# Automated System-wide Strength Evaluation Tool (ASSET)

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# What ASSET does?

- **ASSET** is a free and open-source tool based on python and PSS/E to automatically examine and assess large-scale systems for multiple system operating conditions and contingencies, and their impact on system strength. Calculation results from ASSET are summarized in both tabularized form and can be further visualized on a map.
- This manual contains
  - Installation guide
  - Summary of steps for using ASSET
  - Example on a 23-bus case

# Installation

- ASSET is free and open source on GitHub: https://github.com/NREL/ASSET
- Python and PSS/E need to be installed and licensed, If necessary. Python 2.7 and PSS/E v34 were used for developing this tool, while other versions have not been tested. Detailed installation steps include:
  - Create a Python project and put all files/folders in the GitHub repo into that project folders.
  - Install the following packages to the Python environment: numpy and pandas.
  - Set up the file path to PSS/E API in lines 45-67 of main.py and in lines 37-50 of assetlib.py. Users should change to match the required PSS/E version. The following gives an example for PSS/E v34.

```
pssbindir = r'C:\Program Files (x86)\PTI\PSSE34\PSSBIN'
sys.path.append(pssbindir)
pssepydir = r'C:\Program Files (x86)\PTI\PSSE34\PSSPY27'
os.environ['PATH'] += ';' + pssbindir
os.environ['PATH'] += ';' + pssepydir
```

  - If the users do not know the installation folder, they can use pssepath package for auto-setup. Here's the download link: https://pypi.org/project/pssepath/. Then, add the following to main.py.

```
import pssepath
pssepath.add_pssepath()
```

# Initialization for ASSET

- Configure simulation parameters in lines 88-98 of main.py.

| Simulation Parameters | Description |
|---|---|
| GUIinput_powerflowfile | File path and name of the power flow data in .sav format |
| GUIinput_poidata | File path and name of the point of interconnection data in .csv format (Please look at the example on how to prepare a POI list) |
| GUIinput_outputfolder | Path of the output folder |
| GUIinput_DiscAllOwu | Flag, allow fault current contribution from IBR units at non-tested POIs? 1 – Yes, 0 – No. |
| GUIinput_SimMode | Simulation mode: 0 - Critical N-1/N-2 mode; 1 - Contingency scan mode; 2 – SCRIF Computation |
| GUIinput_K | Currents on branches K-level away from the tested POI are considered for picking critical N-1/N-2. Used only when GUIinput_SimMode = 0. |
| GUIinput_contfolder | Path of the input subfolder storing contingency files in .csv format. Used only when GUIinput_SimMode = 1. |
| busNlimit | Limit of number of buses specified when launching a PSS/E instance |
| ctg_num | Number of contingencies. Used only when GUIinput_SimMode = 1. |

# Interpreting the results

- Then, users can go ahead and execute main.py.
- The analysis will be performed automatically, and the results will be created and stored in the output subfolder.
- If GUIinput_SimMode = 0, there will be three output files: "result_brch.csv", "result_SCMVA.csv", and "result_SCR".
- If GUIinput_SimMode = 1, there will be one output file: "results_CTG_SCAN_yyyy-mm-dd_hh-mm-ss.csv."
- If GUIinput_SimMode = 2, there will be two output files: "result_SCMVA_SCRIF.csv", "result_SCRIF.csv"

