Sustainable Energy Systems 2050
NORDIC ENERGY RESEARCH PROGRAMME

norden
Nordic Energy Research

Smart Transmission Grids Operation and Control

Kick-off Meeting

Helsinki,

October 11-12, 2011

Kjetil Uhlen

STRONgrid
Smart Transmission Grids Operation and Control
KTH - NTNU - AALTO - DTU - UI

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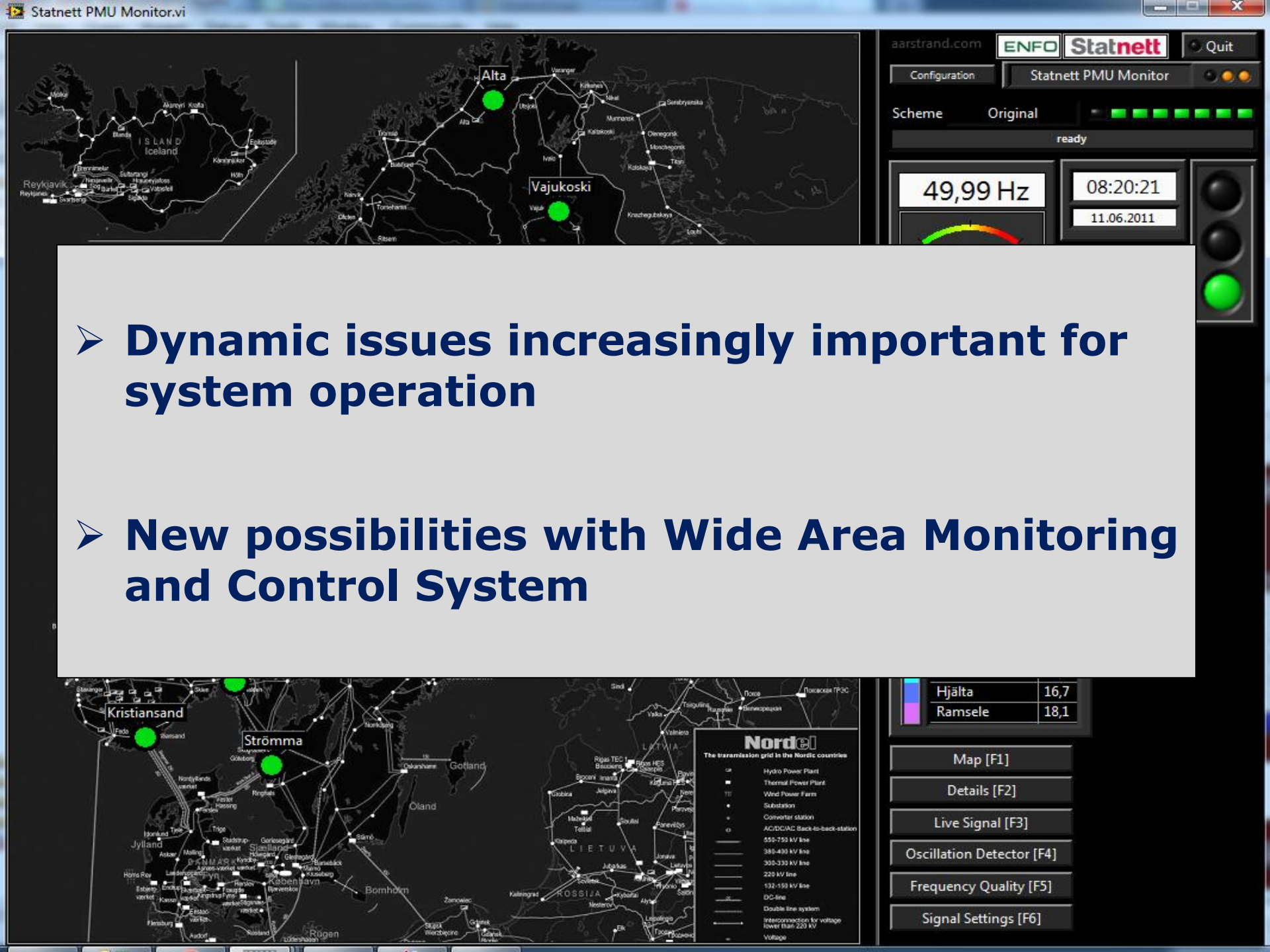
Outline

