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NORCEM
HEIDELBERGCEMENT Group

Forum Safran 2022

Brevik CCS

Evolution of a Risk Model

- The road to ISCRA

Peter Moberg
Project Control Manager

BREVIK CCS

Brevik CCS – Evolution of a Risk Model

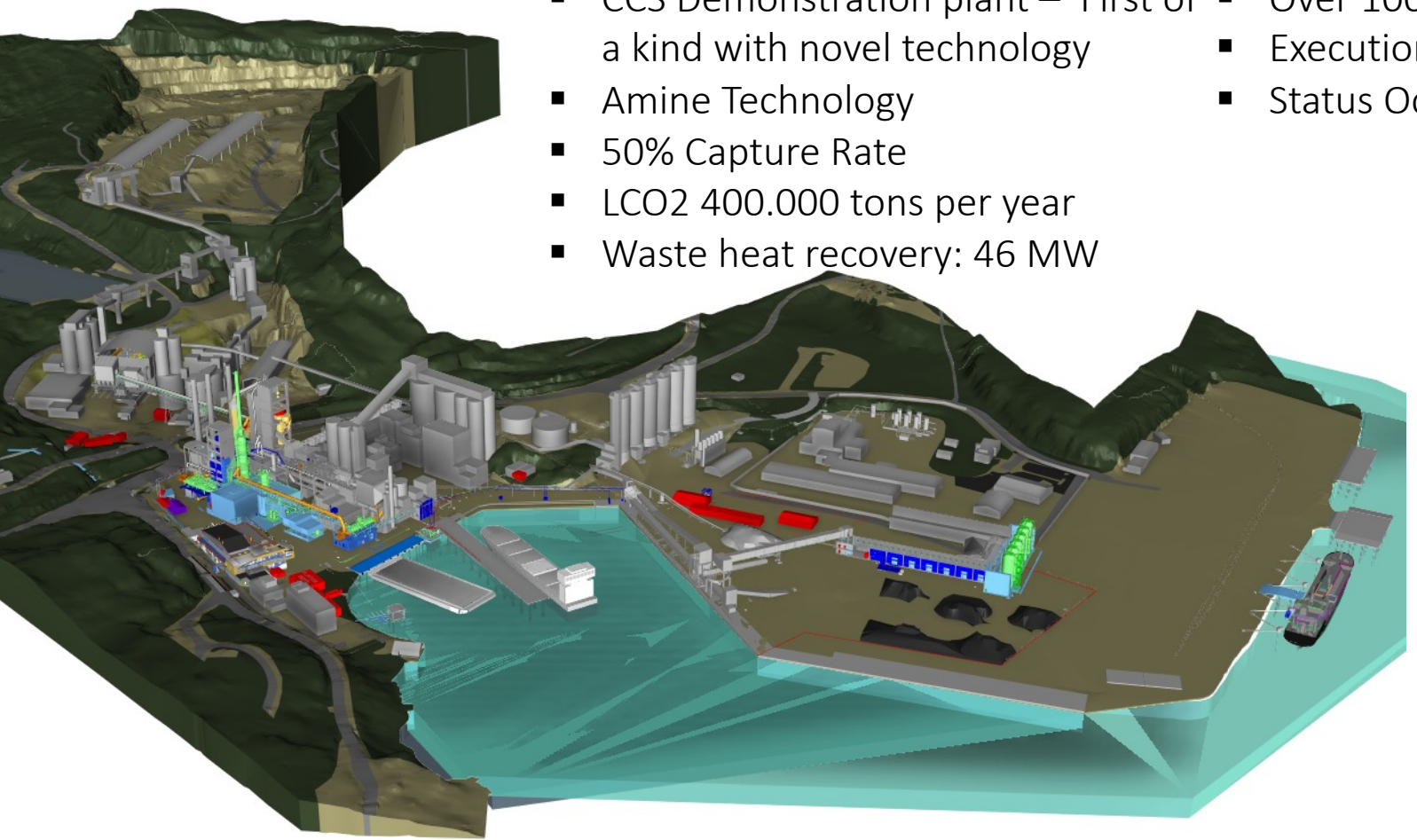
Agenda

1. Project Background and Scope
2. Contract Environment – Requirements for Uncertainty Analysis
3. Uncertainty Model from FEED phase
4. Uncertainty Model in Execution Phase
5. Key Challenges and Learning Points

