



Resilience Application: MIRACL Advisory Board Meeting 2022

October 2022

Changing the World's Energy Future

Megan Jordan Culler, Mathew Wymore, Jody Dillon, Manual Marin



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October 2022

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October 27, 2022

Megan Culler
Power Engineer

Resilience Application

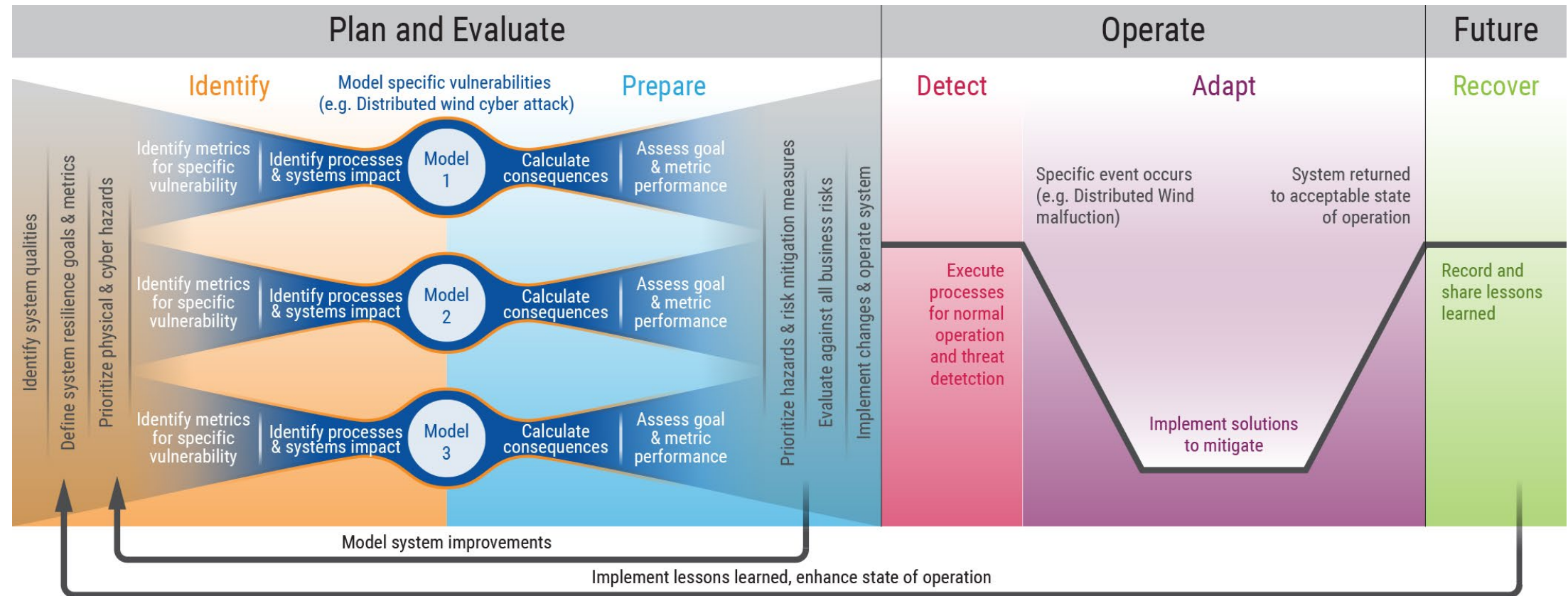
MIRACL Advisory Board Meeting 2022

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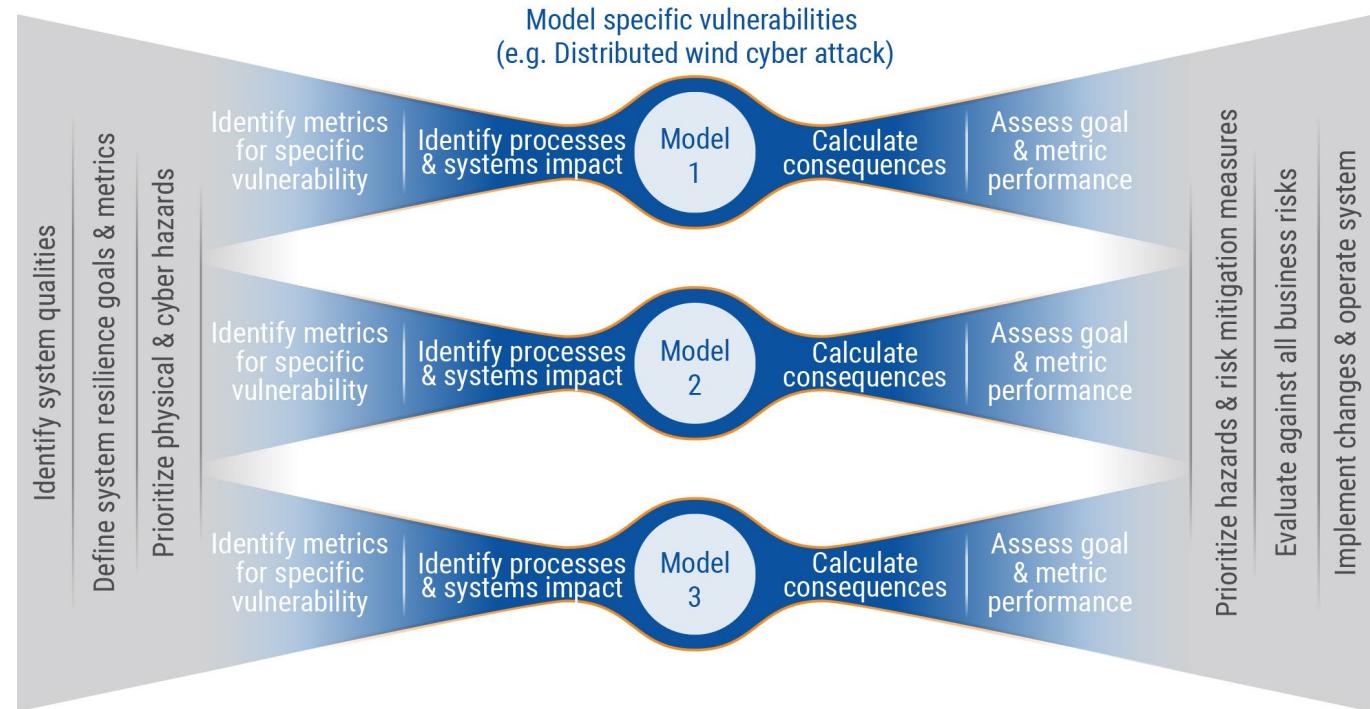
