Quantil

Risk Management Report

Findings, recommendations and contingency advice

Cascade Valley 345 kV Transmission Reinforcement

CVT-345-2026: Varnholt Transmission Partners, LLC

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Prepared with the Quantil Cost & Schedule Risk Analyzer for Excel

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1. Executive summary

This report summarizes the outcomes of the risk workshop for the Cascade Valley 345 kV Transmission Reinforcement, commissioned by Varnholt Transmission Partners, LLC. The session was facilitated by Quantil facilitator (demo) on 2026-09-12 during the Detailed Design phase. In total 50 risks were identified, of which 50 are currently active (open). The quantitative analysis was performed with a Monte Carlo simulation (Beta-PERT distributions with correlation) on both cost and schedule exposure.

The core conclusion is that the project carries material but well-concentrated uncertainty. The expected (mean) cost outcome of USD 17,855,231 exceeds the deterministic base estimate of USD 15,000,000 by USD 2,855,231 (19.0%), reflecting the total weight of the open risk portfolio. To achieve 80% confidence of staying within budget, a total provision of USD 18,906,479 is required, a contingency of USD 3,906,479, equal to 26.0% of the base estimate. The distribution shows a modest right skew (a longer upper tail).

Key figures

Base estimate (deterministic)	**USD 15,000,000**
Expected outcome (mean)	**USD 17,855,231**
P50: median outcome	**USD 17,643,807**
P80: primary confidence level	**USD 18,906,479**
P85: conservative	**USD 19,299,480**
P90: highly conservative	**USD 19,812,408**
Required contingency at P80	**USD 3,906,479**
Contingency as % of base	**26.0%**
Total EMV (expected cost)	**USD 2,852,200**
Standard deviation (spread)	**USD 1,444,224**

Recommendation in brief: adopt the P80 outcome of USD 18,906,479 as the budget control level and explicitly ring-fence the associated contingency of USD 3,906,479. Cost and schedule uncertainty are both concentrated in a limited number of top risks (chapter 3), which makes targeted control highly cost-effective.

2. Risk workshop results

The table below shows the qualitative classification of the 50 open risks after the session. Classification is based on the probability-times-impact (PxI) score in line with the RISMAN method, in which probability and impact are each scored and the product determines the band.

Critical (PxI >= 16)	**1**
High (10-15)	**14**
Medium (5-9)	**35**
Low (1-4)	**0**
Total open	**50**

Portfolio overview: the average probability across the open risks is 26.8%, total PERT cost exposure (unweighted sum of most likely impacts) is USD 11,891,667, and the probability-weighted expected monetary value (EMV) is USD 2,852,200. The gap between PERT exposure and EMV reflects that most individual risks are well short of certain: only a minority combine high probability with high impact. Control effort should therefore be concentrated on the 15 risks in the Critical and High bands, which cause the bulk of the exposure.

3. Top risks

The risks below are ranked automatically by cost EMV (probability times expected impact). They are the principal contributors to cost uncertainty and form the focus of the mitigation strategy in chapter 6. Each individual risk appears exactly once; where two risks share an identical EMV, both are listed and ordered by register sequence.

#	ID	Category	Description	Probability	EMV	Response	Owner
1	R-001	Technical	IF the foundation loading on the lattice towers exceeds the design assumption THEN the pile foundations…	50%	**USD 379,167**	Mitigate	Technical Lead
2	R-012	Financial / economic	IF steel prices for the transmission structures rise by more than 15% THEN the materials budget is exce…	55%	**USD 247,500**	Mitigate	Procurement Mgr
3	R-016	Legal / regulatory	IF the principal civil contractor becomes insolvent during construction THEN retendering and demobiliza…	12%	**USD 210,000**	Transfer	Contract Manager
4	R-014	Financial / economic	IF market interest rates rise by more than 200 basis points THEN project financing costs increase → er…	35%	**USD 154,583**	Transfer	Finance Manager
5	R-021	Organizational	IF the assumptions in the baseline schedule prove too optimistic THEN the project is extended → additi…	40%	**USD 140,000**	Mitigate	Planning Manager
6	R-038	Technical	IF the civil and electrical designs are not synchronized in time THEN interface conflicts arise durin…	40%	**USD 140,000**	Mitigate	Engineering Lead
7	R-013	Financial / economic	IF the USD/EUR exchange rate moves by more than 10% THEN a cost variance arises on imported equipment → budg…	45%	**USD 127,500**	Transfer	Finance Manager
8	R-018	Legal / regulatory	IF the liquidated damages clause for late completion is triggered THEN the profit margin is eroded → direct f…	25%	**USD 122,917**	Mitigate	Project Manager
9	R-017	Legal / regulatory	IF a dispute arises over the scope of a change order THEN it leads to a claim and possible arbi…	30%	**USD 105,000**	Mitigate	Contract Manager
10	R-035	Organizational	IF a serious safety incident occurs during construction THEN a work stoppage and investigation follow → stan…	15%	**USD 92,500**	Mitigate	HSE Manager

Note: risks R-021 (Organizational) and R-038 (Technical) share an identical cost EMV of USD 140,000 and are ranked side by side. They are different risks with separate owners and require separate mitigation actions.

