EEnvest

FINAL CONFERENCE

Technical/financial derisking model approach

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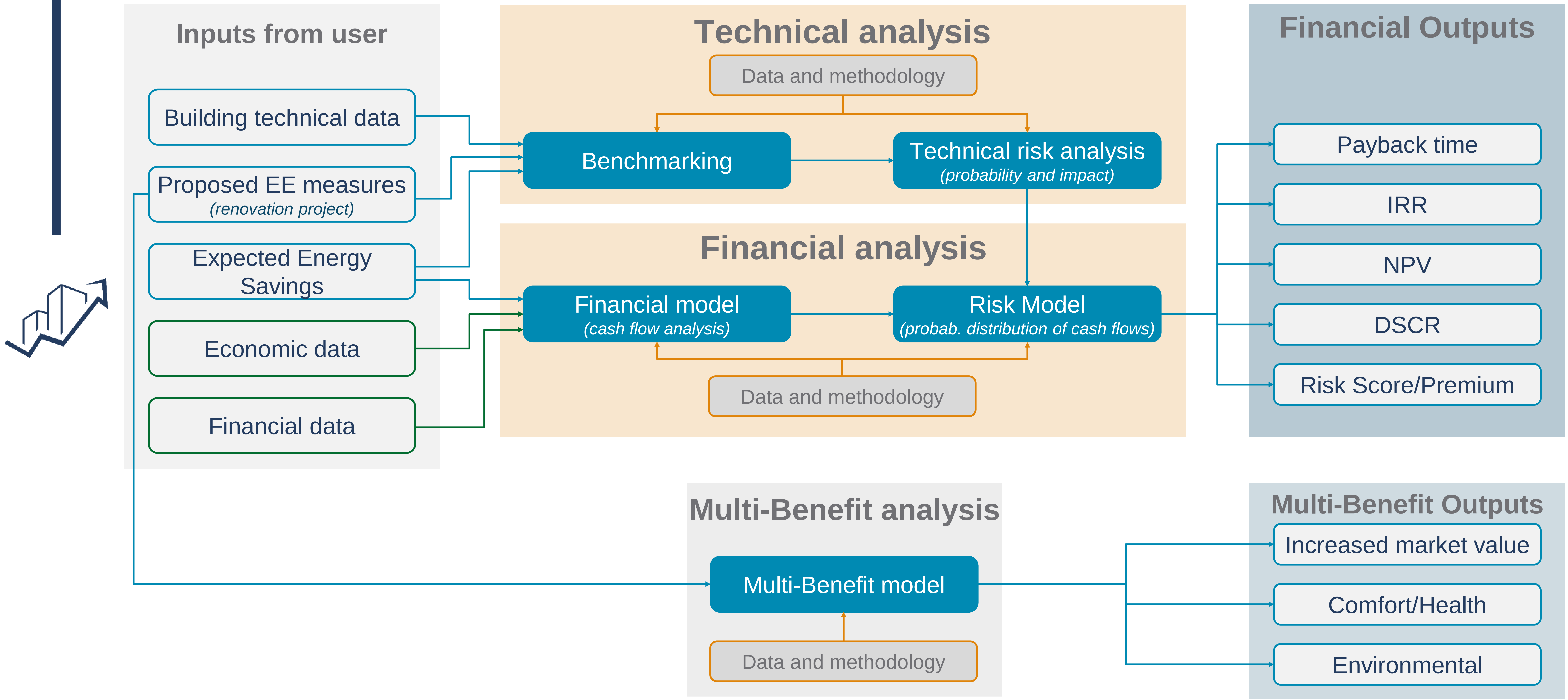
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 833112

The Framework



Technical Risk Database

Building elements (macro areas) → Energy renovation measures → Occurrences (causa-effects): impacts and probability → Mitigation Measures (Correction factors) → Outputs: technical risk ➔ economic inputs for the financing scheme

Building

- Commercial office buildings

Building elements (macro areas)

- Envelope
- Technical systems, including the RES

Renovation measures:

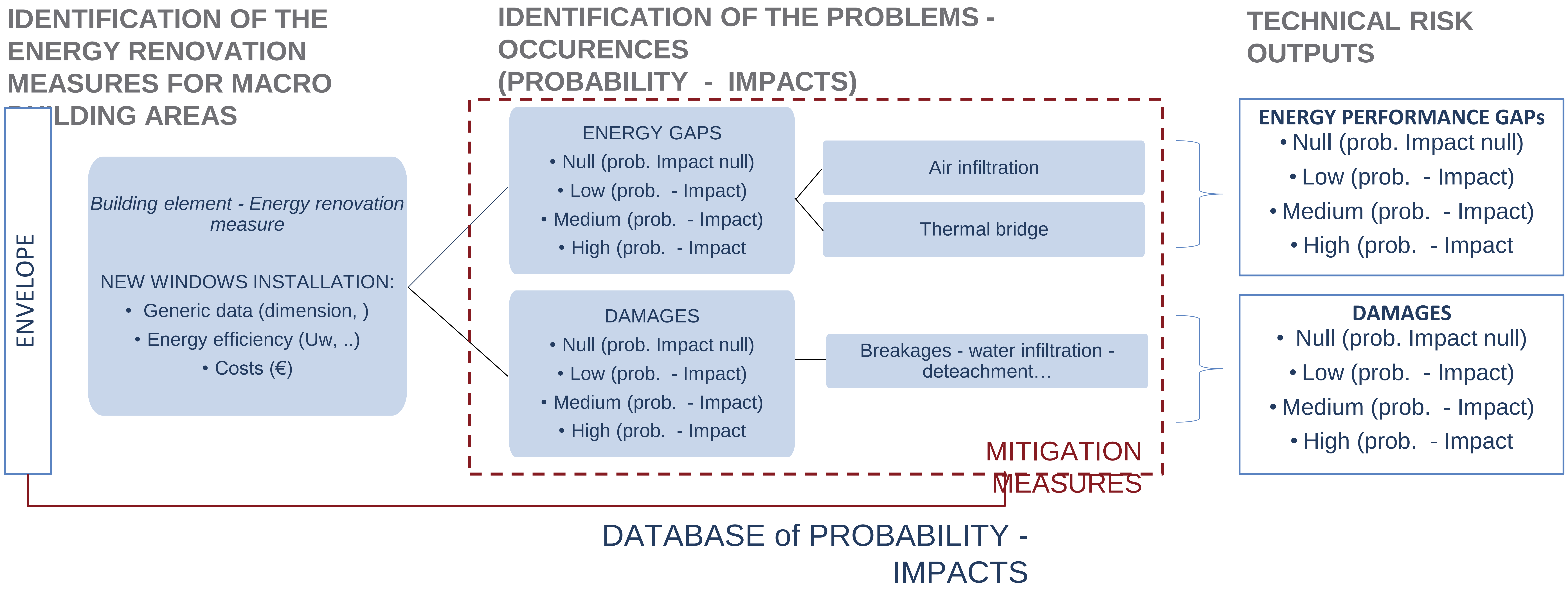
- Identification of technical risks – events/problems/occurrences
- Mitigation measure

