QUANTIFYING RISKS AND BENEFITS FROM UTILITY POWER SHUTOFF (PSPS)

Prepared for:
Mussey Grade Road Alliance
S-MAP II Phase 2 Track 1 Technical Working Group

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Prepared by M-bar Technologies and Consulting

PSPS: A Lot of History

- 2008 SDG&E Application
  - Cost/benefit analysis
  - "Tinder Dry Brush" loophole (exceeds design limits)
- 2012 Modification
  - Mitigation required
  - Loophole "last resort"
- 2018 – ESRB-8
  - Vegetation risks included in loophole
  - Applied to all utilities

Cost/Benefit Ideas, 2009

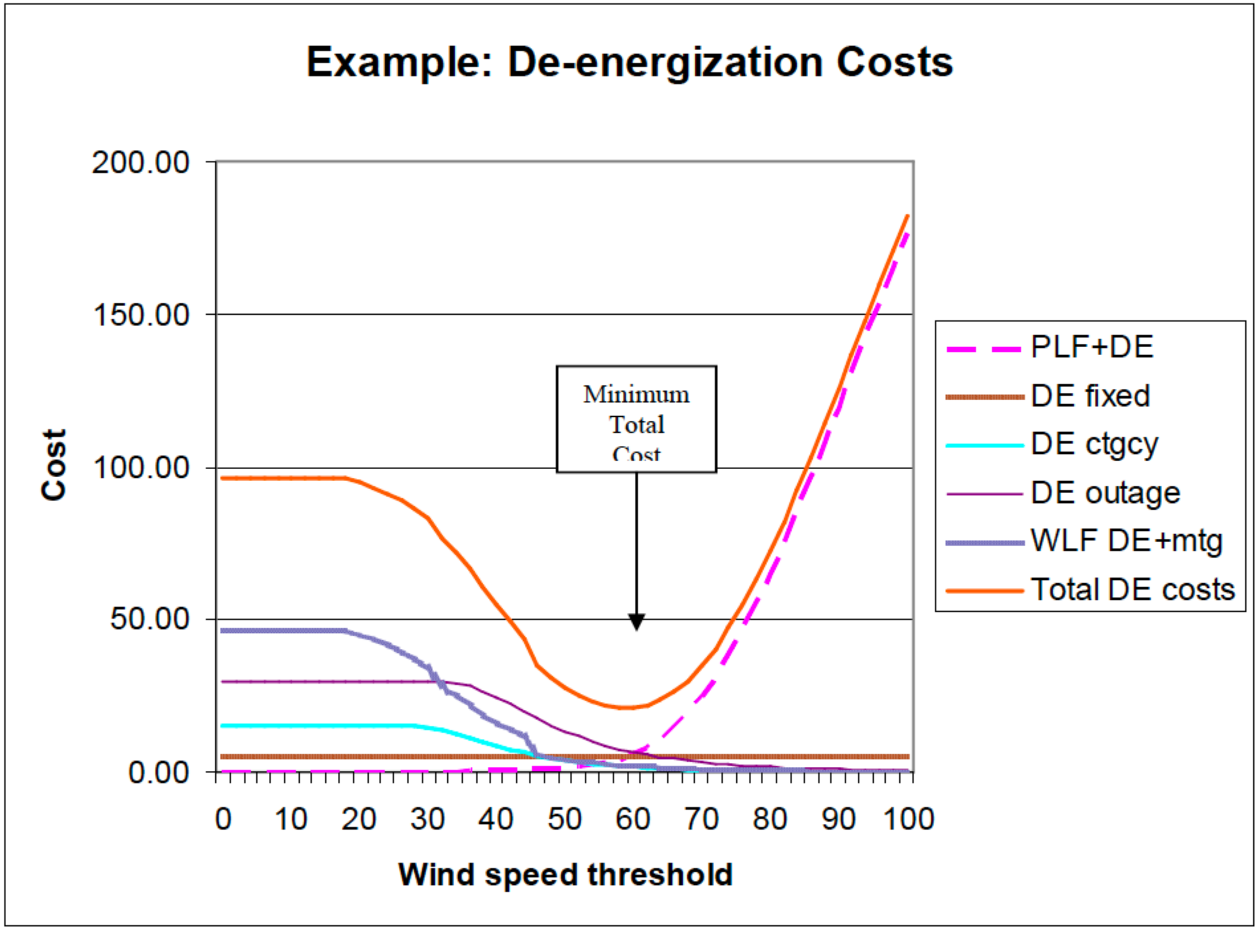


Figure 8 - De-energization cost curves

Classes of Customer Harm

Scope Dependent

- Safety (Accidents)
- Health (At-Risk Population, Communication)
- Economic (Spoilage, Work)