3a. Tornado analysis: largest risks by EMV

The tornado chart ranks the risks by their expected monetary value (EMV = probability x PERT mean cost), from largest to smallest. This makes visible at a glance which risks contribute most to the project's total cost exposure and therefore deserve priority in control and contingency setting. The length of each bar is proportional to the EMV of the risk concerned; the corresponding risk ID is shown along the vertical axis.

Read the chart from top to bottom: the top bars are the dominant risks. A steeply declining profile (a few long bars, then rapidly shorter) indicates a concentrated risk profile in which controlling a few top risks has the greatest effect. A flatter profile indicates a more dispersed exposure. EMV is indicative and no substitute for engineering judgment.

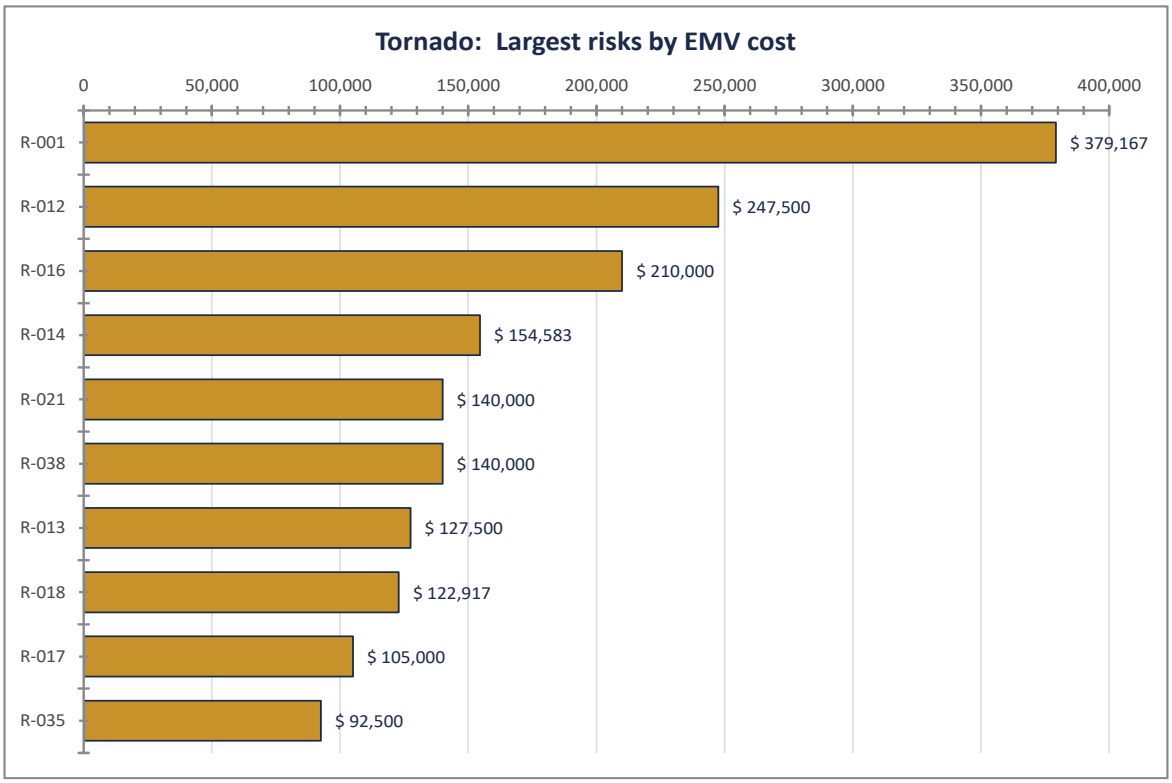


Figure 1: Tornado, the ten risks with the highest cost EMV, ranked in descending order.

4. Monte Carlo analysis: cost

The Monte Carlo simulation produces a probability distribution of total project cost by repeatedly drawing the individual risks according to their Beta-PERT distributions, including correlations between related risks. The chart below shows the cost histogram with the P50 / P80 / P85 / P90 percentile markers and the cumulative S-curve.

