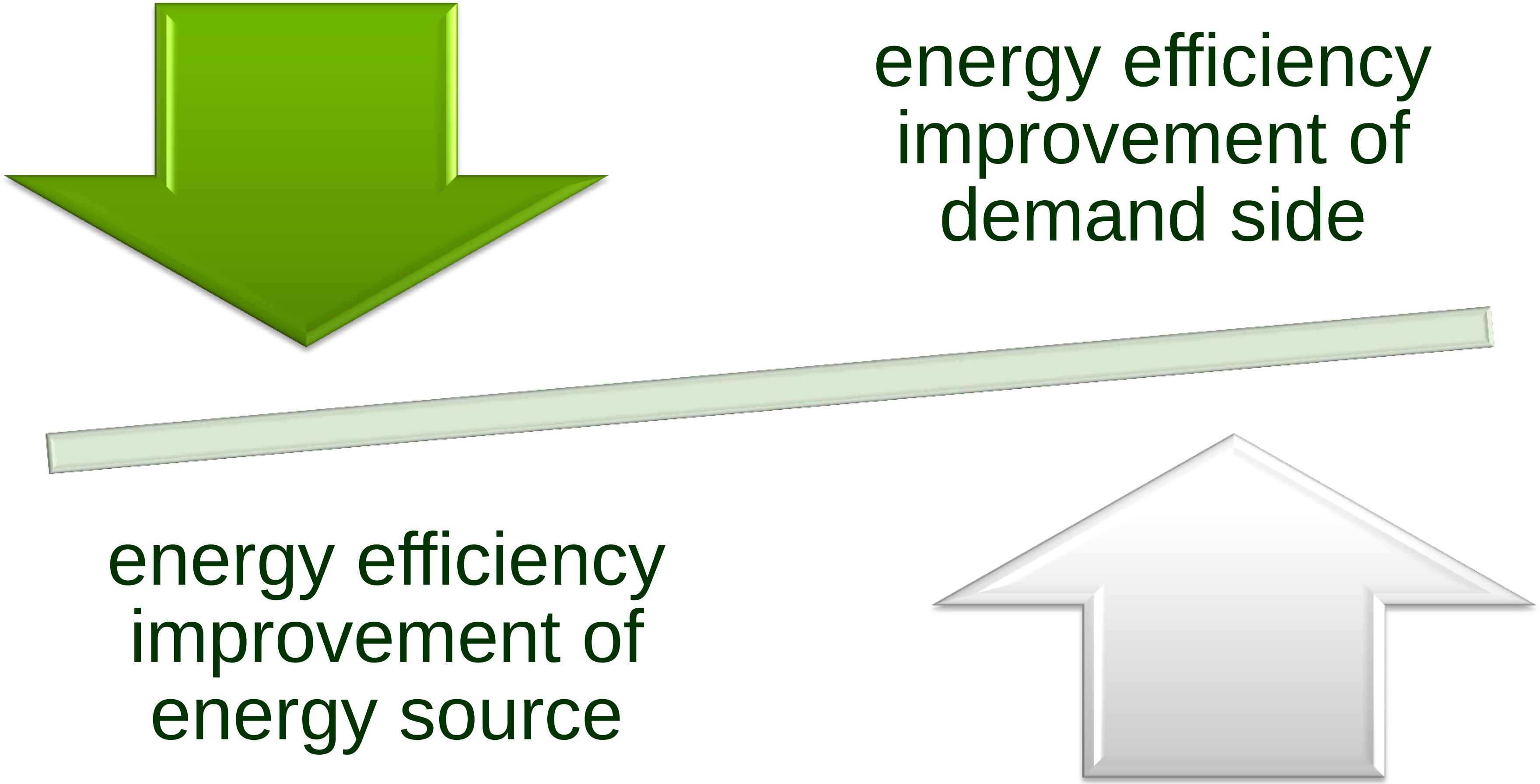
Riga Technical University
Faculty of Power and Electrical Engineering
Institute of Energy Systems and Environment
www.videszinatne.lv

Some aspects of low-temperature district heating systems: optimisation of retrofitting of historic buildings and role of solar energy source

Dagnija Blumberga, Dr.habil.sc.ing.
Riga, Latvia
26.09.2016.