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Resilience Framework for Electric Energy Delivery Systems



Resilience Planning Tool: Motivation

- Make the resilience framework more accessible
- Allow users to customize analysis to their system
- Hazards are difficult to model – tool can help motivate



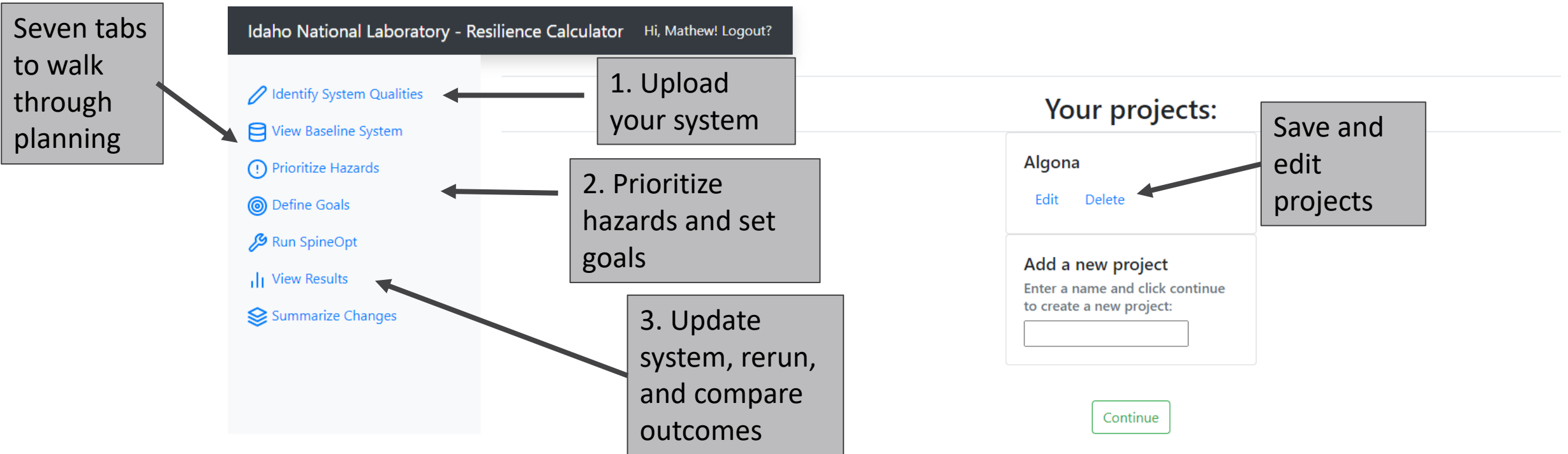
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Resilience Planning Tool: Web Application