Output technical risk, economic inputs:

- Energy performance gap
- Damages

Source: eurac research, POLITECNICO MILANO 1863

Technical Risk Database



Source: eurac research POLITECNICO MILANO 1863

Technical Risk Database

Source: eurac research, POLITECNICO MILANO 1863

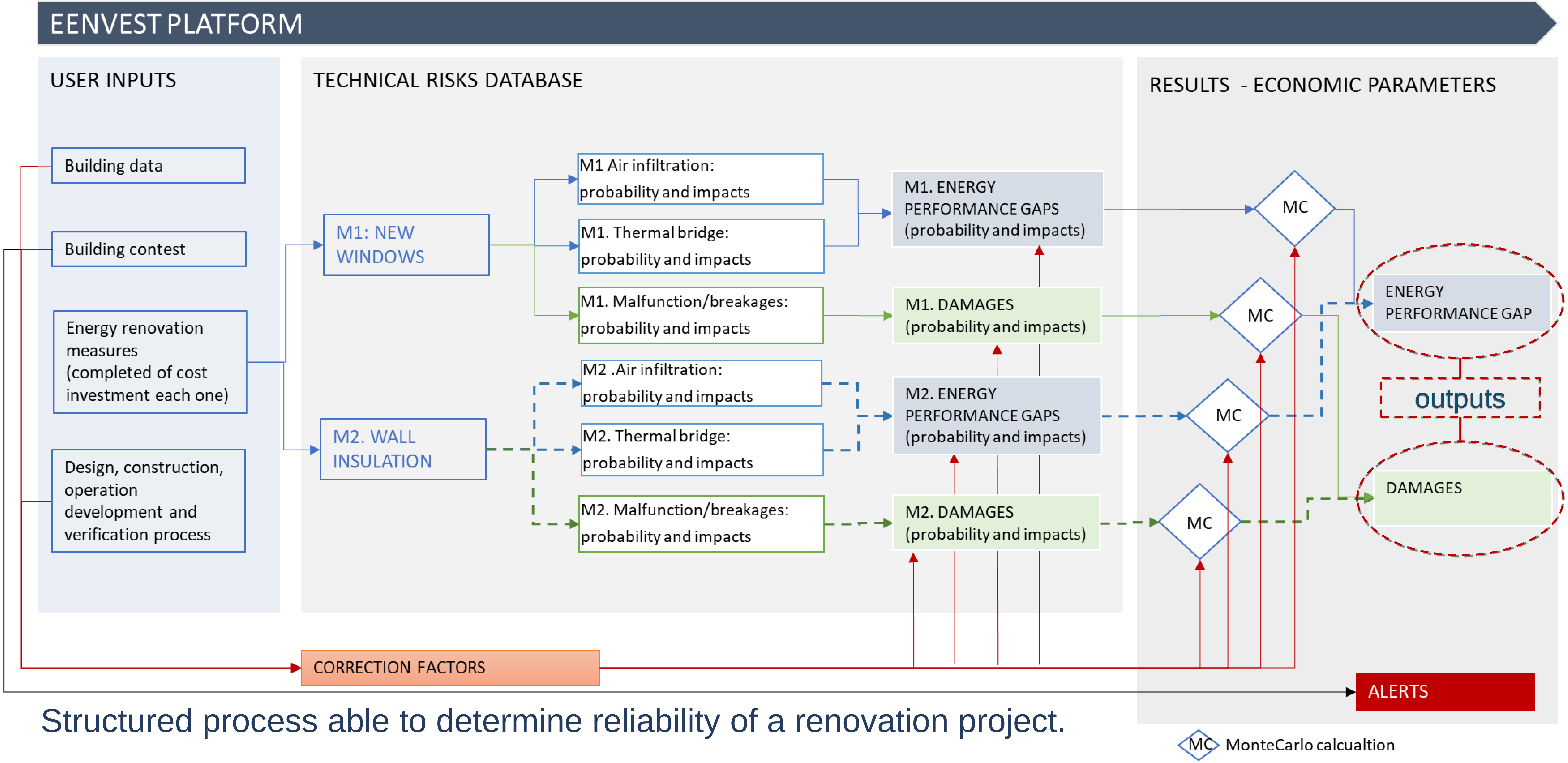
DATABASE of OCCURENCES (probability – impacts)

