

Equipping Utilities to Better Understand Weather Related Outages in a Changing Climate

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24 April 2024



Why Weather-Related Outages?

98.5%

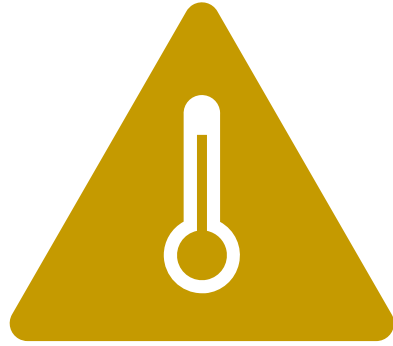
Large North American Transmission Outages Initiated by Weather [1]

17%

of annual distribution faults from weather and the environment or flooding over five-year period for one DNO [2]



Why Weather-Related Outages?



First Met Office red extreme heat warning in 2022 [3]

Wettest 18 Months

in England from 2022-2024 since Met Office Records Began [4]



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[3] <https://www.energynetworks.org/newsroom/heatwave-energy-networks-respond-to-first-met-office-red-extreme-heat-warning>

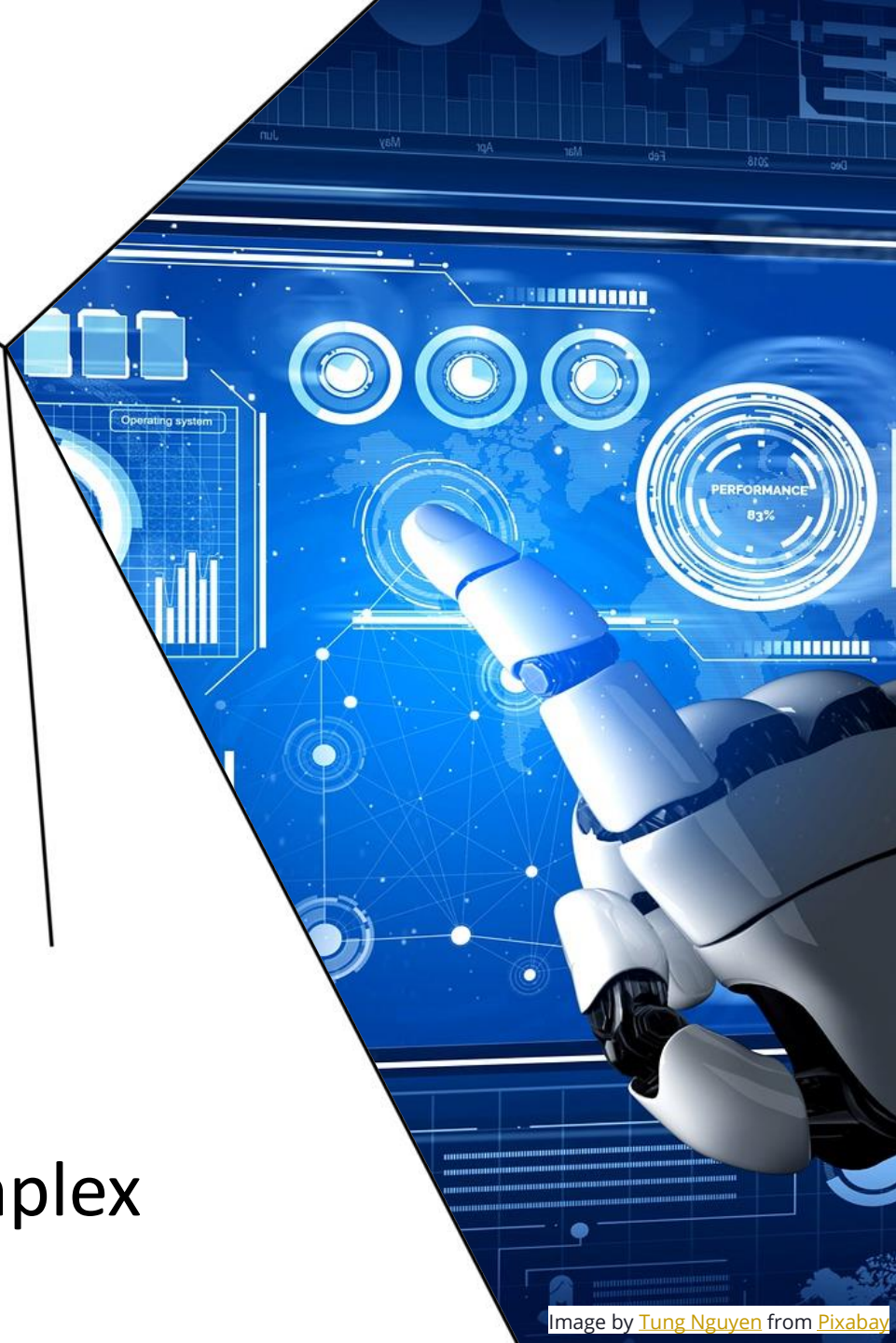
[4] <https://www.gov.uk/government/news/national-drought-group-meets-after-record-wet-october-to-march>