Weather Dependent

- Safety
  - Induced fires (Cooking, generator)
  - Increased fire vulnerability
    - Communications
    - Reporting
    - Smoke
    - Evacuation

PSPS – Dangers on Both Ends

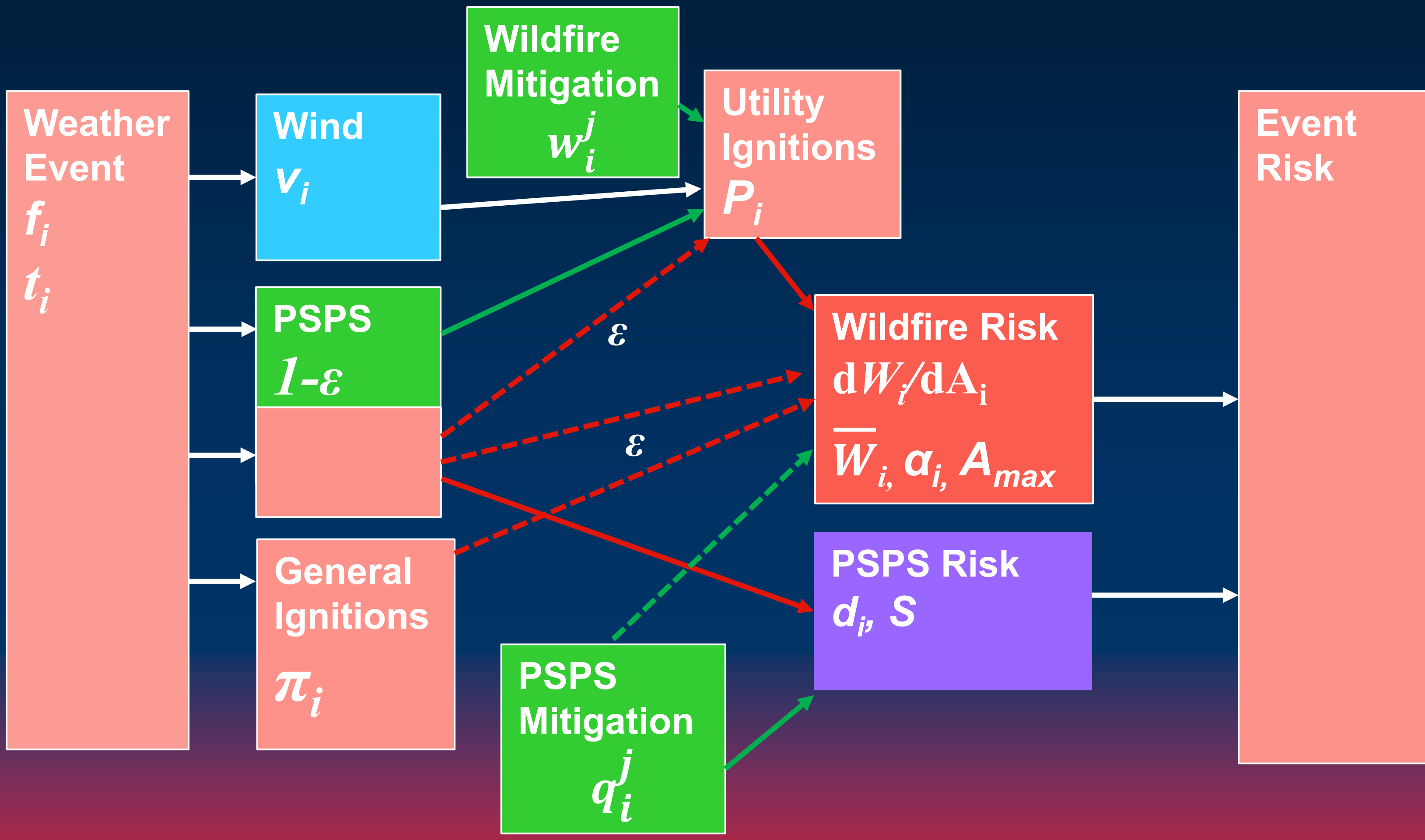
PSPS Hazards
(w. alleged examples)

