# Restriction of District Heating Systems development towards 4GDH

Bio economy approach in district heating development

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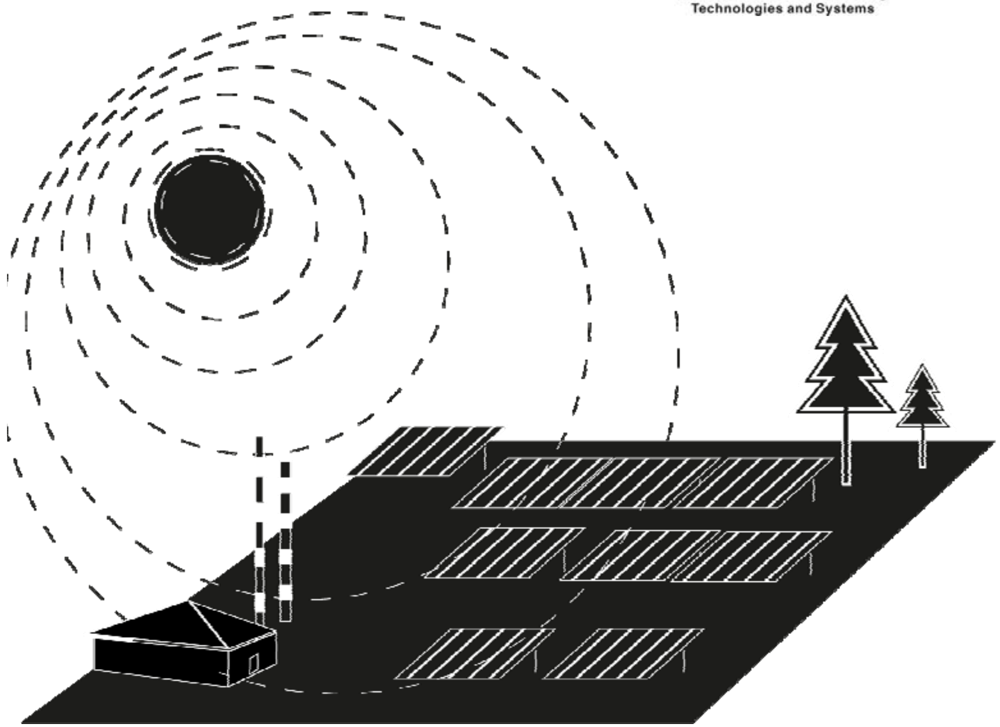
3rd International Conference on Smart Energy Systems and 4th Generation District Heating
Copenhagen, 12-13 September 2017

# Contents

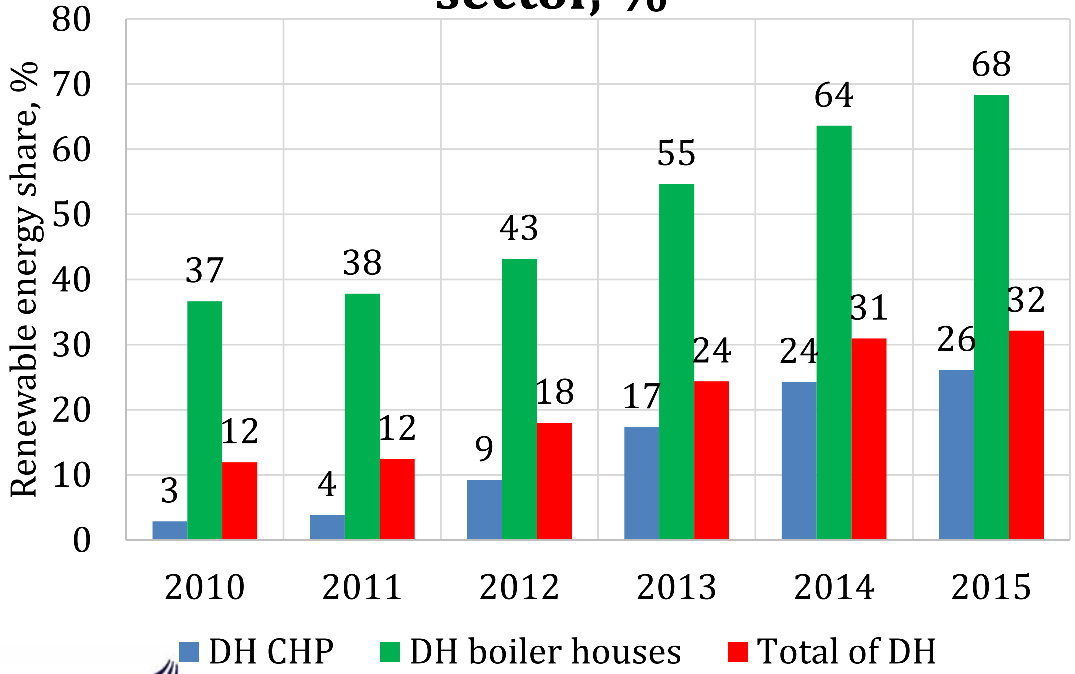
# Goal of research

To analyze possible development scenarios for district heating company towards $4^{th}$ generation district heating system by comparison of technological, economic and bioeconomy indicators. To evaluate barriers and restriction that limit long-term sustainable development of DH system.

