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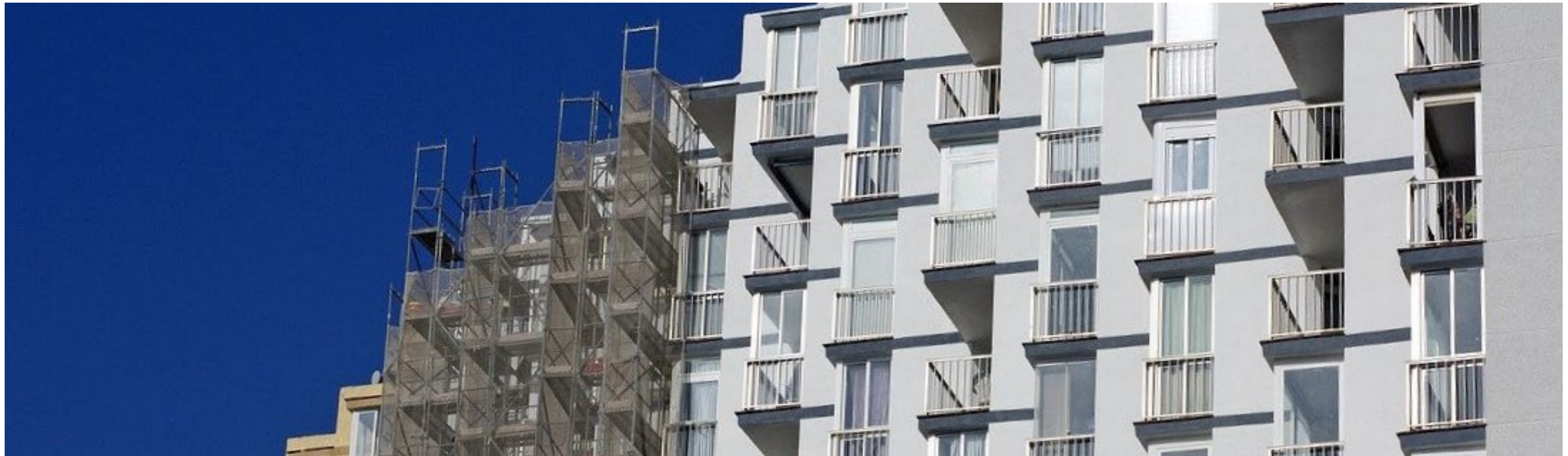
Trends in the cost-benefit analysis of energy efficiency measures as part of the renovation wave

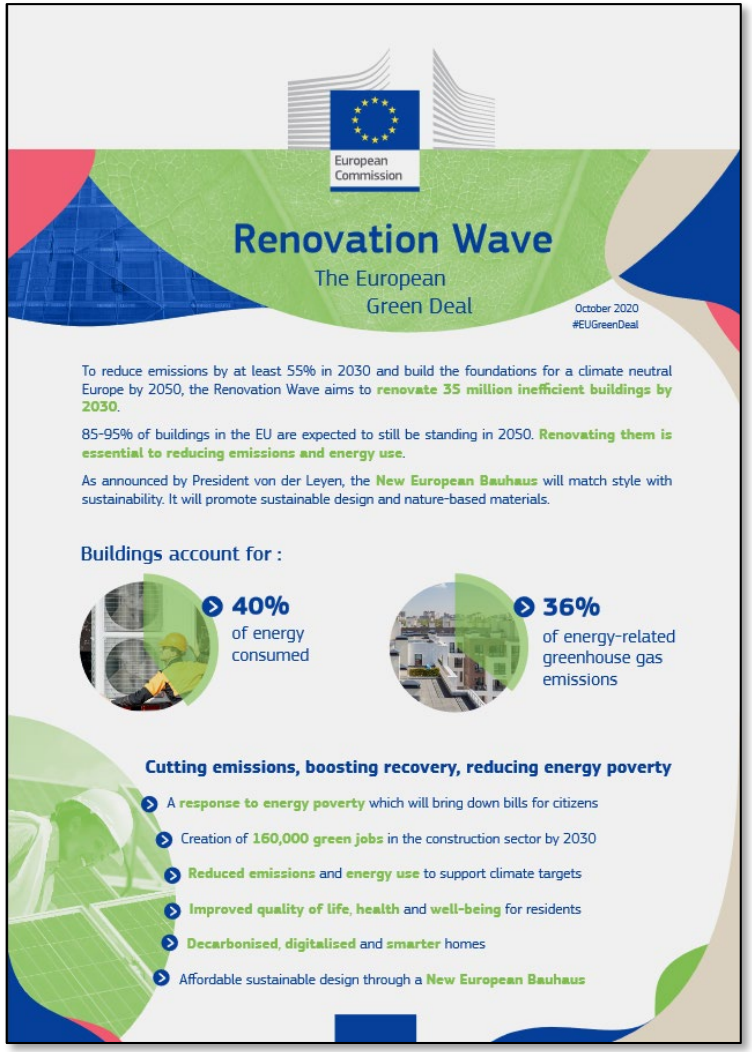
Matthias Buchholz (KIT) , Andreas Enseling (IWU) and Thomas Lützkendorf (KIT)



Motivation

- Energy efficiency measures are the main focus in reducing the energy consumption in the construction, use and operation of buildings
- Need for profitable energy-related investments
- Current trends and issues complicate the conduction and interpretation of cost-benefit analyses

➢ **Need for guidance to politics and practitioners**



Research obectives

- Investigate current trends on the profitability of energy efficiency measures

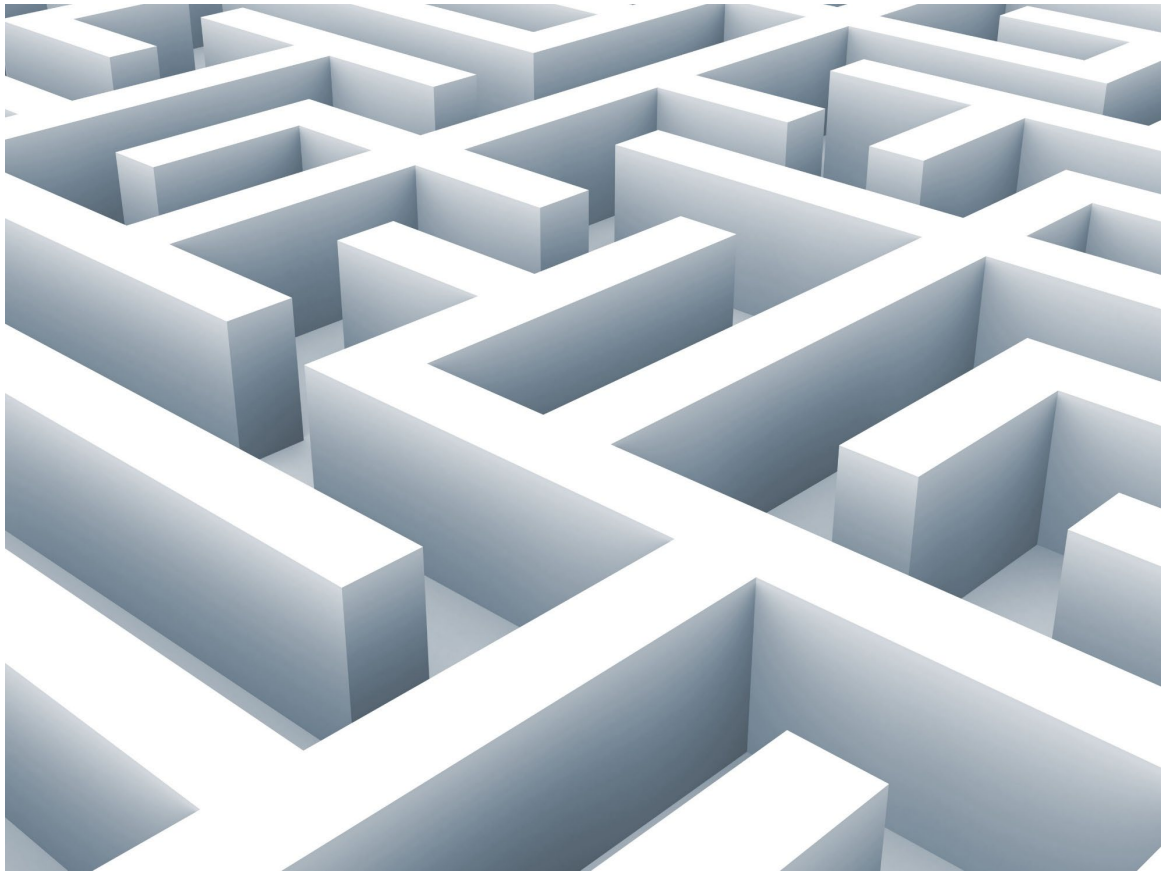
1. What are relevant trends in politics, real estate industry, society and research for cost-benefit analyses of energy efficiency measures in the building stock?
2. Which effects result from these trends and how can they be adapted into specific calculations?

