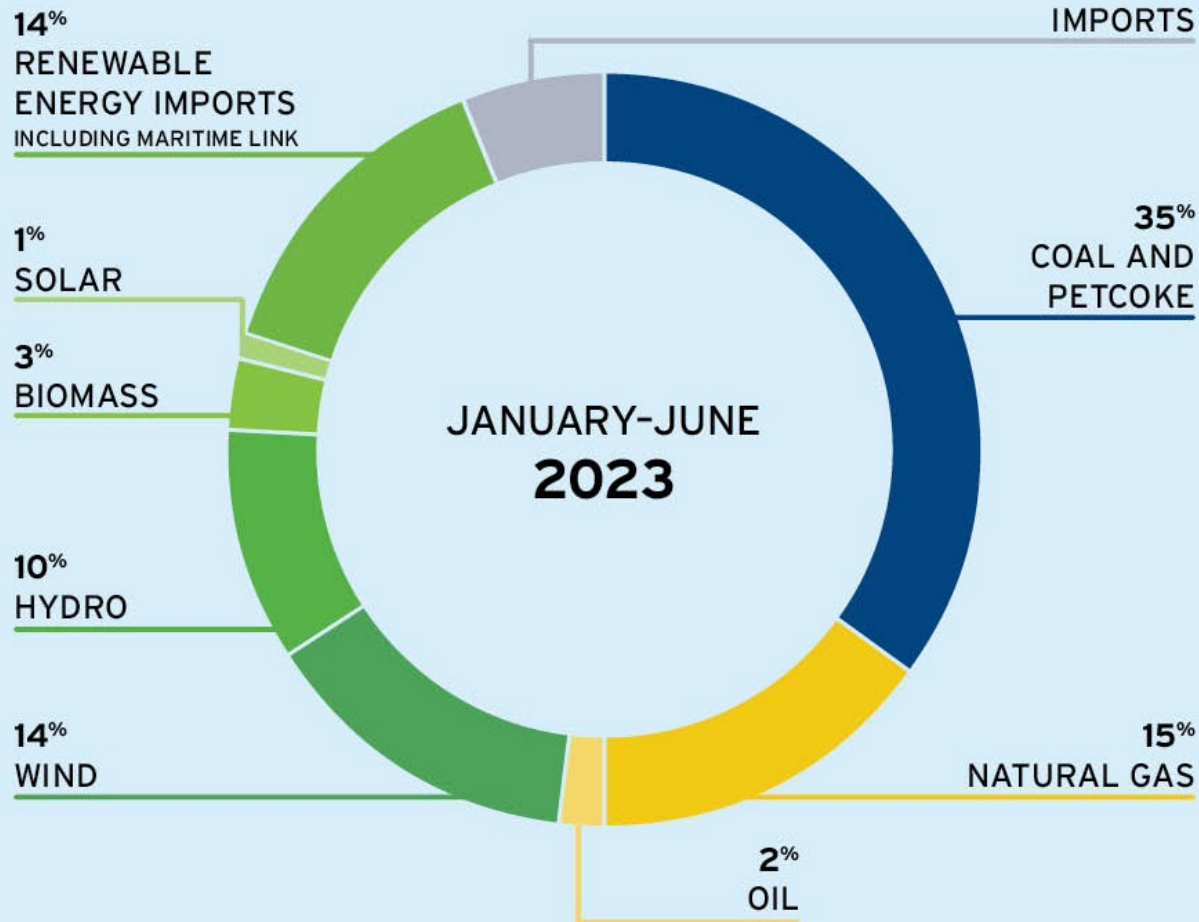


Large Scale Integration of IBR in Nova Scotia

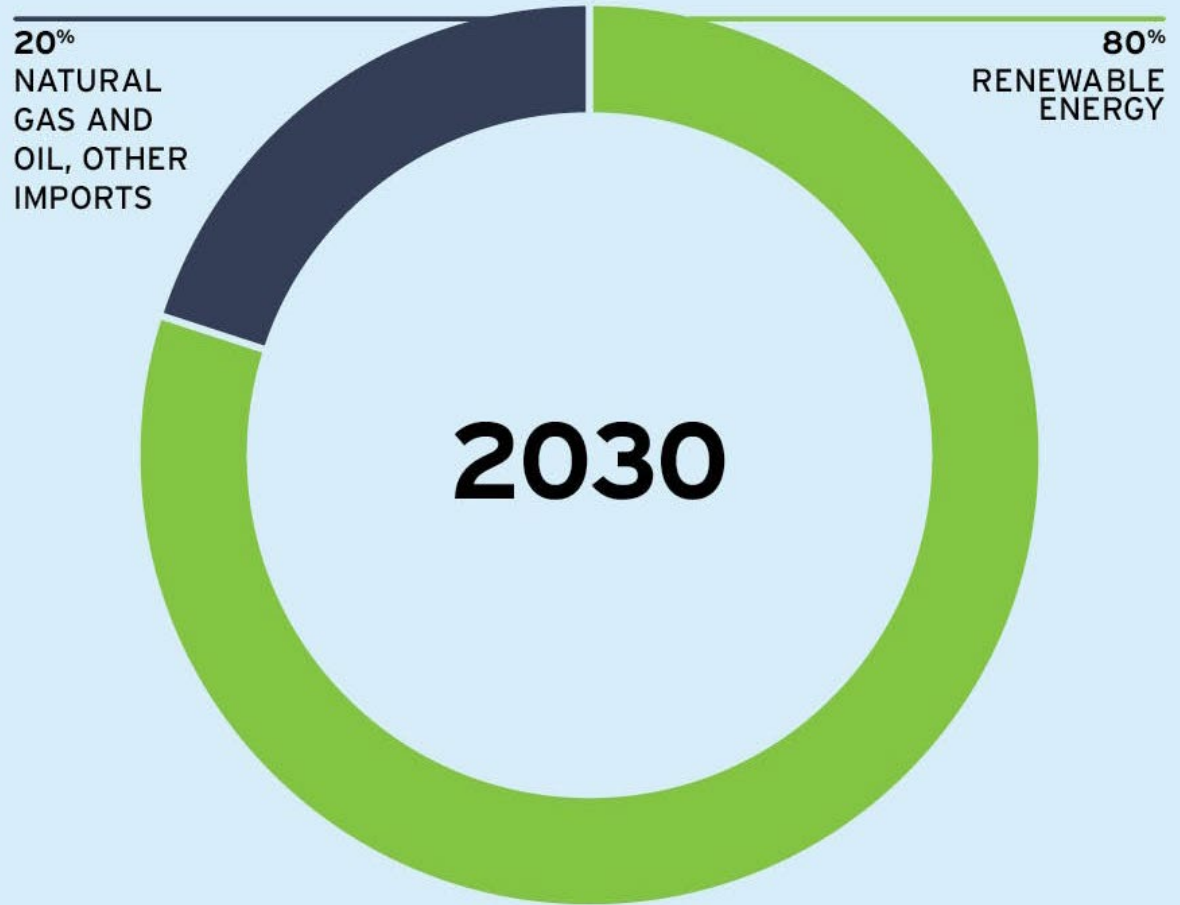
Nova Scotia Power

February 2, 2024

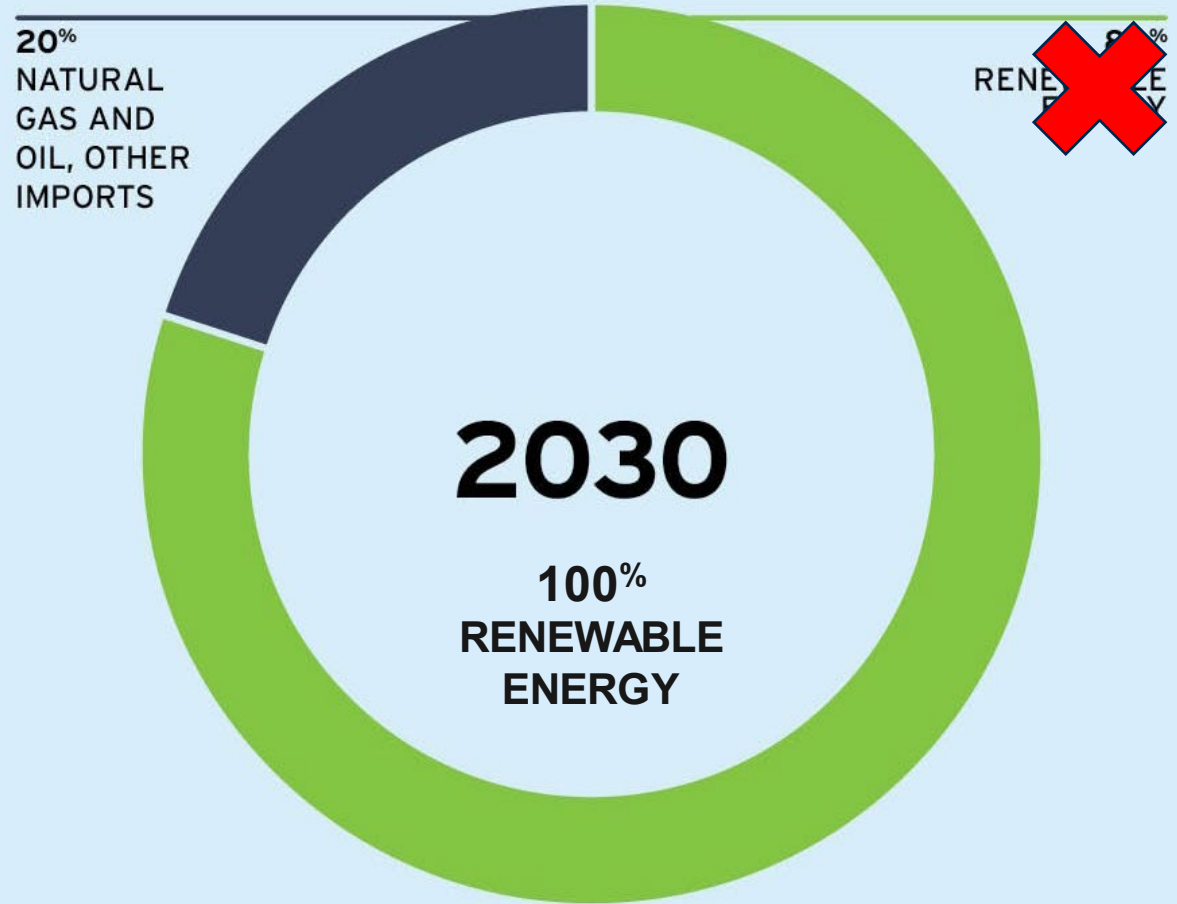
The Energy Transition



