Towards the Utilization of Heat Flexibility: A Study of Danish Dwellings

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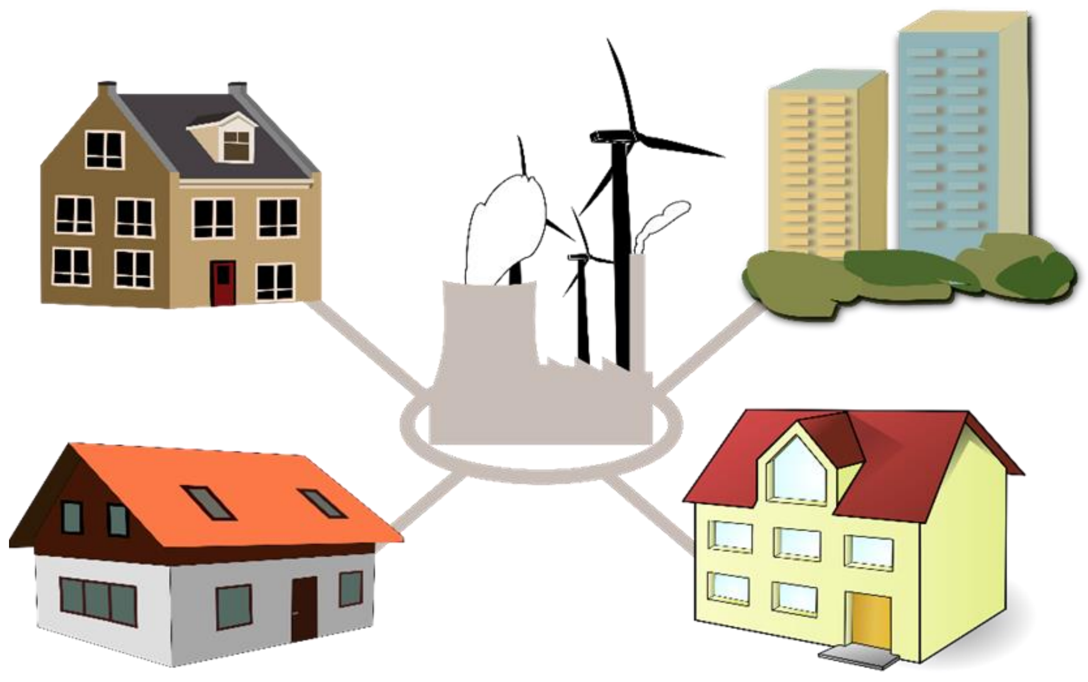
Introduction

This study aims to use building thermal inertia to provide heat flexibility for district heating systems to reduce/avoid the operation of peak load boilers. For such service, the heat flexibility of single buildings have to be aggregated to a larger scale such as a distribution network scale. As one distribution network connects to hundreds of buildings with different building types, the heat flexibility of different building types is investigated for the flexibility aggregation and utilization in the operation of district heating grid.

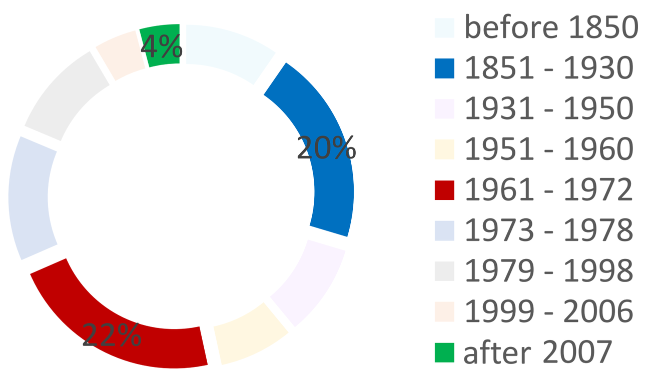


Methodology

The flexibility of Danish residential dwellings built in different time periods is modelled based on TABULA database. Building thermal response is examined after altering heating signal to zero (heat cut-off). The time duration of indoor temperature decreasing from 22°C to 20°C is defined as heat flexibility. It is categorized for different building types based on outdoor climate conditions such as temperature and solar irradiance.