Content

1. Basics of cost-benefit analyses
2. Current trends and issues
3. Selected trends and their effects
   - *External costs and shadow prices*
   - *Non-monetary factors*
   - *Perspective of actors*
   - *Uncertainties and Monte-Carlo-Simulation*
4. Conclusion and recommendations

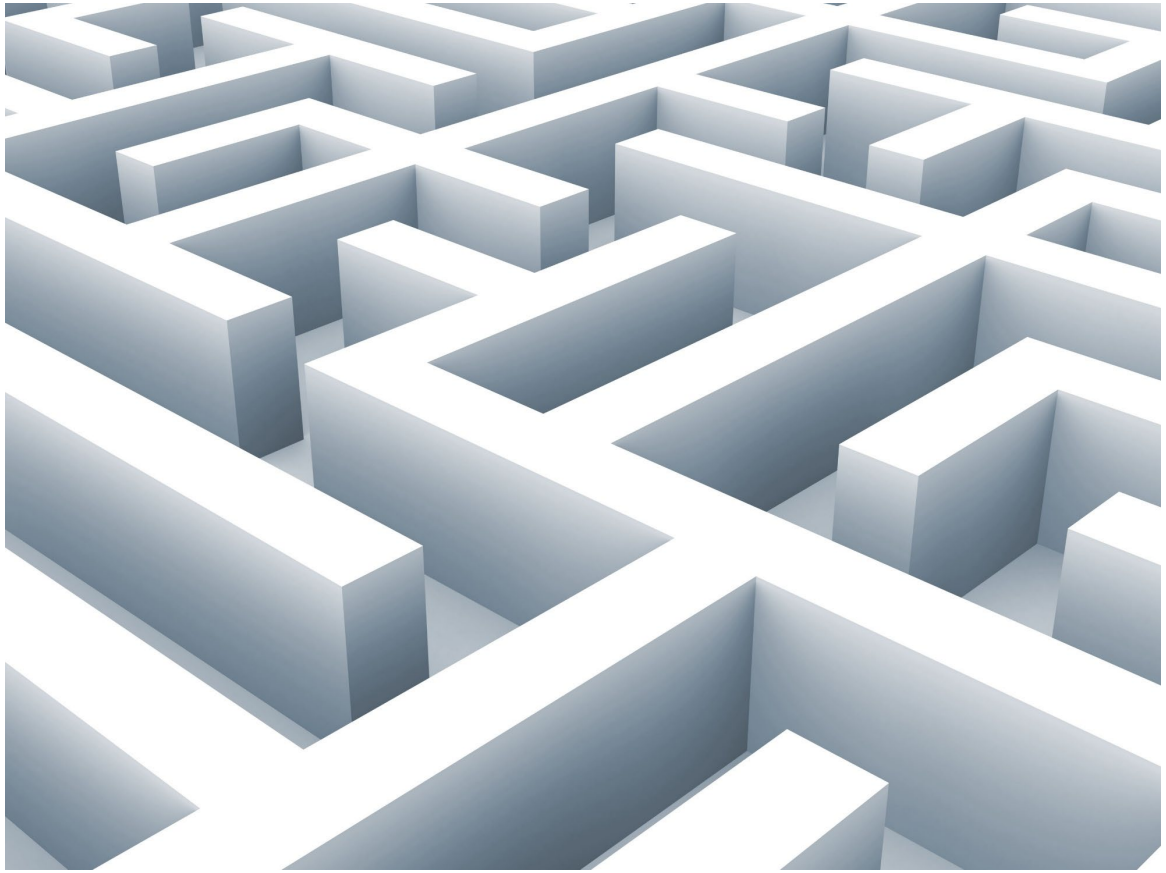
1. Basics of cost-benefit analyses: Terms

- Important terms…
  - *Energy efficiency measure*
  - *Energetic refurbishment*
  - *Energy modernisation*
  - *Energy renovation*
  - *Deep Energy Retrofit*



1. Basics of cost-benefit analyses: Terms

- Important terms…
  - *Energy efficiency measure*
  - *Energetic refurbishment*
  - *Energy modernisation*
  - *Energy renovation*
  - *Deep Energy Retrofit*
  - *Cost-Benefit analysis*
  - *Investment appraisal method*
  - *Profitability assessment*

