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#SESAAU2020

Technical, economic and ecological effects of lowering temperatures in the Moscow district heating system

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Goals of the work:

- to analyze to what extent it is feasible to lower the temperatures in the Moscow DH network, what measures are required, and what effects can be gained;

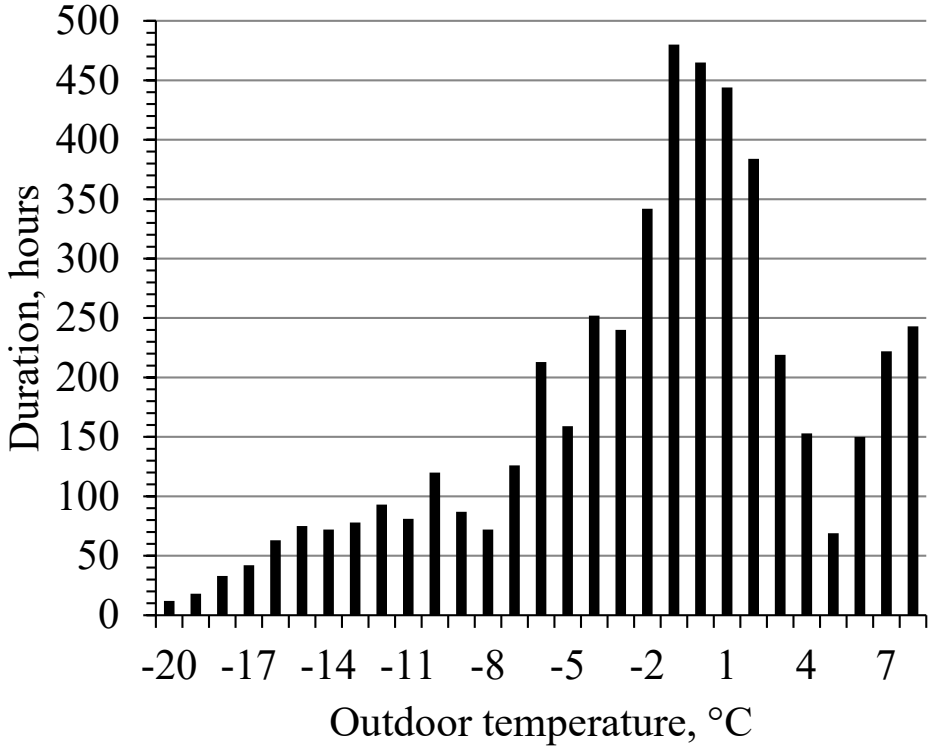
- to start the discussion about gradual transition to more energy efficient and ecologically friendlier LTDH systems in Moscow and other Russian cities.

Initial information about the Moscow heat supply system

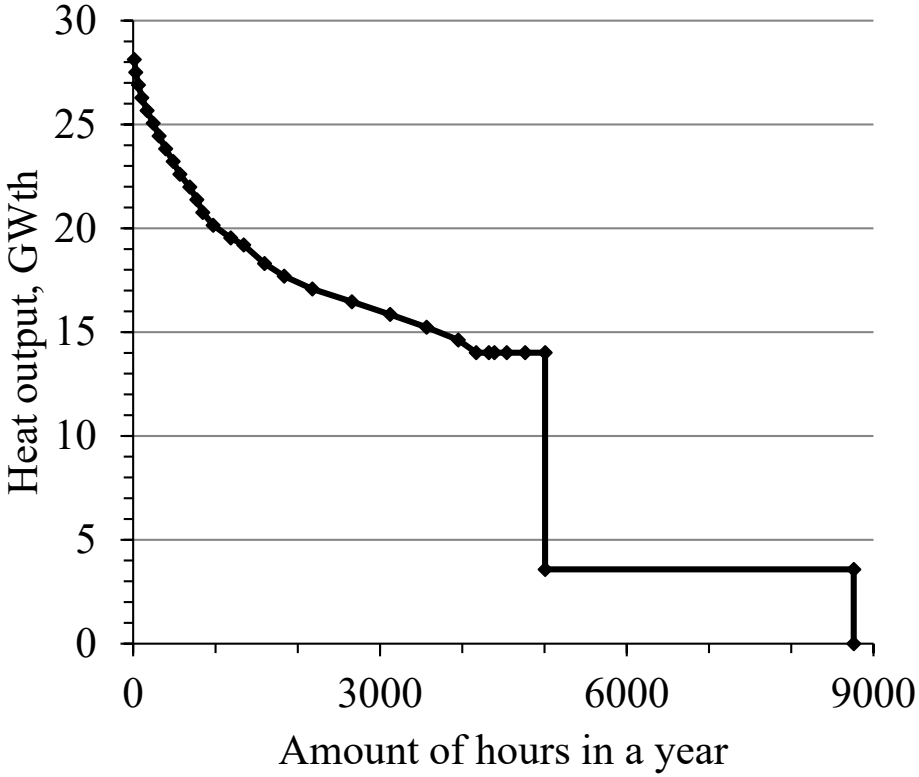
Population	12.6 mln people
Share of district heating	96%
Total length of pipes	17500 km
Total trench length	6240 km
Total heat generation	120 TWh_{th}/a
Linear heat density	19 $MWh_{th}/(a*m)$