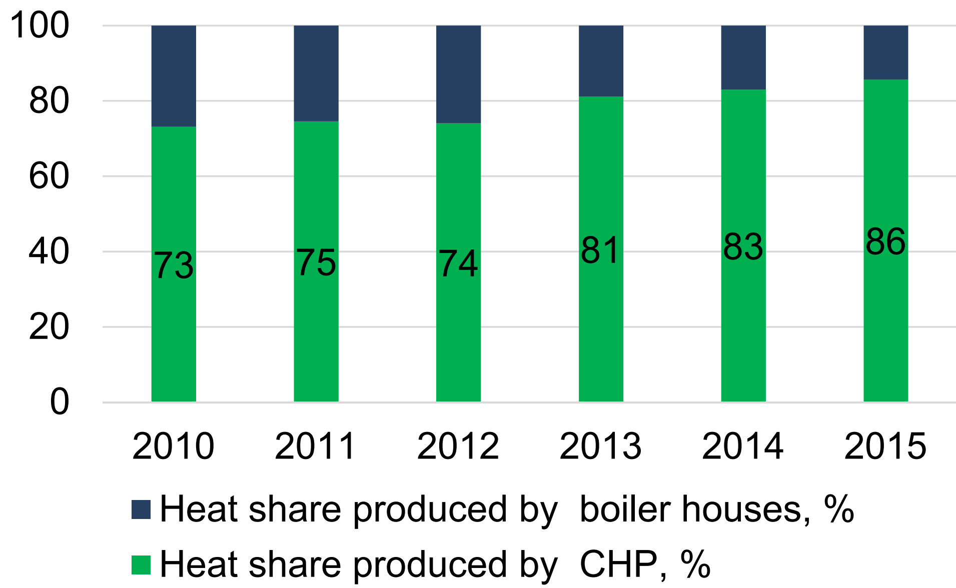


# Current Situation in District heating system in Latvia

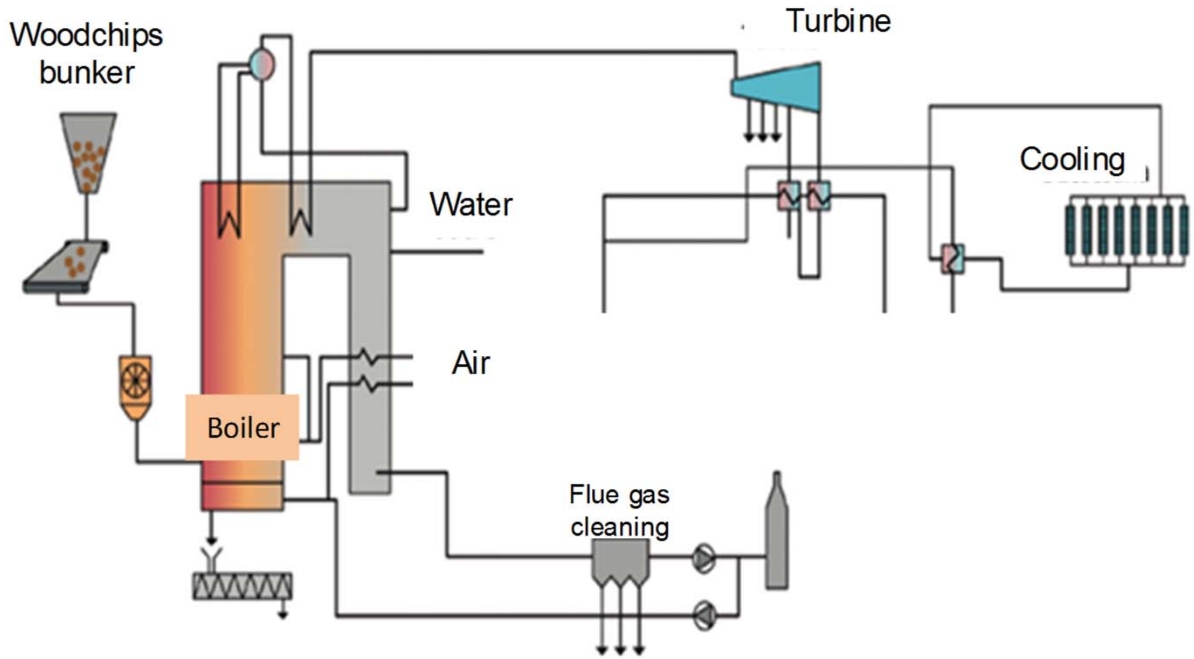
## Renewable energy share in DH sector, %




## Heat energy share produced in CHP and boiler house



# Case study - Fortum Jelgava




| Average production data in the last three years (2014 -2016) | |
|---|---|
| Produced heat, GWh per year | 238.6 |
| Produced electricity, MWh per year | 104.7 |
| Cooling losses, MWh per year | **83950 (35% from produced heat)** |
| Distribution losses, % | 16.7 |

