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Case Study: Resilience Benefits of Distributed Wind Against Fuel and Weather Hazards in Alaska

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Changing the World's Energy Future

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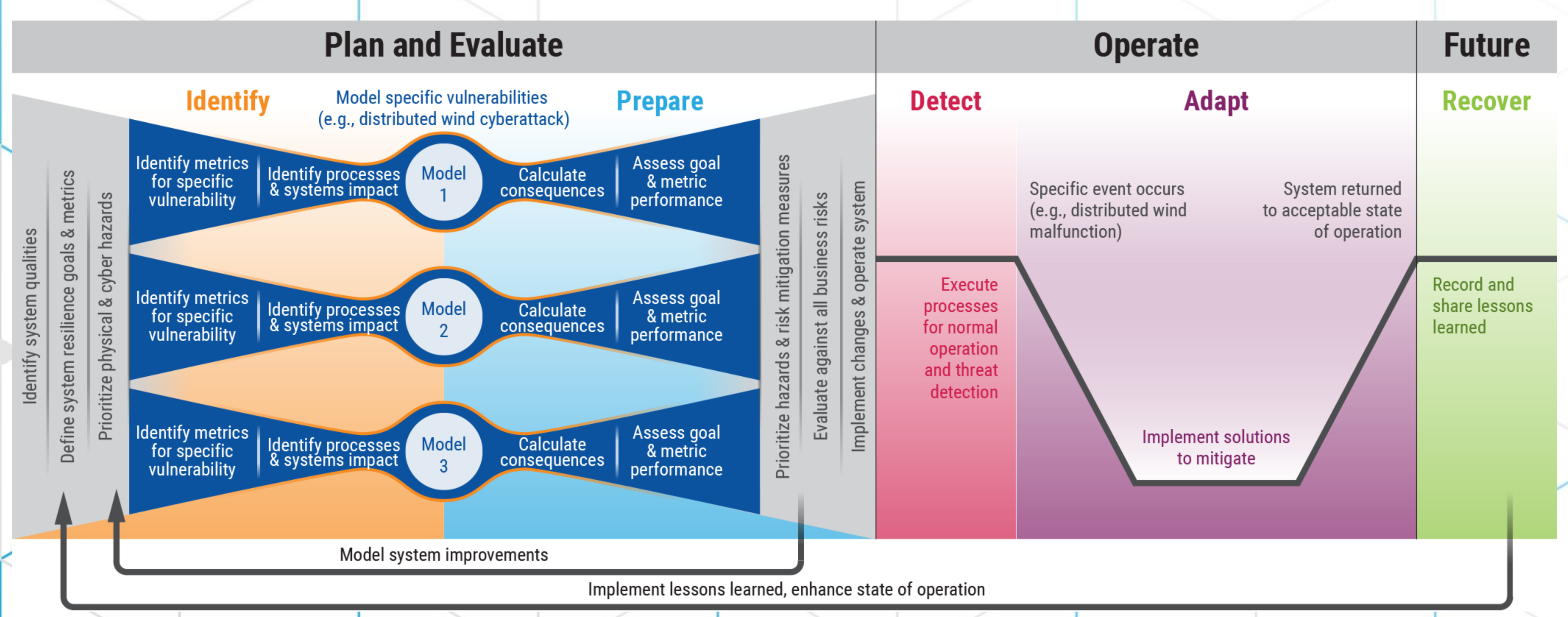
INTRODUCTION

- Resilience for electric energy delivery systems is not well defined or standardized.
- All-hazards approach to resilience allows for consideration of characteristics and hazards unique to a system
- Identification of resilience benefits allows estimations of resilience value, which is not typically captured in cost-benefit analysis.