Problem statement



CONTENT

1. *HISTORIC BUILDING RETROFITTING*
2. *SOLAR ENERGY IMPLEMENTATION IN AN EXISTING DISTRICT HEATING SYSTEM IN LATVIA – case study*

HISTORIC BUILDING RETROFITTING

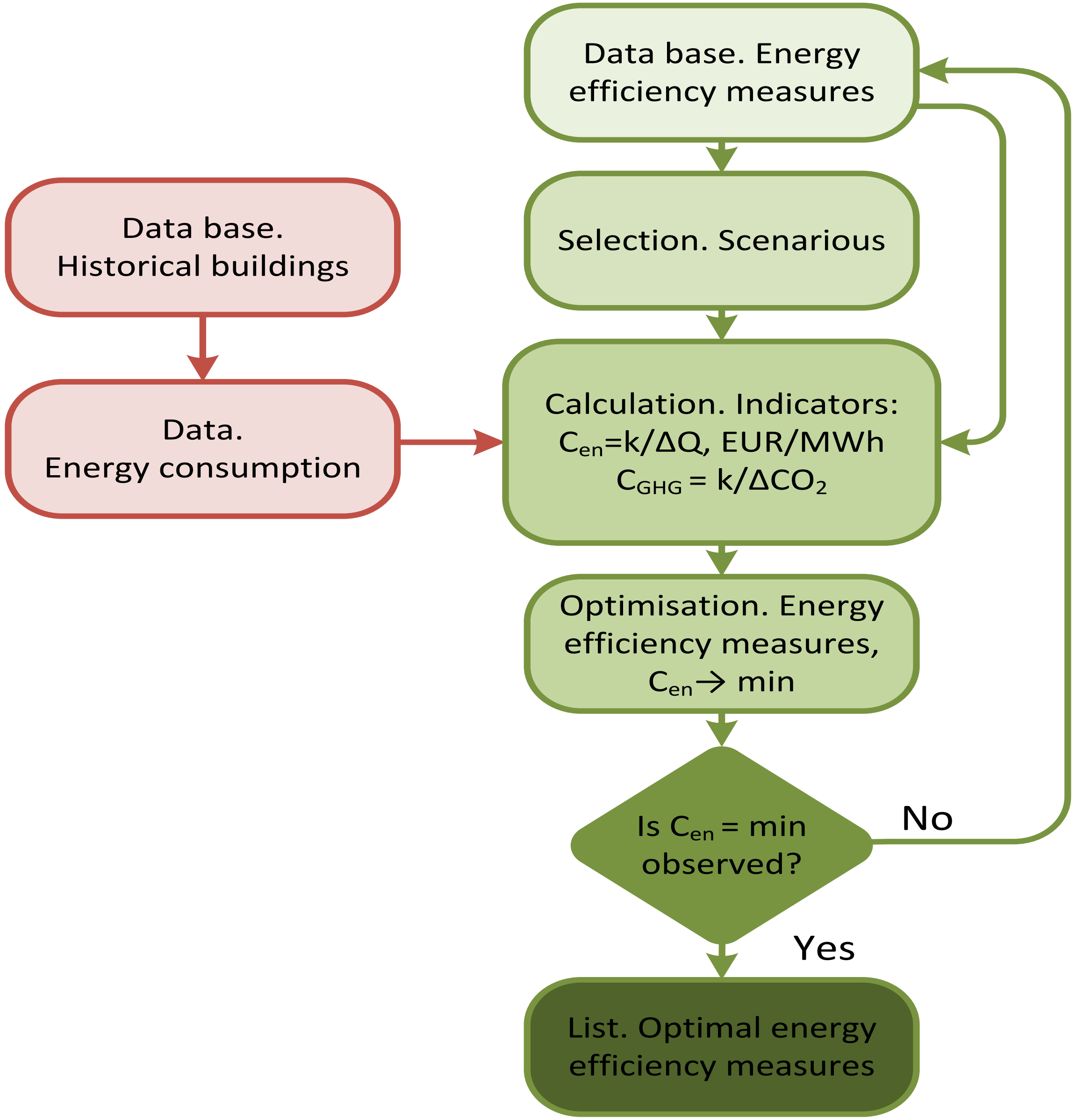
- High density of historic buildings in cities with rich cultural heritage
- Every building has a unique set of elements

PROBLEMS ASSOCIATED WITH HISTORIC BUILDING RENOVATION

- Different building construction
  - Facades with cultural heritage
  - Facades with no significant cultural heritage
- Inapropriate heating system
  - Inappropriate heating system installation
  - Mixed type heating system – in different areas of a building one and two pipe heating systems simultaniously

METHODOLOGY

- Historic building energy model according to the ISO 13790:2008
- Modeling different possible solutions
- Defining necessary heating loads



CASE STUDY. DESCRIPTION OF THE BUILDING

Type	Office building
Year of commissioning, year	1883
Indoor temperature in heating season, °C	20
Heated space, m^2	5084.50

BUILDING ANALYSIS

- Climatic data for Riga – **203** heating days, **0 ºC** standard heating season temperature, **20 ºC** average indoor temperature during heating season;
- Specific heat energy consumption – 119.25 kWh/m^2;
- Heating power at 0 ºC – 124.5 kW, heating power at -20 ºC – 295.6 kW

Construction	**U-value, W/m^{2}K**
Walls (different wall thickness)	0,73 – 1,30
Roof (partly insulated with 30 cm of loose wool)	0,12 – 0,97
Doors (partly retrofitted)	1,8 – 3,0
Basement (partly heated, partly unheated basement)	0,32 – 0,60
Windows (partly retrofitted)	1,8 – 2,4
Radiator count	377 (843,8 m^2)