Artificial Intelligence a Perfect Solution?

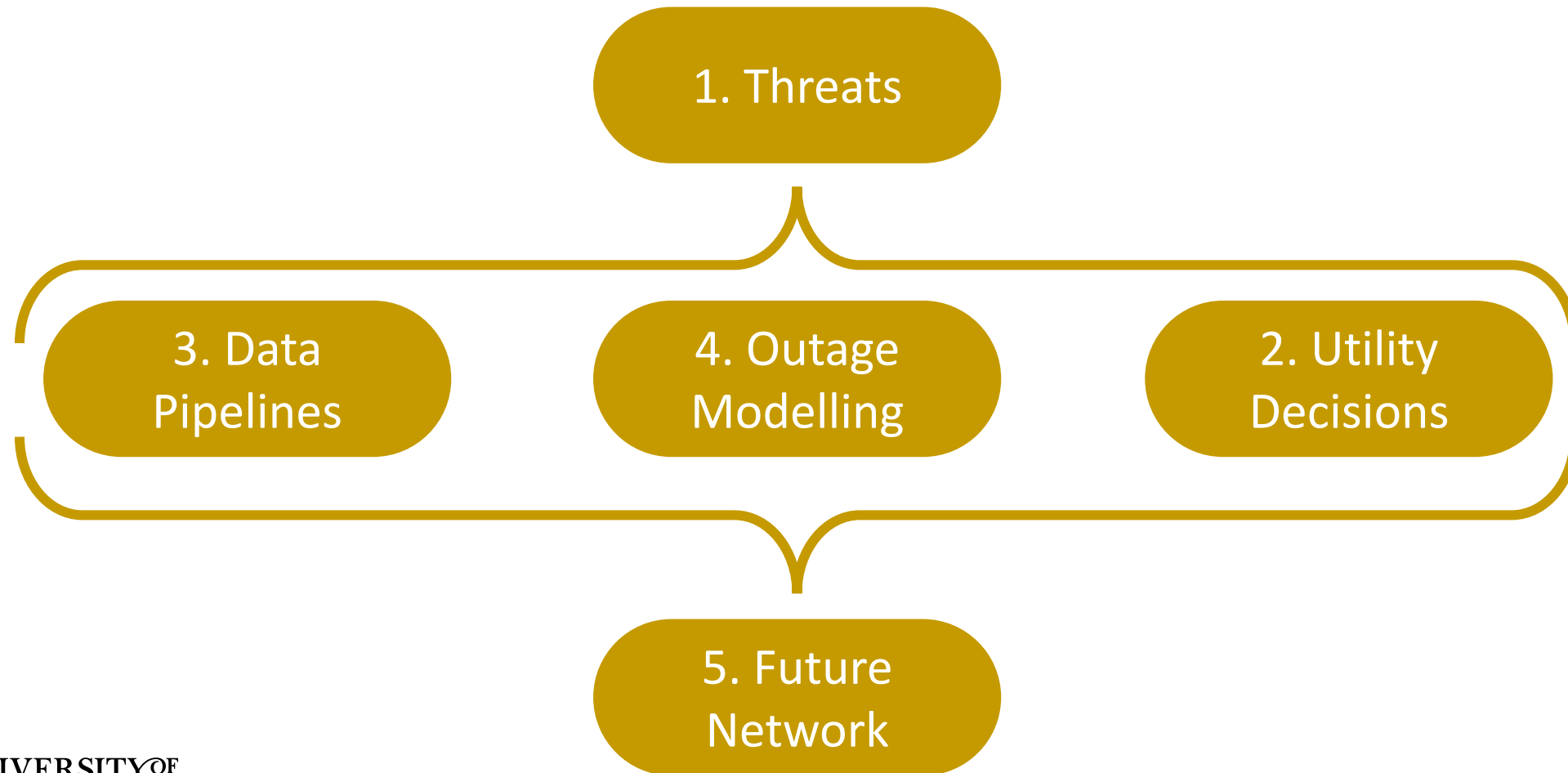


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Reality is much more complex