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



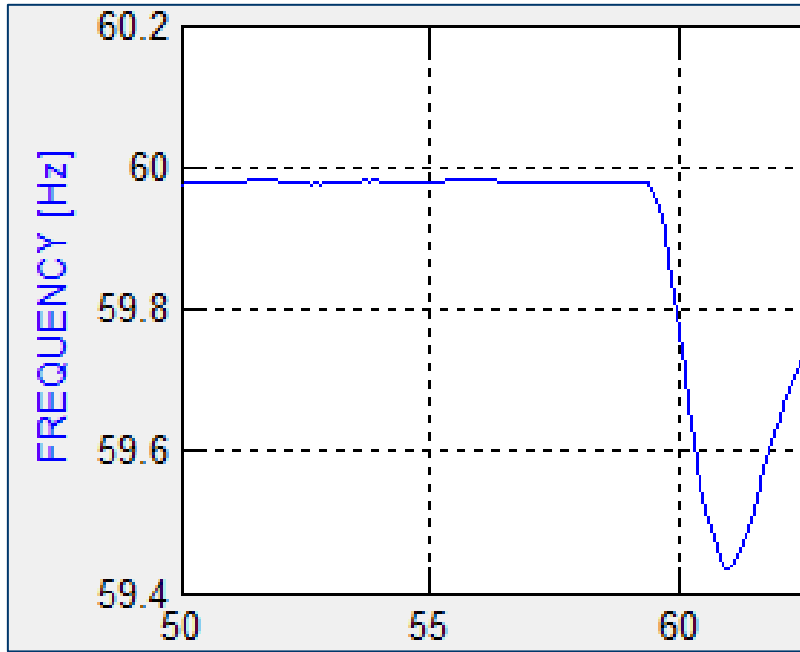
The Transmission System Transition



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
-
- | | |
|---|--|
| <ul style="list-style-type: none">■ Existing Plants and New Connections Models<ul style="list-style-type: none">○ Synchronous machines○ BESS and WECS models○ FACTS devices | <ul style="list-style-type: none">■ Load Modeling<ul style="list-style-type: none">○ 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