RESILIENCE FRAMEWORK

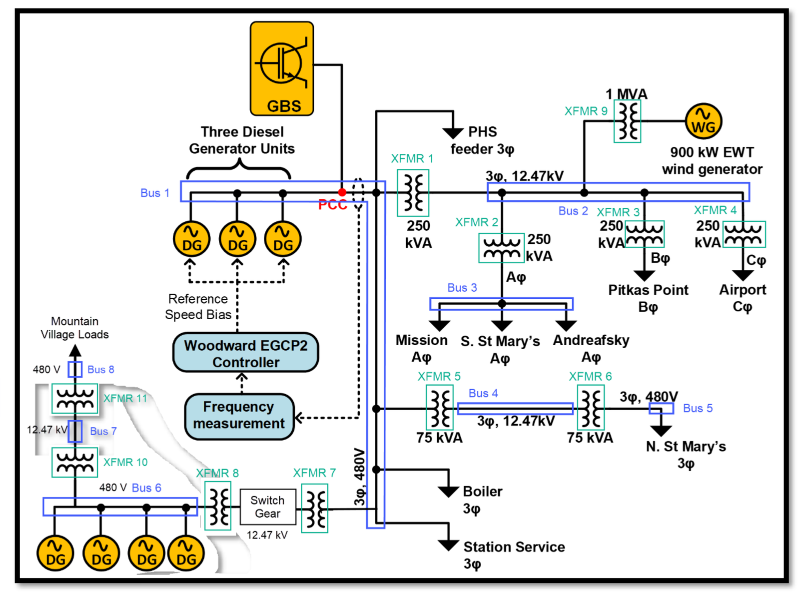
- INL developed a resilience framework for EEDS to cover entire system lifecycle and evaluate resilience using specific steps [1].
- Model-informed consideration of resilience hazards, including the risk of cyber effects, weather, or intentional physical damage.
- 3-tiered approach: lifecycle stages, resilience core functions, and process steps.
- Case study focuses on nested bow-tie process of planning stage.



INL Resilience Framework for EEDS

ST. MARY'S, AK CASE STUDY

System Description



- 900 kW wind turbine installed in 2019 [2].
- Over 2000 kW diesel generation capacity.
- Transmission intertie between St. Mary's and Mt. Village came online in 2020 [3].
- Peak load (combined system): 1072 kW [4].

Hazards

2-day fuel shortage

- Pipe rupture, tank failure, delayed shipment.
- Assume all diesel generation unavailable.

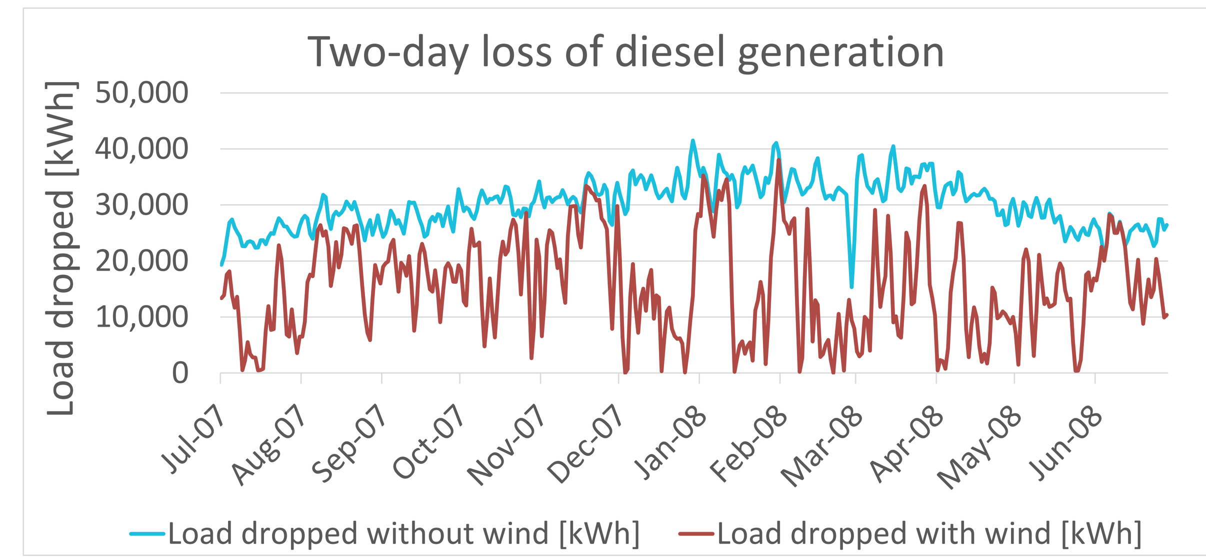
Extreme cold temperatures

- Varying severity: drops of 1°C to 20°C.
- Varying duration: 1 week to 12 weeks.
- Load increases with drops in temperature.

