DOE Office of Electricity TRAC

Peer Review

U.S. DEPARTMENT OF ENERGY | OFFICE OF ELECTRICITY

PROJECT SUMMARY

MASTERRI

Merging power flow simulations , probabilistic risk assessment, and resilience metrics

PRINCIPAL INVESTIGATORS

Dr. Bjorn Vaagensmith, Power Systems Researcher, INL

Shawn West, Senior Power Systems Researcher, INL

WEBSITE

www.INL.gov

The Numbers

DOE PROGRAM OFFICE:
OE – Transformer Resilience and Advanced Components (TRAC)

FUNDING OPPORTUNITY:
XXX

LOCATION:
Idaho Falls, Idaho

PROJECT TERM:
01/20/2020 to 09/30/2021

PROJECT STATUS:
Completed

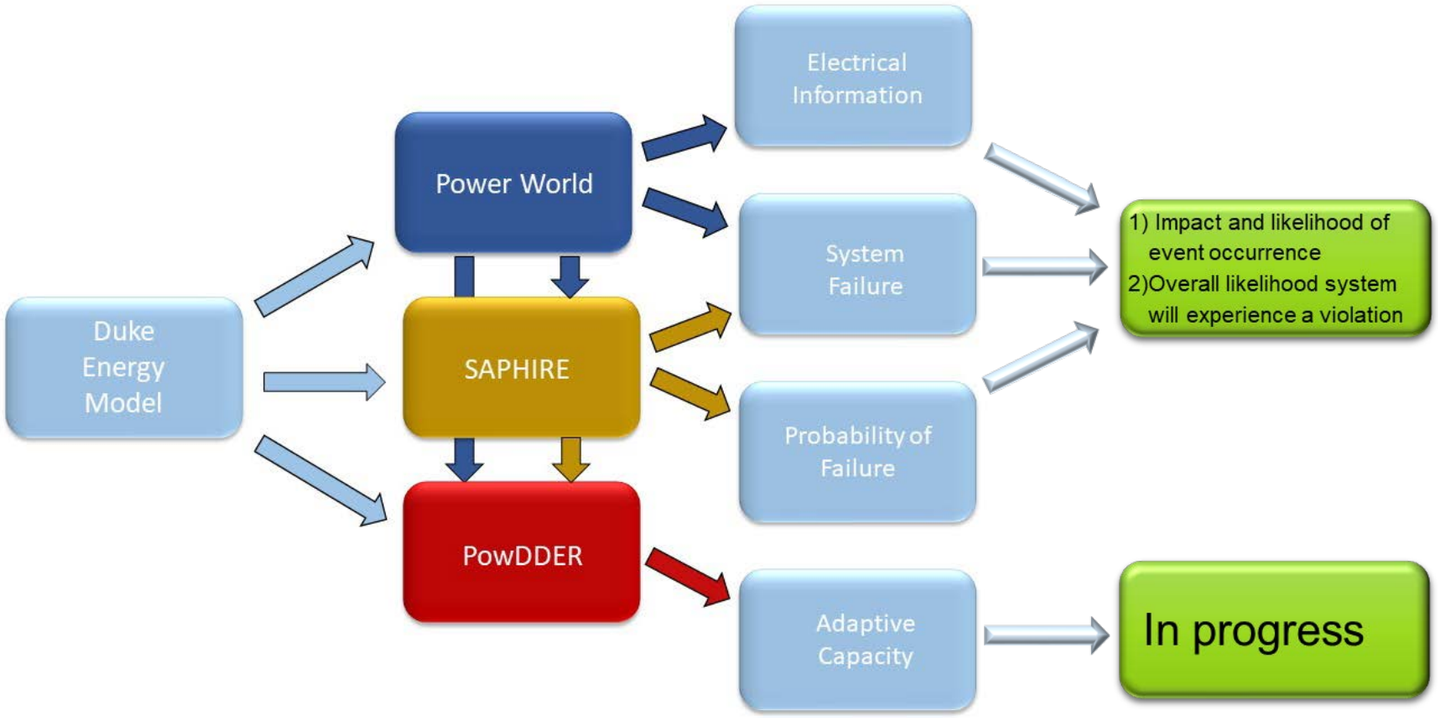
AWARD AMOUNT (DOE CONTRIBUTION):
$390,000