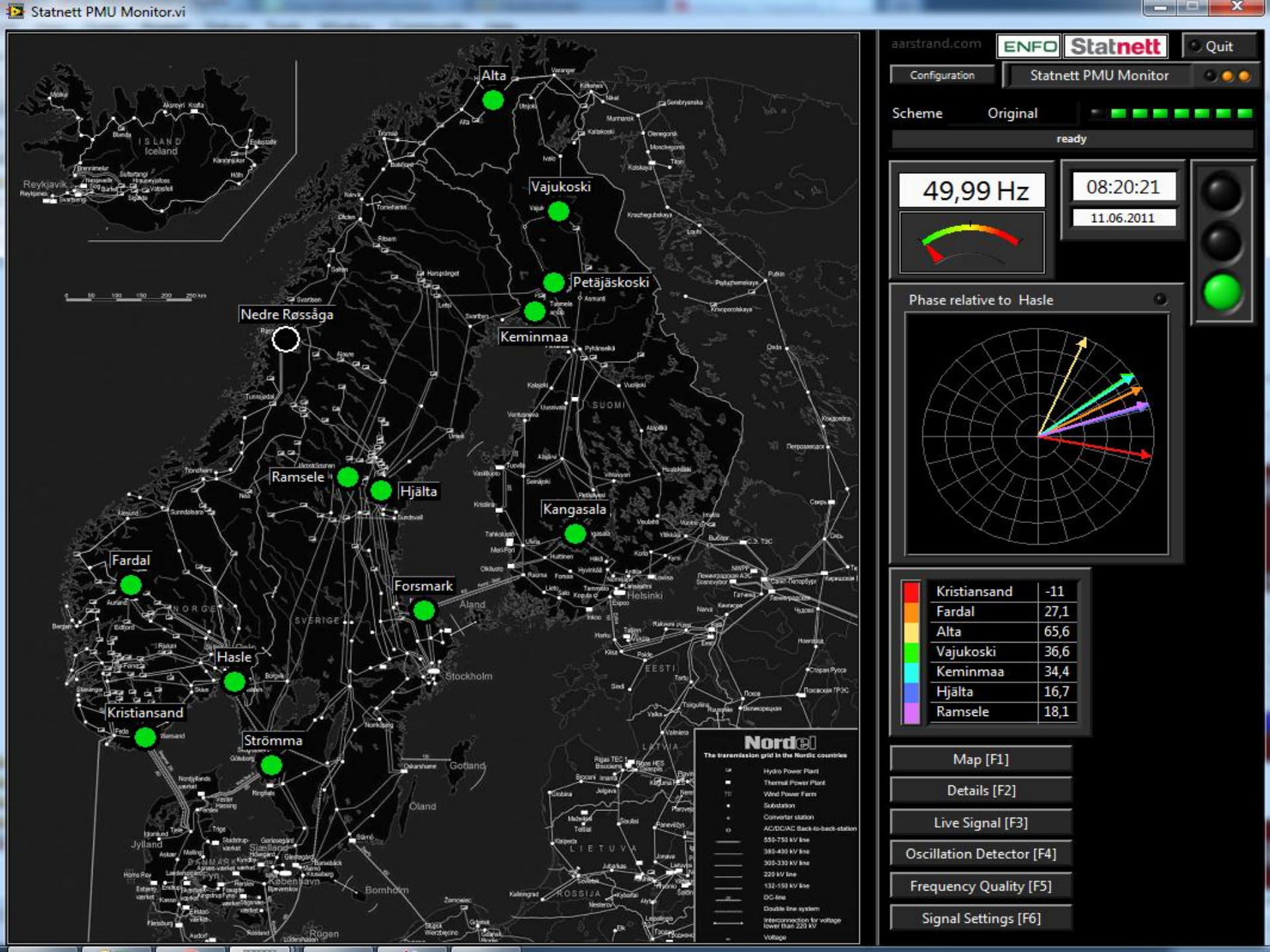
- Challenges
- Objectives
- Goals

Challenges

- Paradigm shift:
  - Variable generation will be a main part of the base power
  - Fossil fuel (previously "conventional") generation becomes peaking units
- Increasing need for power transmission and energy storage
  - Generation further away from load centres and increasing variations in power flow
  - Stronger integration of power markets
- Large capacity (multi-GW) connections will be more common
  - These will challenge present security standards (n-1 and similar)
- Flexibility becomes increasingly important
  - Creates possibilities for "smart solutions" in distribution and transmission



- **Dynamic issues increasingly important for system operation**
- **New possibilities with Wide Area Monitoring and Control System**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Configuration
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Scheme
Original
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49,99 Hz