Resilience Planning Tool: Workflow

- Automate the resilience framework planning process
- Modeling and simulation performed using Spine

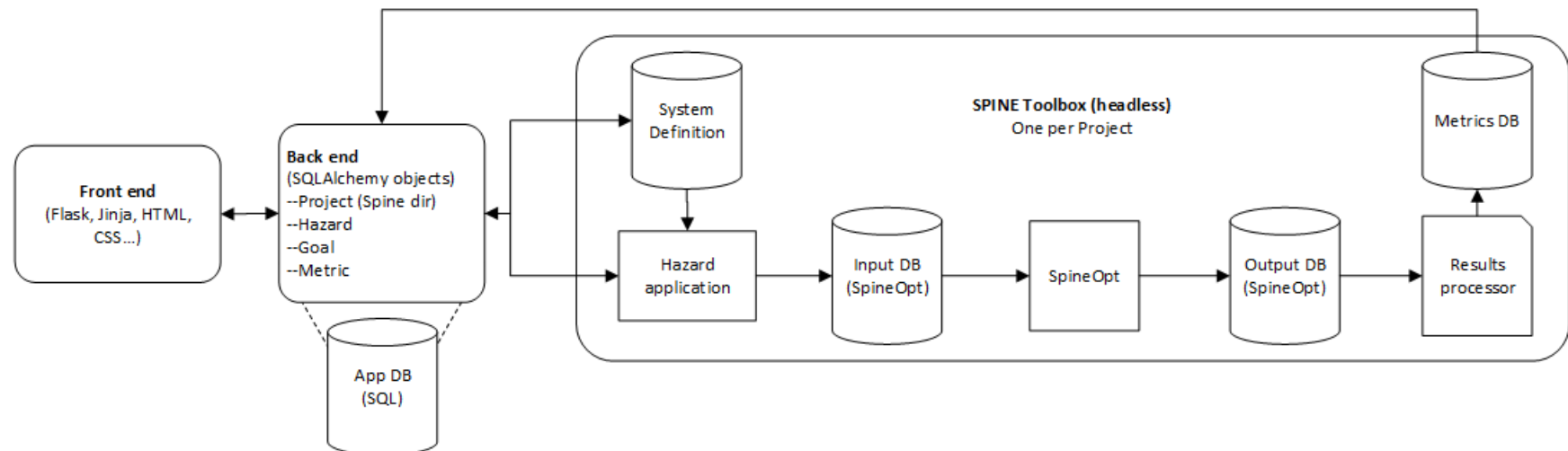


Web Framework  Flask

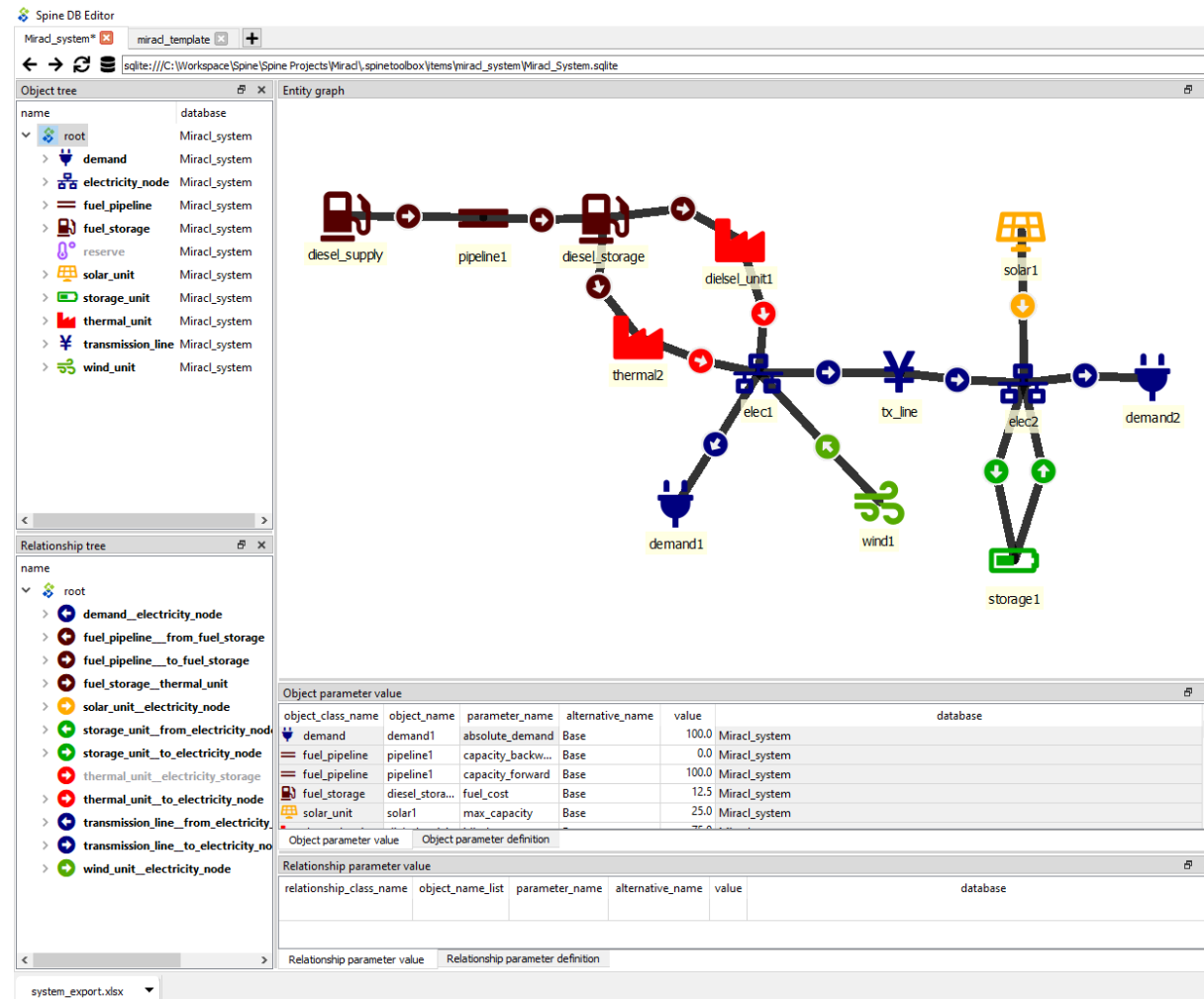
Authentication  okta

Database Toolkit  SQLAlchemy

Database  MariaDB



Resilience Planning Tool: Defining a system in Spine




Spine DB editor, part of Spine Toolbox


Resilience Planning Tool:


Uploading Spine System as a Spreadsheet


Idaho National Laboratory - Resilience Calculator


Hi, Mathew! Logout?


 Identify System Qualities


 View Baseline System

 Prioritize Hazards

 Define Goals

 Run SpineOpt

 View Results

 Summarize Changes

Upload System Spreadsheet

Upload the spreadsheet that defines your system:

Choose File No file chosen

Upload

Download Template

No system spreadsheet?
Download this template and fill it out!

Download

Continue

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Resilience Planning Tool:

Viewing Spine System in Web Application

Idaho National Laboratory - Resilience CalculatorHi, Mathew! Logout?