WINDOWS		ENERGY PERFORMANCE GAPS							
		NULL		LOW		MEDIUM		HIGH	
		PROB	IMPACT	PROB	IMPACT	PROB	IMPACT	PROB	IMPACT
AIR INFILTRATION	WINDOW FRAME	97,00	0,00	0,012	0,75%	0,024	1,50%	0,048	0,75%
	COMPONENT'S CONNECTION	96,50	0,00	0,002	0,88%	0,006	1,75%	0,012	0,88%
	MANUFACTURING	99,25	0,00	0,024	0,38%	0,060	0,19%	0,121	0,19%
THERMAL BRIDGE	WINDOW FRAME	92,50	0,00	0,017	1,88%	0,059	3,75%	0,168	1,88%
	COMPONENT'S CONNECTION	92,50	0,00	0,010	1,88%	0,038	1,88%	0,057	3,75%

WINDOWS		DAMAGE							
		NULL		LOW		MEDIUM		HIGH	
		PROB	IMPACT	PROB	IMPACT	PROB	IMPACT	PROB	IMPACT
WATER INFILTRATION	WINDOW FRAME	0,00	96,40	40%	30%	60%	55%	80%	15%
GLASS BREAKAGES	GLASS	0,00	99,60					90%	0,40%
AUTOMATIC CONTROL SYSTEM	WINDOW SENSOR	0,00	98,40			CAL	2%		
	ACTUATOR	0,00	98,40	CAL	50%			CAL	50%
	METEO STATION	0,00	98,40	100 €	50%			500€	50%

Technical Risk Calculation

Source: eurac research, POLITECNICO MILANO 1863



Structured process able to determine reliability of a renovation project.

