

Managing Grid Infrastructure

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Overview





Risk and Opportunity Management Framework

Identify

- Perform annual review of risk register to ensure company risks are identified

Assess

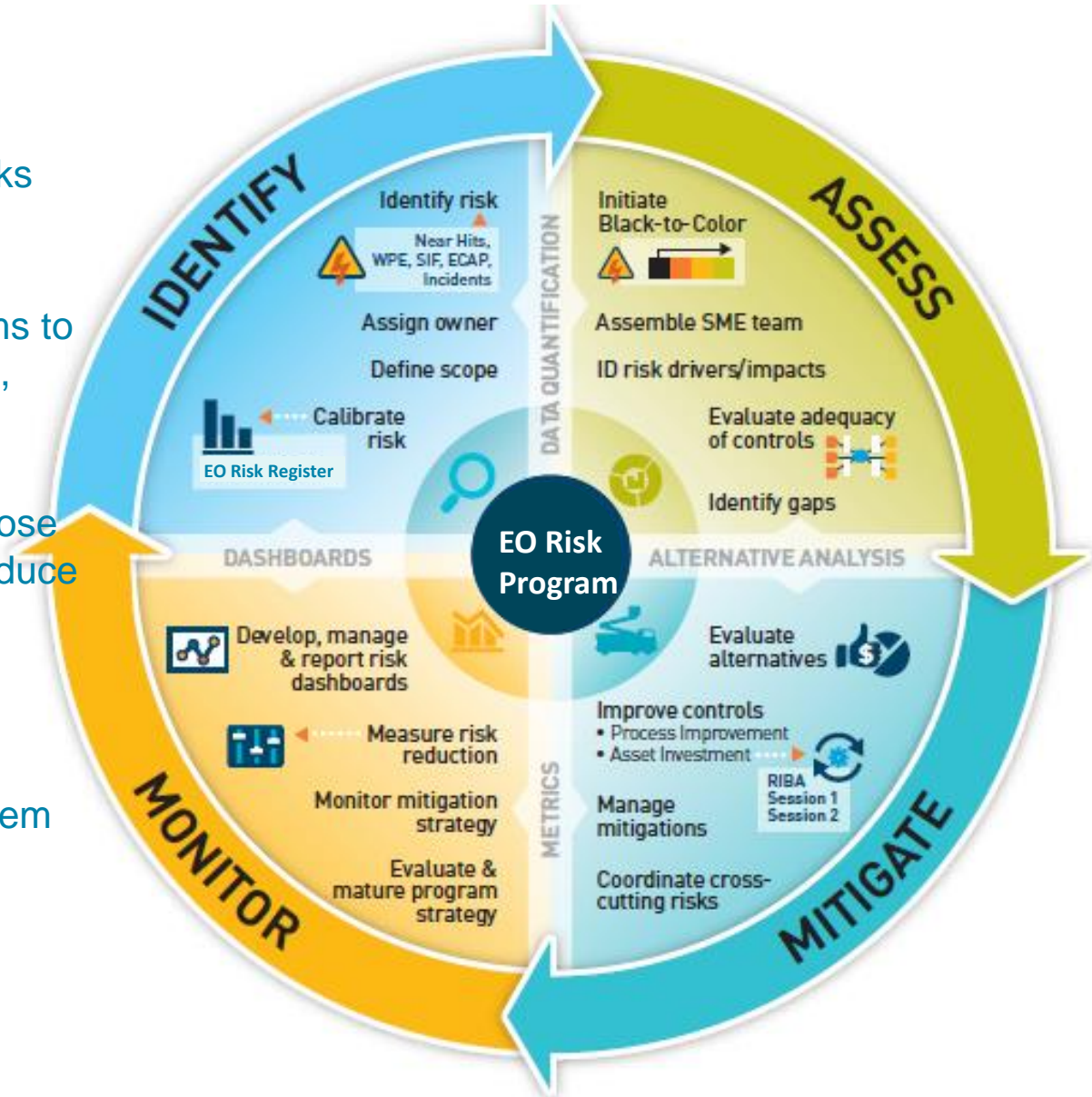
- Leverage cross functional teams to identify and assess risk drivers, gaps and controls

Mitigate

- Evaluate alternatives and propose improvements of controls to reduce the risk

Monitor

- Utilize effectiveness metrics to show risk reduction progress
- Monitor mitigation and action item progress
- Update executives monthly





Wildfire Risk Bow-tie Analysis (Illustrative)