Begin with the End in Mind



Historical Threats – Standardise Outage Analysis



IEEE 1782
IEEE 1366
CNAIM



NaFIRS
TADS
ODIN

[IEEE 1782 - IEEE Guide for Collecting, Categorizing, and Utilizing Information Related to Electric Power Distribution Interruption Events](#)

[IEEE 1366 - IEEE Guide for Electric Power Distribution Reliability Indices](#)

[CNAIM - Common Network Asset Indices Methodology \(OFGEM\)](#)

[NaFIRS – National Fault and Interruption Reporting Scheme \(ENA\)](#)

[TADS – Transmission Availability Data System \(NERC\)](#)

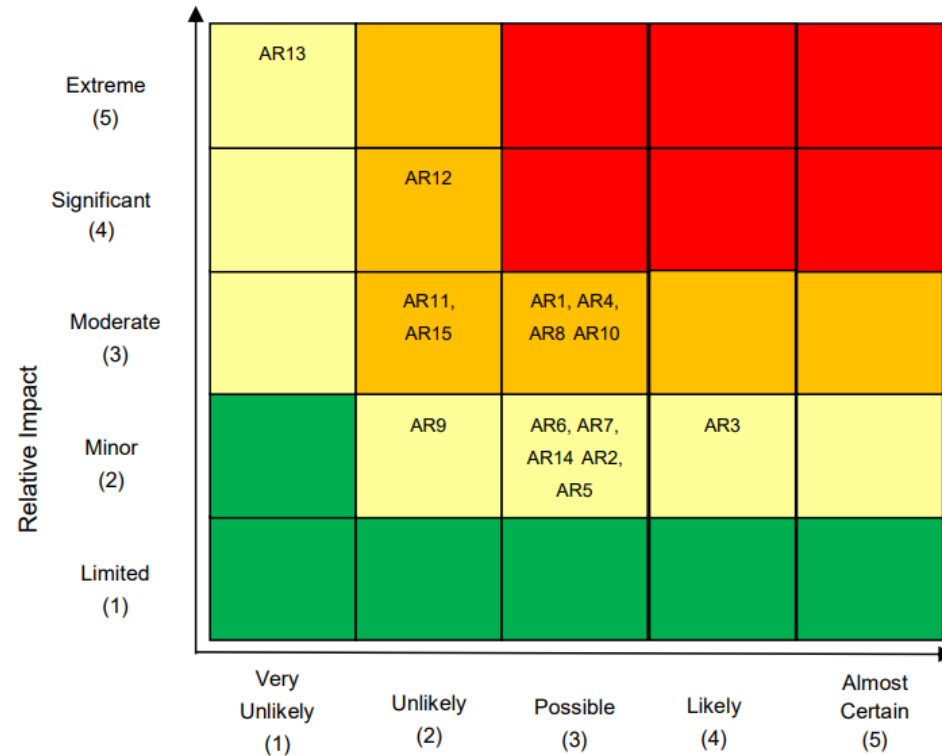
[ODIN - Outage Data Initiative Nationwide \(US DOE/ORNL\)](#)



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What Future Threats Should Be Considered?

ARP3 Risk Matrix (Electricity) [5]



