2nd International Conference on Smart Energy Systems and 4th Generation District Heating
Aalborg, 27-28 September 2016

Development of heat saving platform in the system dynamics model for transition to 4th generation district heating

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AALBORG UNIVERSITY DENMARK

4DH 4th Generation District Heating Technologies and Systems

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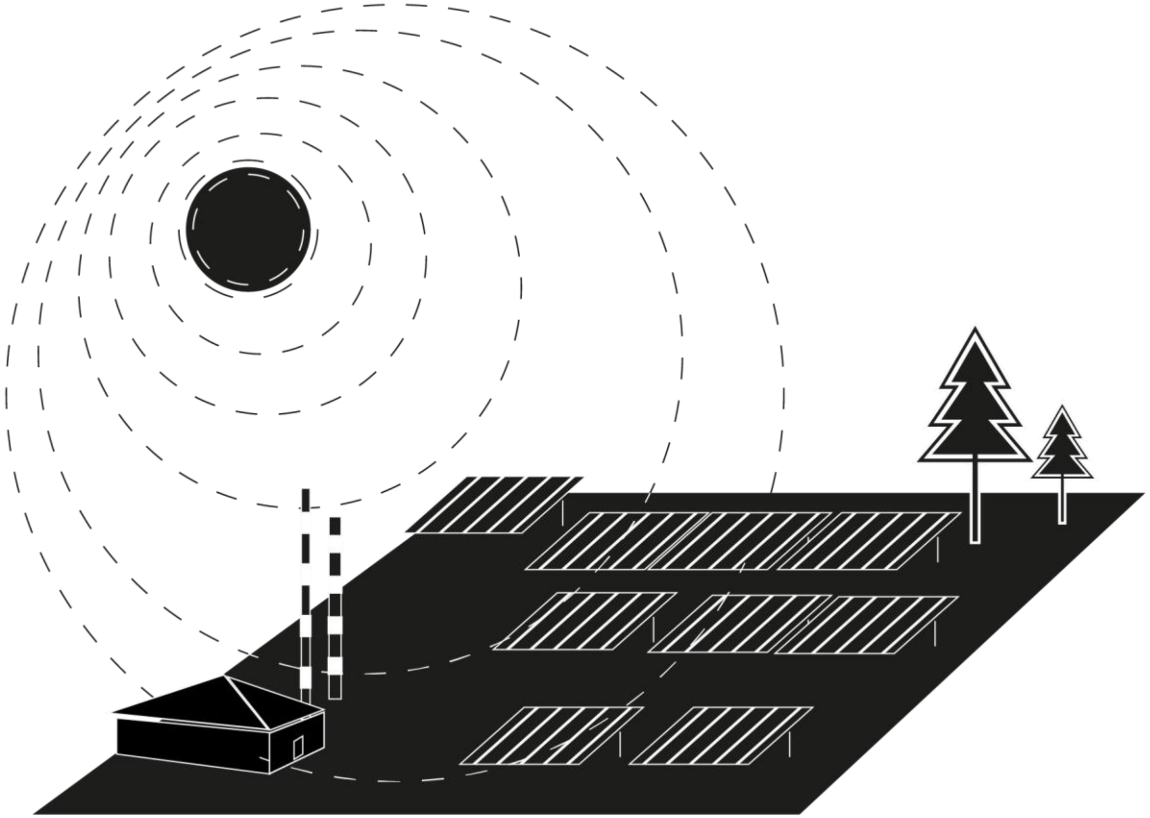
Contents

Goal of research

To evaluate by use of system dynamics model the impact of energy conservation measures for reaching 4th generation DH system



