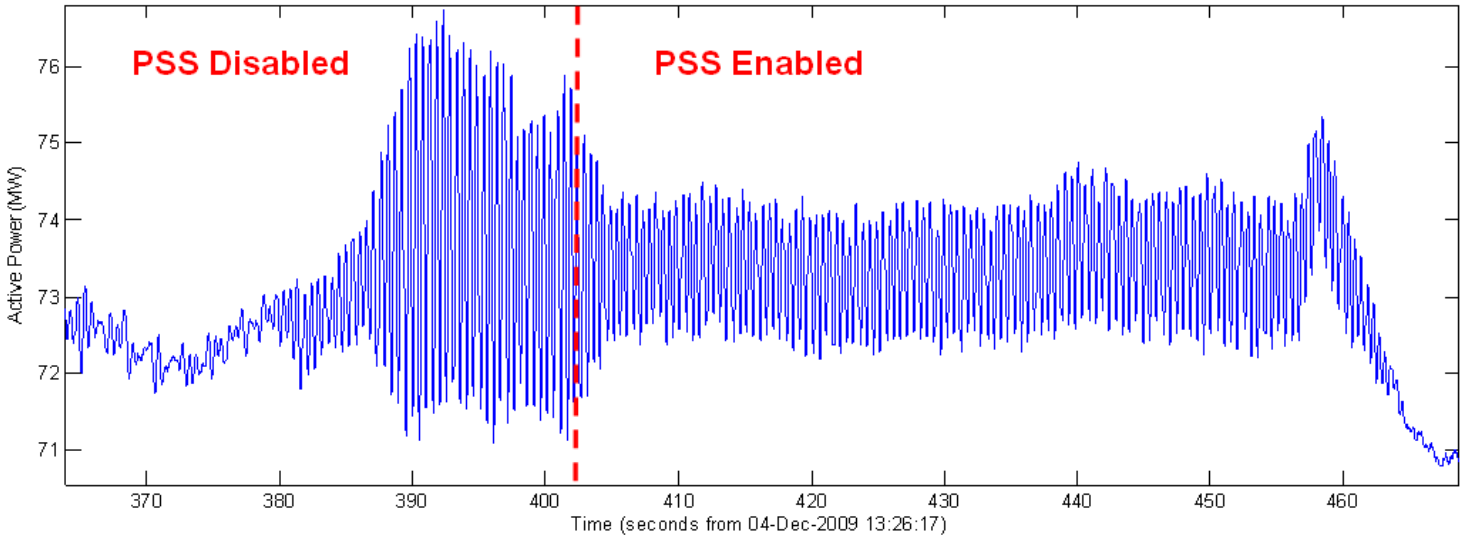
# WAMS – PSS testing at HRA

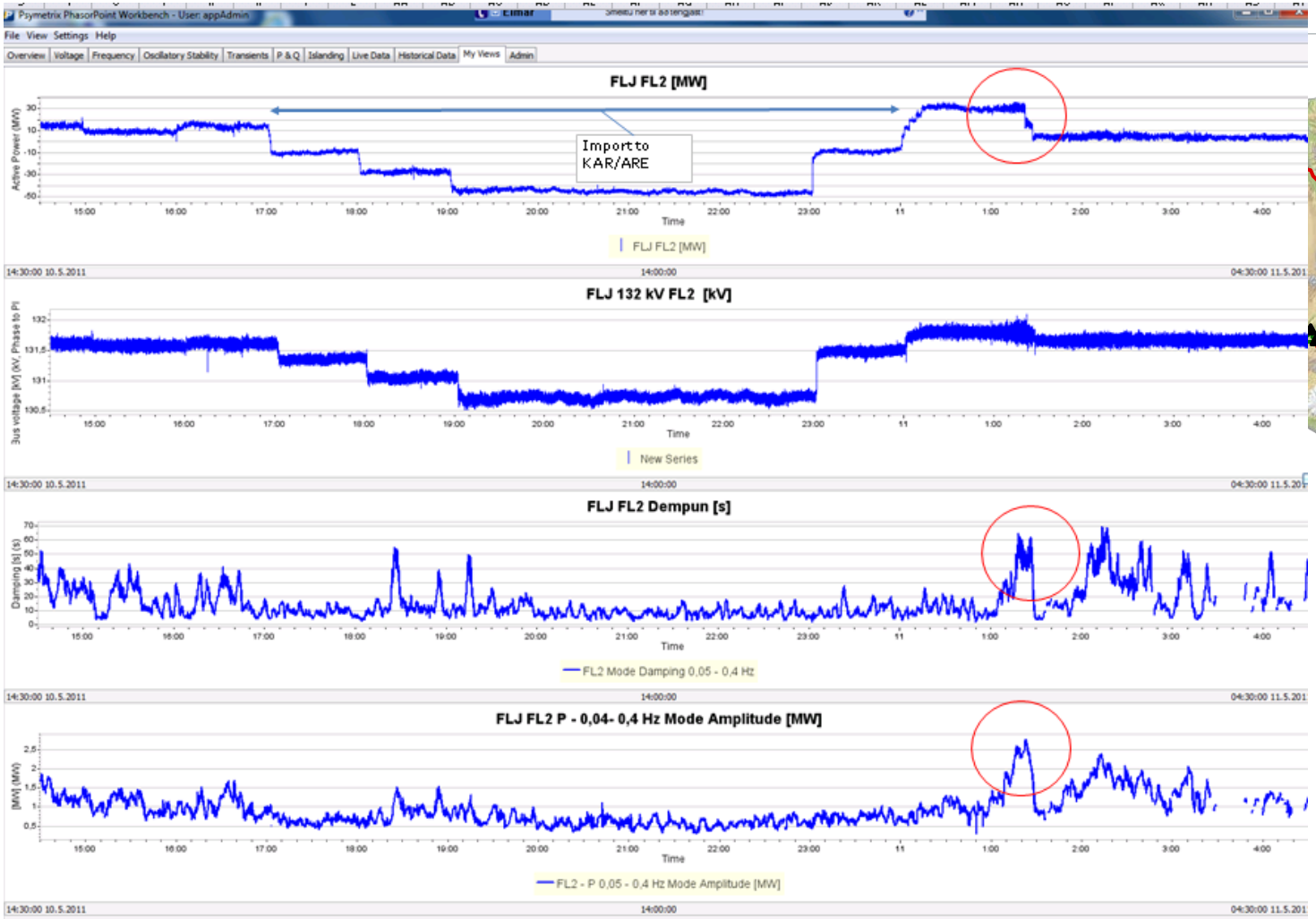
Unit without PSS and above normal operating limits [70 MW]

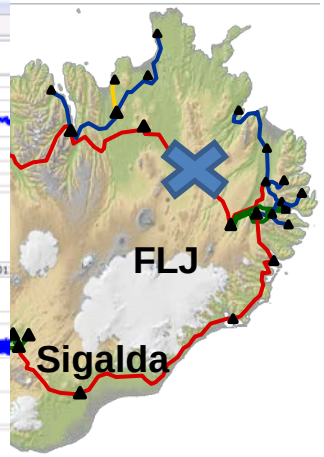



Test during PSS commisioning to check PSS damping performance



# WAMS - KR2 out → production changes

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# 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