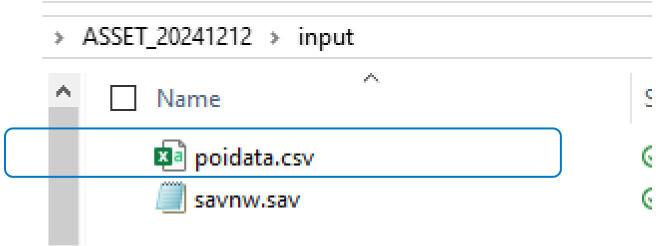
# Example

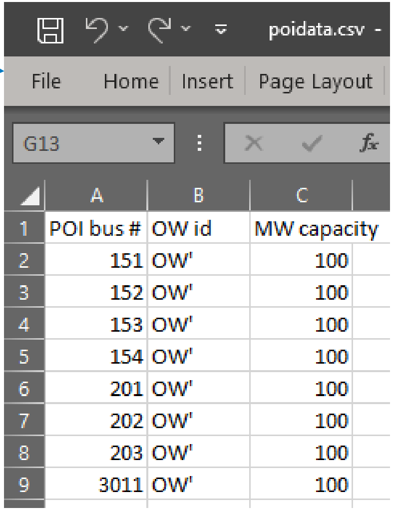
On a 23 bus system

# Example 1: Critical N-1/N-2

- The 23-bus case coming with PSS/E install is used in this example.
- Set simulation parameters as follows:

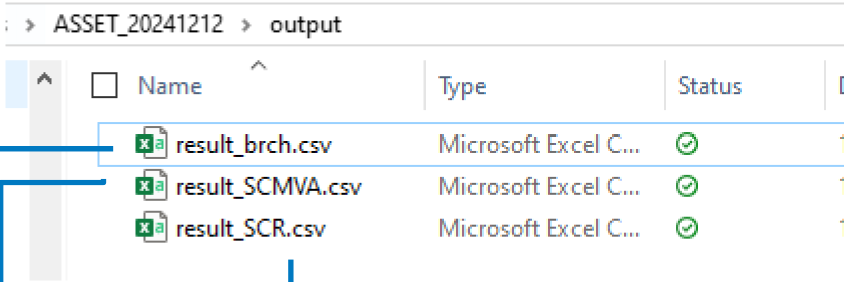
| Simulation Parameters | Description |
|---|---|
| GUIinput_powerflowfile | "…\input\savnw.sav" |
| GUIinput_poidata | "…\input\poidata.csv" |
| GUIinput_outputfolder | "…\output" |
| GUIinput_DiscAllOwu | 0 |
| GUIinput_SimMode | 0 |
| GUIinput_K | 10 |
| GUIinput_contfolder | N/A |
| busNlimit | 50 |
| ctg_num | N/A |



# Example 1: Critical N-1/N-2

- Execute main.py and obtain the results.




| Bus numb | From bus | To bus - B | ID - Branc | From bus | To bus - B | ID - Branch |
|---|---|---|---|---|---|---|
| 151 | 151 | 201 | 1 | 152 | 153 | 1 |
| 152 | 152 | 153 | 1 | 154 | 205 | 1 |
| 153 | 152 | 153 | 1 | 154 | 205 | 1 |
| 154 | 154 | 205 | 1 | 152 | 153 | 1 |
| 201 | 151 | 201 | 1 | 204 | 205 | 1 |
| 202 | 202 | 203 | 1 | 152 | 202 | 1 |
| 203 | 202 | 203 | 1 | 154 | 203 | 1 |
| 3011 | 3001 | 3003 | 1 | 154 | 205 | 1 |

| Bus numb | SCMVA(N- | SCMVA(N- | SCMVA(N-2) |
|---|---|---|---|
| 151 | 7914.71 | 6535.18 | 6303.11 |
| 152 | 6382.47 | 5631.39 | 5550 |
| 153 | 5862.27 | 3447.42 | 2541.05 |
| 154 | 6356.68 | 3992.43 | 3157.35 |
| 201 | 6900.95 | 4834.94 | 3959.95 |
| 202 | 5810.68 | 5047.72 | 2567.2 |
| 203 | 4955.45 | 3476.46 | 2731.31 |
| 3011 | 4576.52 | 3811.83 | 3778.91 |

| Bus numb | SCR(N-0) | SCR(N-1) | SCR(N-2) |
|---|---|---|---|
| 151 | 79.1471 | 65.3518 | 63.0311 |
| 152 | 63.8247 | 56.3139 | 55.5 |
| 153 | 58.6227 | 34.4742 | 25.4105 |
| 154 | 63.5668 | 39.9243 | 31.5735 |
| 201 | 69.0095 | 48.3494 | 39.5995 |
| 202 | 58.1068 | 50.4772 | 25.672 |
| 203 | 49.5545 | 34.7646 | 27.3131 |
| 3011 | 45.7652 | 38.1183 | 37.7891 |