POSSIBLE SOLUTIONS

- **Replacement of windows** – no changes to the external appearance of the building
- **Complete insulation of roof** – no changes to the external appearance of the building
- **Insulation of unheated basement**
- **External insulation of building facade elements without any cultural significance**
- **Internal insulation of building facade elements with cultural significance**
- **Technical servicing** of existing building heating system

DEFINING HEATING SYSTEM

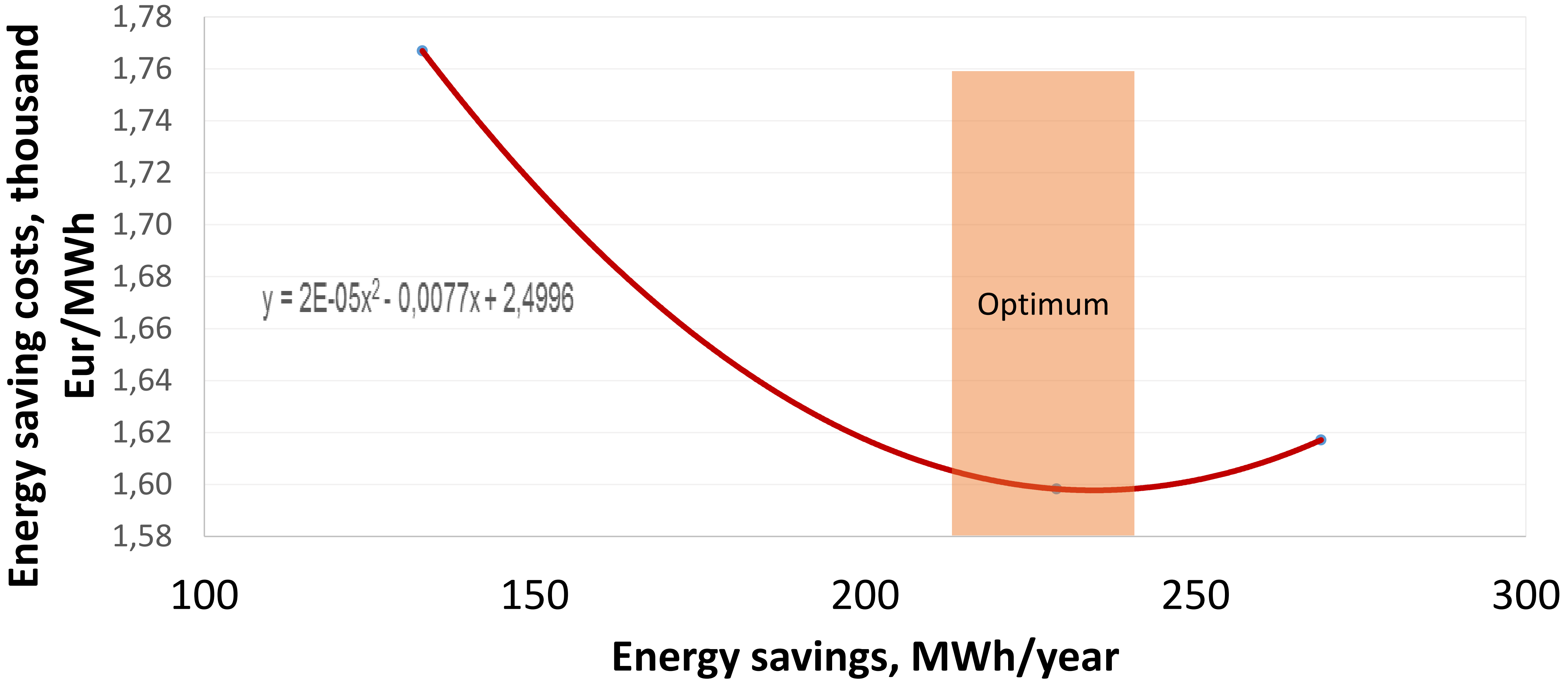
- Existing
  - Old and outworn
  - Unequal heat energy distribution
- Retrofit
  - Technical servicing
  - Replacement of old radiators with new (with thermostatic valves)
  - Infrared heating (tubes in walls)



