Large Scale Integration of IBR in Nova Scotia

Nova Scotia Power

February 2, 2024

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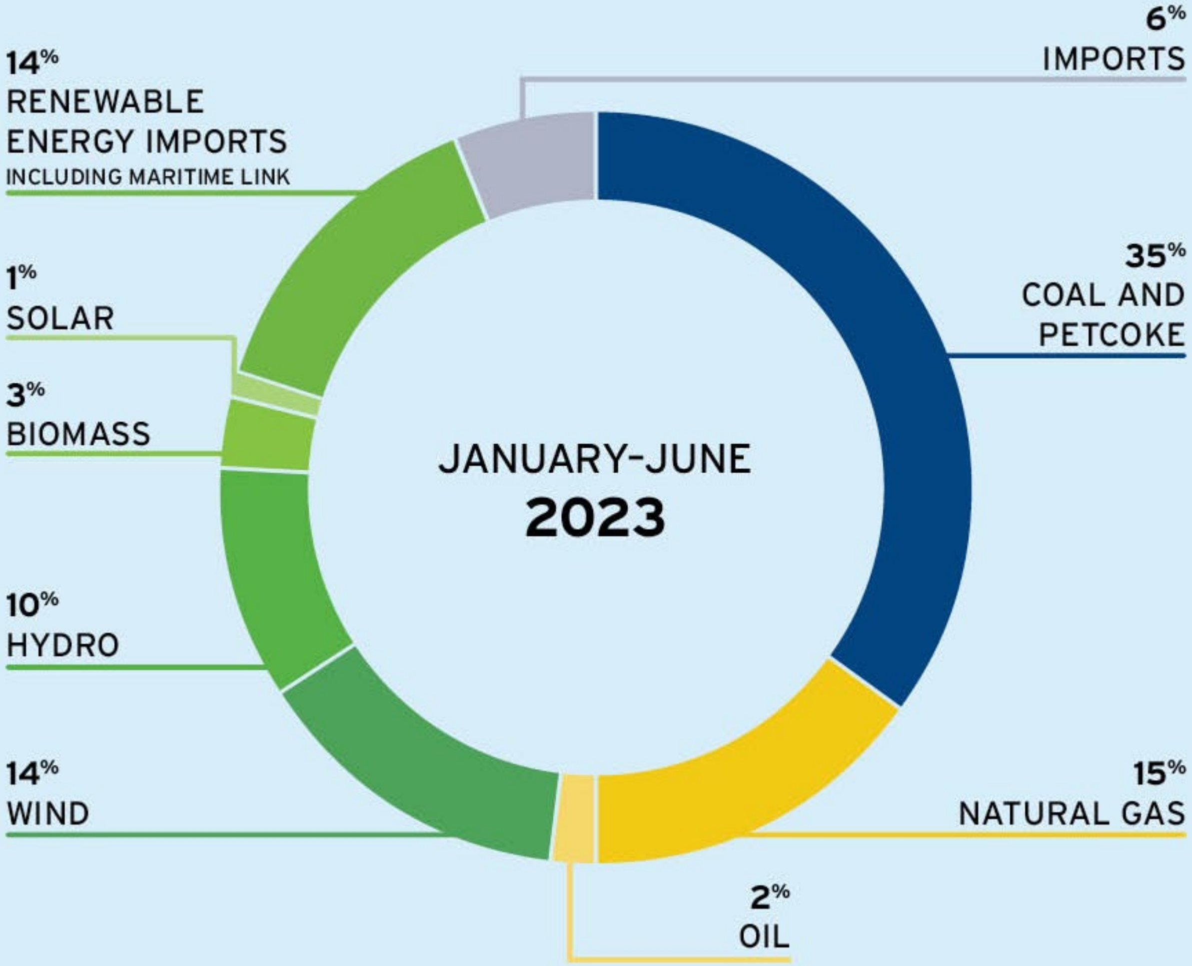
An Emera Company