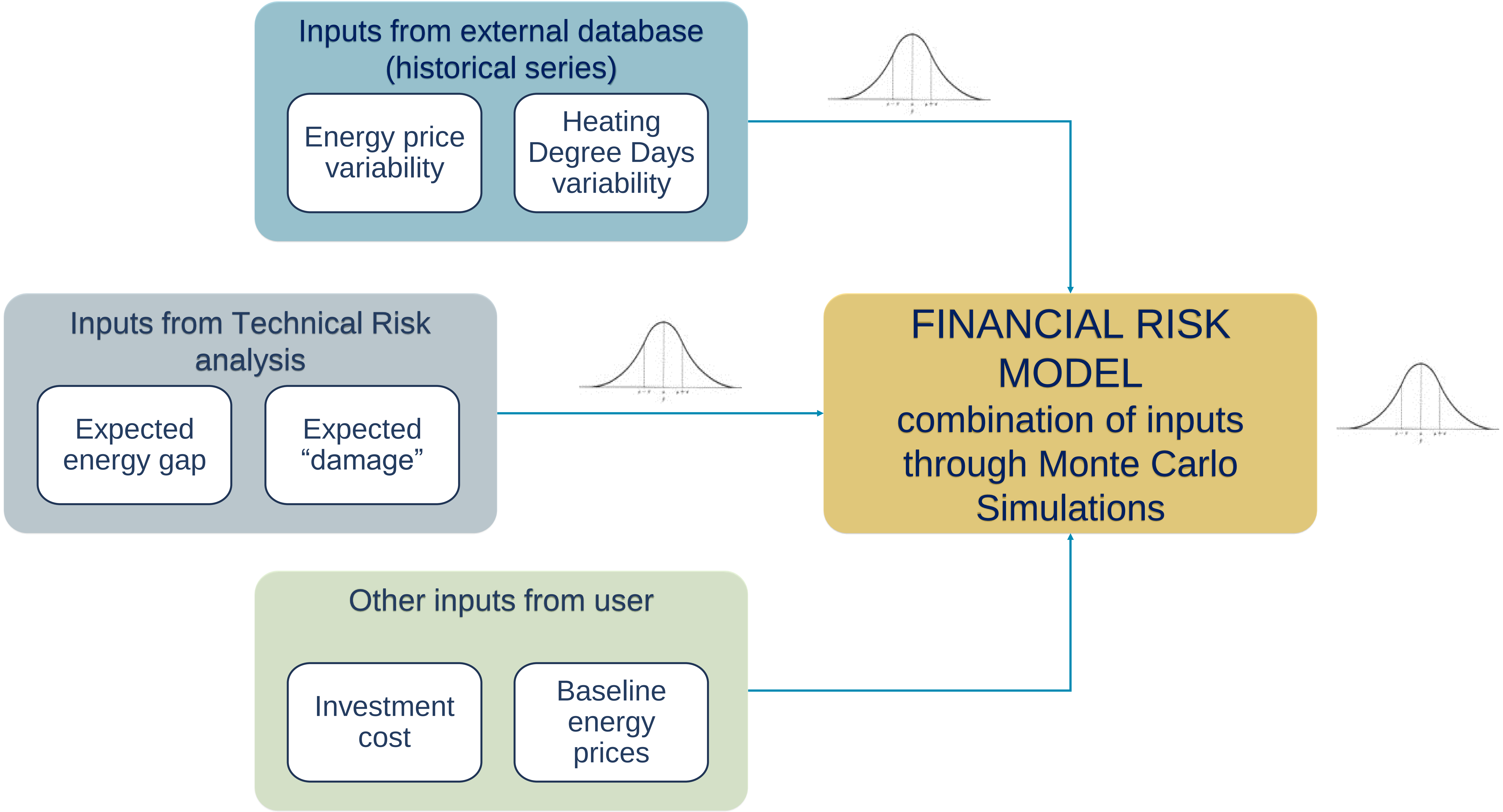
Energy and economic data input

To be uploaded by the project owner/promoter

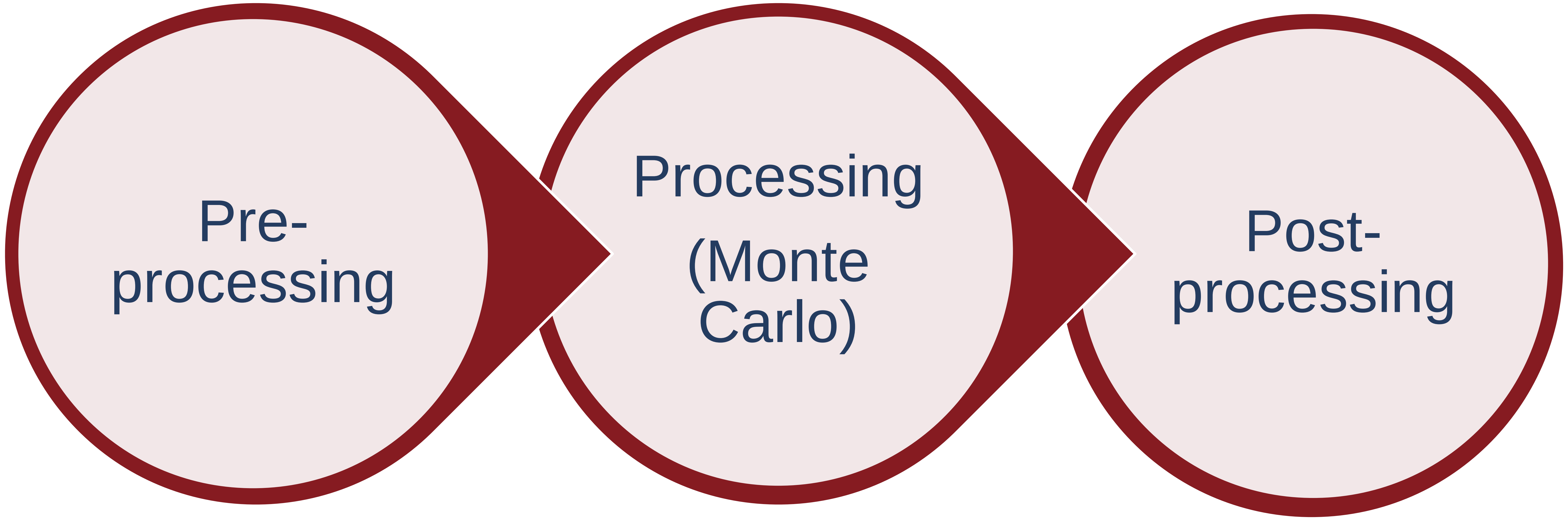
BASELINE ENERGY CONSUMPTION AND COSTS			
Fuel source	Natural gas		470.528,26
Consumption of pre-selcted fuel	1.468.243,00	kWh/a	*It is the average annual energy consumption of natural gas of the last 3 years*
Price pre-selcted fuel	0,03	€/kWh	*It is the average cost of preselected fuel of the last 3 years*
Baseline preselected fuel expenditure	49.920,26	€	*It is the average historical expenditure of preselected fuel for the last 3 years, that will be used to calculate the economic convenienve of the energy efficiency investment*
Consumption of electricity	3.286.000,00	kWh/a	*It is the average annual energy consumption of electricity of the last 3 years. In case of existing renewable energy plants (i.e. PV) or cogeneration plants, don't include self-production but only consider the energy bought from the grid*
Electricity price	0,13	€/kWh	*It is the average cost of electricity of the last 3 years*
Baseline electricity expenditure	420.608,00	€	*It is the average historical expenditure of electricity for the last 3 years, that will be used to calculate the economic convenience of the energy efficiency investment*
Electricity used for heating	Yes		*If the heating system is fueled by electricity, flag "yes"*
If yes to the above, average % of total electric energy consumption due to heating		%	*If electricity is also used for heating (case of electric heat pumps), include the estimate of the percentage of electricity bought from the grid and used for heating.*
O&M cost		€	*It is the average cost for operation and maintenance of the last 3 years. The maintenance program contract is exc*
Tot. O&M cost	316.162,61	€	Total cost of maintenance: contracts + operations + replaced/substituted materials

POST-RENOVATION ENERGY CONSUMPTION AND COSTS			
Fuel source	Natural gas		64268,26 231168,00 295436,26
Consumption of pre-selcted fuel	1.890.243,00	kWh/a	*It is the expected annual energy consumption of preselected fuel after the renovation*
Price pre-selcted fuel	0,03	€/kWh	
Consumption of electricity (excl. RES)	1.806.000,00	kWh/a	*It is the expected annual energy consumption of electricity after the renovation (without considering RES production or production from cogeneration plants, thus only considering the energy bought from the grid)*
Electricity used for heating	Yes		*If the heating system will be fueled by electricity after the renovation, flag "yes"*
If yes to the above, average % of total electric energy consumption due to heating		%	*If electricity will be used for heating (case of electric heat pumps), include the estimate of the percentage of electricity bought from the grid and used for heating*
O&M cost		€	*It is the expected cost for operation and maintenance after the renovation. Excluded the maintenance program co*
Tot. O&M cost	316.162,61	€	It is the expected cost for operation and maintenance after the renovation: contracts + operations + replaced/subs