Natural gas consumption	14 bln m^3/a
CO_2 emissions	26.6 Mt CO_2/a
Heat saving potential in buildings	39-68%
№ of CHP plants	13
№ of district boiler stations	33
№ of quarter boiler stations	17

Duration of outdoor temperatures in Moscow during the heating season of 2016.



Heat output from the considered heat supply sources in Moscow during 2016.



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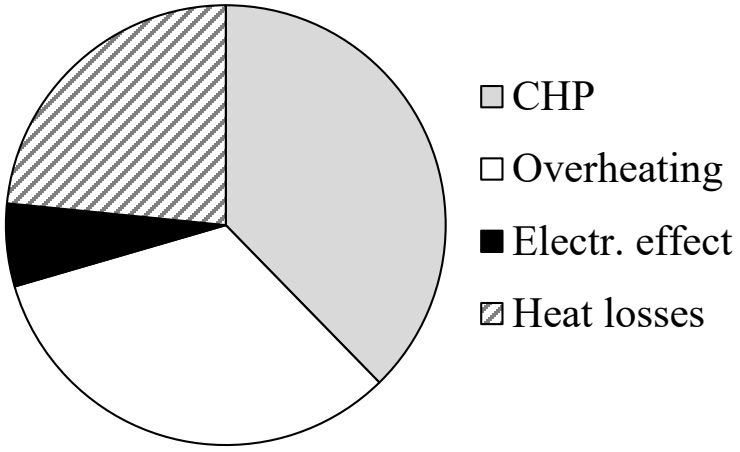
Methodology.

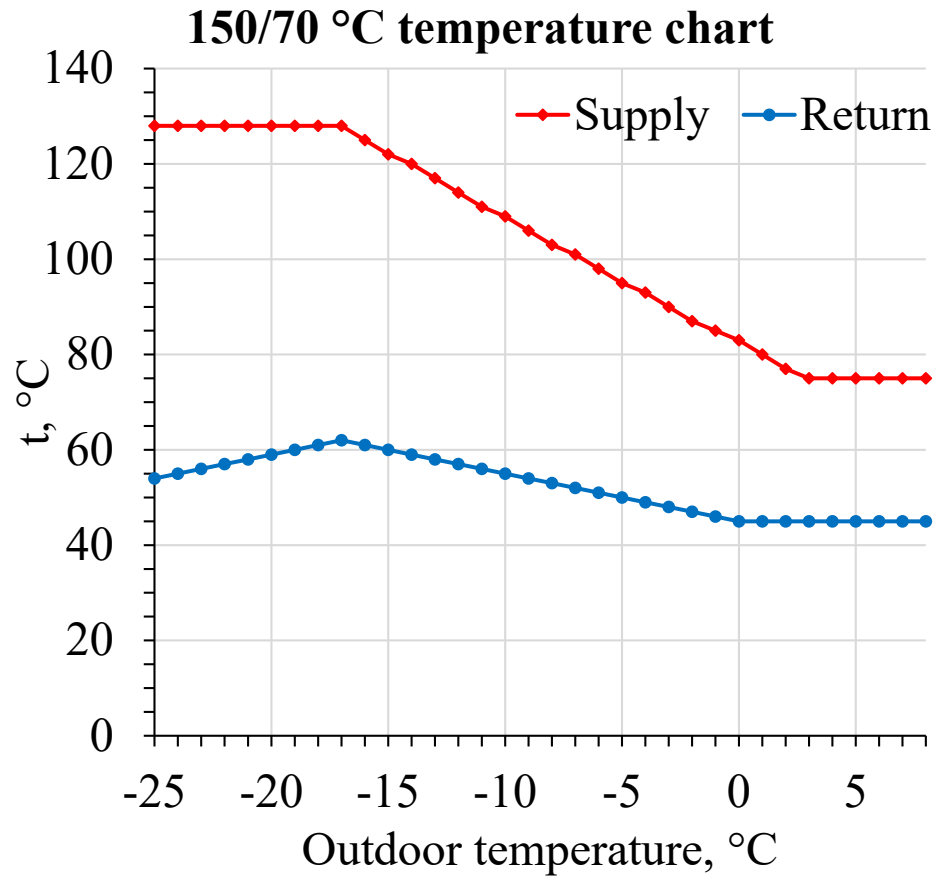
In order to estimate the effects of the transition to lower temperatures in the Moscow DH system, a spreadsheet-based model was developed. Six different temperature charts with reduced design supply and return temperatures were considered in this work: 110/55 °C, 110/50 °C, 105/55 °C, 105/50 °C, 100/50 °C, and 95/50 °C in comparison with the current 150/70 °C and 130/70 °C. Methodology includes 4 main parts:

