Risk Spend Efficiency (RSE) supporting PG&E's 2022 WMP

December 9, 2021

Agenda

1. RSE Calculation Methodology
2. RSE Estimate Verification
3. RSE Estimate and Initiative Selection Process

RSE Calculation Methodology

Risk Spend Efficiency (RSE)

RSE is Benefit-Cost Ratio for Risk Reduction Programs.

If the mitigation has long-term benefits, RSE needs to reflect the full set of benefits.

$$RSE = \frac{\text{[NPV of Risk Reduction Scores]}}{\text{[NPV of Program Costs (in millions)]}}$$

- PG&E's *After-Tax Weighted Average Cost of Capital* (7% per annum) is used for all discounting.
- Risk reduction and cost must be discounted at the same rate. Otherwise, the timing of the program will impact the RSE (e.g., delaying a project may increase the RSE, which is not consistent with decision preferences)

What is needed to calculate risk reduction?

Risk reduction calculations require programs to be characterized at the level of driver/outcome/tranche for relevant risk event(s)

Risk

- What risk event does this activity affect?
- What risk drivers are targeted by the program?
- What outcomes and consequences are targeted?

Effectiveness

- How much less likely is a driver to cause a risk event outcome post program implementation?
- How much less impactful will an outcome be post program implementation?

Scope

- How many work units will be completed by this program?
- How many units of risk exposure are covered by a work unit?

Time

- How long will the risk reduction benefits last?
- Are the benefits constant over time, or is there degradation?

Risk Score

Risk Score = Frequency x Consequence

- Risk is proportional to two primary elements
  - **Frequency** of a risk event

    Frequency = Exposure x Likelihood

    - Likelihood of a Risk Event (LoRE) is frequency of an event per unit exposure
    - For example,
      - Likelihood of an ignition is 0.004 events/mile/year for all drivers,
      - Exposure is 100 miles
      - Frequency = 100 miles x 0.004 events/mile/year = 1.5 events/year
  - **Consequence** of a risk event (CoRE) if it does happen
    - Consequence is quantified for safety, reliability, and financial attributes and combined using PG&E's Multi-Attribute Value Function

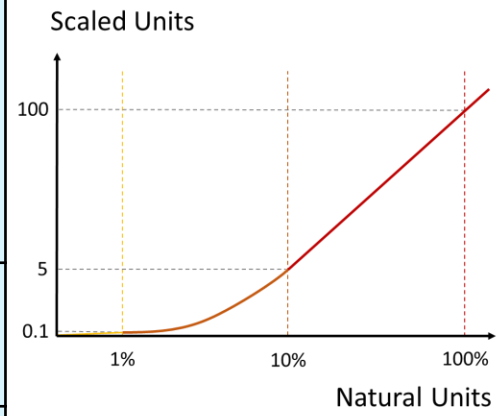
PG&E's Multi-Attribute Value Function (MAVF)

Consequence of a Risk Event (CoRE) = 1000 x Weight x Scaled Unit

Red Flag Warning (RFW) - Catastrophic

MAVF

Attributes	*Example*	Range	Natural Units	Weight	Scaling Function
Safety	13	0 - 100	Equivalent Fatalities	50%	
Electric Reliability	104M	0 - 4 Billion	Customer Minutes Interrupted (CMI)	20%	
Gas Reliability	-	0 - 750,000	Customers Affected	5%	
Financial	1.8B	0 - $5B	$	25%	



