EEnvest H2020 project GA #833112

EEnvest

Framework for evaluating financial impacts of technical risks related to energy efficient renovation of commercial office buildings

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The Framework

Inputs from user (project uploader)

- Building technical data
- Proposed EE measures *(renovation project)*
- Expected Energy Savings
- Economic data
- Financial data

Technical analysis

Data and methodology

- Benchmarking
- Technical risk analysis *(probability and impact)*

Financial analysis

- Financial model *(cash flow analysis)*
- Risk Model *(probab. distribution of cash flows)*

Data and methodology

Financial Outputs

- Payback time
- IRR
- NPV
- DSCR
- Risk Score/Premium

Multi-Benefit analysis

- Multi-Benefit model

Data and methodology

Multi-Benefit Outputs

- Increased market value
- Comfort/Health
- Environmental

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Object of the paper

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Multi-Benefit Outputs

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Technical Risk Database

IDENTIFICATION OF THE ENERGY RENOVATION MEASURES FOR MACRO BUILDING AREAS

ENVELOPE

Building element - Energy renovation measure

NEW WINDOWS INSTALLATION:
- Generic data (dimension,)
- Energy efficiency (Uw, ..)
- Costs (€)

IDENTIFICATION OF THE PROBLEMS - OCCURENCES (PROBABILITY - IMPACTS)

ENERGY GAPS
- Null (prob. Impact null)
- Low (prob. - Impact)
- Medium (prob. - Impact)
- High (prob. - Impact

Air infiltration

Thermal bridge

DAMAGES
- Null (prob. Impact null)
- Low (prob. - Impact)
- Medium (prob. - Impact)
- High (prob. - Impact

Breakages - water infiltration - deteachment...

MITIGATION MEASURES

TECHNICAL RISK OUTPUTS

ENERGY PERFORMANCE GAPs
- Null (prob. Impact null)
- Low (prob. - Impact)
- Medium (prob. - Impact)
- High (prob. - Impact

DAMAGES
- Null (prob. Impact null)
- Low (prob. - Impact)
- Medium (prob. - Impact)
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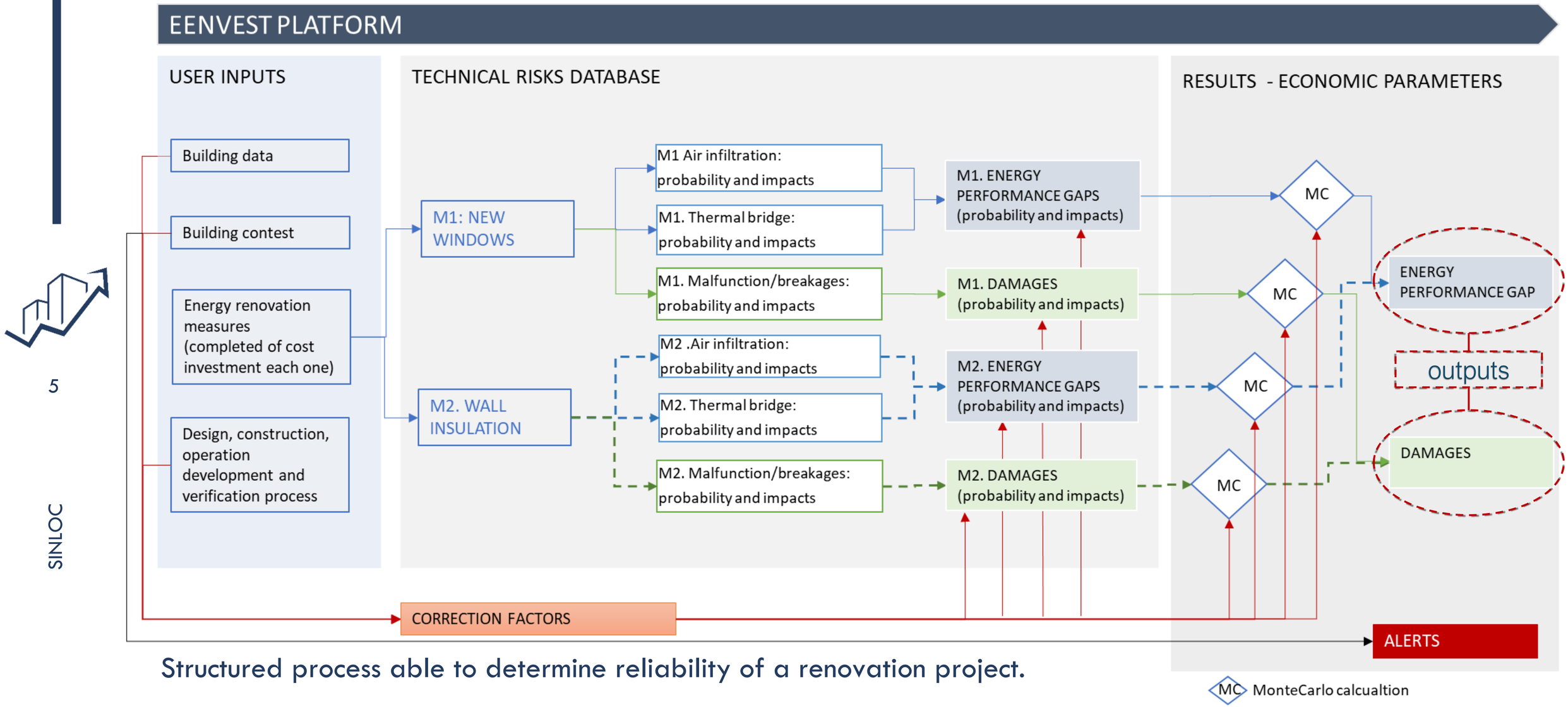
DATABASE of PROBABILITY - IMPACTS

