Fuel Requirements for Black Start Resources Hiatus Activity Review Part 2

Dan Bennett
Lead Engineer, Generation

OC/MIC Special Session
March 10, 2022

FRBSR Roadmap

Stage 1 FRBSR Work

2019 – 2020

- Level of Fuel Assurance
- Universal Fuel Assurance Requirements
- Fuel Assurance Solutions by Primary Fuel Type
- Testing & Verification Requirements
- Compensation Mechanism
- Implementation Plan
- Solution Packages

Stage 2 Hiatus Work

2020 – 2021

- Enhanced Restoration Time Analysis
- **Cost / Benefit Analysis Methodology**
- Gas Supply Risk Assessment

Stage 3 FRBSR Considerations

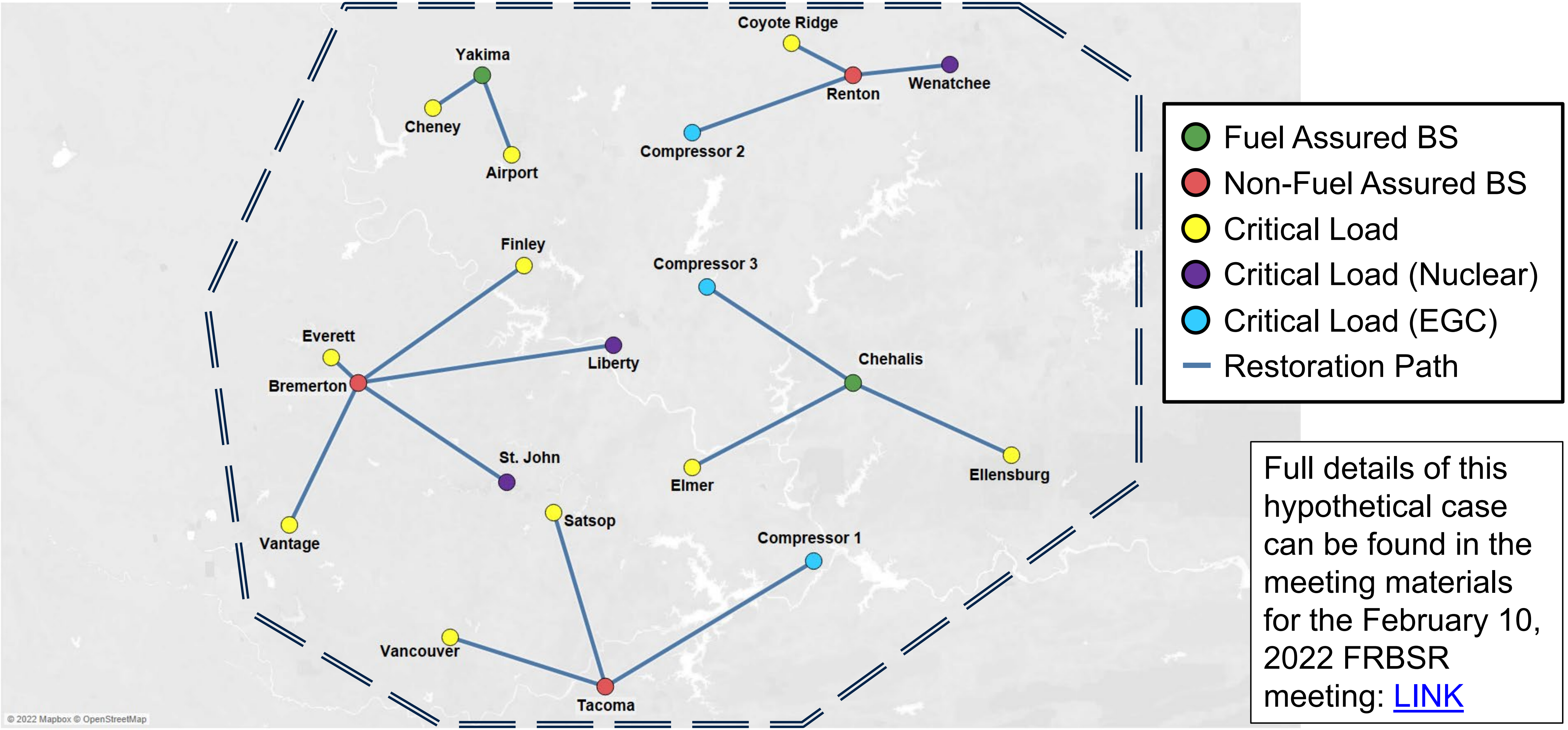
2022

- Updated Design Component Details and Solution Packages
- Enhanced Definitions of Fuel Assurance
- Hydro Packages to align with ELCC
- Inputs from FERC/NERC ERCOT Report

Incremental Restoration Time Increase: Additional time required to restore a TO zone due to the loss of one or more BS sites above and beyond the theoretical zonal restoration time with all BS sites available.

High Impact Black Start Site: A BS site which, when unavailable during a restoration scenario, results in an incremental restoration time increase of ten hours or more. This ten hour cutoff is a PJM suggestion and not tied directly to any standards.

Hypothetical Case: Standard Restoration



Full details of this hypothetical case can be found in the meeting materials for the February 10, 2022 FRBSR meeting: [LINK]

Hypothetical Case: Timing Comparison and High Impact Black Start Sites

Scenario	Hypothetical Zonal Restoration Time	Incremental Restoration Time Increase
Standard Restoration	9.0 Hours	----------------
Scenario 1: Loss of Renton	11.5 Hours	2.5 Hours
Scenario 2: Loss of Bremerton	19.5 Hours	**10.5 Hours**
Scenario 3: Loss of Tacoma	14.5 Hours	5.5 Hours
Scenario 4: Loss of Bremerton & Tacoma	32.5 Hours	**23.5 Hours**

Full details of this hypothetical case can be found in the meeting materials for the February 10, 2022 FRBSR meeting: LINK

Hypothetical Case: Scenario Fuel Assurance Conversion Costs

Scenario	Fuel Assurance Conversion	Annual Conversion Cost
Scenario 1	Renton	$100,000
Scenario 2	Bremerton	$3,000,000
Scenario 3	Tacoma	$2,000,000
Scenario 4	Bremerton & Tacoma (common pipeline)	$5,000,000

Cost vs. Expected Cost of a Blackout

We can approximate the cost of a blackout:

Cost = Load (MW) x Duration (Hours) x Value of Lost Load ($ / MWh)

And with that cost we can calculate expected cost:

Expected Cost = Cost x Probability of Occurrence

With extremely low frequency events like this, it is very difficult to estimate the probability of occurrence. So instead we can calculate the expected costs for a range of probabilities and see the trends in the expected cost. By comparing the expected cost against an annual fuel assurance conversion cost we can determine when it becomes cost effective to implement that conversion.