TABULA WebTool

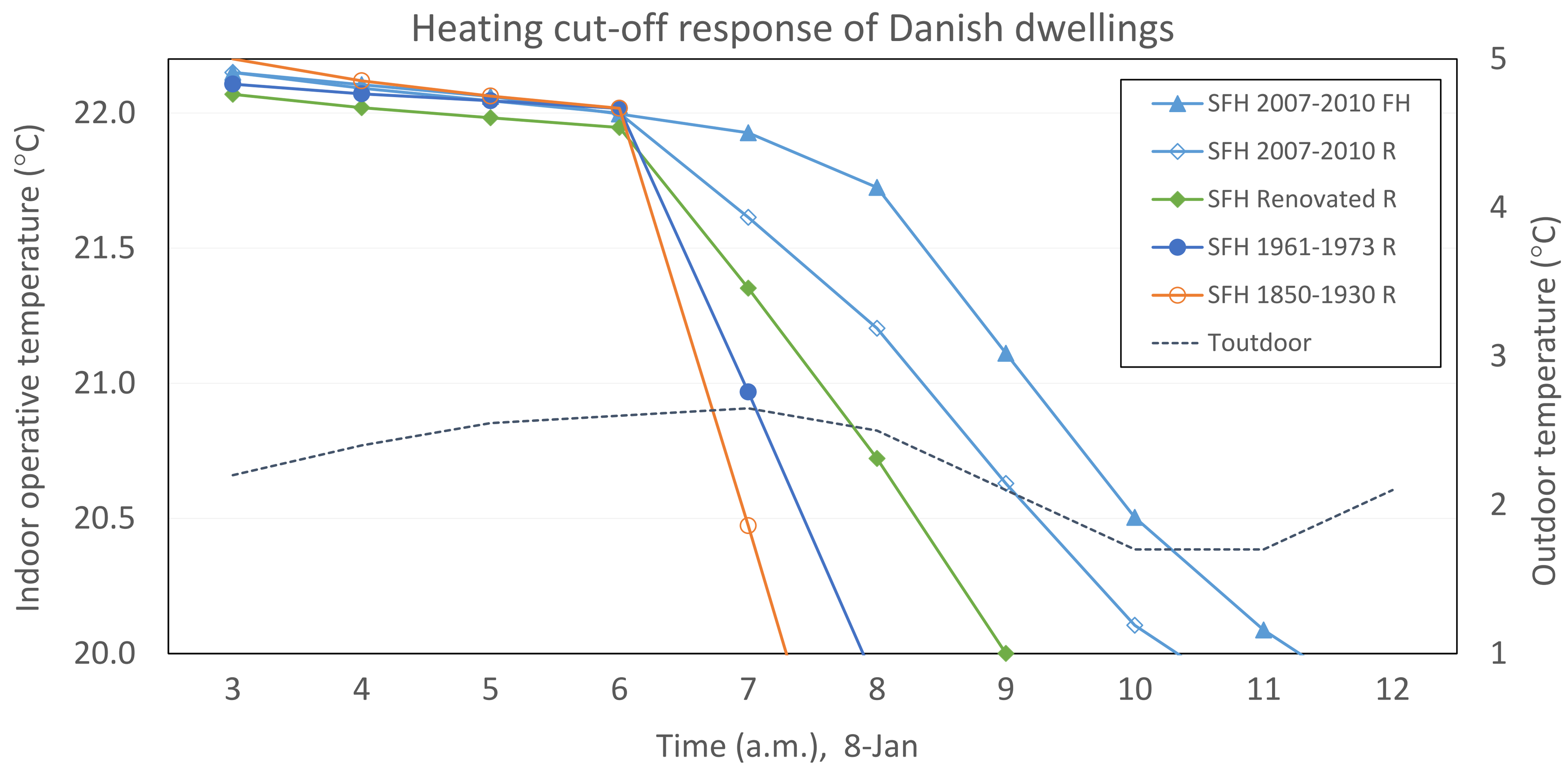
TRNSYS 17



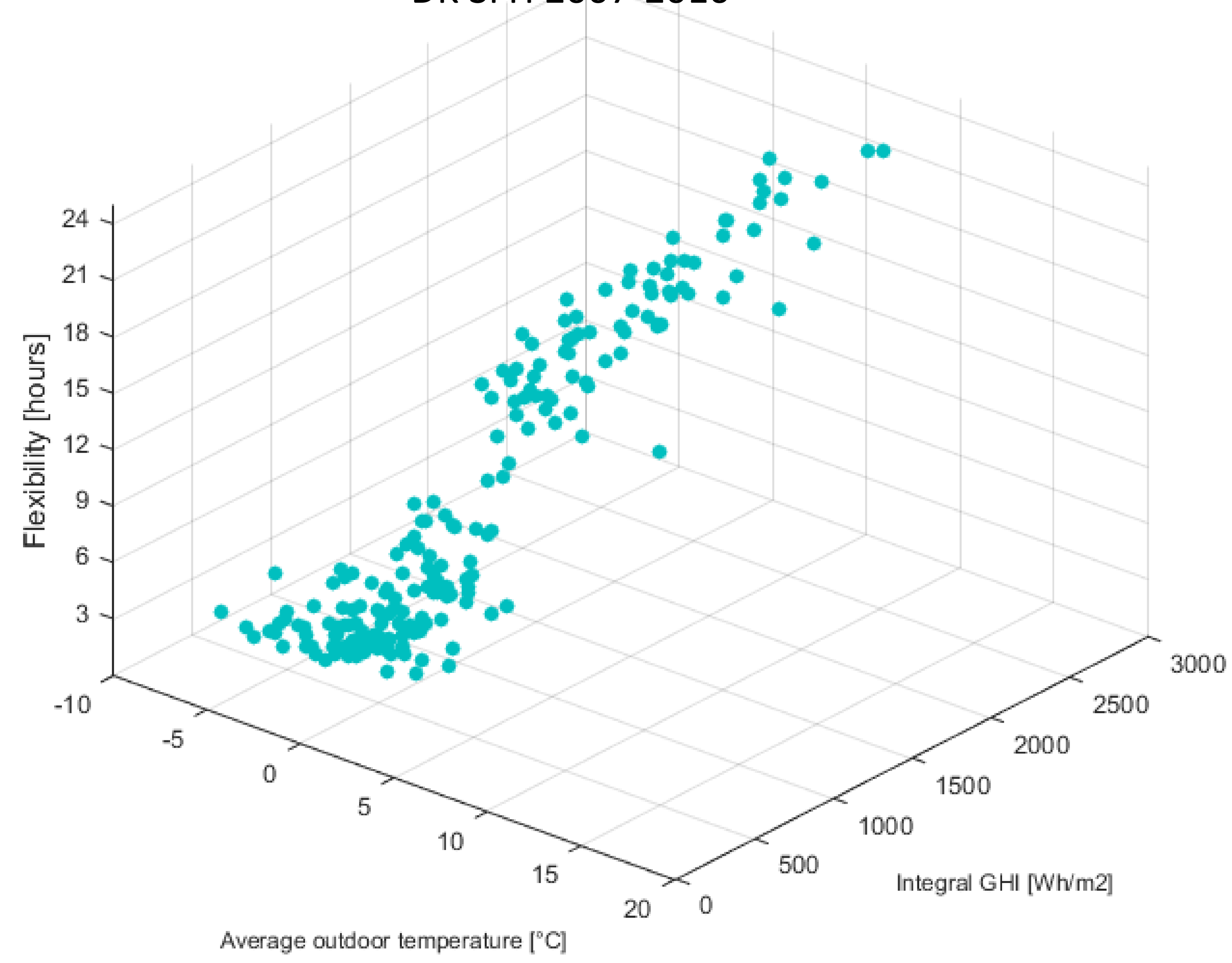
Single Family House	Construction year	U value (W/m²K)			
		Floor	Wall	Ceiling	Window
	1851 – 1930	0.60	1.60	1.50	2.70
	1961 – 1972	0.30	0.60	1.30	2.80
	2007-2010	0.11	0.16	0.12	1.50
Renovated house		(minimum BR15 requirement)			
	1961 – 1972	0.20	0.30	0.20	1.40

Results

The heat flexibility of different building types is different.



Outdoor temperature and solar irradiance have significant impacts on heat flexibility.



SFH 2007-2010

$$Daily\ \widehat{Flexibility} = 3.51 + 1.12T_{o,avg} + 5.56\int_{6am}^{24am} GHI \qquad (R^2=0.85)$$

SFH renovated 1961-1972

$$Daily\ \widehat{Flexibility} = -0.31 + 0.85T_{o,avg} + 4.03\int_{6am}^{24am} GHI \qquad (R^2=0.81)$$

Conclusion

Heat flexibility is calculated for typical types of Danish single-family houses on a daily basis. Daily flexibility was found to correlate with outdoor temperature and solar irradiance. The heat flexibility is therefore applicable for using in the operation of district heating grid based on the weather forecast of the next day.

Acknowledgement

This research is supported by the CITIES project and EnergyLab Nordhavn project.

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