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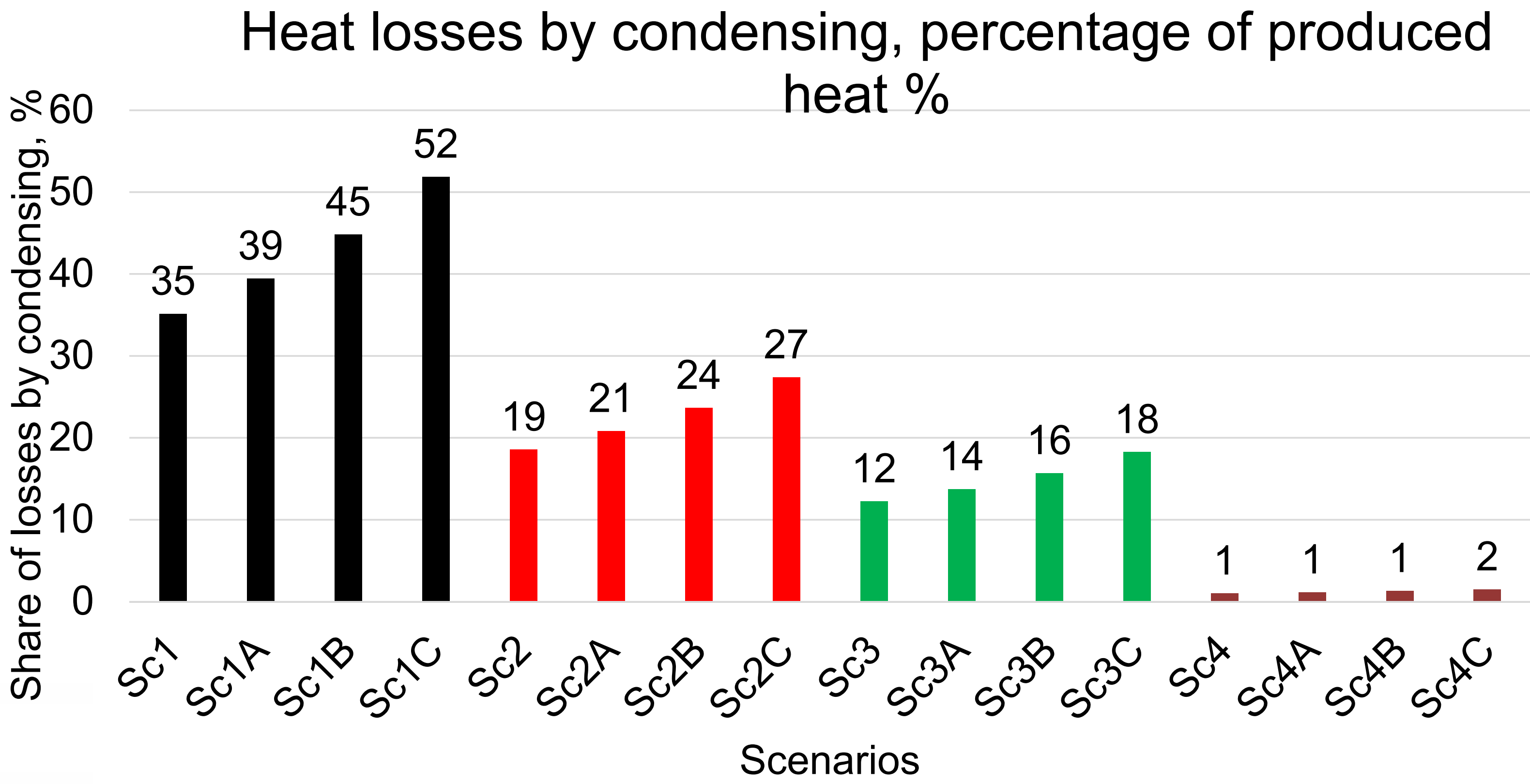
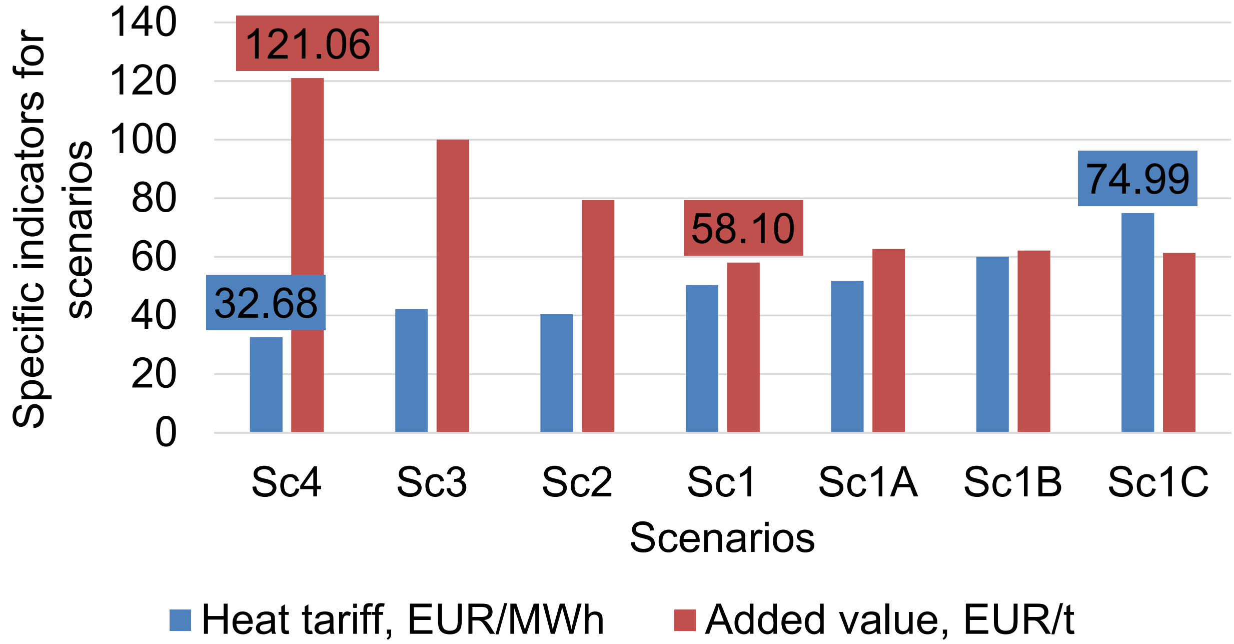
# Scenarios description

| DH system development scenarios description | Heat consumption decrease by end users (retrofitting of existing buildings), % | | | |
|---|---|---|---|---|
| | 0% | 10% | 30% | 50% |
| **Base scenario (Sc1)** | Sc1 | Sc1A | Sc1B | Sc1C |
| **Base scenario plus Bio oil production integration to heat source (Sc2)**<br>***Additional heat consumption 39.6 GWh (31%)*** | Sc2 | Sc2A | Sc2B | Sc2C |
| **Base scenario plus adding of new consumers (Sc3)**<br>***Additional heat consumption 54.7 GWh (42%)*** | Sc3 | Sc3A | Sc3B | Sc3C |
| **Base scenario plus Bio oil production integration to heat source and adding of new consumers (Sc4)**<br>***Additional heat consumption 94.3 GWh (73%)*** | Sc4 | Sc4A | Sc4B | Sc4C |

# Technological indicator improvement by different scenarios



# Evaluation of development scenarios by bioeconomy approach




$$AD = (\mathbf{Pr} + \boldsymbol{Sal} + \boldsymbol{De})/\ \boldsymbol{W}$$

AD – added value, EUR/t;
Pr – profit, EUR per year;
Sal – salary, EUR per year;
De – depreciation, EUR per year;
W – used fuel, ton per year.

# Which economic indicator is most important for sustainable development of DH?

**Heat tariff T, €/MWh?**

$$T = T_{prod} + T_{tr} + T_3$$

Production tariff $T_{prod}$, €/MWh

$$T_{prod} = (VC_R + FC_R)/Q_{prod}$$

**Income of DH company In, € per year?**

$$In = In_{th} + In_e = A_{th}T_{th} + A_eT_e$$

**Profit of DH company, Pr € per year or %?**

$$\mathrm{Pr} = In - Re$$

$T_{tr}$ – transmission and distribution tarifs, €/MWh;
$T_3$ – sales tariff, €/MWh;
$Q_{prod}$ – produced amount of heat, MWh;
$In_{th}$, $In_e$ - net income from thermal energy and electricity sale;
$A_{th}$, $A_e$ - amount of sold thermal energy and electricity; $T_{th}$, $T_e$ - heat tariff and electricity tariff;
$Re$ – net revenue, € per year