Identify System Qualities

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View Results

Summarize Changes

The baseline system loaded from the spreadsheet is shown below.

Click Next to continue, or Back to upload a different spreadsheet.

Back

Next

Object Name	Object Class	Parameters
diesel_unit1	thermal_unit	<div><div>forced_outage_rate</div><div>0.075</div></div>
		<div><div>idle_heat_rate</div><div>0.008</div></div>
		<div><div>incremental_heat_rate</div><div>0.008</div></div>
		<div><div>max_capacity</div><div>3200.0</div></div>
diesel_unit3	thermal_unit	<div><div>min_stable</div><div>25.0</div></div>
		<div><div>minimum_down_time</div><div>3.0</div></div>
		<div><div>minimum_up_time</div><div>3.0</div></div>
		<div><div>ramp_down_rate</div><div>ramp_up_rate</div></div>
diesel_unit1	thermal_unit	<div><div>shutdown_cost</div><div>100.0</div></div>
		<div><div>start_up_cost</div><div>45.0</div></div>
		<div><div>start_up_fuel_use</div><div>45.0</div></div>
		<div><div>forced_outage_rate</div><div>0.075</div></div>
diesel_unit3	thermal_unit	<div><div>idle_heat_rate</div><div>0.008</div></div>
		<div><div>incremental_heat_rate</div><div>0.008</div></div>
		<div><div>max_capacity</div><div>4400.0</div></div>
		<div><div>min_stable</div><div>25.0</div></div>
diesel_unit1	thermal_unit	<div><div>minimum_down_time</div><div>3.0</div></div>
		<div><div>minimum_up_time</div><div>3.0</div></div>
		<div><div>ramp_down_rate</div><div>ramp_up_rate</div></div>
		<div><div>shutdown_cost</div><div>100.0</div></div>
diesel_unit3	thermal_unit	<div><div>start_up_cost</div><div>45.0</div></div>
		<div><div>start_up_fuel_use</div><div>45.0</div></div>
		<div><div>forced_outage_rate</div><div>0.075</div></div>
		<div><div>idle_heat_rate</div><div>0.008</div></div>

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Resilience Planning Tool: Prioritizing Hazards

Idaho National Laboratory - Resilience Calculator

Hi, Mathew! Logout?

Identify System Qualities

View Baseline System

Prioritize Hazards

Define Goals

Run SpineOpt

View Results

Summarize Changes

Drag and drop to align in order of priority.

	0 - Acceptable	1 - Tolerable	2 - Unacceptable	3 - Intolerable
Improbable				
Possible				<div>hurricane</div>
Probable				

Save and Continue

Hazards

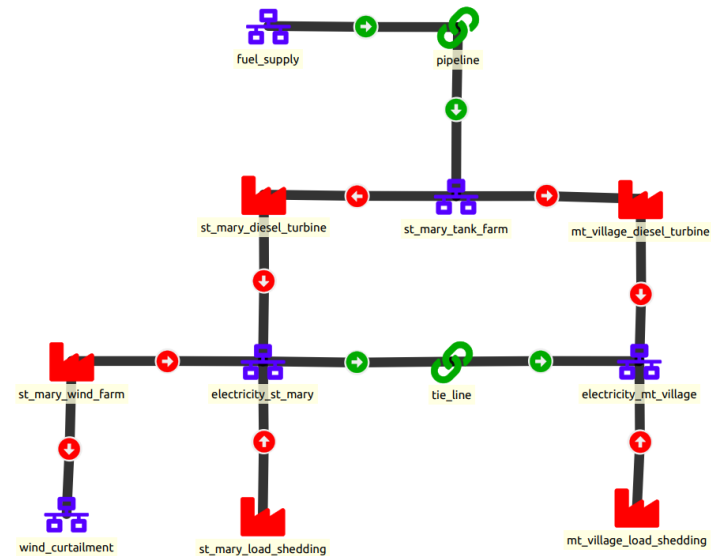
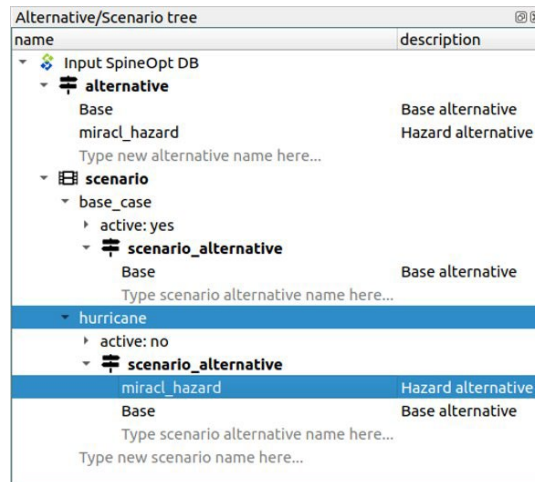
hurricane