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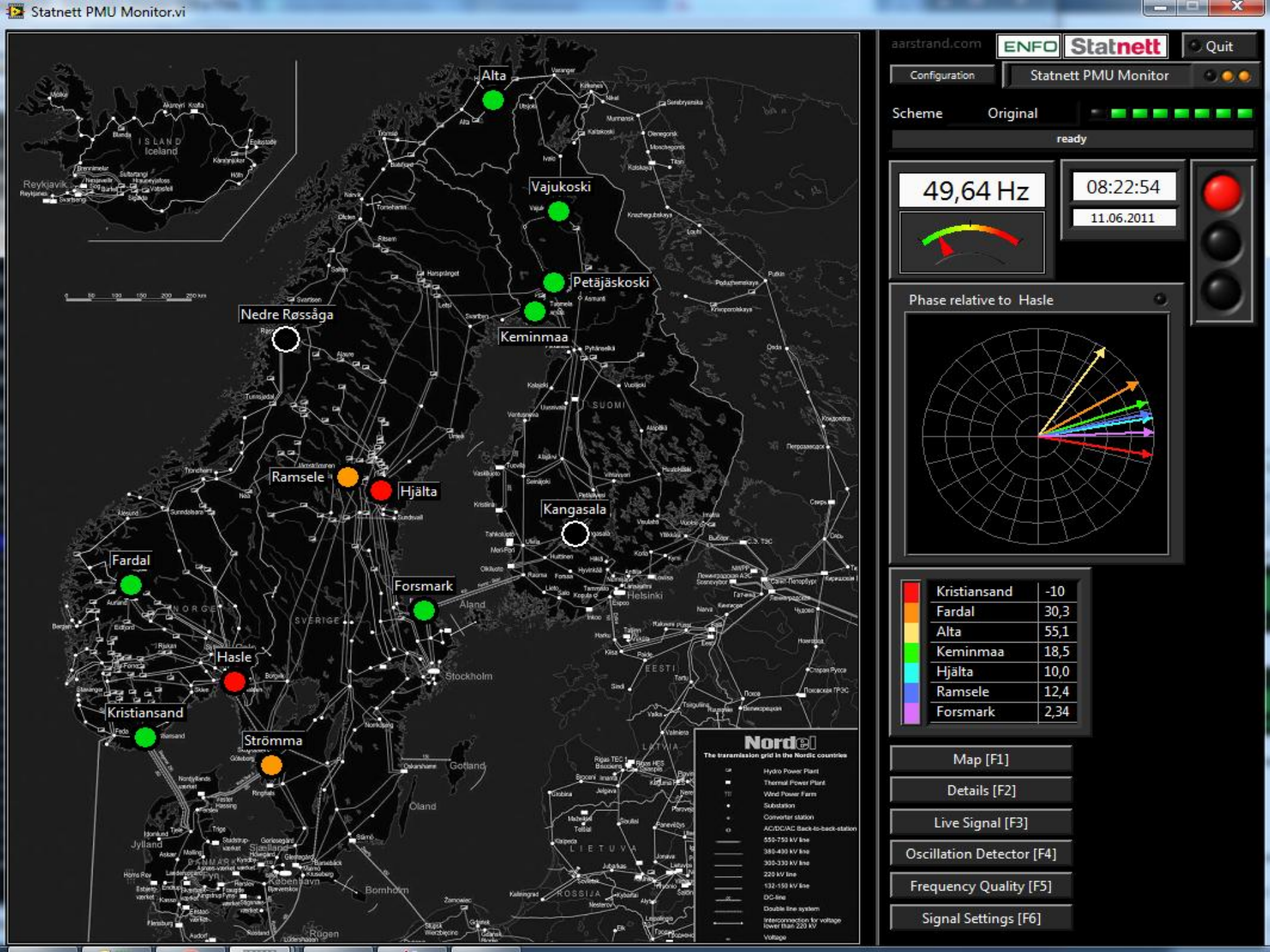
11.06.2011
Phase relative to Hasle
Alta
Vajukoski
Petäjäskoski
Keminmaa
Nedre Røssåga
Ramsele
Hjälta
Kangasala
Fardal
Forsmark
Hasle
Kristiansand
Strömma
Kristiansand -11
Fardal 27,1
Alta 65,6
Vajukoski 36,6
Keminmaa 34,4
Hjälta 16,7
Ramsele 18,1
Map [F1]
Details [F2]
Live Signal [F3]
Oscillation Detector [F4]
Frequency Quality [F5]
Signal Settings [F6]
Nordel
The tranamission grid in the Nordic countries
Hydro Power Plant
Thermal Power Plant
Wind Power Farm
Substation
Converter station
AC/DC/AC Back-to-back-station
550-750 kV line
380-400 kV line
300-330 kV line
220 kV line
132-150 kV line
DC-line
Double line system
Interconnection for voltage lower than 220 kV
Voltage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Kangasala
Fardal
Forsmark
Hasle
Kristiansand
Strömma
Kristiansand -10
Fardal 30,3
Alta 55,1
Keminmaa 18,5
Hjälta 10,0
Ramsele 12,4
Forsmark 2,34
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Objectives