- Economic Losses
- At-risk Individuals
- Loss of Communications (San Anselmo house fire fatality)
- Generator fires (Thief fire)
- Cooking fires (Tick fire)
- Auto accidents (PG&E claims)

Wildfires Before/During/After PSPS
(w. alleged electrical involvement)

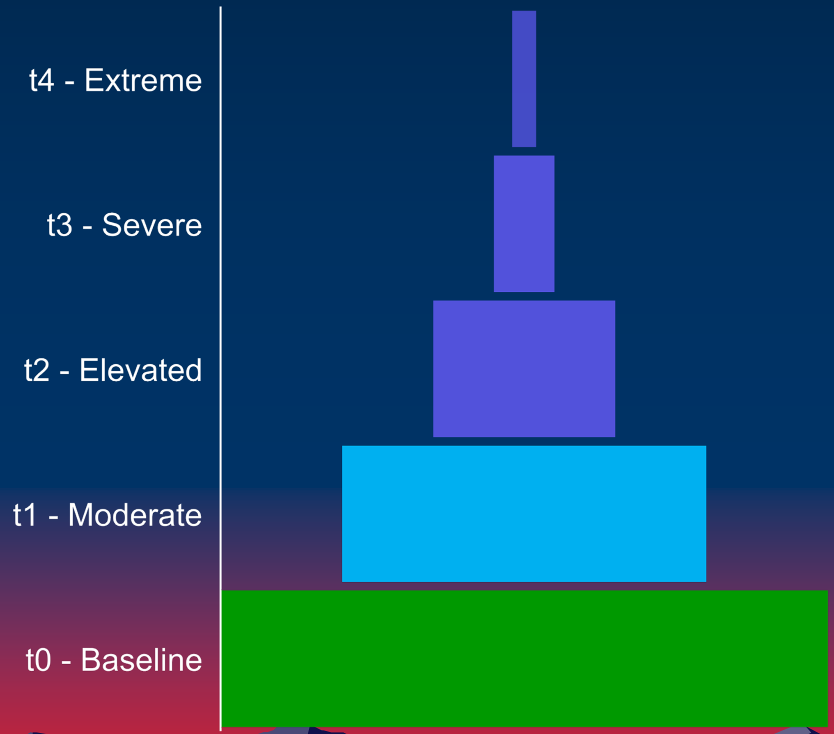
Fire	Date	Utility
Camp	November 8, 2018	PG&E
Kincade	October 23, 2019	PG&E
Zogg	September 27, 2020	PG&E
Silverado	October 26, 2020	SCE
Cornell	December 7, 2020	SCE

Weather Events Drive Risk



Fire Weather Tranches

Short-Term Goal



--- PSPS for severe wildfire risk

--- Mitigation for moderate tranche, raise PSPS threshold

--- Safe operation for baseline risk

Quantifying PSPS Cost/Benefit

Component	Symbols	Difficulty	Source	Comments
Wildfire weather tranches and event rates.	t_i, F_0, f_i	Moderate	Academic, CA fires	Methodology for fire weather event severity has been developed by several groups.
Wildfire consequence distributions and means	dW_i/dA, α_i	Moderate	Academic, CA fires	Methodology for fire size distributions has already been developed by several groups.
Fires per event	π_i		Academic, CA fires	Will come out of tranche analysis.
Power line frequency multiplier	P_i	Moderate	Utility data, weather	Existing utility data is sufficient to show increase in outage/damage rates as a function of wind speed.
PSPS event severity	d_i	Easy	Utility SME, PSPS history	Once tranches & severity are established, extent of associated PSPS event can be calculated.
PSPS consequences and efficiency	S, Di, ε	Hard	Utilities, consultants, CPUC, intervenors	CPUC or WSD needs to develop methodology for quantifying customer harm.
Mitigations for wildfire and PSPS	w_i, q_i	Easy	Utilities	Utilities have mitigation estimates already, need to divide them into weather severity tranches if they depend on wind.