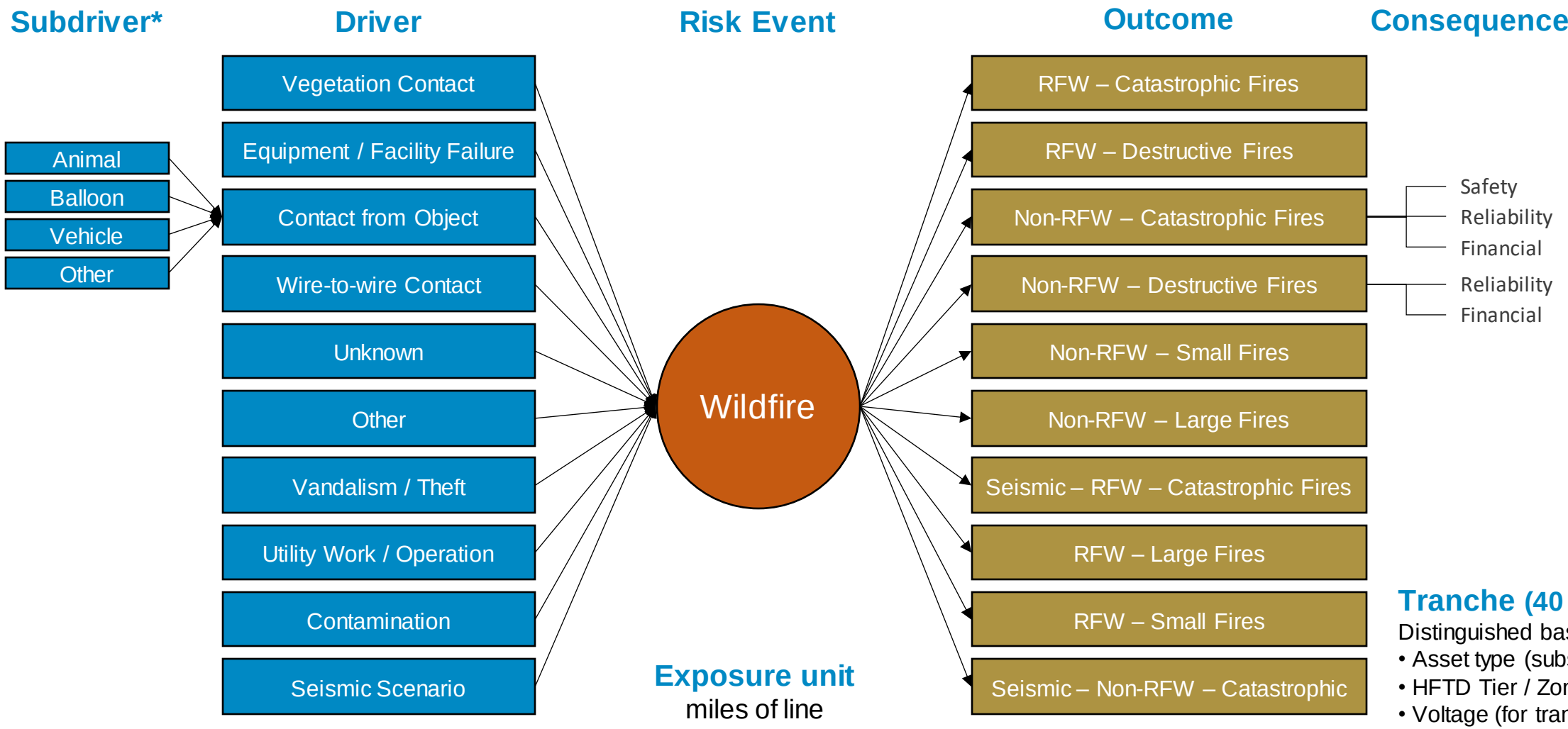
Consequence of Risk Event (CoRE), Unit-less Measure

CoRE

13,707

Structure of PG&E's Wildfire Bow Tie

Risk Score is calculated for each driver/subdriver, outcome, attribute, tranche and year



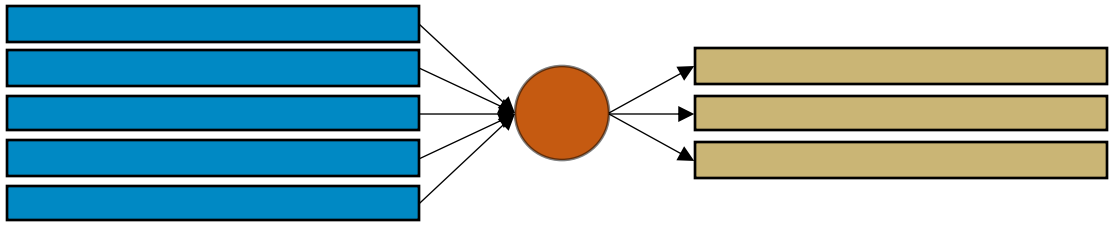
Exposure unit
miles of line

Tranche (40 total)
Distinguished based on:
- Asset type (substation, dist., trans.)
- HFTD Tier / Zone
- Voltage (for trans.)
- LoRE / CoRE quartile (for dist.)

