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

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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

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
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)

...
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.
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?
Sustainable business models for deep energy retrofitting of buildings: state of the art and methodological approach.

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CASE STUDY


http://seopp.net
Before the renovation project

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

After the renovation project
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
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-LePZJ30lQn4vKQ/viewform
LIFE CYCLE ASSESSMENT

Environmental indicators:
- Climate change (kg CO₂ eq.)
- Non-renewable primary energy (MJ)

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
**LIFE CYCLE COSTING ANALYSIS**

**Economic indicator: Global cost**

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

Where:
- \( C_G(\tau) \): 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
- \( \tau \): calculation period

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

(*) For calculation at macroeconomic level only
RESULTS:
ENVIRONMENTAL & ECONOMIC INDICATORS

- **Non-renewable primary energy** (MJ·10⁻¹/m²)
- **Climate change** (kg CO₂ eq./m²)
- **Global cost** (NOK/m²)

- **Construction phase**
- **Operation phase**
- **End-of-life**

- **Investment costs**
- **Replacement costs**
- **Maintenance costs**
- **Energy costs**
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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