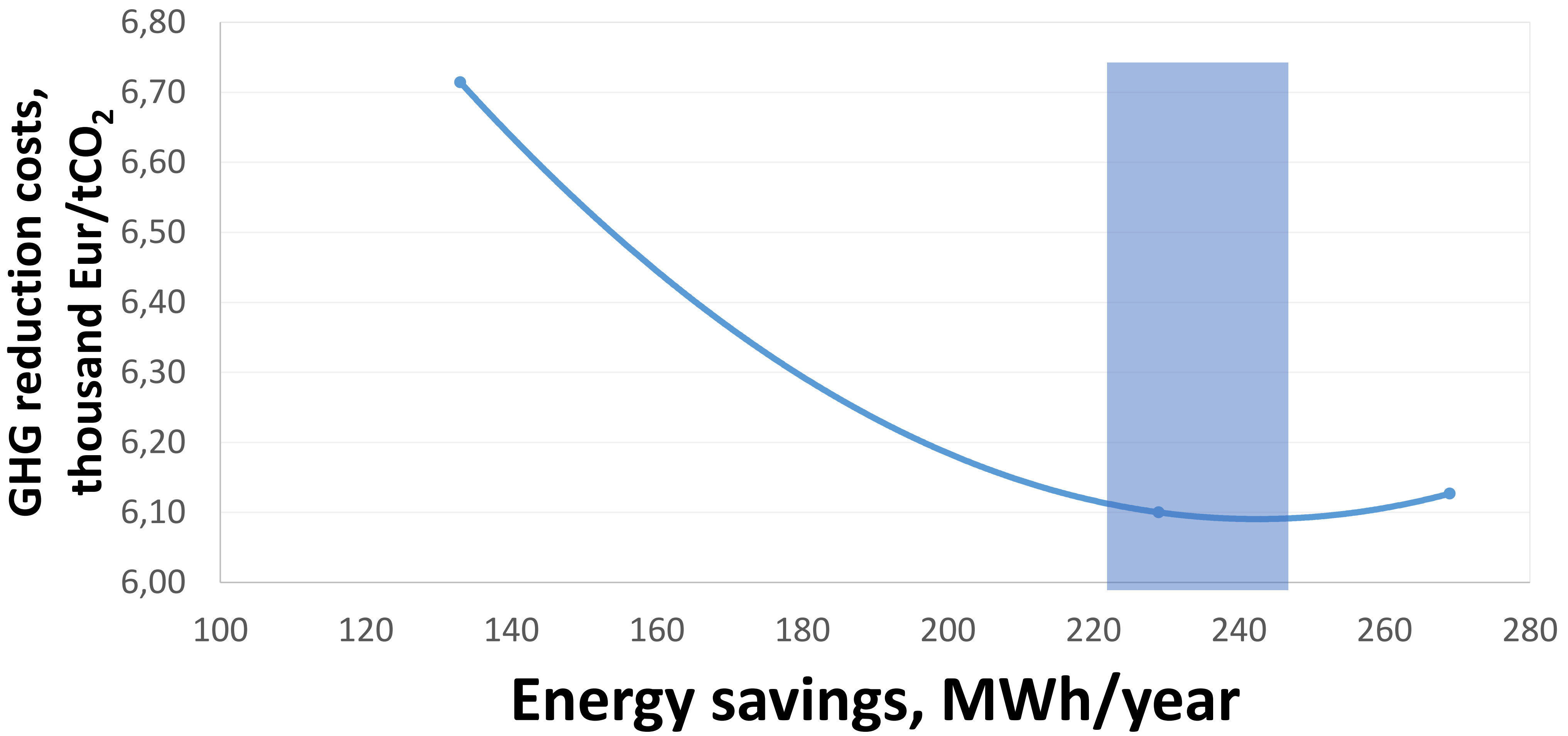

POTENTIAL SCENARIO ANALYSIS

- **1. scenario**
  - Roof insulation;
  - Replacement of windows
  - Heating system technical servicing (+ heating element replacement)
- **2. scenario**
  - Insulation of roof
  - Replacement of windows
  - Heating system technical servicing (+ heating element replacement)
  - **Insulation of walls from the outside (without cultural significance)**
- **3. scenario**
  - Insulation of roof
  - Replacement of windows
  - Heating system technical servicing (+heating element change)
  - Insulation of walls from the outside (without cultural significance)
  - **Insulation of culturally significant walls from the inside**

RESULTS (I)