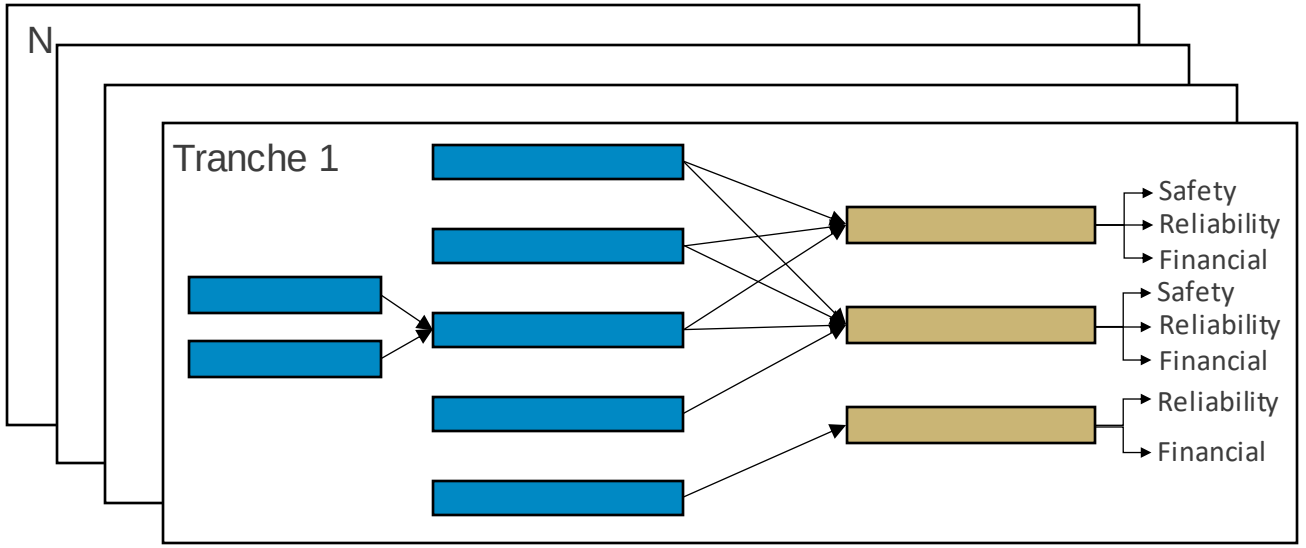
* Subdrivers, Consequences shown only for subset of elements for illustrative purposes. 37 subdrivers/drivers total.

Quantified relationships between drivers, outcomes, consequences all possible mitigation points

Bow tie presentation…



…under the hood, there are as many bow ties as tranches



…where each arrow represents a quantified relationship between driver, outcome, and attribute each year

PG&E's Wildfire Risk bow tie:

40 tranches

37 subdriver/drivers

10 outcomes

3 consequence types

Quantification effort generated:

40*37*10 = **14,800** likelihood of risk event (LoRE) values

40*10*3 = **1,200** distributions to compute consequence of risk event (CoRE) values

Risk reduction calculation depends on estimating Freq or CoRE reduction

If **Risk** is reduced by:

<u>Risk Reduction (Δ Risk)</u> is calculated as:

1. Reducing event frequency → Reduction in Frequency (Δ Freq) × CoRE

2. Reducing event consequences → Freq × Reduction in CoRE (Δ CoRE)

3. Reducing both event freq. and conseq. → Δ Freq × CoRE + Freq × Δ CoRE - Δ Freq × Δ CoRE

Freq Reduction Calculation

Can be different for Mitigation program vs Control program

Mitigation Program

Reduces risk relative to current, baseline conditions

Δ LoRE = % effectiveness x LoRE

Example:

Let's say PG&E data show LoRE of 0.1
(equiv. to 10% prob. of event in a given year, or, a 1-in-10 yr event)

New equipment design that will be used is estimated to be reducing asset failure by 86% *relative to current conditions*

Δ LoRE = **86%** x 0.1 = **0.086** per mile
Δ Freq = 100 x **0.086 = 8.6**

Control Program

Current, baseline conditions are achieved by program, so risk reduction is relative to conditions absent control

Δ LoRE = direct calc. or estimate per work unit

Example:

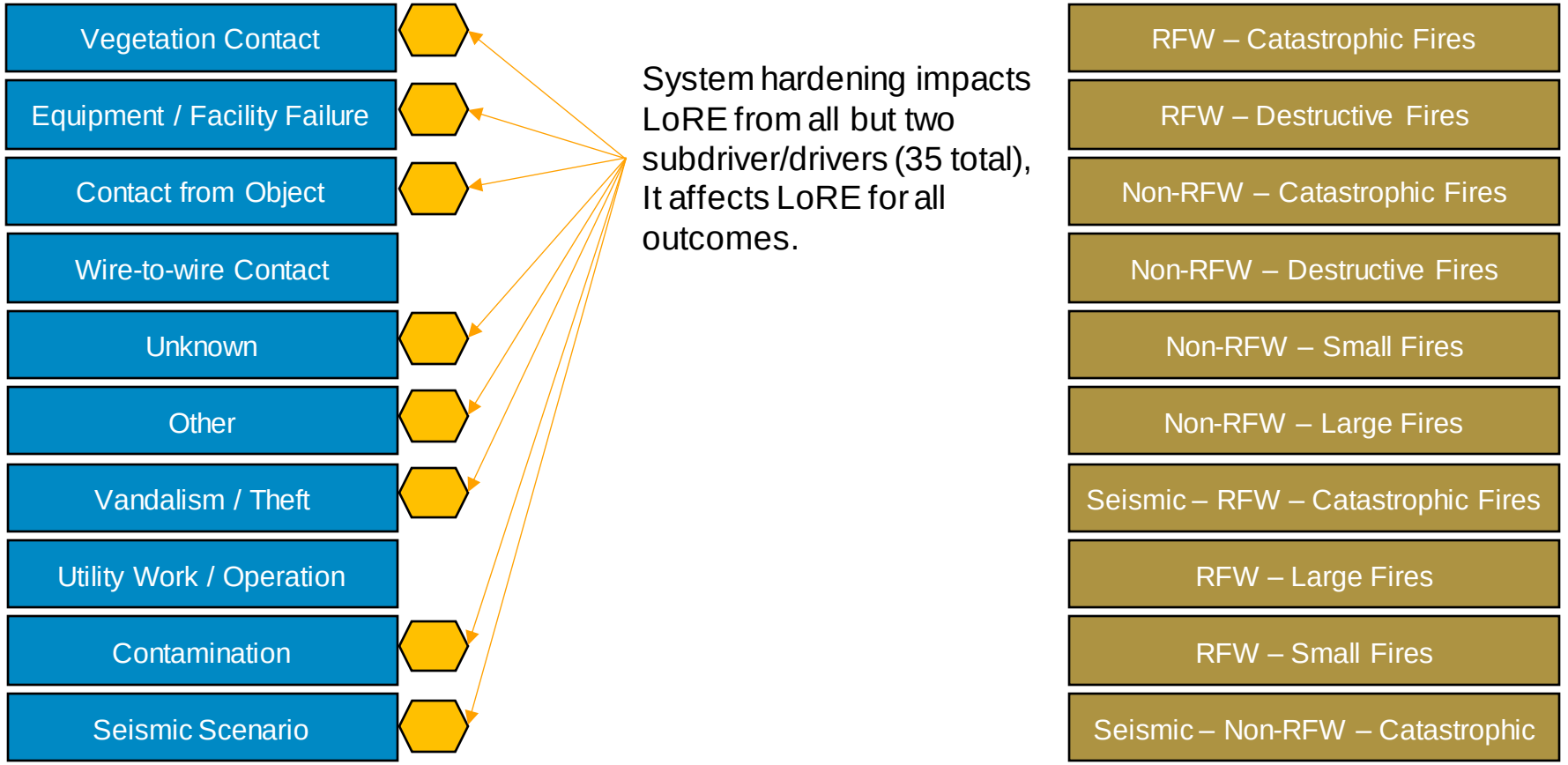
Pole replacement program replaces 100 high-risk poles. It is estimated to reduce LoRE by 0.02 per pole. We can then calculate frequency reduction by multiplying # of poles.

