INTEGRATION OF SUSTAINABILITY ANALYSES INTO BUSINESS MODELS FOR ENERGY RENOVATION OF BUILDINGS: A CASE STUDY IN NORWAY

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BUSINESS MODELS and SUSTAINABLE BUSINESS MODELS

A **Business Model** is

"A conceptual tool aiming to express the business logic of a firm/project"

Osterwalder et al., 2005

A **Sustainable Business Model** is

"A *business model that tries to incorporate the triple bottom line approach, typical of sustainability analyses*"

Bocken et al., 2014

Business Model framework

Value proposition:
Service/product, customer segments and relationships

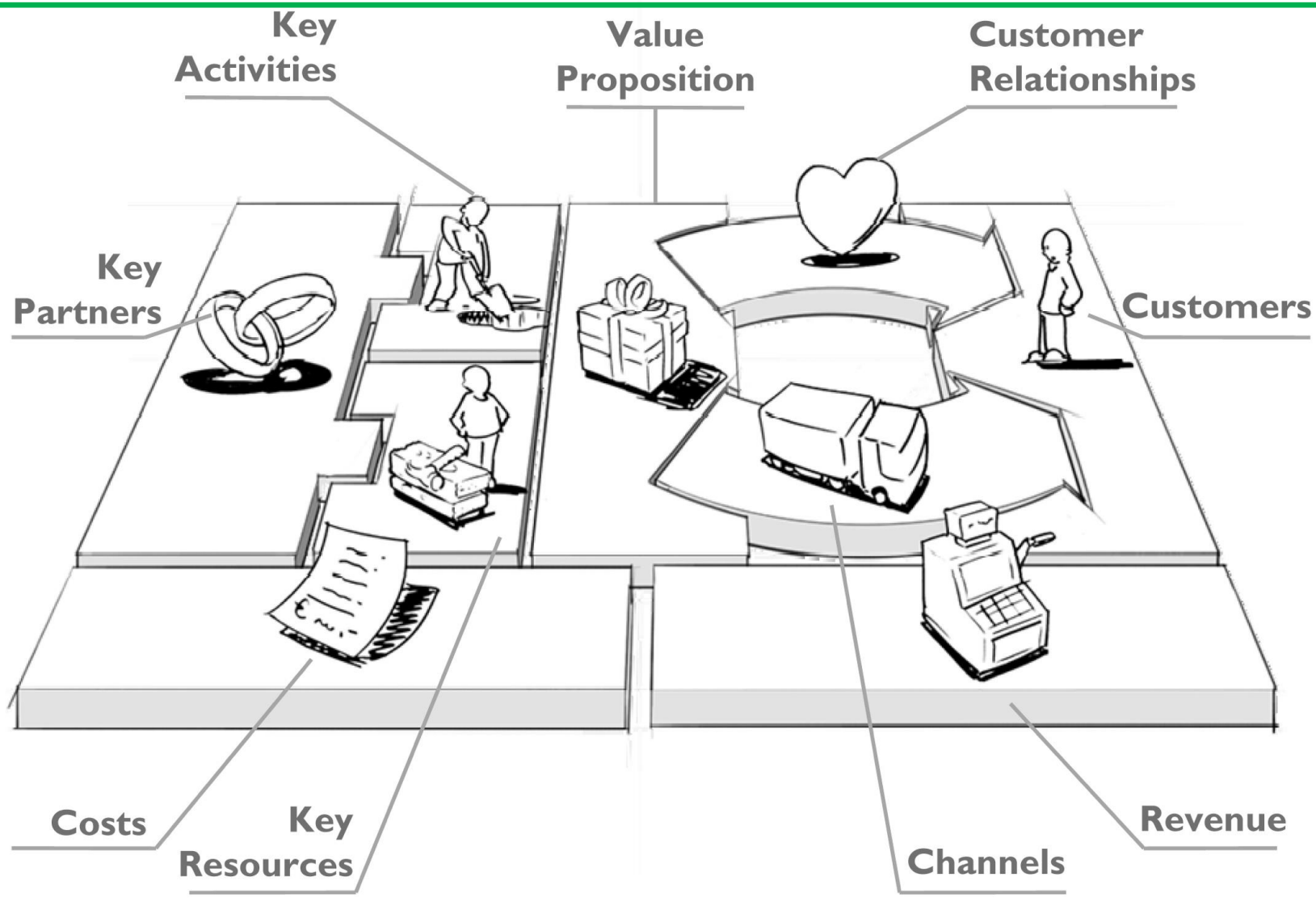
Value creation:
Key activities, resources, channels, partners, technology