Brevik CCS - Project Overview

BREVIK CCS

- CCS Demonstration plant – First of a kind with novel technology
- Amine Technology
- 50% Capture Rate
- LCO2 400.000 tons per year
- Waste heat recovery: 46 MW
- Over 100 year old Facility
- Execution Period late 2020 to 2024
- Status Oct-22, 45% Complete



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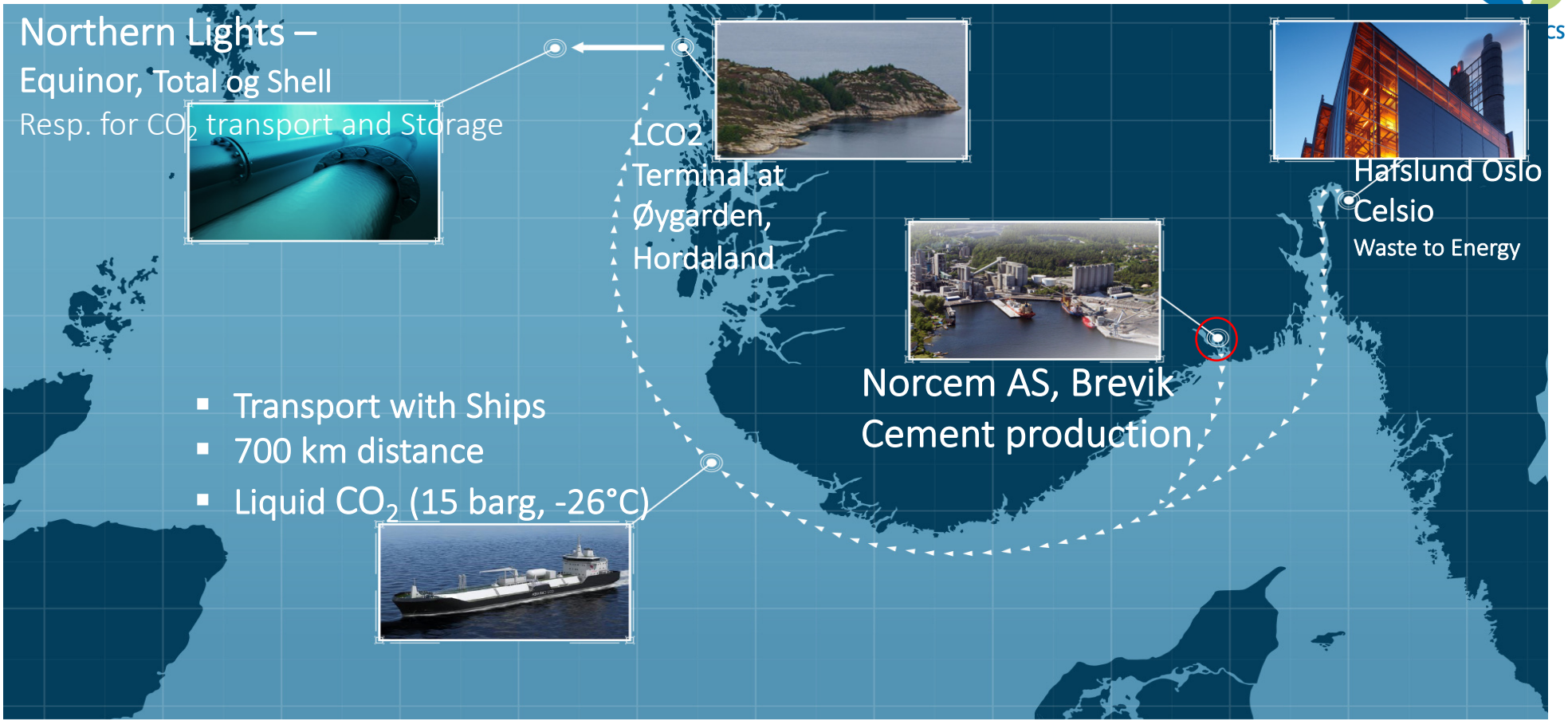
Brevik CCS - Part of Longship



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Brevik CCS - Contract Environment

The Project is governed by a Grant Support Agreement with the Norwegian State and parallel contracts for scope of work

