Session 5: Low Temperature District Heating and Building

Use Case of Sustainable Generation Model methodology: Infrared Heating in combination with indoor multi reflection insulation systems to overcome lock in effects for low enthalpy sources

Sustainable Generation Model

A methodology approach for developing sustainable innovations

Author: Peter Heßbrüggen
Agenda

- Highlight Result
- SGM Methodology
- Use Case IFRED
- Scenario Analysis
- Discussion and Next Steps
IF-RED System:
- > 10% Convective Heat Flow
- -> 10% Conductive Heat Flow
- -> 90% Infrared Heat Flow,
- > 95% IR Reflection
- < 10% Conductive Resistance

Result: High Insulation Efficiency -> Low Energy up to Passiv House Standard

By conduction
By convection
Convection transports conduction
Infrared absorption
Infrared radiation

4th Generation District Heating Technologies and Systems
Agenda

- Highlight Result
- SGM Methodology
- Use Case IFRED
- Scenario Analysis
- Discussion and Next Steps
Toolbox to analyse, develop and assess ideas for a viable and healthy world

Templates and tools to identify the sustainable optimum

Innovative Ideas

Drivers

Stakeholders

Economy

Technologie

Environment

Impact

Risk

Sustainable Innovation

Design

Drivers

Stakeholders

Economy

Technologie

Environment

Impact

Risk

Sustainable Innovation

Design

Drivers

Stakeholders

Economy

Technologie

Environment

Impact

Risk

Sustainable Innovation

Design

Drivers

Stakeholders

Economy

Technologie

Environment

Impact

Risk

Sustainable Innovation

Design

Drivers
Agenda

• Highlight Result
• SGM Methodology
• Use Case IF-RED
• Scenario Analysis
• Discussion and Next Steps
Problem and Research Question
System Design of Smart Energy System – 100% RES

Core Assumption:
Heat demand decrease and energy transmission on low temperature due to heat pump and heat transport efficiency

Problem:
High percentage of existing old buildings
Investment for energetic refurbishment is not Economic feasible

-> Research Question:
Searching for innovative ideas to decrease costs for using low enthalphy sources that have a sounding sustainable impact

Source: Smart Energy System - David Connolly http://www.energyplan.eu/smartenergysystems/
Lean Disruptive Innovation Idea
Elevator Pitch – IR HEATING SYSTEM

Example of a Sustainable Value Provision Diagram for Energy Saving Measures

Renewable Power Provision → Electricity Storage → Transport Electricity → Building Insulation

Fossil Energy Provision → Heating System → Transport Heat

Short Heat Storage → Saisonal Heat Storage

Smart Grid Industrie 4.0 Infrastruktur → Energy Provision Service → Energy Provision Billing

Value Proposition
- Cosy
- Flexible
- Fast
- Inexpensive
- Reliable

Lean Design Process: Find the Gap! Sustainable Solution

Service Providers

Example of a Sustainable Value Provision Diagram

Analyse Innovation

Value Proposition
- Cozy
- Flexible
- Fast
- Inexpensive
- Reliable

Building Insulation

Transport Heat

Short Heat Storage

Resident

Find the Gap!

Sustainable Solution

4DH

Value Proposition Solution Fit

Discussion and Recommendation:
Based on the analysis it can be concluded, that innovation system designs are preferred, that are able to reduce heat demand in buildings, lower heat flow temperature and take advantage of short heat storage systems.
Promising System Design

Transport Heat
- Transport Heat <30 °C
- Capillary Ceiling
- Infrared Heating 26-28 °C

Infrared Insulated building envelope
- Including windows from inside with less than 1% conductive elements.

Building Insulation
- Control System: No Convection if Delta T between matter is <12°K
- Conductive Insulation through dry (existing) walls
- Reduce thermal bridging through infrared reflective coating

Short Heat Storage
- Heat Storage System
- Room Temperature <18 °C
- Inside matter absorbs infrared radiation and changes to Infrared heater with average temp of 22-23°C

Best Humidity Level for Humans 45-60%
- No fungi no flu virus

Average felt temperature 19 °C (Best temperature for human body) feels warm and comfortable
- Resident
- Value Proposition
  - Cozy
  - Flexible
  - Fast
  - Inexpensive
  - Reliable

Residents

Control System:
- No Convection
- if Delta T between matter is <12°K

Solutions Design Map

Transport Heat

Heat Storage System

Room Temperature <18 °C

Inside matter absorbs infrared radiation and changes to Infrared heater with average temp of 22-23°C

Average felt temperature 19 °C (Best temperature for human body) feels warm and comfortable

Best Humidity Level for Humans 45-60%
- No fungi no flu virus

Consumer

No Convection if Delta T between matter is <12°K

Conductive Insulation through dry (existing) walls

Reduce thermal bridging through infrared reflective coating

IFRED: Infrared Heat Flow System Application
Agenda

• Highlight Result
• SGM Methodology
• Use Case IFRED
• Scenario Analysis
• Discussion and Next Steps
S. Decision Matrix