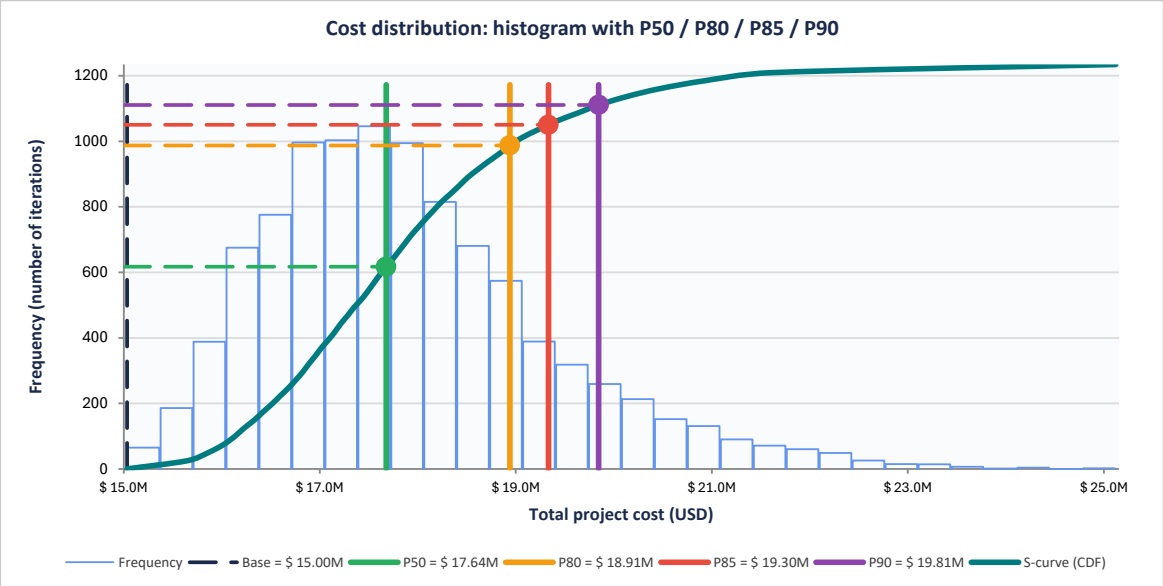


Figure 2: Distribution of total project cost (Monte Carlo)

Cost statistics

Minimum	**USD 15,000,000**
P10	**USD 16,189,396**
Mean	**USD 17,855,231**
P50	**USD 17,643,807**
P80	**USD 18,906,479**
P85	**USD 19,299,480**
P90	**USD 19,812,408**
Maximum	**USD 25,086,773**
Standard deviation	**USD 1,444,224**

Interpretation: the difference between the base estimate (USD 15,000,000) and the P80 outcome (USD 18,906,479) represents the cost contingency required to achieve 80% confidence. The mean (USD 17,855,231) lies above the median (USD 17,643,807), indicating a modest right skew (a longer upper tail). The tail beyond P90 reflects low-probability, high-impact risks that should be monitored but need not be fully funded within the base contingency.

5. Monte Carlo analysis: schedule

The same simulation is applied to project duration. Each risk contributes a schedule impact (in weeks), drawn from its Beta-PERT distribution. The chart below shows the duration histogram with the P50 / P80 / P85 / P90 percentile markers and the cumulative S-curve, which expresses how much schedule buffer is required for a given confidence level.