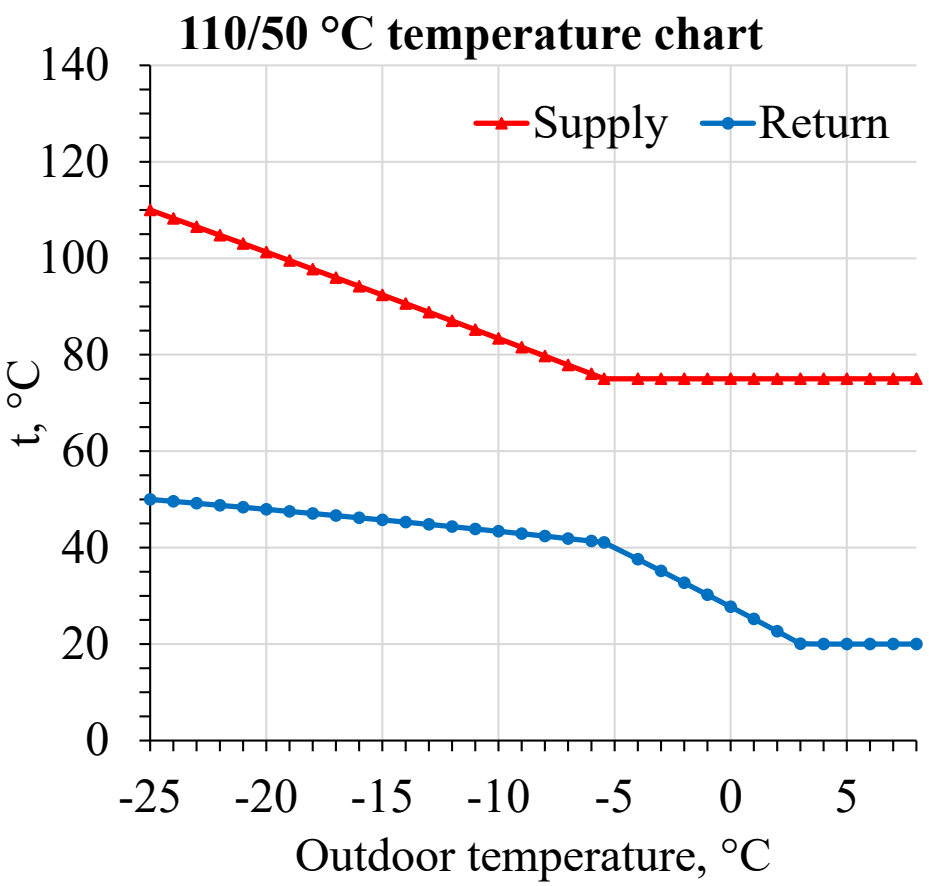
- Heat losses reduction calculation;
- Electricity consumption calculation;
- Fuel savings at CHP plants;
- Elimination of overheating in the rectification zone.