*This is an illustrative example and does not reflect actual control status



Risk-Informed Budget Allocation (RIBA)

- RIBA provides a common framework for evaluating work
- Work is evaluated in three components: safety, reliability, and the environment
- Scores based on the frequency and impact of the worst reasonable direct consequence of not performing the work
- In addition to the score, work is also categorized by drivers such as regulatory compliance, commitment, inter-relationship to other work, etc.
- RIBA provides consistency across organizations, comparability of work portfolios and transparency to stakeholders

		Impact Levels						
		Negligible	Minor	Moderate	Major	Extensive	Severe	Catastrophic
Frequency	Frequency Level	1	2	3	4	5	6	7
	Common (7)	10	32	100	316	1,000	3,162	10,000
	Regular (6)	6	18	56	178	562	1,778	5,623
	Frequent (5)	2	7	23	74	234	740	2,340
	Often (4.5)	2	7	21	67	211	669	2,113
	Occasional (4)	2	6	18	56	178	562	1,778
	Infrequent (3)	1	4	14	43	135	427	1,351
	Rare (2)	1	3	10	32	100	316	1,000
	Remote (1)	1	2	6	18	56	178	562



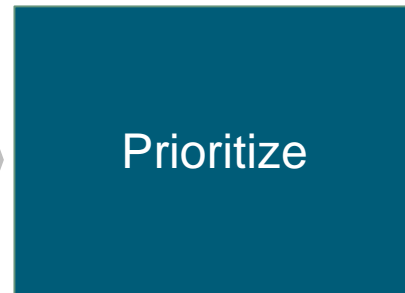
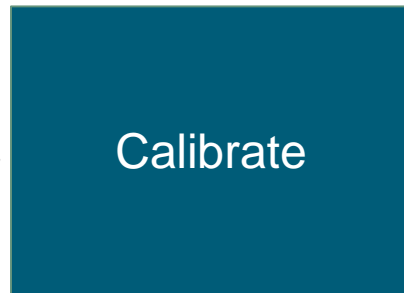
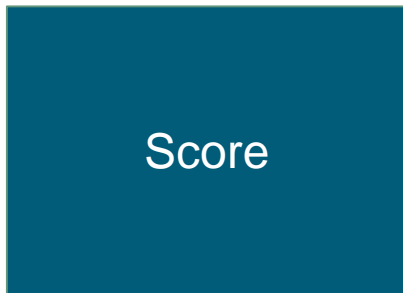
Using RIBA at PG&E

- Projects are scored along three dimensions:
 - Safety
 - Reliability
 - Environmental
- Additional benefits/commitments are flagged

- Scorers present their methodology to the broader group to ensure standard application of scoring taxonomy
- Projects are calibrated across portfolios

- Scored and calibrated projects are stack-ranked based on risk scores and flags
- Prioritization discussions are based on expanded dynamics (i.e., executability)

- Confidence using the RIBA process to make budget decisions in current and future years



- Each project is risk-scored by a subject matter expert

- RIBA expanded scoring team, including directors, participate

- Directors and managers across the LOBs participate

- Executive leadership

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	7	10	32	100	316	1,000	3,162	10,000
6	6	18	56	178	562	1,778	5,623	
5	2	7	23	74	234	740	2,340	
4.5	2	7	21	67	211	669	2,115	
4	2	6	18	56	178	562	1,778	
3	1	4	14	43	135	426	1,348	
2	1	3	10	32	100	316	1,000	
1	1	2	6	18	56	178	562	

Safety	Impact: 4	Frequency: 2	Impact: 6	Frequency: 2
	• Cable failure results in fire that allows off-mantle cover, few serious injuries	• 1 manhole explosion that resulted in injury in last 5 yr over 500 miles of cable, this is 5 miles so $(1/97)(1/500)^5 = 0.0011$	• Cable failure results in fire that allows off-mantle cover, few fatalities	• 1 manhole explosion that resulted in injury in last 5 yr over 500 miles of cable, this is 5 miles so $(1/97)(1/500)^5 = 0.0011$
Environmental	Impact: 2	Frequency: 4	Impact: 4	Frequency: 4
	• PLC failure leads to small amount of petrochemical release/cleanup	• 18 failures in 2013 over 500 miles of cable, this project is 5 miles, $(20/500)^5 \cdot 5 = 0.18$	• PLC failure leads to small amount of petrochemical release/cleanup	• 18 failures in 2013 over 500 miles of cable, this project is 5 miles, $(20/500)^5 \cdot 5 = 0.18$
Reliability	Impact: 4	Frequency: 3	Impact: 4	Frequency: 3
	• System is redundant, concurrent cable failure leads to outage for 8 hours = 8HC customer hours	• Would require 2 concurrent failures, >8 fails in 2013 over 500 miles of cable, this is 5 miles, $(0.26)^2 = 0.067$	• System is redundant, concurrent cable failure leads to outage for 8 hours = 8HC customer hours	• Would require 2 concurrent failures, >8 fails in 2013 over 500 miles of cable, this is 5 miles, $(0.26)^2 = 0.067$