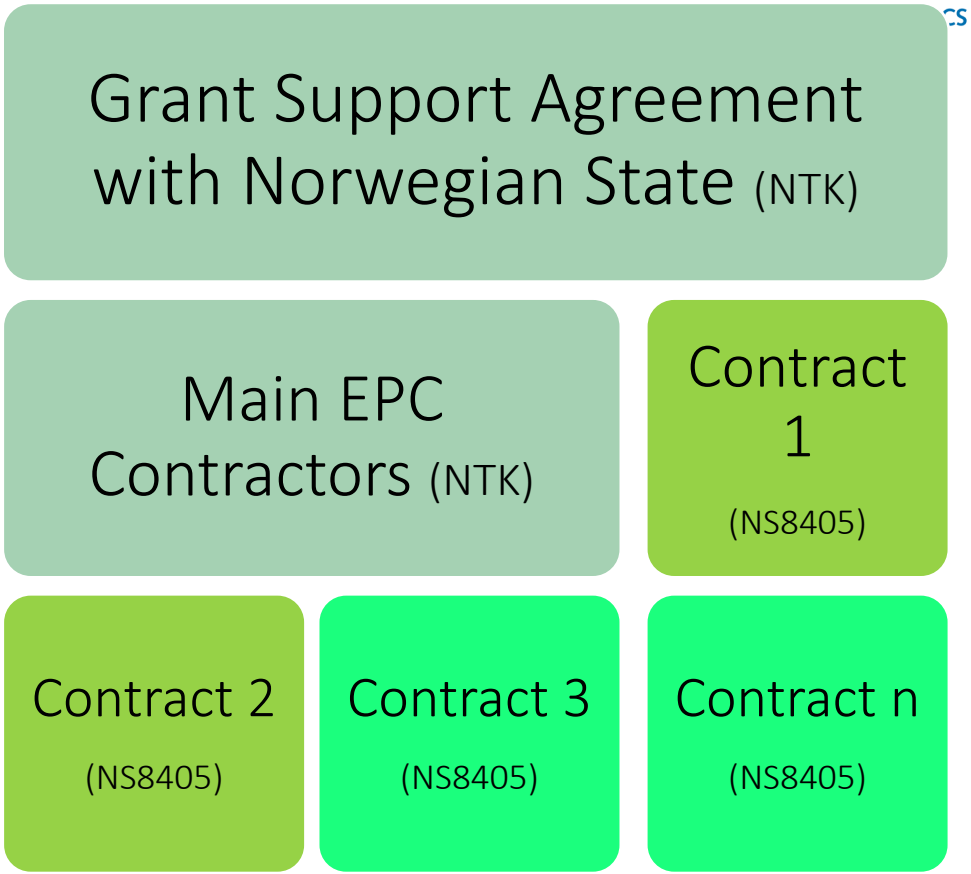
The Administrative Provisions (App D.) has a "SHALL" requirement for performing Baseline Revisions twice a year. (April & October)

The requirement for Baseline revision in App D. includes the following statement:

*a)Risk analysis of the schedule and costs **shall** be performed, and must list the most important risks and opportunities for remaining work"*

Where "Risk Analysis" is understood to include Quantitative Risk Analysis.

Uncertainty Analysis is performed for both CAPEX Investment project and OPEX.

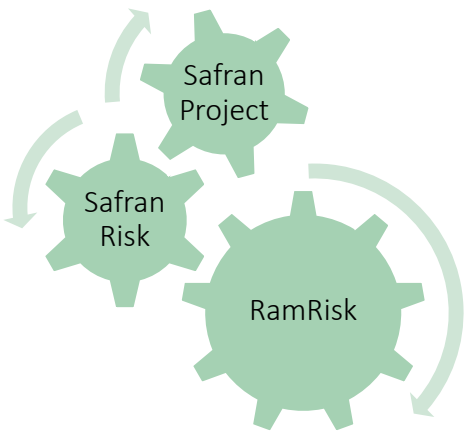


Brevik CCS - UA Process & Model

UA - Process

- Based on ISO 31000
- Start with Kick off meeting with all, continue with smaller groups in workshops
- Introduced Structured Walk Through of results

- Project Control Team
- Quality & Risk Manager (Qualitative)
- Risk Analyst – Quantitative



