Future energy pathways for a university campus considering possibilities for energy efficiency improvements

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Objectives

- Find the most relevant energy efficiency measures that will decrease the total energy use of the NTNU campus
- The NTNU campus consists of many existing buildings and new will be built
- The work was developed in collaboration with the NTNU Property Division as a part of NTNU development

Big picture of energy planning

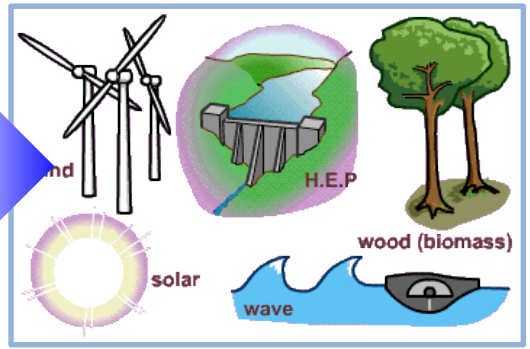
Regulative and standards

Energy market and prices

Technical and physical factors

Human influenced and social factors

Energy system



Users

Primary energy

Delivered energy

Emission

Demography and social economy

Method

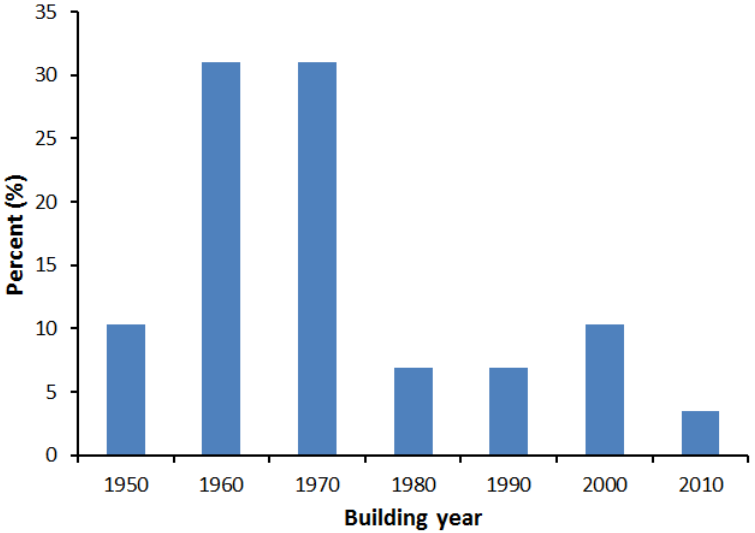
- Typical reference buildings have been defined based on the construction years
- Each group of reference building was called “Cohort”
- Energy efficiency measures were introduced as packages
- IDA-ICE was used for modeling
- Material flow analysis was used to aggregate the energy use data