The Value of Lost Load (VoLL) is a representation of the costs associated with the interruption of electric supply. VoLL is not a static number and there are many variables that impact VoLL.

Because of the complexity around VoLL, PJM used a range of values in its calculations during the hiatus analysis:

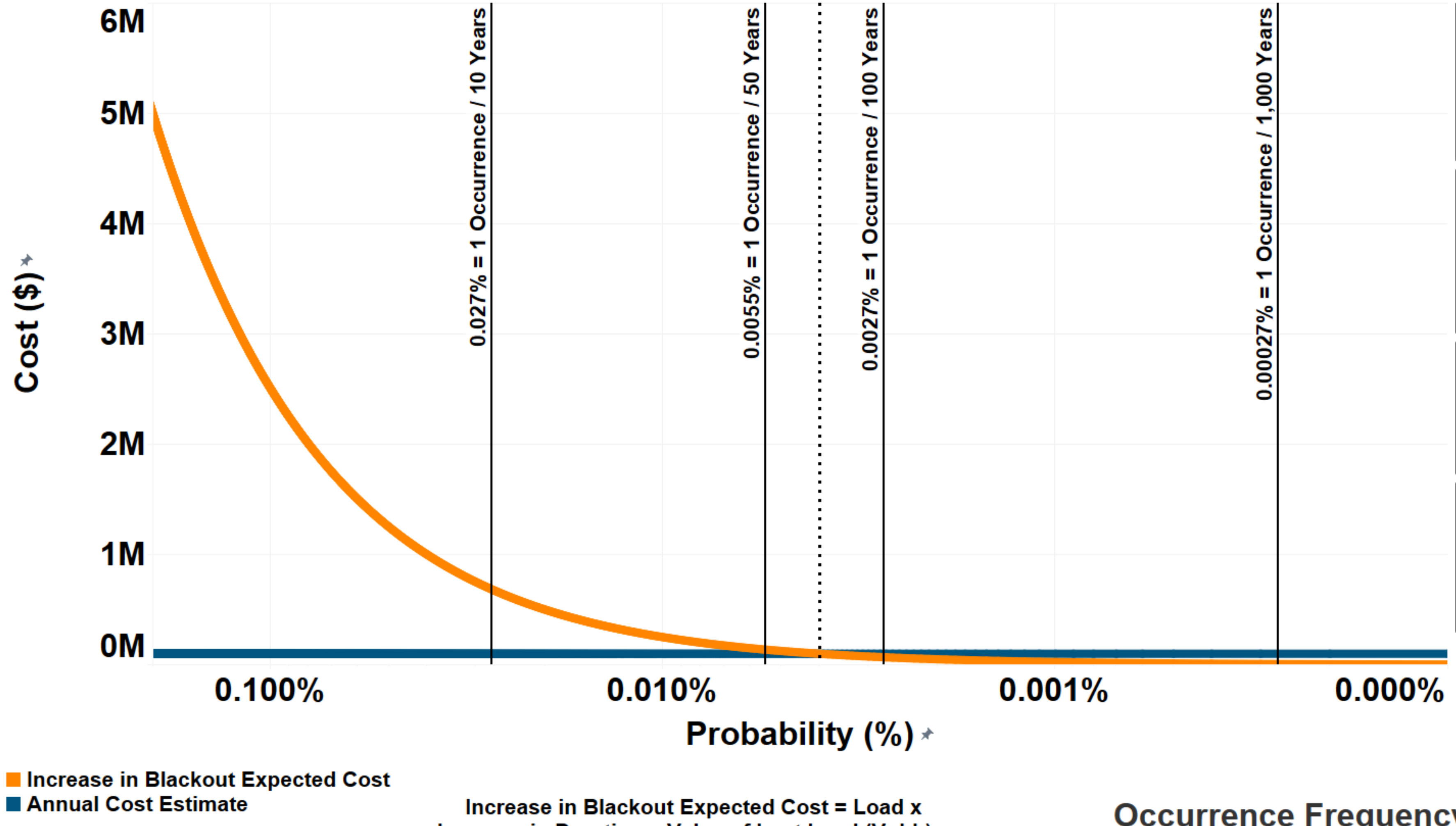
$10,000 / MWh to **$100,000 / MWh**

The objective was to provide a upper and lower bound for the analysis and provide stakeholders with a range of results.

The **occurrence frequency** is the frequency of an event (simultaneous blackout and fuel failure) required to financially justify the conversion investment and is represented as once every **X** Years.

If **X** is large (e.g. 100 Yrs.)	More financially justifiable Only a rare occurrence needed
If **X** is small (e.g. 3 Yrs.)	Less financially justifiable Needs to be a common occurrence