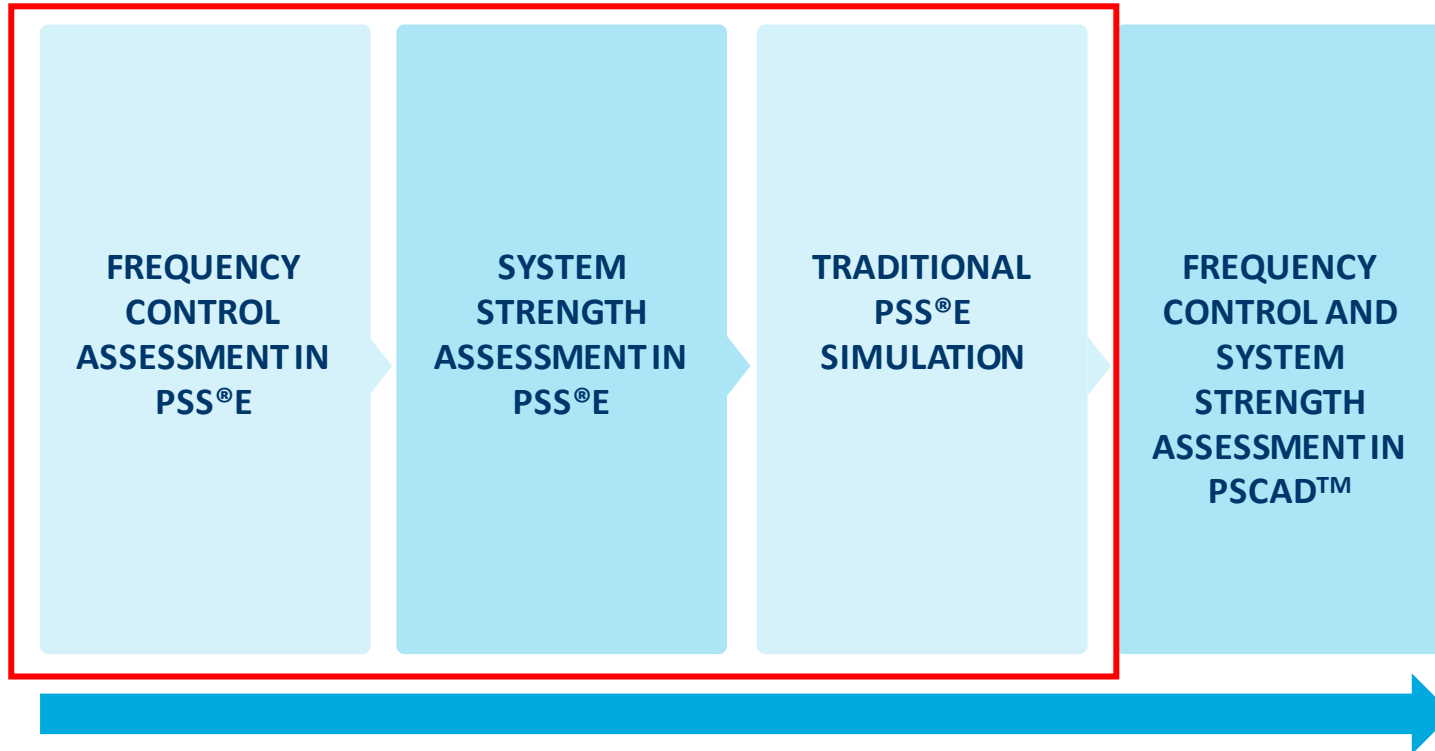
- Study Methodology
 - Studies and Findings