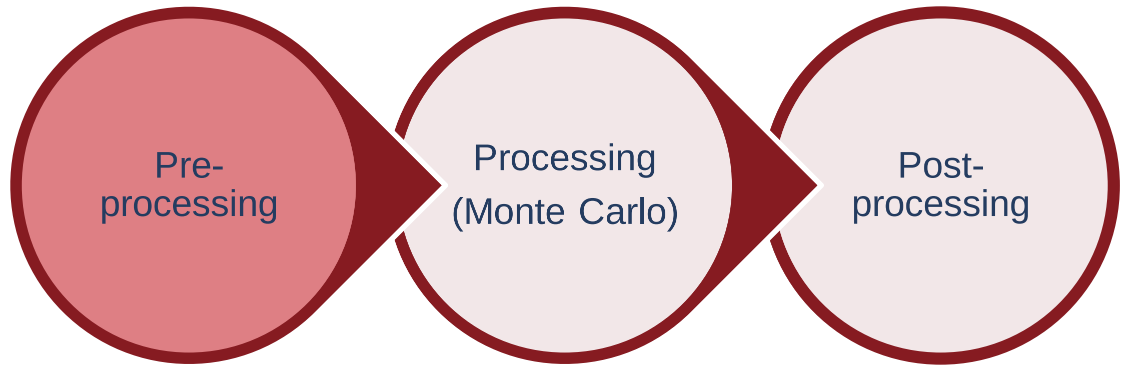
Financial Risk Calculation



Financial Risk Calculation Process



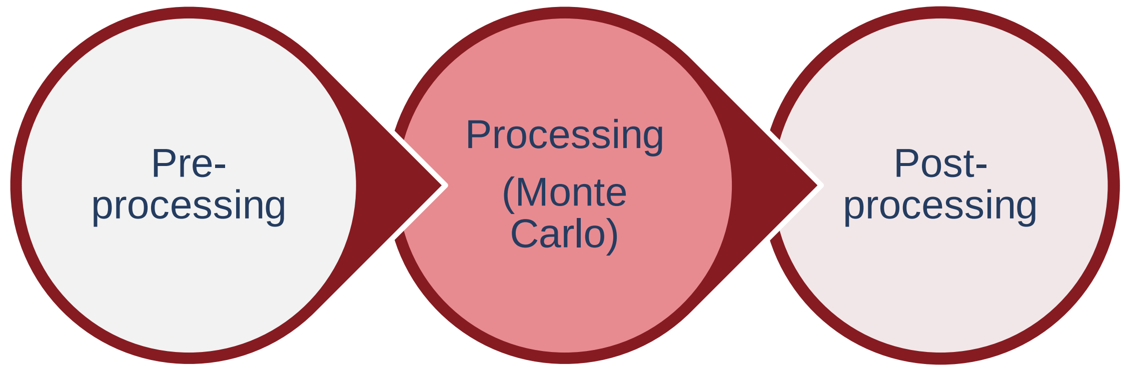
Data Pre-Processing



- Check the consistency of data
- Prepare the data in the format required by the Monte Carlo simulation

- **Distributions of Expected Damage**
  - select relevant table (with/without mitigation factors)
  - from Euro amount to % of Investment
  - multiply for sqm if needed
- **Distributions of Expected Energy Gap (Thermal and Electricity)**
  - select relevant table (with/without mitigation factors)
  - transform to Kwh if needed
  - multiply for sqm if needed
- **Distribution of Gas (G) and Electricity (E) prices**
  - from historical series of prices to series of returns (G+E)
  - calculate mean and variance (G+E)
  - find the correlation btw G and E
- **Distribution of the Climatic factor (HDD)**
  - select the historical series according to location of the building
  - calculate mean and variance

Data Processing



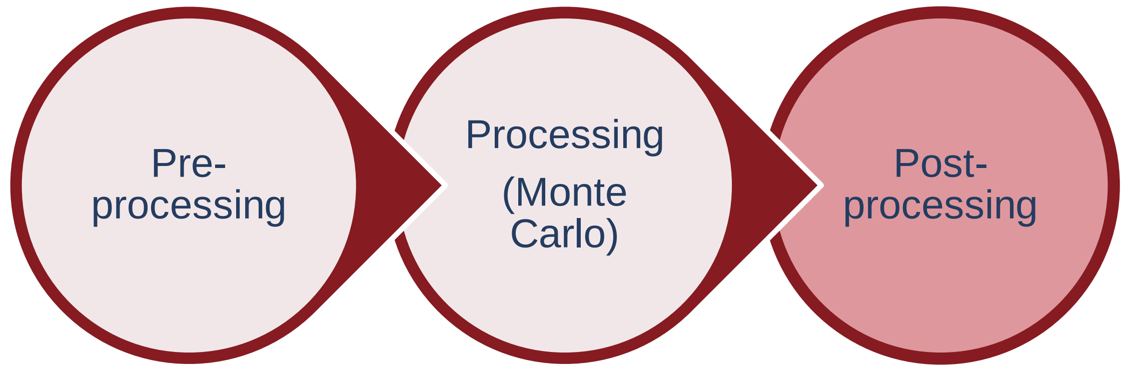
- Run the Monte Carlo simulation
- Combine data from different sources
- Generate Simulated Cash Flow

For each step of the Monte Carlo Simulation

- **Simulate the Expected Value of Damage**
  - extracted randomly from the discrete distribution
- **Simulate the Expected Value of Energy Gap**
  - extracted randomly from the discrete distribution
- **Simulate the Expected Value of Energy Prices**
  - according to Normal Distribution using mean and variance of hist. data
  - apply the simulated price variation to the reference starting price
- **Simulate the Expected Value of HDD (Heating Degree Days)**
  - according to Normal Distribution using mean and variance of hist. data
  - rescale HDD to Average Season HDD to get an Adjustment Factor (HDD)
- **Calculate the Expected Cash Value of Energy Saving (CashFlow)**
  - combine all simulated values according to the formula below

CashFlow = ExpEnergySaving * EnergyPrice * (1 – EnergyGap) * HDD – Investment * Damage