Calculations were performed for four scenarios: reference case and three cases with reduced heat demand in buildings by 5, 10 and 20 %.



Average structure of the fuel savings for the reference case


150/70 °C temperature chart
Supply
Return
t, °C
140
120
100
80
60
40
20
0
-25
-20
-15
-10
-5
0
5
Outdoor temperature, °C


110/50 °C temperature chart
Supply
Return
t, °C
140
120
100
80
60
40
20
0
-25
-20
-15
-10
-5
0
5
Outdoor temperature, °C

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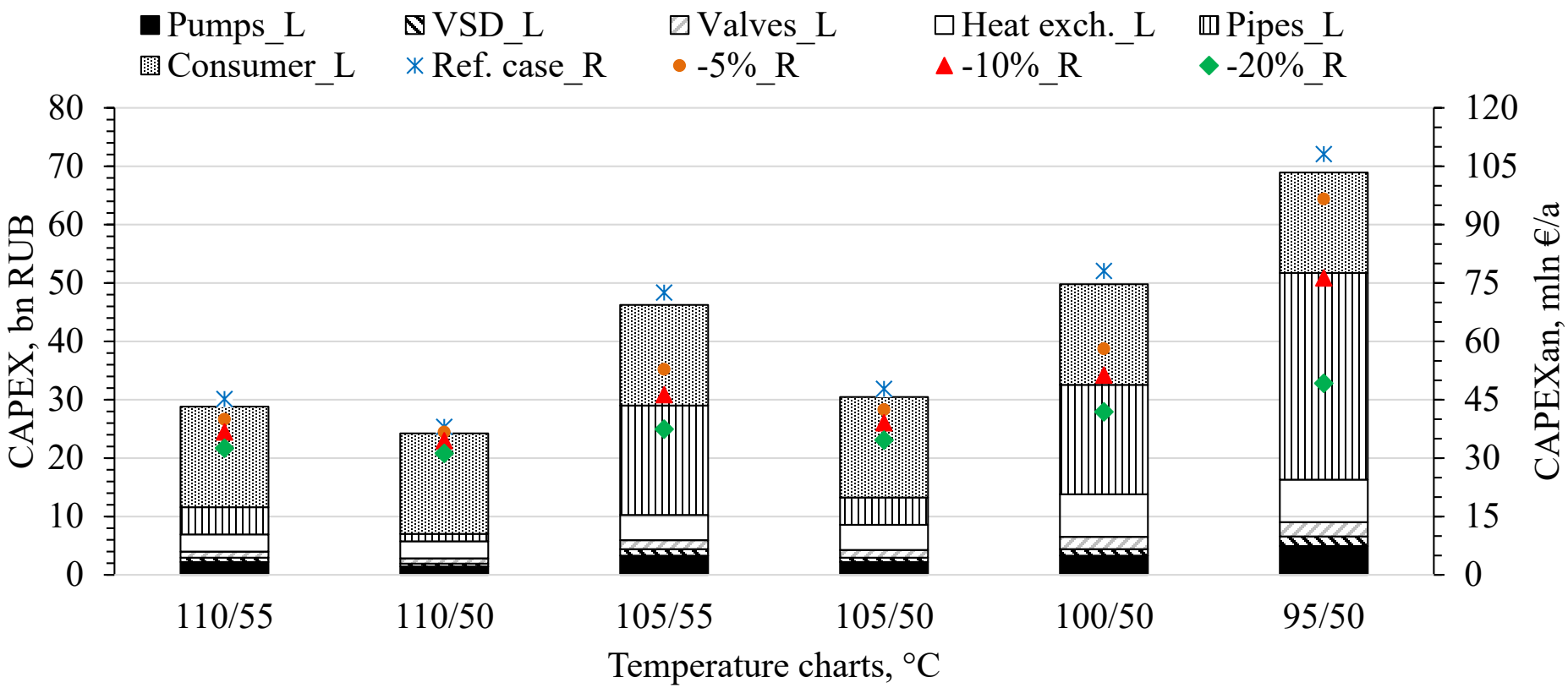
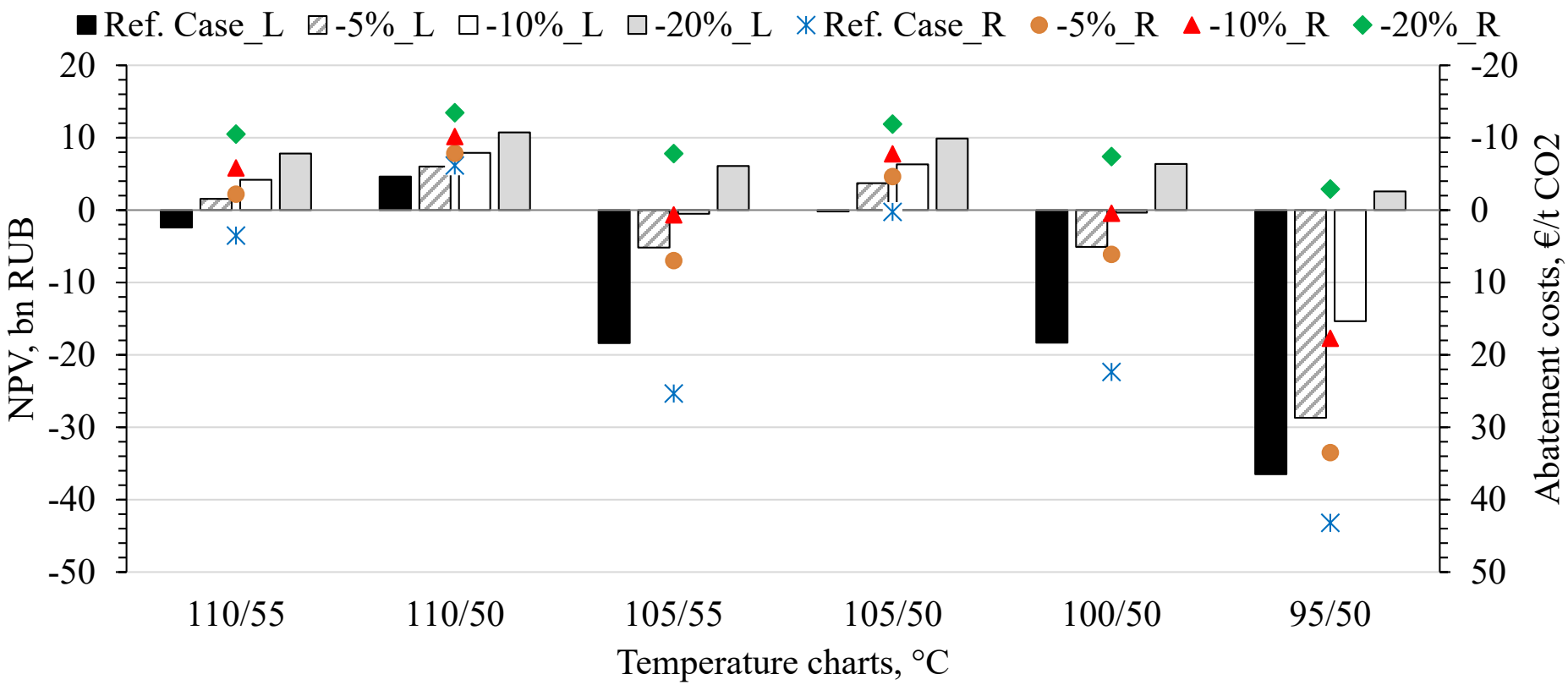
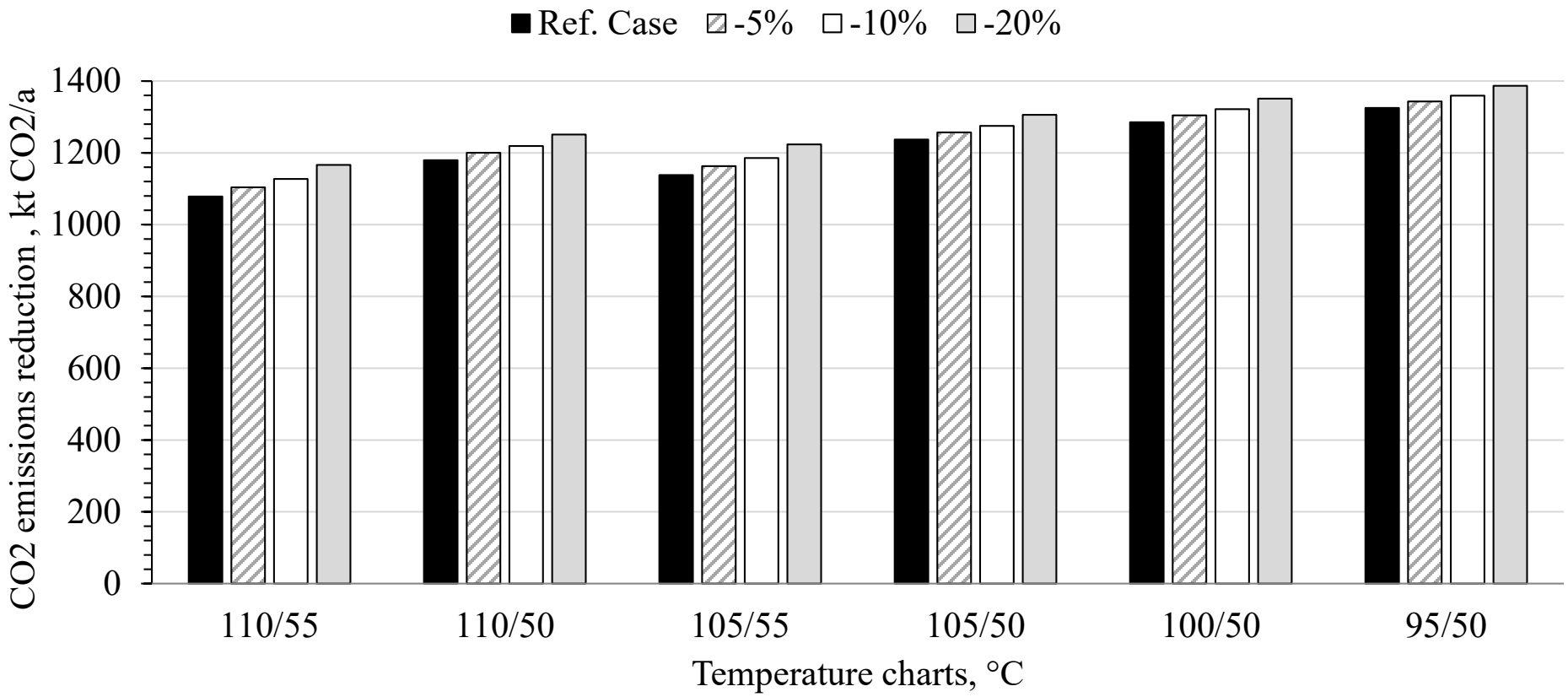
Capital expenditures on equipment for the transition to different temperature charts in the reference case (_L – left Y-axis) and annualized capital expenditures for four cases (_R – right Y-axis).