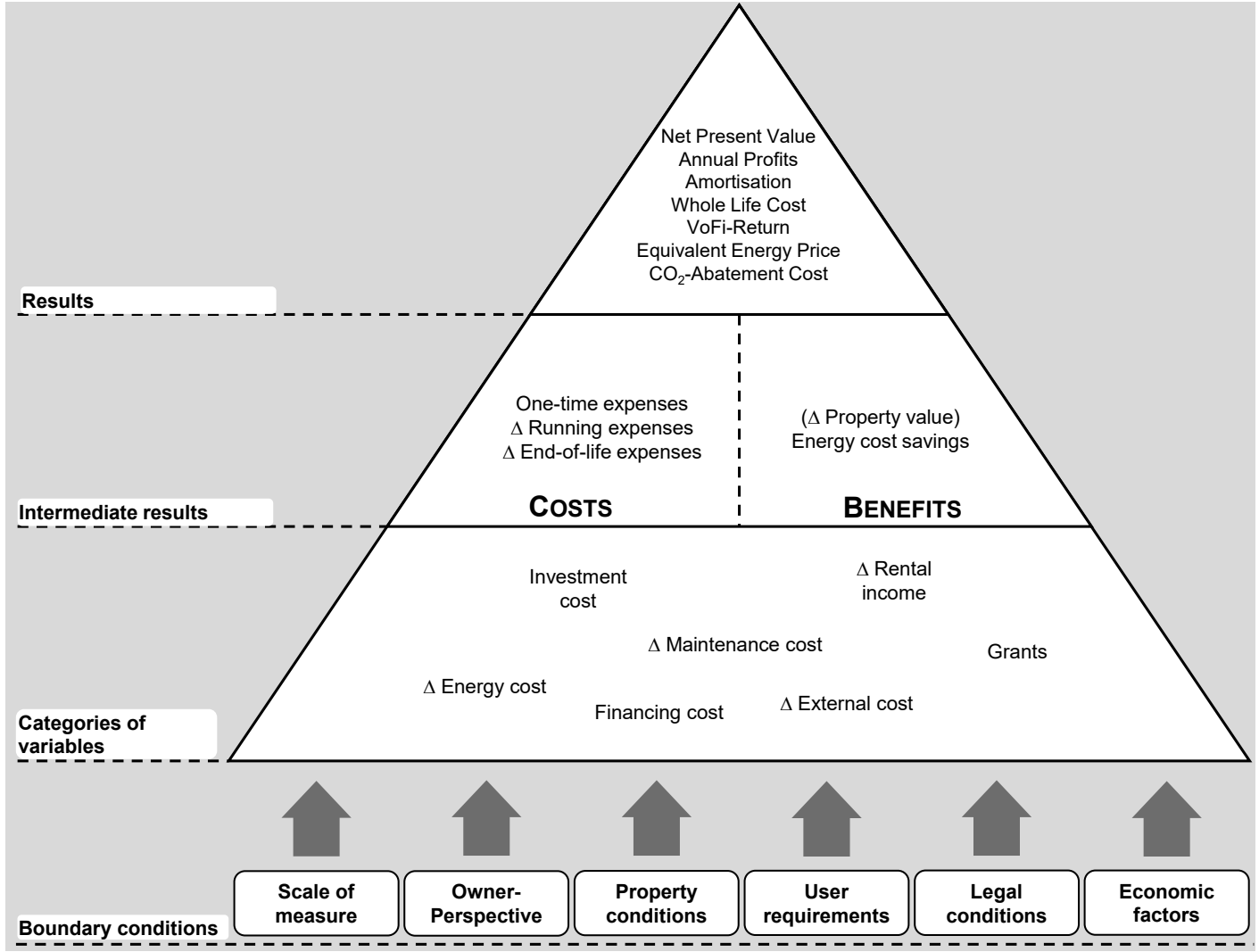


1. Basics of cost-benefit analyses: Methods

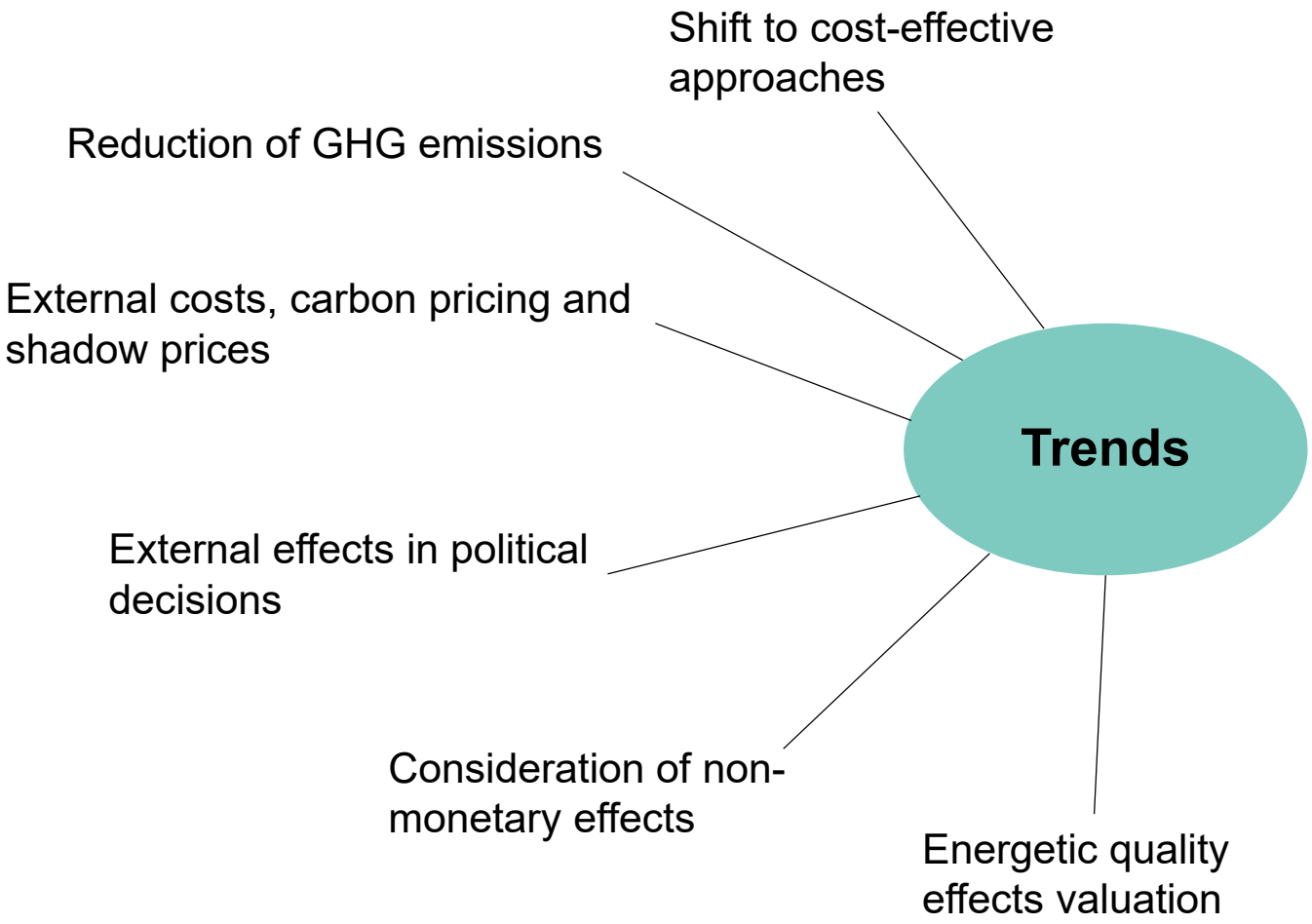
	Method	Question for interpretation
1	**Annuity method**	Is the payback period below the service life of the measure or below a defined expectation horizon?
2a	**Net present value method**	Which measure achieves the highest net present value (relative)? Is the net present value greater than zero (absolute)?
2b	**Amortisation method**	Are the costs after an energy renovation (new energy costs + interest and repayment for the measure) lower or higher than the former energy costs?
3	**Dynamic cost comparison calculation**	Which variant has the lowest present value of life cycle costs?
4	**Visulisation of financial implications (VoFI)**	Which variant has the highest return on equity or the highest final asset value?
5	**Equivalent energy price**	Is it more expensive or cheaper to save one kWh of final energy than to generate or procure one kWh?
6	**CO_2 abatement costs**	Is it more expensive or cheaper to avoid one kg of CO_2 or CO_2 equivalent than with a reference alternative?

1. Basics of cost-benefit analyses: Hierarchy

- Same calculation principle for different investment appraisal methods…



2. Trends & issues related to cost-benefit analyses



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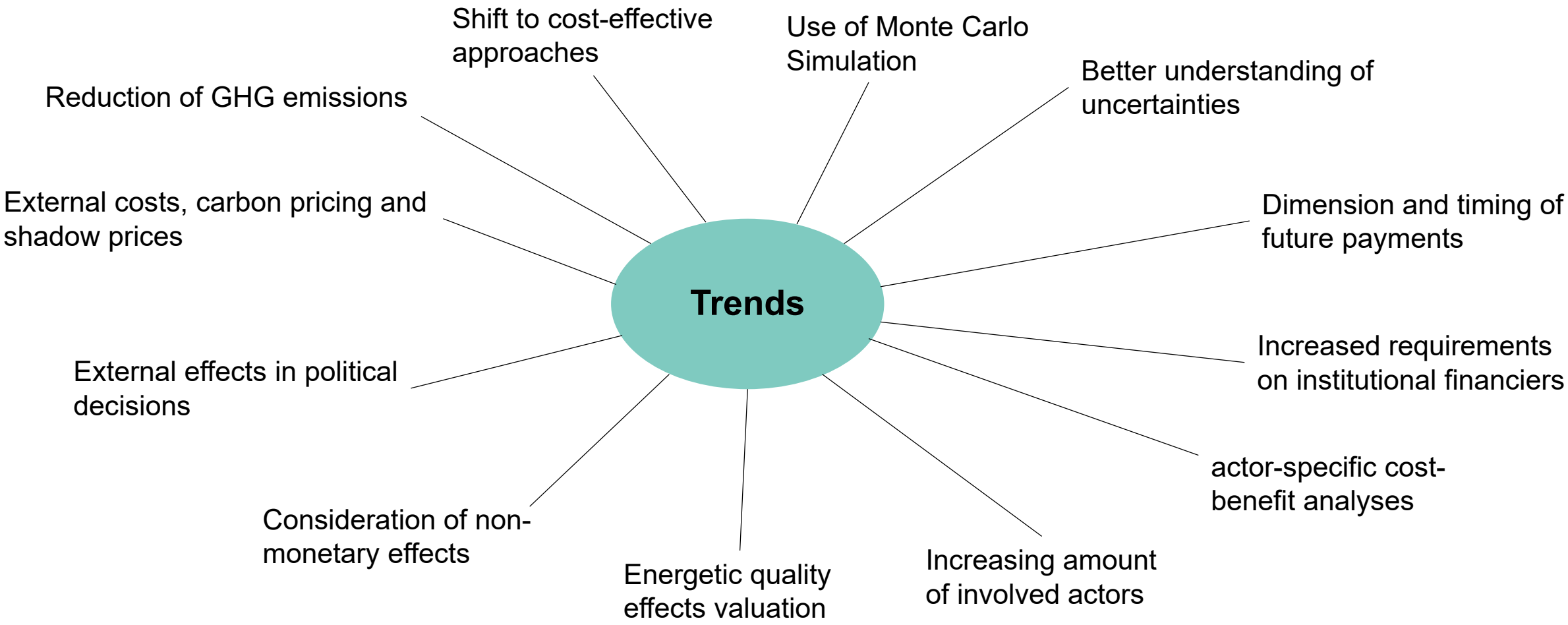