Source: eurac research, POLITECNICO MILANO 1863

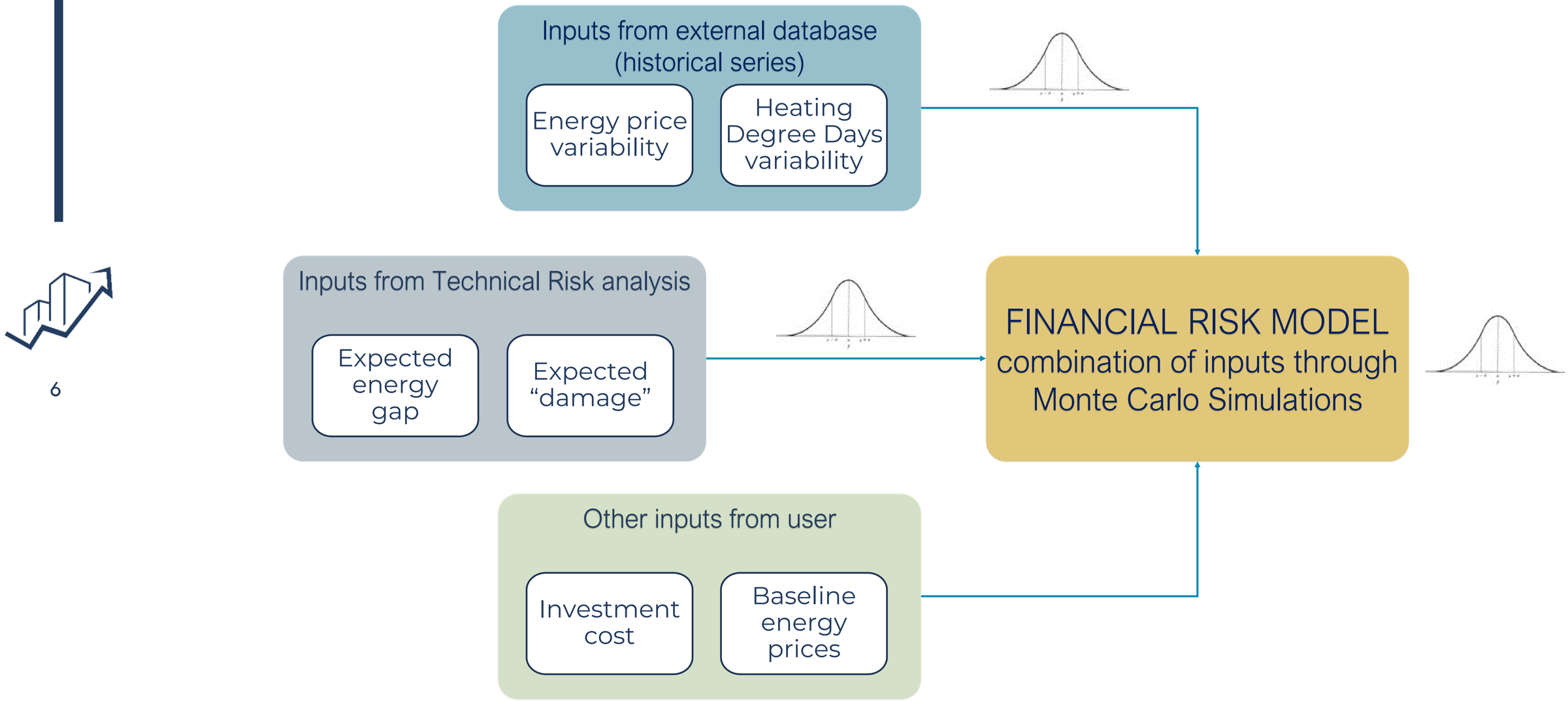
Technical Risk Calculation

Source: eurac