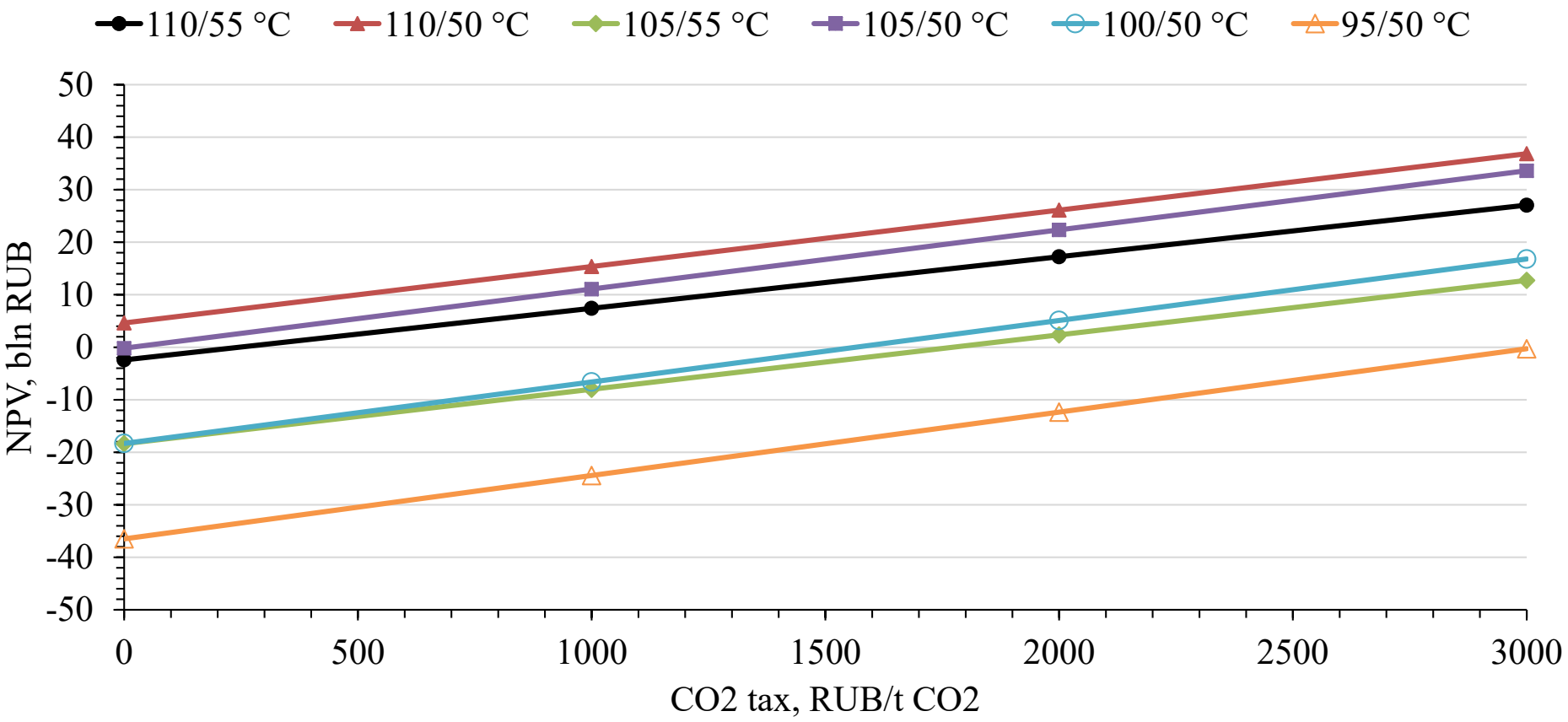
Net present values for 15 years in case of the transition to different temperature charts (_L – left Y-axis) and CO_2 abatement costs (_R – right Y-axis).



