

GRID EMT

SIMULATION INITIATIVE

Challenges with Large Load Integration & EMT Needs

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Engineering Policy & Innovation

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Overview

- ***What are HILLs?***
- ***Project Overview and Context for Large Load Network Model***
- ***Challenges Encountered During Model Development***



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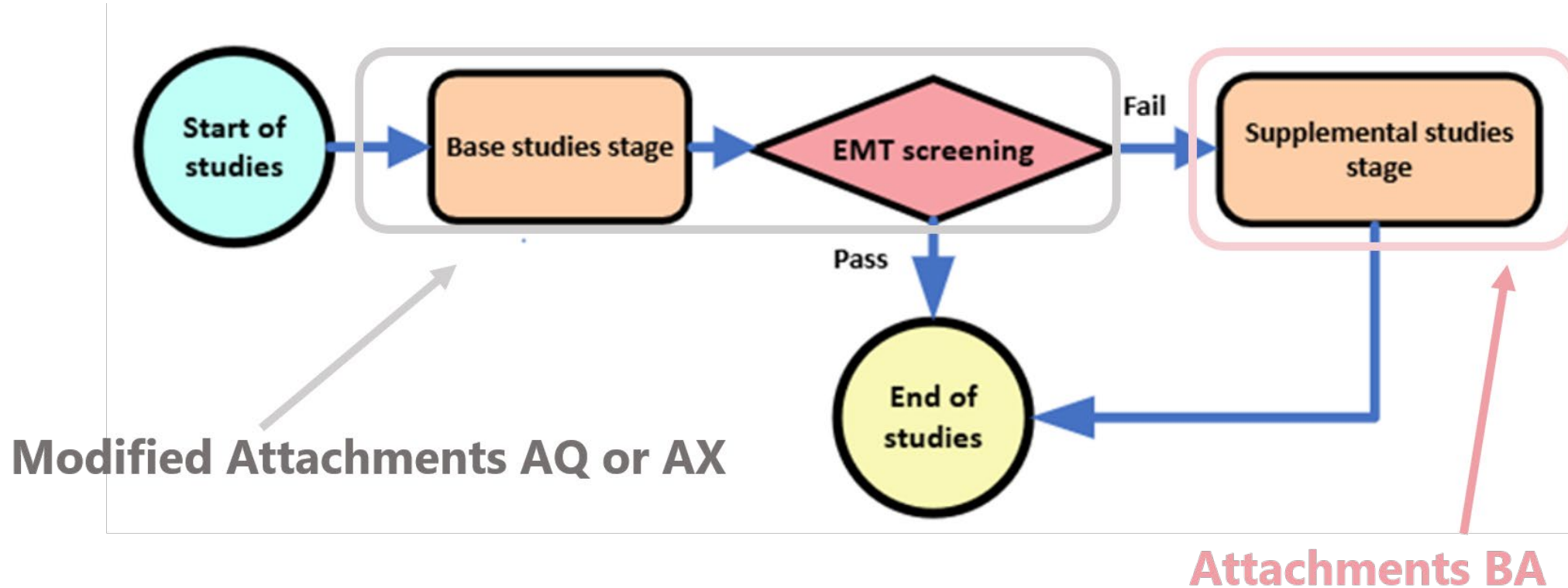
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High Impact Large Load