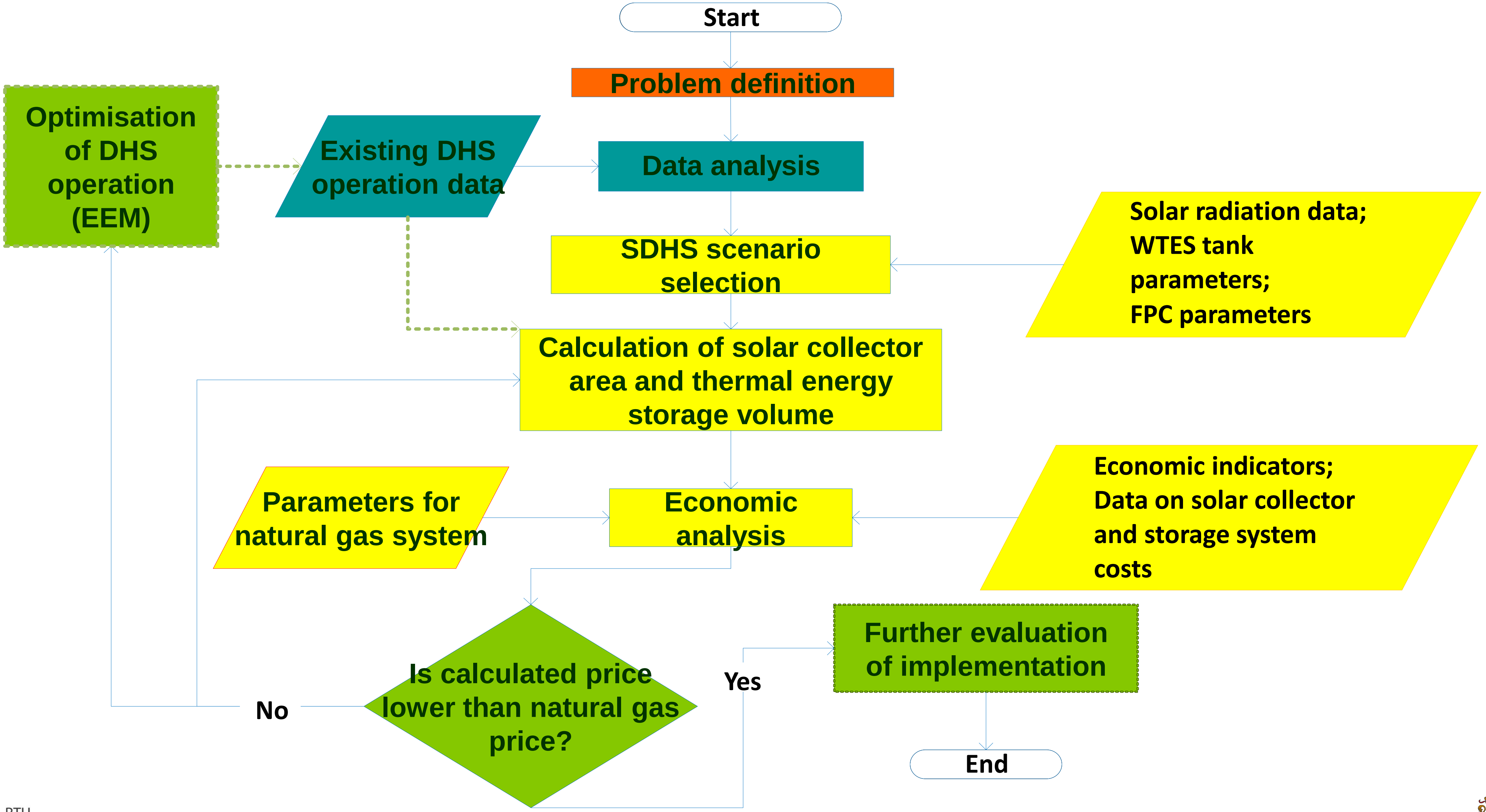

Energy saving costs, thousand Eur/MWh
1,78
1,76
1,74
1,72
1,70
1,68
1,66
1,64
1,62
1,60
1,58
y = 2E-05x2 - 0,0077x + 2,4996
Optimum
100
150
200
250
300
Energy savings, MWh/year

RESULTS (II)


GHG reduction costs,
thousand Eur/tCO2
6,80
6,70
6,60
6,50
6,40
6,30
6,20
6,10
6,00
100
120
140
160
180
200
220
240
260
280
Energy savings, MWh/year

Energy source

- Analysis of 8 scenarious with integration of Solar collectors and accumulation


Start
Problem definition
Optimisation of DHS operation (EEM)
Existing DHS operation data
Data analysis
Solar radiation data;
WTES tank parameters;
FPC parameters
SDHS scenario selection
Calculation of solar collector area and thermal energy storage volume
Parameters for natural gas system
Economic analysis
Economic indicators;
Data on solar collector and storage system costs
Is calculated price lower than natural gas price?
No
Yes
Further evaluation of implementation
End