The Energy Transition



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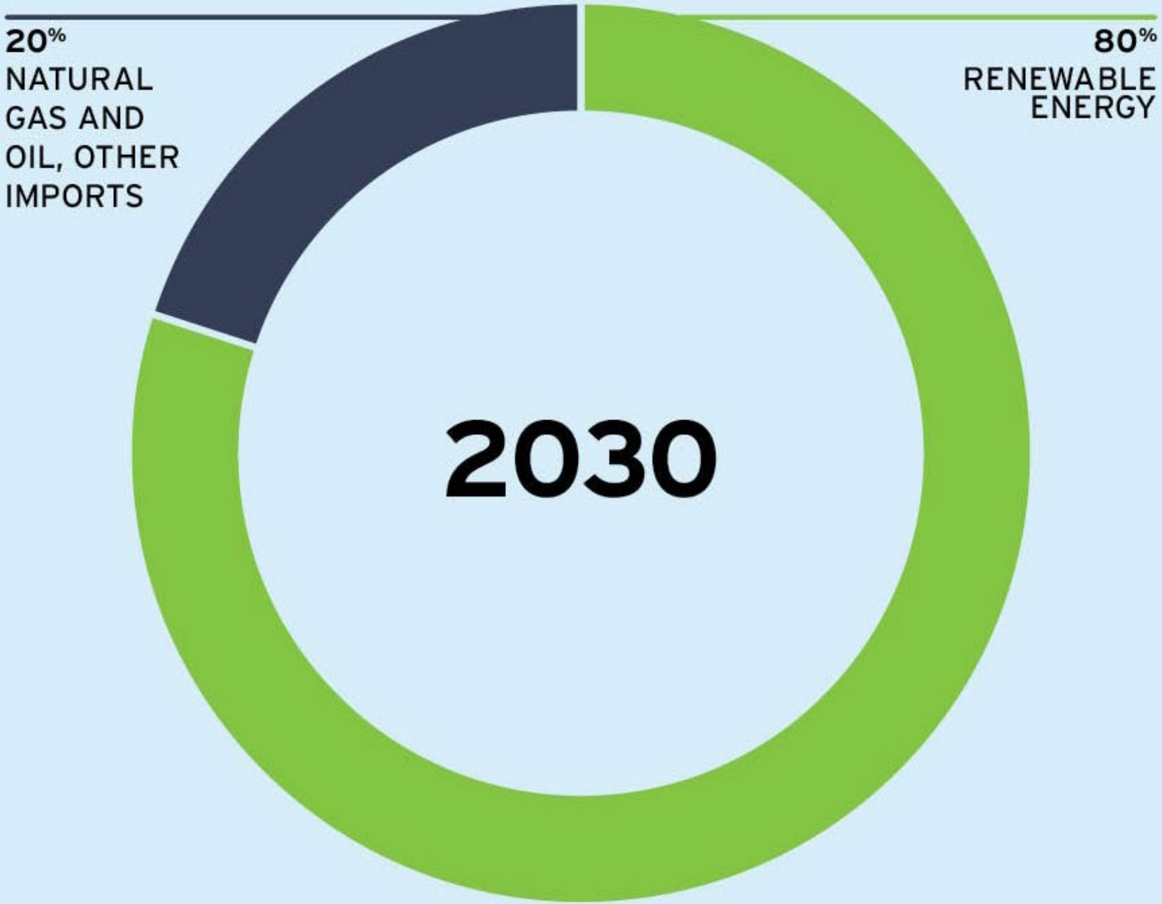
- Nova Scotia is committed to getting off coal and generating 80 percent of its electricity from renewables by 2030