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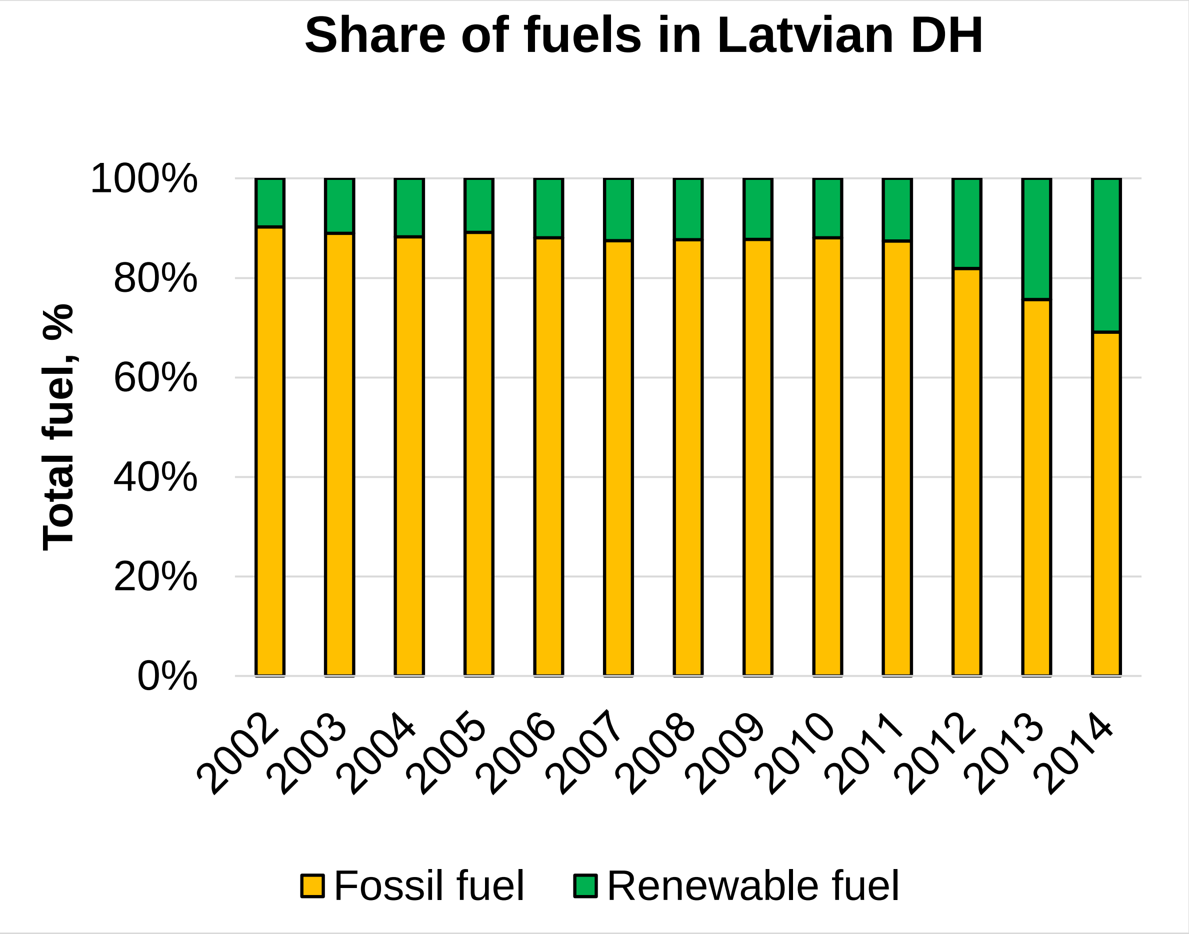
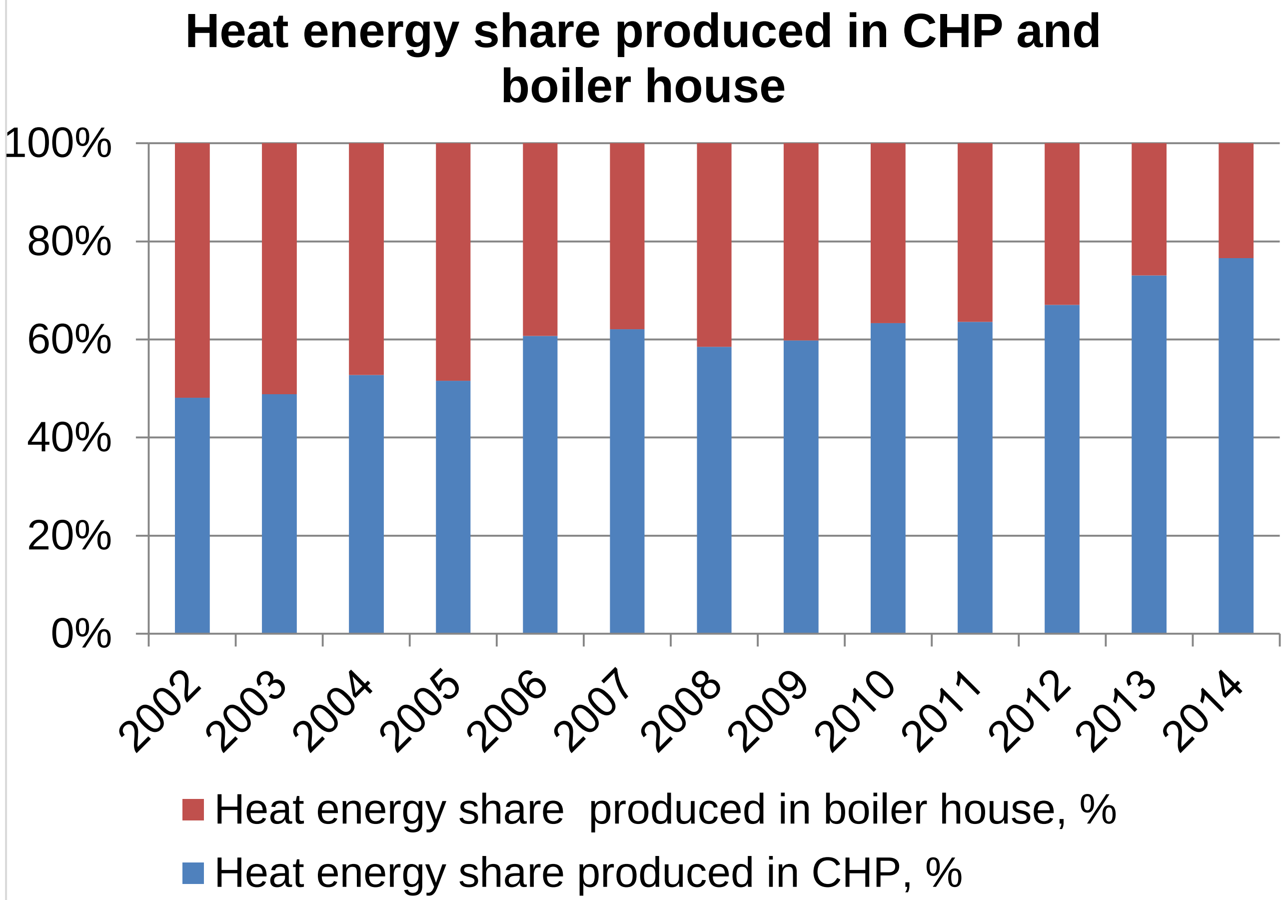
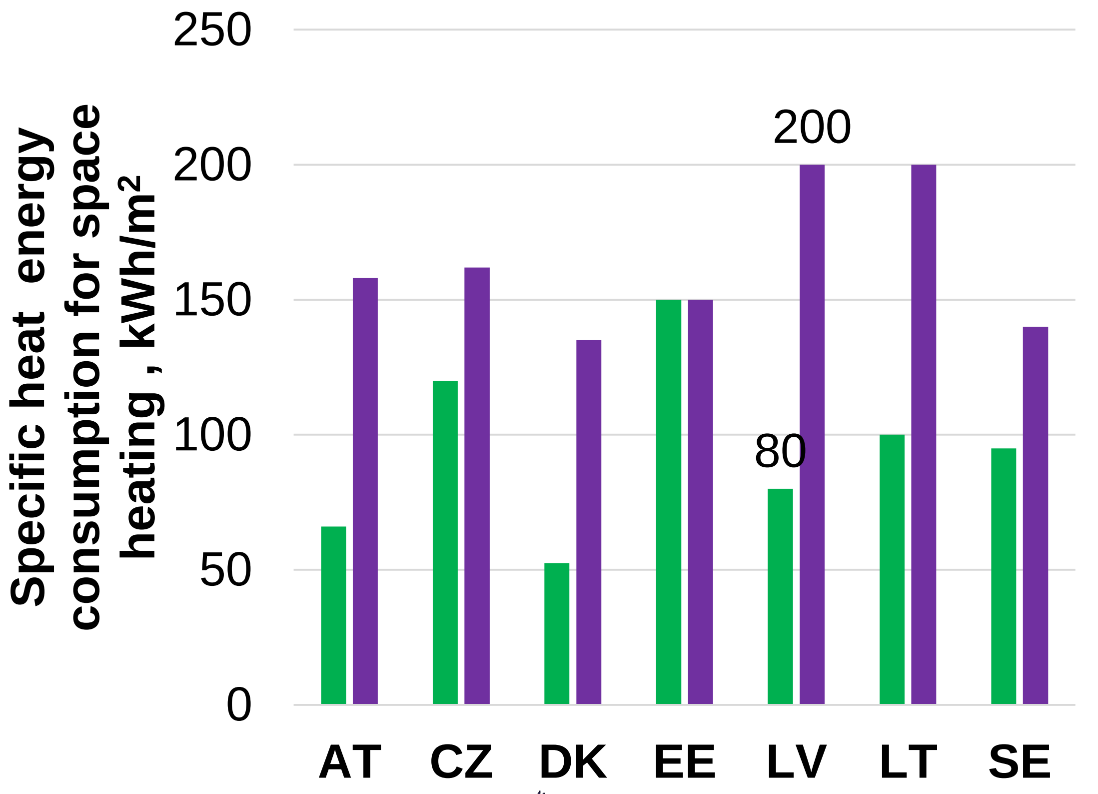
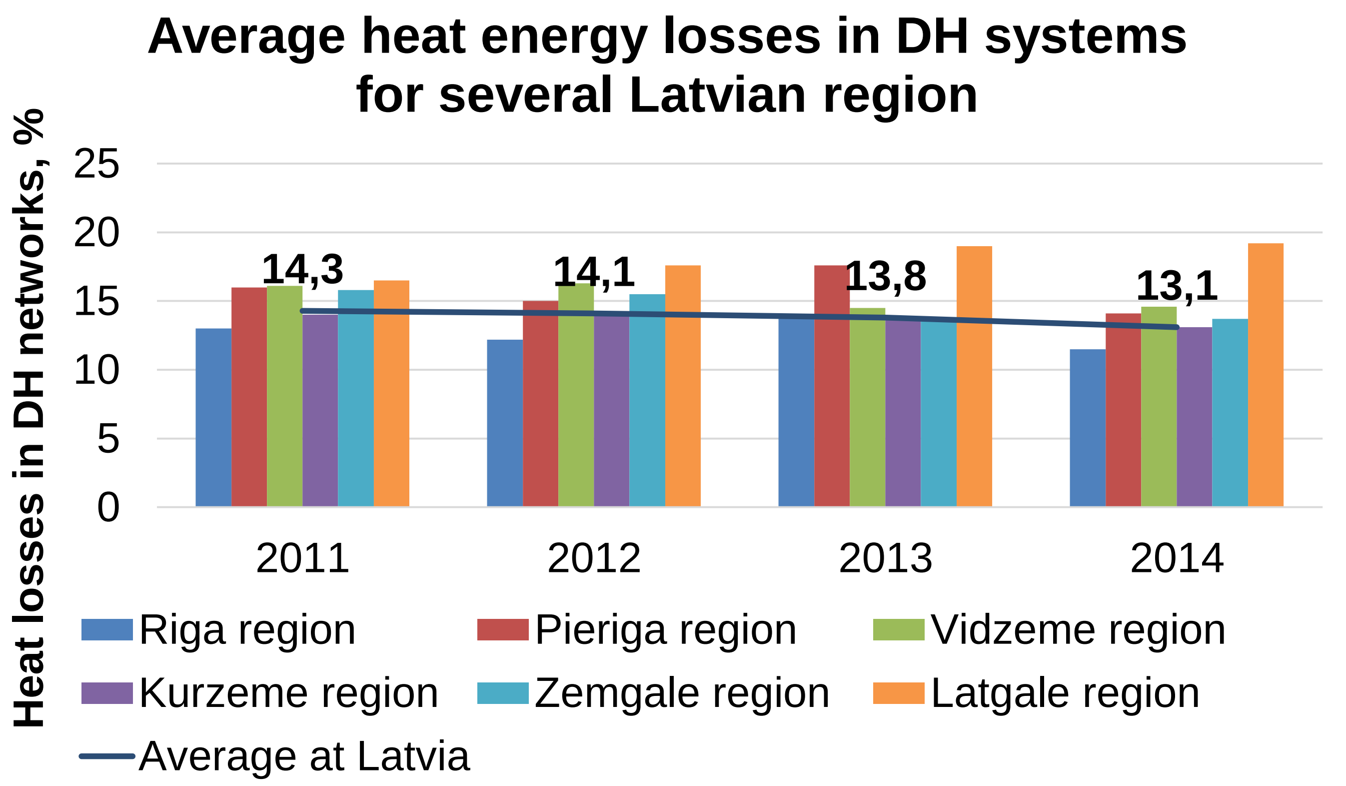
Current Situation in the Latvian District heating (heat sources)