Conversion of Renton VoLL = $100,000



Annual Cost Estimate ($ Million)
0.1

Increase in Duration (hours)
2.5

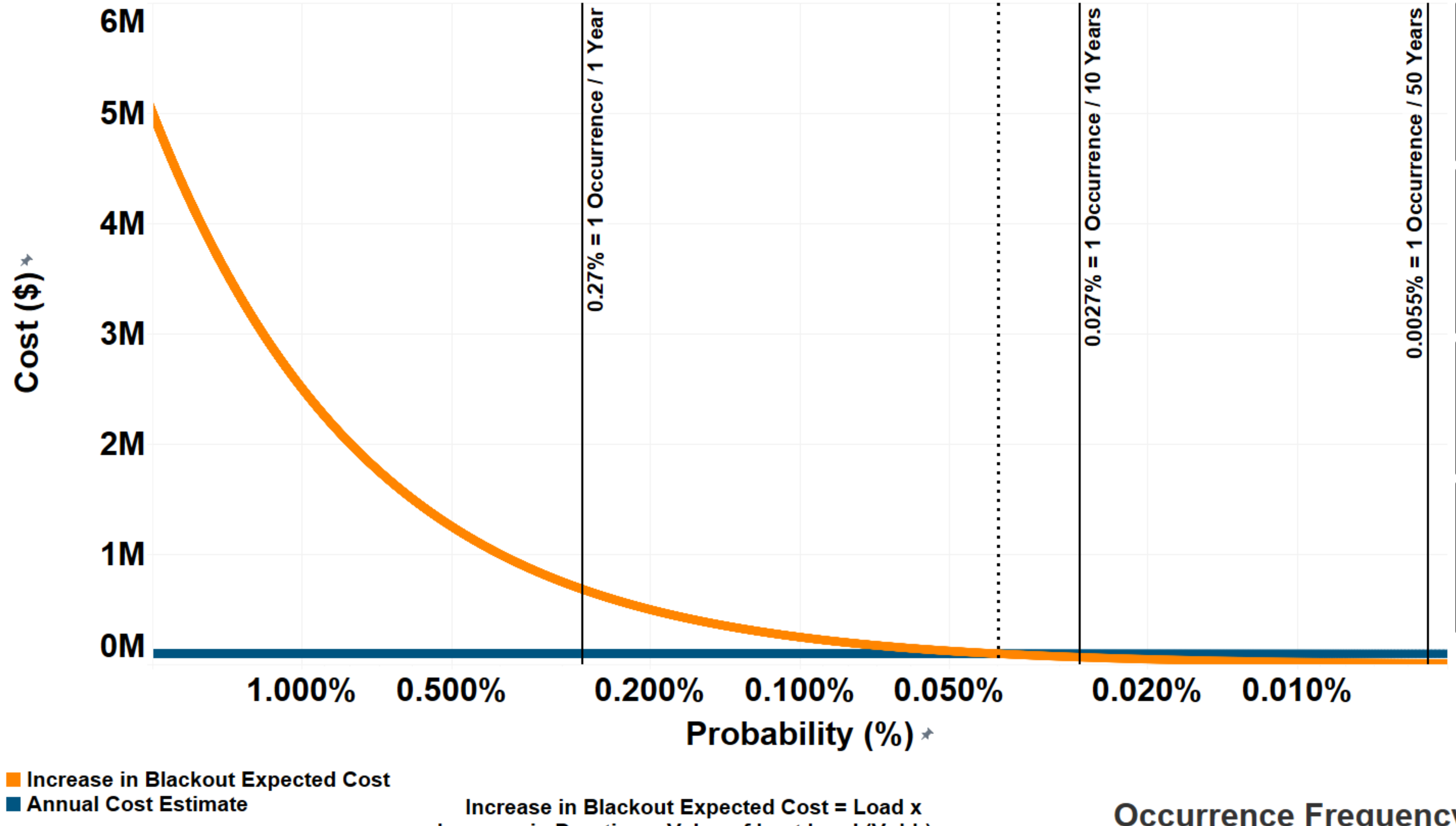
Average Load (MW)
10,000

Value of Lost Load ($ / MWh)
100,000

Increase in Blackout Expected Cost = Load x Increase in Duration x Value of Lost Load (VoLL) x Probability of Occurence

Occurrence Frequency
1 Occurrence / 68.5 Year(s)