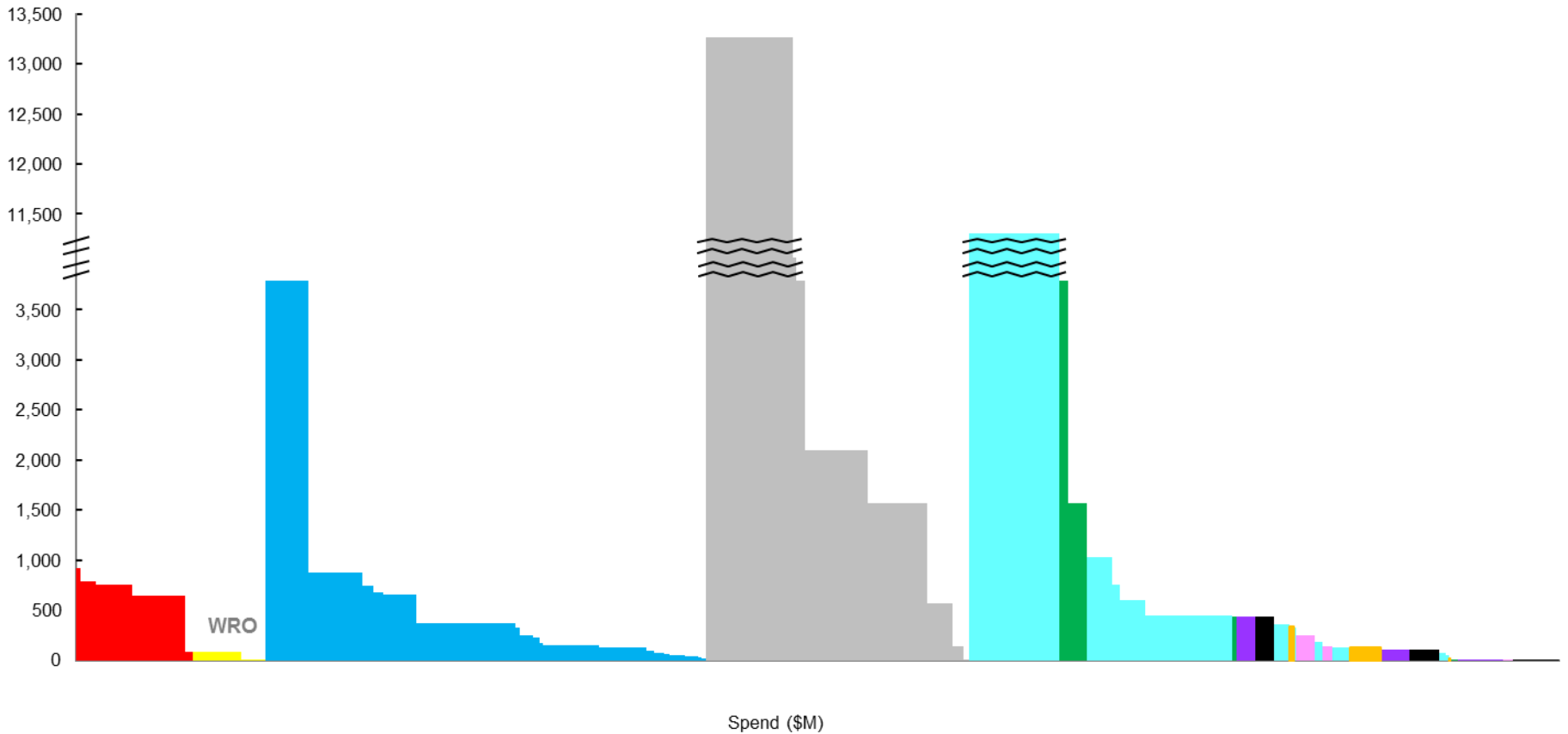
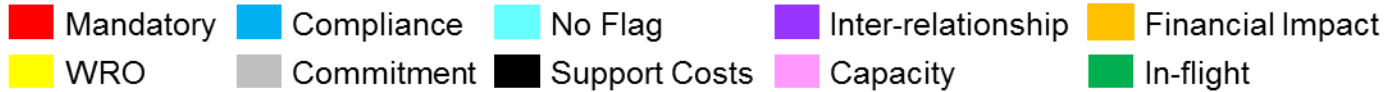