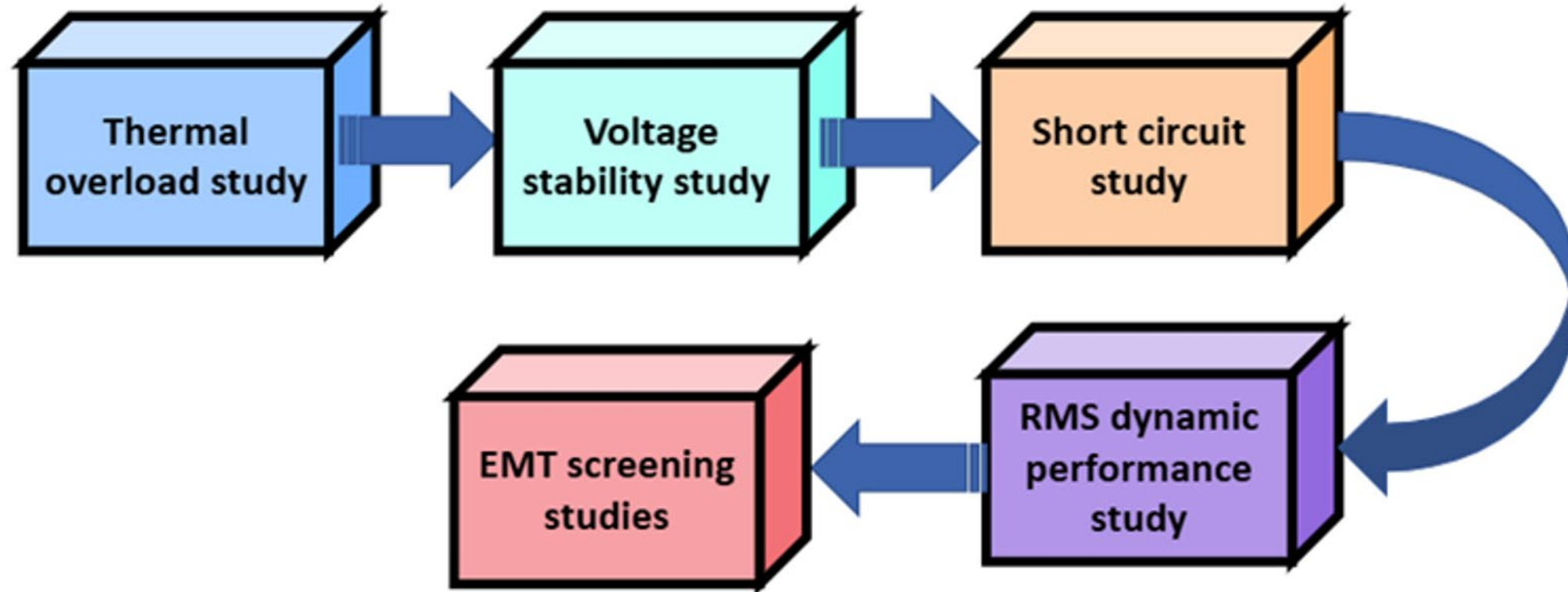
Definition	• A new commercial or industrial load, or increase in commercial or industrial load, at a single site connected through one or more shared Points of Interconnection (POIs) or delivery points
MW Threshold	• Less than or equal to 69 kV: Greater than or equal to 10 MW • Greater than 69 kV: Greater than or equal to 50 MW
Exclude	• Electric Storage Resource
Requirements	• Register in Market • Evaluated by existing Tariff study processes and under new supplemental study processes • SPP Ride-through Requirements Compliance
Perform within 90 Calendar Days	• Steady state, short circuit, and Transient Stability considering SPP HILL ride through requirements • Electromagnetic Transient (EMT) Screening includes Short-Circuit Ratio and Critical Clearing Time (SCRCCT) screening • Note: If issues occur, perform full EMT analysis