Value capture:
Cost structure and revenue streams

ECONOMIC VALUE

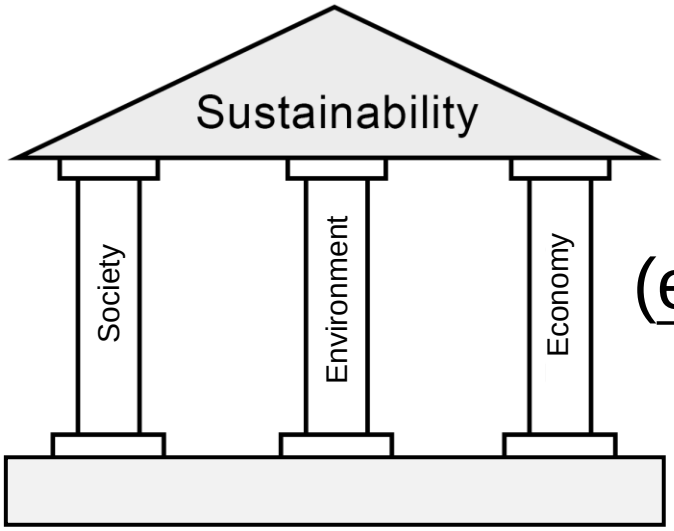
ENVIRONMENTAL & SOCIAL VALUE

BUSINESS MODEL CANVAS



***Source**: Osterwalder, A. & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*

SUSTAINABILITY and SUSTAINABILITY ANALYSES



Sustainability analyses

allow assessing the overall performance (environmental, economic and social) of services or products, during the whole life cycle.

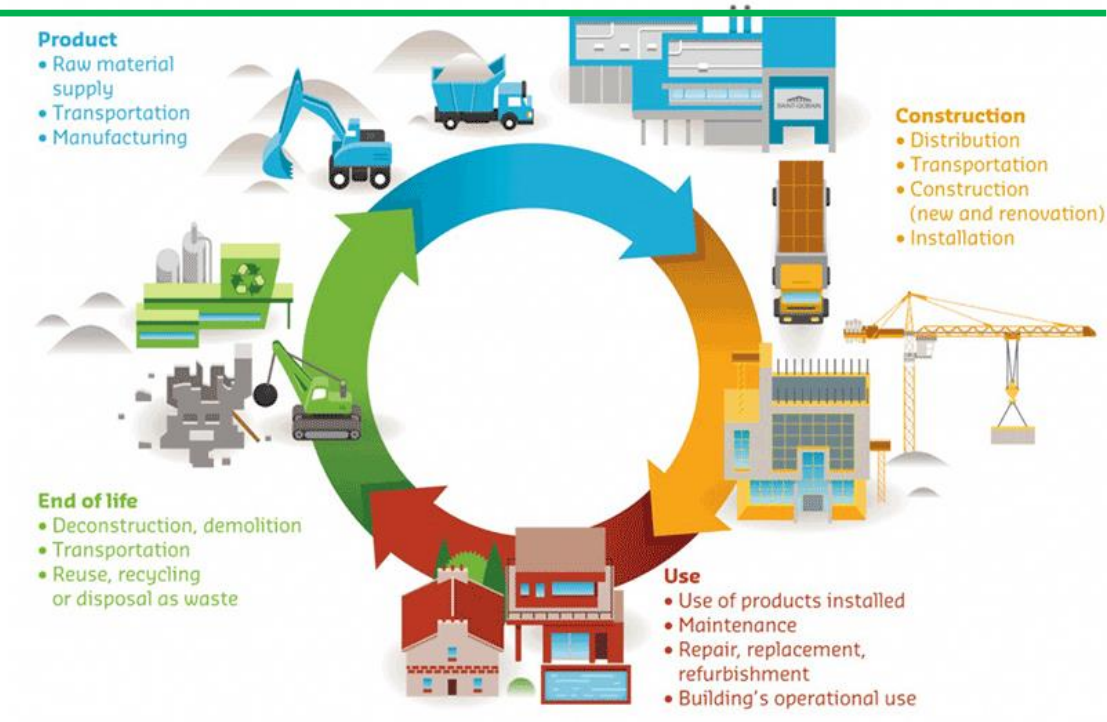
Related **TOOLS:**

- Life Cycle Assessment (LCA)
- Life Cycle Costing Analysis (LCCA)
- Social Life Cycle Assessment (S-LCA)
- …