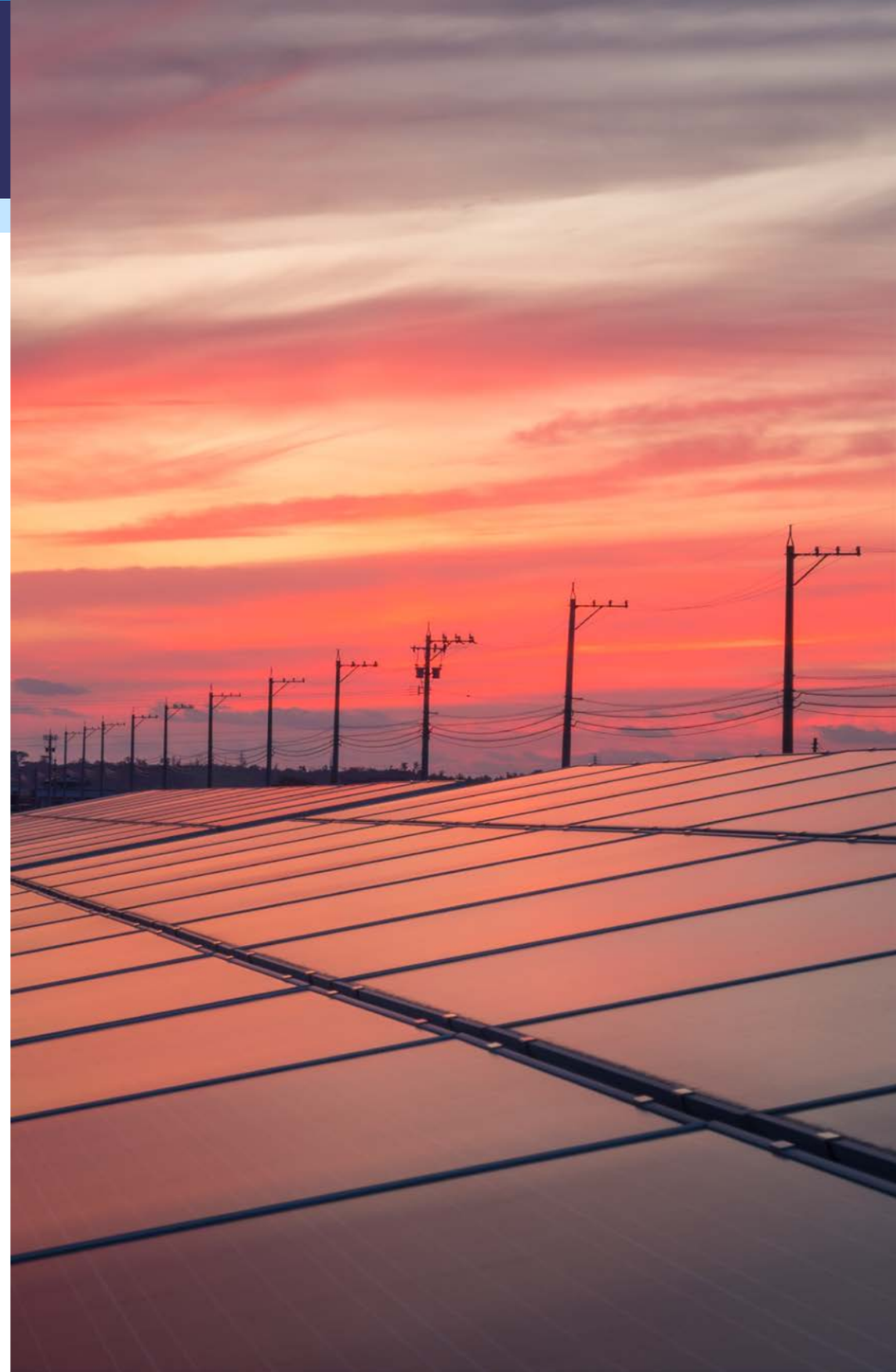
AWARDEE CONTRIBUTION (COST SHARE):
INL - $0

Duke Energy Collaboration Partners:
Engineering Analysis In Kind

Primary Innovation

- Combining power flow simulations with probabilistic risk assessment
  - quantify event severity and likelihood of occurrence