HILL Delivery point studies (HDPS) Overview



Base Studies Stage

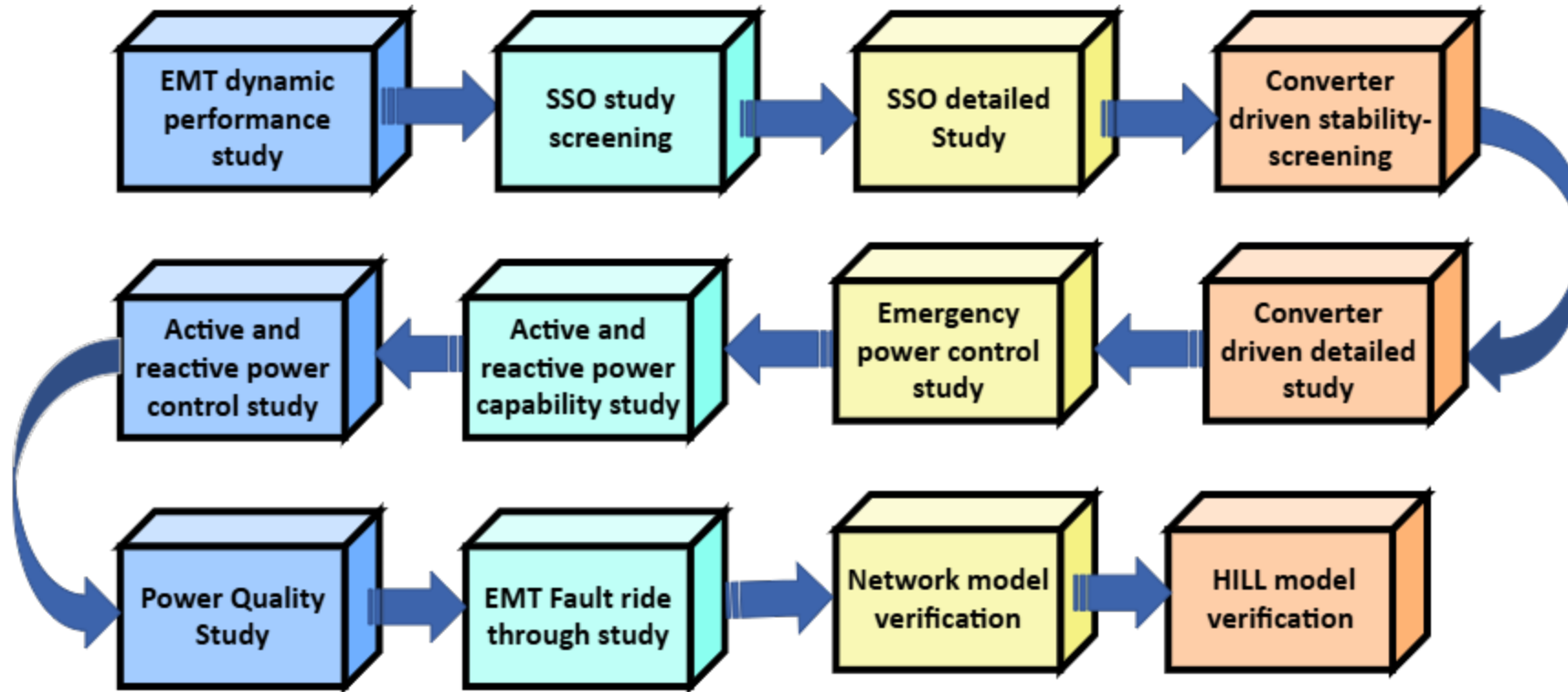


EMT Screening

- **Screening thresholds:** identify weak/unstable interconnection points.
- **SCR, WSCR, CSCR < 3.0** = electrically weak → higher risk of voltage/control instability.
- **CCT < 0.15s** = system may not withstand common fault durations → transient stability risk.
- **If thresholds not met (SCR/WSCR/CSCR < 3.0 or CCT < 0.15s):** detailed studies (e.g., EMT simulations) are required.



Supplemental Studies Stage



Large Load Network Integration Test Case

- Project Overview and Context for Large Load Model
- Challenges Encountered During Network Model Conversion
- Challenges Encountered During Network Model Evaluation



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Project Overview and Context for Large Load Network Model

Large Load Connections

Studying OGE due to the number of Large Loads being requested and due to its relative grid strength.

Model creation

Creating a network model in PSCAD to connect these Large Loads to study, and to see the effects of high penetration of inverters in a relatively small area.