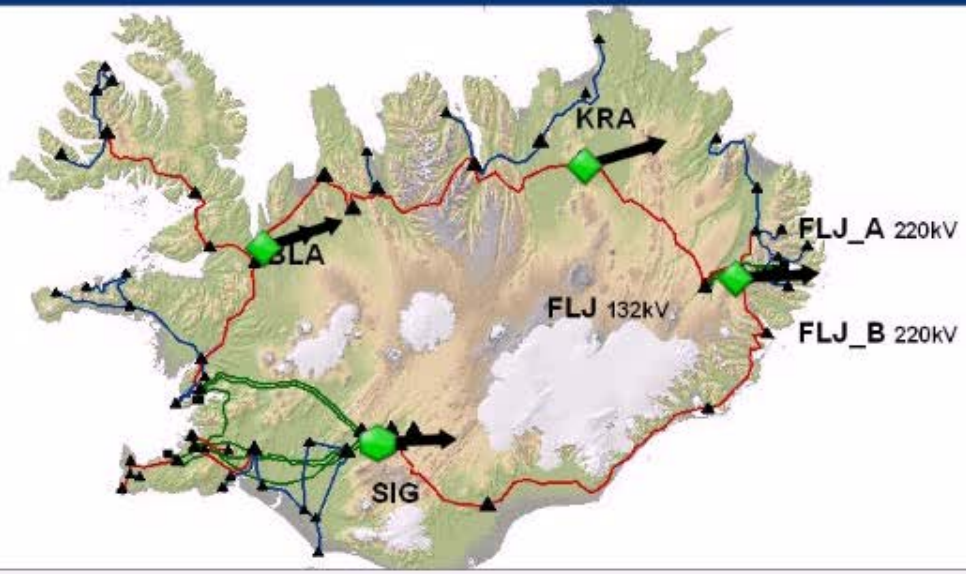
- Increased power flow on 132 kV ring
- Faster shedding after system split
- More focus on lower voltage levels (smart grid)
- Increased system security
- PMU – PDC – Tetra modem → trip of load

Psymetrix PhasorPoint Workbench - Islanding - appAdmin on phasorpoint

File View Settings Window Help

Overview | Oscillatory Stability | Voltage | Frequency | P & Q | Islanding | Live Data | Historical Data | Events | Admin | System Disturbance | Voltage Condition | Angle Condition | Frequency Condition