BUILDING ENERGY RENOVATION PROJECTS

EXISTING BUILDINGS

High sustainability-related impacts during the whole life cycle



ENERGY RENOVATION PROJECTS

Implementation of energy efficiency measures in the building envelope and/or the technical building systems.

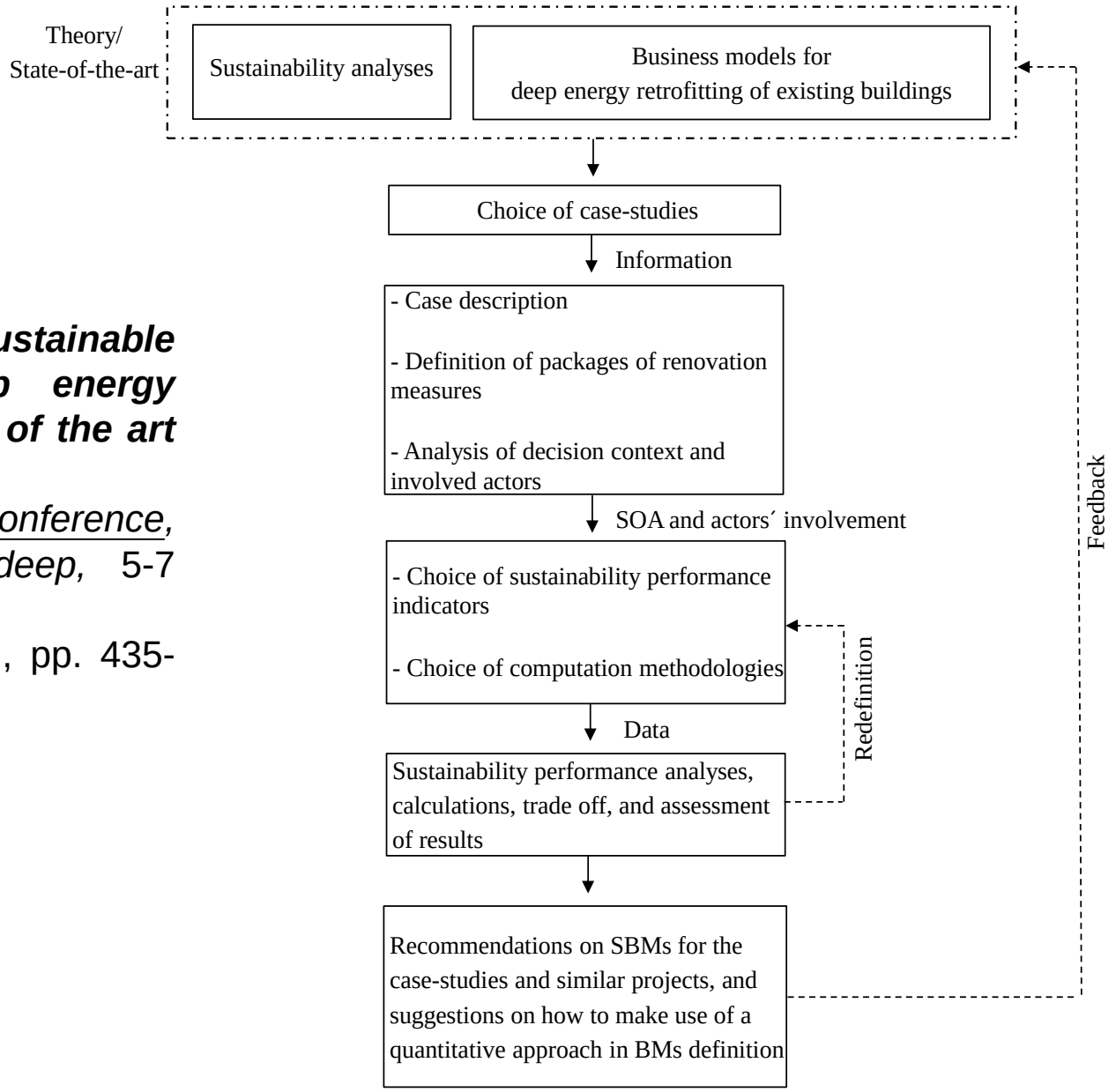
- Improvement of energy performance;
- reduction of utility bills and maintenance costs;
- improvement of wellbeing;
- etc.

