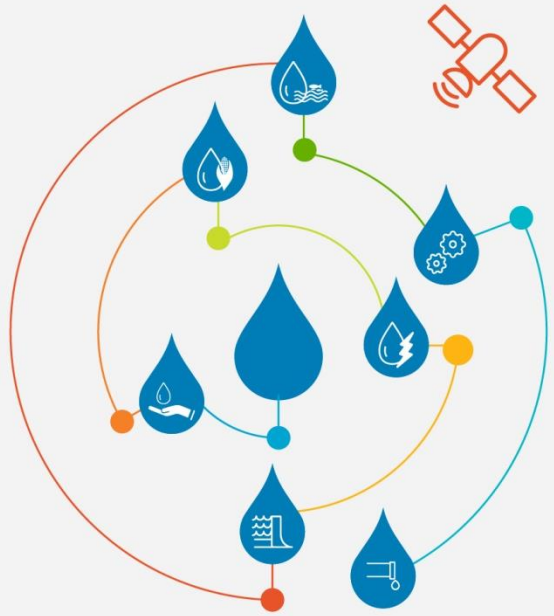
Developing Bankable Hydropower Projects – Techno-Economic Optimization through Bottom-Up Monte Carlo Simulations



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AWF 2018, 3. October 2018

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- RENRisk™: A holistic approach to Project Development based on the Monte Carlo Method
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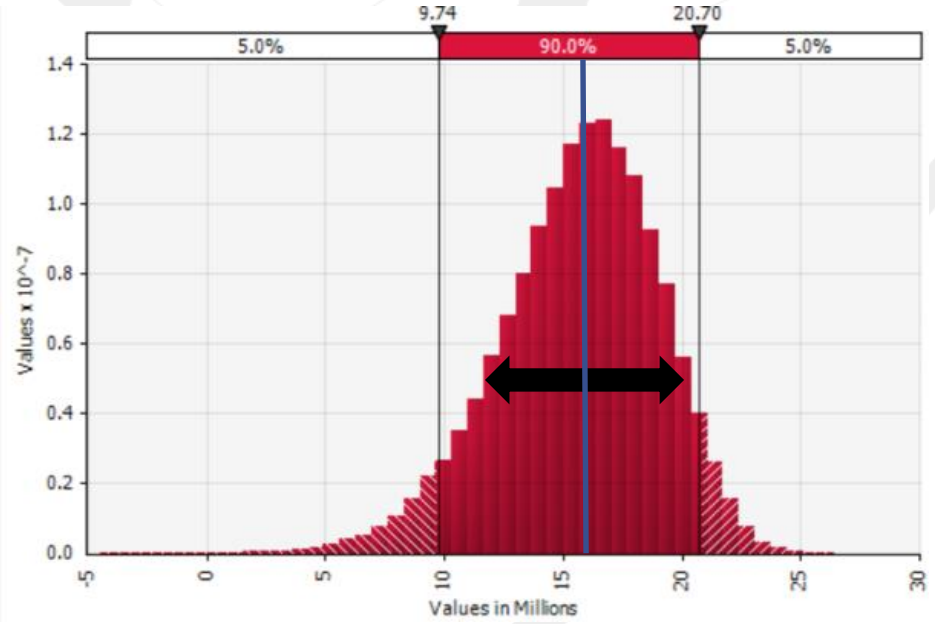