Iterative Assessment for EMT Studies



Stage 1, Iterative Assessment



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**

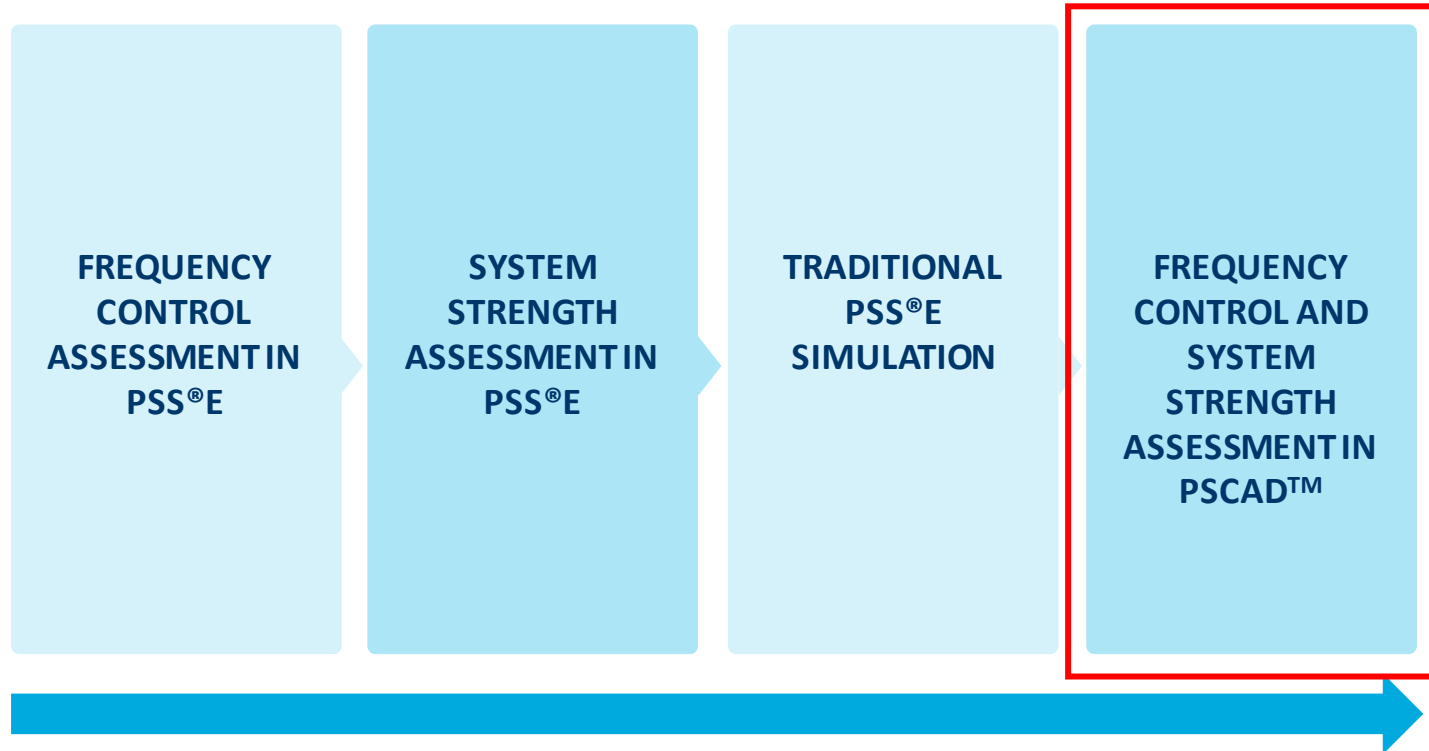
**MINIMUM SCR FOR
EXISTING WIND PLANTS**