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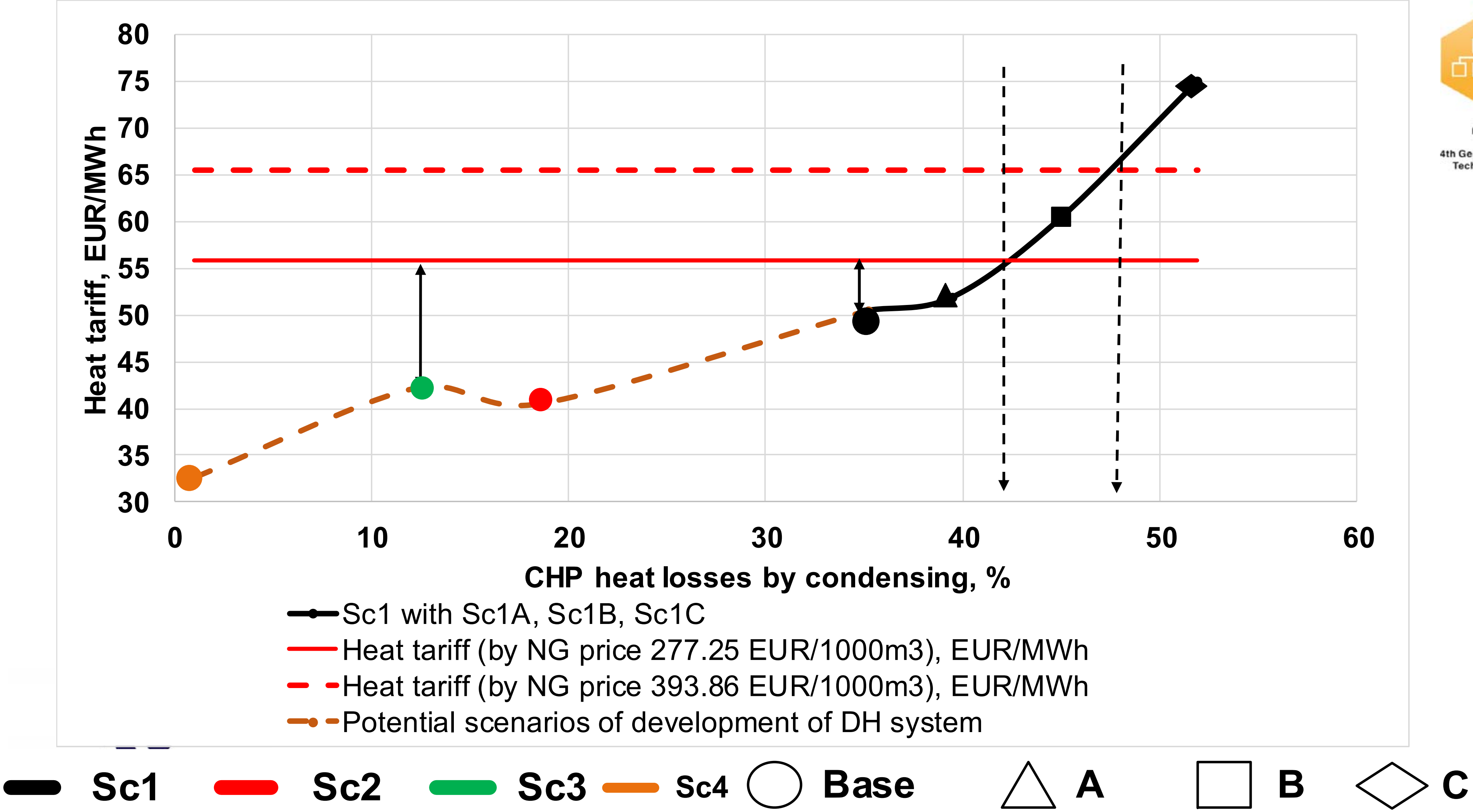
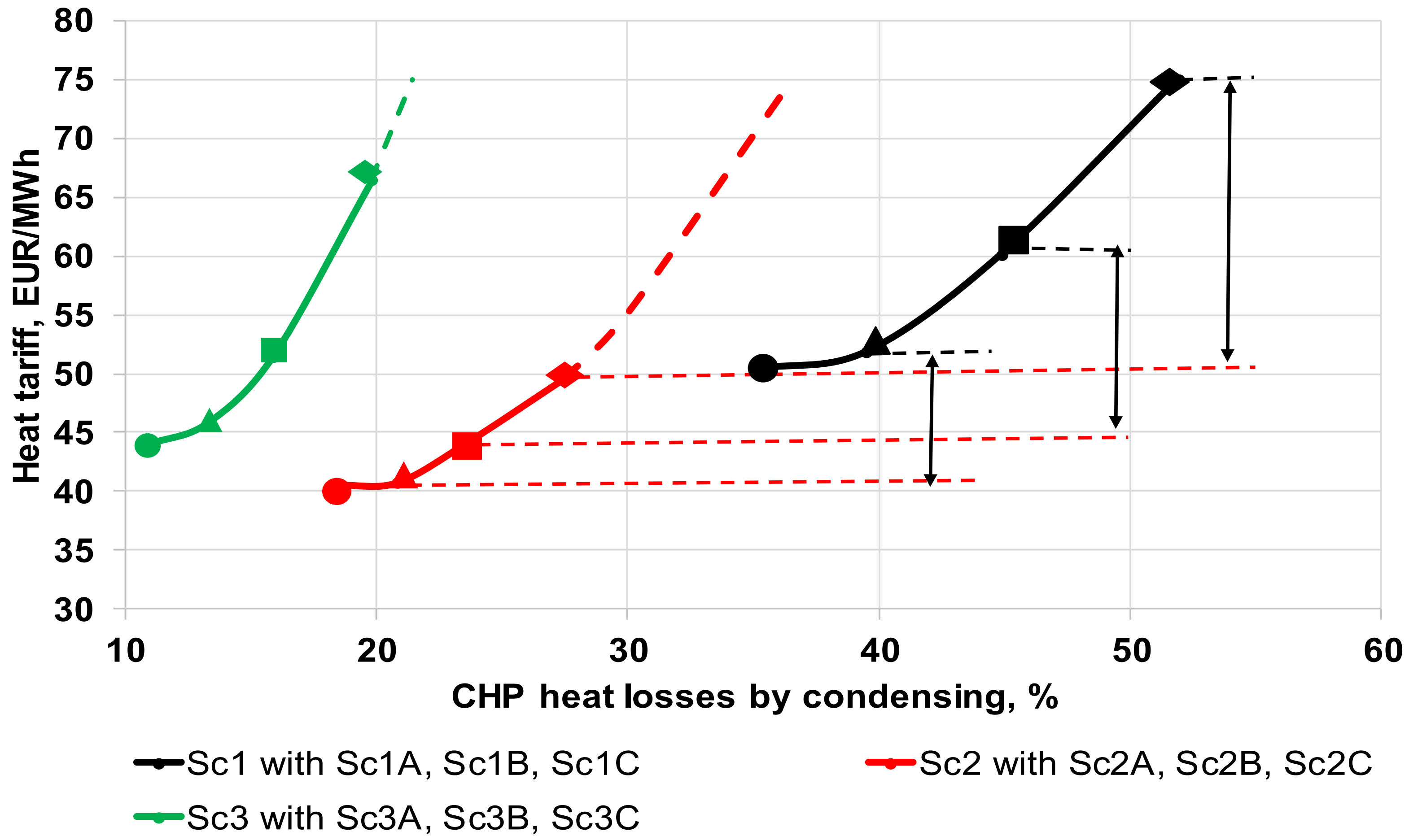
# Comparison of heat tariff for different scenarios