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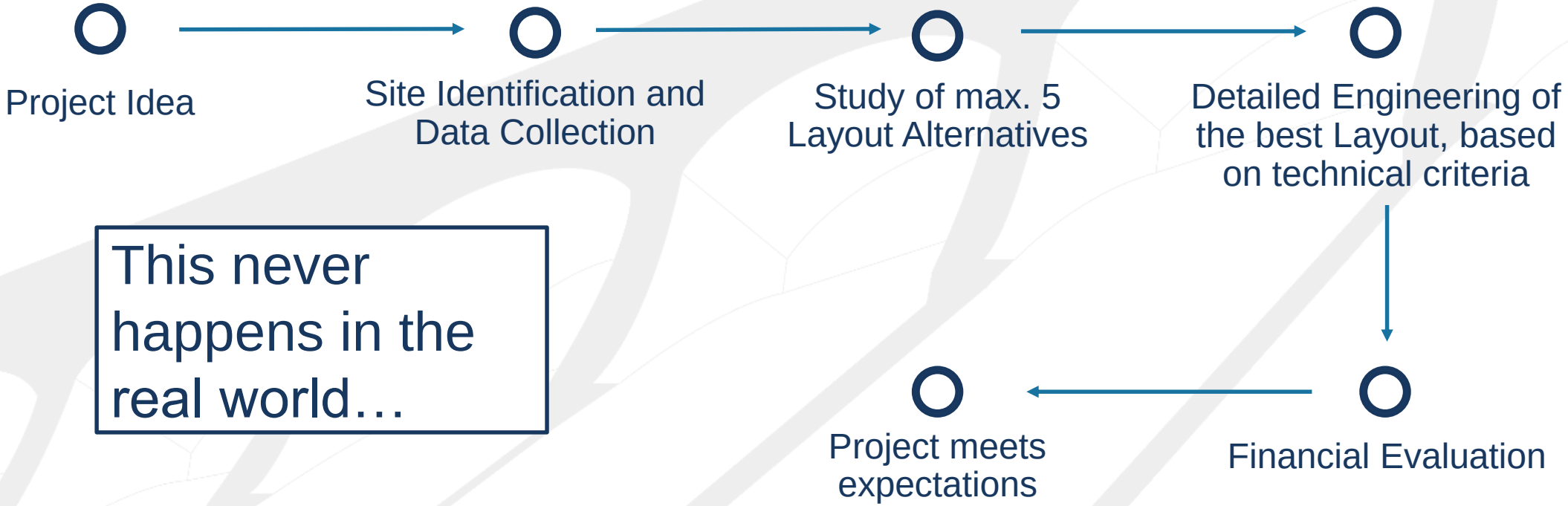
Project Development: The Ideal World

Project Development is a time and cost **efficient straight-forward Process**.



This never happens in the real world…

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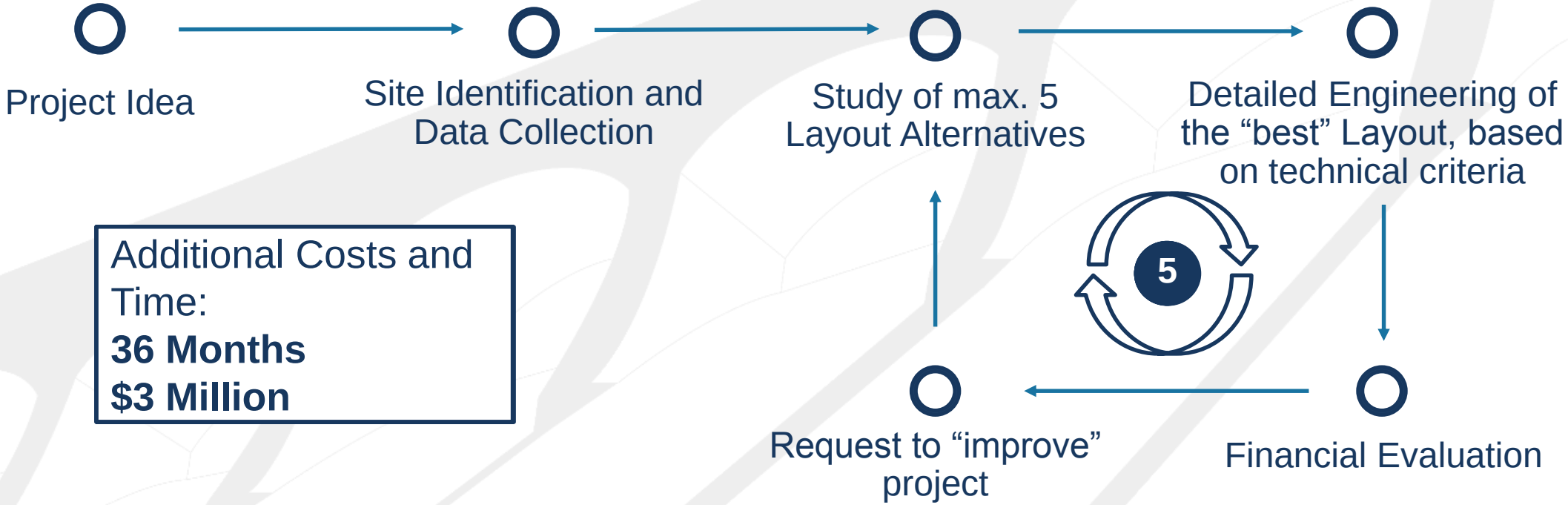
Project Development: The Reality