Current Situation in the Latvian District heating (heat networks and end users)

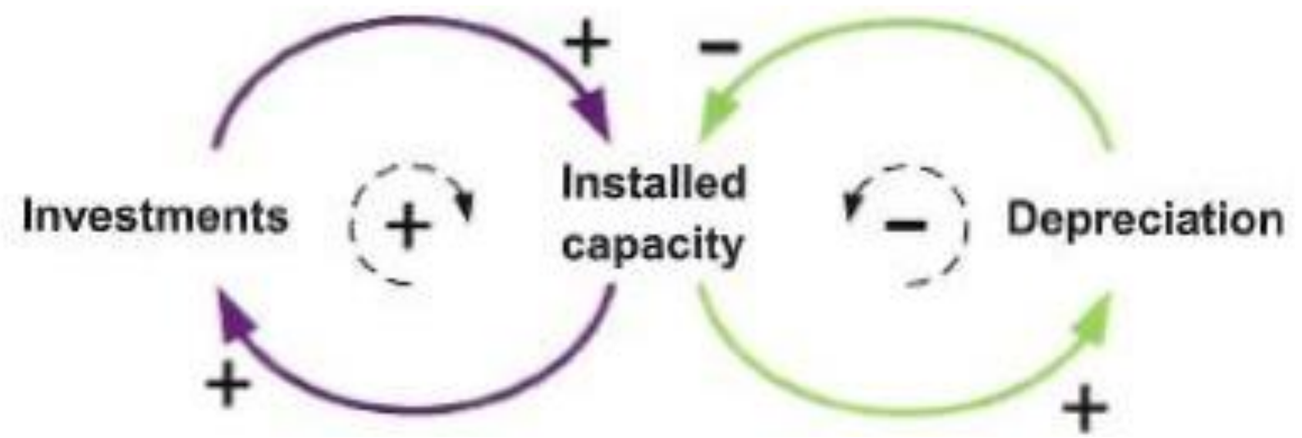




Creation of dynamic hypotheses

The diffusion of 4GDH concept within traditional DH :

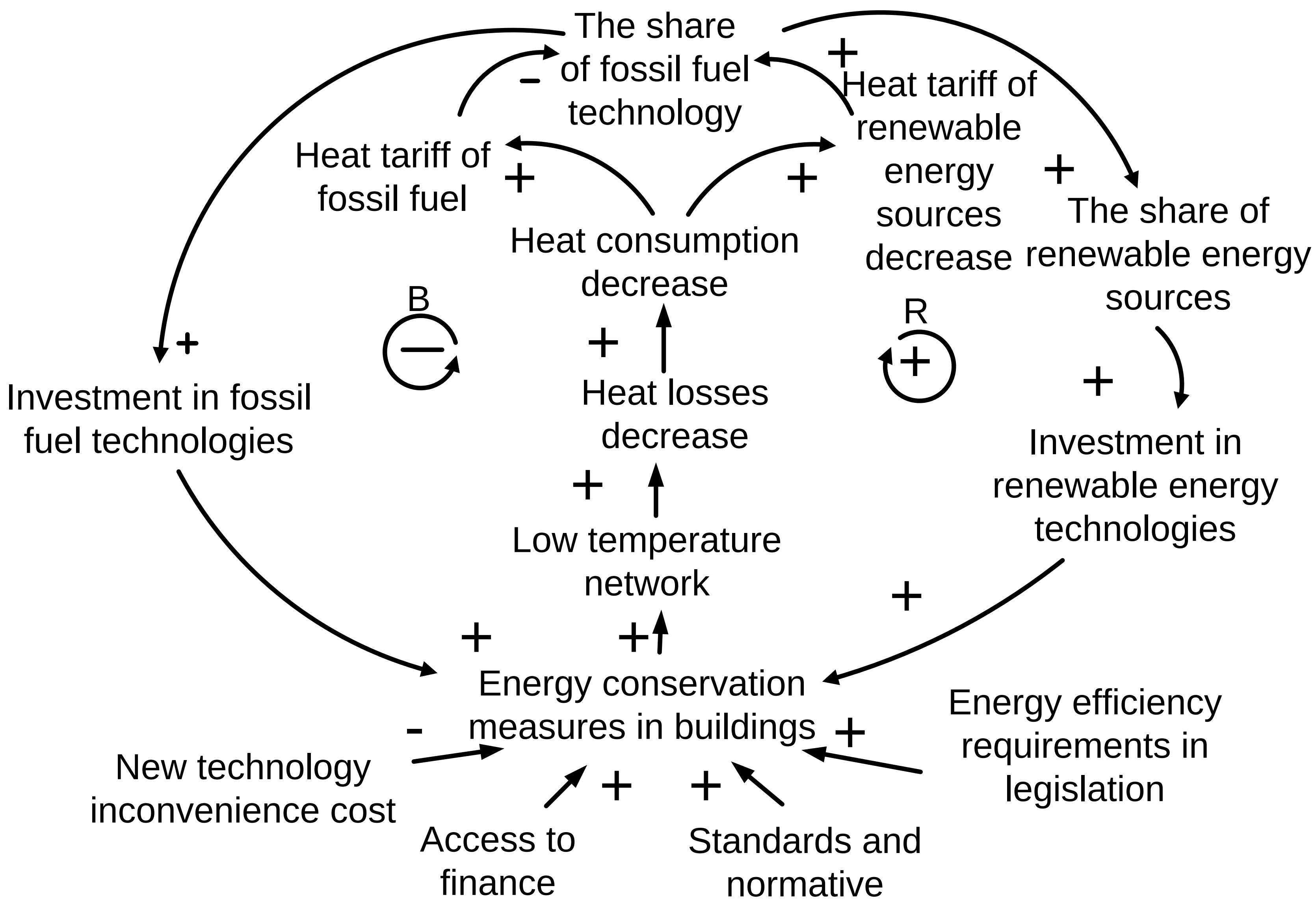
- Efficiency measure in heat source, renewable energy technology;
- Low temperature heat network;
- Efficiency measure by consumers, Low energy consumers