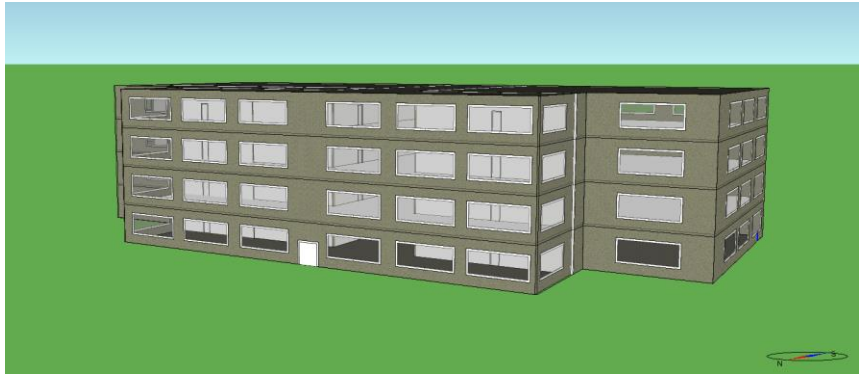
Building type

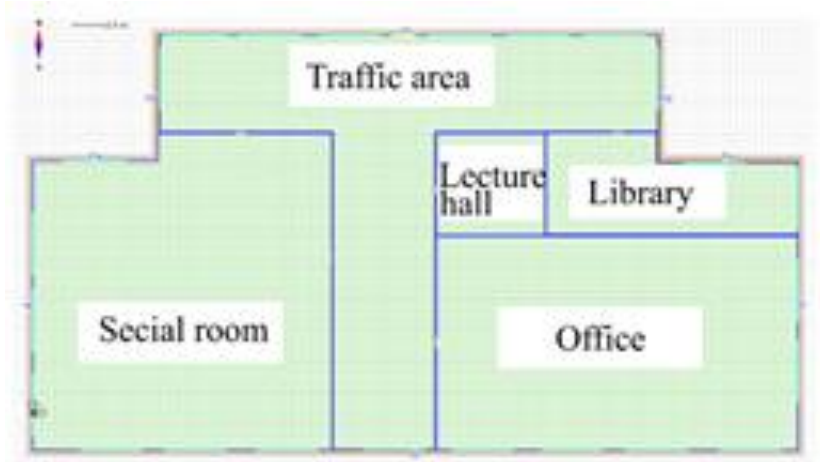
Cohort	Model
Before 1950 – C1	B1
1951-1970 – C2	B2
1971-1999 – C3	B3
2000-2010 – C4	B4
2017 – after – C5	B5

Typical building

Based on the statistical analysis and the methodology to define a typical building, a representative building model was developed







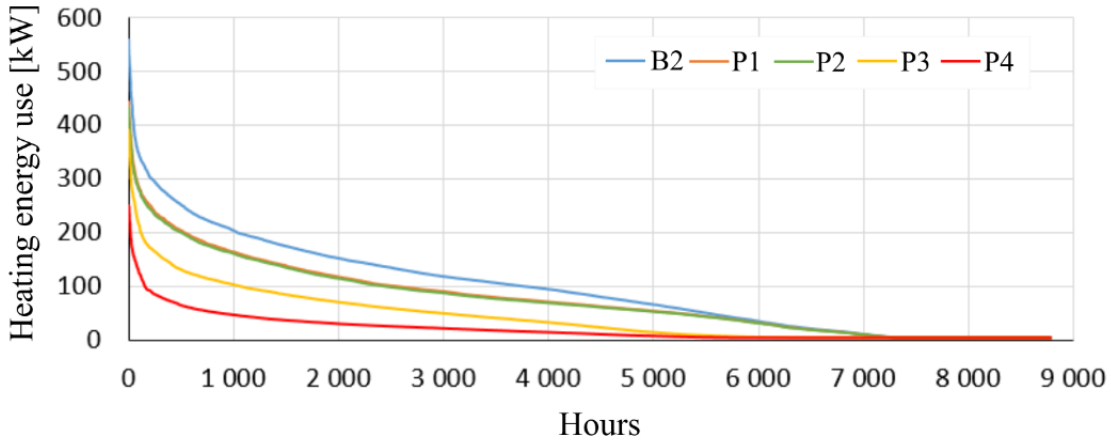
Eirik Nesgård and Minh Huy Ngo, Future energy pathways – possibilities for energy efficiency improvement and transition to renewable energy sources in building stock, MSc thesis, NTNU, 2018

Energy efficiency measures

Package		Component	Energy efficiency measures
P1: Standard package		Outer walls 1	Insulation with 50 mm mineral wool
		Roof	Insulation with 50 mm mineral wool
		Windows 1	TEK17 level (U-value 0.8 W/(m^{2}K))
		Air tightness	Improvement of leakage rate to 1.5 l/h
		Thermal bridge	Improvement of thermal bridge to 0.06 W/(m^{2}K)
P2: Ambitious package		Outer walls 2	Insulation with 100 mm mineral wool
		Roof	Insulation with 50 mm mineral wool
		Windows 2	Ambitious level (U-value 0.6 W/(m^{2}K))
		Air tightness	Improvement of leakage rate to 1.5 l/h
		Thermal bridge	Improvement of thermal bridge to 0.06 W/(m^{2}K)
P4 = P2 + P3	P3: Technical package	Heat recovery ventilation	Replacement of heat recovery with 80%
		Low temperature heating system	Switch from 80/60°C to 60/40°C