Iceland



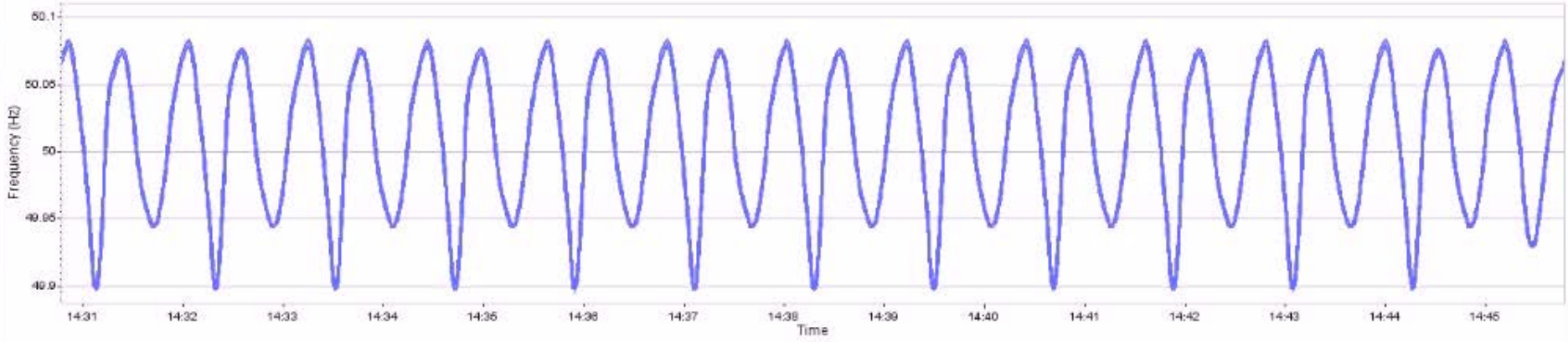

132 kV 220 kV

Deviation from Mean Frequency

-1.0 -0.5 -0.1 0.1 0.5 1.0

Upper/Lower Frequency | Voltage & Frequency Deltas

**Synchronous Area 1 Upper/Lower Frequency (Live)**

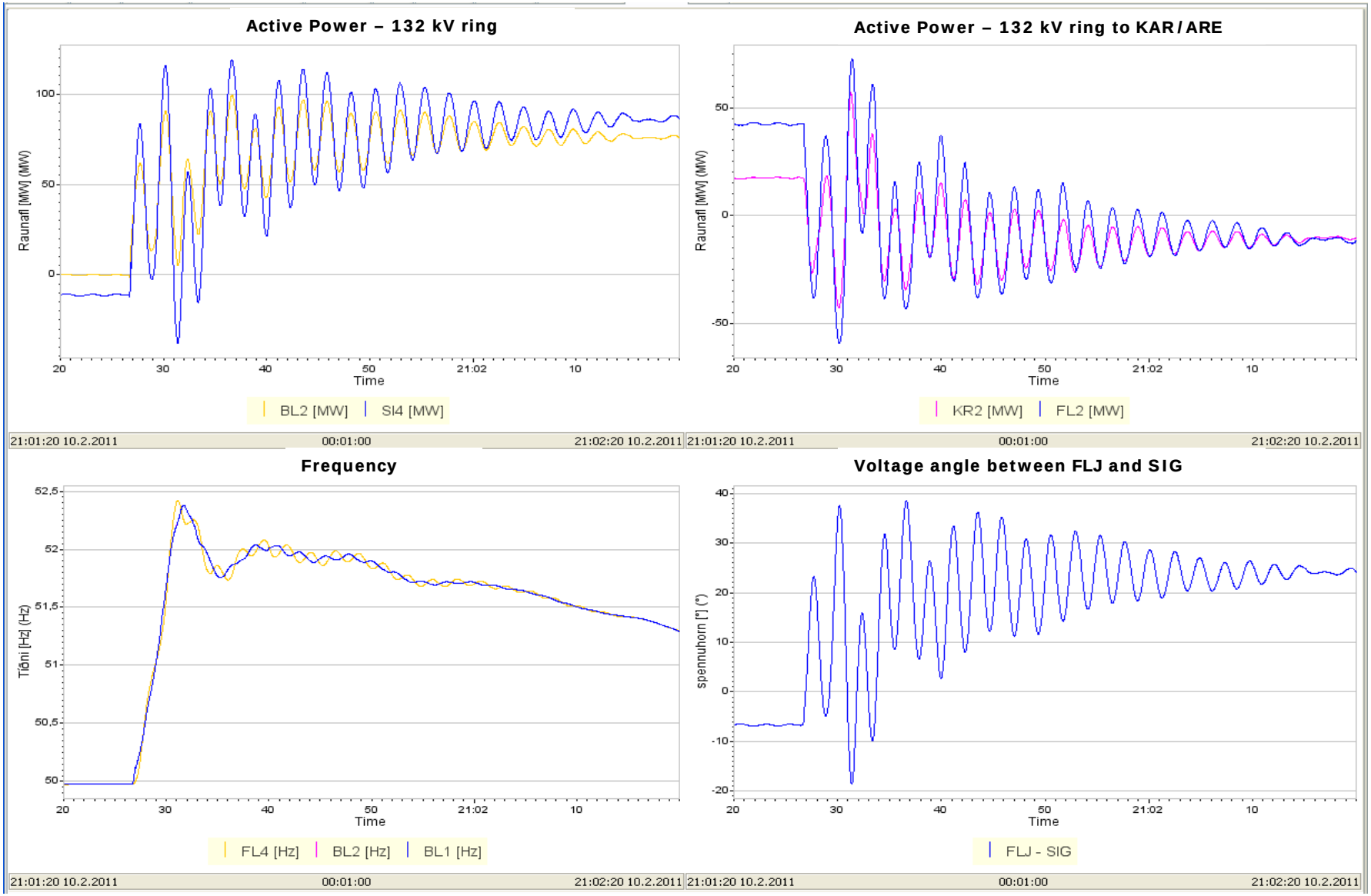



14:30:47 25/10/12 00:14:59 14:45:47 25/10/12

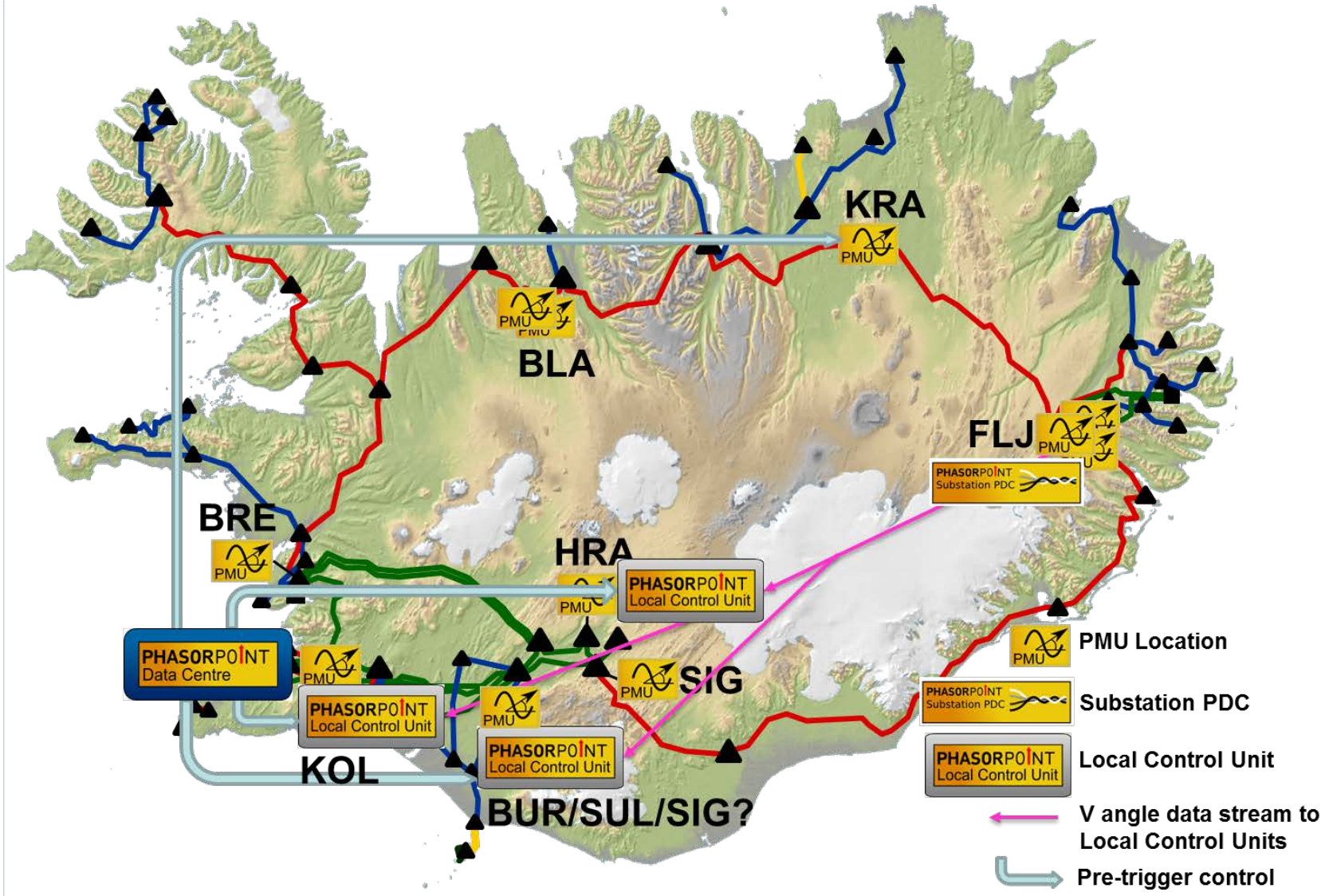
Active Profile: VideoOSM | Loaded Profile: VideoOSM | Status

# WACS - dynamics related to 132 kV ring

# WACS - Trip of 500 MW smelter load in SouthWest



# WACS - Wide Area Defence Scheme

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# 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 tunning
- 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