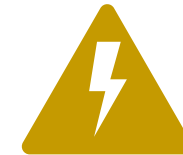
Adaptation Risks



AR 1-9



AR 10-13



AR 14



AR 15

Relative Likelihood

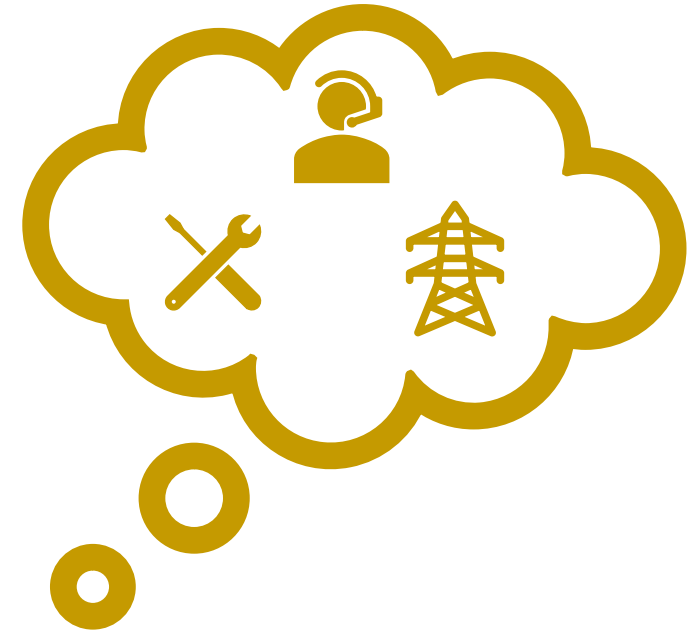
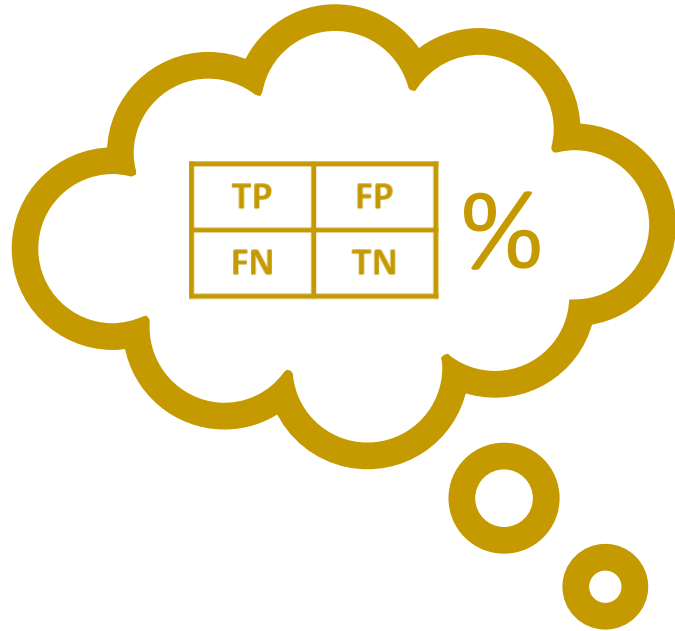
- High = major up-rating
- Low = minor up-rating
- Medium = minor up-rating
- Negligible = updated specification of new assets



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[5] Figure from: ENA 3rd Round Climate Change Adaptation Report. 2021.
<https://www.energynetworks.org/assets/images/CCRA3%20report%20v1.0%20final.pdf>

What is needed to Improve Current/Future Practice?