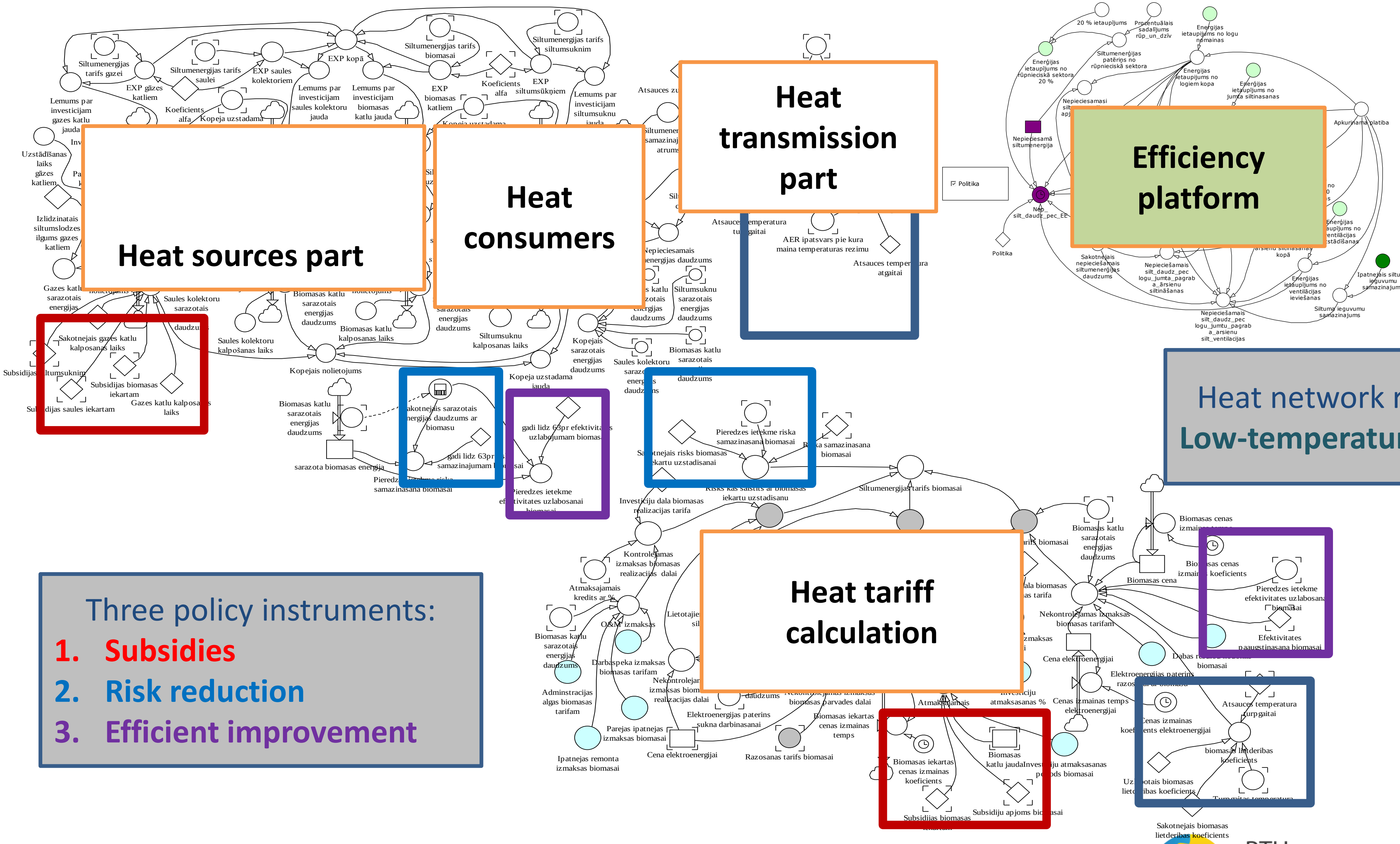
Causal loop diagram representing the relationships between the total capacity of installations and investment and depreciation flows *

*"System Dymamics" edited by A.Blumberga, RTU, 2011

Causal loop


The share of fossil fuel technology
Heat tariff of renewable energy sources decrease
The share of renewable energy sources
Heat tariff of fossil fuel
Heat consumption decrease
B
R
Investment in fossil fuel technologies
Heat losses decrease
Investment in renewable energy technologies
Low temperature network
Energy conservation measures in buildings
Energy efficiency requirements in legislation
New technology inconvenience cost
Access to finance
Standards and normative
+
–
-

System dynamics model structure



Heat network regime:
Low-temperature 60/30

Three policy instruments:
1. **Subsidies**
2. **Risk reduction**
3. **Efficient improvement**

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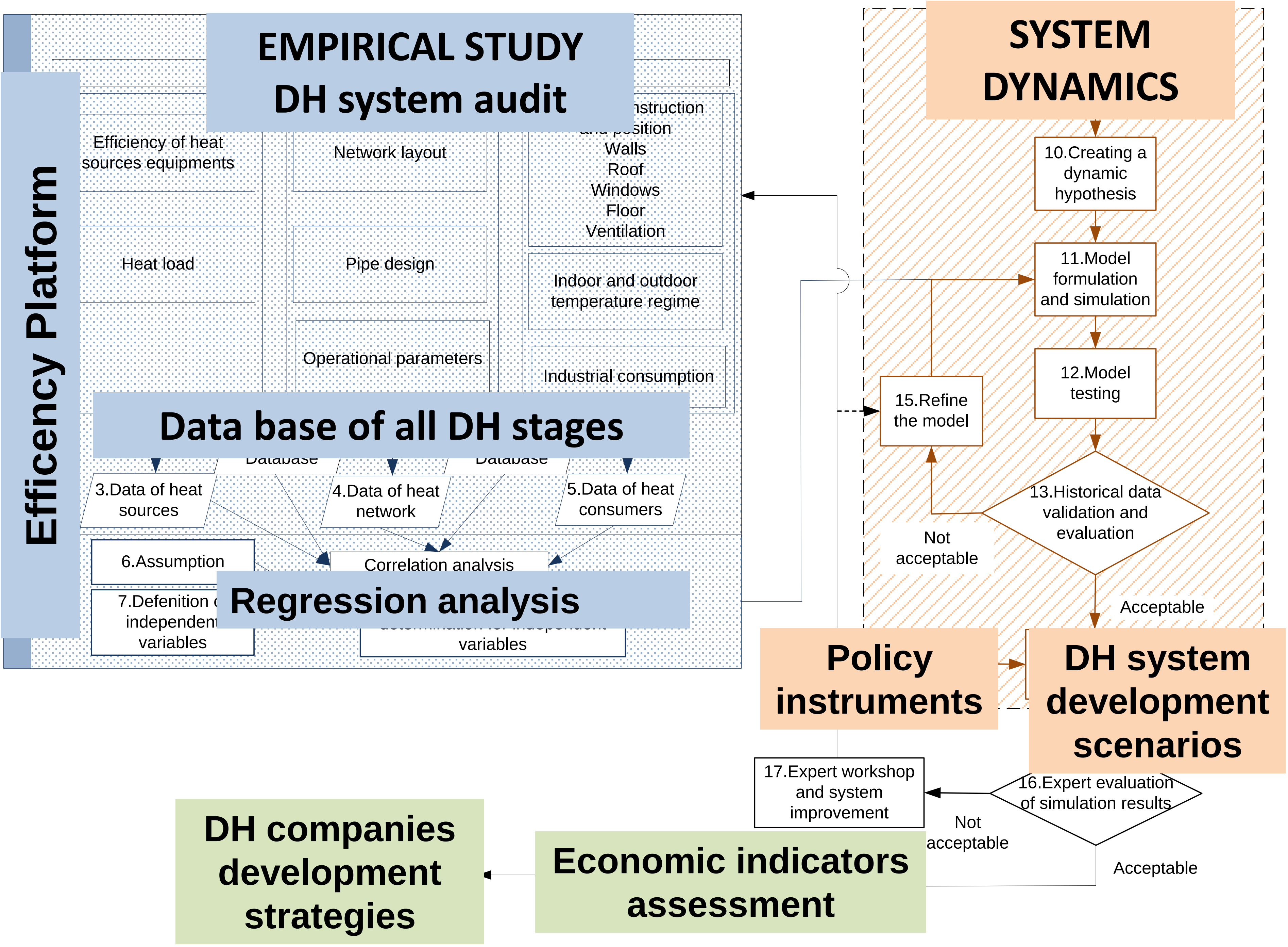