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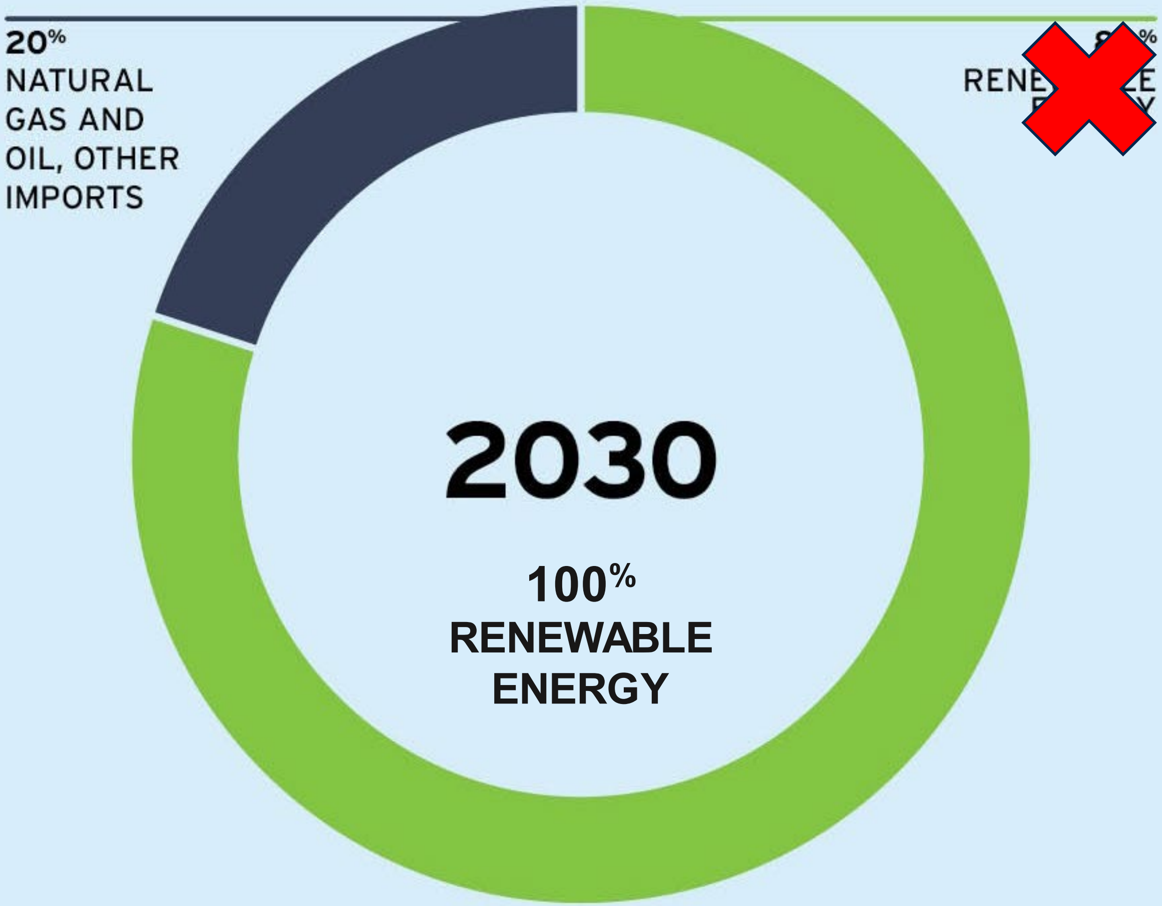
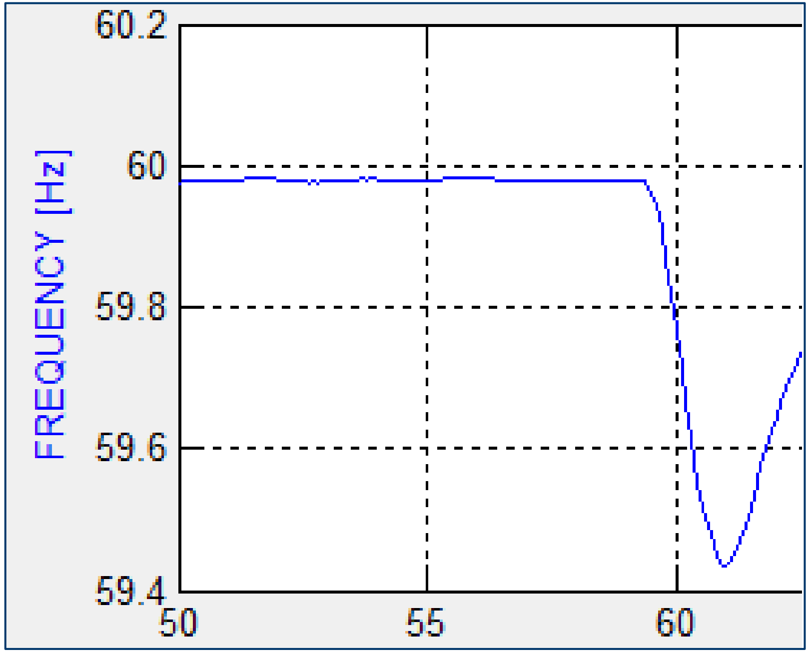
The Transmission System Transition