Conversion of Renton VoLL = $10,000



Annual Cost Estimate ($ Million)
0.1

Increase in Duration (hours)
2.5

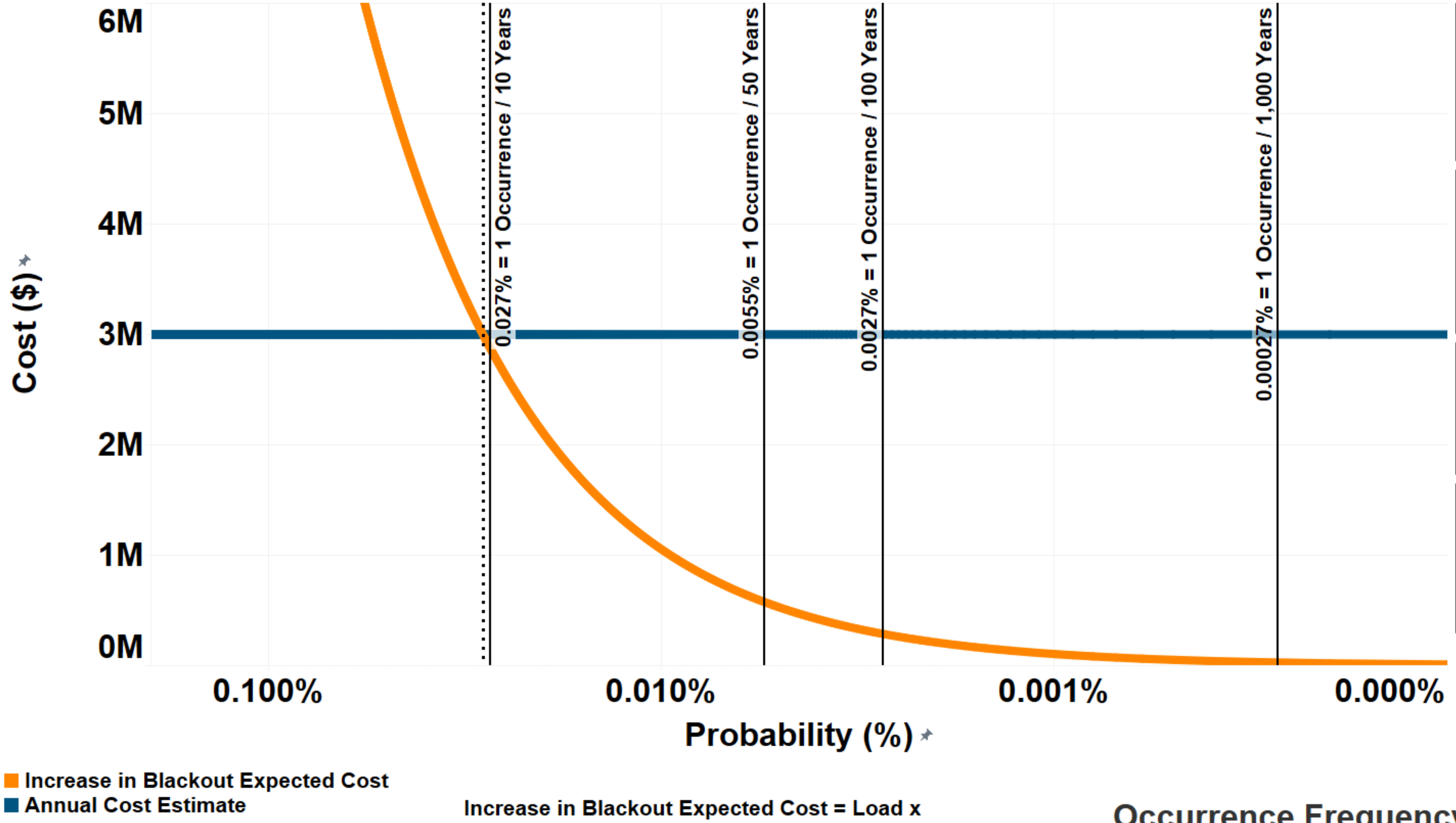
Average Load (MW)
10,000

Value of Lost Load ($ / MWh)
10,000

Increase in Blackout Expected Cost = Load x Increase in Duration x Value of Lost Load (VoLL) x Probability of Occurence

Occurrence Frequency
1 Occurrence / 6.8 Year(s)

Conversion of Bremerton VoLL = $100,000



Annual Cost Estimate ($ Million)
3

Increase in Duration (hours)
10.5

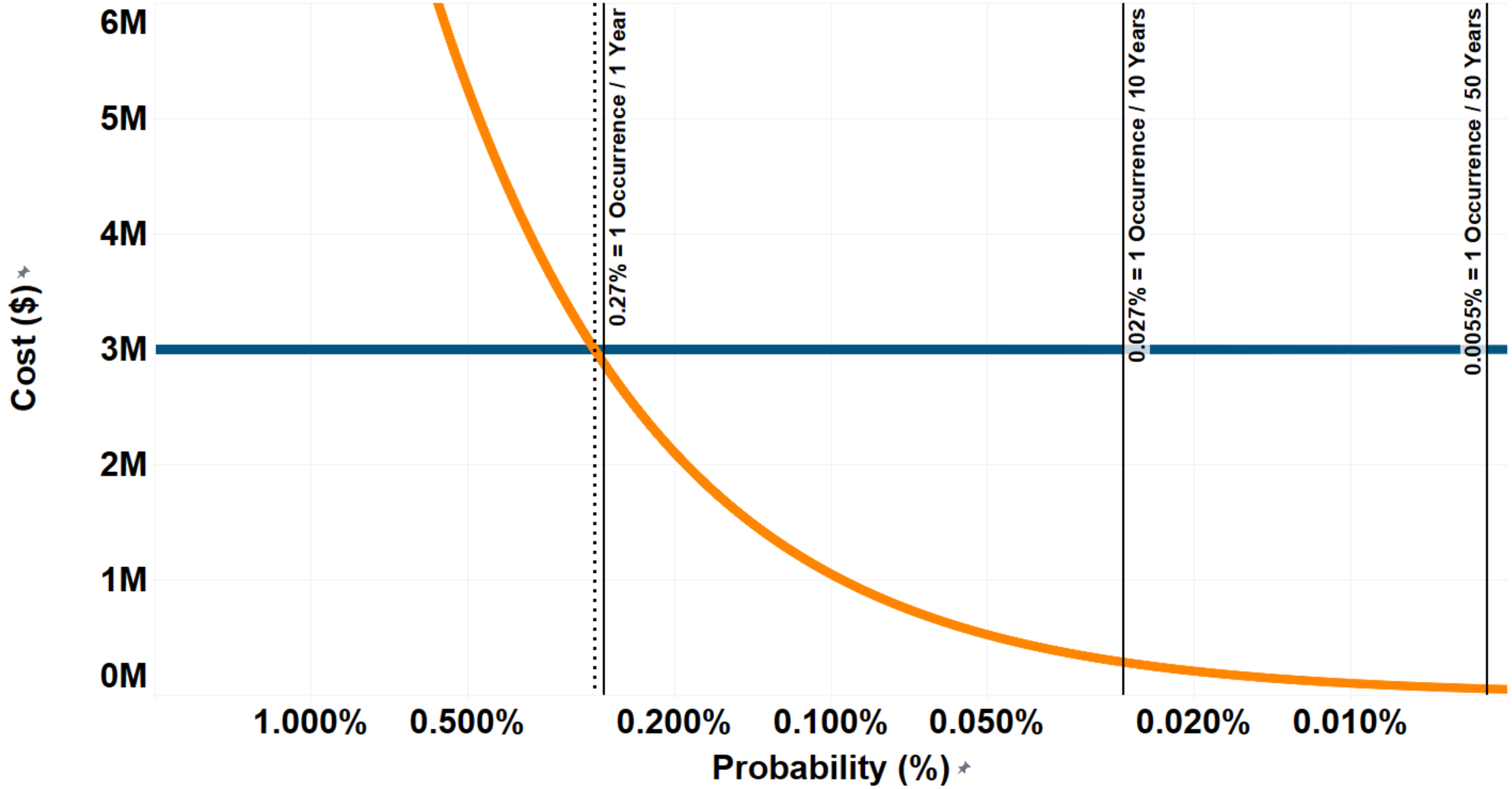
Average Load (MW)
10,000

Value of Lost Load ($ / MWh)
100,000

Increase in Blackout Expected Cost = Load x Increase in Duration x Value of Lost Load (VoLL) x Probability of Occurence

Occurrence Frequency
1 Occurrence / 9.6 Year(s)