Data collection

Getting data that was not a requirement before Jan 16th 2026 (i.e User defined Models)

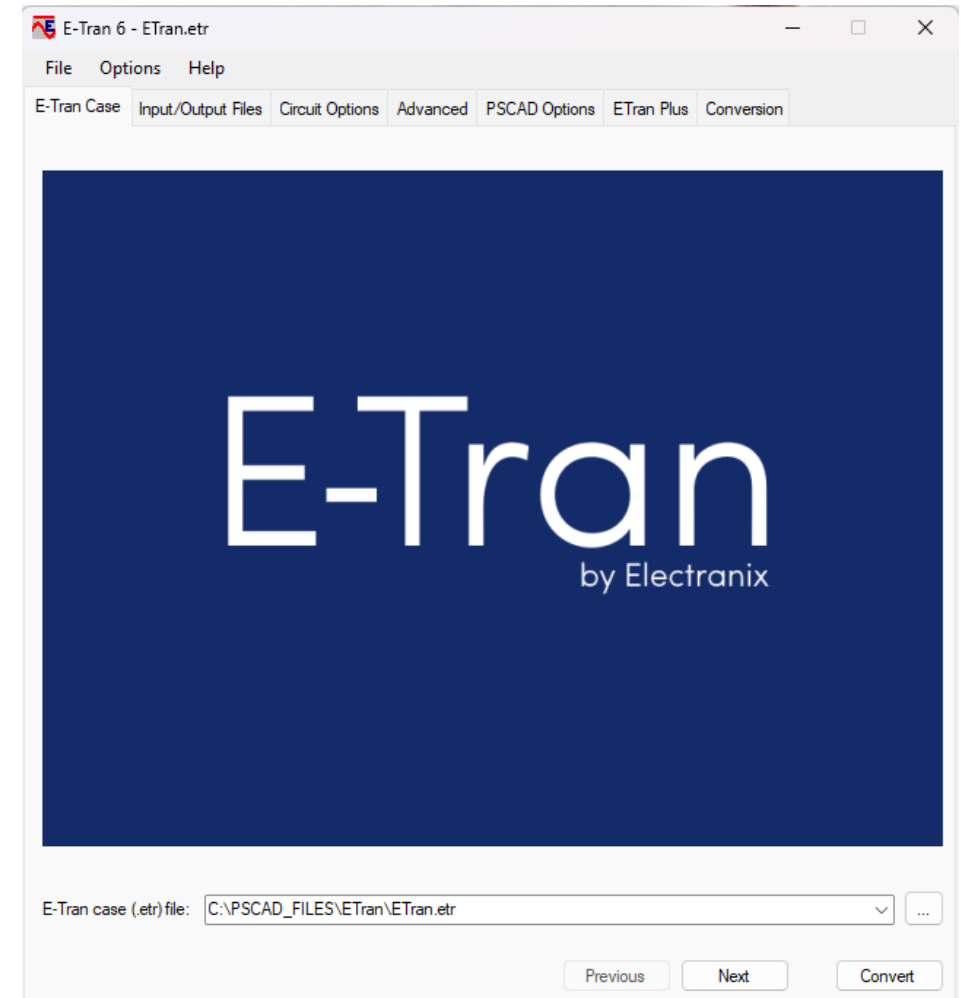
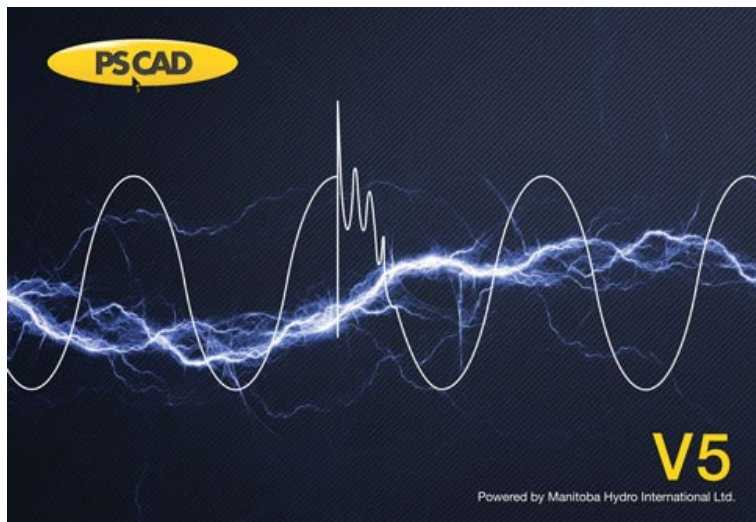