Energy and Transmission System Transition

- The **Energy Transition** can be local, in Canada at the provincial level
  - Decisions and choices in one province do not have huge impact on a neighbouring utility
  - Timelines do not have to be aligned for changes to the generation mix between provinces
- The **Transmission System Transition** to accommodate Inverter Based Resources (IBRs) in one area can have an impact on a neighbouring area. With high IBR:
  - The grid can be slow to stabilize or go unstable for a grid disturbance.
  - Oscillations (frequency or voltage) can occur
  - Control Interactions between IBR power electronic control systems
  - Increased potential for harmonic distortion

Frequency Control



- The Frequency control
    - Inertia for Frequency and Damping Control
    - Fast Frequency Response
    - RoCoF

Voltage Control

- Voltage Regulation
  - Voltage Ride Through
  - Voltage Recovery Failure

- SCR and SCMVA Requirements
  - Ride Through for IBR facilities, WECS, BESS, HVDC
  - Manufacturing plants, motor starting
  - Grid Protection Devices


Q & A

Transmission System Design and SMEs

- Developing good quality **EMT** simulations models:
  - Faster response to grid disturbances
  - Higher frequency oscillatory response
  - Work with IC, OEM, Simulation and EMT consultants

- Existing Plants and New Connections Models
  - Synchronous machines
  - BESS and WECS models
  - FACTS devices

- Load Modeling
  - Changing load response characteristic
  - Heat pumps, time of day load characteristic
  - Cold Load
  - Non-traditional load such as EVs and hydrogen loads

Looking to 2030

- Study Methodology
  - Studies and Findings

Iterative Assessment for EMT Studies

1. FREQUENCY CONTROL ASSESSMENT IN PSS®E
2. SYSTEM STRENGTH ASSESSMENT IN PSS®E
3. TRADITIONAL PSS®E SIMULATION
4. FREQUENCY CONTROL AND SYSTEM STRENGTH ASSESSMENT IN PSCAD™

Stage 1, Iterative Assessment

FREQUENCY CONTROL ASSESSMENT IN PSS®E

SYSTEM STRENGTH ASSESSMENT IN PSS®E

TRADITIONAL PSS®E SIMULATION

FREQUENCY CONTROL AND SYSTEM STRENGTH ASSESSMENT IN PSCAD™

Frequency Control Assessment in PSS®E

CRITICAL DYNAMIC CONTINGENCY

Frequency Control Assessment in PSS®E

CRITICAL DYNAMIC CONTINGENCY

CASE DEVELOPMENT

Frequency Control Assessment in PSS®E

CRITICAL DYNAMIC CONTINGENCY

CASE DEVELOPMENT

FAST FREQUENCY RESPONSE

Frequency Control Assessment in PSS®E

Case	Total Inertia (MWs)	ML FFR
51	1044	50MW
52	1102	0MW
53	1603	-
101	2381	50MW
102	2381	0MW
103	3158	-

Frequency Control Assessment in PSS®E

CRITICAL DYNAMIC CONTINGENCY

CASE DEVELOPMENT

FAST FREQUENCY RESPONSE

RATE OF CHANGE OF FREQUENCY

Frequency Control Assessment in PSS®E

Case	Total Inertia (MWs)	ML FFR	RoCoF (Hz/s)
51	1044	50MW	2.65
52	1102	0MW	3.31
53	1603	-	2.32
101	2381	50MW	3.10
102	2381	0MW	3.27
103	3158	-	2.48

Frequency Control Assessment in PSS®E

Case	Total Inertia (MWs)	ML FFR	RoCoF (Hz/s)
511	1565	50MW	1.91
521	1890	0MW	2.09
531	2586	-	2.06
1011	4219	50MW	2.02
1021	4355	0MW	2.05
1031	4234	-	2.09