RESEARCH QUESTIONS

How can the sustainability level of a building energy renovation project be defined?

How can quantitative sustainability results be integrated into business models for such project?

METHODOLOGICAL APPROACH



Source:
R. Moschetti, H. Brattebø, ***Sustainable business models for deep energy retrofitting of buildings: state of the art and methodological approach***.
In proceedings of *SBE16 Conference, Build green and Renovate deep,* 5-7 October 2016, Tallin&Helsinki.
Also in *Energy Procedia* (2016), pp. 435-445.

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CASE STUDY

SEOPP: Systematic energy renovation of small houses in the period 1960 – 1990, in Norway.

http://seopp.net

CASE STUDY BUILDING

Before the renovation project

After the renovation project

RENOVATION MEASURES:

- New internal layout with floor area extension;
- upgrade of the building envelope;
- bathroom renovation;
- new external drainage;
- exterior/interior painting;
- new mechanical ventilation system with heat recovery;
- new electric radiators;
- new electric floor heating;
- new clean burning wood stove.

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BUSINESS and DECISION CONTEXT

Value proposition:

Deep energy renovation of the house, with possible reduction of energy/operating costs and overall improvement of the house functionality.

Measure implementation:

Individual solutions by several service providers

Business model drivers:

Economic incentives covering part of investment costs

Network of actors

SINTEF, MESTERHUS, HUNTON, NorDan, isola, GLAVA ISOLASJON, RATIO ARKITEKTER AS, BOLIGENØK - et selskap i Glavagruppen, BYGGMA group, VELUX, enova, Husbanken, FLEXIT REN OG FRISK LUFT, NVE

Active choice of a set of performance indicators to evaluate, covering all sustainability dimensions, through a questionnaire

https://docs.google.com/forms/d/e/1FAIpQLSeqb15n4bfP5fa1VM5VF1g2fQsN0FTkHq-LePZ2J30lQn4vKQ/viewform

LIFE CYCLE ASSESSMENT

Environmental indicators:

- **Climate change (kg CO_2 eq.)**
- **Non-renewable primary energy (MJ)**

EPD Environmental Product Declaration + Ecoinvent Database 3

SimaPro

Main assumptions:

- Life phases: construction, operation, end-of-life
- Impact assessment method: ReCiPe & Cumulative energy demand
- Life span: 50 years
- Electricity mix: Nordel

Operation phase

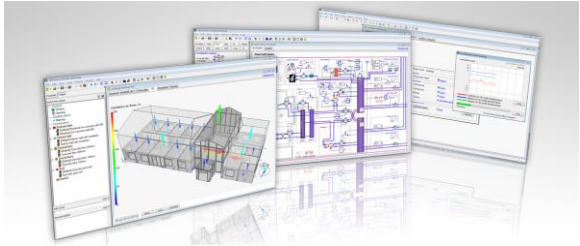
- Space heating (electricity + 20% wood fuel)
- Domestic hot water
- Ventilation
- Lighting and electric appliances