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Challenges Encountered During Model Development

- Network Model Conversion issues
- Network Model Evaluation issues



Network Model Conversion issues

- Crashing
- Size limitations
- Warnings and errors in log file during conversion
- Kept/Equivalent system Warnings/Errors



Crashing

E-Tran 6 - ETran.etr

FileOptionsHelp

E-Tran CaseInput/Output FilesCircuit OptionsAdvancedPSCAD OptionsETran PlusConversion

- Reading Switched Shunt Data...

- Reading GNE Device Data...

- Reading Induction Machine Data...

- End of Reading Data...

Q Record read, rest of file will be ignored.

Read routine exiting normally.

PSSE Summary

PSSE Buses: 104916

PSSE Generators: 14969

PSSE Loads: 49081

PSSE Branches: 125107

PSSE Transmission Lines: 92992

PSSE Transformers: 32020

PSSE DC Terminals: 38

PSSE VSCDC Terminals: 5

PSSE Switched Shunt Branches: 8115

PSSE Fixed Shunt Branches: 2759

Creating subsystems, buses etc...

Initial indexing of branches and b...

Subsystem Creation Complete.

- Reading PSSE .seq input file: Z:\R and ... (C:\D\DOE-EMT Initiatives\ORNL folder\2025MDAGProposedFinal-26S+30S_SC\2025MDAGProposedFinal-26S_SC.seq



Progress:

Pause

Cancel

Export Bus List

Open Log File

Open Case in PSCAD

Previous

Next

Convert

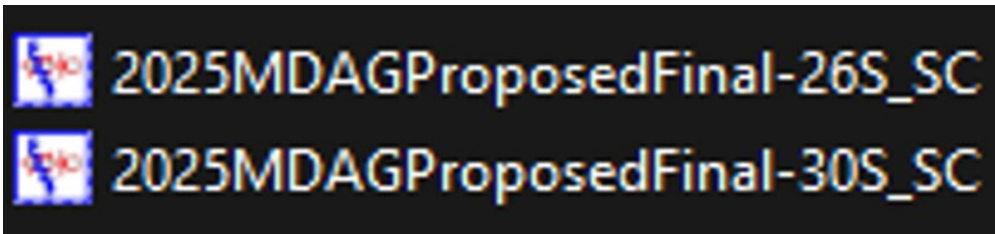


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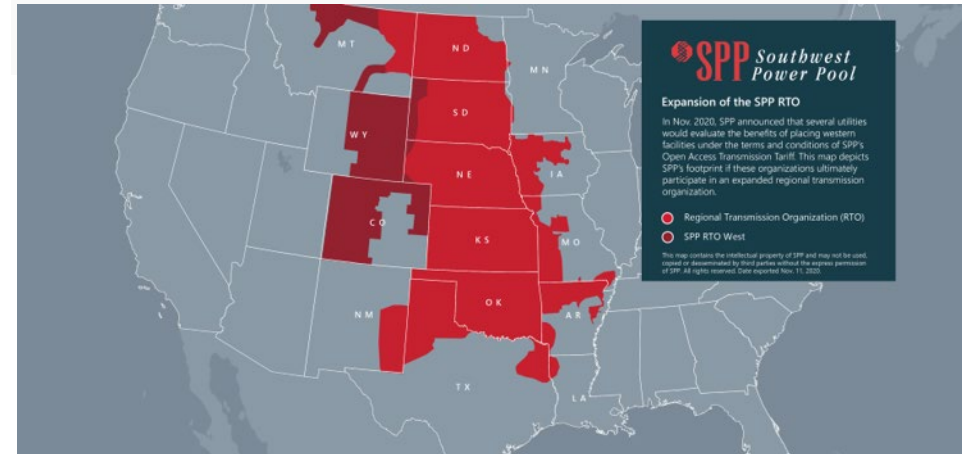
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System being too large (PSPD Model)