- Address the challenges that the secure and reliable operation of the power grids will face in the future.
- We seek to establish an interdisciplinary theoretical and experimental foundation for research and development
- Support the development of better tools for planning, operation and control of power grids
  - at various voltage levels (Distribution ←→ Transmission)
  - interconnected across traditional national boundaries (supergrid level)

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Project organisation and main responsibilities

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NTNU
Project coordinator:
kjetil Uhlen

Steering Group
-Fingrid
-Landsnet
-Statnett
-Svenska Kraftnät
-Troms Kraft Nett
-Gothia Power

Nordic Synchrophasor Group
-Workshops and meeting place
- Dissemination of results

KTH
Lead WP1 :
(Luigi Vanfretti, Lars Nordström)

-WA development platform
-ICT architectures

Aalto
Lead WP2:
(Liisa Harla)

- WA monitoring applications
- Wide area stabilising control

NTNU
Lead WP3:
(Kjetil Uhlen)

-PMU-applications in distribution
-Smartgrid control challenges
- Laboratory implementations

DTU
Lead WP4:
(Rodrigo Garcia-Valle)
-Education and dissemination
-Laboratory implementations
- WAMS applications

U-Iceland
(Magni Þ. Pálsson)

-Smart end-user metering as an aid in damping power oscillations
- Implement wide-area control algorithms.

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Goals

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- Create innovative applications that will enable operation and control of the Nordic power grid more reliably and with better information about security margins.

- Develop a research platform comprised by a power systems emulator (software and hardware labs), PMUs, PDCs and specialized software.

- Develop a set of software interfaces allowing PMU-data application development, and implementation.