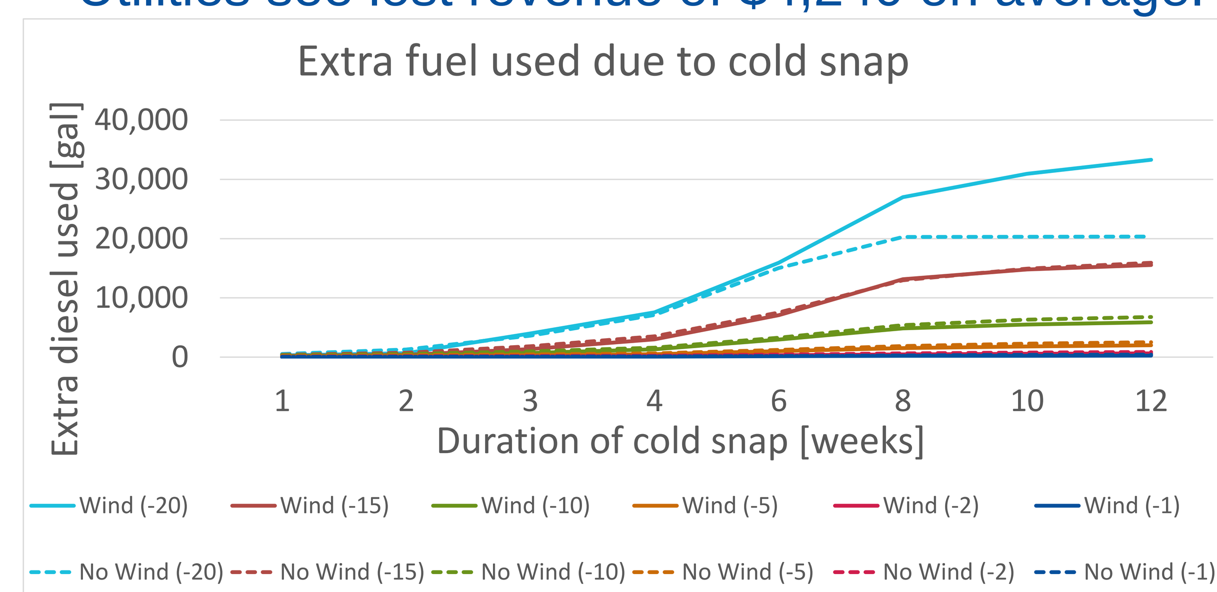
Simulations

- Wind speed and temperature data collected at airport, wind speeds adjusted for height and location [5].
- Manufacturer's wind production curve [6].
- 3 diesel generators dispatched for load and spinning reserves, fuel use calculated.
- Synthetic load data generated with HOMER using characteristics profiled in 2009-2011 [4].

RESULTS



- The presence of the wind turbine decreases the diesel use, and the severity of outages, if any.
- Customers see losses of $447,592, on average.
- Utilities see lost revenue of $4,240 on average.



- Wind that was curtailed in base case instead used to help serve excess load.
- Exception: extreme cold dropped temperature below turbine's operating point.
- Savings from having wind installed are maximized for temperature drops of 5-10° below normal.

REFERENCES

[1] M. J. Culler, S. A. Bukowski, K. A. Hovland, S. Morash, A.F. Snyder, N. Placer, and J.P. Gentle, "Resilience framework for electric energy delivery systems," Idaho National Laboratory, Tech. Rep. INL/EXT-21-62326, July 2021.
[2] "Closeout report for USDOE Office of Indian Energy award DEIE0000035 project: St. Mary's/Pitka's Point wind construction," Alaska Village Electric Cooperative Inc. (AVEC), Tech. Rep., 2020.
[3] "Alaska village electric cooperative 2020 annual report," Alaska Village Electric Cooperative, April 2020.
[4] D. Vaught, "Saint Mary's Alaska REF 8 wind-diesel project analysis." V3 Energy, LLC, Tech. Rep., 2014.
[5] "ASOS-QWOS-METAR data download," 2021. [Online]. Available: https://mesonet.agron.iastate.edu/request/download.phtml?network=AK ASOS
[6] "DW61 900kw specification sheet," Emergya Wind Technologies. [Online]. Available: https://ewtdirectwind.com/products/dw61/

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