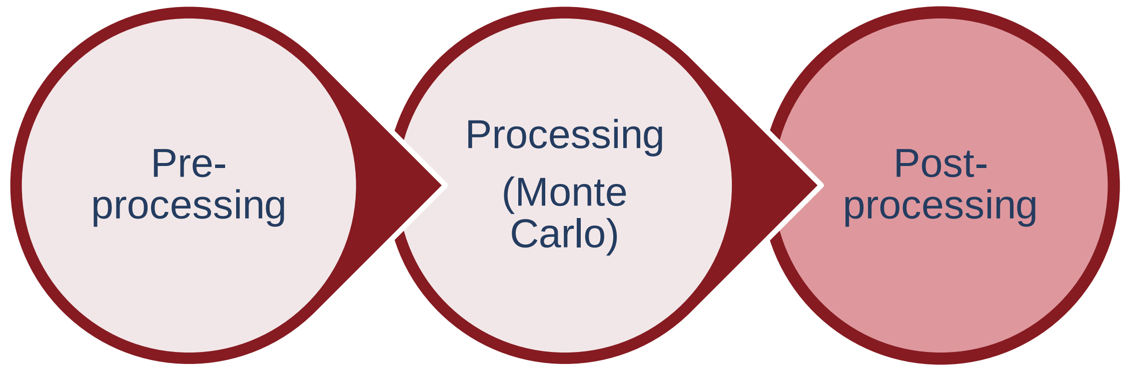
Post-Processing



- From simulated values to model outputs
- Use simulation values combined with other financial data

- **Draw the Distributions of Revenues**
  - find appropriate bins
  - find frequency for each bin based on simulated Revenues
- **Draw the Distribution of Payback Time**
  - find appropriate bins
  - transform Revenues to Payback times (Revenues/Investment)
  - find frequency for each bin based on simulated Payback times
- **Draw the Distribution of Project IRR (and NPV)**
  - for each Bin, generate Cash Flows according to Project expected duration
  - use Cash Flows and Investment to find Project IRR for each Bin
  - use probability of each Bin to find Distribution of Project IRR
- **Draw the Distribution of Equity IRR (and NPV)**
  - generate Debt Repayment Instalment stream according to loan amount, loan duration and interest rate
  - deduct the Debt Repayment Instalment from Project Cash Flows to find the Equity Cash Flows
  - use Equity Cash Flows and Investment to find Equity IRR for each Bin
  - use probability of each Bin to find Distribution of Equity IRR
- **Draw the Distribution of DSCR**
  - ratio btw Cash Flow and Debt Repayment Instalment
  - use probability of each Bin to find Distribution of DSCR

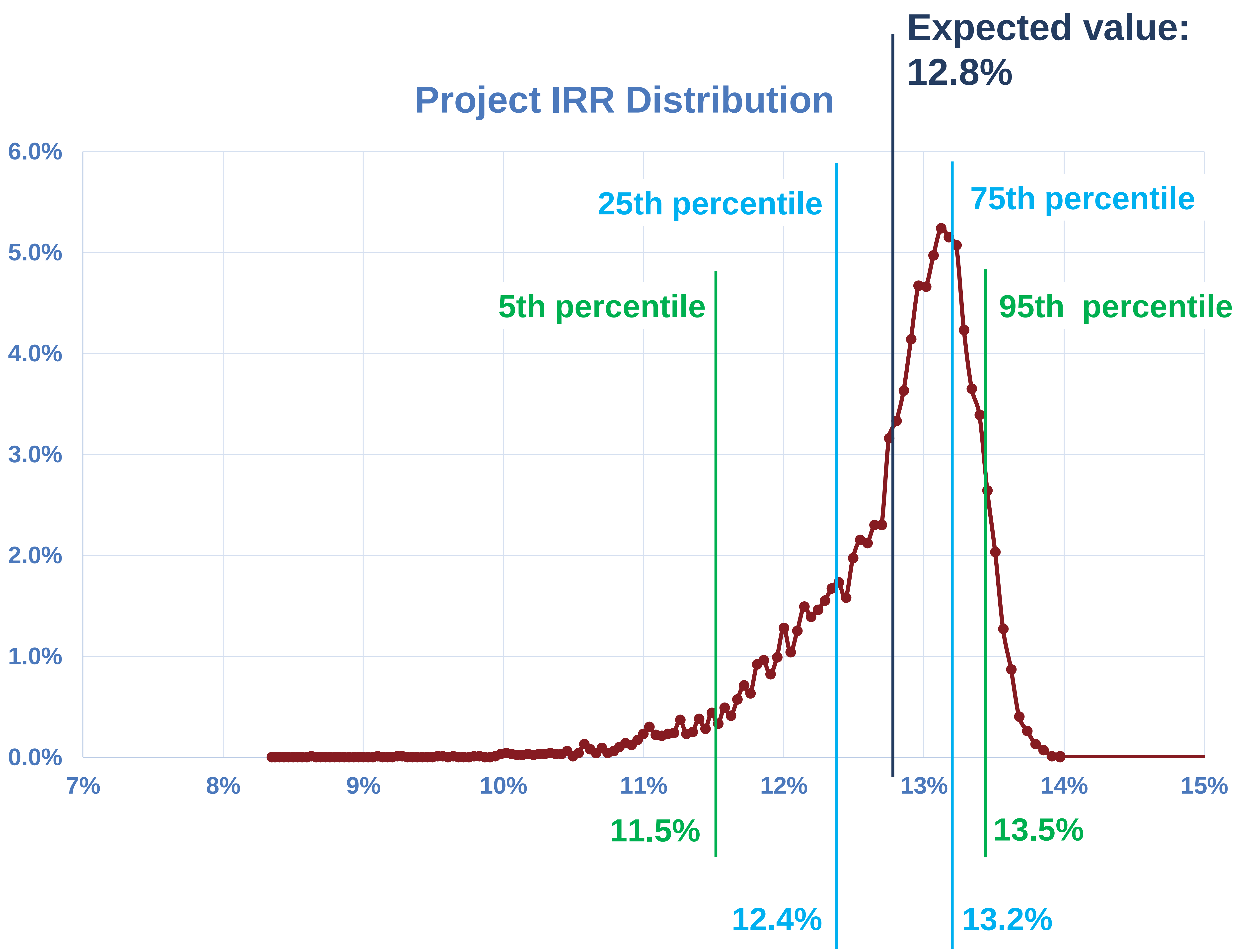
Post-Processing



- The importance of knowing theprobability distribution of IRR (and KPIs in general)