Standard Project Development is a time and cost intensive **Trial-and-Error Process.**



Additional Costs and Time:
36 Months
$3 Million

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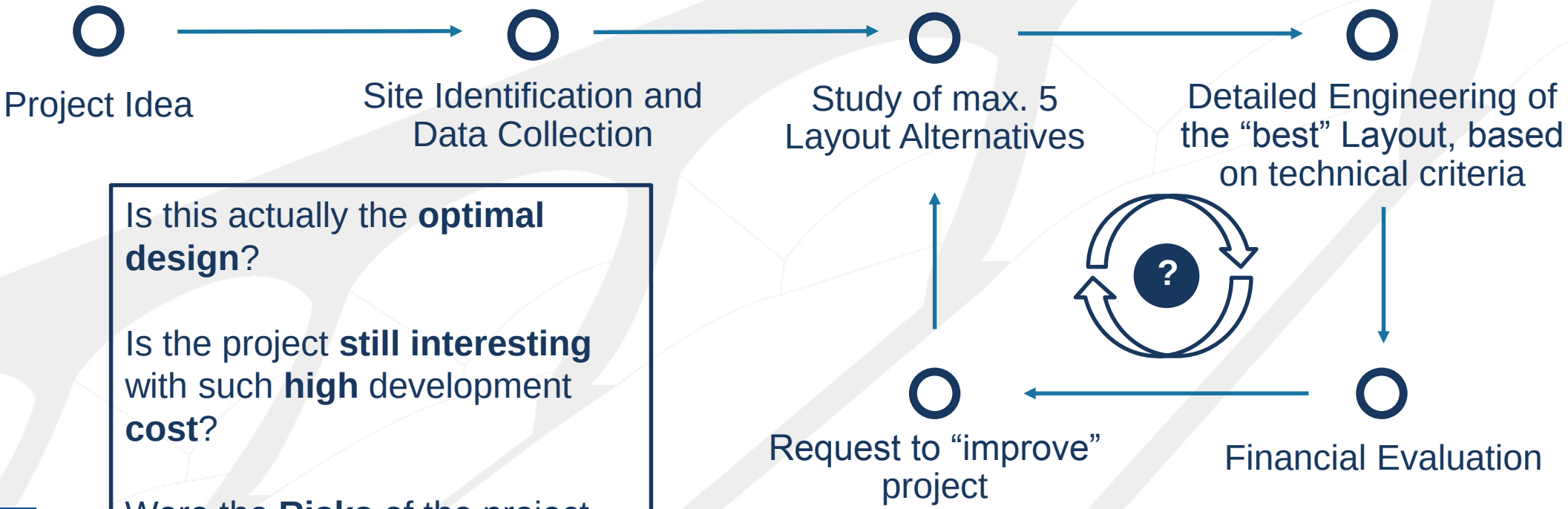
Project Development: The Reality

Uncertainty: Will this **costly** Process deliver **the best** Project?



Is this actually the **optimal design**?

Is the project **still interesting** with such **high** development **cost**?

Were the **Risks** of the project assessed properly?