Cost UA Model CAPEX

- Cost Breakdown Structure according WBS 1:1 – Cost pane in Safran Risk
- Estimate uncertainty in use
- Uncertainty Drivers in use (Risk Register)
- Risk Register in Safran Risk aligned with Qualitative Risk Register (RamRisk-Rambøll)

COST UA Model – OPEX

- Separated UA Model for OPEX Cost
- Estimate Uncertainty only (for now)
- Global Factors

Brevik CCS – Baseline Revisions Timeline

FEED / Post FEED → DG3 ★ → Execution

September-2019

- Cost UA only
- Excel and @Risk - Periti
- Table of Building Elements
- Uncertainty Drivers and Cost Elements
- 16 participants 1 day workshop, re-iterated post FEED

Feed UA

March-2021

Org. Baseline

- Project Team
- Budget and Contingencies Price Indexed
- NO UA
- Budget back to WBS/CBS

October-2021

- Cost UA - Excel and @Risk - Advansia
- SRA- Safran Risk - pre-mitigated uncertainty levels only
- Based on WBS/CBS
- Uncertainty Drivers and Cost Elements
- 6 workshops ++
- Great Cost Increase

Baseline Rev01

Cost UA SRA

April-2022

Cost UA SRA

Baseline Rev02

- Cost UA Excel and @Risk - Advansia
- SRA - Safran Risk
- Uncertainty Drivers and Cost Elements
- 7 Workshops ++

★ 3 Audits

Project Framework – DnV
Budget and UA – Oslo Econ. And Atkins
Prj. Accounting - PwC

October-2022

- Project Team
- ISCRA – Safran Risk
- OPEX UA – COST
- Uncertainty Drivers
- Specific Risk impact
- 6 Workshops ++