ransomware

tornado

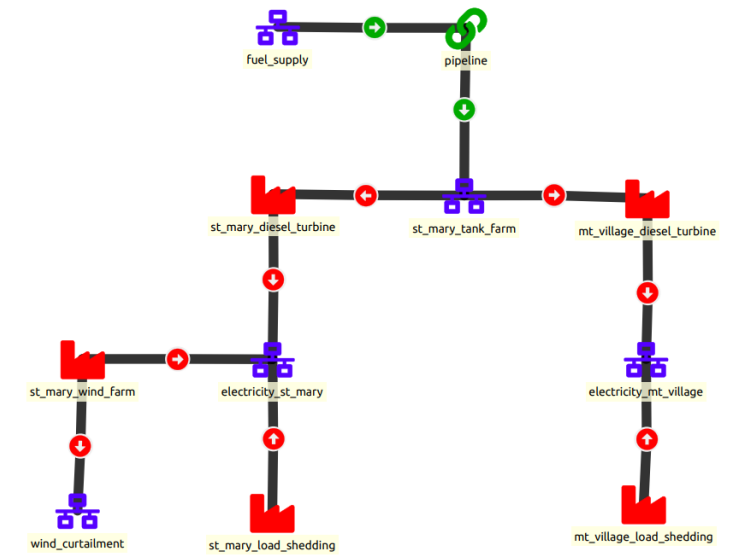
Resilience Planning Tool: Hazard Modeling

- Alternatives represent different states of components
- Scenarios are collections of alternatives



Base case system

Object parameter value					
object_class_name	object_name	parameter_name	alternative_name	value	database
connection	tie_line	is_active	miracl_hazard	False	Input SpineOpt DB
connection	tie_line	is_active	Base	True	Input SpineOpt DB



System with hazard applied

Resilience Planning Tool:

Setting Resilience Metric Goals for each Hazard

Idaho National Laboratory - Resilience Calculator

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Prioritize Hazards

Define Goals

Run SpineOpt

View Results

Summarize Changes

Define quantitative goals by selecting a target value for each metric.

Base goals

These will be used if no other value is specified.

base.Load unserved	<div>≤</div>	<div>1000.0</div>	kWh
base.Total capacity	<div>≥</div>	<div>5000.0</div>	kW
base.Total energy storage	<div>≥</div>	<div>12345.0</div>	kWh

Goals for tornado

tornado.Load unserved	<div><</div>	<div>1500.0</div>	kWh
tornado.Total capacity	<div><</div>	<div></div>	kW
tornado.Total energy storage	<div><</div>	<div></div>	kWh

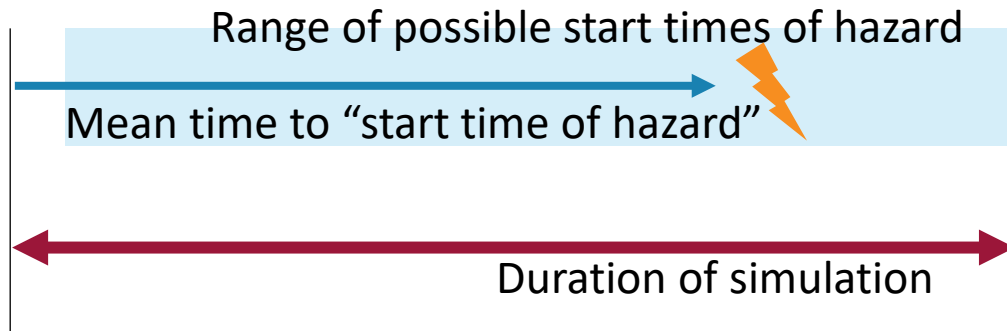
Goals for hurricane

hurricane.Load unserved	<div><</div>	<div>5000.0</div>	kWh
hurricane.Total capacity	<div><</div>	<div></div>	kW
hurricane.Total energy storage	<div><</div>	<div></div>	kWh