Inputs to Modelling - Robust Data Pipelines

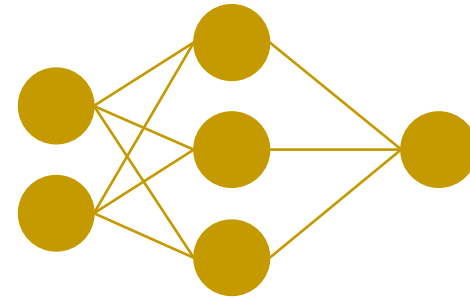


Outage Classification



Outage Prediction

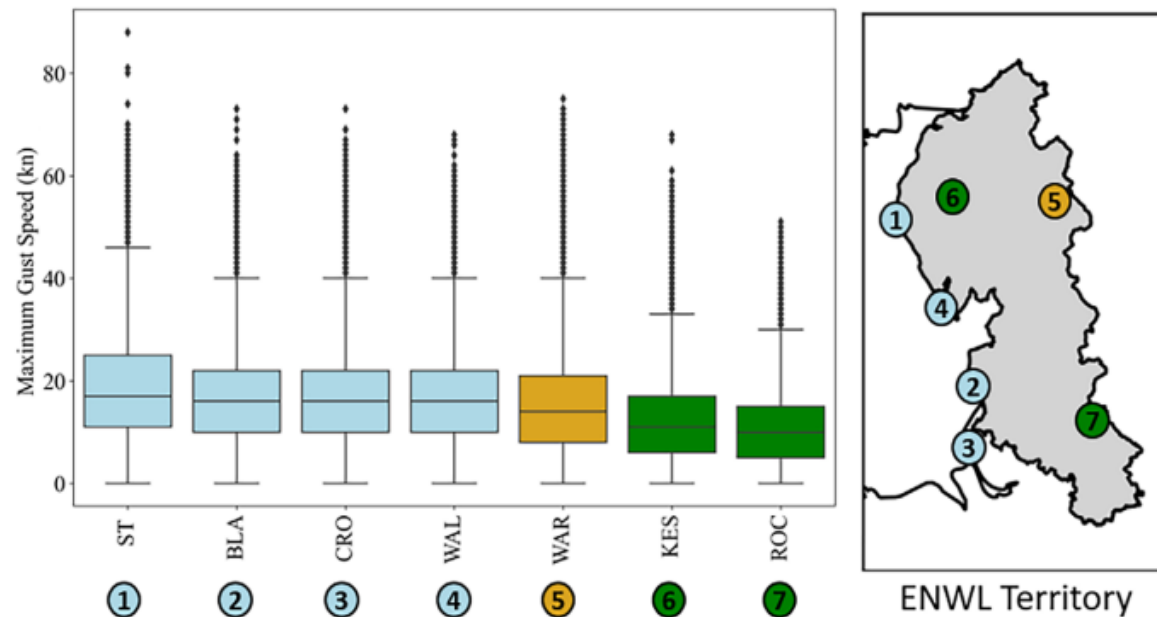
Conducted in 1993 ?



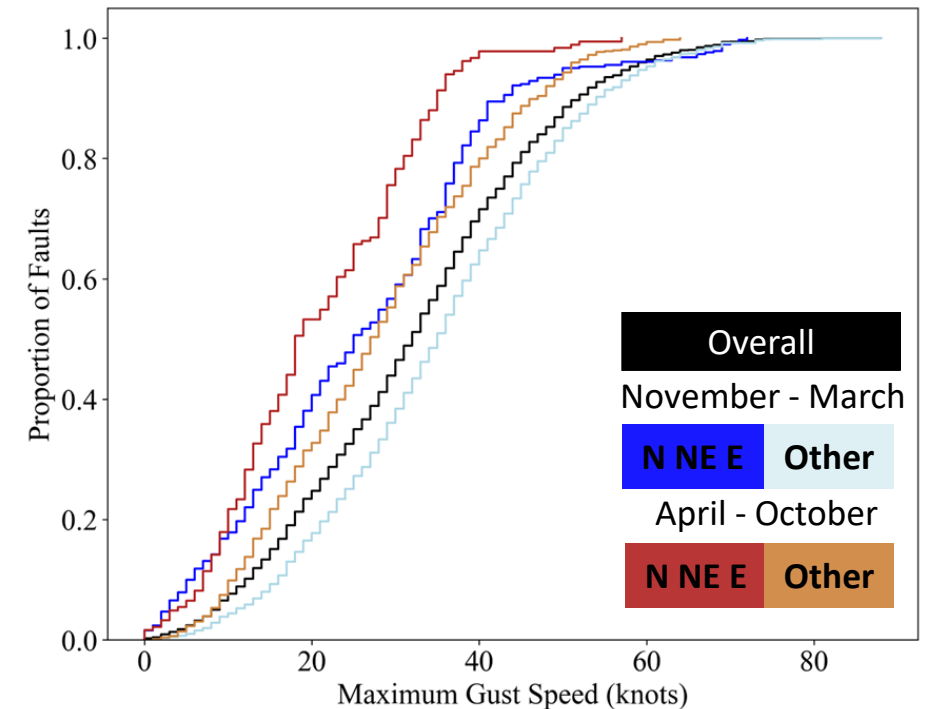
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Inputs to Modelling - Robust Data Pipelines

Regional Differences in Data [6]

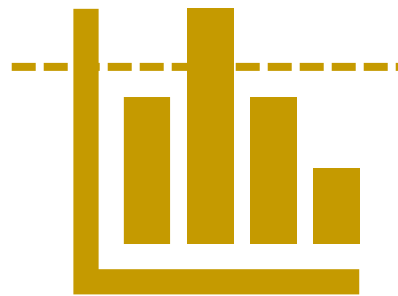


Season/Directionality of Wind [6]