Conversion of Bremerton VoLL = $10,000



Annual Cost Estimate ($ Million)
3

Increase in Duration (hours)
10.5

Average Load (MW)
10,000

Value of Lost Load ($ / MWh)
10,000

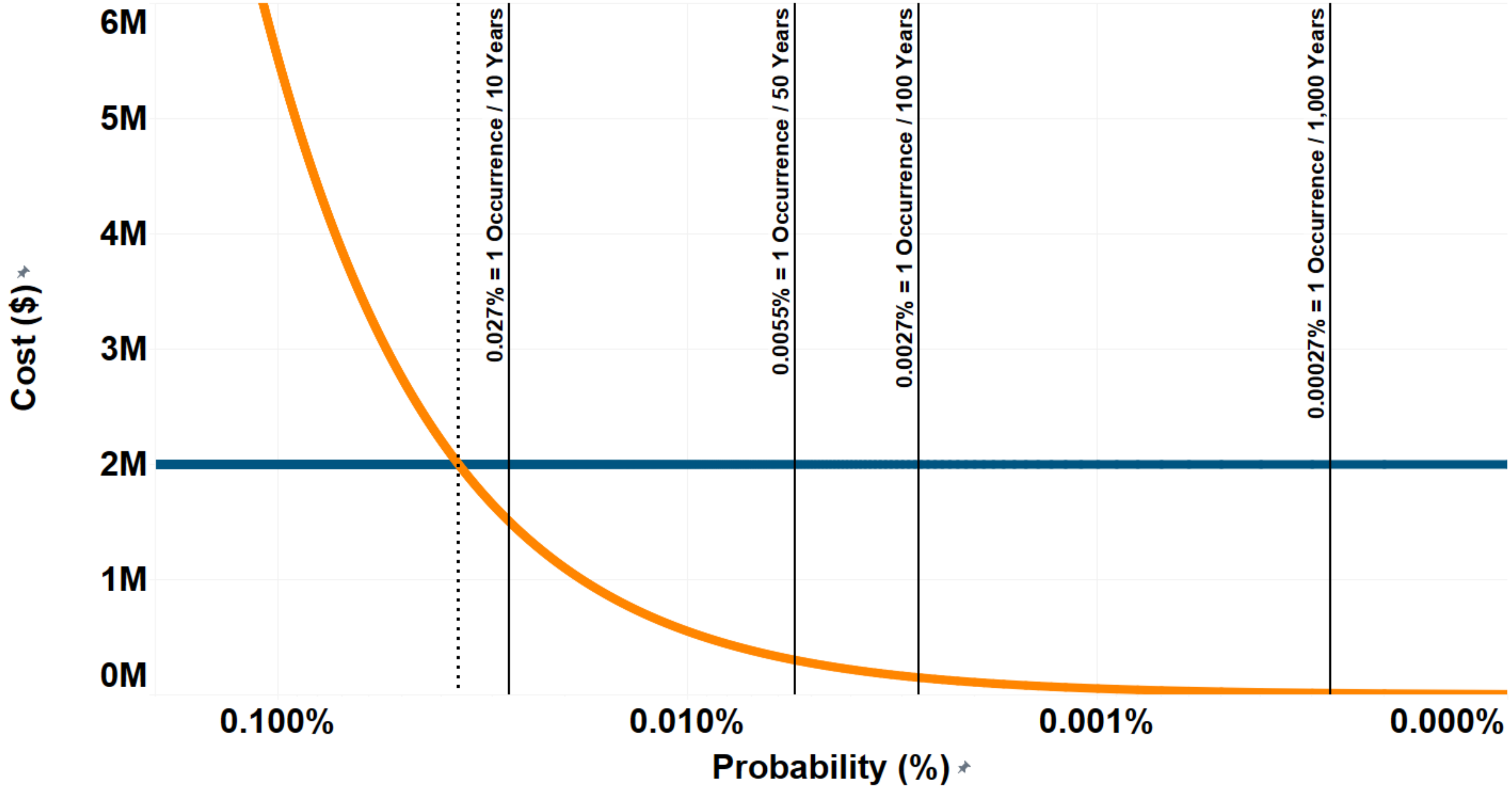
- Increase in Blackout Expected Cost
- Annual Cost Estimate

Increase in Blackout Expected Cost = Load x Increase in Duration x Value of Lost Load (VoLL) x Probability of Occurence