Conceptual scheme of methodology

Description of Scenarios

Scenario	Resulting U-value (W/(m·K)) Wall ,Floor, Roof Window,Ventilation Industrial area*	Technology life time (years)	Policy instruments		
			Subsidies	Risk reduction	Efficient improvement
Base scenario (BSc)	1.07;0.82;0.42 2.0; -; -	NG-25; S-20; B-25; HP-20	0	0	0
Scenario 1(Sc1)	0.19; 0.22;0.15 1.5; -; -	NG-20; S-20; B-20; HP-20	0	0	0
Scenario 2(Sc2)	0.15; 0.22;0.11 1.1; 0.9**;20*	NG-15; S-20; B-15; HP-20	0	0	0
Scenario 2P(Sc2P)	0.15; 0.22;0.11 1.1; 0.9**;20*	NG-15; S-20; B-15; HP-20	1	1	1
Scenario 3(Sc3)	0.08; 0.22; 0.09 0.80;0.9**;40*	NG-10; S-20; B-10; HP-20	0	0	0
Scenario 3P(Sc3P)	0.08; 0.22; 0.09 0.80;0.9**;40*	NG-10; S-20; B-10; HP-20	1	1	1

NG – natural gas HOB; B – biomass HOB; S- solar collector; HP – heat pump; 1- activ; 0- non activ ; HOB – heat only boiler

