

#### **Aalborg Universitet**

#### Renovation strategies of typical Danish single-family house for optimization of energy efficiency and flexibility

Marszal-Pomianowska, Anna; Johra, Hicham; Loukou, Evangelia; Liu, Mingzhe; Pomianowski, Michal Zbigniew; Sharif, Nadin Hisham; Monne, Laia Tuixent Morgo; Levane,

Creative Commons License CC BY 3.0

Publication date: 2019

Document Version Publisher's PDF, also known as Version of record

Link to publication from Aalborg University

Citation for published version (APA):

Marszal-Pomianowska, A., Johra, H., Loukou, E., Liu, M., Pomianowski, M. Z., Sharif, N. H., Monne, L. T. M., & Levane, U. (2019). Renovation strategies of typical Danish single-family house for optimization of energy efficiency and flexibility. Poster presented at CISBAT 2019 – International Scientific Conference:, Lausanne, Switzerland. https://iopscience.iop.org/article/10.1088/1742-6596/1343/1/012182

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
  You may not further distribute the material or use it for any profit-making activity or commercial gain
  You may freely distribute the URL identifying the publication in the public portal -

#### Take down policy

If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from vbn.aau.dk on: December 05, 2025



# Renovation strategies of typical Danish single-family house for optimization of energy efficiency and flexibility

Paper ID: 1283

Anna Marszal-Pomianowska, Aalborg University; Hicham Johra, Aalborg University; Evangelia Loukou, Aalborg University; Mingzhe Liu, Aalborg University; Michal Pomianowski, Aalborg University; Nadin Hisham Sharif, Aalborg University; Laia-Tuixent Morgo Monne, Aalborg University; Una Polonowa, Aalborg University

#### **INTRODUCTION:**

- 1. The ability to be flexible in the way energy is used will be just as important as implementing energy efficiency and generating energy from renewable sources, if planned CO<sub>2</sub> emissions are to be achieved.
- 2. The **heating need** still represents **25% of the final energy consumption** in Denmark despite the tightening of the building regulation and in **64% of Danish households** the heat demand is satisfied by **district heating**.
- 3. Thermal grids struggle with delivering the hot water to their customers during the morning peaks.
- 4. The renovation initiatives are focused on minimizing the overall energy consumption of the buildings and not on improving the control of heat demand.

#### **RESEARCH QUESTIONS:**

How typical cost-effective renovation packages contribute to energy consumption reduction as well as influence the energy flexibility, and if simple rule-based controller (RBC) can contribute in reducing morning consumption peaks.

## **CASE STUDY**



# RESULTS

Renovation package	Heat consumption (kWh/m²)	Energy efficiency improvement (%)	Autonomy time (min)
Before renovation	192.8	<del>-</del>	13.6 - 26.1
P1	126.9	34.2	23.0 - 41.0
P2	92.9	51.8	44.4 - 79.2
P3	71.9	62.7	69.2 - 111.7
P4	69.5	64.0	71.5 - 126.0
<b>P5</b>	70.8	63.3	70.7 - 115.0

### Thermal comfort for P5 and cut-off control strategy

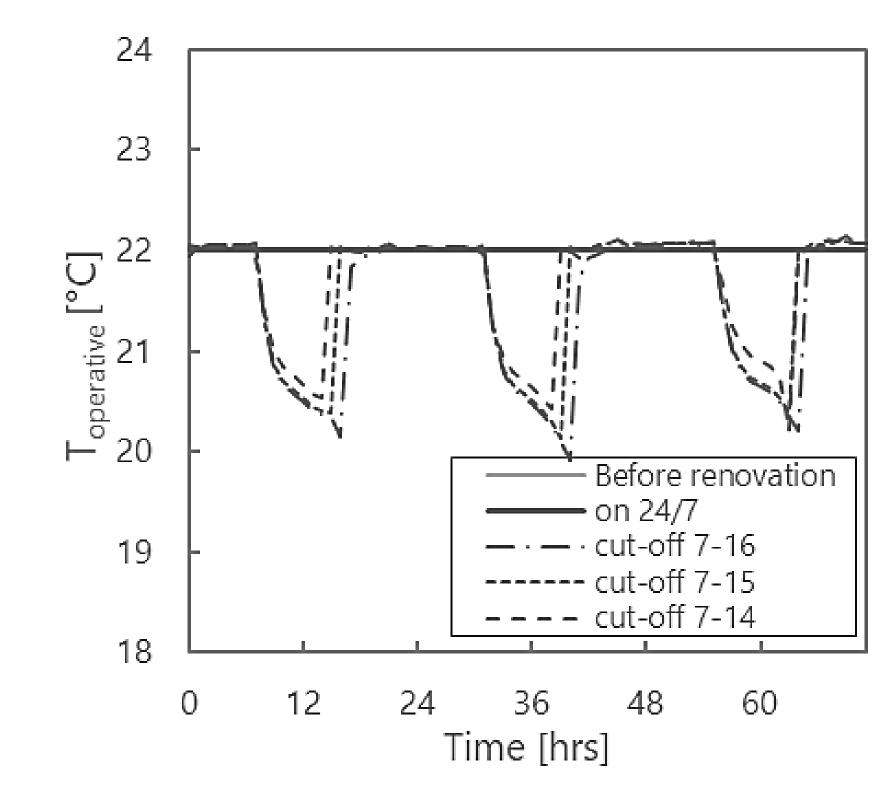
Control strategy	Number of hours < 20°C	Toperative,min (°C)
Cut-off 7:00-14:00	143	18.3
Cut-off 7:00-15:00	231	18.0
Cut-off 7:00-16:00	333	17.6