Δ LoRE (per pole) = **0.02 per pole**
Δ Freq = **100** x **0.02** = **2**

RSE Calculation Walkthrough (1)

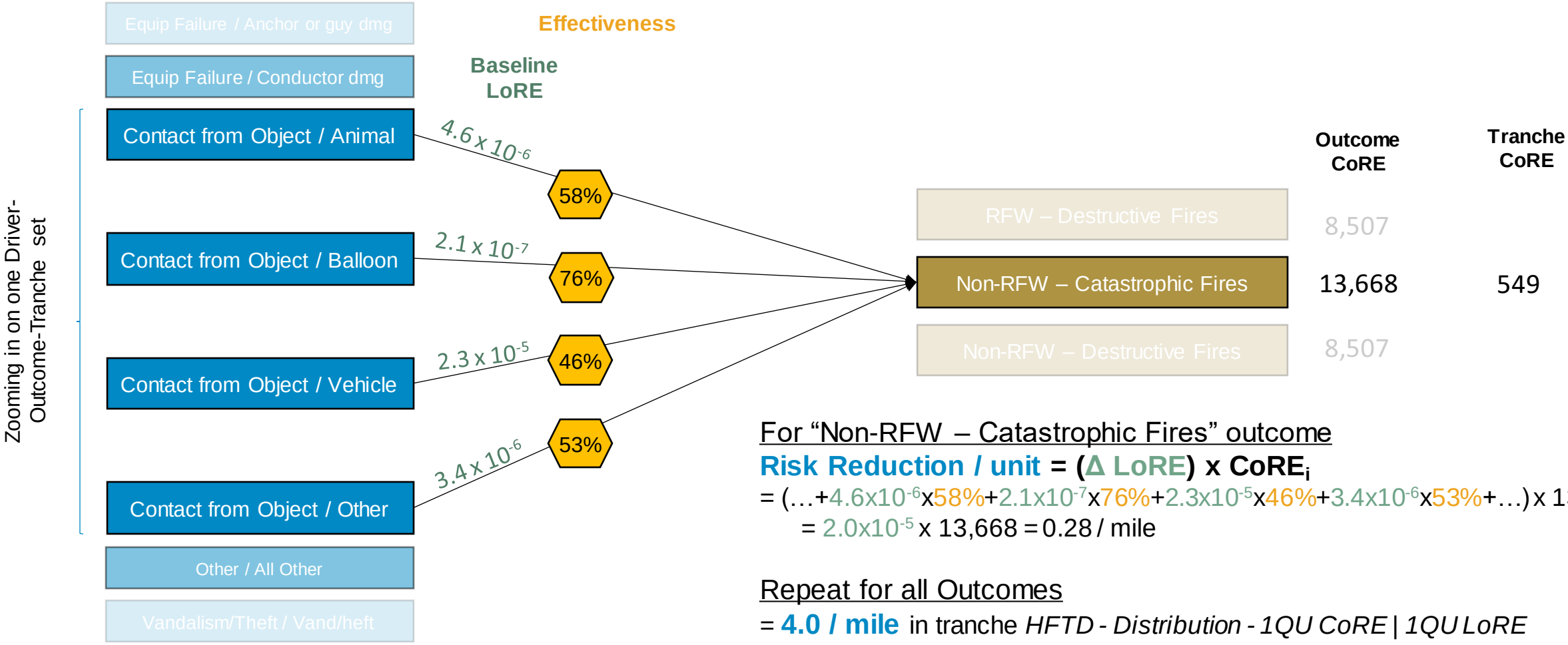
System Hardening [Overhead] as an Example

1. Specify which subdriver/driver and outcome relationships are targeted by a program.



RSE Calculation Walkthrough (2)

2. Specify the effectiveness of the program in reducing likelihood of risk event (LoRE) in order to calculate Risk Reduction per unit of tranche exposure addressed by program.



For "Non-RFW – Catastrophic Fires" outcome

Risk Reduction / unit = (Δ LoRE) x $CoRE_i$

= (…+$4.6x10^{-6}$x58%+$2.1x10^{-7}$x76%+$2.3x10^{-5}$x46%+$3.4x10^{-6}$x53%+…) x 13,668

= $2.0x10^{-5}$ x 13,668 = 0.28 / mile

Repeat for all Outcomes

= **4.0 / mile** in tranche *HFTD - Distribution - 1QU CoRE | 1QU LoRE*

RSE Calculation Walkthrough (3)

3a. Specify the risk exposure tackled by the program for each year of program execution by tranche.