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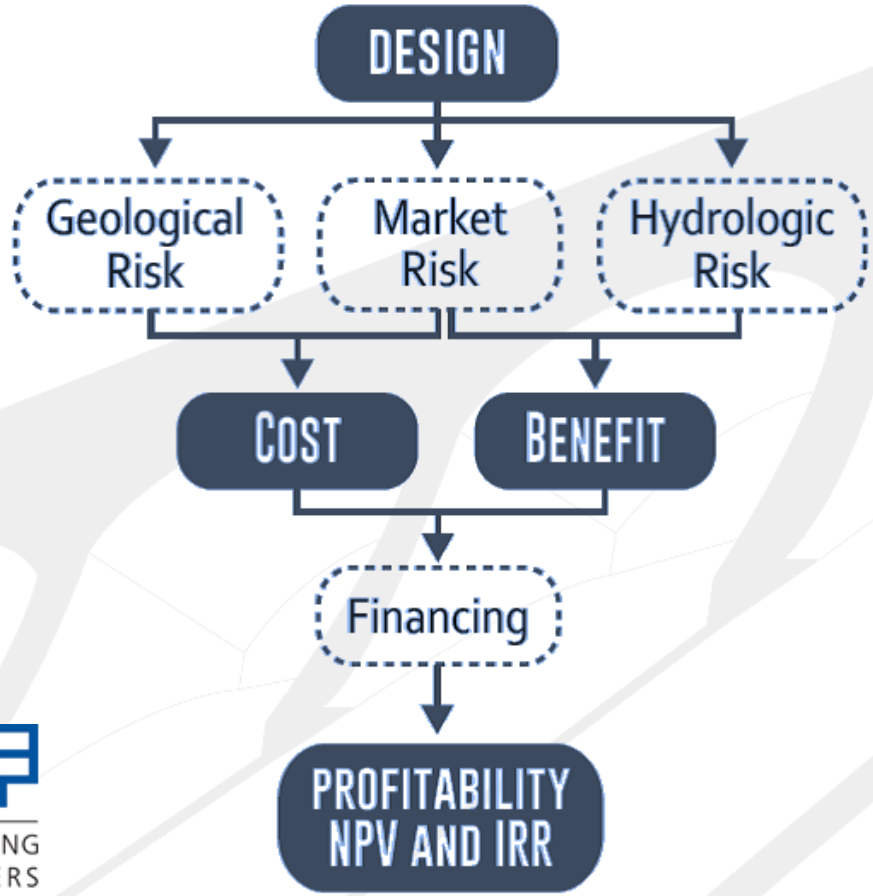
REN Risk: A Holistic Approach to Project Development

Software-based Analysis of **Engineering** Design focused on Economic **Performance** and **Risk**.



The **impact** of each engineering choice on the project's **Economic Risk and Return** is considered from the outset

The technical option that best meets **the return expectations & risk aptitude** of the developer can be identified in a straight-forward manner

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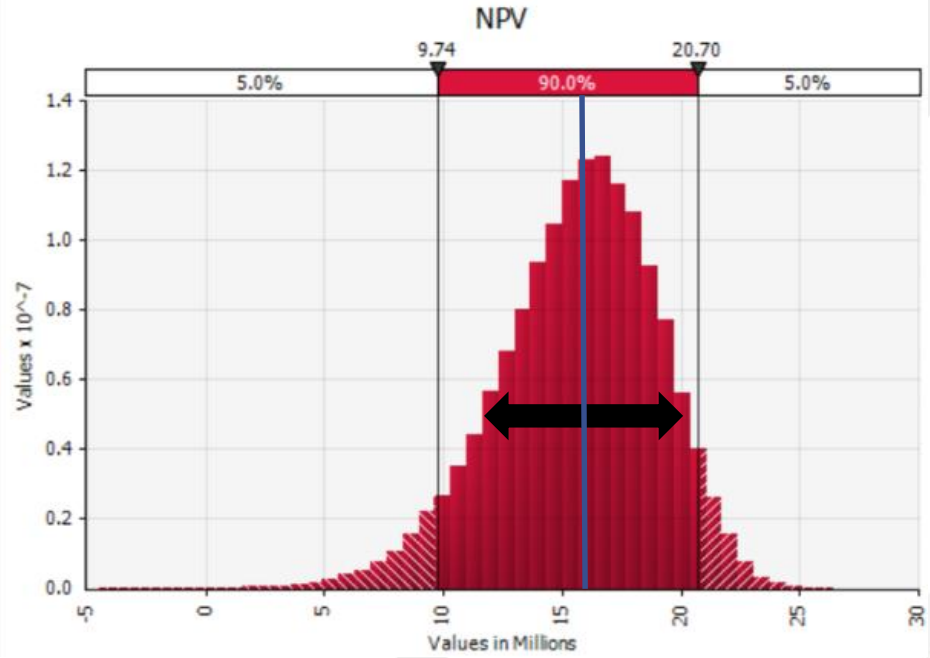
Risk Assessment with Monte Carlo Simulations