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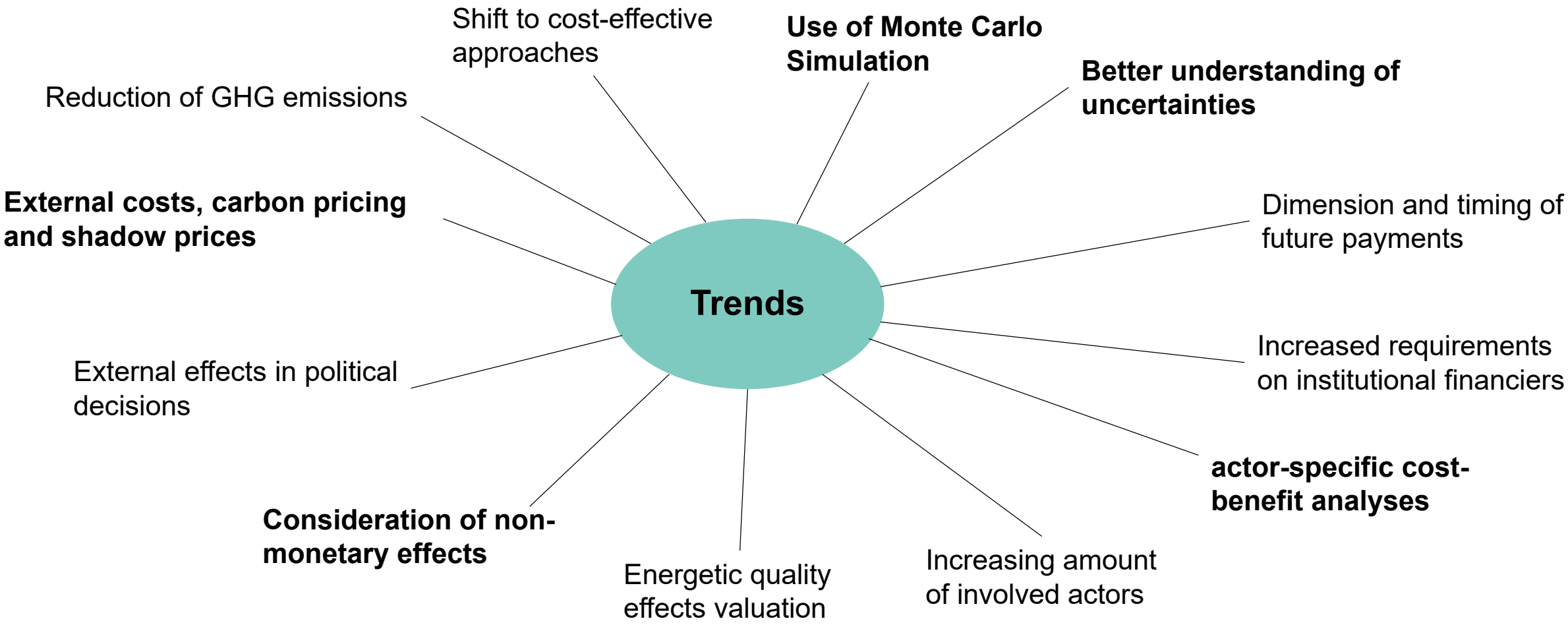

3.1 External costs and shadow prices

Economic activity generally includes **externalities** which occur in the shape of external effects. The sum of **negative external effects** is called **external costs**.

Two possibilities to deal with external costs in economic calulations…

- **Internalisation** of external costs e. g. in form of taxes or charges (a popular instrument is the use of CO_2-pricing)
- **Voluntary incorporation** of external costs

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➢ Suggestion to incorporate external effects for different types of actors…

Actor	Perspective	Consideration of external effects
Private	microeconomic	voluntary
Institutional	microeconomic	recommendable for additional assessment
Public	macroeconomic	mandatory

3.1 External costs and shadow prices

- The consideration of external effects in economic appraisals should orientate on the expected true value of external costs
- Problem: CO_2-prices in Germany for example remain far below scientifically calculated climate cost
- **Shadow prices** could be used as an addition to better incorporate the expected true value of climate cost
- Shadow price = assignment of a value to an unpriced (or insufficiently priced) commodity

3.2 Dealing with non-monetary factors

- Non-monetary factors that can be part of economic appraisals…
  - Environmental aspects, e.g. built-in materials
  - Social aspects, e.g. cultural value, asthetics
  - Technical aspects, e.g. flexibility and modularity

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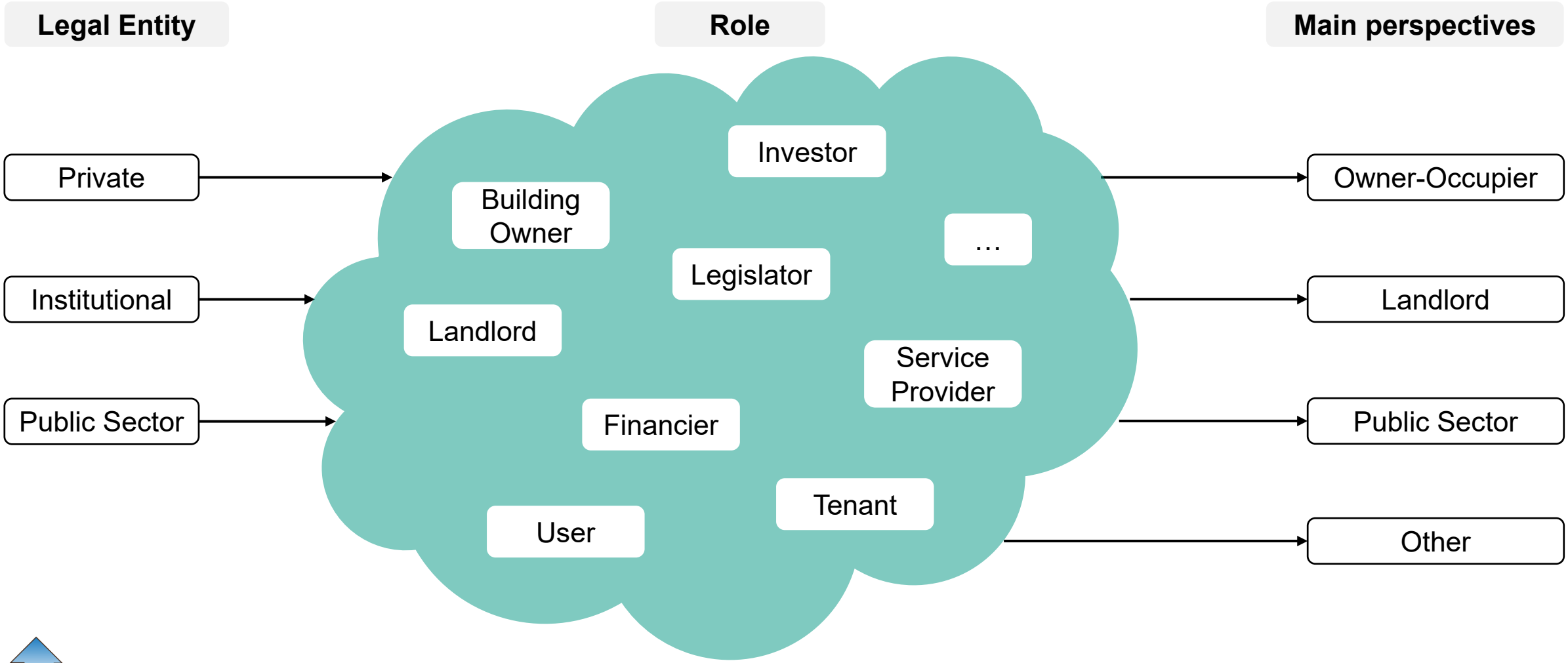
- ➢ Actors integrate non-monetary factors either as costs or benefits in their **decision-making**
- ➢ Non-monetary factors can be **monetised** or quantified via **utility-value analysis** for example
- ➢ The integration of non-monetary factors allows for assessing the **overall advantageousness** of decision alternatives