System Strength Assessment in PSS®E

EXISTING FAULT LEVEL ASSESSMENT

System Strength Assessment in PSS®E

EXISTING FAULT LEVEL ASSESSMENT

MINIMUM SCMVA FOR SENSITIVE FACILITIES

System Strength Assessment in PSS®E

EXISTING FAULT LEVEL ASSESSMENT

MINIMUM SCMVA FOR SENSITIVE FACILITIES

MINIMUM SCR FOR EXISTING WIND PLANTS

Traditional PSS®E Simulation

LOAD FLOW ASSESSMENT

DYNAMIC ASSESSMENT

Stage 2, Iterative Assessment

FREQUENCY CONTROL ASSESSMENT IN PSS®E

SYSTEM STRENGTH ASSESSMENT IN PSS®E

TRADITIONAL PSS®E SIMULATION

FREQUENCY CONTROL AND SYSTEM STRENGTH ASSESSMENT IN PSCAD™

Q & A

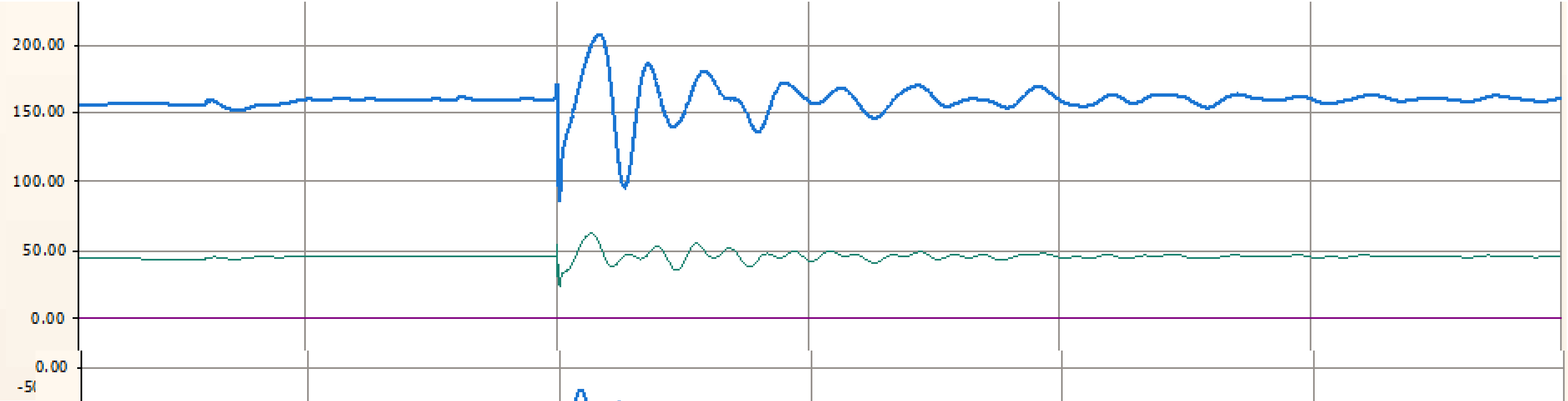
Stage 2

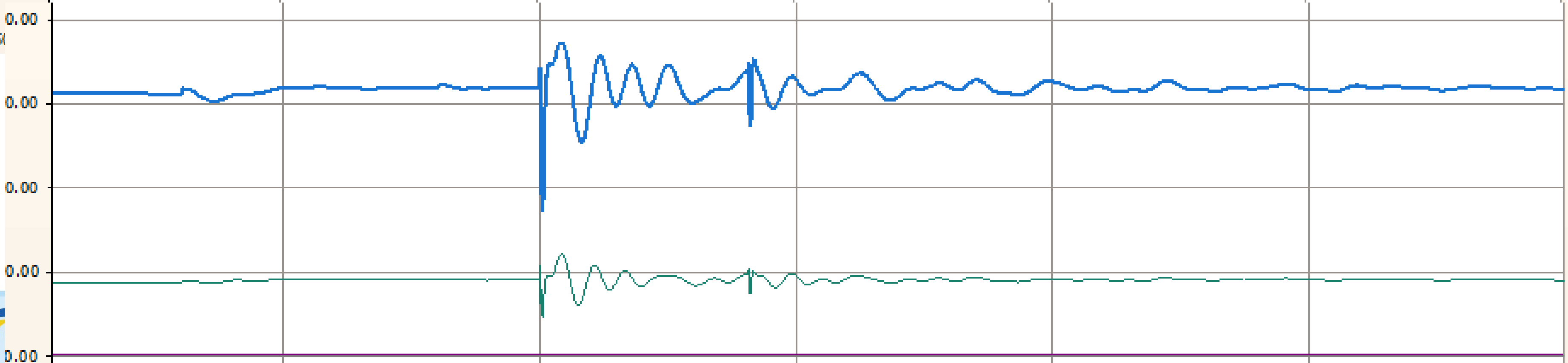
- Case Building
  - Models
  - IP concerns and NDAs
  - Resourcing

- Interconnection Studies
  - Make it work!
  - Timelines!