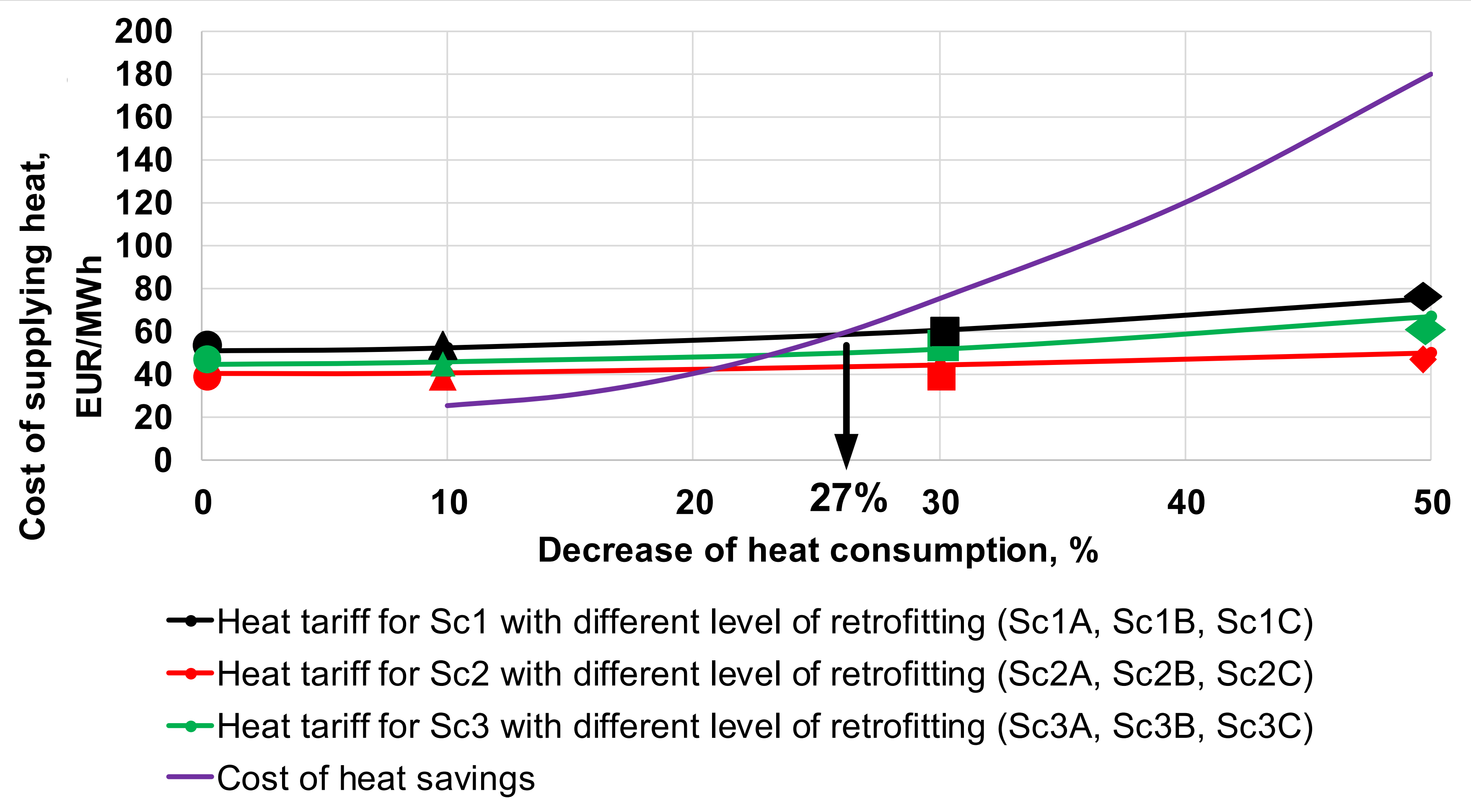
# Comparison of heat tariff for different scenarios with different level of retrofitting by end users




Sc1 Sc2 Sc3 Base A B C

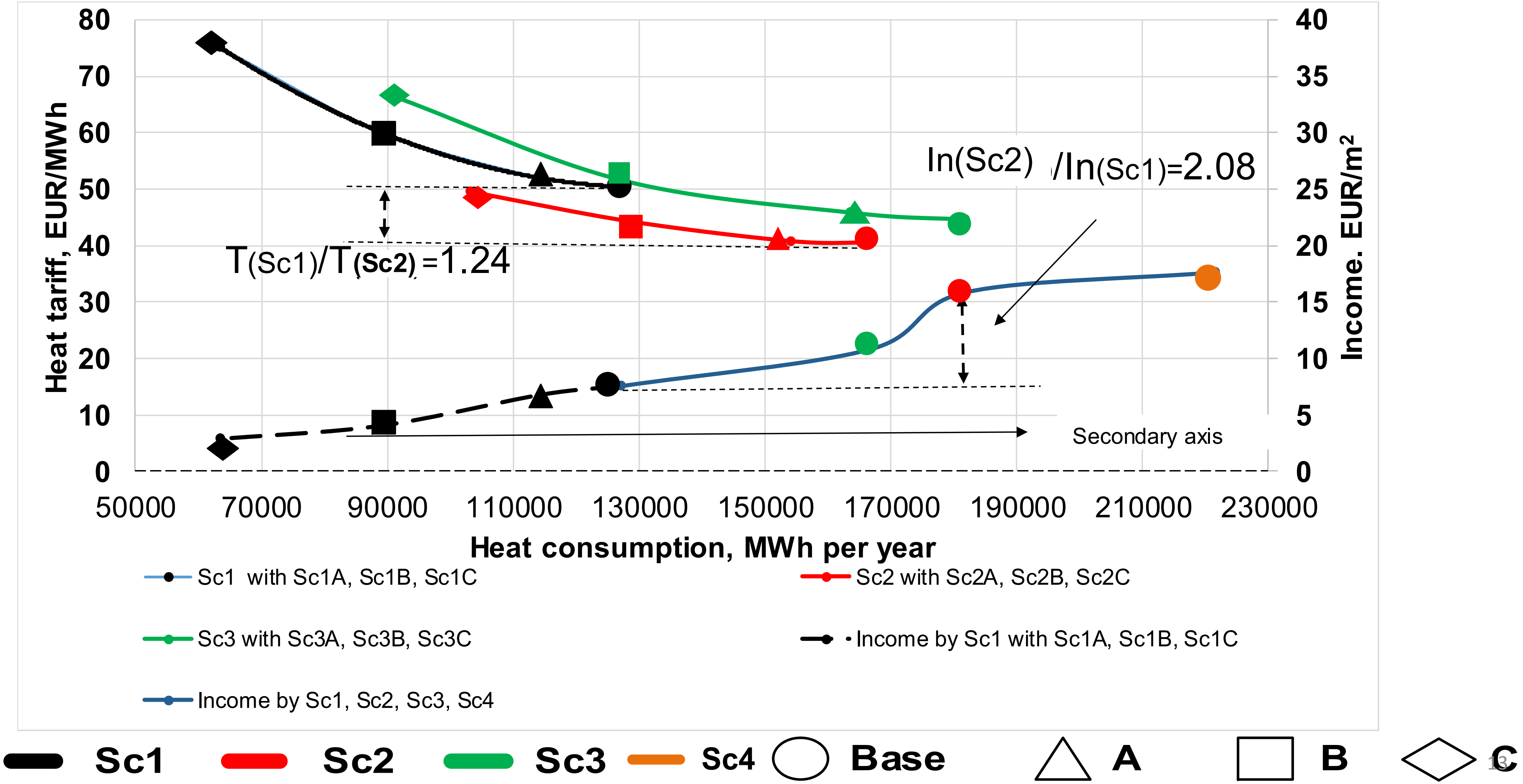
4DH
4th Generation District Heating Technologies and Systems