3.3 Perspective of actors



3.3 Perspective of actors

Perspective	Requirements for economic viability	Recommended method
Owner-occupier	... if the **annual costs** (investment and running costs) for energy saving measures are **lower than the annual energy cost savings** and the measures are fully amortised within their life time.	Annuity Method Amortisation Period Equivalent Energy Price
Landlord	... if the **investment costs** for energy saving measures are **compensated** by achievable **additional rental income** and the **property value** remains constant or increases as a result of the measure.	Net Present Value VoFI-Method
Public sector	... if scientifically derived and politically **justified goals** are achieved with **minimal financial resources**, taking a **macroeconomic perspective** and including external effects. Ecological meaningfulness must be given.	Whole Life Cost Calculation CO_2 Abatement Costs

3.4 Dealing with uncertainties: Basics

- The approach of calculating the profitability of energy renovations can be characterised via a four-field matrix…

	Static	Dynamic
Deterministic	①	②
Stochastic	③	④

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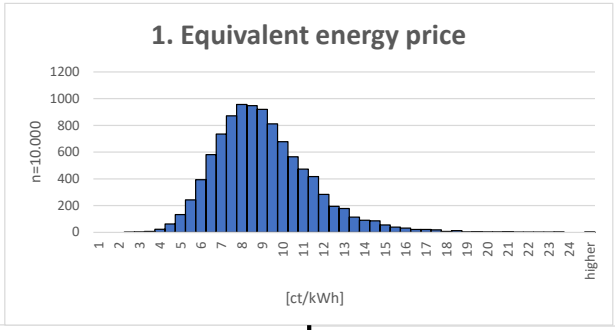
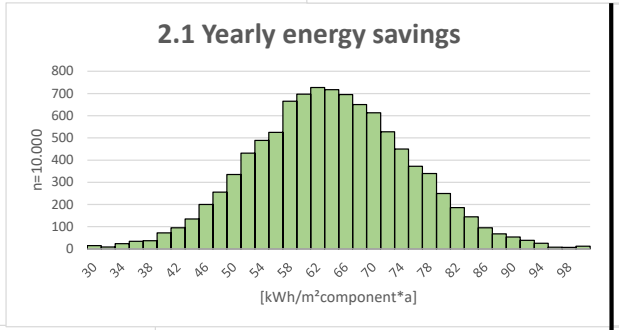
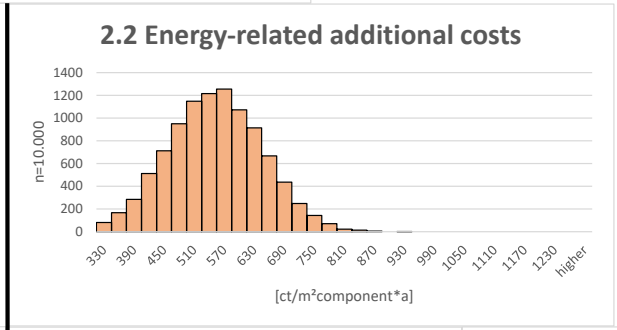
	Static	Dynamic
Deterministic	①	②
Stochastic	③	④

- Static approaches (1 & 3) are generally not recommended because they do not consider the time value of money
- The trend goes to calculations that are dynamic and stochastic
  - Stochastic approaches like **Monte-Carlo-Simulations (MCS)** do not only calculate single values as a result but involve the calculation of a range of possible values
  - The uncertainty of a calculation result gets more visible and can be quantified