Year	Program Exposure Units
2023	423 miles
2024	405
2026	405
2026	405

Tranche	2023 Exposure Units	2024 Exposure Units	…
HFTD - Distribution - 1QU CoRE | 1QU LoRE	12.4	11.9	
HFTD - Distribution - 1QU CoRE | 2QU LoRE	25.0	24.0	
HFTD - Distribution - 1QU CoRE | 3QU LoRE	39.3	37.7	
HFTD - Distribution - 1QU CoRE | 4QU LoRE	57.8	55.3	
HFTD - Distribution - 1QU CoRE | 5QU LoRE	64.5	61.8	
HFTD - Distribution - 2QU CoRE | 1QU LoRE	21.6	20.6	
…	…	…	
	423	**405**	**…**

Risk Reduction = Risk Reduction / unit x Program Exposure Units

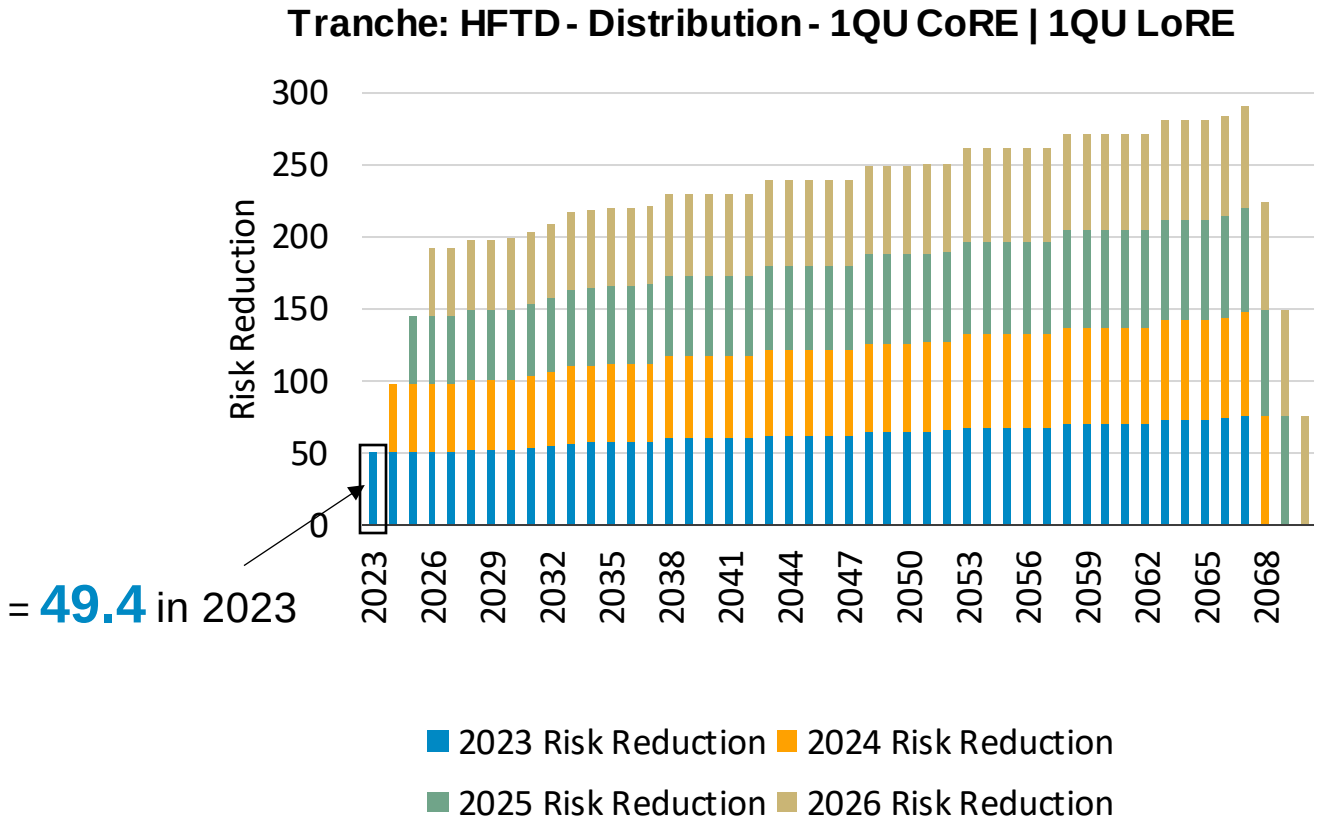
= **4.0 / mile** x 12.4 miles in tranche *HFTD - Distribution - 1QU CoRE | 1QU LoRE*

= **49.4** in 2023

RSE Calculation Walkthrough (4)

3b. Specify how long the Risk Reduction benefit will last, and if there is any degradation with time.

- System hardening work will be executed in each of 2023-2026
- System hardening to overhead assets will provide consistent benefit for **45** years.