# Comparison cost of supplying heat and cost of heat saving




Sc1 Sc2 Sc3 Base A B C

# Comparison of DH company income for different scenarios



# Conclusions

1. The analyzed DH development scenarios based on biomass using show that it needs balanced approach to technologic, economic, environmental and social responsibility issues to increase the competitiveness of DH company with benefits for all stakeholders and for moving DH towards 4GDH.
2. Research shows that by using bioeconomy approach it is possible to evaluate added value for all scenarios. Scenarios with production from new biomass products (bio oil) are a more sustainable solution which allows to increase added value twice from **58.1 €/t** wood chips to **121.1 €/t.**

# Conclusions

3. Heat tariff is an important indicator, which combines efficiency of DH stages (heat source, distribution network, end users) all together. Reducing tariffs by improving DH's operation is not a sustainable solution for DH company because it reduces the company's revenue that decreases possibility to invest in next development.
4. In additional, reduction of heat tariff reduces the willingness to invest in the retrofitting of buildings and increases the time of reimbursement of the cost of these measures. The research shows that energy saving strategies are economically feasible only until **27%** of decrease of heat consumption which cost of heat saving repayment is less than heat tariff. Such a small reduction of thermal energy consumption does not allow making qualitative retrofitting of buildings

# Conclusions

5. Optimal solution, which allows the DH transition to 4GDH, shows the best system design and minimizing DH system's costs and optimal payment for heat energy for consumers.
6. Research shows that DH system should clearly concentrate their focus to development scenarios, which give possibility to raise income approximately 2 times.

**Acknowledgements**

The work has been supported by the National Research Program "Energy efficient and low-carbon solutions for a secure, sustainable and climate variability reducing energy supply (LATENERGI)".