RIBA Informs Investment Discussions

Risk scores, non-risk drivers, and costs are placed into a chart to provide **transparent justification** for proposed work. This chart can be sorted in different ways as needed to inform budgeting decisions.

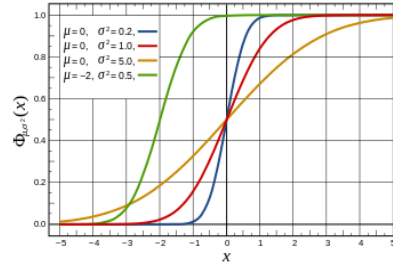
ILLUSTRATIVE





Using Analytics to Plan the Grid of the Future

Frequency Description	Frequency per Year	Frequency Level	Impact Level
> 10 times per year	F = > 10	Common (7)	Catastrophic (7)
1 - 10 times per year	F = 1 - 10	Regular (6)	Severe (6)
Once every 1 - 3 years	F = 1 - 0.3	Frequent (5)	Extensive (5)
Once every 3 - 10 years	F = 0.3 - 0.1	Occasional (4)	Major (4)
Once every 10 - 30 years	F = 0.1 - 0.033	Infrequent (3)	Moderate (3)
Once every 30 - 100 years	F = 0.033 - 0.01	Rare (2)	Minor (2)
Once every 100+ years	F = < 0.01	Remote (1)	Negligible (1)



Risk-Based Asset Management Strategies



Common Operating Picture

Individual Asset Risk Analytics

Improved Programmatic Risk Quantification

“Worst Reasonable Direct Impact”

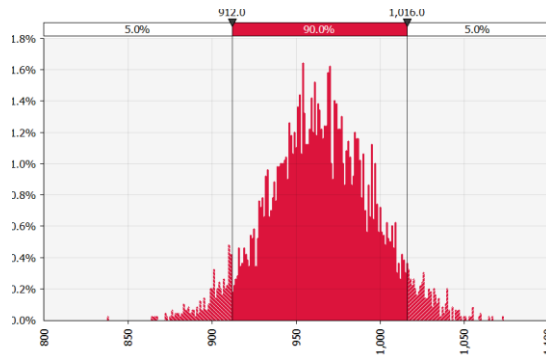




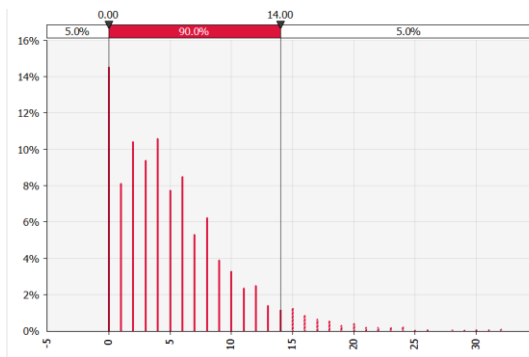
Model Outputs: Frequency and Outcomes

Using simulation, baseline probability distributions for event frequency and outcomes can be computed

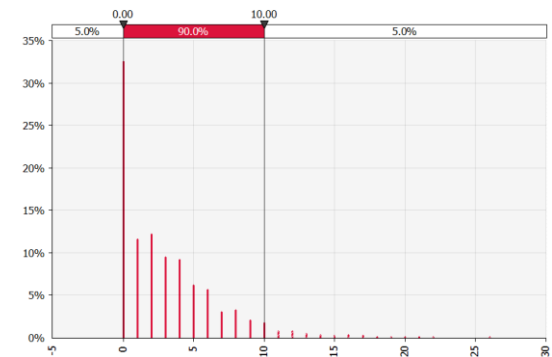
Probability distribution for events per year



Probability distribution for Outcome #1 per year



Probability distribution for Outcome #2 per year



Mean	964	5.2	2.9
P50	964	4.0	2.0
P95	1016	14.0	10.0
P99	1037	20.0	15.0
Max	1073	32.0	26.0
Units	Events / year	Outcome #1 /year	Outcome #2 / year