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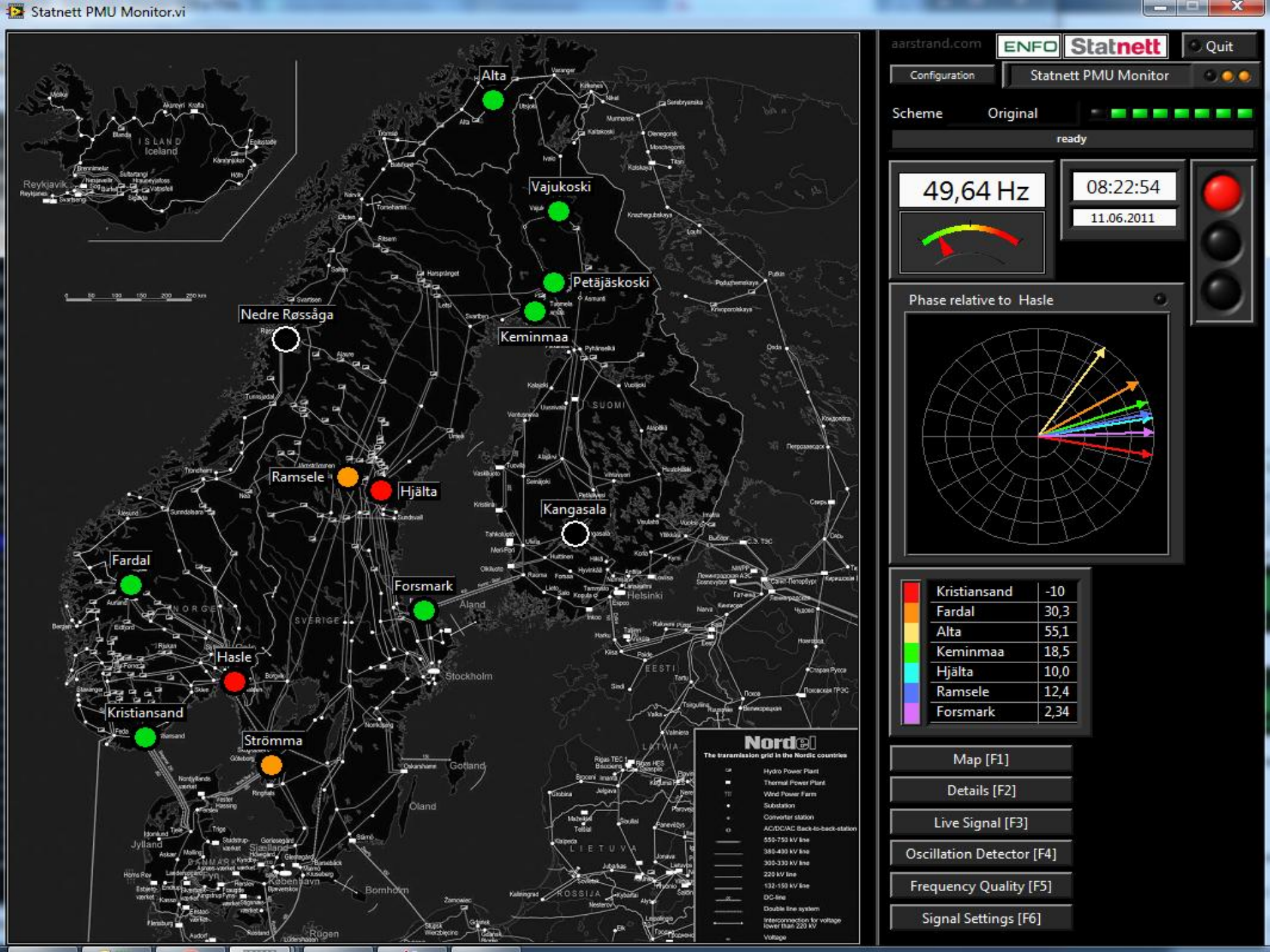
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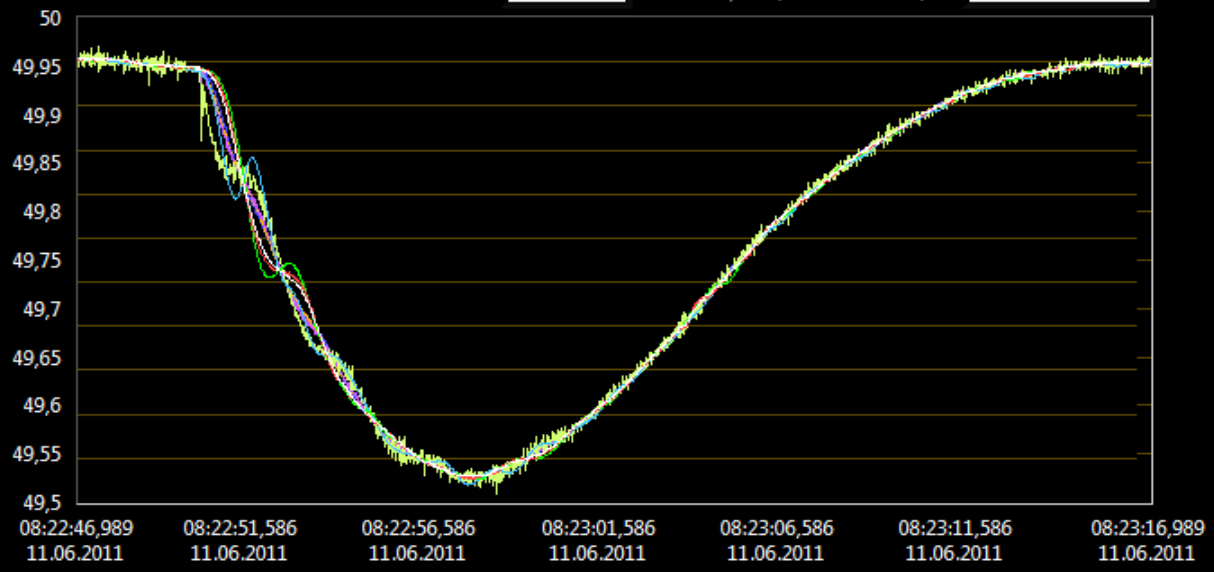
Chart