- Max wind and 100% renewables
  - Second tie
  - New technologies

Stage 2, Synchronous Machines, P&Q



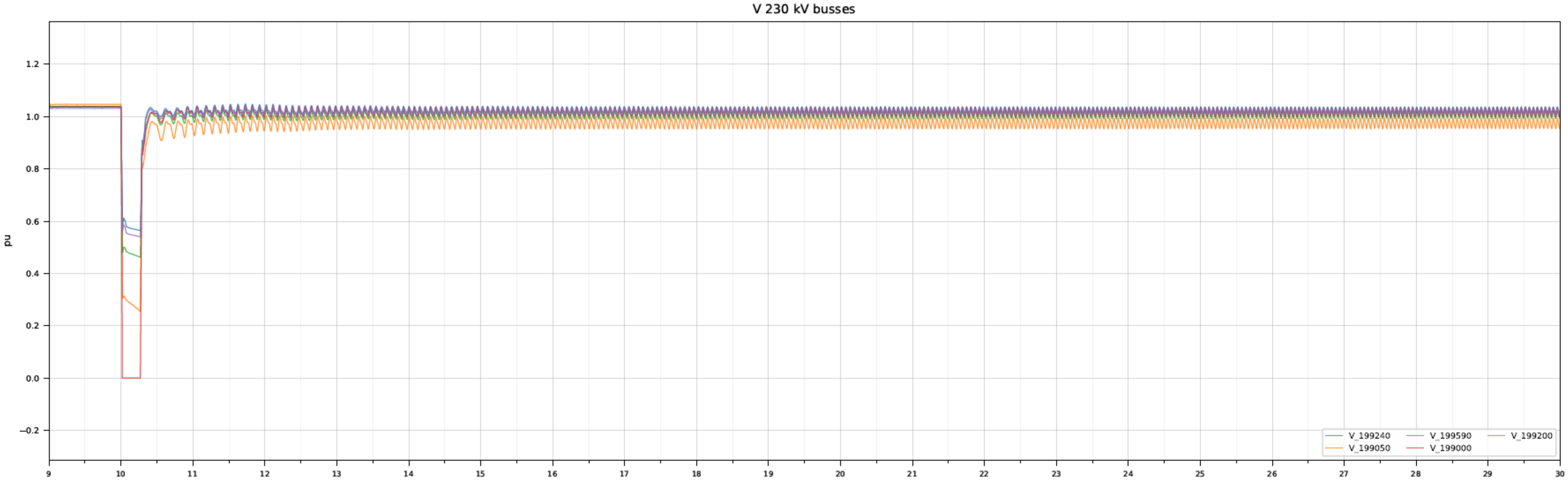


Stage 2, 12 Hz system wide oscillation

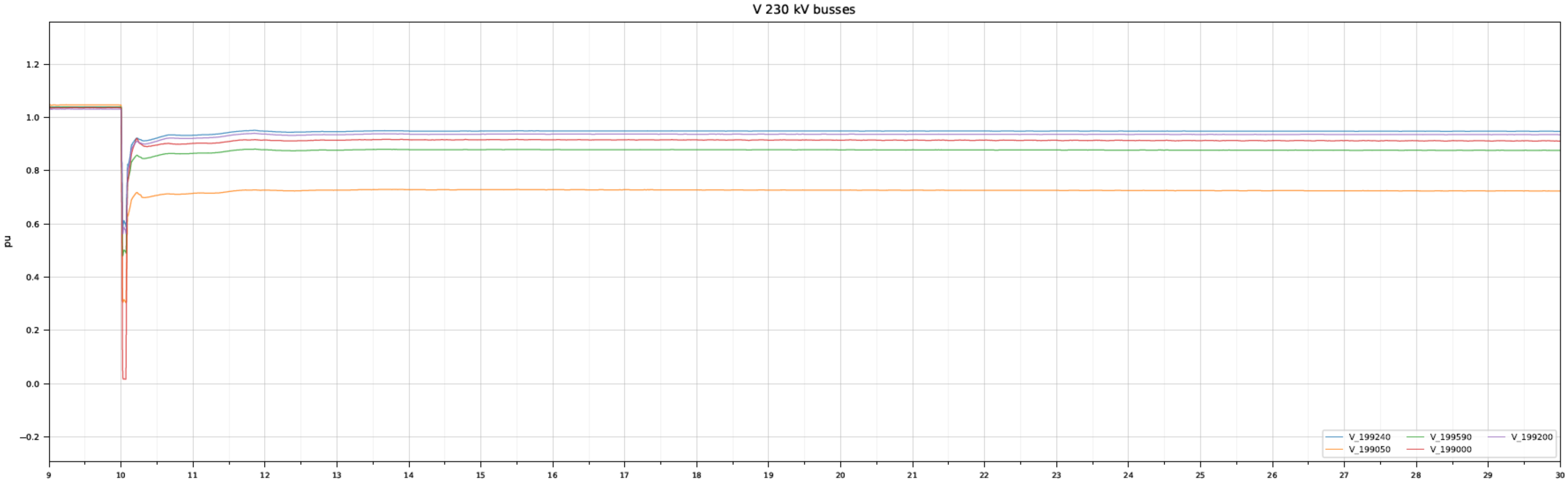
There is a possibility that this is a real issue since