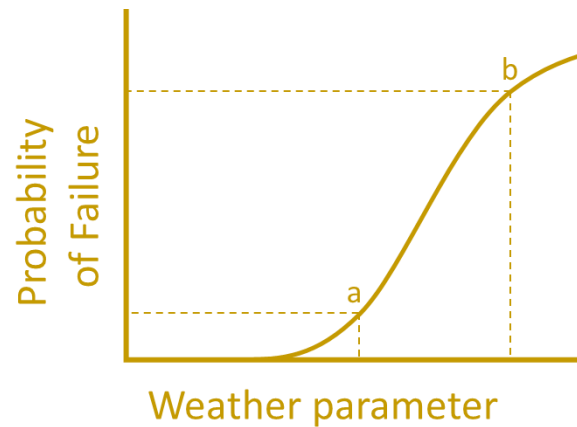


Modelling – Decisions of Interest Inform Models

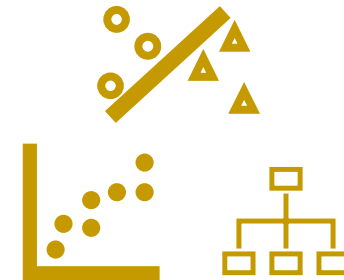
Thresholds



Fragility



AI/ML/Stats



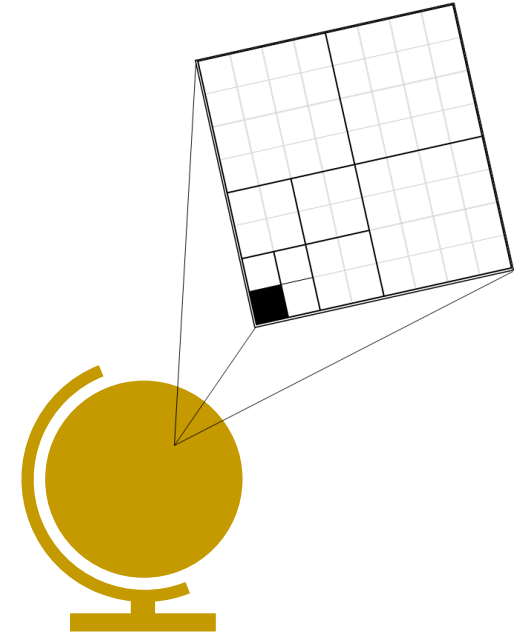
Why Increased Opportunity Now?



Open Data



Computation



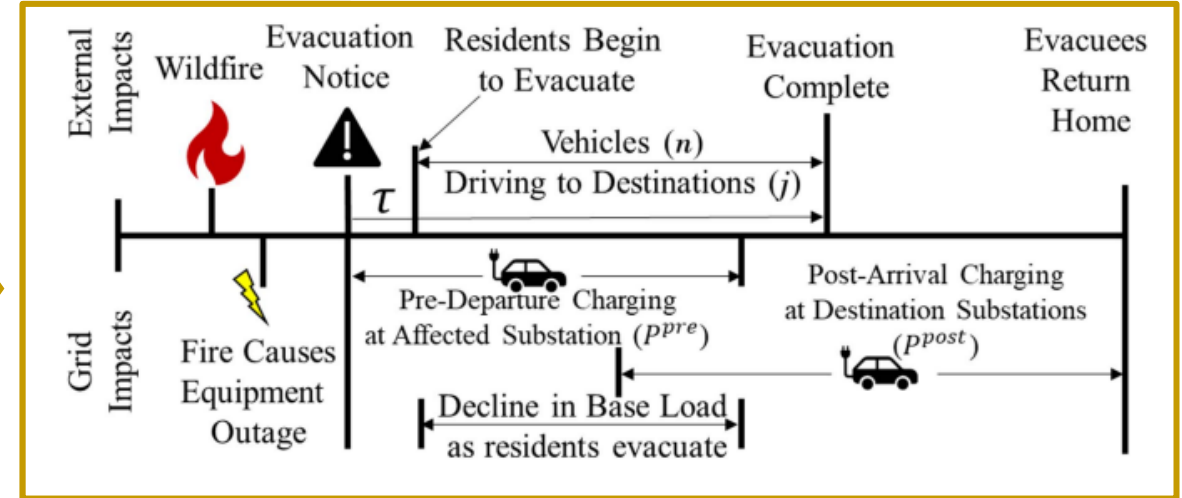
Data Resolution



Design for Future Decarbonised Power System



Image by Chil Vera from Pixabay



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D. L. Donaldson, M. S. Alvarez-Alvarado and D. Jayaweera, "Integration of Electric Vehicle Evacuation in Power System Resilience Assessment," in *IEEE Transactions on Power Systems*, vol. 38, no. 4, pp. 3085-3096, July 2023.