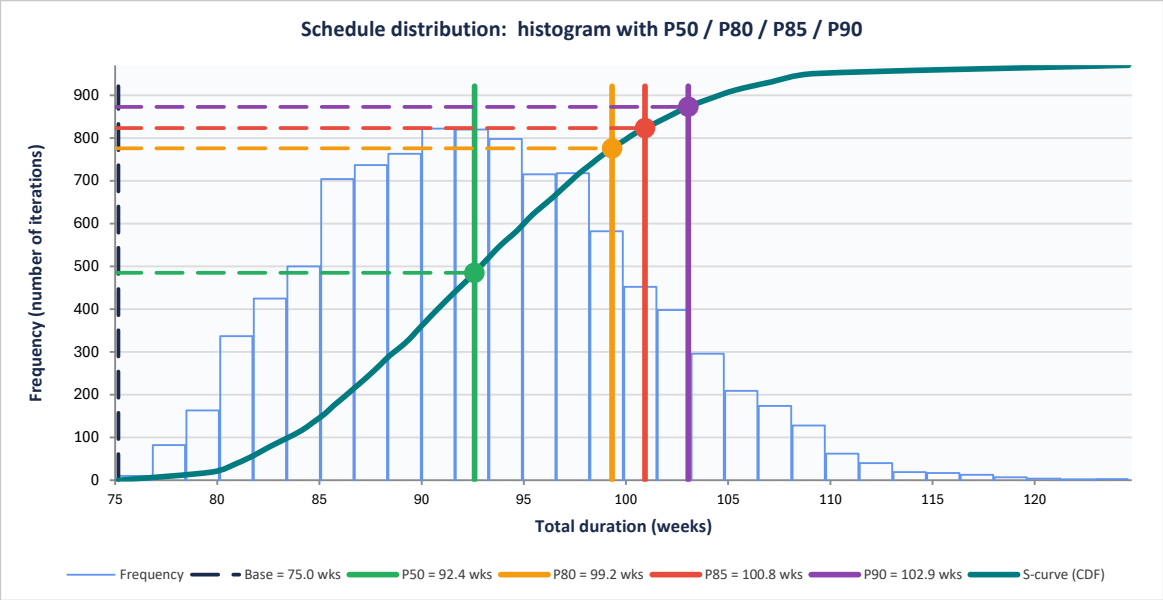


Figure 3: Distribution of project duration (Monte Carlo)

Schedule statistics (weeks)

Minimum	**75.0 wk**
P10	**83.2 wk**
Mean	**92.8 wk**
P50	**92.4 wk**
P80	**99.2 wk**
P85	**100.8 wk**
P90	**102.9 wk**
Maximum	**124.4 wk**
Standard deviation	**7.5 wk**

The deterministic base duration entered in Project Setup is 75 weeks. The figures above are the total duration including risk effect (base duration plus risk-driven delay). Managing to P80 means reserving a schedule buffer of approximately 24.2 weeks on top of the baseline schedule, i.e. a risk-adjusted program of 99.2 weeks at 80% confidence.

6. Appropriate mitigation measures

For each top risk an appropriate control strategy is set out below, derived from the selected response type (mitigate / transfer / accept / avoid) and the risk category, combined with the owner's own response action where recorded. The measures aim to reduce probability, impact or both, and each must be translated into a concrete action with a named owner and a deadline.

ID	Category	Response	Recommended mitigation measure
R-001	Technical	Mitigate	Mitigate (reduce): Carry out additional investigation and engineering (geotechnical investigation, design reviews, prototyping), set up an interface register with clash detection, and build engineering margins into the design. Owner action: Geotechnical boring program early in design + bearing capacity verification.
R-012	Financial / economic	Mitigate	Mitigate (reduce): Hedge price and currency exposure through indexation, hedging or fixed-price agreements, and monitor market prices continuously. Owner action: Forward contract locking steel prices 6 months ahead.
R-016	Legal / regulatory	Transfer	Transfer: Secure the risk allocation contractually (back-to-back clauses, liability caps, bank guarantees) and track permitting and objection procedures with explicit lead times. Place the residual risk with the party best equipped to carry it, through contract or insurance. Owner action: Performance bond + back-up contractor held in reserve.
R-014	Financial / economic	Transfer	Transfer: Hedge price and currency exposure through indexation, hedging or fixed-price agreements, and monitor market prices continuously. Place the residual risk with the party best equipped to carry it, through contract or insurance. Owner action: Fixed-rate financing where available + scenario analysis.
R-021	Organizational	Mitigate	Mitigate (reduce): Secure capacity and knowledge (key roles plus back-up), assign responsibilities unambiguously, and validate schedule and governance assumptions. Owner action: Independent schedule risk analysis + realistic buffer build-up.
R-038	Technical	Mitigate	Mitigate (reduce): Carry out additional investigation and engineering (geotechnical investigation, design reviews, prototyping), set up an interface register with clash detection, and build engineering margins into the design. Owner action: BIM clash detection protocol + weekly coordination meetings.
R-013	Financial / economic	Transfer	Transfer: Hedge price and currency exposure through indexation, hedging or fixed-price agreements, and monitor market prices continuously. Place the residual risk with the party best equipped to carry it, through contract or insurance. Owner action: Currency hedging via FX forward contracts for imported components.
R-018	Legal / regulatory	Mitigate	Mitigate (reduce): Secure the risk allocation contractually (back-to-back clauses, liability caps, bank guarantees) and track permitting and objection procedures with explicit lead times. Owner action: Schedule risk management + protection of critical path float.
R-017	Legal / regulatory	Mitigate	Mitigate (reduce): Secure the risk allocation contractually (back-to-back clauses, liability caps, bank guarantees) and track permitting and objection procedures with explicit lead times. Owner action: Clear change order procedure + early contract management involvement.
R-035	Organizational	Mitigate	Mitigate (reduce): Secure capacity and knowledge (key roles plus back-up), assign responsibilities unambiguously, and validate schedule and governance assumptions. Owner action: Weekly HSE audits + toolbox talks + pre-task hazard assessment for high-risk work.