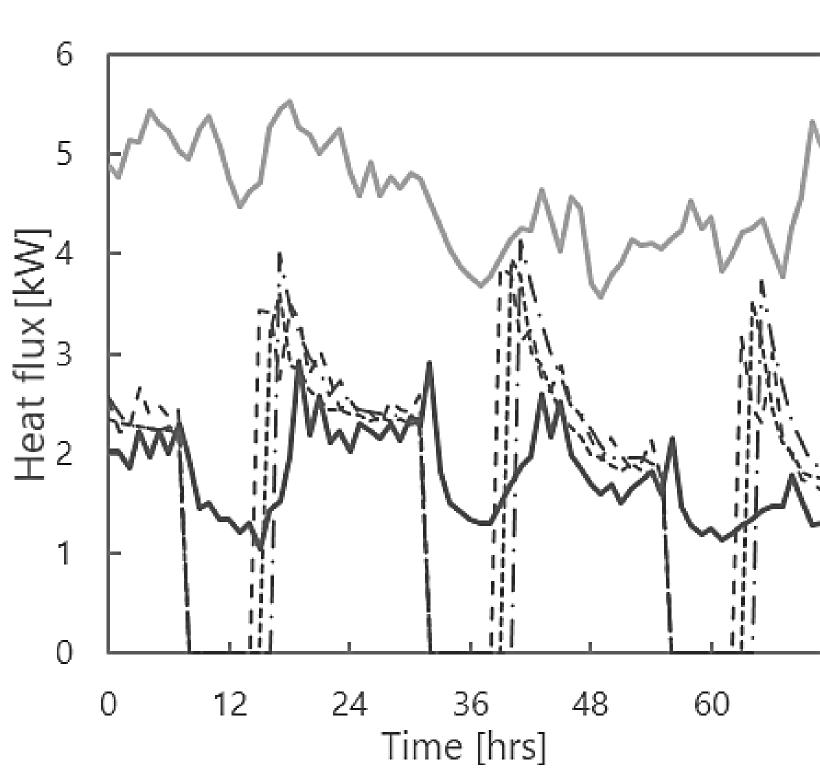
#### **RENOVATION PACKAGES**

- P1: renovation of 54 % of envelope including the roof and the crawl floor
- P2: renovation of 75 % of envelope except the windows and ground floor
- P3: renovation of 80 % of envelope except the ground floor
- P4: renovation of 100 % of envelope & light finish
- P5 renovation of 100 % of envelope & new brick finish

# **CONTROL STRATEGIES**

- Cut-off the heating power is turned off at 7:00 a.m. until
   a) 2:00 p.m. (7h); b) 3:00 p.m. (8h) and c) 4:00 p.m. (9h).
- Pre-heating before cut-off  $-T_{\rm set}$  is increased by 2K for 1h-2h before the heating power is turned off at 7:00 a.m. for the same duration as in the cut-off modulation: 7h, 8h or 9h.





### **CONCLUSIONS**

- Different renovation packages can reduce the space heating by 34 64% and increase the flexibility time by 200 500%.
- The building envelope thermal resistance has a great importance for both energy efficiency and flexibility, since it conserves the heat indoors.
- The simple RBC of turning off the heating power can further reduce the heating consumption and contribute in reducing the morning load peak with small compromise on the thermal comfort level. However, special attention should be given to the period of afternoon activation of the heating system (end of the cut-off period) in order not to create the new peaks close to the already known afternoon peak