Occurrence Frequency

1 Occurrence / 1.0 Year(s)

Conversion of Tacoma VoLL = $100,000



Annual Cost Estimate ($ Million)
2

Increase in Duration (hours)
5.5

Average Load (MW)
10,000

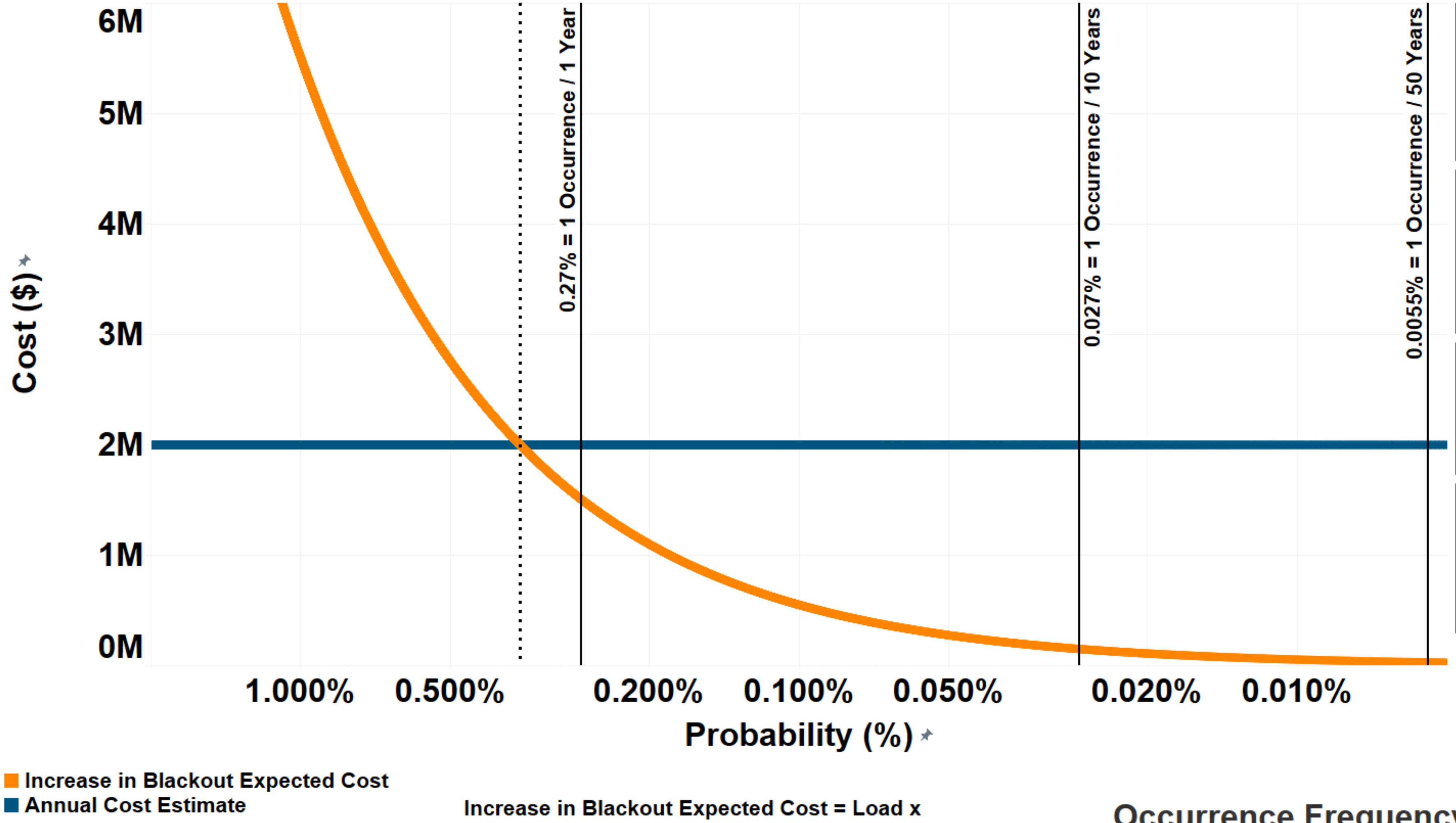
Value of Lost Load ($ / MWh)
100,000

■ Increase in Blackout Expected Cost
■ Annual Cost Estimate

Increase in Blackout Expected Cost = Load x Increase in Duration x Value of Lost Load (VoLL) x Probability of Occurence

Occurrence Frequency
1 Occurrence / 7.5 Year(s)

Conversion of Tacoma VoLL = $10,000

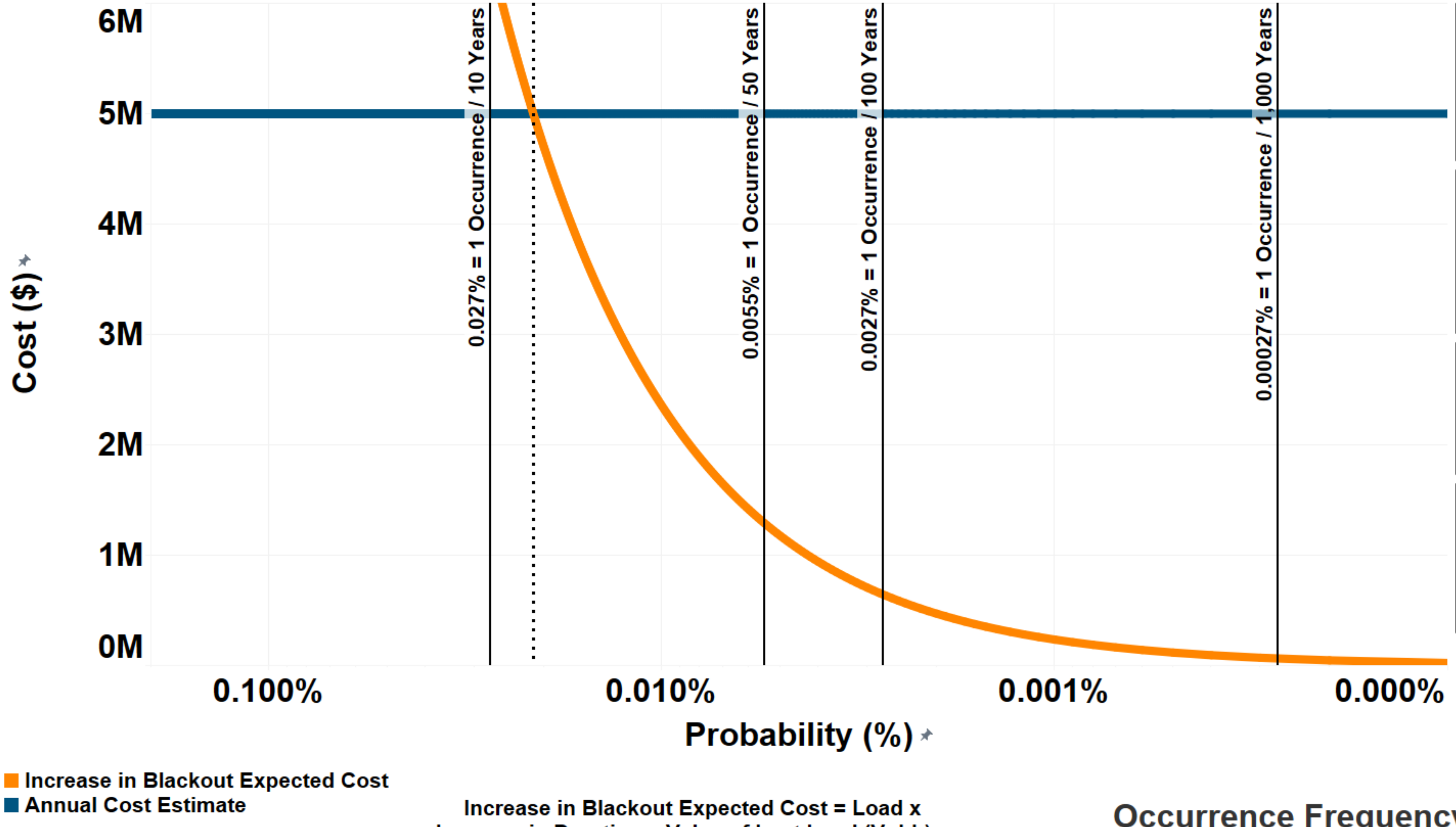


Annual Cost Estimate ($ Million)	2
Increase in Duration (hours)	5.5
Average Load (MW)	10,000
Value of Lost Load ($ / MWh)	10,000