How these measures are determined: the engine matches each risk to a measure based on the risk category (which determines the substance of the control, e.g. additional geotechnical investigation for Technical, hedging for Financial / economic, contractual safeguards for Legal / regulatory) and the selected response type (which determines the framing). These measures are indicative starting points for the action plan and are no substitute for risk-specific engineering and commercial judgment; in particular, risks that erode the contractor's own margin cannot always be transferred and may instead require active mitigation.

7. Conclusion and recommendations

The risk workshop and quantitative analysis show that the Cascade Valley 345 kV Transmission Reinforcement carries material cost and schedule uncertainty, which is nevertheless concentrated in a limited number of top risks. The expected cost outcome is USD 17,855,231 against a base estimate of USD 15,000,000. To stay within budget at 80% confidence, a total of USD 18,906,479 is required, a contingency of USD 3,906,479 (26.0%). On the schedule side, a buffer of approximately 24.2 weeks is required at P80 (total duration 99.2 weeks). Because both cost and schedule exposure are driven by a small set of risks, targeted control is the most cost-effective response.

Recommendations

- Adopt P80 (USD 18,906,479) as the budget control level and explicitly ring-fence the associated contingency of USD 3,906,479.
- Reserve a schedule buffer of approximately 24.2 weeks (P80 duration 99.2 weeks) and protect the critical path against the highest-impact schedule risks.
- Assign a risk owner to every top risk and link the mitigation measures to concrete actions with deadlines, reviewed at least monthly.
- Concentrate the control effort on the 15 risks classified as Critical and High; these cause the bulk of the exposure.
- Treat risks with an identical EMV as separate items: they are different risks with different owners and control measures, and each must be tracked separately.
- Control 'Transfer' risks contractually (insurance / back-to-back) and secure the transfer before the relevant phase begins; mitigate actively where the risk cannot genuinely be transferred.
- Re-run the Monte Carlo simulation at every phase gate or significant scope change, so that the contingency follows the live risk profile rather than a snapshot.
- Report the top risks and contingency drawdown to the steering committee as a standing agenda item in the periodic progress report.

8. Method and assumptions

Approach: risks were identified and scored in a facilitated risk workshop and recorded in the live risk register. Each risk carries a probability and three-point (minimum / most likely / maximum) estimates for cost and schedule impact. A Monte Carlo simulation draws each risk from a Beta-PERT distribution fitted to those three points, applies correlations between related risks, and aggregates the results across many iterations to produce the cost and schedule distributions shown above.

Correlation between risks: the simulation can correlate related risks in two ways. In single-factor mode, related risks are linked to a shared underlying driver through a link strength (0-1), so that they move together. In Cholesky mode, a full correlation matrix between risk pairs is applied, with automatic correction to the nearest valid matrix when the input is inconsistent. Which mode is active is set in the tool; the reported figures follow the selected mode.

Schedule impact and critical path: the schedule outcome expresses the risk-driven delay in weeks on top of the deterministic base duration. For the schedule, the engine uses a hybrid aggregation. Risks flagged in the register as critical path are summed per iteration, because their delays pass through serially to the completion date. The remaining, non-critical risks are included through their largest single delay, as an approximation of delays that occur in parallel or are absorbed within the available float. The schedule impact per iteration is therefore the sum of the critical path delays plus the heaviest non-critical delay. This approach avoids both the understatement of a pure maximum and the overstatement of a pure sum. Which risks lie on the critical path is an expert judgment per risk; the model contains no network schedule with activities and dependencies, so the actual critical path and its movement are not determined automatically but approximated through this flag.

- EMV (expected monetary value) = probability x PERT mean impact; it is the probability-weighted cost of a risk.
- PERT exposure is the unweighted sum of most likely impacts and is therefore higher than EMV.
- Percentiles (P50 / P80 / P85 / P90) are read off the cumulative S-curve and express the confidence of staying within a given amount.
- Contingency at P80 = P80 outcome minus the deterministic base estimate.
- Schedule figures are the total duration: base duration plus risk-driven delay (hybrid aggregation: critical path risks summed, the remainder as a maximum).

Limitations: results are only as good as the inputs. Probabilities and three-point estimates are expert judgments; correlation assumptions are simplified; the flagging of critical path risks that drives the schedule aggregation is an expert judgment and not the outcome of a network schedule; and the qualitative PxI classification and the quantitative EMV ranking may differ for an individual risk. The report is an aid to decision-making, not a guarantee of outcome.