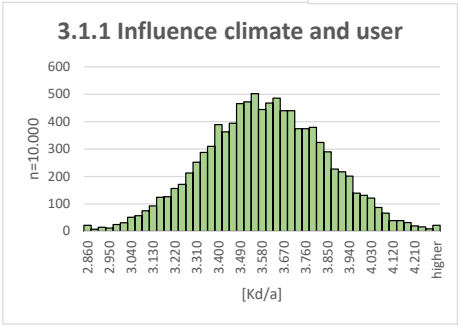
3.4 Dealing with uncertainties: MCS

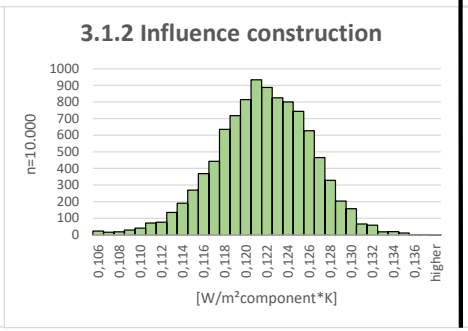


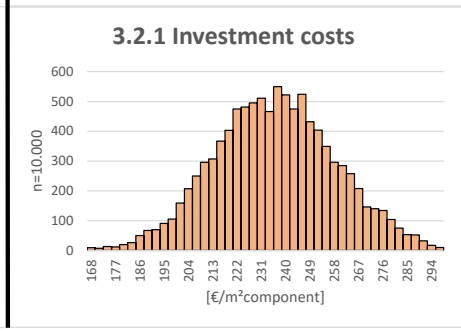


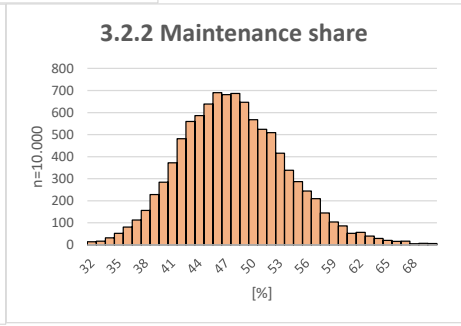


Boundary conditions:
* Interest rate: 1,5 %/a
* Reference study period: 30 a



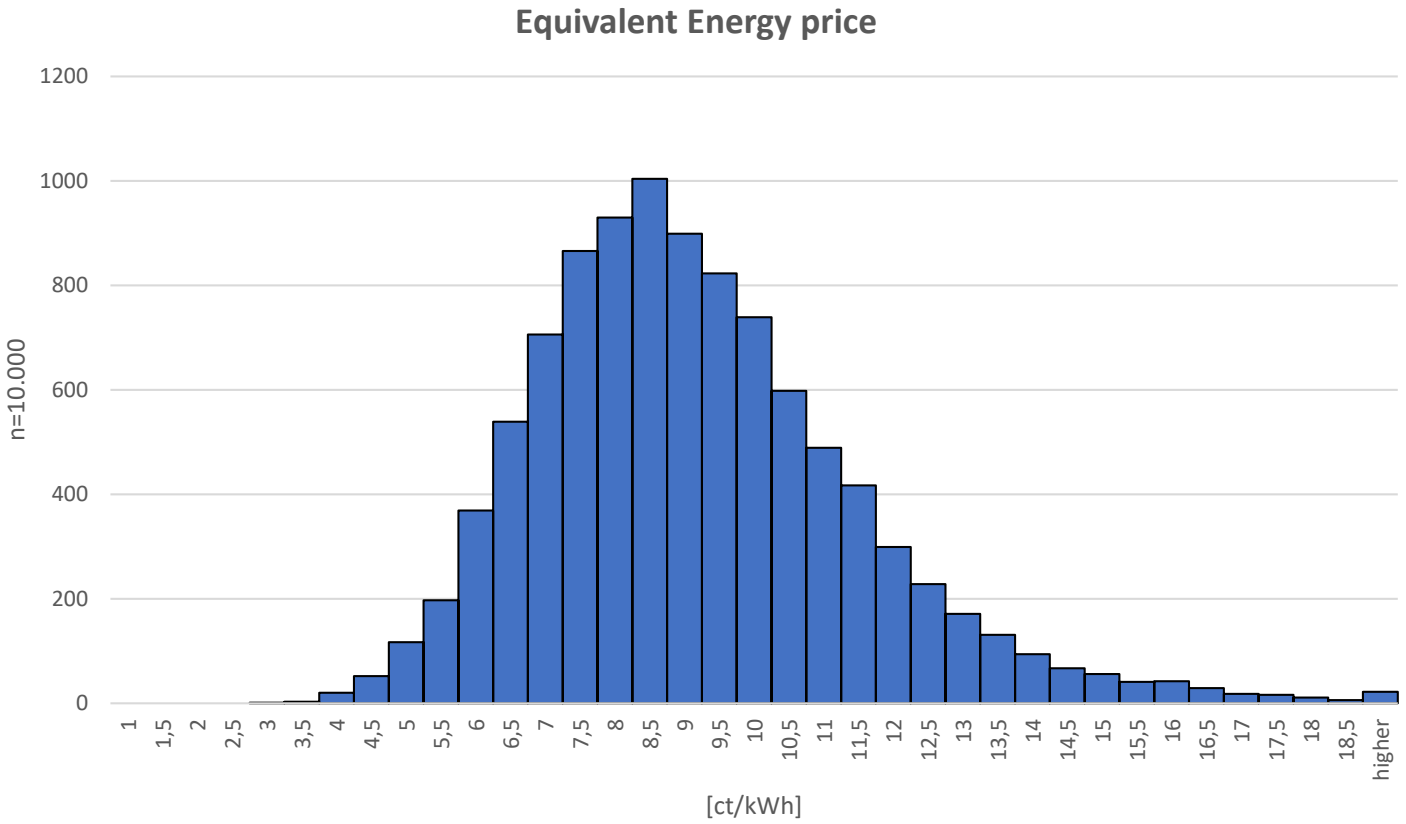






- Distributions from the lower level are used for calculations on the highter level
- MCS enable a more comprehensive perspective on the probability of a result

3.4 Dealing with uncertainties: MCS



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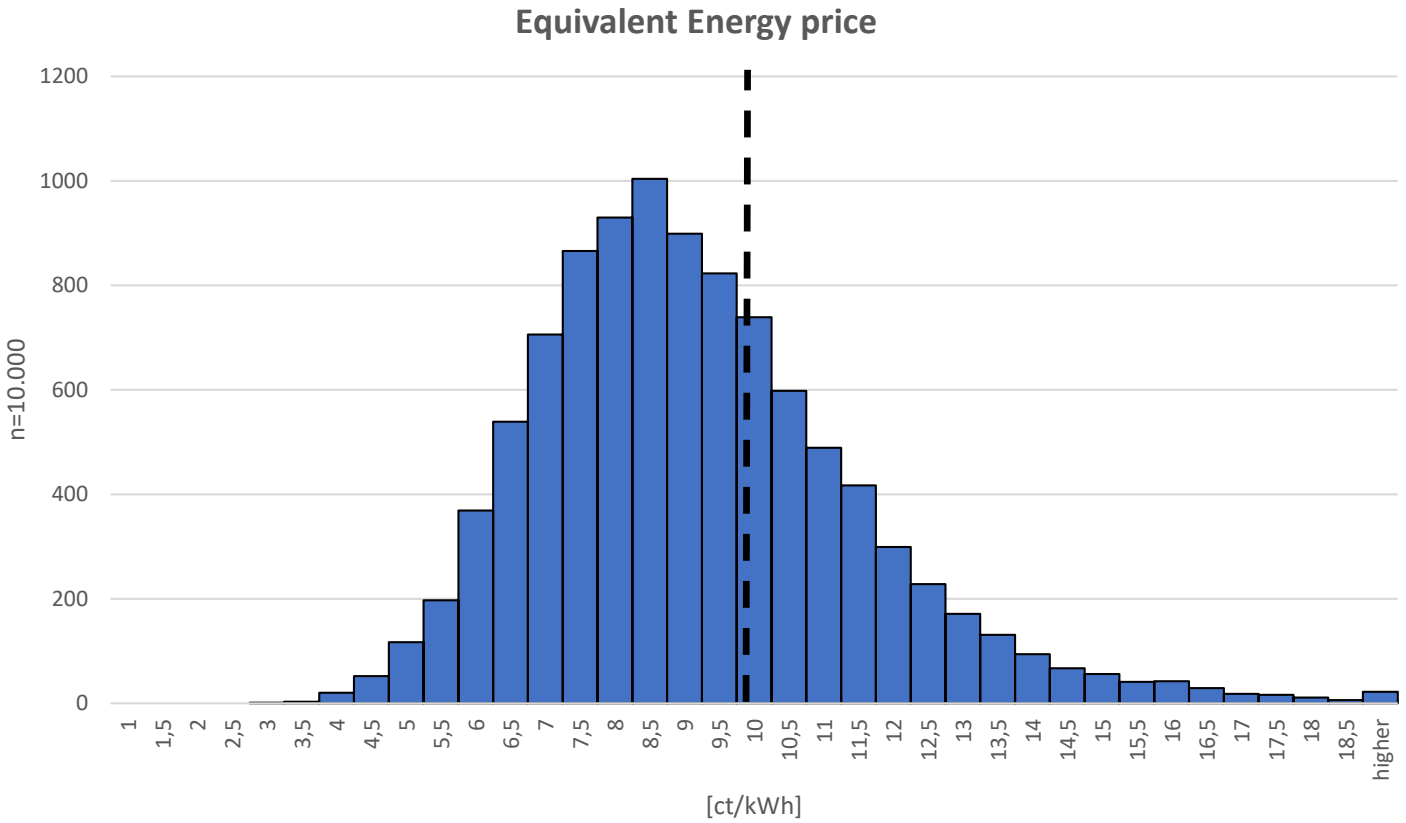