- Energetic Refurbishment
- Current Price of Building
- Costs of Refurbishment
- Energetic forced Refurbishment Costs
- Insulation
- Wärmeabgabe
- Heating Source
- Heat Storage
- Heat Transport
- Electricity Source
- Electricity Storage
- Capital Expenditure
- Amortization Period
- External Energy As-Is €/kWh
- Depreciation/ Jahr (€)
- operating costs (€)
- TCO/ Year (€)
- Cost of Th €/kWh
- Cost of Fossile E €/kWh
- Demand th/kWh
- Demand e/kWh
- External Energy Should-Be €/kWh
- Depreciation Energetic Refurbishment
- Indirect Costs €/kWh
- Cost/ year(€)
- Profit/ Year (€)
- CashFlow & PeakFund
- Energetic BreakEven
- Net Present Value
- Economic Value Added
- CO2 Reduction
- Waste/ Pollutants Reduction
- Fire Prevention
- Health Prevention
- WACC

### Scenarios

**Legend Scenarios**

1. As-IS
2. Best Practice
3. IF-RED

<table>
<thead>
<tr>
<th>Size of Base Building</th>
<th>161 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg rental cost without energy / m²</td>
<td>6,00 €</td>
</tr>
</tbody>
</table>

**Business As Usual + new windows**
- New condensing boiler
- Outwall insulation mineral whool
- Existing boiler with
- Wall heating and local water storage tank 500 l
- Inwall infrared reflection

**Location**
- Germany/Plön Schleswig Holstein
Empirical Scenario Analysis

- Capital Costs / Year (20)
- Energy Costs / Year

- 1: As/IS
- 2: Best Practice
- 3: IF-RED

- CO2 t /Year

1: As/IS
2: Best Practice
3: IF-RED
The Sustainable Generation Model

**Project:** Energy Refurbishment

**Designed by:** Peter Hessbrueggen

---

**Problem, Risk, Desire**
- **Problem:** Fulfill EnEv and Climate Goals
- **Risk:** Climate Penalty
- **Interest:** Sustainable Owner
- **Need:** Low Energy House
- **Desire:** Cosy and environment friendly home

**Value Proposition**
- Cosy secure and healthy refurbishment with passiv house standard to lowest cost
- Resident Owner of building with refurbishment backlog and >150 kWh/m²a heat demand

**Unique Strengths**
- Achieve Low Energy up to Passiv House Standard with less cost than outside insulated houses. No mold through wet walls.

**Solution**
- Infrared Heat Flow System

**Customer Archetype**
- Resident Owner of building with refurbishment backlog and >150 kWh/m²a heat demand
- District Road Show Inhouse insulation fairs
- Property developer

**Customer Channels**
- Increased fire hazard possibility
- Sickness Mold and flu virus Reduction
- Mortage coverd by savings

**Cost Structure**
- IR Multifoil Insulation
- Wall/Ceiling IR Heating System
- Heating System Storage Interface
- Consulting Implementation Maintenance

**Revenue Streams**
- Monthly rent include service charges

**Stakeholder**
- Key Customer
- Founder Team
- Key Partners
- Employees
- Key Investors

**Economy**
- 26-55% Reduction
- High Energy Costs

**Nature**
- CO2 Emission
- X% Reduction
- Plastic Waste

**Society**
- High Energy Costs
- 26-55% Reduction
- High Investment Mortage coverd by savings

**Sketch Canvas!**

---

**Who is involved and wins?**
- Key Customer
- Founder Team
- Key Partners
- Employees
- Key Investors

**What is your impact to society?**
- Increased fire hazard possibility
- Sickness Mold and flu virus Reduction
- Mortage coverd by savings

**What is your economic impact?**
- High Energy Costs
- 26-55% Reduction
- High Investment Mortage coverd by savings

**What is your impact to nature?**
- CO2 Emission
- X% Reduction
- Plastic Waste

**Unique Strengths**
- Achieve Low Energy up to Passiv House Standard with less cost than outside insulated houses. No mold through wet walls.

**Solution**
- Infrared Heat Flow System

---

**Calculation Tools not available!**

---

www.reee.de
Agenda

• Highlight Result
• SGM Methodology
• Use Case IFRED
• Scenario Analysis
• Discussion and Next Steps
Discussion and Next Steps

- Promising solution for low enthalpy sources
- Setup INSITU environment for empirical measures
- Adopt calculation methodology EnEv
- Develop Sustainable Business Model and
- test additional hypothesis
Creative common licence
Peter Heßbrüggen

More information under http://creativecommons.org/

Dipl. Ing-(FH) Peter Heßbrüggen

Rathjensdorfer Weg 14
24306 Plön
sgm@evoltas.de
www.reee.de

peter.hessbrueggen@uni-flensburg.de
(PhD Research about SGM)

Other Utility Patents have to be accepted as well