

Impact of Heat Pumps Applications to Primary Energy Consumption in Serbian Schools

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Introduction

- Heat pumps and district heating in buildings
- Sustainable business operation of heat producers
- Electricity market development towards further liberalization
- Cost-effectiveness of energy efficiency measures
- Life-cycle cost assessment approach

Introduction

- Wider goals:
- Thermal comfort and more sustainable energy supply in schools
- More accurate assessment of indicators for EE measures
- Using sophisticated tools and methods for decision making in the energy sector

Problem Formulation

- Cooling in schools: examination of VRV heat pump systems for comfort, efficiency, and reliability
- Impact on heat supply: heat pumps vs district heating
- Optimal operations
- Price development scenarios

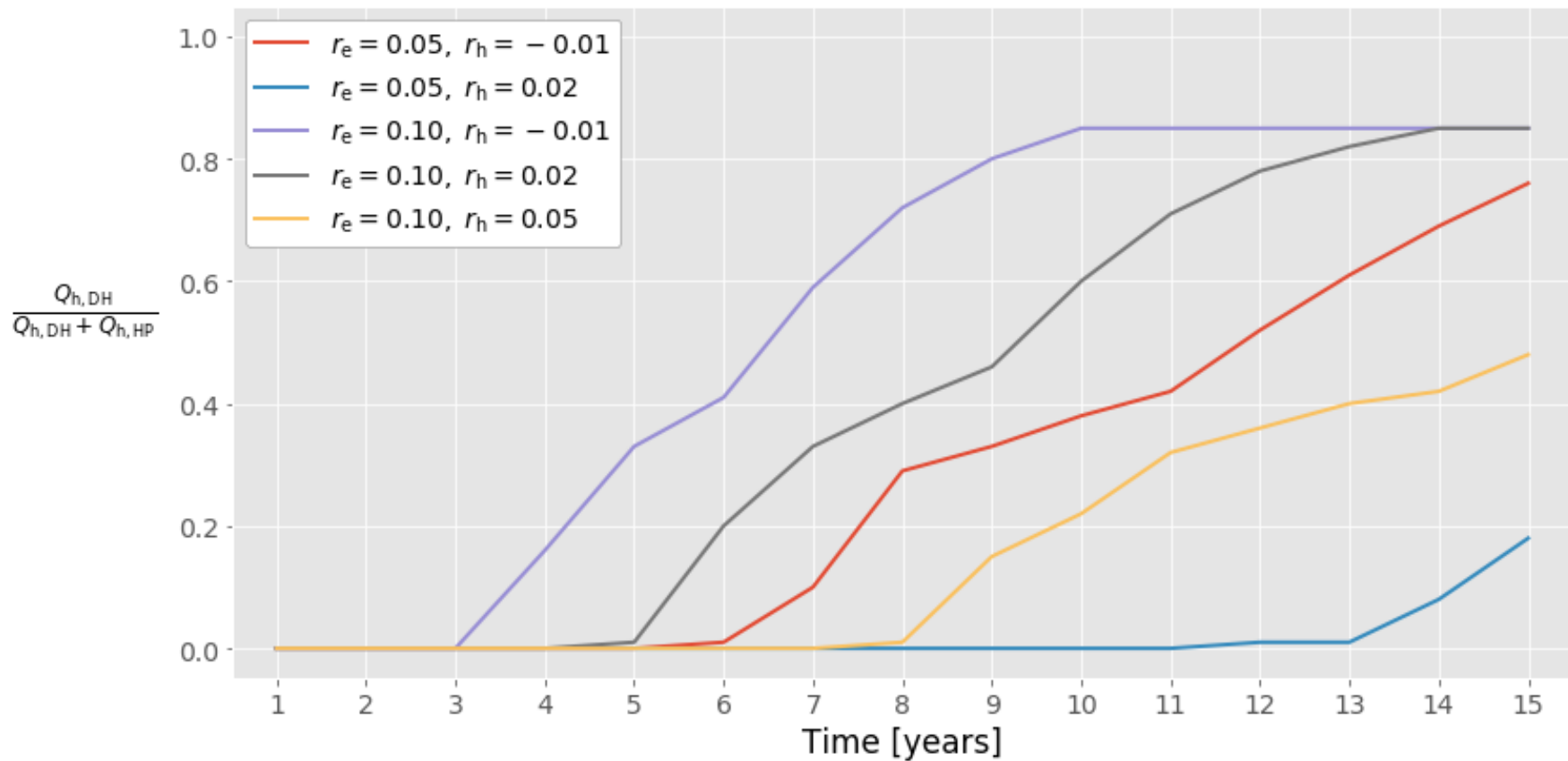
Methodology

- EnergyPlus simulations
- VRV systems sizing according cooling demand
- Cost-optimal operation for economic life-time: linear programming

Results and Discussion

- For most scenarios, HP-based heating is preferable from both PE and costs aspects, especially at the beginning of the horizon
- High efficiency of VRF systems and relatively high primary energy factor for district heat
- Variation of the results for different scenarios

Results and Discussion



Results and Discussion

School No.	PEC for Baseline [MWh]	PEC Range [MWh]	PEC Savings Range
1.	3395.56	1339.46–2334.57	31.25%–60.55%
2.	3083.95	1250.37–2092.63	32.14%–59.46%
3.	3698.74	1472.50–2574.43	30.40%–60.19%
4.	2323.96	909.37–1618.59	30.35%–60.87%
5.	4044.71	1592.68–2818.06	30.33%–60.62%
6.	3043.77	1206.95–2123.93	30.22%–60.35%
7.	5803.82	2303.88–4070.19	29.87%–60.30%
8.	1938.79	750.34–1341.45	30.81%–61.30%
9.	10182.65	4473.57–7445.45	26.88%–56.07%

Conclusions

- The importance of the LCA approach and consideration of the operating regimes of energy systems
- As the prices of energy commodities vary, the optimal operating regimes change, causing sometimes significant changes in operational cost and primary energy consumption
- Heating systems based the heat pumps of high efficiency might become a preferable option in

Thank you for your attention!

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