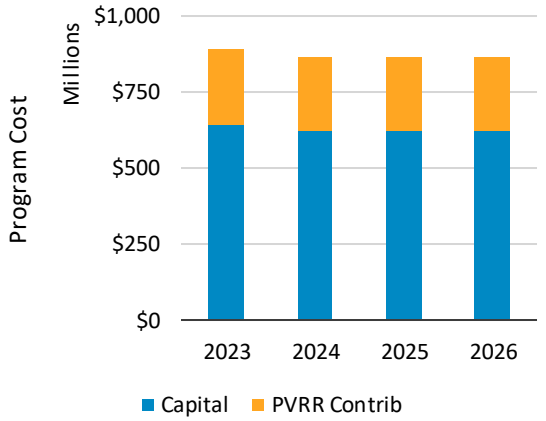
Why is does the risk reduction for future years trend upwards?

The baseline risk is not constant with time for Wildfire; it is expected to increase due to expected climate change impacts.

RSE Calculation Walkthrough (4)

4. Given the scope of the program, specify the cost by type (Expense, Capital), and specify assets built with Capital dollars such that the revenue requirement can be factored in.

- To account for all costs associated with capital investments subject to cost-of-service ratemaking (e.g., depreciation, income taxes, property tax, insurance, incremental expenses and return on investment over the life of an asset), PG&E uses an estimated Present Value of Revenue Requirement (PVRR) associated with capital investment in the denominator of the RSE
- Factor of 1.389 used for System Hardening [Overhead], as program assets are of type 'electric distribution overhead (<69 kV)'



Year	Total Exposure Units	Capital Cost ($M/mile)	PVRR Unit Cost ($M/mile)
2023	423 miles	$1.516	$2.106
2024	405	$1.533	$2.129
2026	405	$1.538	$2.135
2026	405	$1.543	$2.144

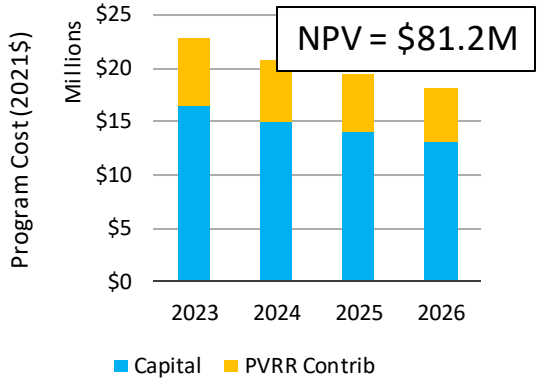
Where to find more on PVRR? PG&E Enterprise Risk Model Documentation and User Guide, Section 1.6.2