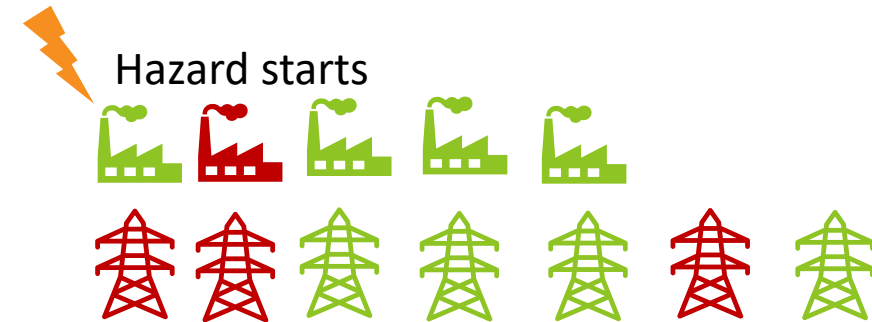
Goals for ransomware

ransomware.Load unserved	<div><</div>	<div></div>	kWh
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Resilience Planning Tool: Automated Hazard Analysis



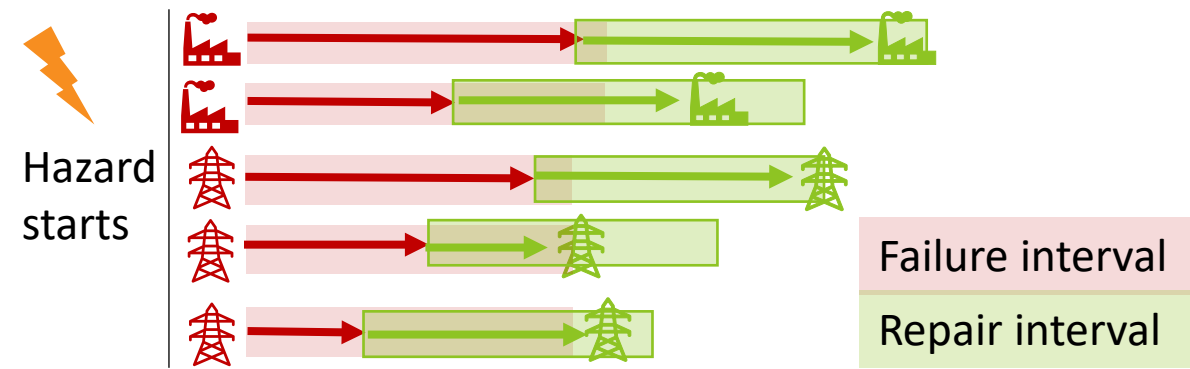
Randomizing start time of hazard



Define components that could be affected



a) Apply hazard for duration of failure



b) Apply mean time to failure/repair

Resilience Planning Tool:

Automated Hazard Analysis from Web Application

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Identify System Qualities

View Baseline System

Prioritize Hazards

Define Goals

Run SpineOpt

View Results

Summarize Changes

Your proposed system is shown below.

Run SpineOpt to evaluate resilience metrics, upload a new spreadsheet, or edit values and click Save.

Upload Spreadsheet

Upload a new system spreadsheet to update the proposed system. Uploading a spreadsheet will overwrite the current proposed system.

Choose FileNo file chosen

Upload

Run SpineOpt

Run SpineOpt simulations to evaluate resilience metrics of the proposed system.