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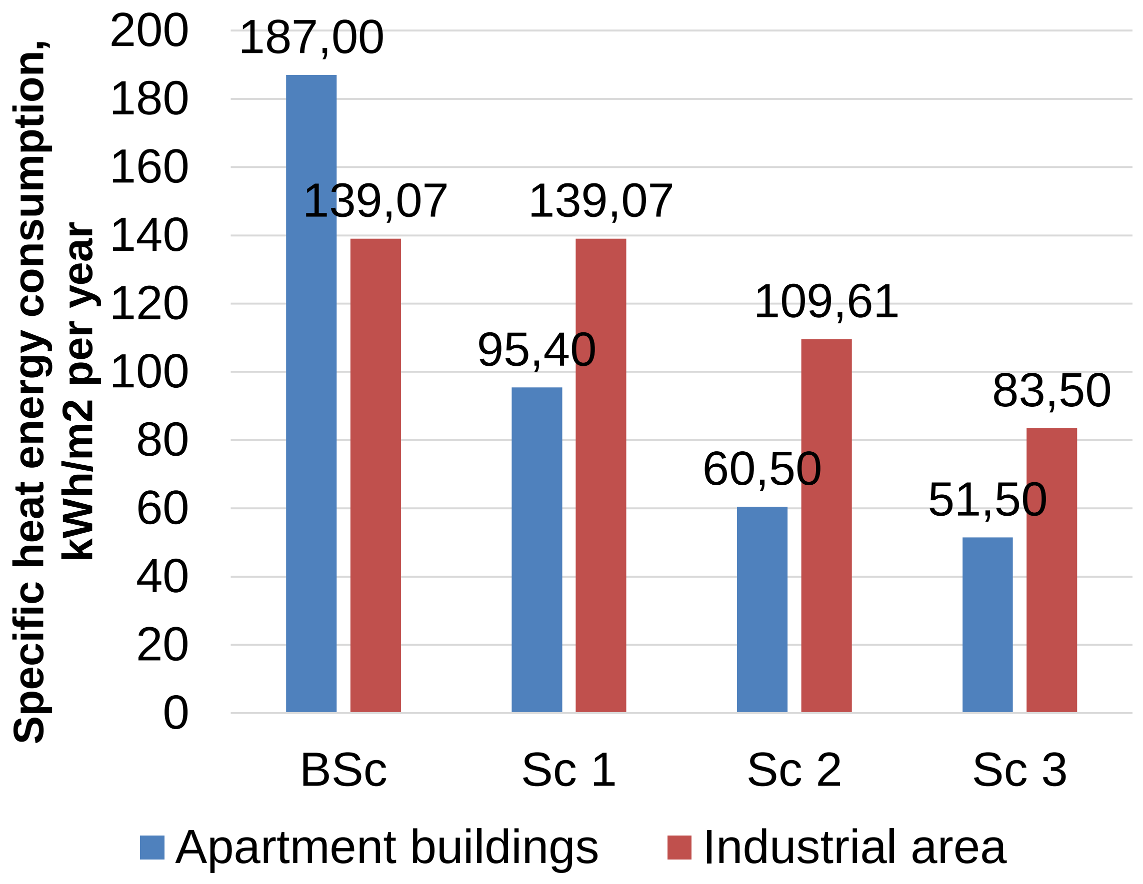
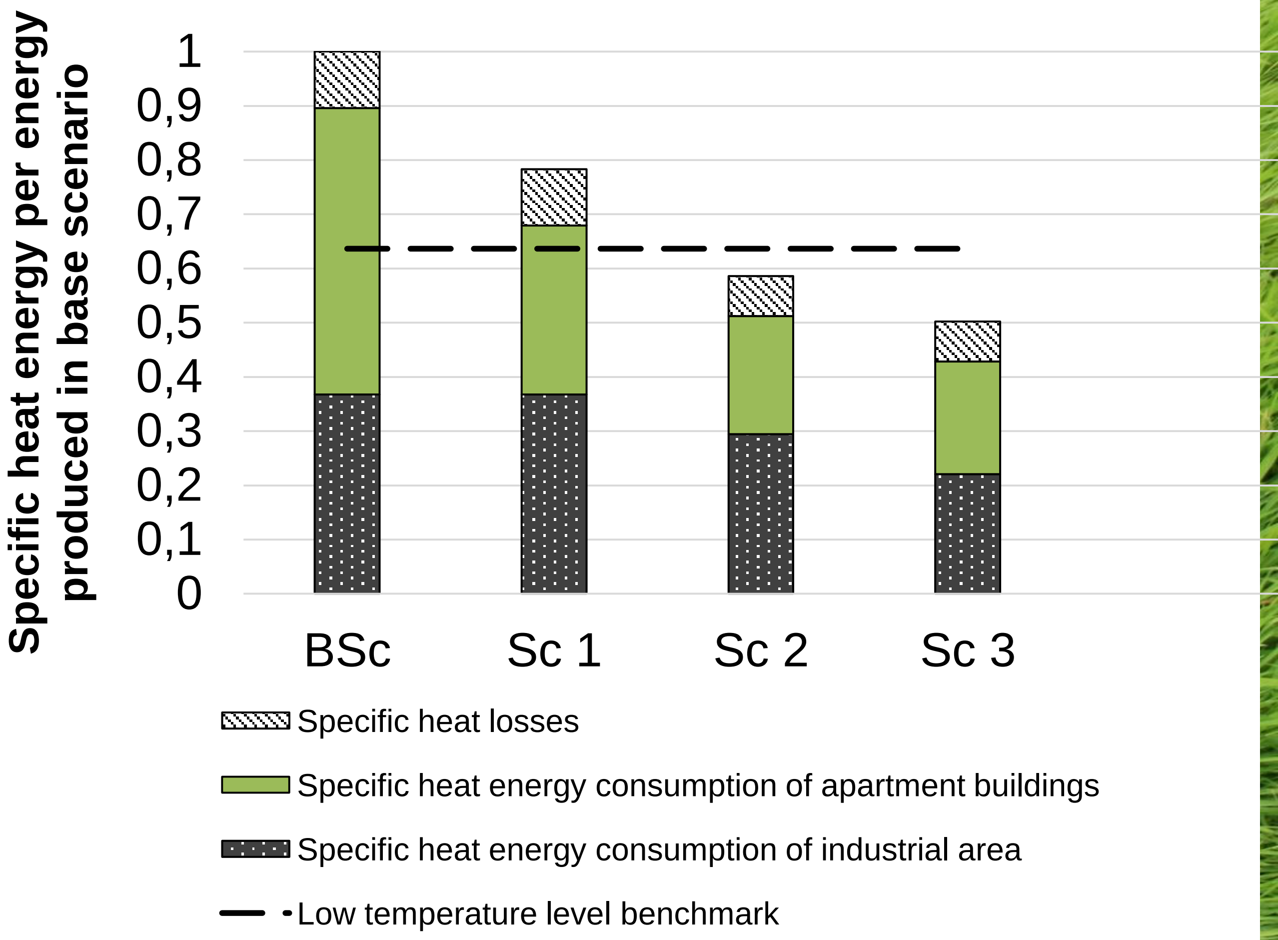
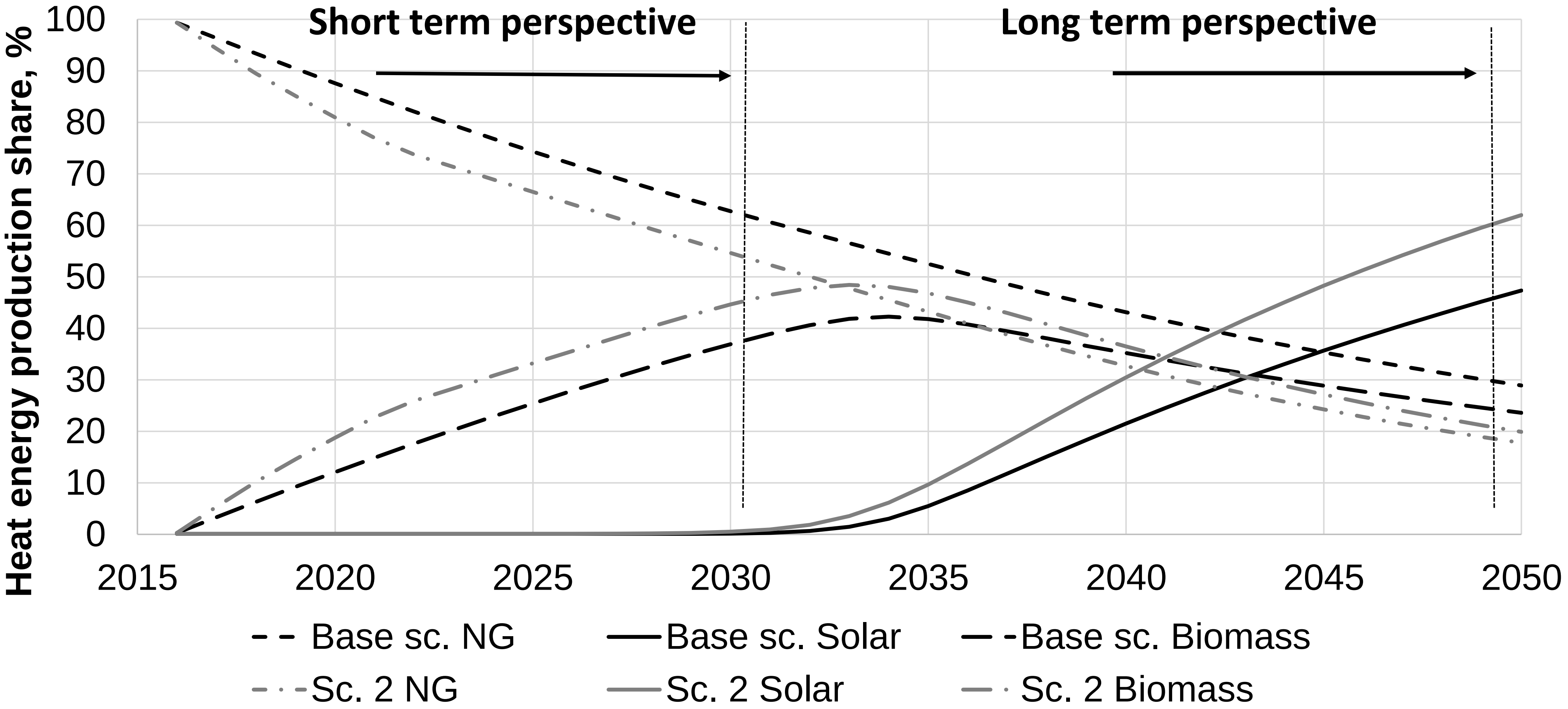
Energy consumption analysis.
Low temperature benchmarking