Baseline Rev03

UA Report

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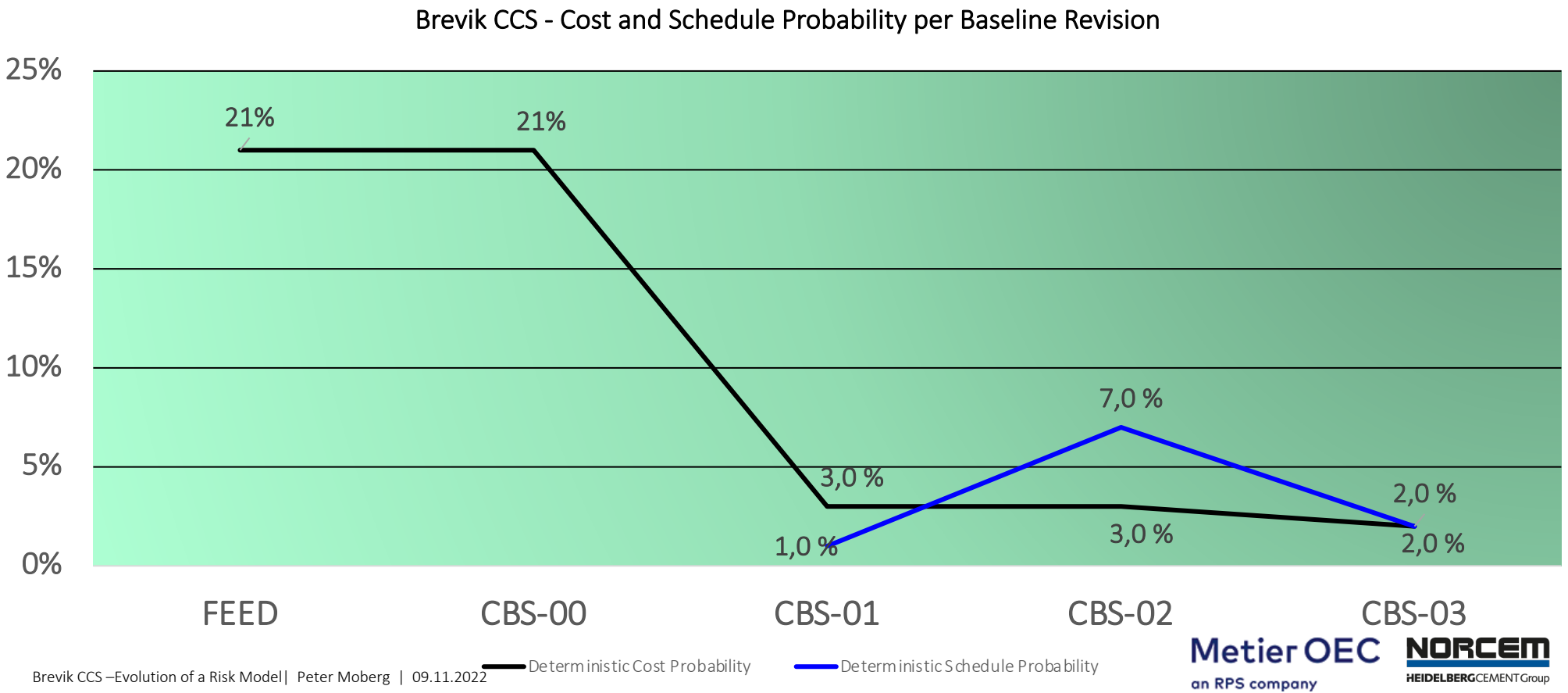
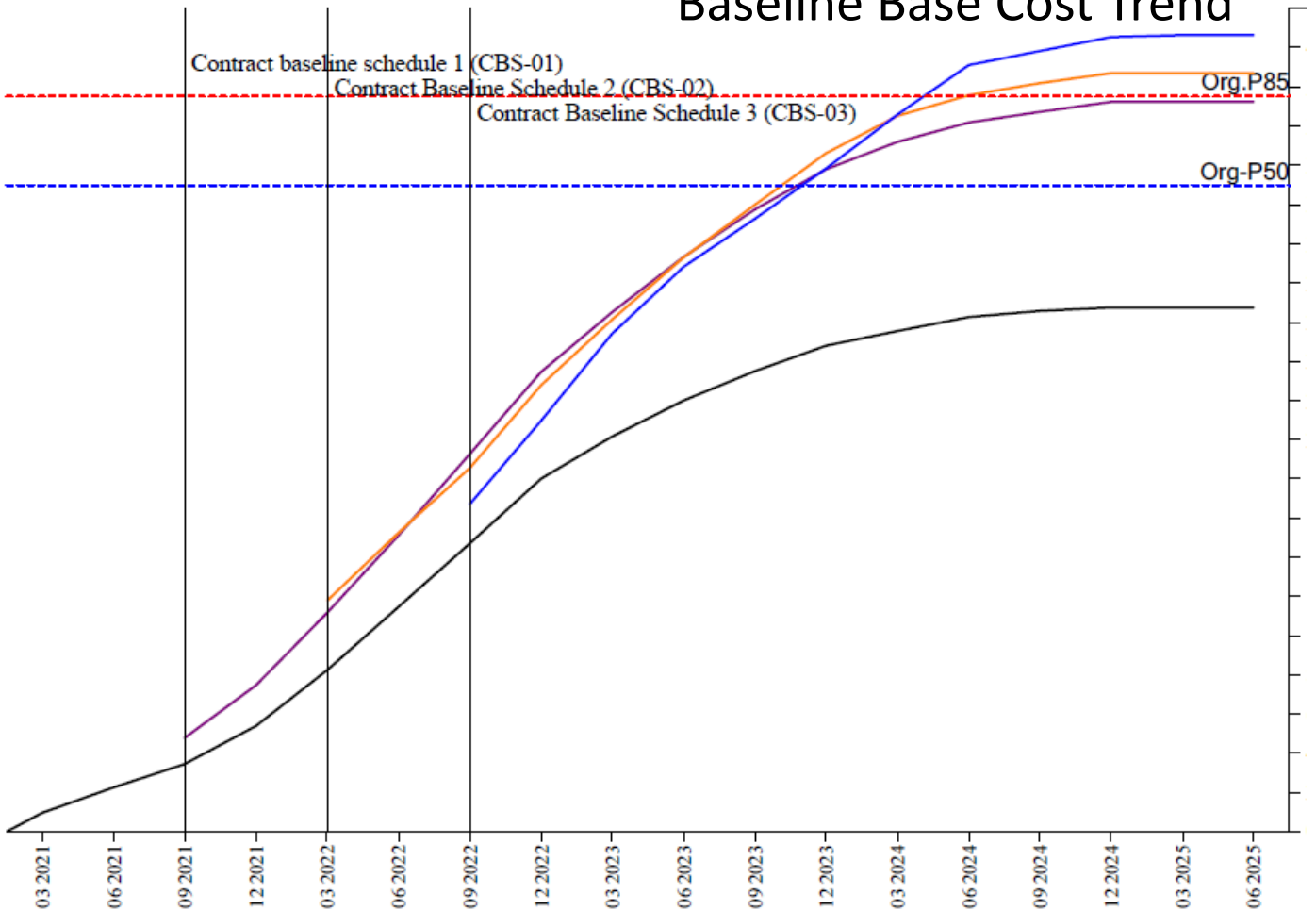
Brevik CCS – Baseline Revisions Timeline