Dynamic energy simulations

+

Standard NS 3031:2014

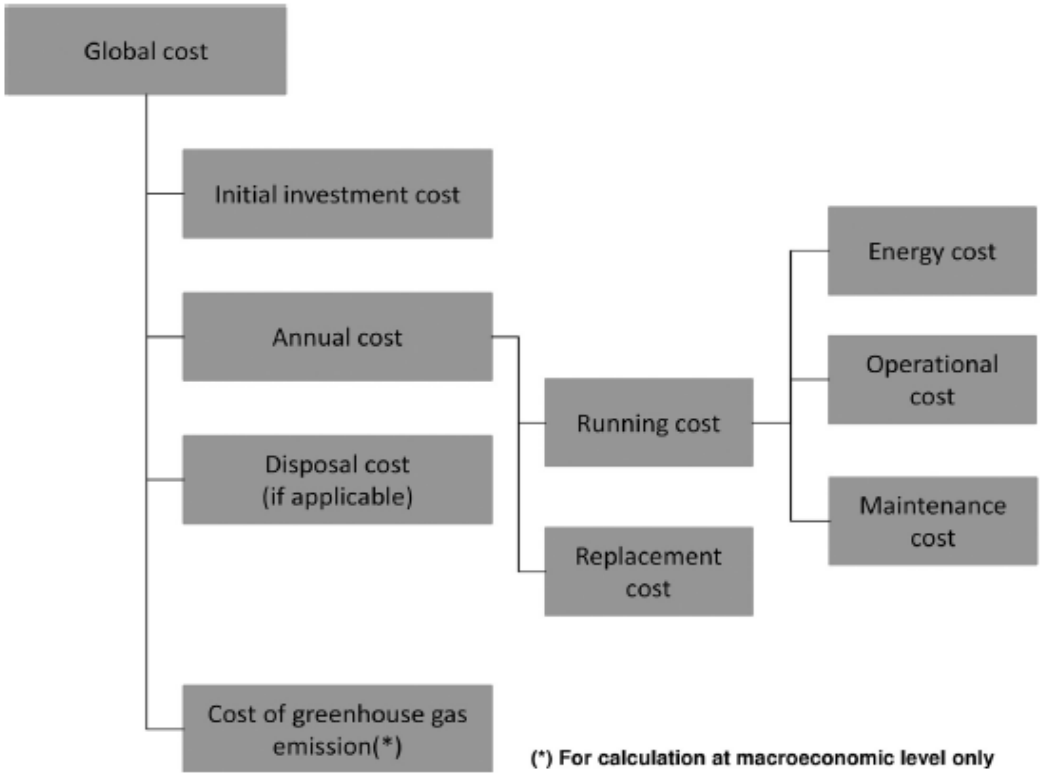
IDA ICE Indoor Climate and Energy



LIFE CYCLE COSTING ANALYSIS

Economic indicator: **Global cost**

$$C_G(\tau) = C_I + \sum_j [\sum_{i=1}^{\tau} \frac{C_{a,i}(j)}{(1+r)^i} - \frac{V_{f,\tau}(j)}{(1+r)^\tau}]$$