the investigation was performed using a very weak dispatch.

Cont{10}

Figure 10.1



Stage 2, Voltage Recovery Failure



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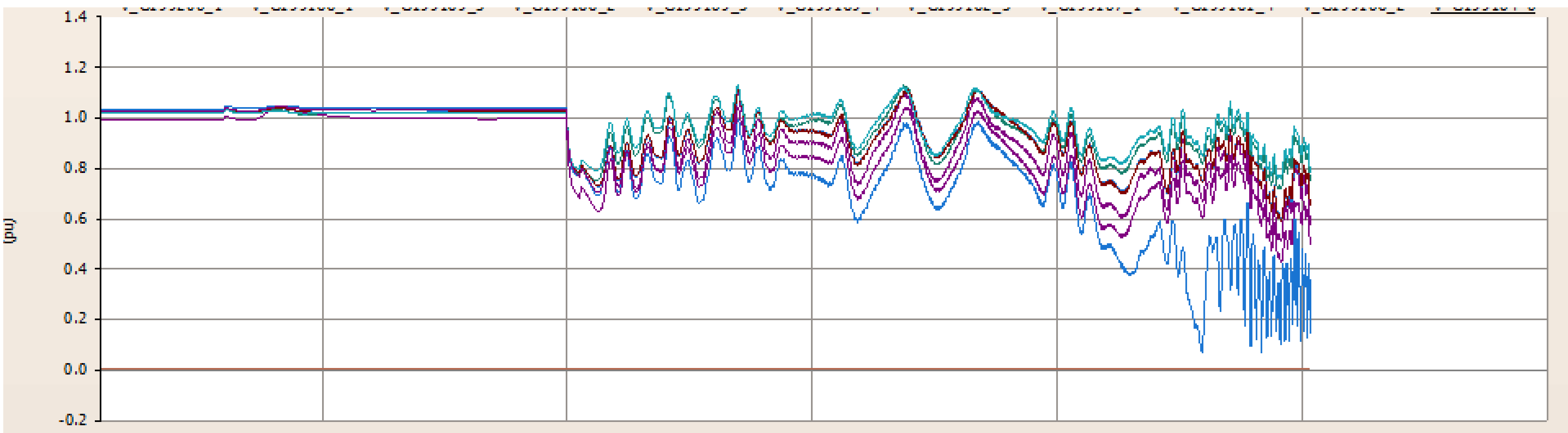
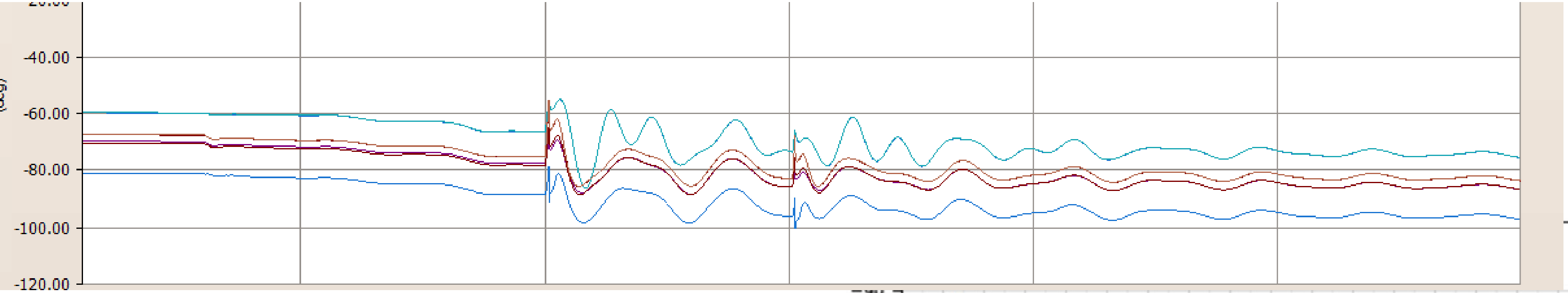
Stage 2, Voltage collapse