Increase in Blackout Expected Cost = Load x Increase in Duration x Value of Lost Load (VoLL) x Probability of Occurence

Occurrence Frequency
1 Occurrence / 0.8 Year(s)

Conversion of Bremerton and Tacoma VoLL = $100,000

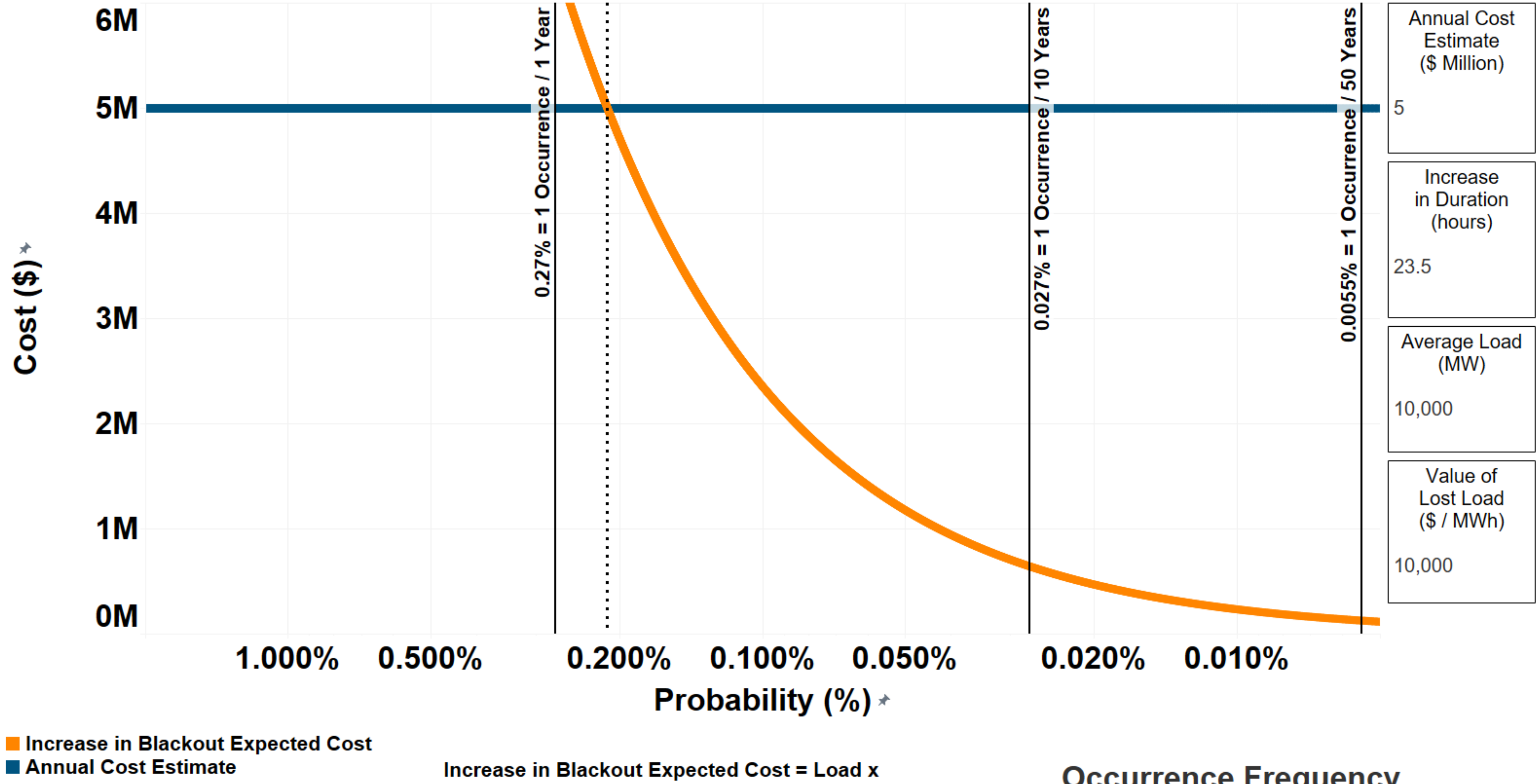


Annual Cost Estimate ($ Million)	5
Increase in Duration (hours)	23.5
Average Load (MW)	10,000
Value of Lost Load ($ / MWh)	100,000

Increase in Blackout Expected Cost = Load x Increase in Duration x Value of Lost Load (VoLL) x Probability of Occurence

Occurrence Frequency
1 Occurrence / 12.9 Year(s)

Conversion of Bremerton and Tacoma VoLL = $10,000



Increase in Blackout Expected Cost = Load x Increase in Duration x Value of Lost Load (VoLL) x Probability of Occurence

Occurrence Frequency

1 Occurrence / 1.3 Year(s)

Hypothetical Case: Scenario Occurrence Frequencies

Scenario	Fuel Assurance Conversion	Annual Conversion Cost	Occurrence Frequency (VoLL = $10k)	Occurrence Frequency (VoLL = $100k)
Scenario 1	Renton	$100,000	6.8 years	68.5 years
Scenario 2	Bremerton	$3,000,000	1.0 years	9.6 years
Scenario 3	Tacoma	$2,000,000	0.8 years	7.5 years
Scenario 4	Bremerton & Tacoma (common pipeline)	$5,000,000	1.3 years	12.9 years

Conclusions

- This methodology is a cost/benefit analysis of fuel assurance conversions of Black Start sites
  - This analysis is a purely financial calculation
  - This analysis factors in a probabilistic assessment of risk
  - This analysis integrates variables
    - Zonal Load
    - Value of Lost Load
    - Incremental Restoration Time Increase
    - Probability of Event
    - Fuel Assurance Conversion Cost