- Understanding the technical and financial riskiness of the project

- According to certain confidence intervals, the probability of the outcome to be within two percentiles of the distribution



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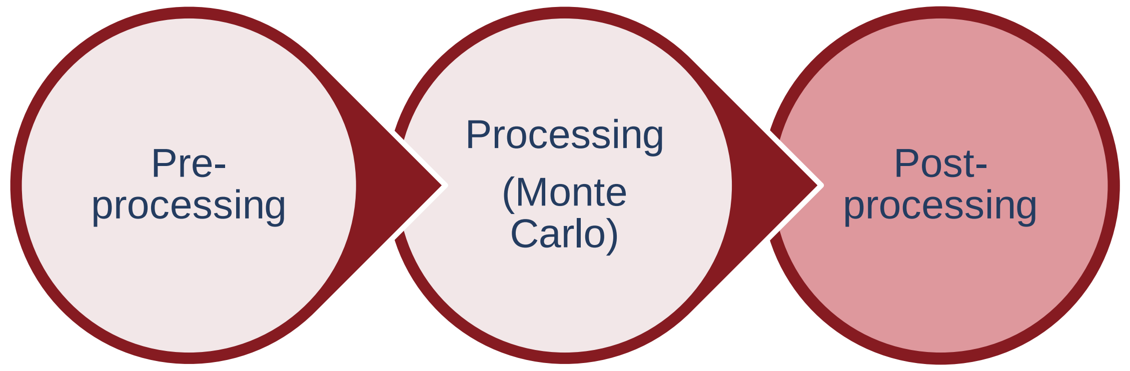
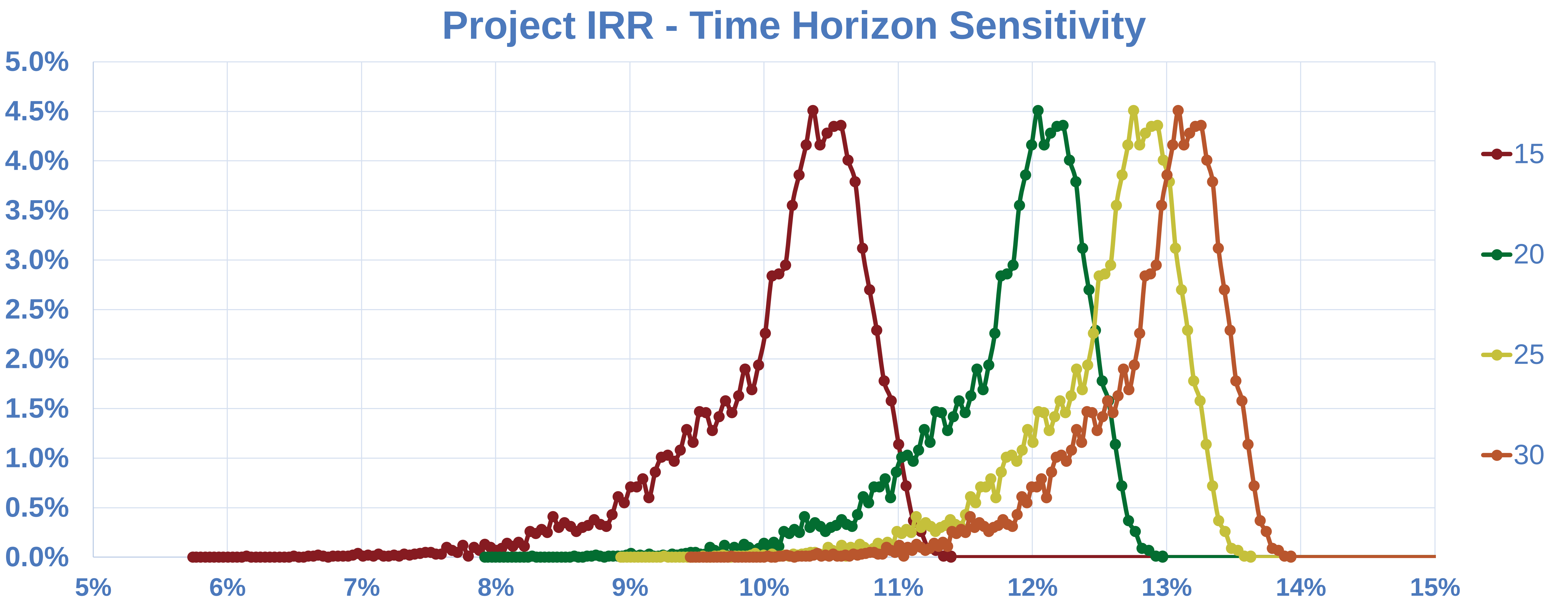