research, POLITECNICO MILANO 1863

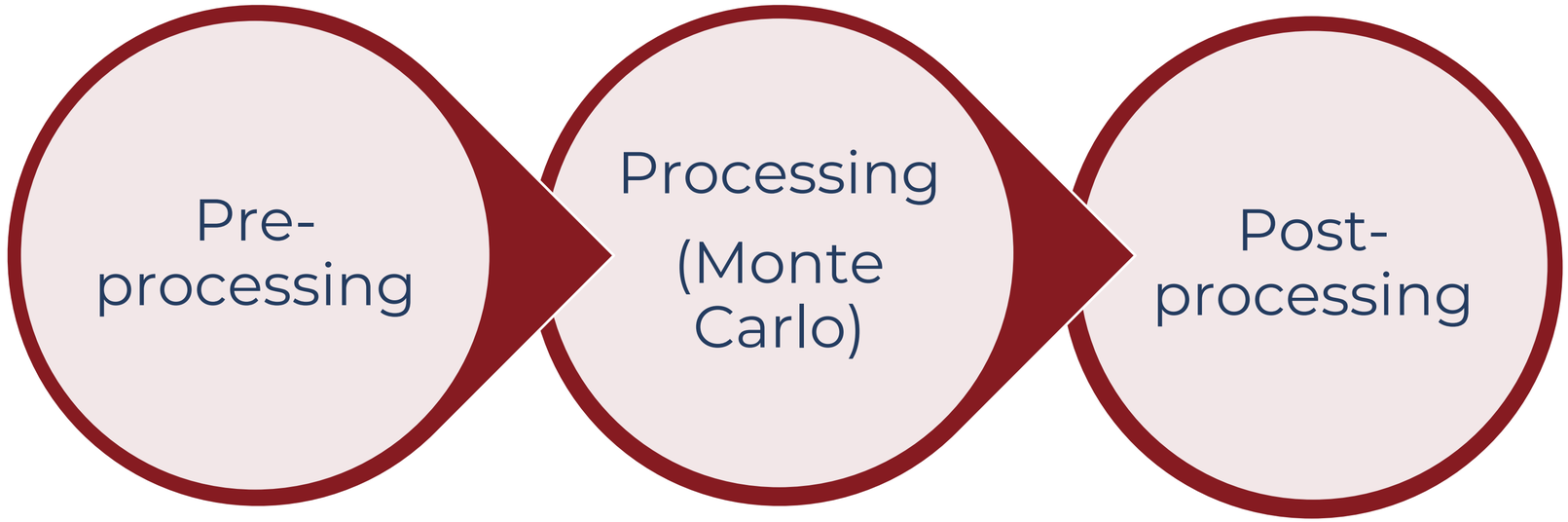


Structured process able to determine reliability of a renovation project.