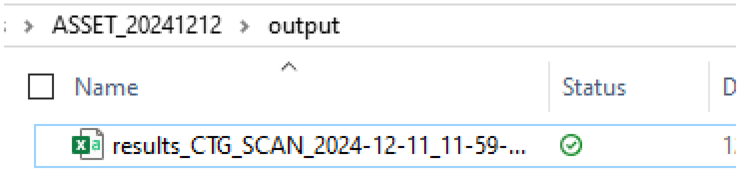
# Example 2: Contingency Scan

- Set simulation parameters as follows, where most parameters are same as in example 1:

| Simulation Parameters | Description |
|---|---|
| GUIinput_powerflowfile | “…\input\savnw.sav" |
| GUIinput_poidata | “…\input\poidata.csv" |
| GUIinput_outputfolder | “…\output" |
| GUIinput_DiscAllOwu | 0 |
| GUIinput_SimMode | 1 |
| GUIinput_K | N/A |
| GUIinput_contfolder | “…\ctg" |
| busNlimit | 50 |
| ctg_num | 5 |

# Example 2: Contingency Scan

- Execute main.py and obtain the results.




| POI | SCMVA_0 | SCR_0 | SCMVA_1 | SCR_1 | SCMVA_2 | SCR_2 | SCMVA_3 | SCR_3 | SCMVA_4 | SCR_4 | SCMVA_5 | SCR_5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 151 | 7915.079 | 79.15079 | 7732.502 | 77.32502 | 7595.087 | 75.95087 | 7709.132 | 77.09132 | 5749.405 | 57.49405 | 7368.364 | 73.68364 |
| 152 | 6382.914 | 63.82914 | 5947.455 | 59.47455 | 5781.601 | 57.81601 | 5631.891 | 56.31891 | 5597.314 | 55.97314 | 5391.94 | 53.9194 |
| 153 | 5862.376 | 58.62376 | 5663.524 | 56.63524 | 5450.32 | 54.5032 | 3447.586 | 34.47586 | 5268.817 | 52.68817 | 4960.834 | 49.60834 |
| 154 | 6356.777 | 63.56777 | 6271.063 | 62.71063 | 6173.19 | 61.7319 | 5964.185 | 59.64185 | 5863.056 | 58.63056 | 5569.971 | 55.69971 |
| 201 | 6901.365 | 69.01365 | 6769.936 | 67.69936 | 6901.345 | 69.01345 | 6839.977 | 68.39977 | 5898.841 | 58.98841 | 6399.653 | 63.99653 |
| 202 | 5811.167 | 58.11167 | 5597.98 | 55.9798 | 5572.284 | 55.72284 | 5620.859 | 56.20859 | 5188.585 | 51.88585 | 5141.362 | 51.41362 |
| 203 | 4955.567 | 49.55567 | 4872.849 | 48.72849 | 4825.015 | 48.25015 | 4952.906 | 49.52906 | 4588.037 | 45.88037 | 4486.826 | 44.86826 |
| 3011 | 4576.523 | 45.76523 | 4152.484 | 41.52484 | 4529.369 | 45.29369 | 4551.295 | 45.51295 | 4500.776 | 45.00776 | 1721.385 | 17.21385 |

# Citing ASSET

- If you use ASSET for research or consulting, please cite the following paper in your publication.

P. Sharma, L. Rese, B. Wang, B. Vyakaranam, S. Shah, “Grid Strength Analysis for Integrating 30 GW of Offshore Wind Generation by 2030 in the US Eastern Interconnect,” 22nd Wind & Solar Integration Workshop, Copenhagen, Denmark, Sept. 2023.

P. Sharma and S. Shah, "Application of the Extra Element Theorem for Grid Strength Analysis in IBR-Dominated Systems," 2025 IEEE Power & Energy Society General Meeting (PESGM), Austin, Texas, USA, 2025

# Thank you

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