

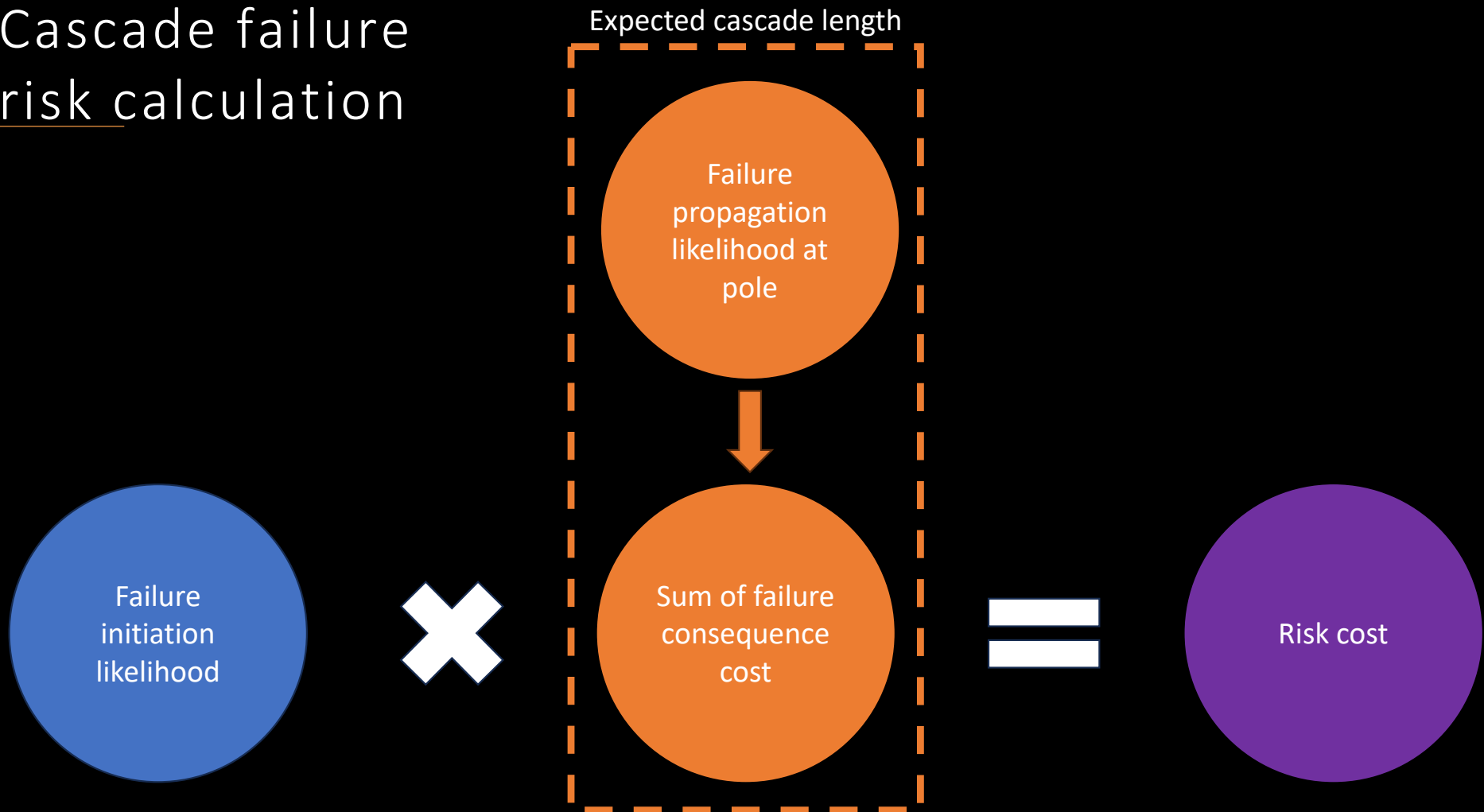
Cascade failure mitigation

Calibrating mitigations against cascade failure.

PRESENTED BY

Carl Rathbone · 20/05/2026

Cascade failure risk calculation



Failure initiation likelihood components

Failure
initiation
likelihood



Initiation
likelihood due
to falling
vegetation



Initiation
likelihood due
to design/
condition



Initiation
likelihood due
to vehicle
impact

Consequence cost components

Consequence
cost



Repair cost



Line
environment
consequence
cost



Unserviced
energy cost

Basic Cascade failure risk calculation

$$Risk = P_{initiation} \times E[N_{fail}] \times C_{span}$$

Where:

$P_{initiation}$ = Probability of initiation

$E[N_{fail}]$ = Expected cascade length = $1 + P_p + P_p^2 + P_p^3 \dots$

P_p = Probability of failure propagation at structure

C_{span} = Consequence of failure in a span

Detailed Cascade failure risk calculation

$$\text{Risk} = P_{\text{initiation}} \times [C_1 + P_{p,1}C_2 + P_{p,1}P_{p,2}C_2 + P_{p,1}P_{p,2}P_{p,3}C_3 + \dots]$$

Where:

$P_{\text{initiation}}$ = *Probability of initiation*

$P_{p,n}$ = *Probability of failure propagation at structure n*

C_n = *Consequence of failure in span n*

Analysis

A prototype tool was developed to quantitatively assess the value of cascade failure mitigation