Traditional PSS®E Simulation

LOAD FLOW ASSESSMENT

DYNAMIC ASSESSMENT

Stage 2, Iterative Assessment



Q & A



Stage 2

- Case Building

- Models
- IP concerns and NDAs
- Resourcing

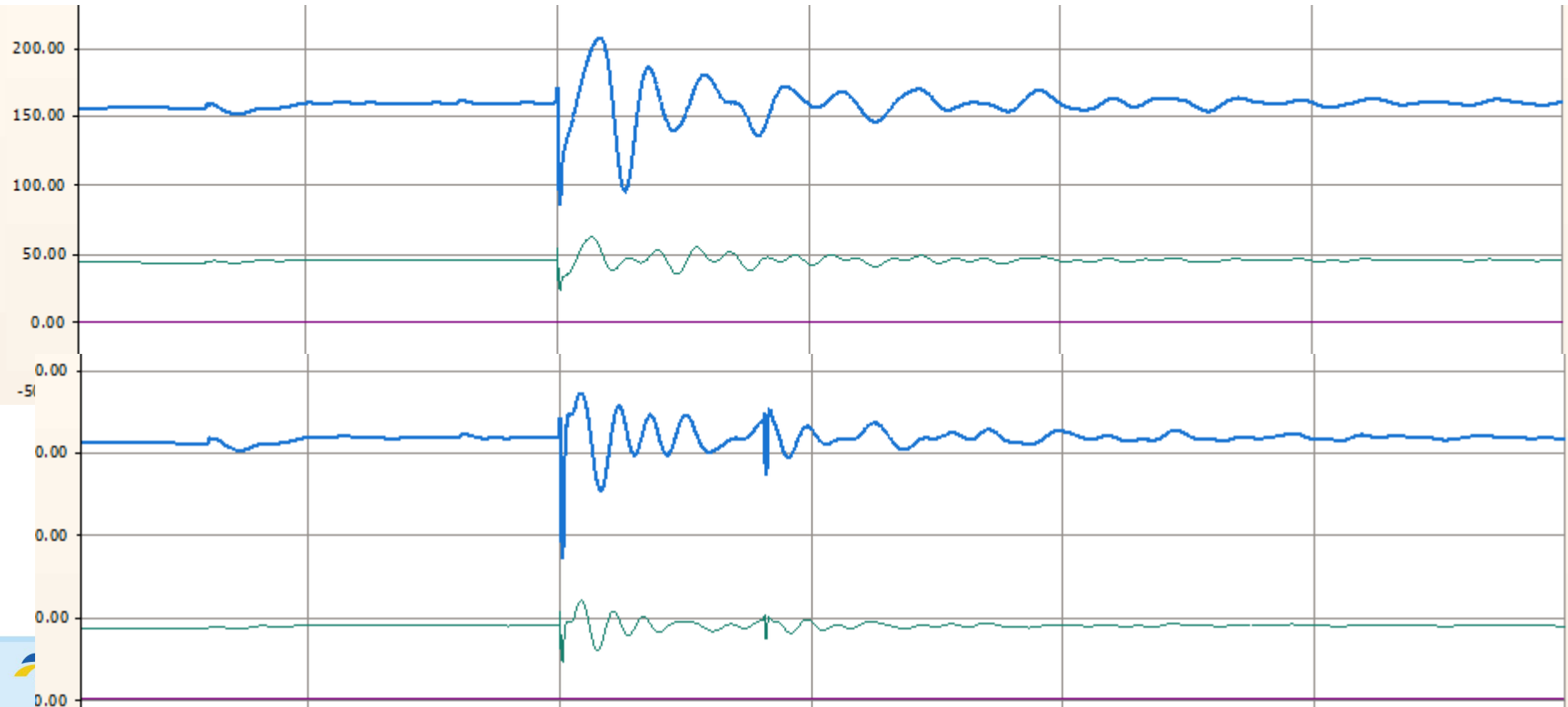
- Interconnection Studies

- Make it work!
- Timelines!