- 100,000 Buses in our model
- 15,000 Generators
- 50,000 Loads
- 125,000 Branches
- 32,000 Transformers



```
- End of Reading Data...
Q Record read, rest of file will be ignored.
Read routine exiting normally.
PSSE Summary
PSSE Busses: 104916
PSSE Generators: 14969
PSSE Loads: 49081
PSSE Branches: 125107
PSSE Transmission Lines: 92992
PSSE Transformers: 32028
PSSE DC Terminals: 38
PSSE VSCDC Terminals: 5
PSSE Switched Shunt Branches: 8115
PSSE Fixed Shunt Branches: 2759
```



Warnings and errors in log file during conversion

- Logs generated during failures are blank or non helpful
- Equivalent system vs Kept system
 - 19 Different types of Errors/warnings
 - 5 Different types of Errors/warnings

[illegible]

Kept system Errors/Warnings

- 11 transformers had invalid phase shifter angles.
- 46 .seq data branches not found and ignored.
- 110 negative sequence machine impedances ignored.
- 301 transformer sequence data records not supported and ignored.
- 1 exciter VRefs were set to handle DYR generator data controlling remote bus voltages but missing compensation data.



Equivalent System Errors/Warnings

1. 1 branches are connected to disabled busses.
2. 20 ideal transformers were found on busses which can cause PQ mis-matches.
3. 84 branches had -ve inductance and were converted to series capacitors.
4. 9 generators on load busses were disabled.
5. **1897** loads had negative P which will be converted to infinite busses.
6. 5 switched shunts had an invalid control mode and were set to discrete control
7. 2 DC links had rectifiers on Tap Limits.
8. 1 DC links had inverters on Tap Limits.
9. 2 transformers had invalid magnetizing admittances.
10. 112 transformers had both series impedances set to 0.
11. 70 transformers had invalid phase shifter angles.
12. 49 transformers have phase shifters on winding 2 or 3.
13. 32 fixed shunts had negative P which will be converted to infinite busses.
14. 1143 busses overriding load flow data with .seq data
15. 11031 negative sequence machine impedances ignored.
16. 288 sequence data records not supported and ignored.
17. **31560** transformer sequence data records not supported and ignored
18. 3 generators have invalid ZR impedance.
19. 151 branches have been converted to transformers due to different voltages on each end