Run SpineOpt

Object Name	Object Class	Parameters		
diesel_unit4	thermal_unit	<input type="text"/>	<input type="text"/>	<input type="text"/>
		forced_outage_rate	idle_heat_rate	incremental_heat_rate
		<input type="text"/>	<input type="text"/>	<input type="text"/>
		4400.0		
diesel_unit1	thermal_unit	<input type="text"/>	<input type="text"/>	<input type="text"/>
		max_capacity	min_stable	minimum_down_time
		<input type="text"/>	<input type="text"/>	<input type="text"/>
		minimum_up_time	ramp_down_rate	ramp_up_rate
		<input type="text"/>	<input type="text"/>	<input type="text"/>
		shutdown_cost	start_up_cost	start_up_fuel_use
		<input type="text"/>	<input type="text"/>	<input type="text"/>
		<input type="text"/>	<input type="text"/>	<input type="text"/>
		forced_outage_rate	idle_heat_rate	incremental_heat_rate
			0.075	0.008

27.0.0.1:5000

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Resilience Planning Tool: Web Application Results

Idaho National Laboratory - Resilience CalculatorHi, Mathew! Logout?

Identify System Qualities

View Baseline System

Prioritize Hazards

Define Goals

Run SpineOpt

View Results

Summarize Changes

Does your proposed system meet your goals? Check below.

Base goals

	Name		Goal	Calculated Value	Delta	
⊗	Load unserved	≤	1000.0	1480.64	+ 441.6500000000001	kWh
⊗	Total capacity	≥	5000.0	2753.41	-1283.65	kW
⊗	Total energy storage	≥	12345.0	6481.12	-1379.9700000000003	kWh

Goals for tornado

	Name		Goal	Calculated Value	Delta	
✓	Load unserved	<	1500.0	905.74	+ 105.48599999999999	kWh
✓	Total capacity	≥	5000.0	5695.88	-594.21	kW
✓	Total energy storage	≥	12345.0	15640.4	+ 8946.86	kWh

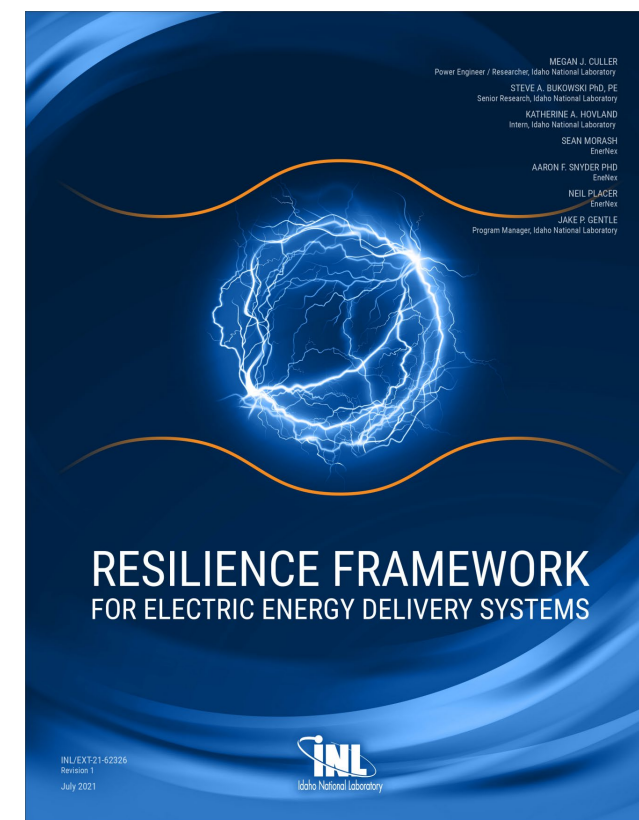
Goals for hurricane

	Name		Goal	Calculated Value	Delta	
⊗	Load unserved	<	5000.0	7041.4	+ 3566.6299999999997	kWh
✓	Total capacity	≥	5000.0	5379.71	+ 1091.8400000000001	kW
✓	Total energy storage	≥	12345.0	16141.4	+ 4531.6	kWh

Goals for ransomware

Resources

- Resilience Framework for Electric Energy Delivery Systems
- Case Study: Applying the Framework to St. Mary's, Alaska
- Case Study: Applying the Framework to Iowa Lakes, Iowa
- Isolated Grids and Grid-Connected Turbine Reference Systems
- More coming soon



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Idaho National Laboratory

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