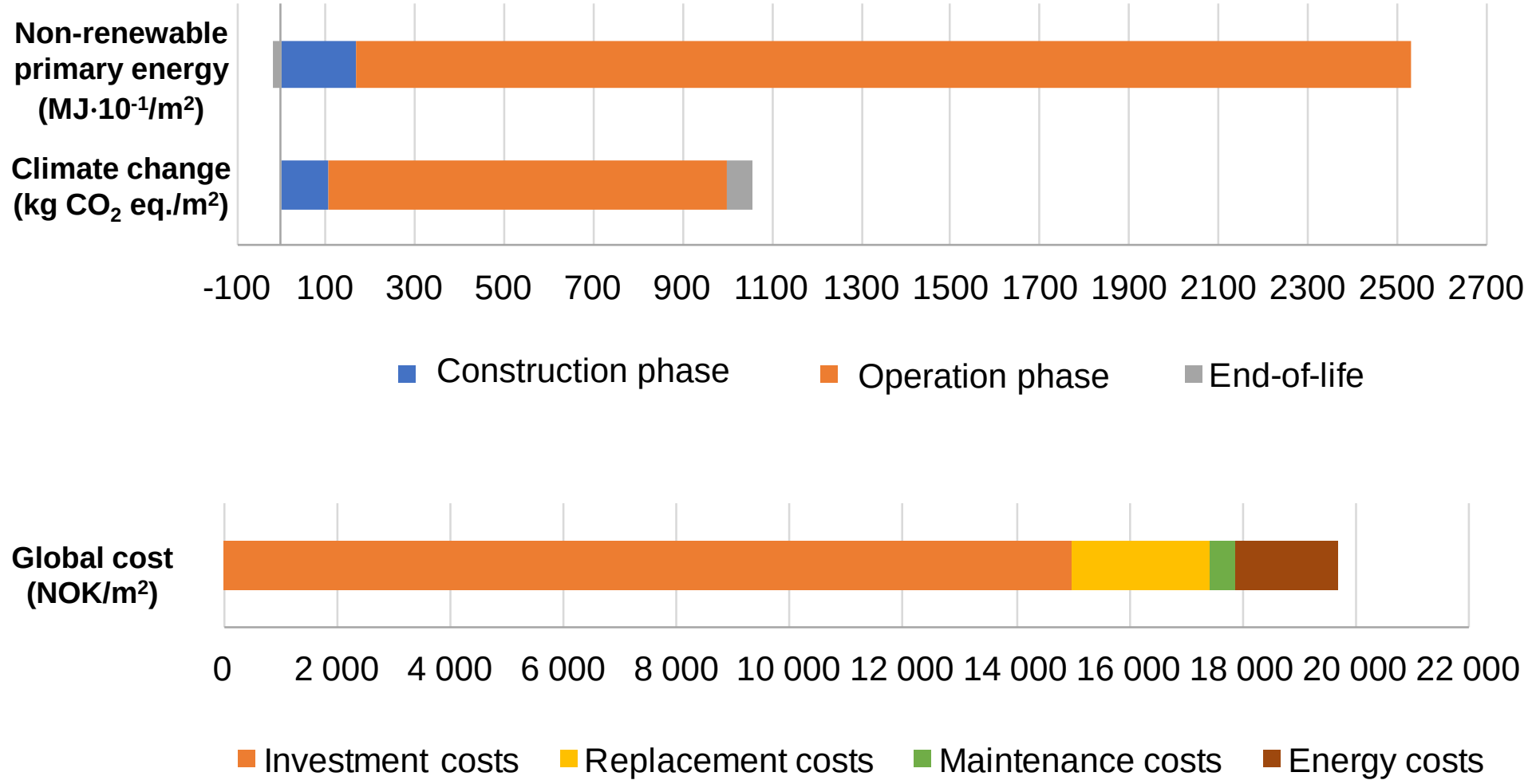


Where:
C_G (τ) : global cost
C_I : initial investment cost
$C_{a,i}$ (j) : annual cost for component j
$V_{f,\tau}$ (j) : final value of component j
r : real interest rate
τ : calculation period

Main assumptions:

- Life phases: construction and operation
- Real discount rate: 4%
- Life span: 50 years

RESULTS:
ENVIRONMENTAL & ECONOMIC INDICATORS



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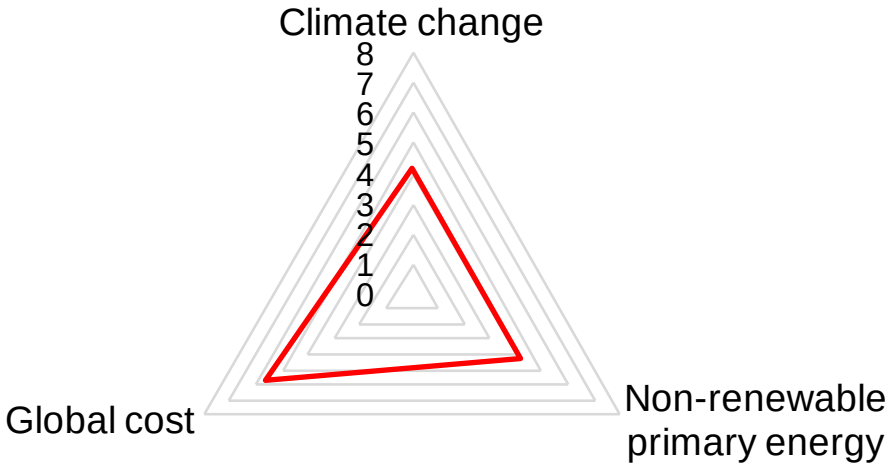
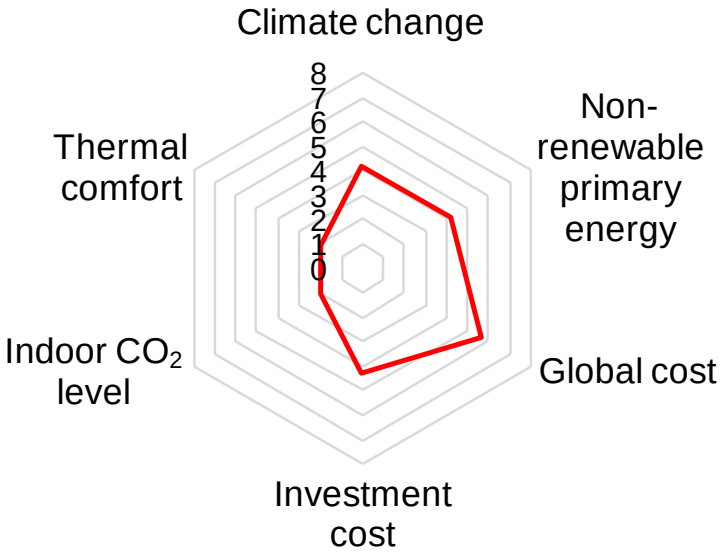
RESULTS: OVERALL PERFORMANCE