- Max wind and 100% renewables

- Second tie
- New technologies

Stage 2, Synchronous Machines, P&Q

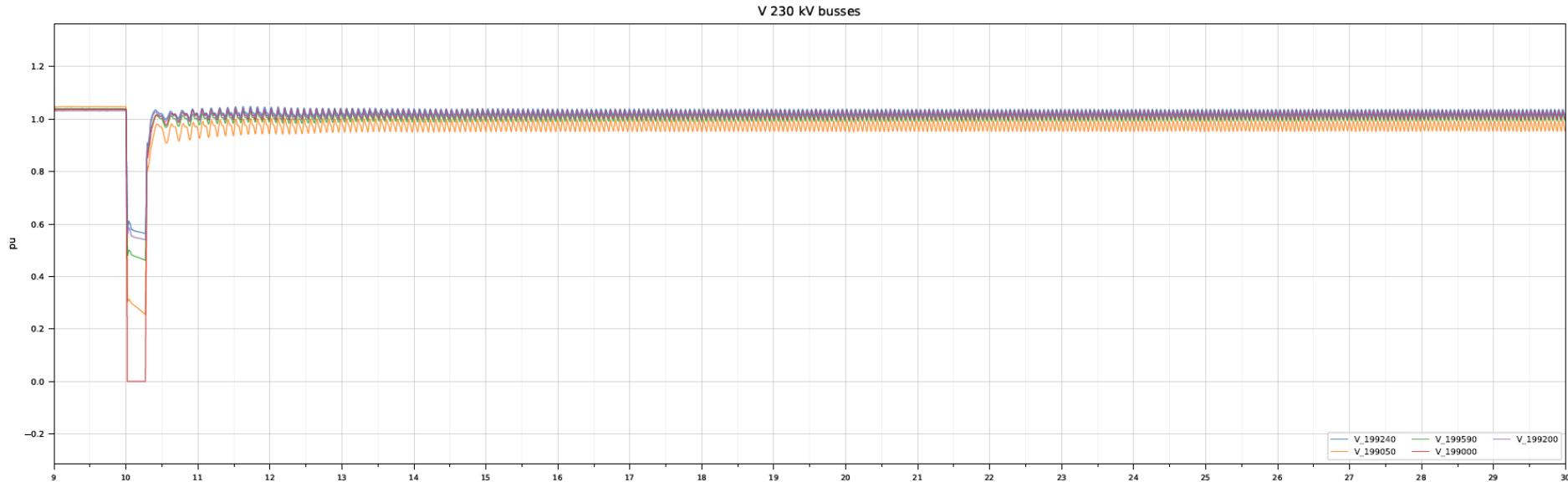


Stage 2, 12 Hz system wide oscillation

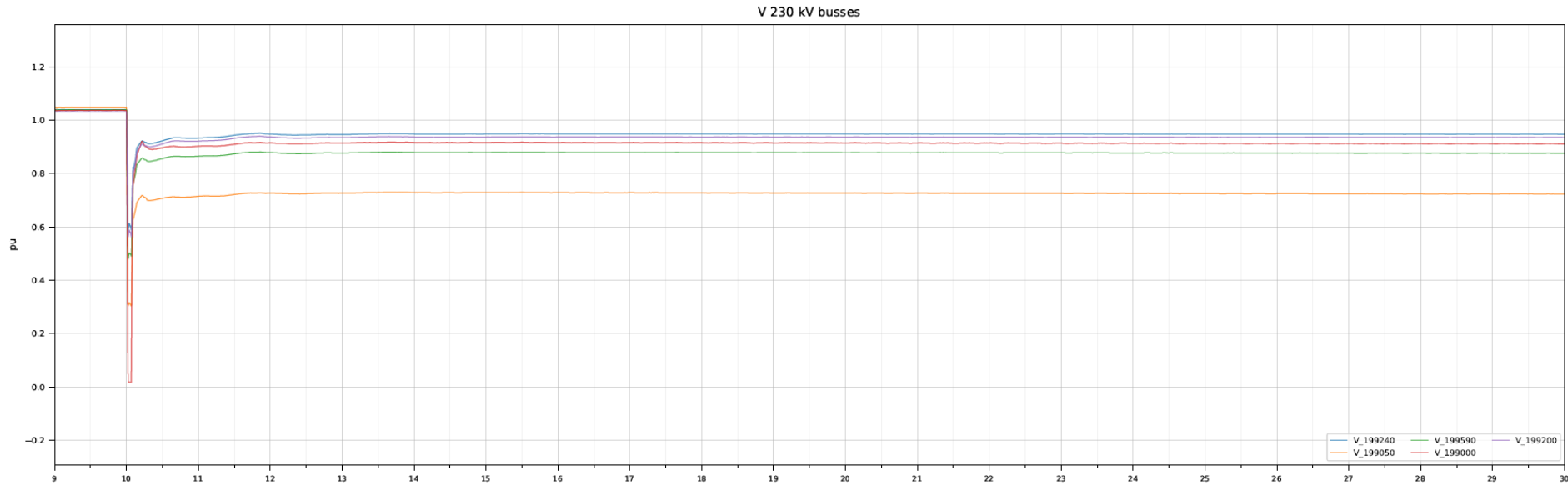
There is a possibility that this is a real issue since the investigation was performed using a very weak dispatch.