Quantification of Economic Risks: A **probabilistic** approach.

Monte Carlo Analysis

- **Thousands of input variable scenarios**
- Results are plotted as **probability distributions** to show **expected values** and **variance**
- Other indicators to quantify risk available such as **skewness, kurtosis** and **confidence intervals**

Standard evaluations neglect the **variability of outcomes:** What is the **Risk** associated with a certain **Return**?



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Top-Down Approach to Probabilistic Modelling

Make assumptions about the probability distribution of financial model input variables.

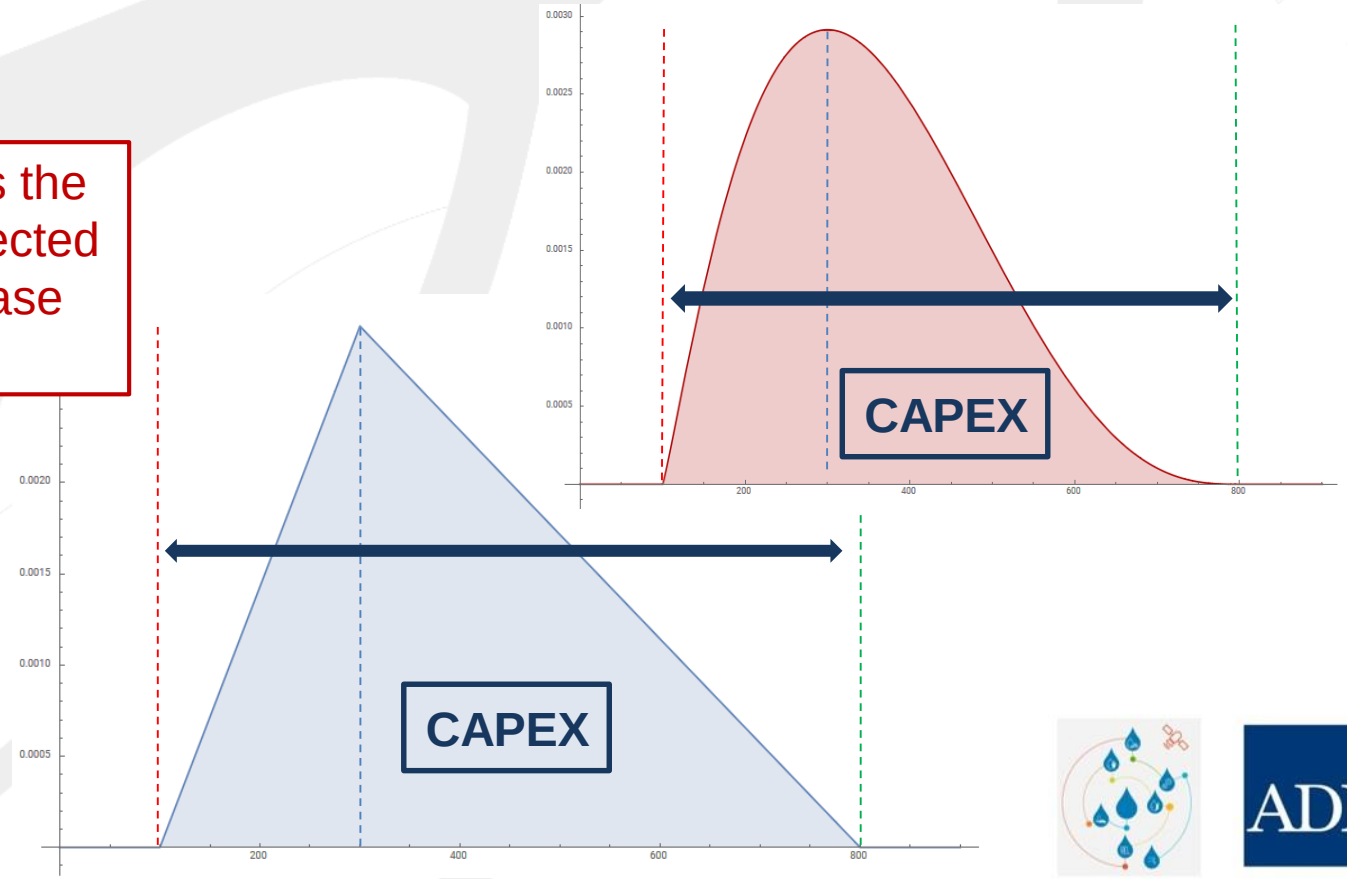
Common Steps:

1) Identify **Worst, Expected** and **Best-Case scenario**

2) Choose a **probability distribution** that **fits** these scenarios

But **what** is the worst, expected and best case scenario?

Which distribution?



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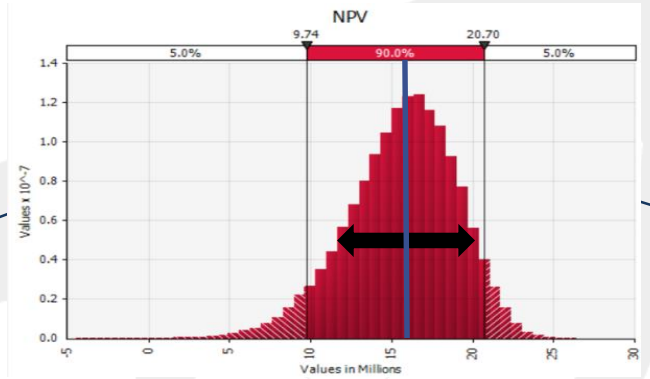
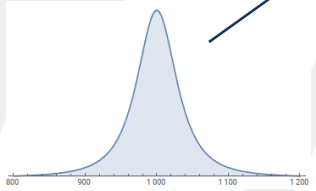
Bottom-Up Approach to Probabilistic Modelling

Model the **lowest possible level** of input variables to compute **project returns** from **verifiable assumptions**.