Contact

Presenter:
Dan Bennett
Daniel.Bennett@pjm.com

Facilitator:
Janell Fabiano
Janell.Fabiano@pjm.com

Secretary:
Nicole Militello
Nicole.Militello@pjm.com

Fuel Requirements for Black Start Resources

Member Hotline
(610) 666 – 8980
(866) 400 – 8980
custsvc@pjm.com

Appendix

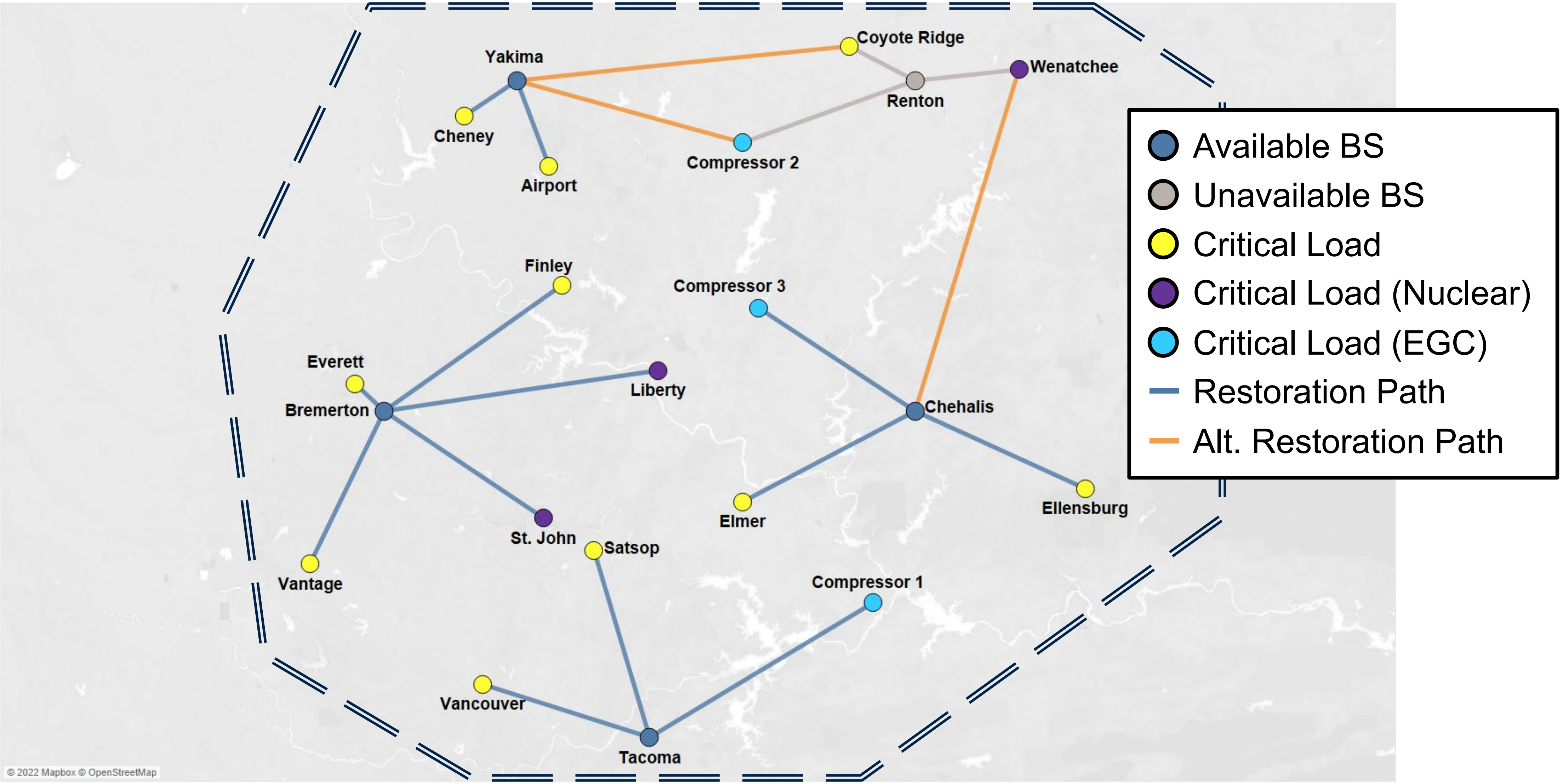
Terms

- BSR (Black Start Resource): A generation resource capable of providing black start service during a restoration event
- CL (Critical Load): A generator, nuclear reactor, or electric gas compressor identified in a TO’s restoration plan that must be energized by a BSR as part of the restoration process
- FA BSR (Fuel Assured BSR): A Black Start Resource that meets the fuel assurance requirements identified in the table in Slide 4
- NFA BSR (Non-Fuel Assured BSR): A Black Start Resource that does not meet the fuel assurance requirements identified in the table in Slide 4

Post-Hiatus Black Start Fuel Assurance Classification

Classification	Description
Fuel Assured (FA)	Black Start sites that can operate using fuel that is stored on site, this includes oil units and dual fuel units with the capability to start without requiring gas
Fuel Assured (Multiple Pipelines)	Gas only Black Start sites that are connected to more than one interstate natural gas pipeline
Non-Fuel Assured (NFA)	Gas only Black Start sites with one interstate pipeline connection
Non-Fuel Assured (LDC)	Gas only Black Start sites that receive their gas supply via a LDC connection
Non-Fuel Assured (Gas to Start)	Black Start sites that have fuel storage on site but require natural gas for startup ignition
Hydro	Black Start sites that rely on natural river flow to generate electricity or store an inventory of water in an elevated reservoir

Hypothetical Case: Scenario 1 Loss of Renton



Hypothetical Case: Scenario 1
Loss of Renton Timing

To account for the loss of Renton in a restoration, alternate black start sites must crank those critical loads in addition to what they normally crank.

Bremerton Island: 9.0 Hours

Chehalis Island: 6.5 + **5.0** = **11.5** Hours

Renton Island: **N/A**

Tacoma Island: 8.0 Hours

Yakima Island: 5.5 + **1.5** + **2.0** = **9.0** Hours

→ Hypothetical Zonal Restoration Time: **11.5 Hours**