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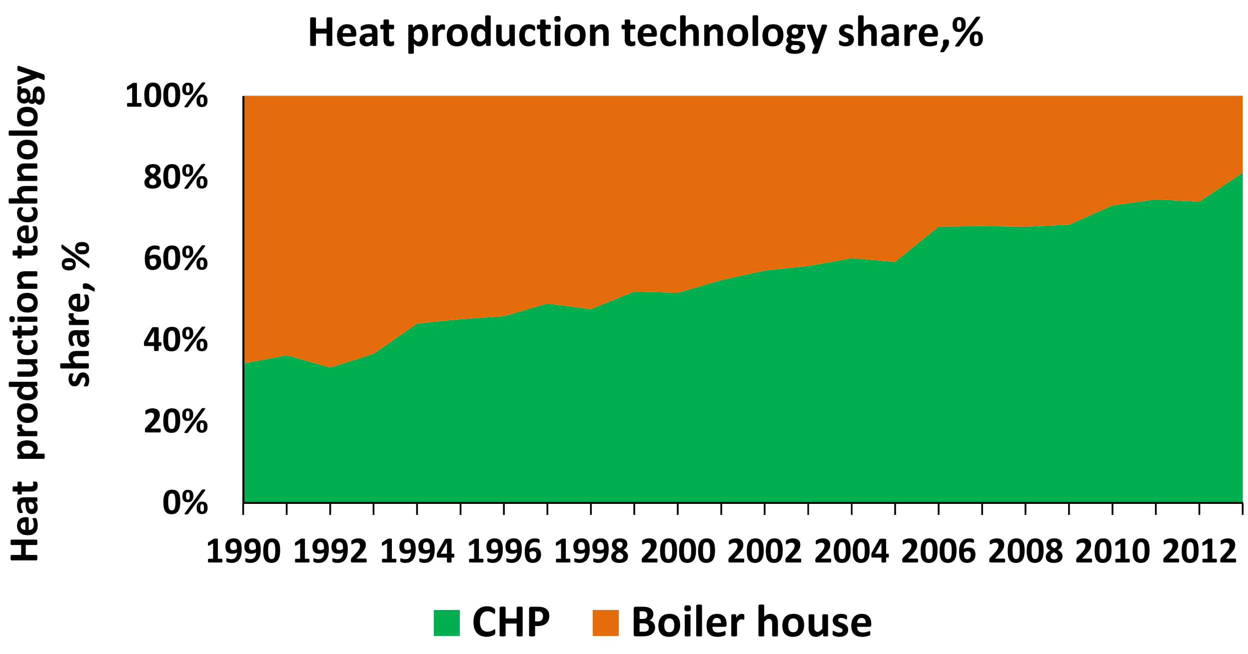
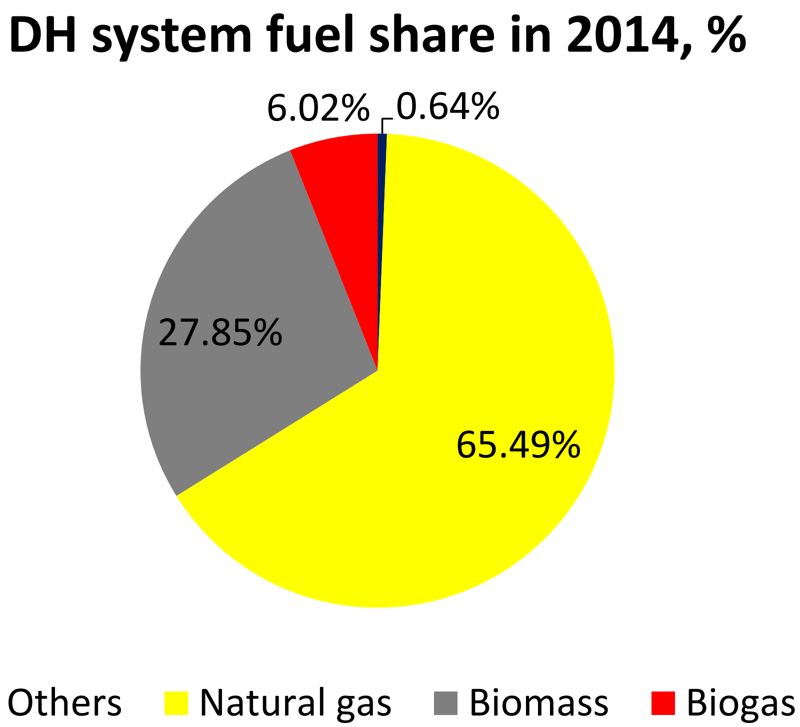
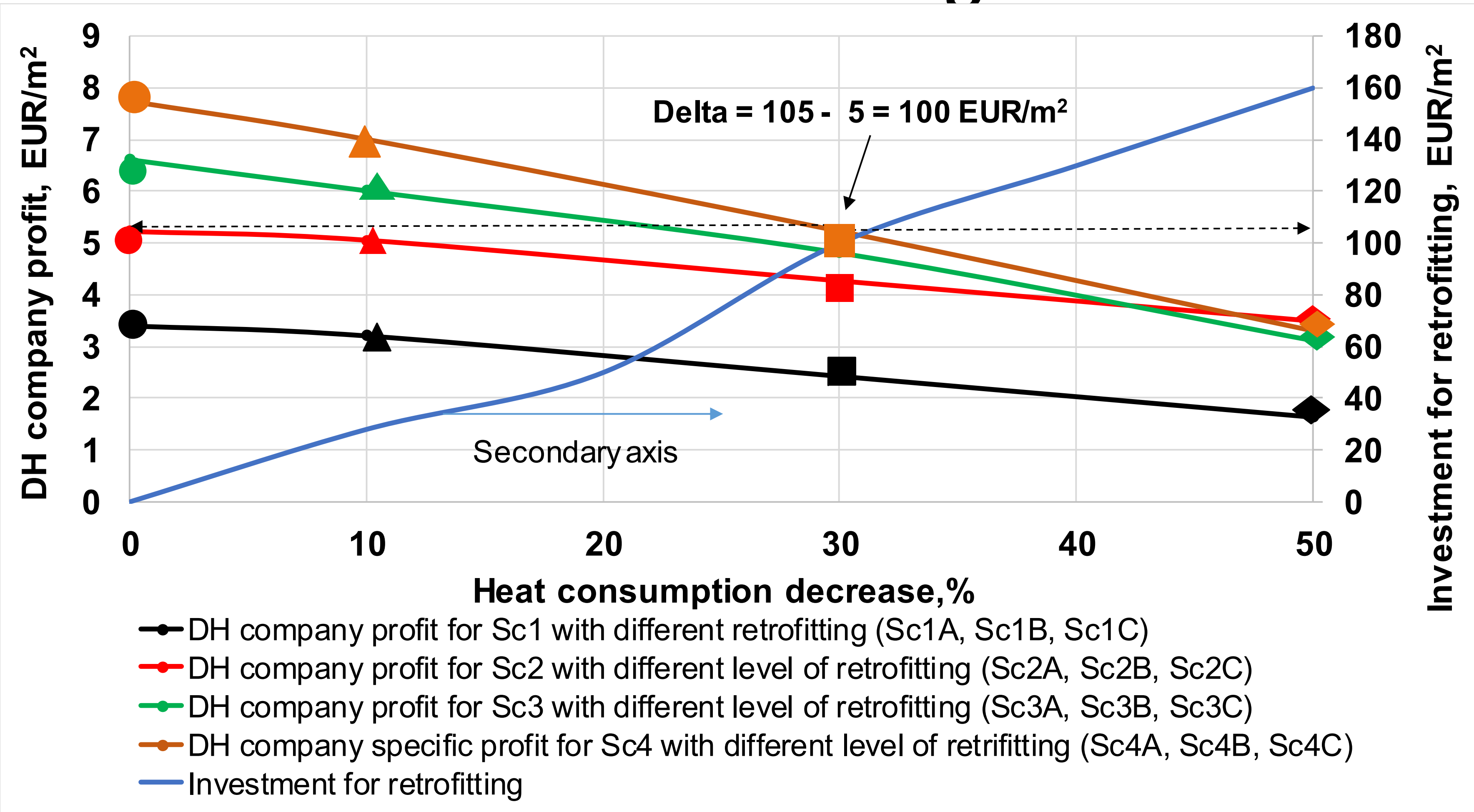
# Current Situation in the Latvian  District heating (2)