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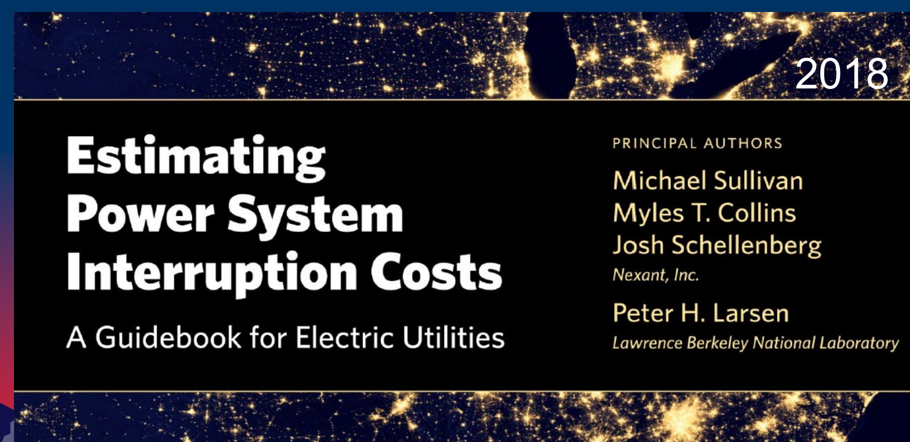
LBL / ICE Methodology

- Primarily economic, not safety
- Limitations / appropriate use of LBL/ICE model.
  - *To date, the literature is very limited with regard to using non-market valuation methods to estimate the costs of long duration interruptions (see Sullivan & Schellenberg (2013)). More research should be conducted to test the effectiveness of using surveys to quantify CICs for outages lasting more than 24 hours for residential customers.*
  - *A third limitation of survey-based CIC estimation methods described in this guidebook is that they are most appropriate for outages lasting 24 hours or less.*



PSPS Quantification - 1

- Communications:
  - Loss of 9-11
    - Increase in bad health/safety outcomes from delays (medical data)
    - Delay in fire reporting / initial attack delay (CAIRS/CAL FIRE/NFIRS)

Extreme Losses Possible

      - *Mitigation: Satellite detection / Wildfire detection cameras*
  - Wildfire notification
    - Safety risk from delayed evacuation (literature?)
  - *Mitigation: backup power, re-energization*
- Transportation:
  - Traffic signals
    - Accidents (we have some claims data)
    - Safety risk from delayed evacuation

    - *Mitigation: Microgrids, Backup, Re-energization*

PSPS Quantification - 2

- Ignitions (CAIRS/NFIRS/CAL FIRE): 

  - Outdoor Cooking (Tick fire)
  - Generators (Thief fire)
    - Safety risk from delayed evacuation
    - *Mitigation: free inspections?*
- Transportation:
  - Traffic signals
    - Accidents (we have some claims data)
    - Safety risk from delayed evacuation
    - *Mitigation: Microgrids, Backup, Re-energization*

PSPS Quantification (3)

- Water Supply
  - Firefighting (official/unofficial) (Use PSPS results)
    - *Mitigation: Re-energization*
  - Wells
  - *Mitigation: Generators*
- Vulnerable Populations: (Getting data)
  - Medical Equipment
  - Mobility
  - Smoke

PSPS Quantification - Final

- Surveys to ascertain economic losses from affected people. We have lots of data now.
- Dig into ignition data for “PSPS-caused” effects. Is this significant?
- Epidemiological data for smoke, delayed care, vulnerable populations
- New / unknown research – effect of delayed evacuation.

Technosylva – Quick Look

- Yesterday SED released "what-if" analysis using utility damage reports.
- Finally!!!! – Most important data we have.
- Concludes 2019 fires would have caused major losses.

