



U.S. DEPARTMENT
of ENERGY

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Automated System-wide Strength Evaluation Tool (ASSET)

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_Public
- 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
GUinput_powerflowfile	File path and name of the power flow data in .sav format
GUinput_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)
GUinput_outputfolder	Path of the output folder
GUinput_DiscAllOwu	Flag, allow fault current contribution from IBR units at non-tested POIs? 1 – Yes, 0 – No.
GUinput_SimMode	Simulation mode: 0 - Critical N-1/N-2 mode; 1 - Contingency scan mode
GUinput_K	Currents on branches K-level away from the tested POI are considered for picking critical N-1/N-2. Used only when GUinput_SimMode = 0.
GUinput_contfolder	Path of the input subfolder storing contingency files in .csv format. Used only when GUinput_SimMode = 1.
busNlimit	Limit of number of buses specified when launching a PSS/E instance
ctg_num	Number of contingencies. Used only when GUinput_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`.”

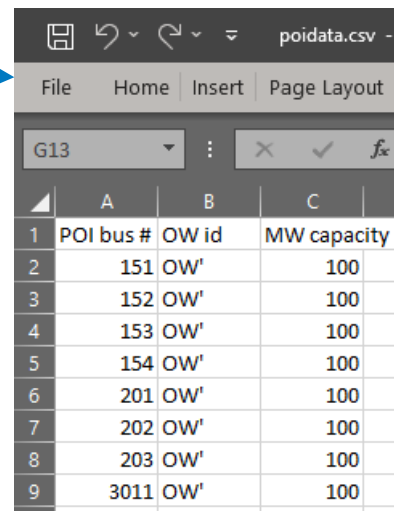

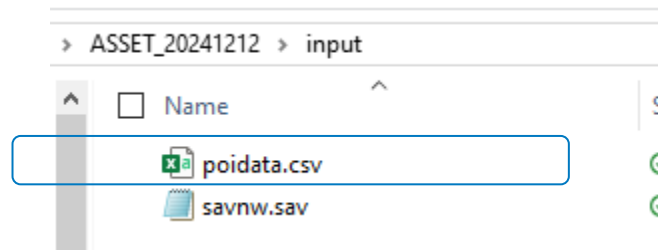
Example

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
GUinput_powerflowfile	"...\input\savnw.sav"
GUinput_poidata	"...\input\poidata.csv"
GUinput_outputfolder	"...\output"
GUinput_DiscAllOwu	0
GUinput_SimMode	0
GUinput_K	10
GUinput_contfolder	N/A
busNlimit	50
ctg_num	N/A



	A	B	C
1	POI bus #	OW id	MW capacity
2	151	OW'	100
3	152	OW'	100
4	153	OW'	100
5	154	OW'	100
6	201	OW'	100
7	202	OW'	100
8	203	OW'	100
9	3011	OW'	100

Example 1: Critical N-1/N-2

- Execute main.py and obtain the results.

ASSET_20241212 > output

Name	Type	Status
result_brch.csv	Microsoft Excel C...	✓
result_SCMVA.csv	Microsoft Excel C...	✓
result_SCR.csv	Microsoft Excel C...	✓

A	B	C	D	E	F	G
Bus numb	From bus	To bus - B ID - Branch	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

A	B	C	D
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

A	B	C	D
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
GUinput_powerflowfile	"...\input\savnw.sav"
GUinput_poidata	"...\input\poidata.csv"
GUinput_outputfolder	"...\output"
GUinput_DiscAllOwu	0
GUinput_SimMode	1
GUinput_K	N/A
GUinput_contfolder	"...\ctg"
busNlimit	50
ctg_num	5

ASSET_20241212 > ctg

Name
CTGs_3wind.csv
CTGs_blkDC.csv
CTGs_branch.csv
CTGs_clobbranch.csv
CTGs_discbus.csv
CTGs_gentrip.csv
CTGs_swshunt.csv

	A	B	C	D	E
1	CTG num	From bus	To bus 1	To bus 2	ID
2					

	A	B	C
1	CTG num	DC line terminal	
2			

	A	B	C	D
1	CTG num	From bus	To bus	ID
2	1	152	3004	1
3	1	3002	3004	1
4	1	3004	3005	1
5	2	151	152	2
6	3	152	153	1
7				

	A	B	C	D
1	CTG num	From bus	To bus	ID
2	4	152	202	1
3				

	A	B
1	CTG num	Bus
2	1	3004
3		



	A	B	C
1	CTG num	Bus	ID
2	4	101	1
3	5	3011	1
4			


	A	B
1	CTG num	Bus
2		

Example 2: Contingency Scan

- Execute main.py and obtain the results.

ASSET_20241212 > output

<input type="checkbox"/> Name	Status	D
 results_CTG_SCAN_2024-12-11_11-59-...		1.



A	B	C	D	E	F	G	H	I	J	K	L	M
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

Shahil Shah

Principal Engineer

shahil.shah@nrel.gov

Power Systems Engineering Center

National Renewable Energy Laboratory

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