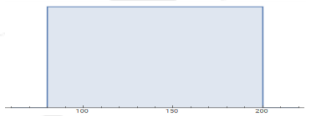


Income

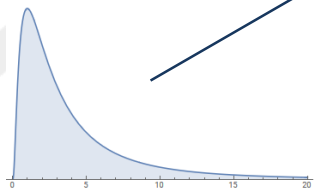
CAPEX



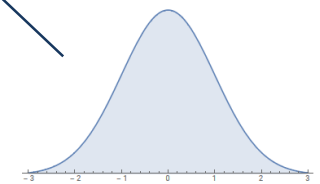
Energy Production



Tariffs



Construction Time



Geological Risk

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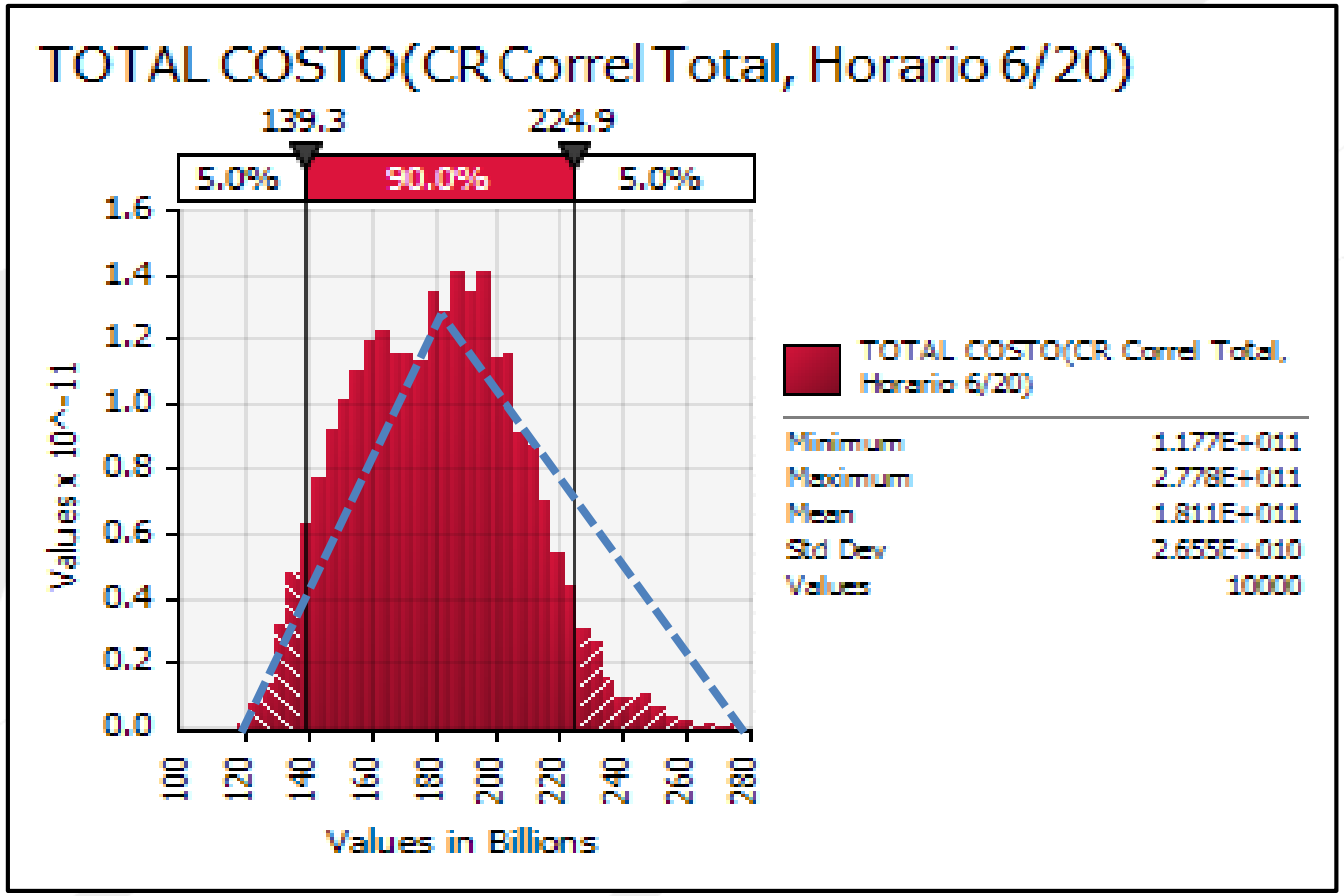
Case Study: Risk Analysis of a 1000 MW Hydropower Plant

Bottom-Up Modeling

- Explicit modeling of **construction quantities, unit prices**
- Capture the impact of real cost drivers rather than assuming it

Top-Down Approach always over- or underestimates the probability of certain scenarios.

What is the value of an analysis where the result is actually an assumption?