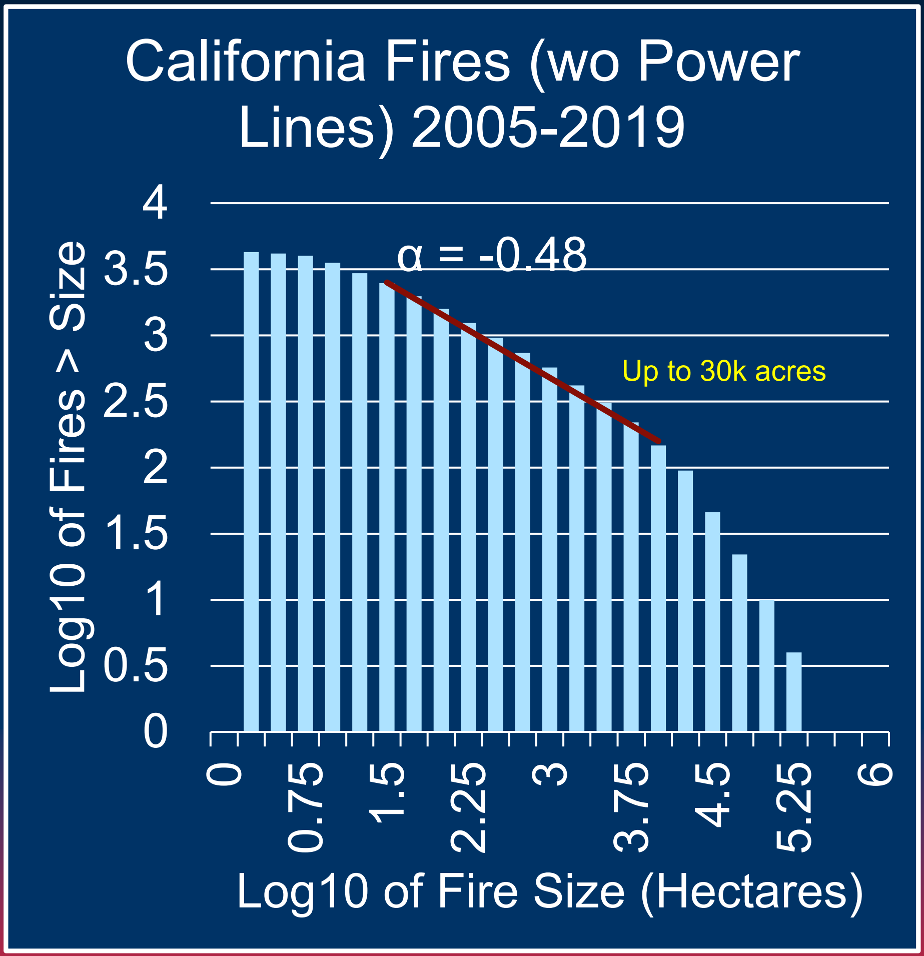
Table 2. Total expected impact, mean and maximum per fire simulation for all 114 damage incident predictions.

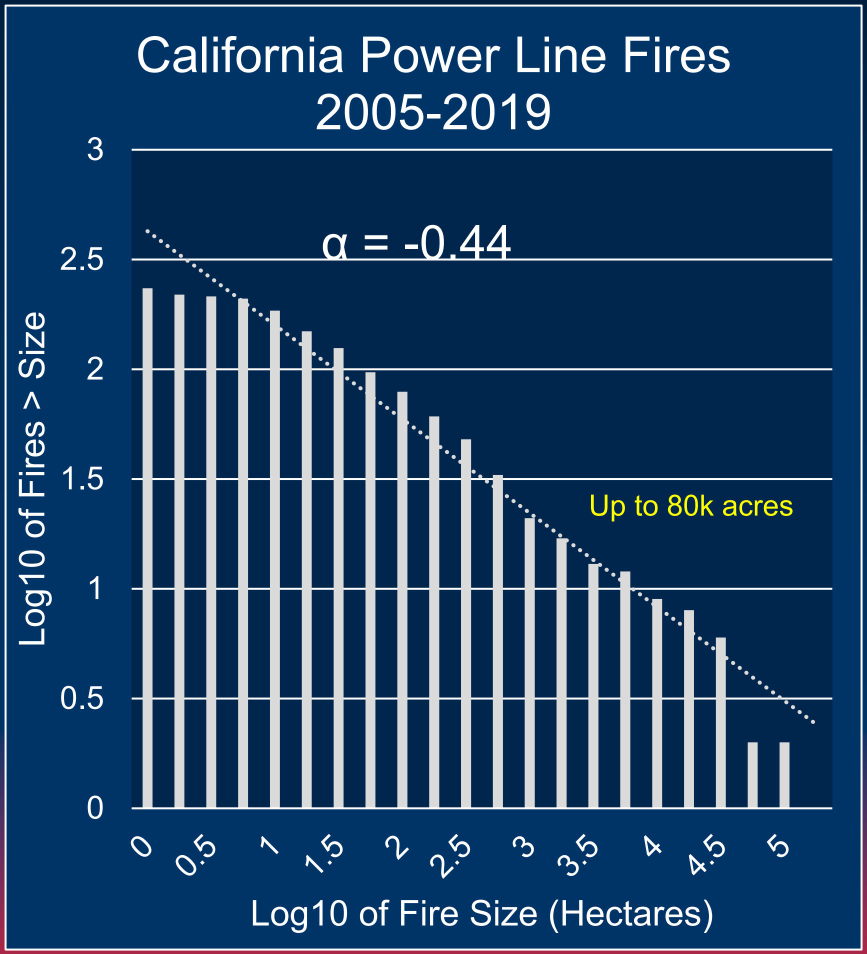
Impact Type	Total	Mean	Maximum	Standard deviation
Population	36,015	316	3,366	548
Buildings	18,819	165	2,173	326
Acres Burned (ac)	274,977	2,412	46,437	5,721

- Needs some critical analysis/review. Some biases:
  - Eight hour simulation results in fires *too small.*
  - No firefighting input / initial slow growth – *too many/too large*
  - Assumes almost all damage ignites fires – *too many*.
- With appropriate adjustments/calibration, might be used for inclusion in utility risk models.