Cont{10}

Figure 10.1

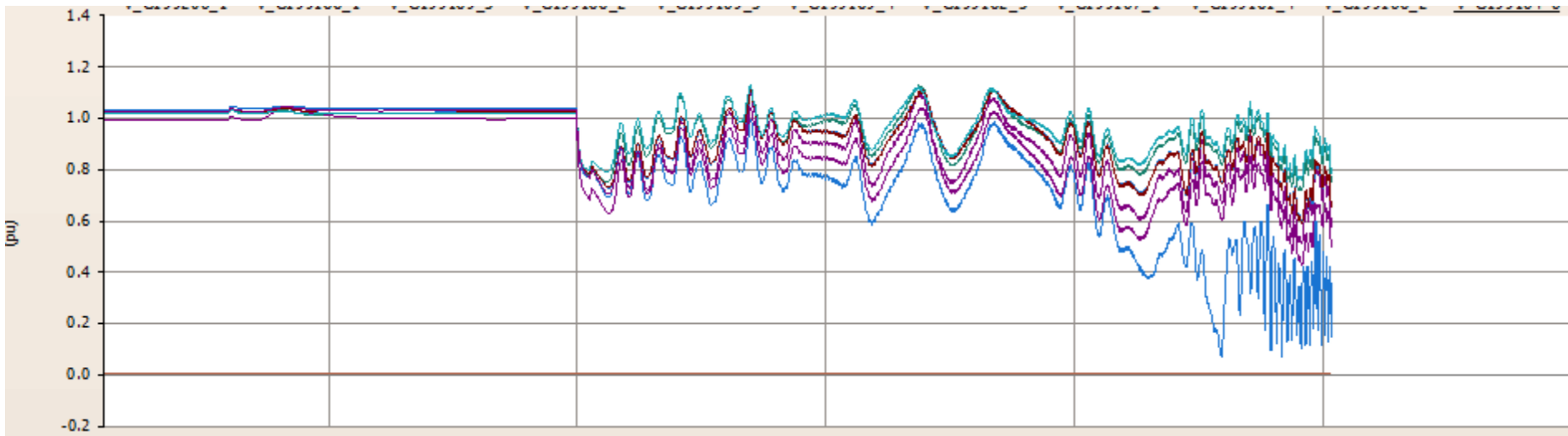


Stage 2, Voltage Recovery Failure

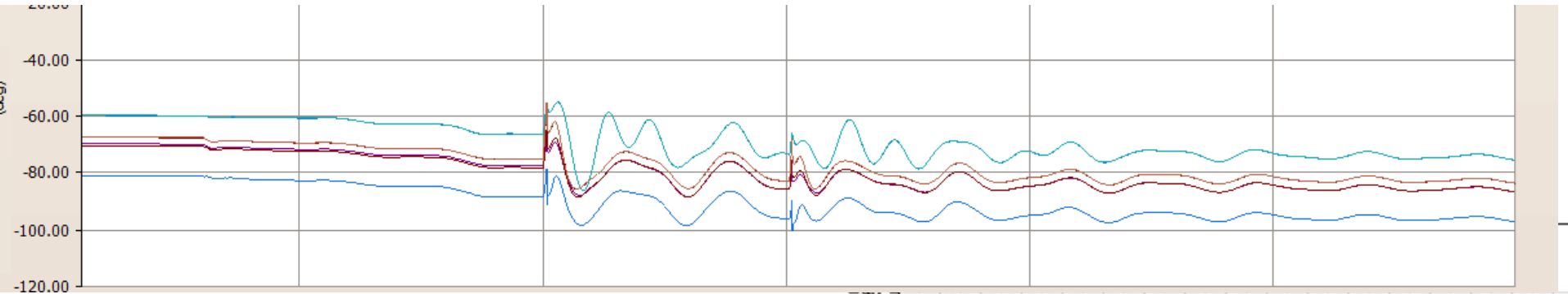


Stage 2, Voltage collapse

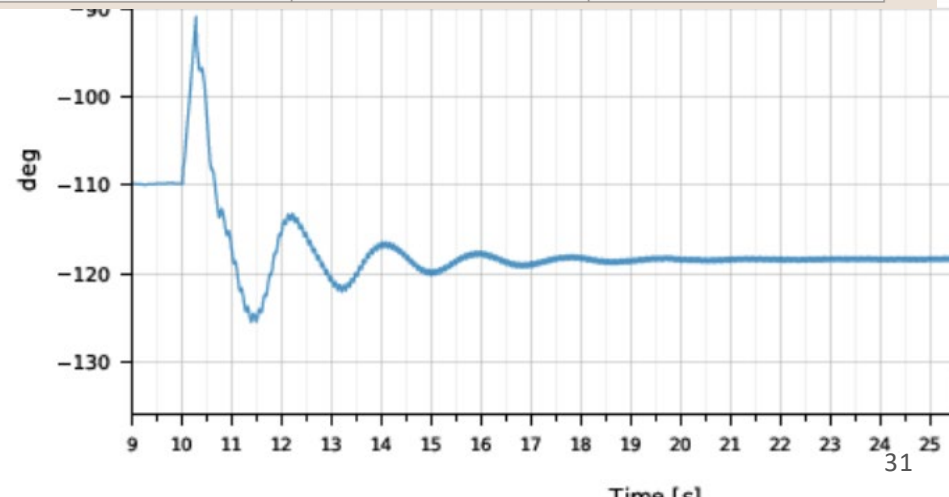
System wide (or partial) voltage collapse post contingency



Stage 2, Voltage Phase Angle Change



Motor Out of Step



Mitigation Options

IBR Control Systems

Mechanical Inertia from WECS

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