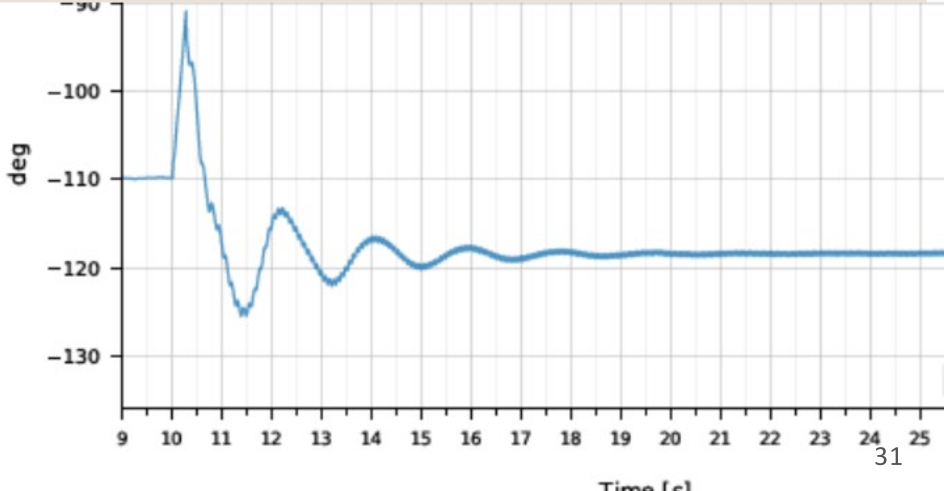
System wide (or partial) voltage collapse post contingency



Stage 2, Voltage Phase Angle Change



Motor Out of Step




IBR Control Systems
~~Mechanical Inertia from WECS~~
Mitigation Options
Fast Frequency Response
Grid Forming IBR
SIR
BESS
Synchronous Condensers
Fast Acting Generation
FACTS, SVC, STATCOM
Transmission
Operating Guidelines

Q & A

General Findings

- IBR for Frequency Support – Grid Following Limits
- IBR for System Strength
- Minimum Inertia and FFR
    - Non traditional sources can reduce the need for synchronous support
    - A sliding load/IBR generation online scale will be developed
- EMT Model Quality
- Operability
    - Dispatch and Operating Guidelines
    - Inertia, SCMVA, uncontrolled DER

Recommendations

- Stable and Reliable Operation
    - RoCoF review for existing plant
    - TSIR and DSIR revision for high IBR
    - Studies for each wave of change, IBR, plant retirements, load growth
- Resource Planning, Update IBR and Inertia Constraints
- Planning Practices
    - Periodic System Strength assessment, system studies for load growth for the West
- Operation of a Grid with High IBR
    - Real time Tools, Operating Guidelines
    - Black Start for a dual grid

Next Steps

- Stage 2 Studies Ongoing
  - Current focus is Interconnection Requests
  - Ongoing studies
  - Control Integrations
- Generation and Load Models
- Protection and Control
- Operating Philosophy
- Equipment Specification
- Harmonics


Q & A