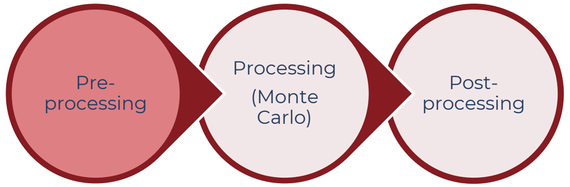
Financial Risk Calculation



Financial Risk Calculation Process



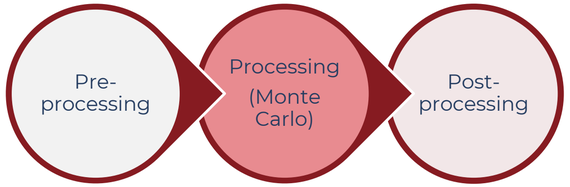
Data Pre-Processing



- 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



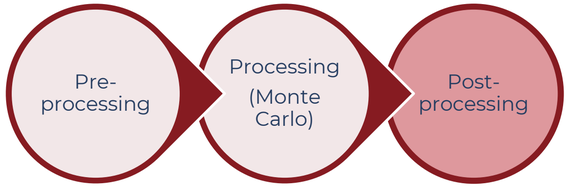
- Run the Monte Carlo simulation
- Combine data from different sources
- Generate Simulated Cash Flow

For <u>each step</u> of the Monte Carlo Simulation

- **Simulate the Expected Value of <u>Damage</u>**
  - extracted randomly from the discrete distribution
- **Simulate the Expected Value of <u>Energy Gap</u>**
  - extracted randomly from the discrete distribution
- **Simulate the Expected Value of <u>Energy Prices</u>**
  - 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 <u>HDD</u> (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

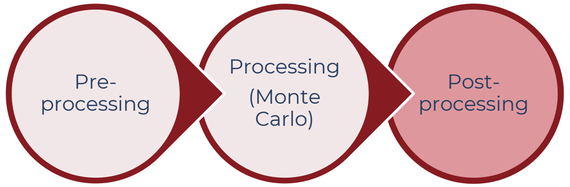
Post-Processing



- 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



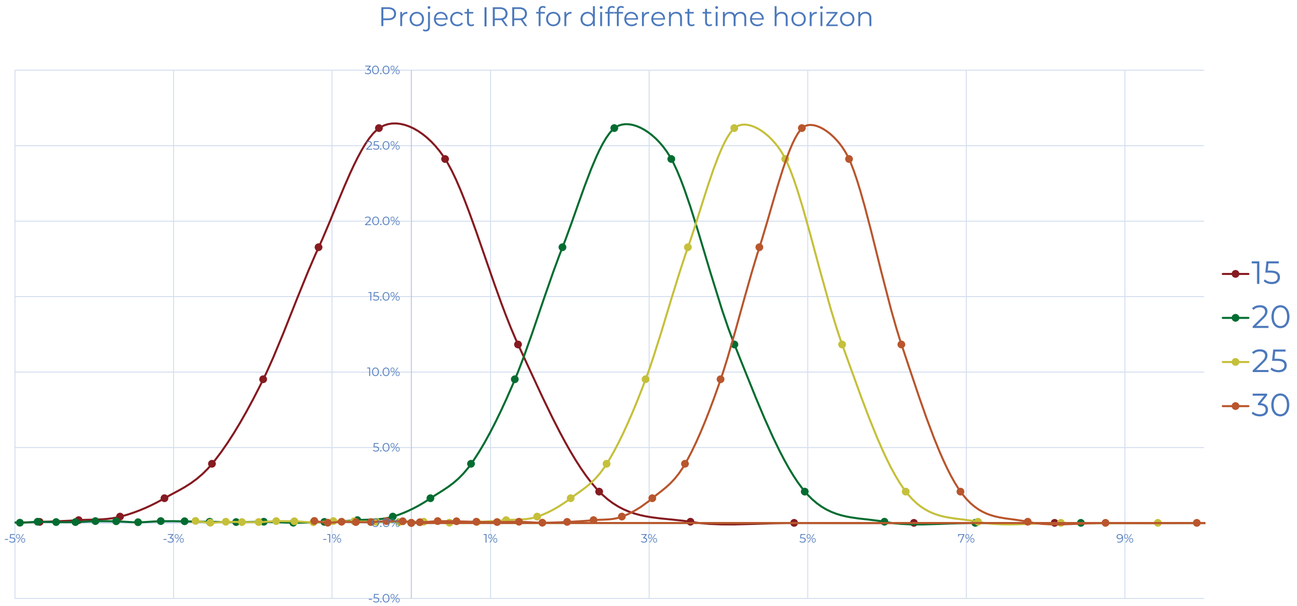
- Calculation of several indicators on the outputs (V@R)
- Additional sensitivity calculations