RESULTS (I) - scenarios

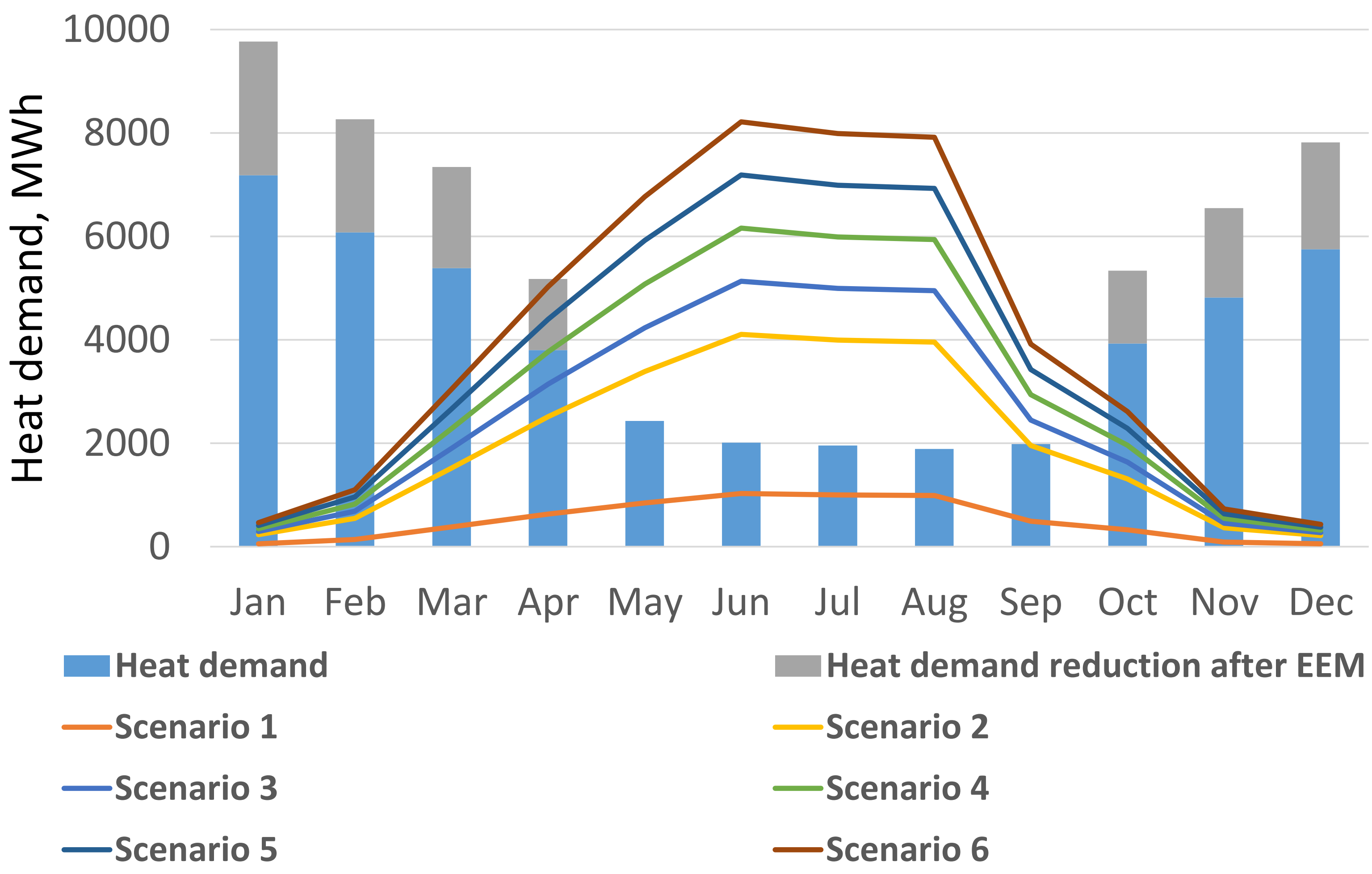
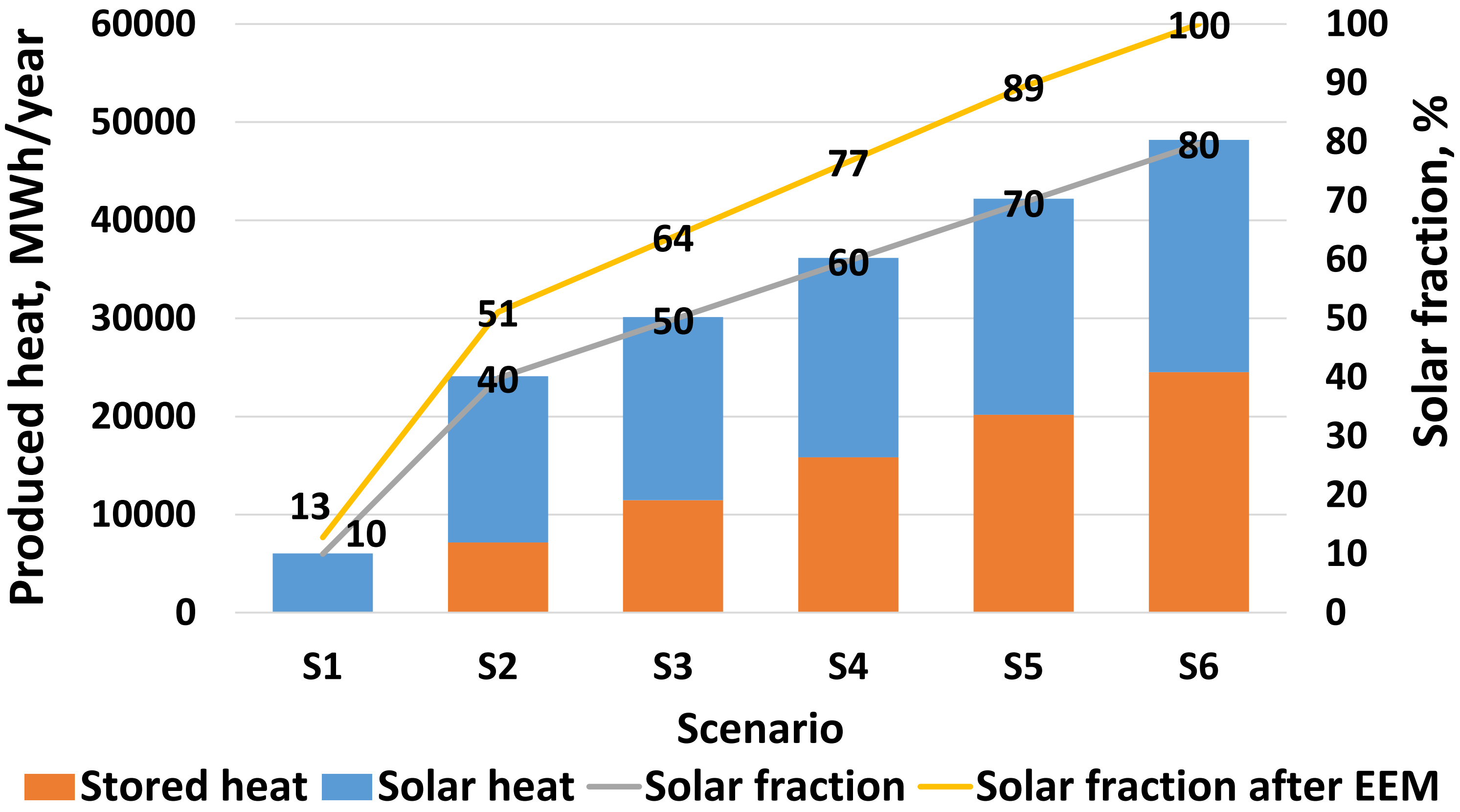