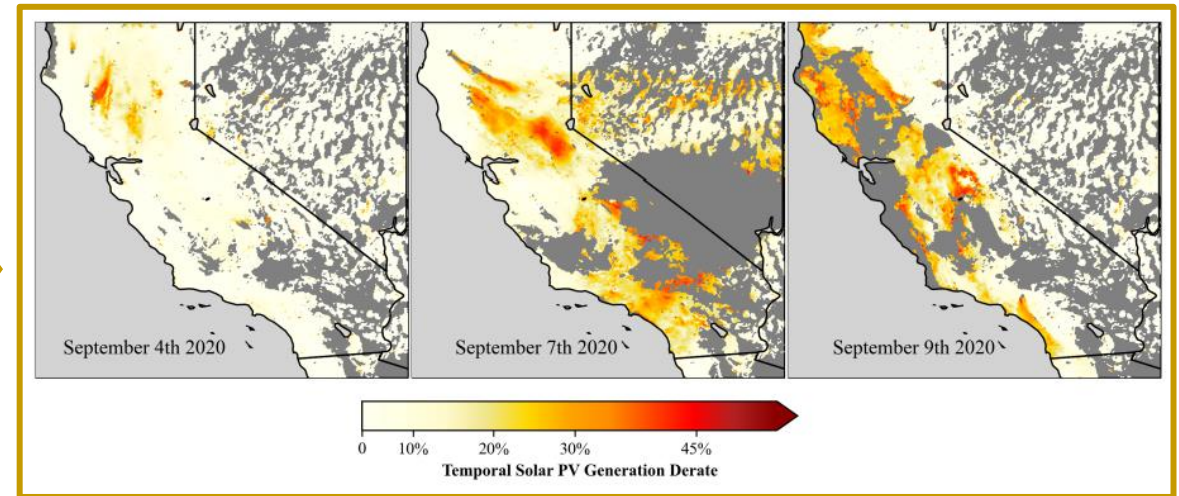
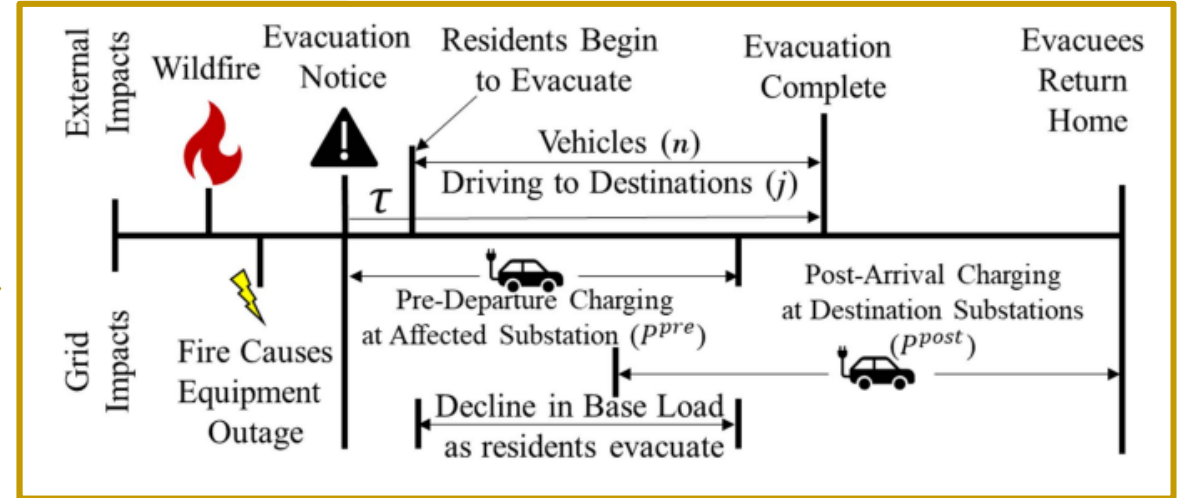
1.1 Million evacuees from 2017-2019 California Wildfires



Photo by [Marcus Kauffman](#) on [Unsplash](#)