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



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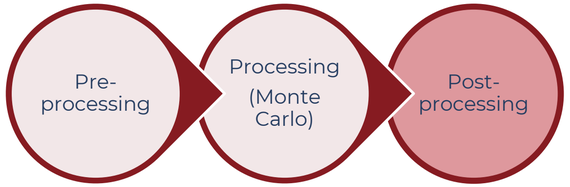
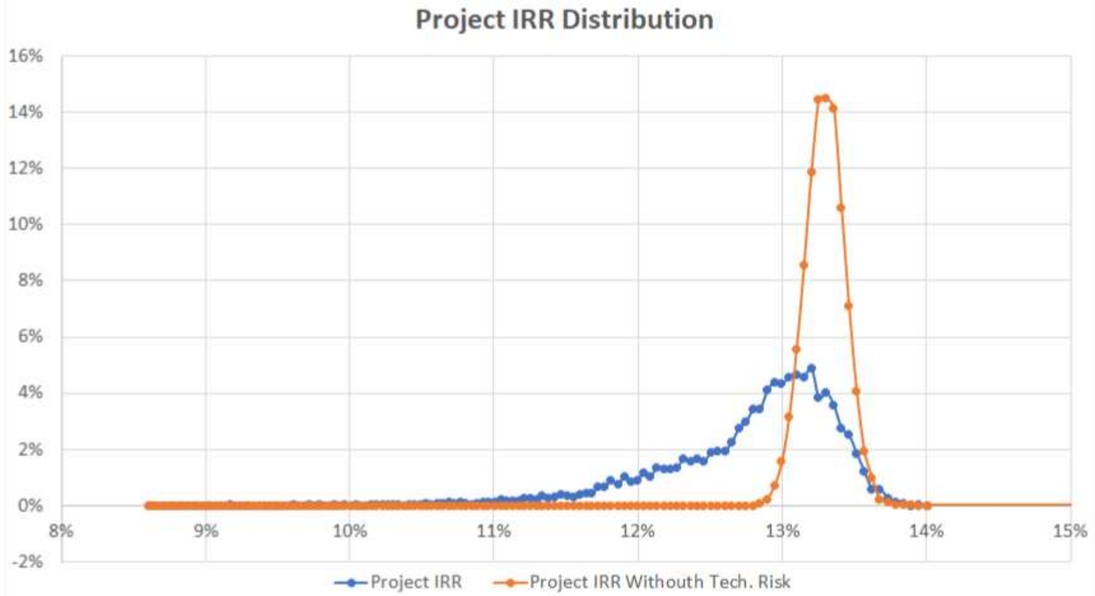


- User or contract specific analysis
- Different distribution according to different risk allocation

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



Conclusions

- The paper presents the current state of development for the EEnvest technical and financial risk evaluation model, created within the frame of EEnvest project funded by the European Commission in 2019 and running for 36 months

- To date, the assumption of the technical and financial risk evaluation model have been **successfully tested on a case study building** located in Rome, which is part of the demonstration activities of the research project. Results showed that accounting for context risks, such as energy price and climate variability, as well as technical risk, such as energy gap and damage, has an impact on project financials, such as IRR

- The EEnvest model is also being developed to enrich its current risk evaluation methodology with the impact of the so-called **non-energy benefits**, such as increased thermal comfort, reduced productivity cost, higher air quality level, lower vacancy rates

- EEnvest platform is not online yet, as its database is still being populated and case studies are still being developed. The web-based search and match platform **will be going live in late 2022**

Thank you

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