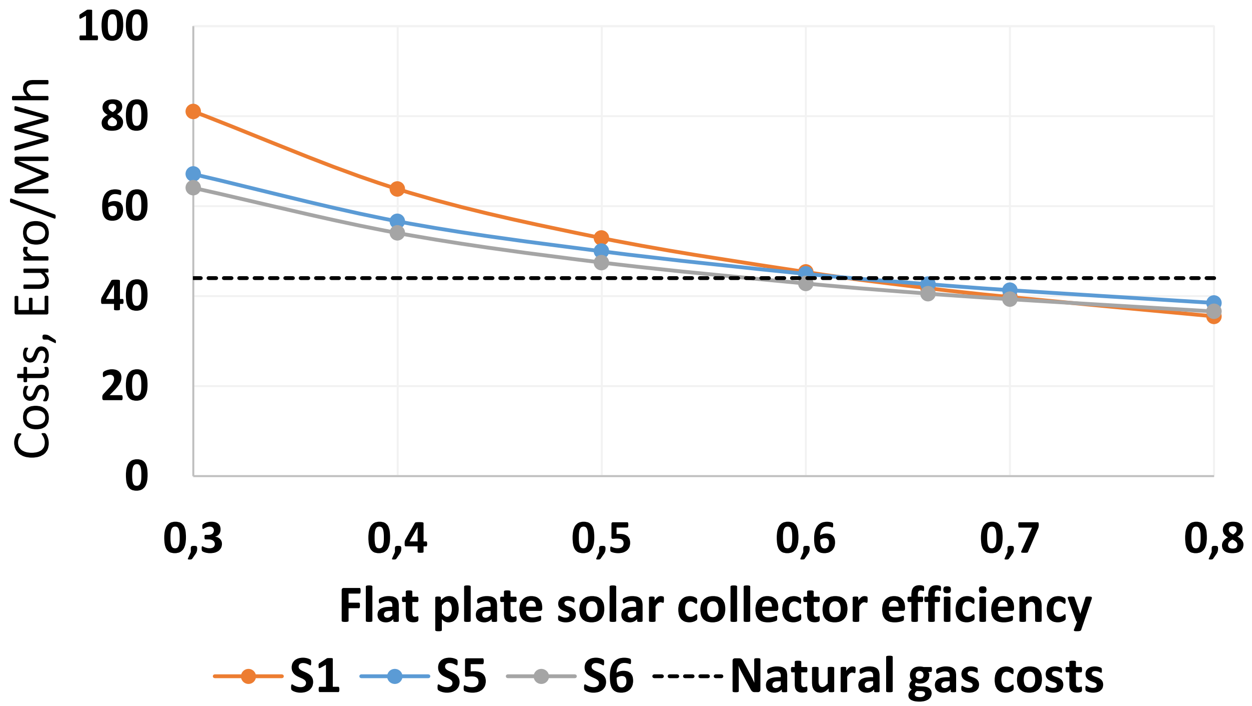
Figure 2. Heat demand and produced amount of heat in solar DHS for various scenarios