Impact of energy efficiency measures for reaching 4th generation DH system



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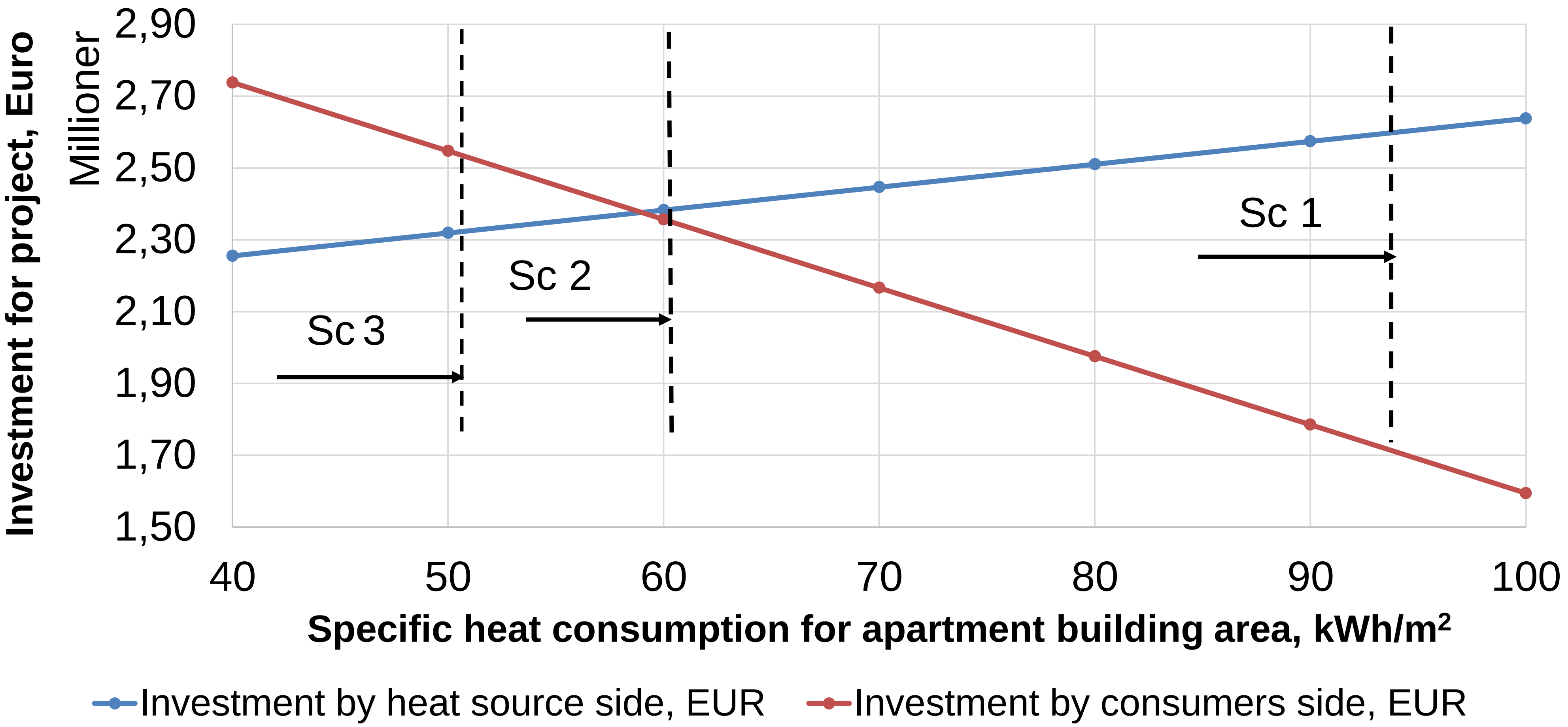
Economic feasibility of energy conservation measures by heat sources and consumers



Conclusions

1. Implementation of energy conservation measures influece transition of DH system to 4th generation. For the analysed case the low temperature benchmark was at 0.63 from produced energy at the base scenario.
2. The modeled scenarios show that the pace of 4GDH implementation depends on the policies used by each country. Subsidies are the most effective mechanisms for transition toward 4GDH.
3. The developed system dynamic model with efficiency platform could be applied to other heating systems if corresponding initial data are added.
4. The optimal development scenario depends on efficiency measures which are implemented at consumers and/or producers, an the integrated effect of these measures. This optimum can be identified through economic feasibility assessment

Additional information:

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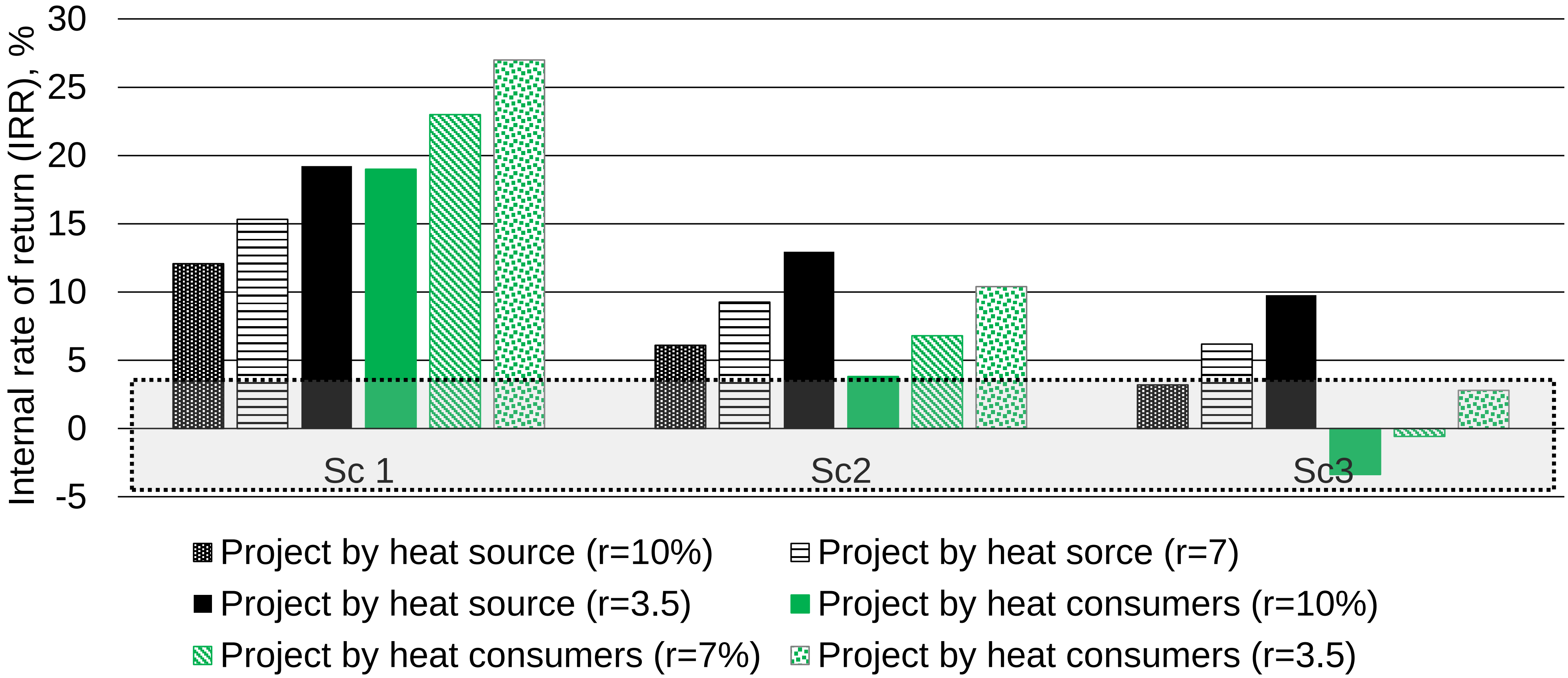
Economic feasibility of energy efficiency measures by heat sources and consumers