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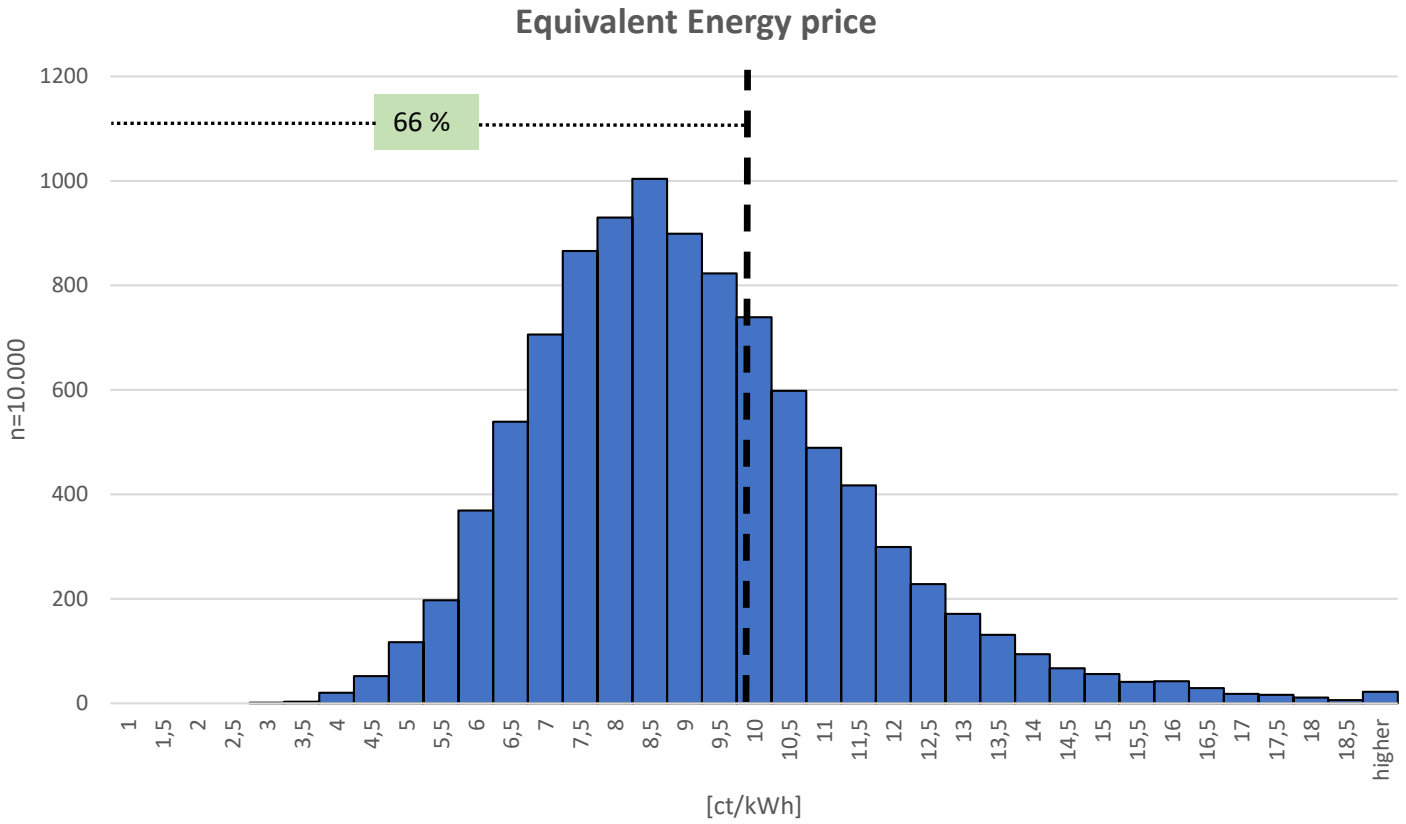

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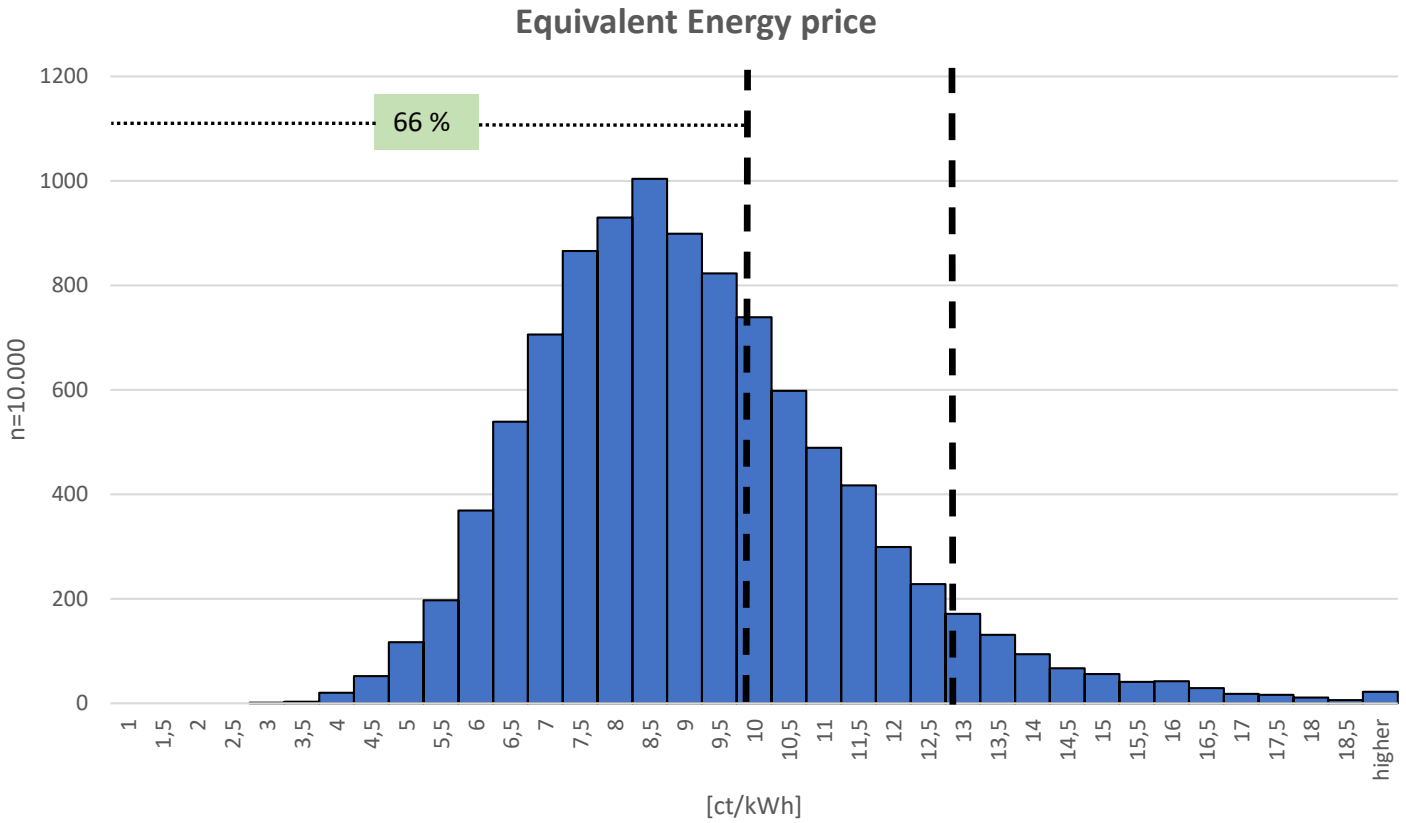