Deterministic Probability



Baseline Base Cost Trend

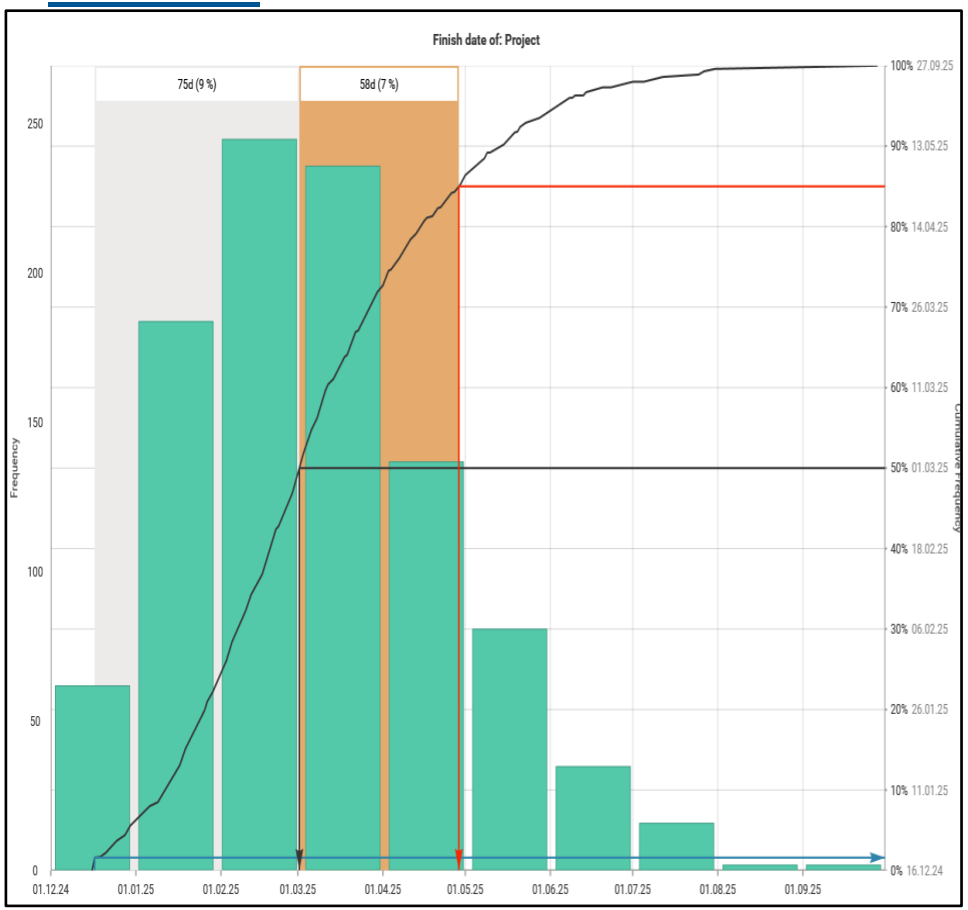


Between Org. Baseline and Baseline Rev 01 the Base Cost reached the org-P85

Brevik CCS – Schedule Risk Model

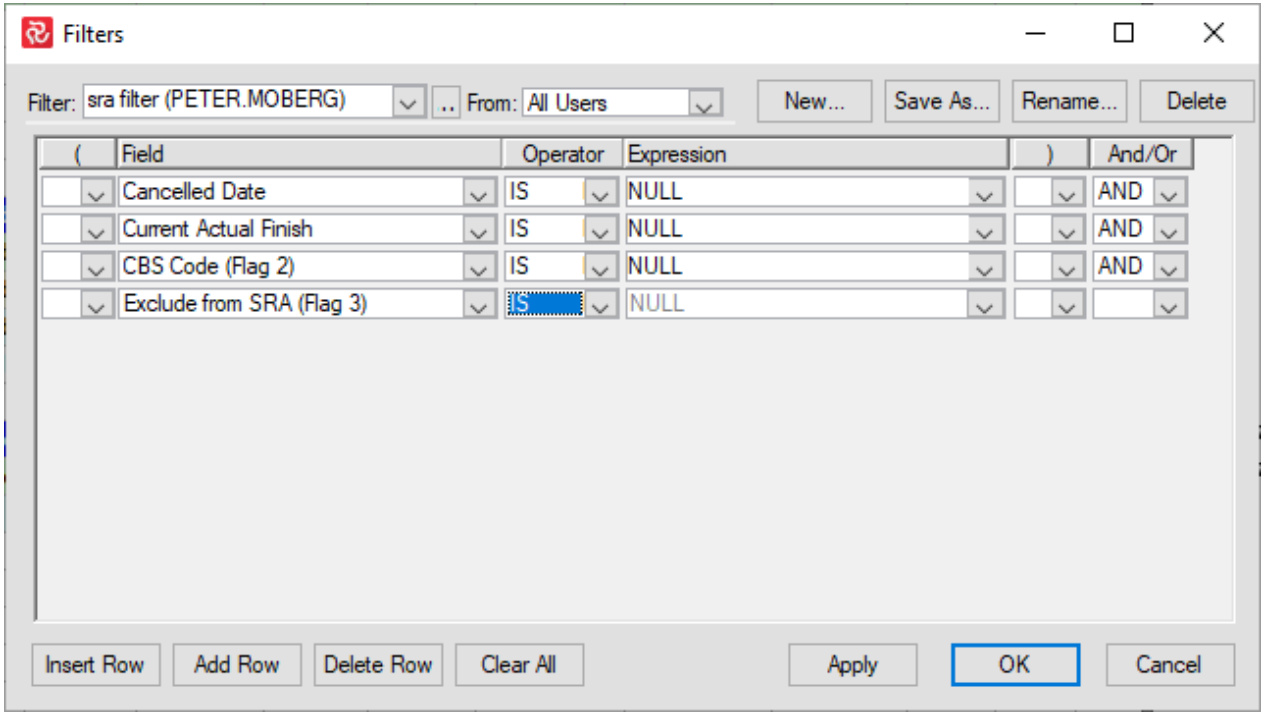
Schedule UA Model in Safran Risk

- Use the integrated project schedule as basis (NO separately created schedule just for SRA)
- Import from Safran Project with a filter that excludes non-relevant schedule data
  - Needs to contain only ongoing and future activities
  - Created Flag fields for easy exclusion
- Simplify the analysis by having the last Activity/Milestone on the Deterministic Finish date
- Use Hammocks to simplify simulations



Brevik CCS – UA Model

Schedule import to Safran Risk



Excluded Activities from Detail Schedule:

Cancelled Activities
Completed Activities
Management & Preliminary Activities
Year long activities
Engineering Follow On
Activities after point of interest for SRA

Created a filter to easy exclude these types of activities.

Key Challenges

Challenges – how to:

- Establish a common Understanding of Uncertainty Framework and terminology
- Transpose probability and consequence from a Qualitative Risk Register (RamRisk) to Quantitative Uncertainty Model (Safran Risk)
- Get reliable input on risk from Main Contractors – Very difficult if not included in contract, Difficult if included → Knowledge and capability to work systematically with uncertainty
- Deal with risk correlation
- Use Factors and Specific Risks
- Model prolongation of project duration and Costs (answer is ISCRA)
- Handle the need for tweaking the results – “We need less/more uncertainty”, “which number do you want.

Key Learning Points

Learning points:

- **Get your inputs right:** Schedule integrity, Cost Breakdown Structure, and the Risk register (impacts, relative/absolute)
  - Facilitate process and accommodate for collaboration across organizational boundaries.
- Process Lead and performing Workshops
- Communication of results – To team, to Project Director, to SteCo and Owner
  - What does it mean? What does the numbers mean.
- Spread of Contingency levels is arbitrary – Subjective after UA result – Who needs how much.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Projects - Shaping the future!

Questions?