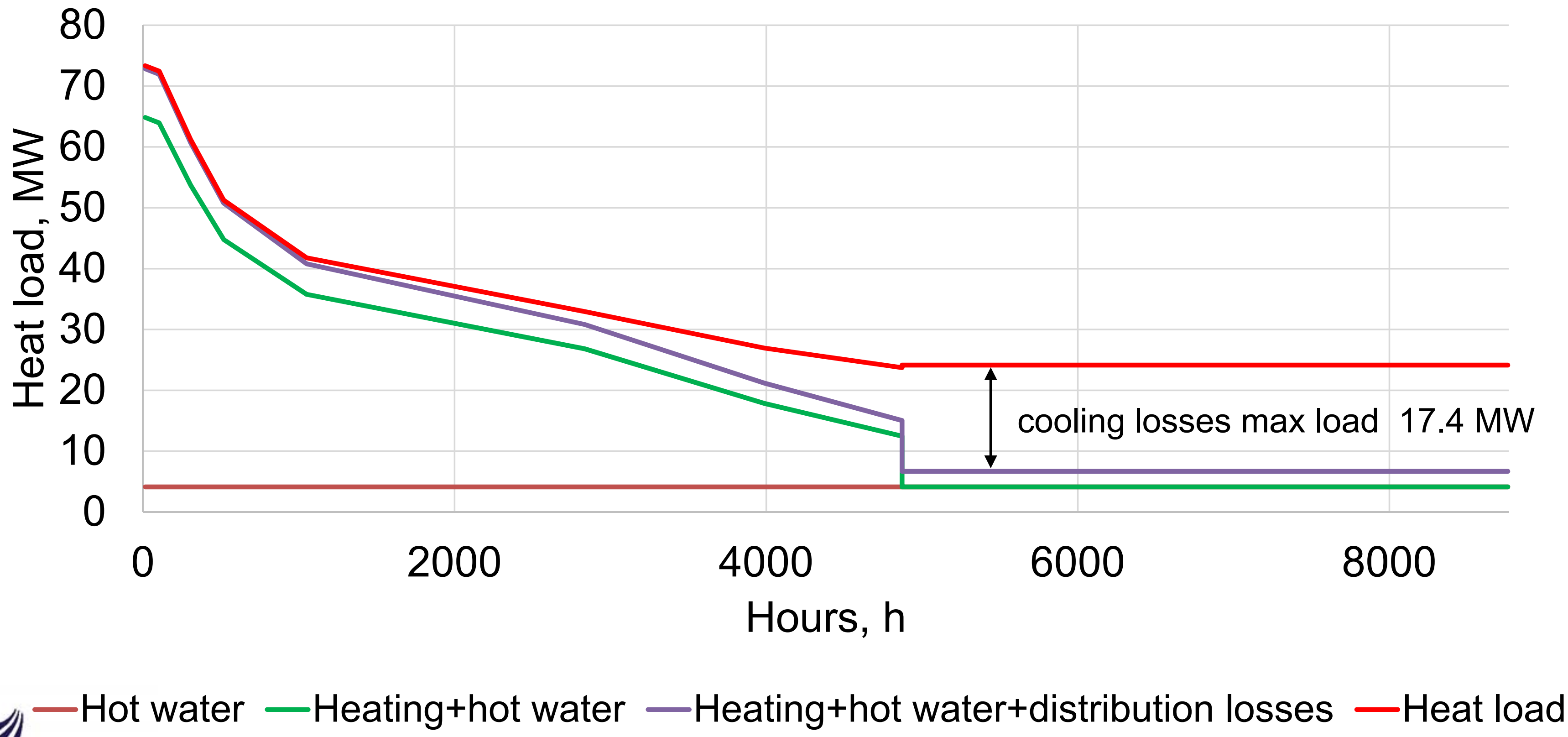

**Source: Central Statistical Bureau. www.csb.gov.lv*

# Comparison of DH company profit and investment for retrofitting

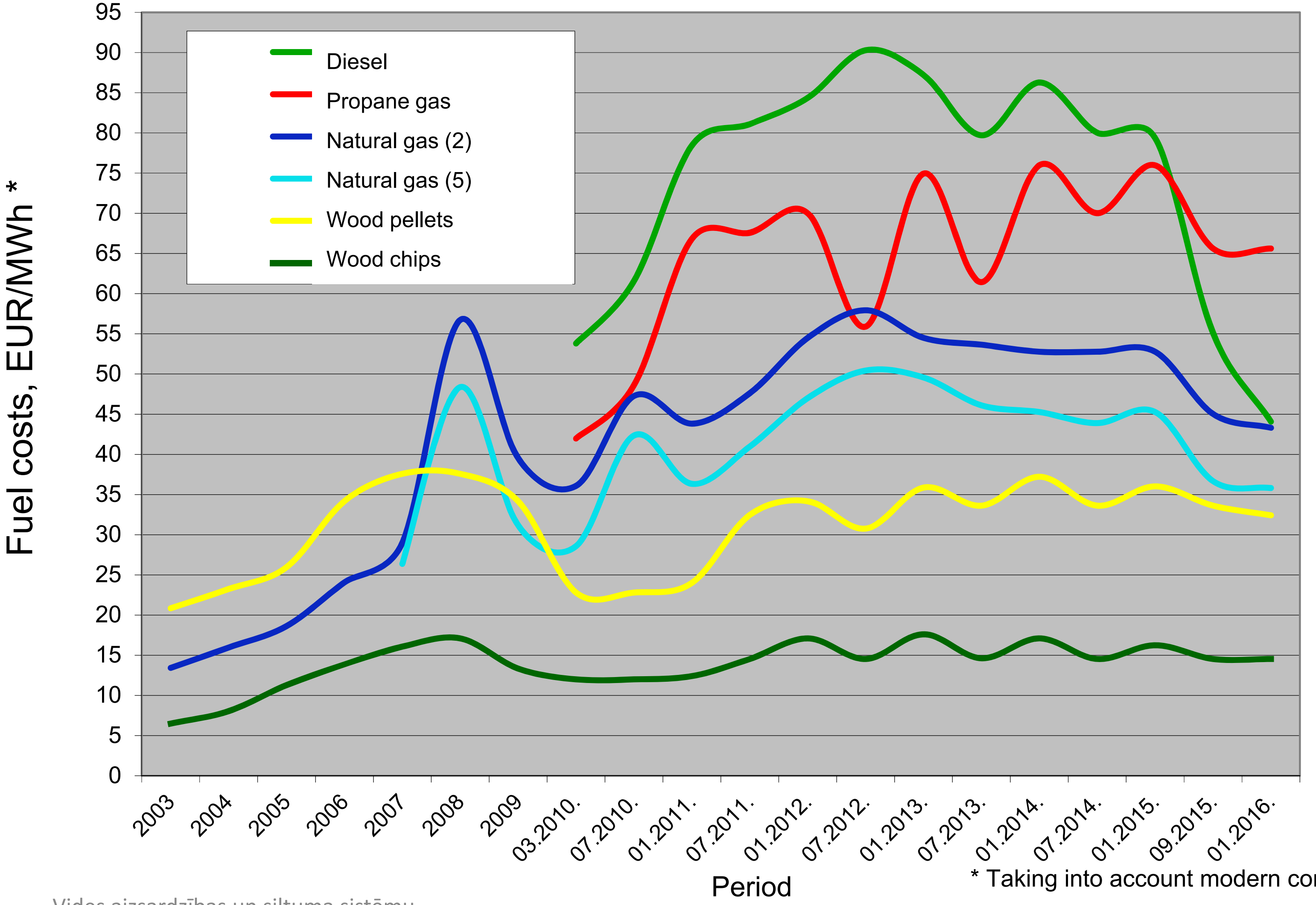



Sc1 Sc2 Sc3 Sc4 Base A B C

# Heat load curve



# Different fuel prices




Price (without VAT):

- diesel 472 EUR/t

- propane gas 760 EUR/t

- Natural gas (2.group) 0,3581 EUR/m3

- Natural gas (5.group) 0,2961 EUR/m3

- Wood pellets 135 EUR/t

- Wood chips 8,50 EUR/bulk m3

* Taking into account modern combustion efficiency coefficient