Impact/Commercialization

Impact

- Identified issues on the power grid and their likelihood of occurrence
  - Results validated by utility power engineers
- Aids engineers in deciding what system upgrades are most impactful or the best reconfiguration to avoid negative consequences
- Aids engineers in communicating to non-engineering management

IP STATUS/Commercialization

Patent App. PCT/US19/4253

Innovation Update

- Adaptive capacity resilience metrics did not provide clear actionable results
  - Grouped components by bus resulted in little to no changes in adaptive capacity
  - New grouping mechanisms or new metrics are needed
- A technology commercialization funding project was awarded to improve the interface between the different analysis tools used in MASTERRI.
- Working with cyber capital partners to help with customer discovery

Component likelihood of violation contribution

Name	F-V Point Est.	% of Top Event	Description
Line 1	2.06E-01		AVERAGE LENGTH 200-499 KV LINE, 19.01 MI
Line 2	2.06E-01		AVERAGE LENGTH 200-499 KV LINE, 19.01 MI
Line 3	2.06E-01		AVERAGE LENGTH 200-499 KV LINE, 19.01 MI
Line 5	2.06E-01		AVERAGE LENGTH 200-499 KV LINE, 19.01 MI
Line 6	2.06E-01		AVERAGE LENGTH 200-499 KV LINE, 19.01 MI
Line 1000000	2.06E-01		AVERAGE LENGTH 200-499 KV LINE, 19.01 MI
Line 1.5	1.27E-01	61.65%	##.## MILE 230 KV LINE
Line 4	1.27E-01	61.65%	##.## MILE 230 KV LINE
Line 23	9.08E-02	44.08%	##.## MILE 230 KV LINE
Line 25	9.08E-02	44.08%	##.## MILE 230 KV LINE
Line 26	8.08E-02	39.22%	AVERAGE LENGTH 200-499 KV LINE, 19.01 MI
Line 27	6.88E-02	33.40%	AVERAGE LENGTH 200-499 KV LINE, 19.01 MI
Line 28	6.88E-02	33.40%	AVERAGE LENGTH 200-499 KV LINE, 19.01 MI
Line 29	4.04E-02	19.61%	##.## MILE 230 KV LINE
Line 30	4.04E-02	19.61%	##.## MILE 230 KV LINE
Line 31	1.36E-02	6.60%	8.44 MILE 230 KV LINE
Line 32	1.36E-02	6.60%	8.44 MILE 230 KV LINE
Transformer 1	1.91E-04	0.09%	TRANSFORMER XXXX FAILURE