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Cascade risk failure assessment												
				Section	Annual section risk cost	PV Lifetime section failure risk cost	Pole count	Section	Annual section risk cost	PV Lifetime section failure risk cost	Pole count	
1				1	\$29,983	\$366,798	28	1	\$29,983	\$366,798	28	
2	Conductor type	Fluorine		2	\$460	\$5,623	3	2	\$460	\$5,623	3	
3	Conductor tension	10	%UTS	3	\$699	\$8,551	3	3	\$699	\$8,551	3	
4	Number of phases	3		4	\$862	\$10,540	9	4	\$862	\$10,540	9	
5	Conductor tension	3.54	kN	5	\$29	\$350	2	5	\$29	\$350	2	
6	Asset design life	50	years	6	\$708	\$8,661	8	6	\$708	\$8,661	8	
7				7	\$440	\$5,385	4	7	\$440	\$5,385	4	
8												
9												
10												
11		Pole number	Pole function	Pole type	Section	Pole function	Pole type	Section	Ahead span criticality	Falling vegetation	Design/Condition related	
12	1	123456	Strain (Stayed)	Busck-11	1	Strain (Stayed)	Busck-11	1	Road crossing (Motorway)	A few trees that may damage the line if falling	Normal (1/25,000/yr)	Less than 1m from
13	2	123457	Intermediate	Busck-11	1	Intermediate	Busck-11	1	Undeveloped land	A few trees that may damage the line if falling	Normal (1/25,000/yr)	Less than 1m from
14	3	123458	Intermediate	Busck-7.5	1	Intermediate	Busck-7.5	1	Undeveloped land	A few trees that may damage the line if falling	High (1/5,000/yr)	Less than 1m from
15	4	123459	Intermediate	Busck-9.5	1	Intermediate	Busck-9.5	1	Undeveloped land	A few trees that may damage the line if falling	High (1/5,000/yr)	Less than 1m from
16	5	123460	Intermediate	Busck-9.5	1	Intermediate	Busck-9.5	1	Undeveloped land	A few trees that may damage the line if falling	High (1/5,000/yr)	Less than 1m from
17	6	123461	Intermediate	Busck-11	1	Intermediate	Busck-11	1	Undeveloped land	A few trees that may damage the line if falling	High (1/5,000/yr)	Less than 1m from
18	7	123462	Intermediate	Busck-11	1	Intermediate	Busck-11	1	Undeveloped land	A few trees that may damage the line if falling	High (1/5,000/yr)	Less than 1m from
19	8	123463	Intermediate	Busck-11	1	Intermediate	Busck-11	1	Undeveloped land	A few trees that may damage the line if falling	Normal (1/25,000/yr)	Less than 1m from
20	9	123464	Intermediate	Busck-11	1	Intermediate	Busck-11	1	Undeveloped land	A few trees that may damage the line if falling	Normal (1/25,000/yr)	Less than 1m from
21	10	123465	Intermediate	Busck-11	1	Intermediate	Busck-11	1	Undeveloped land	A few trees that may damage the line if falling	Normal (1/25,000/yr)	Less than 1m from
22	11	123466	Intermediate	Busck-11	1	Intermediate	Busck-11	1	Rail crossing	A few trees that may damage the line if falling	Normal (1/25,000/yr)	Less than 1m from
23	12	123467	Intermediate	Busck-11	1	Intermediate	Busck-11	1	Undeveloped land	A few trees that may damage the line if falling	Normal (1/25,000/yr)	Less than 1m from
24	13	123468	Intermediate	Busck-11	1	Intermediate	Busck-11	1	Undeveloped land	A few trees that may damage the line if falling	Normal (1/25,000/yr)	Less than 1m from

Conclusions

Greater effort should be applied to the management of cascade failure risk where:

1. The likelihood of initial failure is elevated (e.g. exposure to vehicle collision, presence of danger tree/s);
2. The consequence of failure is elevated. Examples include:
 - Urban areas
 - Road crossings
 - Lifeline circuits
 - Structures carrying more than one HV circuit
 - Circuits supporting critical industry
3. The line is highly utilised (e.g. typically > 75% of its ULS capacity under governing load cases)

Cascade failure risk may be managed by reducing section lengths or including strong poles along the line.

Conclusions

Where practical, sections of line with a high likelihood or consequence of failure should be isolated using Stop Structures. This may occur where:

1. The likelihood of initial failure is high. Examples include:
 - High exposure to vehicle collisions
 - Danger tree corridors
 - Unstable land
2. The consequence of failure is high. Examples include:
 - River crossings,
 - Long spans
 - Major road crossings
 - Rail crossings
 - High fire risk areas
 - Highly frequented public areas.

Conclusion

It has been demonstrated that a quantitative (cost benefit analysis) method could be used to automatically design reasonable mitigations against cascade failures

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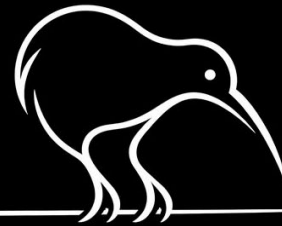
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Likelihood of conductor failure in ahead span												
	Pole number	Pole function	Pole type	Section	Pole function	Pole type	Section	Ahead span criticality	Falling vegetation	Design/Condition related		
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O L E N Z



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