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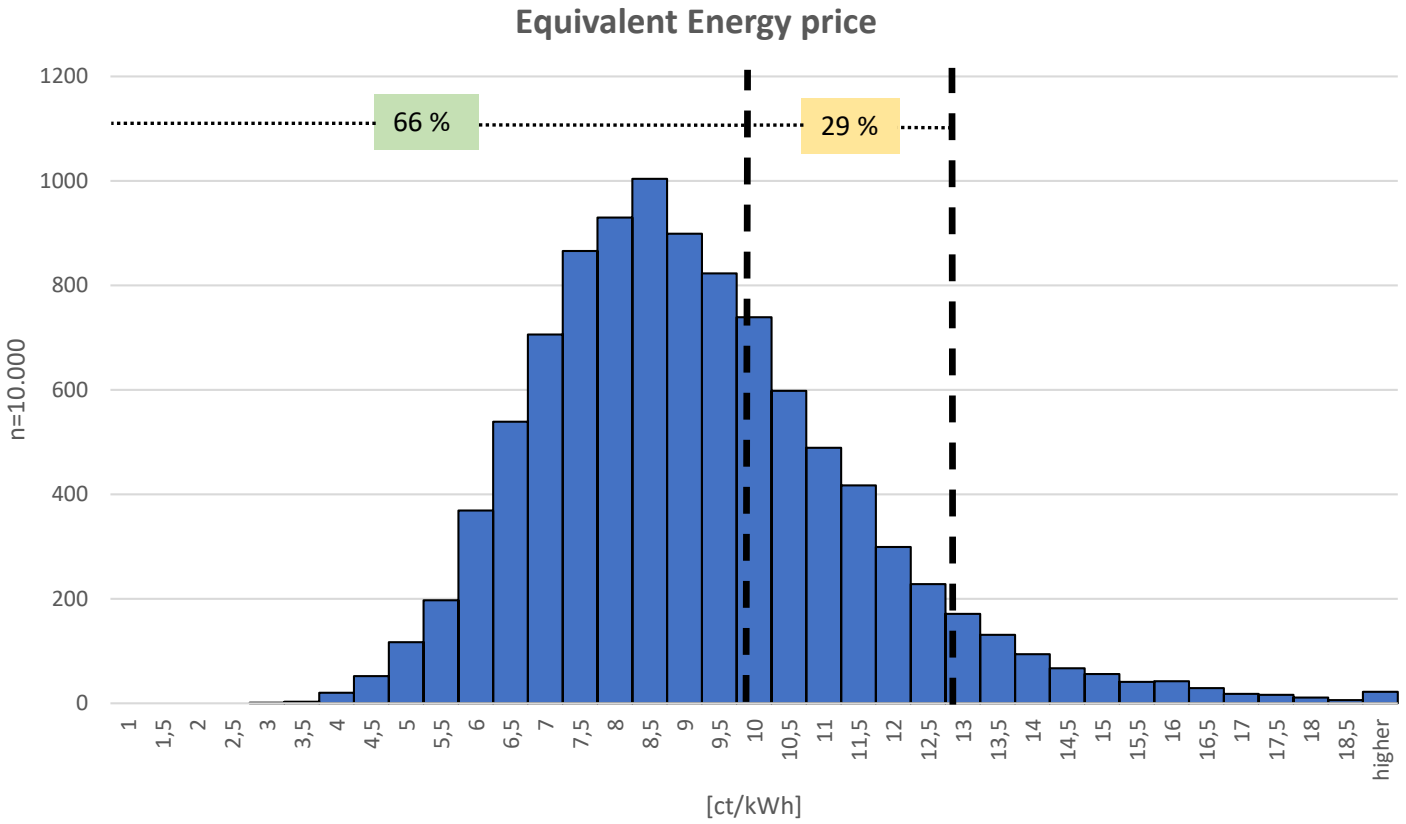

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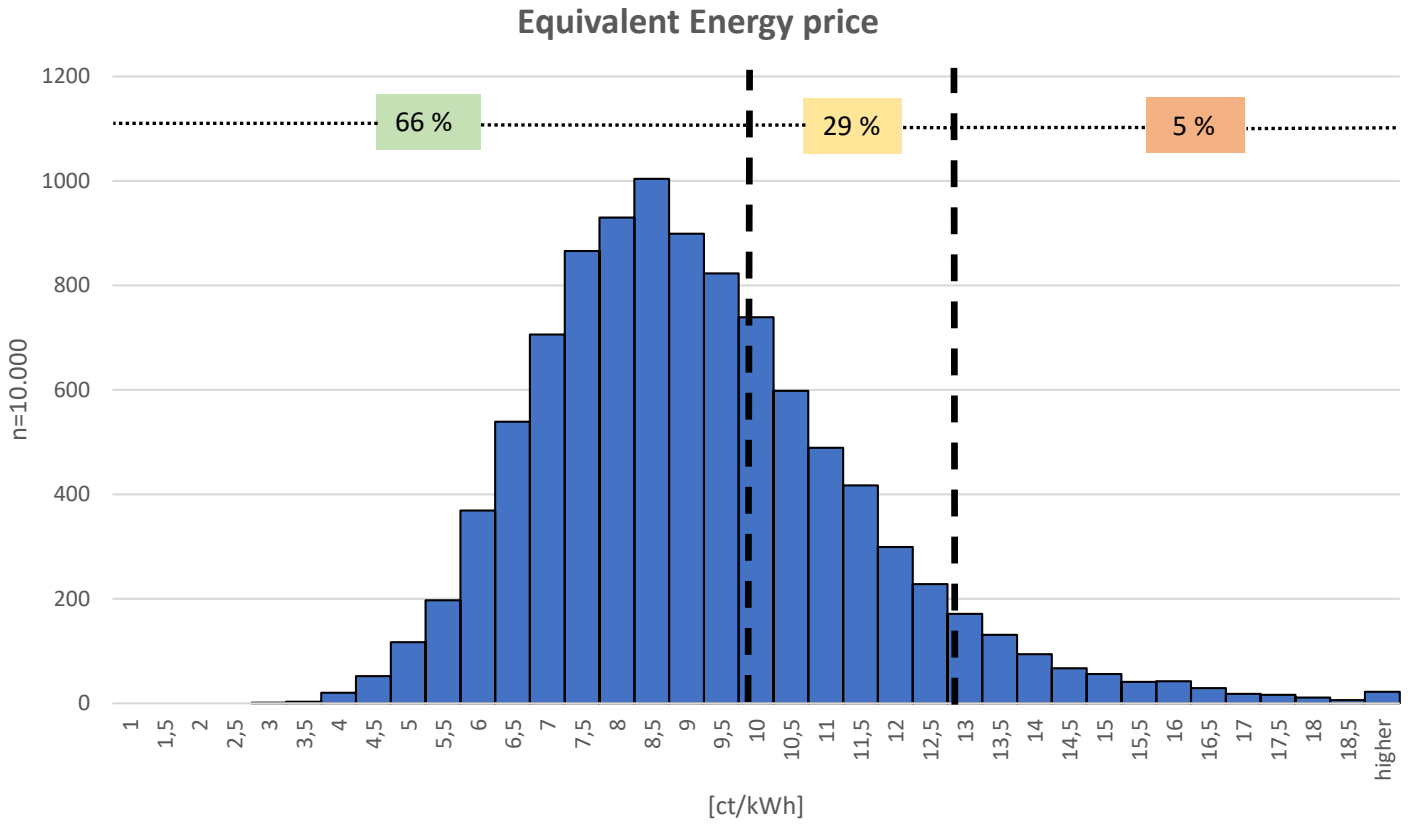

- Propabilities for the profitability of the energy efficiency measure can be derived
- Benchmarks: Future scenarios for energy prices

4. Conclusion and recommendations

- Cost-benefit analyses are **evolving** under the premise of **new targets, changing boundary conditions** and **changing actor perspectives**
- Current and future **trends** must be **considered thoroughly** in an specific calculation
- Concretely, cost-benefit analyses should be **adapted** so that they…
  - serve the **perspective of an actor** by considering specific costs and benefits and using suitable methods
  - take into account **dynamic developments** and better illustrate **uncertainties**, e.g. through the use of Monte-Carlo-Simulation

THANK YOU FOR YOUR ATTENTION.

Matthias Buchholz

Karlsruhe Institute of Technology (KIT)
Centre for Real Estate, Chair for Sustainable Management of Housing and Real Estate
Engesserstraße 6 - 76131 Karlsruhe
matthias.buchholz@kit.edu

Web: https://www.oew.kit.edu

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