Resample 20 ms

Snapshot Timespan 30 seconds



Channels

- Hjälta->Moliden (Voltage) [kV]
- Hjälta->Stornorrfors (Voltage) [kV]
- Hjälta->Nysäter (Voltage) [kV]
- Ramsele->Storfinnforsen (Voltage) [kV]
- Forsmark->Tuna (Voltage) [kV]
- Strömma->Ringhalsverket (Voltage) [kV]
- Strömma->Lindome (Voltage) [kV]
- Kangasala->Petäjäskoski (Voltage) [kV]
- Hasle (Frequency) [Hz]
- Kristiansand (Frequency) [Hz]
- Fardal (Frequency) [Hz]
- Alta (Frequency) [Hz]
- Keminmaa (Frequency) [Hz]
- Hjälta (Frequency) [Hz]
- Ramsele (Frequency) [Hz]
- Forsmark (Frequency) [Hz]
- Kristiansand (Phase Relative to Hasle) [deg]
- Fardal (Phase Relative to Hasle) [deg]
- Alta (Phase Relative to Hasle) [deg]
- Keminmaa (Phase Relative to Hasle) [deg]
- Hjälta (Phase Relative to Hasle) [deg]
- Ramsele (Phase Relative to Hasle) [deg]
- Forsmark (Phase Relative to Hasle) [deg]

Hasle (Frequency) [Hz]
Kristiansand (Frequency) [Hz]
Fardal (Frequency) [Hz]
Alta (Frequency) [Hz]
Keminmaa (Frequency) [Hz]
Hjälta (Frequency) [Hz]
Ramsele (Frequency) [Hz]
Forsmark (Frequency) [Hz]

Live Update Rate 5 Hz

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Configuration Statnett PMU Monitor

Scheme Original

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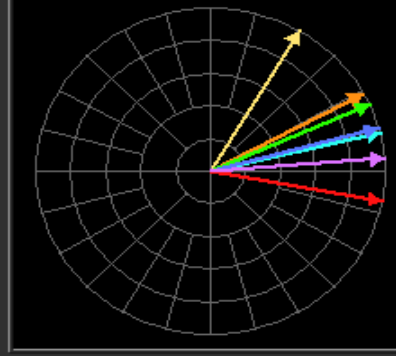
Phase relative to Hasle



Kristiansand	-10
Fardal	28,5
Alta	59,3
Keminmaa	24,2
Hjälta	13,4
Ramsele	15,6
Forsmark	4,60

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