Component combination violation likelihood

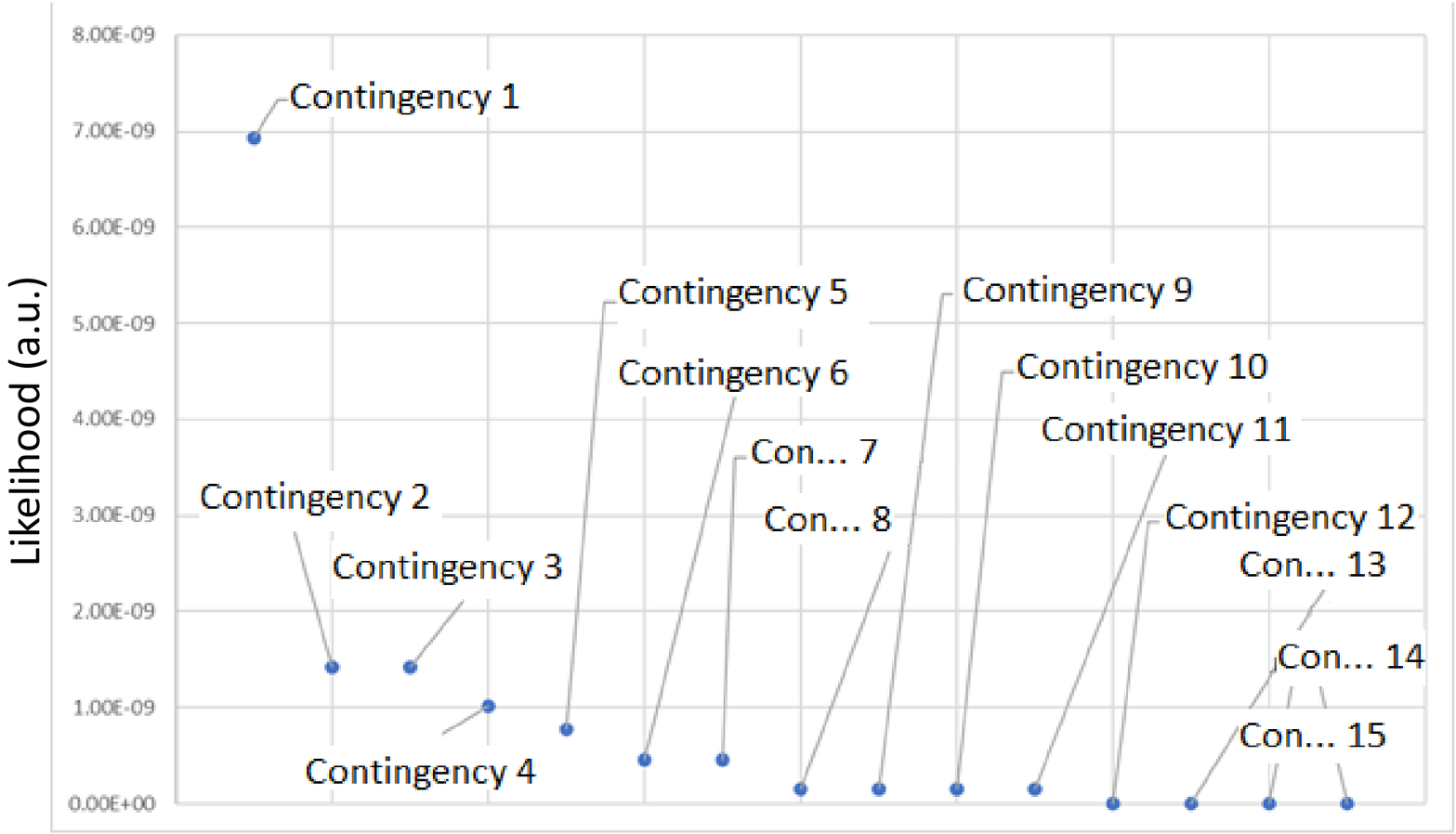
#	Prob/Freq	Total %	Cut Set
Total	XXXXXXX	100	Displaying ###### Cut Sets.
1	1.06E-07	0.76	Line 56, Line 42
2	6.38E-08	0.46	Line 32, Line 52
3	6.38E-08	0.46	Line 45, Line 41
4	5.56E-08	0.4	Line 6, Line 2
5	5.38E-08	0.38	Line 5, Line 4
6	5.38E-08	0.38	Line 5, Line 42
7	5.38E-08	0.38	Line 6, Line 4
8	5.38E-08	0.38	Line 6, Line 42
9	5.38E-08	0.38	Line 156, Line 242
10	5.38E-08	0.38	Line 56, Line 422
11	5.38E-08	0.38	Line 566, Line 42
12	5.38E-08	0.38	Line 546, Line 442
13	5.38E-08	0.38	Line 563, transformer 42
14	5.38E-08	0.38	Line 526, Line 2
15	5.38E-08	0.38	Line 56, Line 3

Ranks component combination failures in terms of likelihood that are most likely to result in a system violation

Probability of occurrences contingency ranking

TABLE INFORMATION:
MASTERRI can rank

- Contingency scenarios
  - Under different grid configurations
- Contingency scenario pairs



Summery

MASTERRI provides the likelihood and impact of power grid violations

- Components most likely to contribute to a system violations
- Component combinations most likely to contribute to a system violation
- Contingencies most likely to contribute to a system violation

Future work

- Advance data visualization methods
- Frequency consequence curves
- Reevaluate resilience metrics
- Dynamic analysis

Acronyms

MASTERRI:

- Modeling And Simulation for Targeted Reliability and Resilience Improvement

THANK YOU

Acknowledgment to DOE-OE-TRAC program for supporting this work

U.S. DEPARTMENT OF ENERGY | OFFICE OF ELECTRICITY