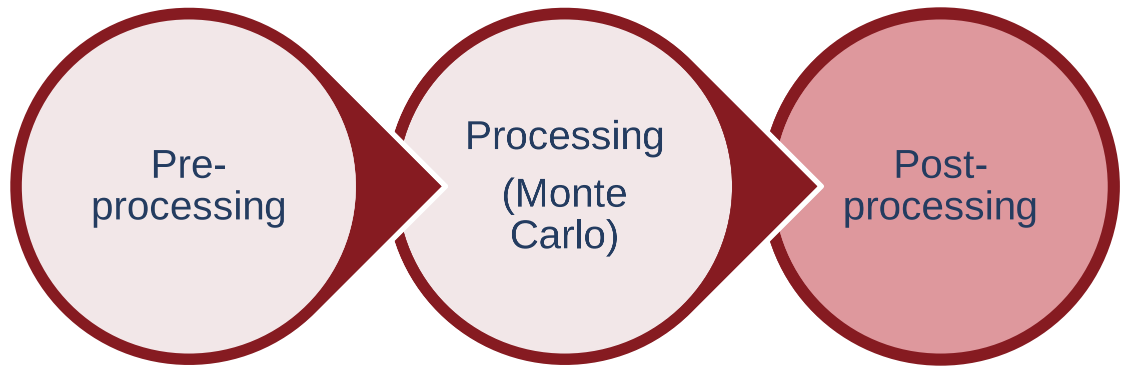
Value-at-Risk Analysis of
- Revenues
- Payback time
- Project & Equity NPV
- Project & Equity IRR
- DSCR

Sensitivity Analysis
- Project duration
- Loan duration
- Time horizon
- Interest rate
- Financial leverage

- Calculation of several indicators on the outputs (V@R)
- Additional sensitivity calculations



Post-Processing

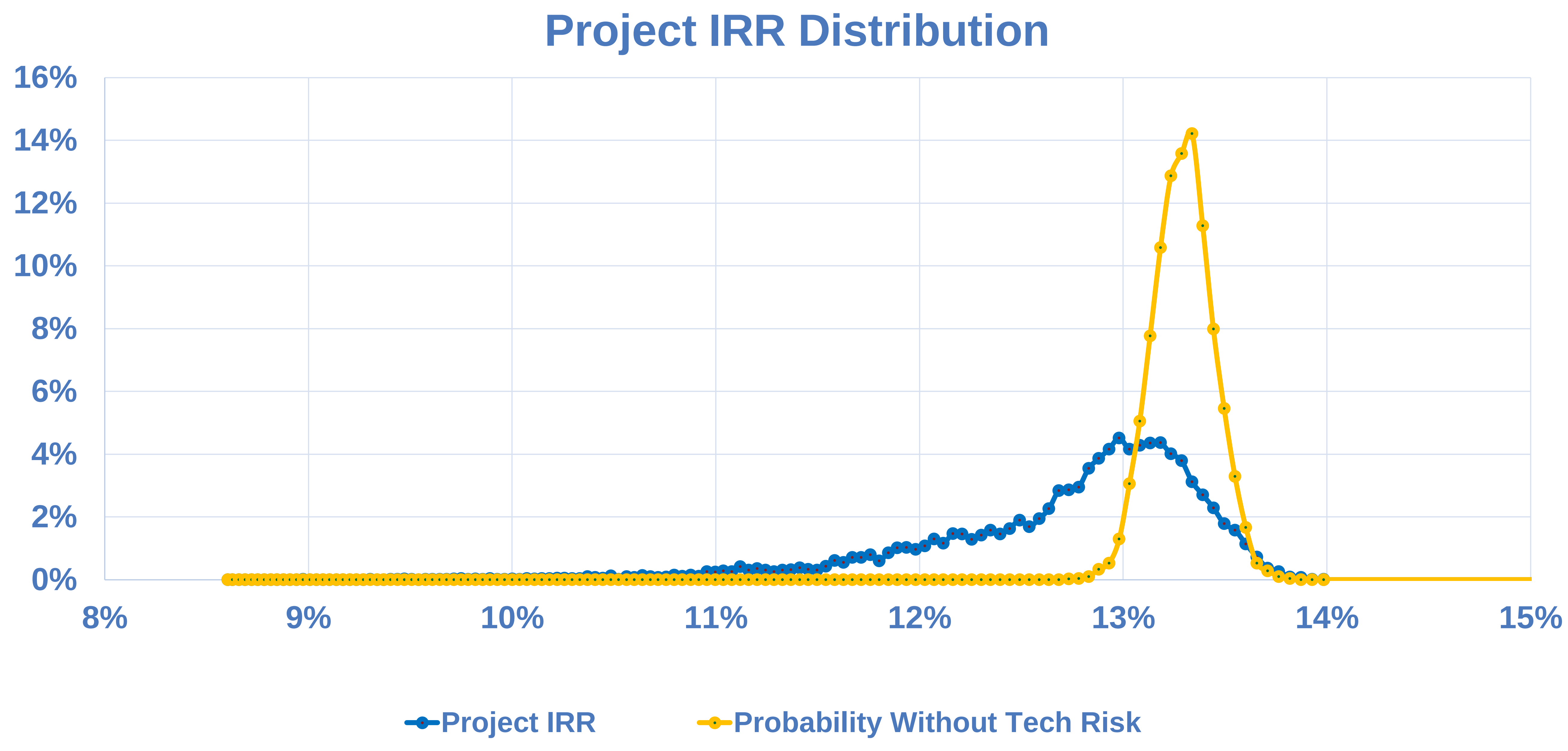


- User or contract specific analysis

- Different distribution according to different risk allocation

Compare probability distribution for specific contract

- In the case of Energy Performance Contract, technical risk is fully transferred from the property owner to the ESCO
- The outputs (Revenues, Payback time, IRR, NPV) can also be provided according to the different contract risk allocation
- For example, if the user is owner and wants to check the investment risk in the case of EPC, the model won't consider technical risk



Thank you

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