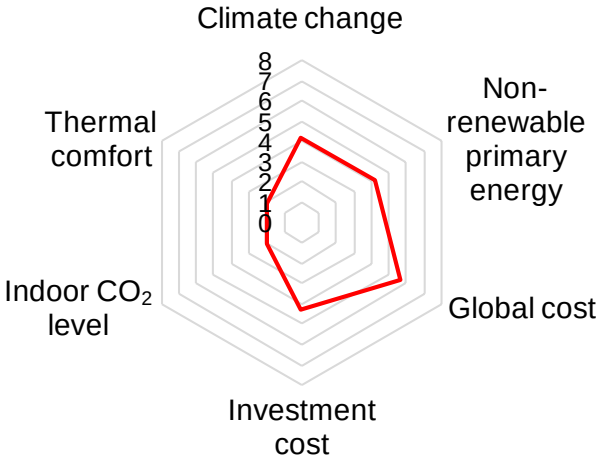
Computation of further indicators



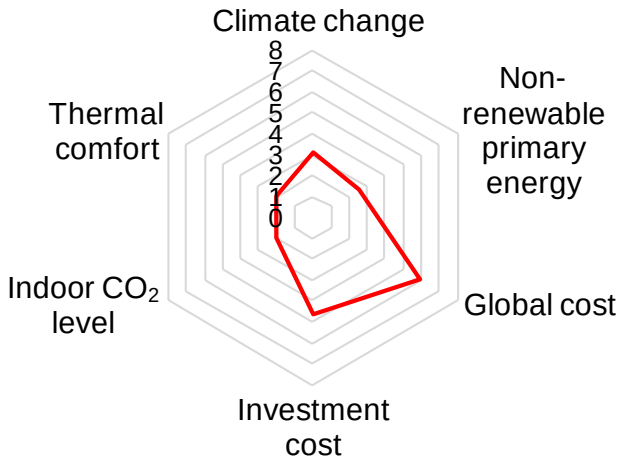


Comparison of different scenarios

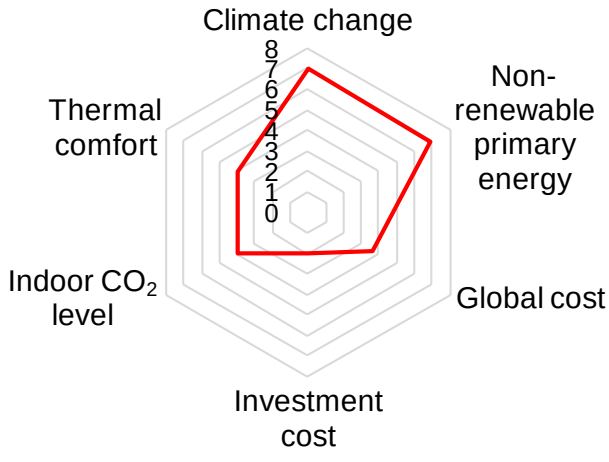
0: BEST
8: WORST



Scenario 1



Scenario 2



Scenario 3

CONCLUSIONS and OUTLOOK

- Life cycle environmental and economic assessment of an energy renovation project => discussion on how results might be integrated into business models of these projects.

- A new methodological approach for sustainable business modeling in the building field.

- Focus on how the project could propose, create, and capture value, in a triple bottom line perspective and based on quantitative results.

Future research work:

- Benchmark values for performance indicators;
- Other energy efficiency projects, e.g. nearly zero-energy buildings (nZEB).

Thank you

Questions, comments and suggestions are welcome!

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