Network Model Evaluation

- Errors/warnings regarding actual PSCAD model
- Network example
- Next steps

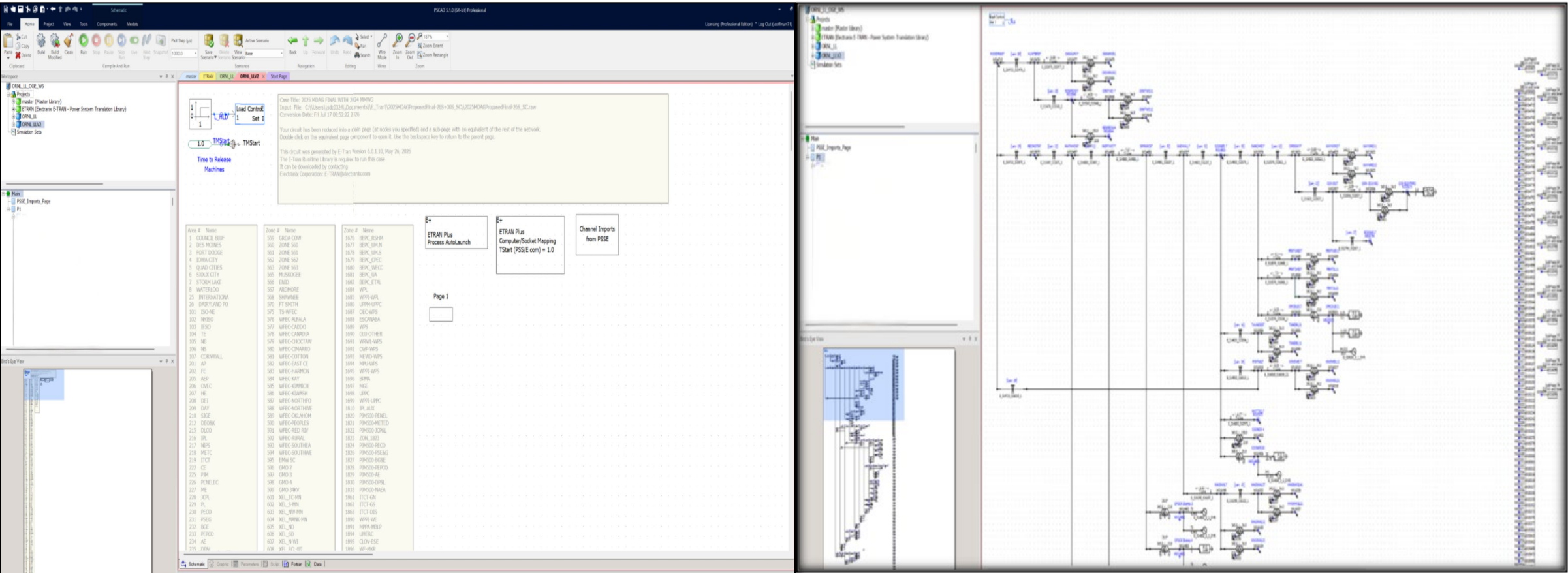


Errors/Warnings in PSCAD Model

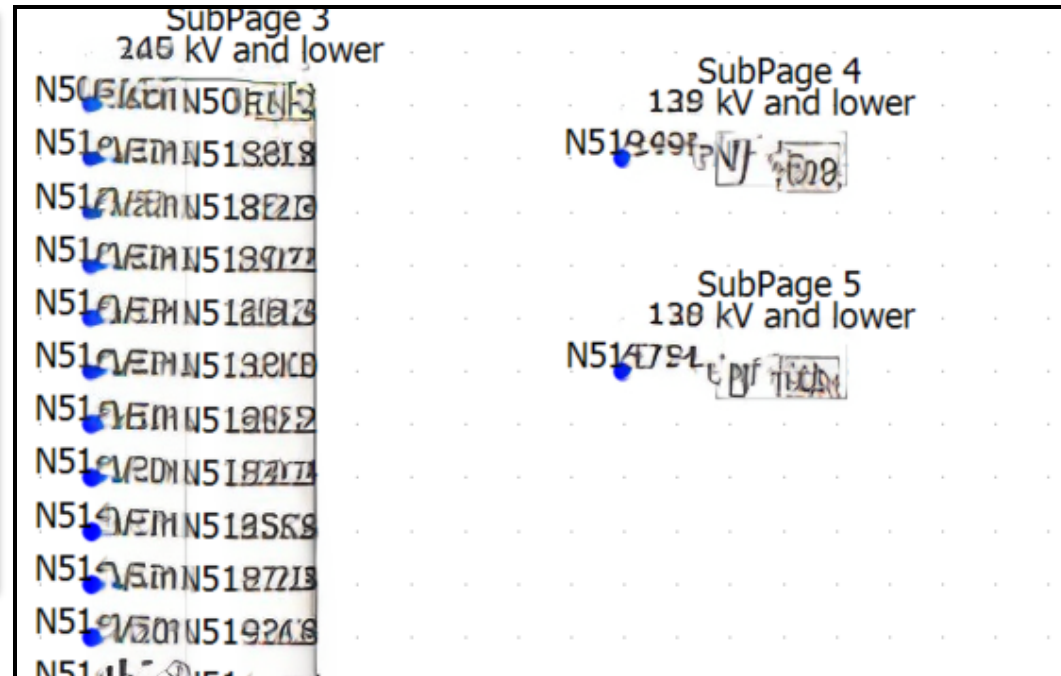
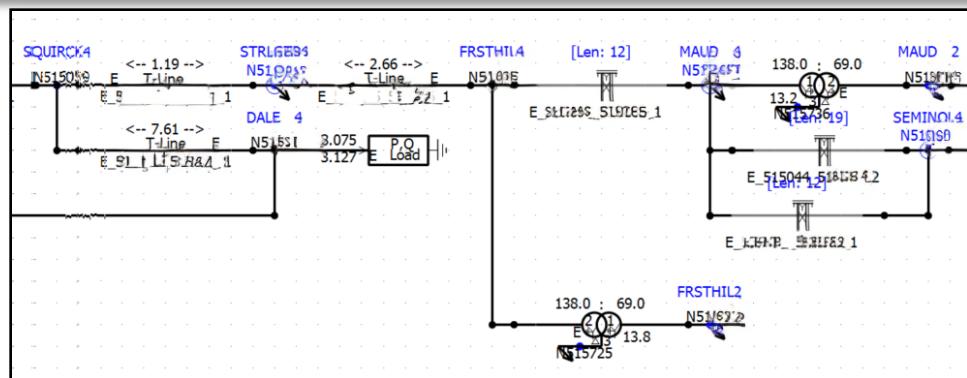
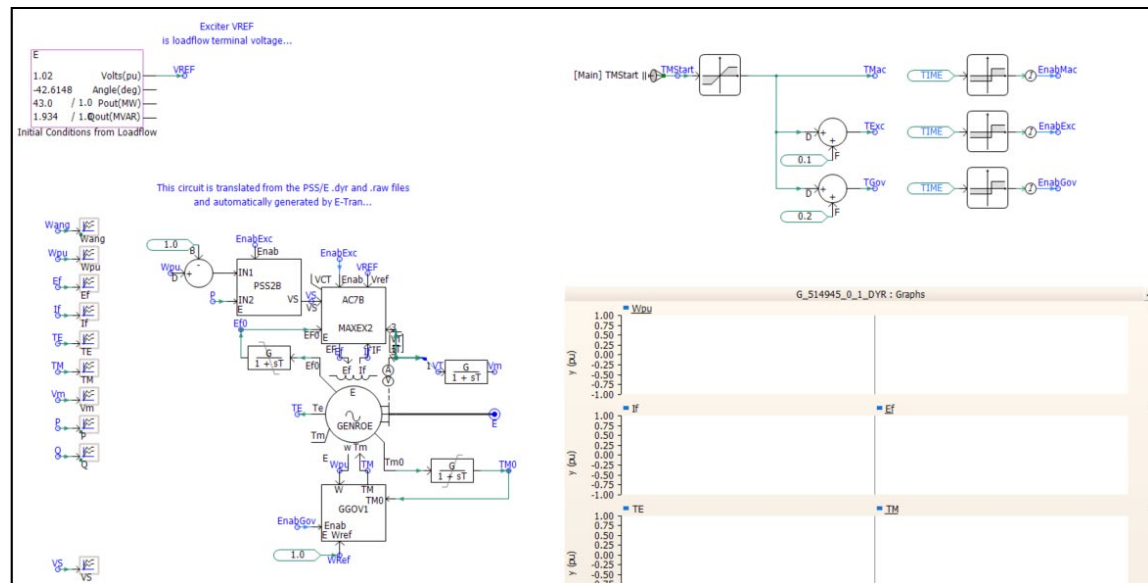
- (7)Zero sequence X should be larger than the positive sequence X!
- (2)Input parameter (XPU=-0.466614) is below range (min=0).
- (4) Input parameter (XI13=1.2391) is above range (max=1).
- (44)Suspicious floating terminal at node 'NT_1'.



Network



Network



Next steps

- Matching PSSE case with PSCAD case
- MQT the network model
- Getting as much data as possible to connect to the network model
 - I.e. Single line diagram, ride through characteristics.
- PSCAD models from the determined LL projects in the AQ process.

Thank You

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Q&A



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