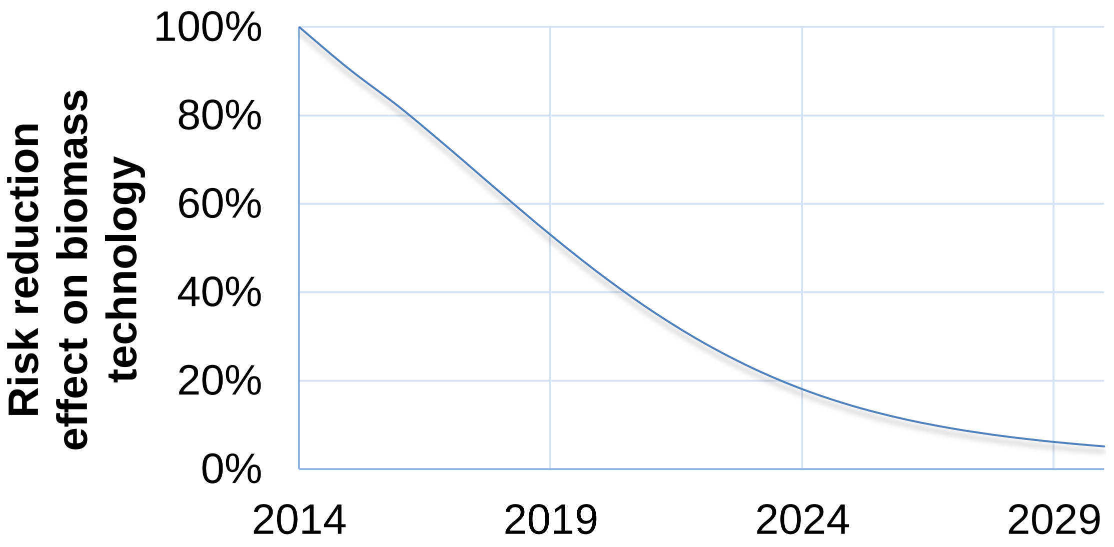


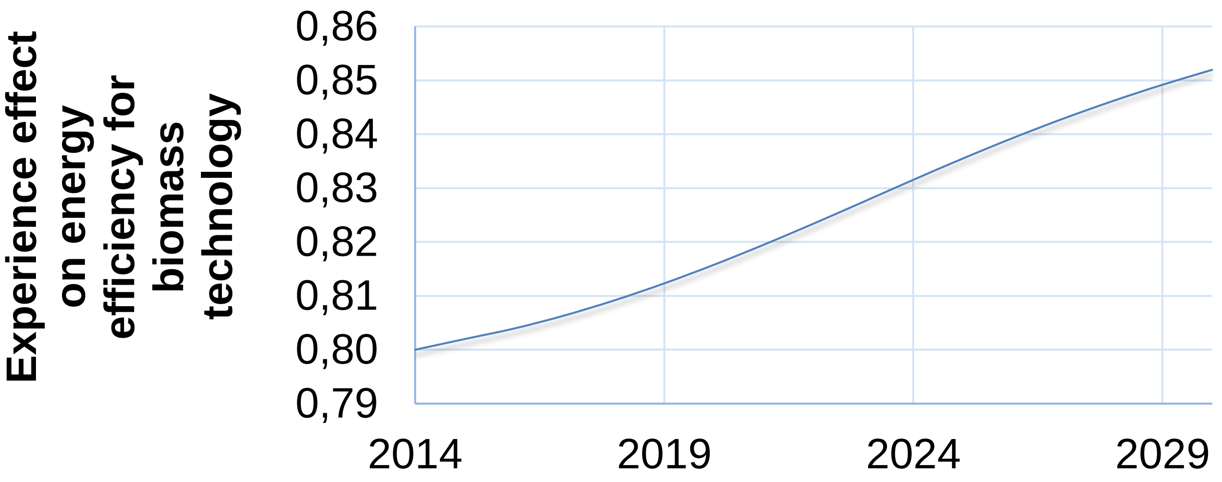
Choice of model indicators

Heat sources	Heat network	Heat consumers
Efficiency factor,%	Heat losses, MWh per year	Specific heat energy consumption, kWh/m^2 per year
Heat production,MWh	Electricity consumption, MWh per year	
Fuel and electricity price, EUR/MWh	Insulation size and quality, W/(mK)	Heating area, m^2
Operation & Maintenance cost, EUR/MWh	Thermal length, m	
Installed capacity, MW	Pipes surface, m^2	
Investment cost, EUR/MWh		
CO_2 emission, tCO_2/MWh		
Sollar collector area, m^2 accumulation volume, m^3		
Coefficient of performance, MWh_{th}/Mwh_{el}		

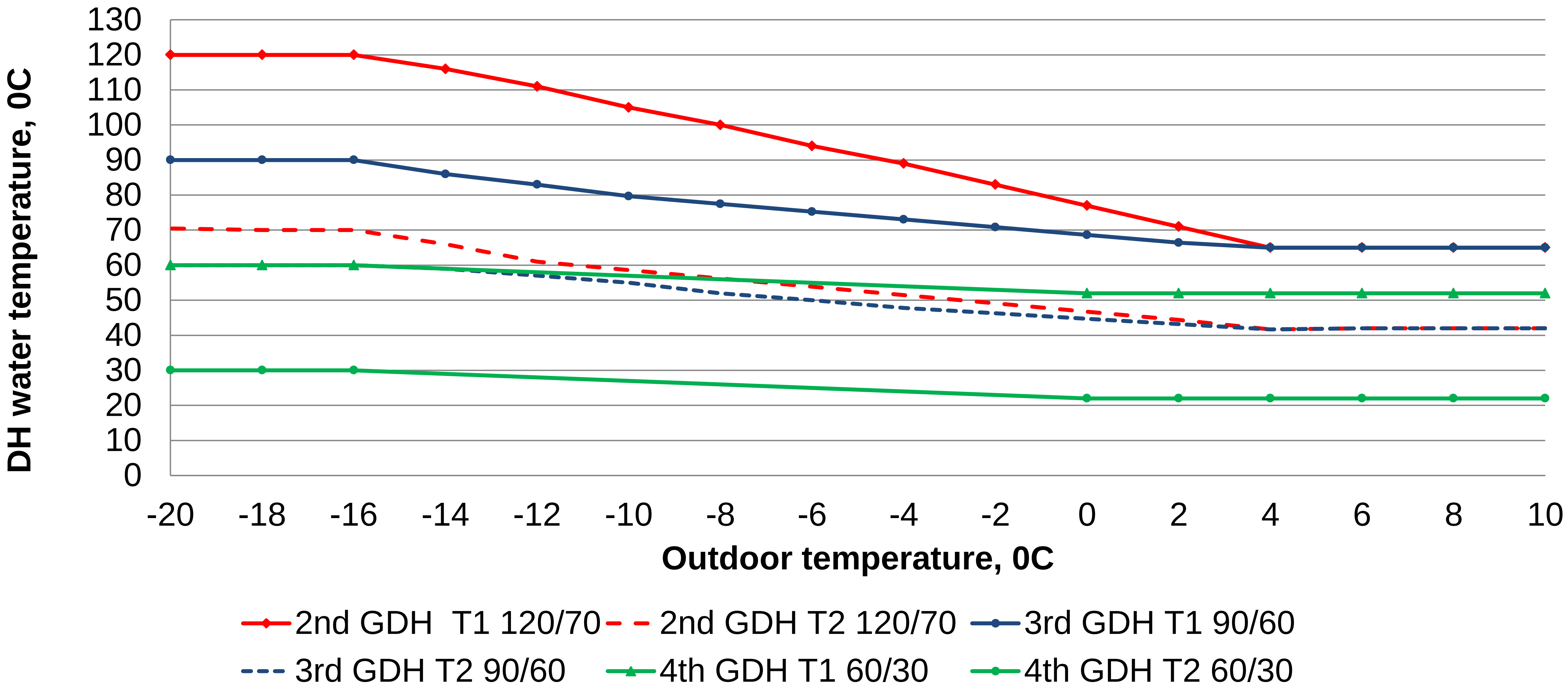
Policy

- Subsidies:
  - 25% of investment costs
  - Reduced service life for gas boilers
- Risk reduction:
  - Initial risk – 10 EUR / MWh for renewable energy technologies
- Efficiency improvement:





Supply(T1) and return (T2) water temperature regime



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