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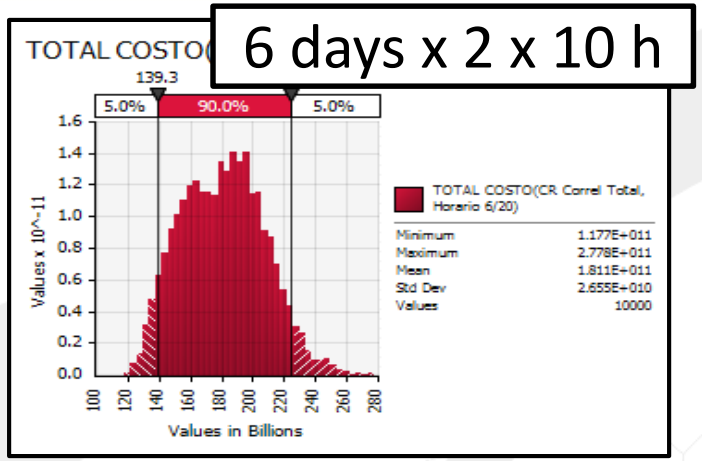
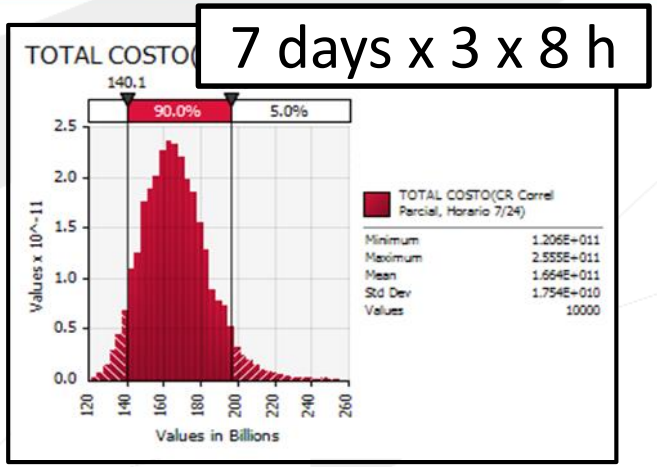
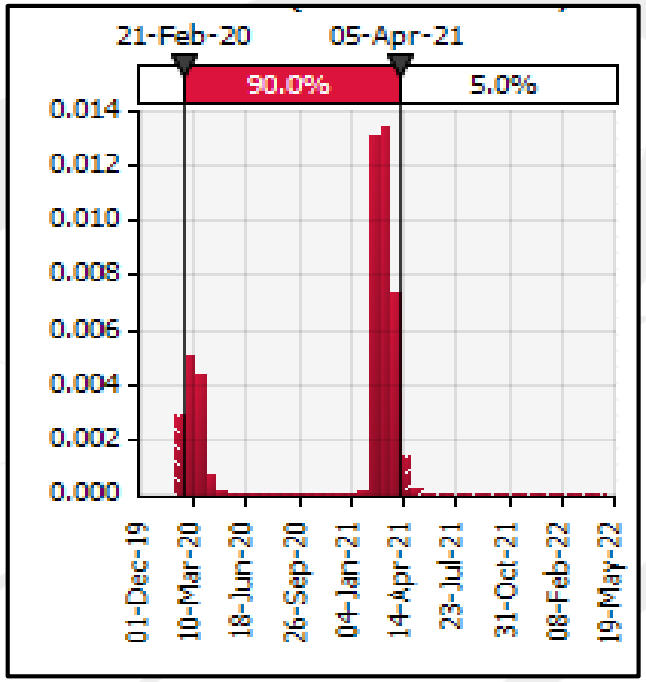
Case Study: Risk Analysis of a 1000 MW Hydropower Plant

Bottom-Up Modeling

- Explicit modeling of **construction schedule depending on quantities and advance rates**
- Capture the impact of real construction time drivers rather than assuming it







- **Bimodal distribution** of construction period due to rainy season depends on work shifts and impacts total costs!

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Conclusion

- Project Development can be straight-forward if a holistic rather than a sequential approach is taken.
- Probabilistic Risk analysis based on the Monte Carlo method is a powerful tool for the investment decision making process.
- The Top-Down Modelling Approach often leads to erroneous conclusions and bad investment decisions.
- The Bottom-Up Modelling Approach allows capturing the full complexity of energy projects and enables truly sound investment decisions.

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Questions? Thank You!

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