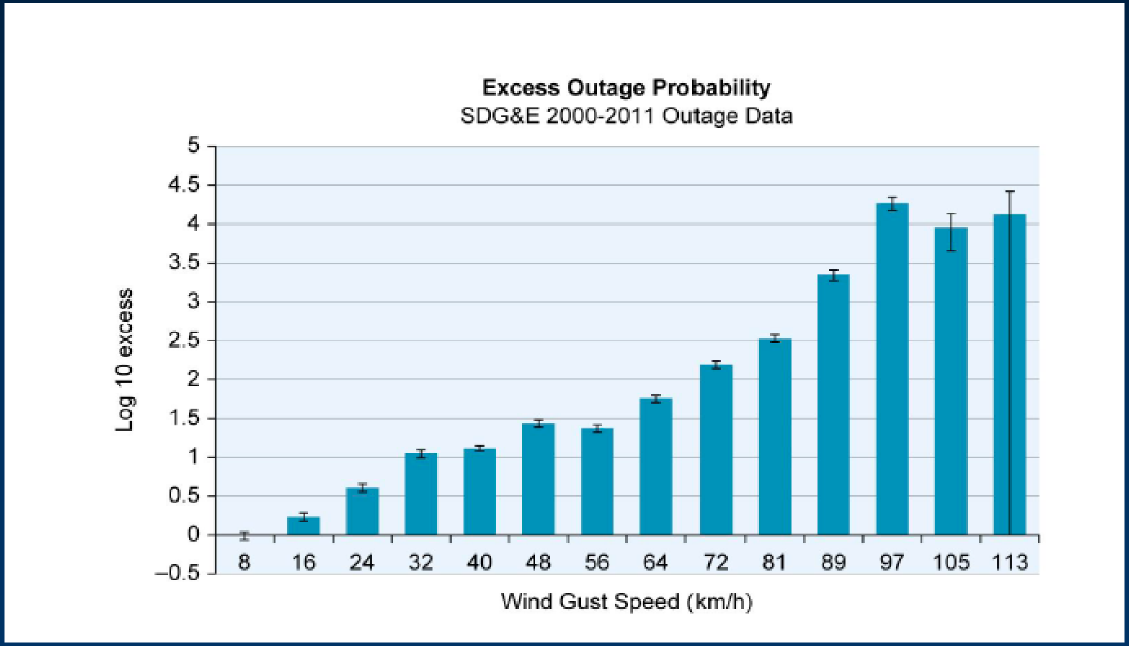
Extra Slides

Power Line Fires





Power Lines and Wind



- Outages as proxy for ignition
- Wind gusts from nearest weather station
- Exponential growth with wind speed.

Mitchell, J.W., 2013. Power line failures and catastrophic wildfires under extreme weather conditions. Engineering Failure Analysis, Special issue on ICEFA V- Part 1 35, 726–735. https://doi.org/10.1016/j.engfailanal.2013.07.006

Elements of the MAVF

- **Tranches: $t_i \ldots t_N$**
- **Baseline Tranche: t_0**
- **Baseline Wildfire Rate: F_0**
- **Fire Weather Event Frequency: f_i**
- **Fire Multiplier: π_i**

Fires per weather event

- **Tranche Wind Speed: v_i**

Not ideal. Will be broad range of wind speeds

Elements of the MAVF

- **Power Line Frequency Multiplier:** P_i

  Increase of ignition rate for each severity ranking
- **Wildfire Consequence Distribution:** $\mathrm{d}W_i/\mathrm{d}A_i$

  Probability distribution – used for Monte Carlo
- **Wildfire Consequence Mean:** $\overline{W}_i$
- **Cutoff Size:** $A_{max,i}$
- **Minimum Reliable Size:** A_{min}
- **Power Law Exponent:** α_i

Elements of the MAVF

- **De-energization Severity:** $d_i, i > 0$

  How extensive is PSPS, geographically & in time?

- **De-energization Consequences:** $D_i = Sd_i$

  S is PSPS harm per customer per hour - TBD