CO_2 emissions reduction in case of the transition to different temperature charts.



Dependence of net present value on a CO_2 tax for the reference case.



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Discussion.

- the Moscow DH system can be characterized as a 2GDH system. That is why this work focused on a relatively small reduction of the temperatures in the network, which suggests a gradual movement towards the 3GDH and the 4GDH level of temperatures.
- the obtained values of reduced CO2 emissions as the result of a temperatures decrease are 5-6% of total emissions (22.4 Mt CO2/a). That is why the extensive use of renewable energy sources and the utilization of waste heat are required.
- the LMTD of consumers' radiators will decrease by 16-25%. That is why either existing radiators must be replaced or the heat demand in buildings must be reduced by at least 20%.
- the transition is possible if the additional equipment (pumps, heat exchangers, valves and so on) is installed. In order to avoid installing a large amount of additional equipment and enlarging heat substations during the transition to lower temperatures, energy-saving measures in buildings are necessary.

Conclusion.

- The transition from the current 150/70 °C and 130/70 °C temperature charts to the 110/55 °C, 110/50 °C, 105/55 °C, 105/50 °C, 100/50 °C, and 95/50 °C temperature charts in the Moscow heat supply system allows for:

- fuel savings of 680-870 $\frac{ktce}{a}$;
- carbon dioxide emissions reduction by 1.1–1.4 Mt CO_2/a.

- The 110/50 °C temperature chart is the most profitable solution with the NPV varying from 4.6 to 10.7 bn RUB (from 66 to 153 mln €).
- The essential prerequisite for the transition is a reduction of the heat demand in buildings by at least 20 % in order to have less capital expenditures for the transition and to avoid potential thermal discomfort of consumers.

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Thank you for your attention!

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