RESULTS (II) – SOLAR FRACTION



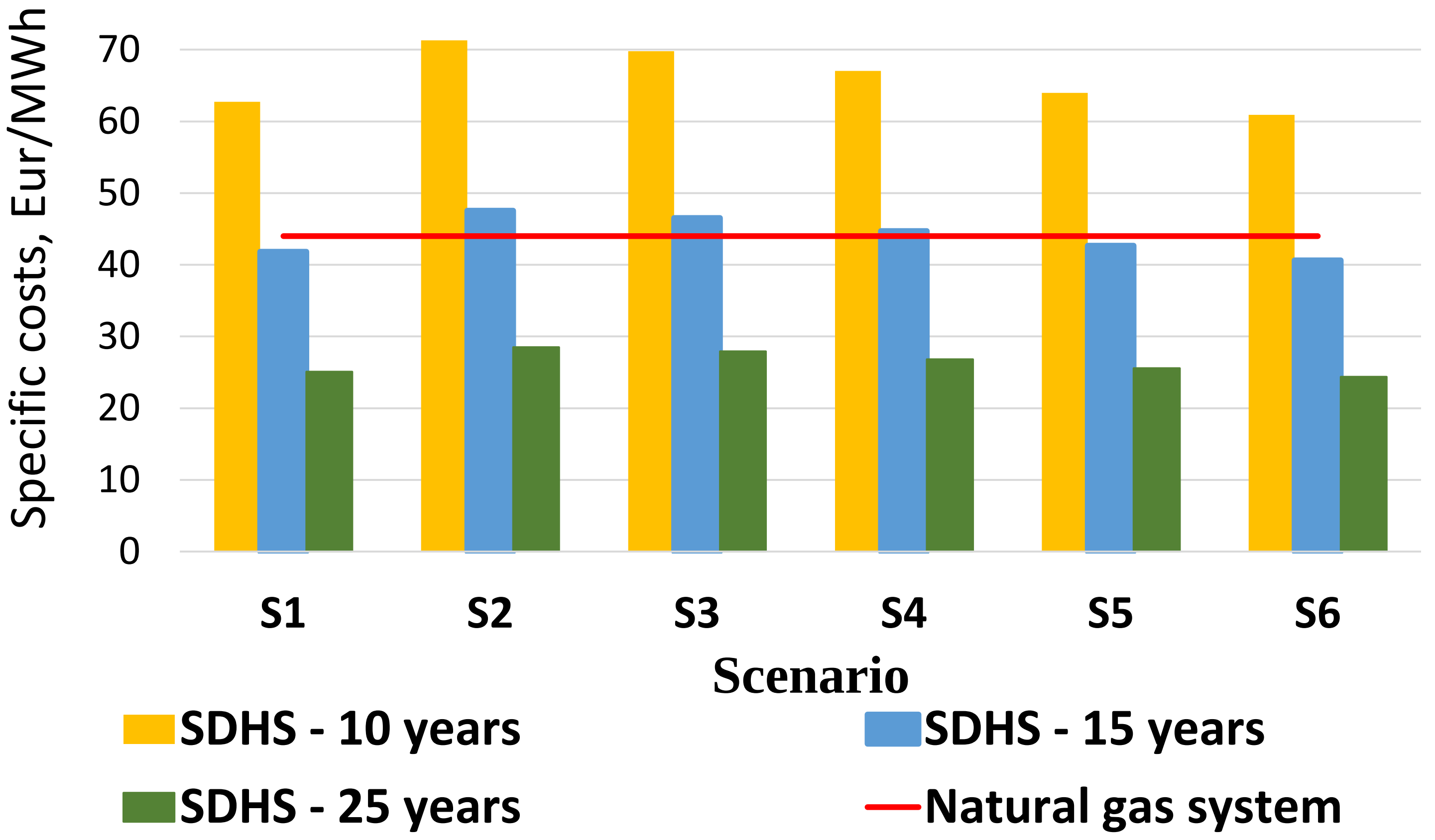
In solar fraction calculation it was taken into account that after energy efficiency measure (EEM) implementation total heat demand will be reduced.

RESULTS – COLLECTOR EFFICIENCY (III)



- Higher collector efficiency allows producing more energy.
- However, collector efficiency is affected by technological parameters, climate and operation conditions etc.

RESULTS (IV) – SPECIFIC COSTS



- For larger system's operation time, specific costs are lower.
- Specific costs for larger SDH systems are lower
- S1 – no storage system implementation costs

DISCUSSION

- Energy efficiency improvement measures is possible to optimise and reach minimum of specific costs.
- Specific costs of solar energy use depend from different parameters (efficiency both collectors and consumers, lifetime of solar collectors) and it is possible to find optimum too

More info

Institute of Energy Systems and Environment

Riga Technical University

info@videszinatne.lv

www.videszinatne.lv