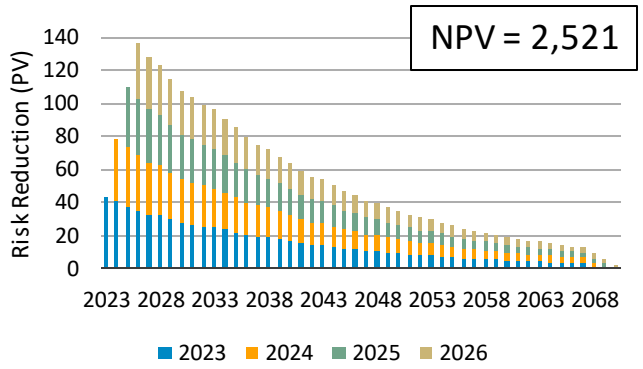
Risk Reduction Calculation Walkthrough

5. Discount total program Risk Reduction and Cost, compute Risk Spend Efficiency value

Tranche: HFTD - Distribution - 1QU CoRE | 1QU LoRE

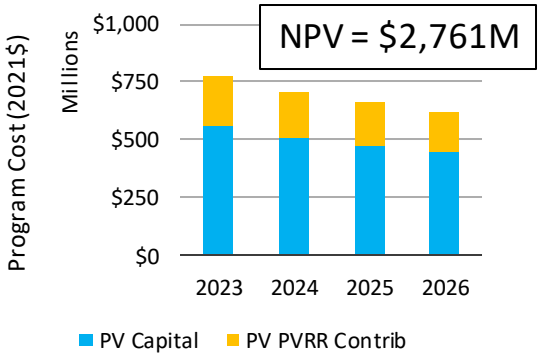
Tranche RSE = 2521 / 81.2 = **31**

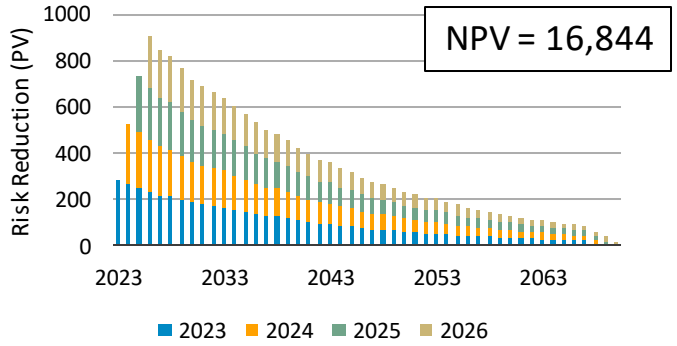




Aggregated Over All Tranches

Program RSE = 16,844 / 2,761 = **6.1**





Where to find more on discounting? PG&E Enterprise Risk Model Documentation and User Guide, Section 1.6.1

RSE Estimate Verification Process

RSE Estimate Verification Process

Confidence values and Range of Uncertainty of RSE estimates

PG&E has not established numerical Confidence Intervals or values for its RSEs because quantitative data to do so is generally lacking.

RSEs are shown as a single number. PG&E recognizes that this approach can give the viewer the impression that a higher valued RSE is always a more worthy project than one with a lower valued RSE. This isn't always the case due to uncertainty of the estimate, as well as factors that could be outside the control of the utility, such as weather and other natural forces.

Budget prioritization should take into account many factors including the RSE and factors such as feasibility of execution, resource management, risk management, strategic goals, etc.

RSE Estimate Verification Process

Overview of PG&E's RSE Governance process for WMP initiatives

- Beginning in Oct 2021, PG&E formalized an RSE Governance process for WMP RSEs.
- The RSE governance process includes:

  Creation of a RSE Governance Committee (underway for 2022 WMP):
  - Ensure a replicable and documented RSE verification process for each initiative quantified
  - Verification of RSE inputs: activity scope, exposure, effectiveness, benefit life, costs, etc.
  - Assessment of confidence in RSE for each input type – low, medium, high
  - Recommendations of how to improve confidence in the future
  - Review approaches of other IOUs in order to facilitate a robust benchmarking

- After 2022 WMP filing, review of RSE Governance process will be undertaken for future improvements

RSE Estimate Verification Process

Systems used to verify RSE estimates	Key contribution of the system
SMEs	SMEs competence in their programs to help facilitate conversations about relative ranking of a program relative to their own programs and also with programs they support, align to, enhance or supercede
Comparison against historical data	Assess if metrics such as tag rate, ignition rate, outage rate are indeed impacted as assumed in the RSE inputs
3rd party assessment	Consistent and independent review of RSE inputs and estimates
Cross-utility verification	Alignment of logic and approach can be checked

RSE Estimate Verification Process

Anticipated changes to RSE estimate verification process from now to 2023 WMP

PG&E's RSE estimate verification process will mature from lessons learned during review of initiatives for the 2022 WMP filing. Key features of the change will be:

- As possible, incorporate more quantitative than qualitative components
- Continued education of SMEs to facilitate deeper understanding of how their inputs are used and sensitivity of different inputs for RSE calculations. Expose SMEs to other comparable and related programs to calibrate their understanding of their program compared to others.
- Support SMEs by expanding and capturing relevant data to inform RSE Inputs
- Support SMEs by expanding and capturing relevant data to inform lookbacks of key RSE related data points

RSE Estimate and Initiative Selection Process

RSE Estimate and Initiative Selection Process

PG&E continues to evaluate how RSE estimates can most effectively be used in its decision-making

- **How RSEs are considered when Selecting Mitigation Initiatives**
  - RSEs are used at the overall program level to compare different programs
  - RSEs are used within the System Hardening Program initiative to select different options such as line removal, overhead covered conductor, and undergrounding.

- **Other decision-making factors**
  - Execution constraints, planning and execution lead times
  - knowledge from the field and public safety specialists

- **Anticipated Changes to how RSE estimates are used for mitigated initiative selection from now to 2023 WMP**
  - PG&E will continue to learn lessons from its RSE Governance oversight process and plans to leverage those learning into further application of RSE.
  - PG&E will continue to expand the development and reporting of risk reduction and RSEs and at the project level