Source: Wong, Broader, & Shaheen 2020. DOI:10.7922/G29G5K2R

Design for Future Decarbonised Power System

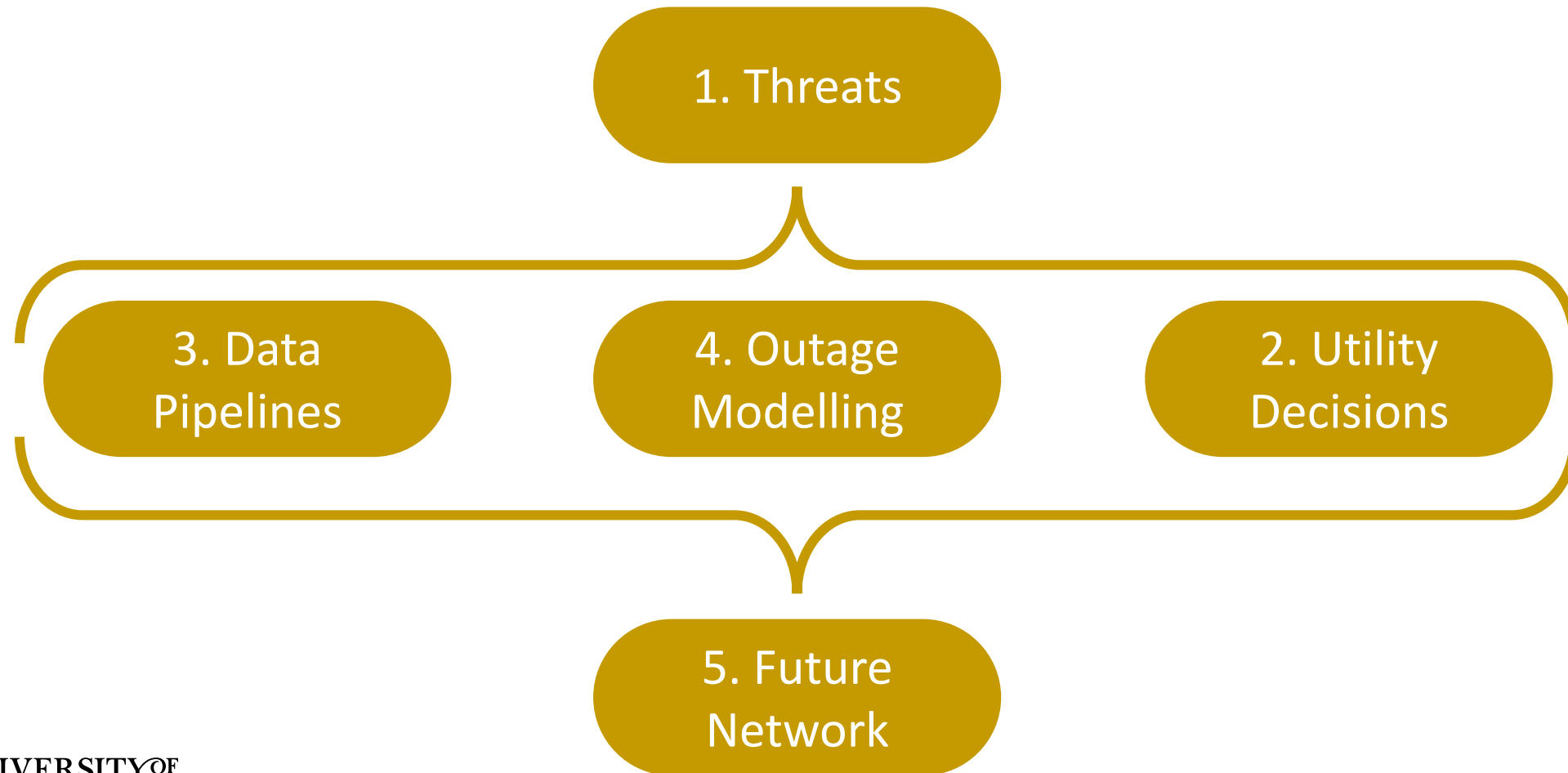


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D. L. Donaldson, D. M. Piper and D. Jayaweera, "Temporal Solar Photovoltaic Generation Capacity Reduction From Wildfire Smoke," in *IEEE Access*, vol. 9, pp. 79841-79852, 2021.

Begin with the End in Mind



Learn from the
Past...

...Engineer
for the Future



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