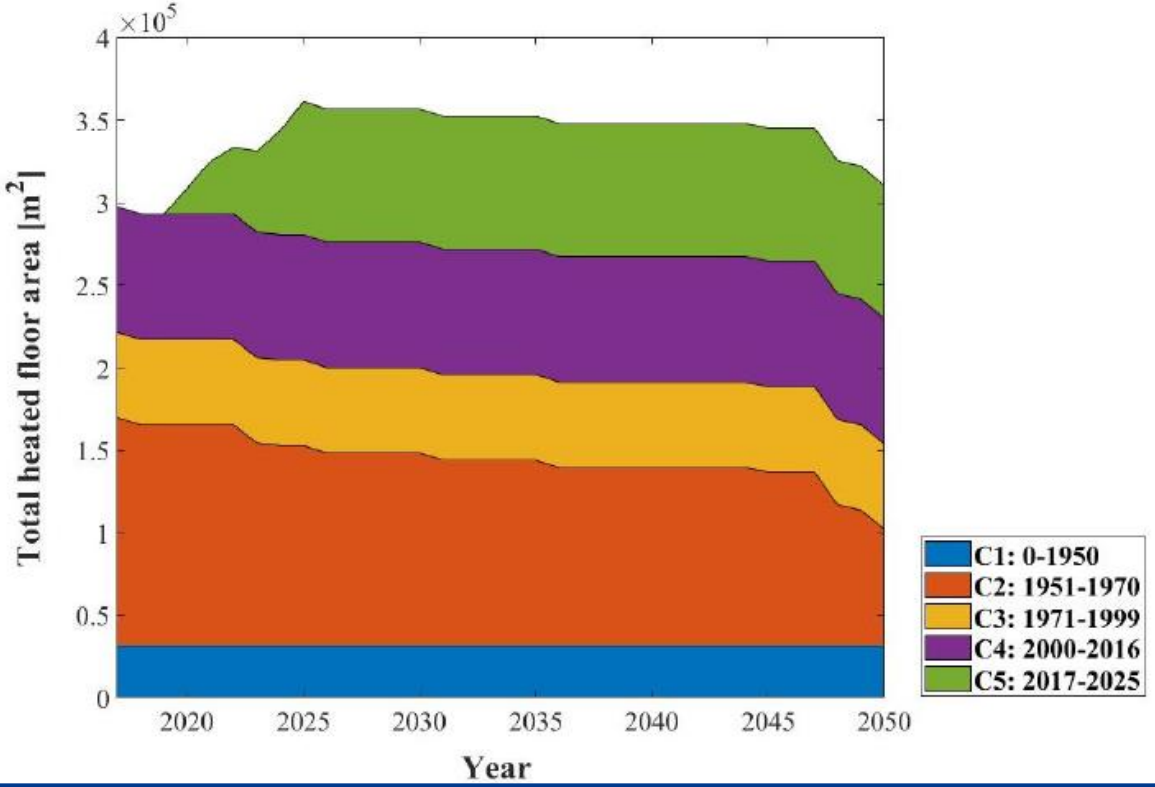
Heat duration curves

Heat duration curve for the representative building built between 1951 - 1970



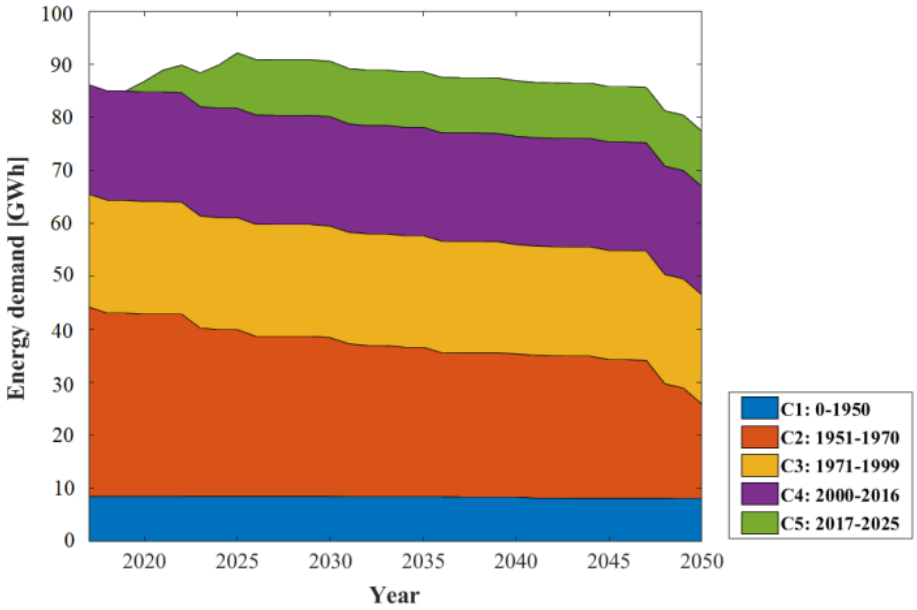
Building stock development at NTNU

The total campus area development over until 2050

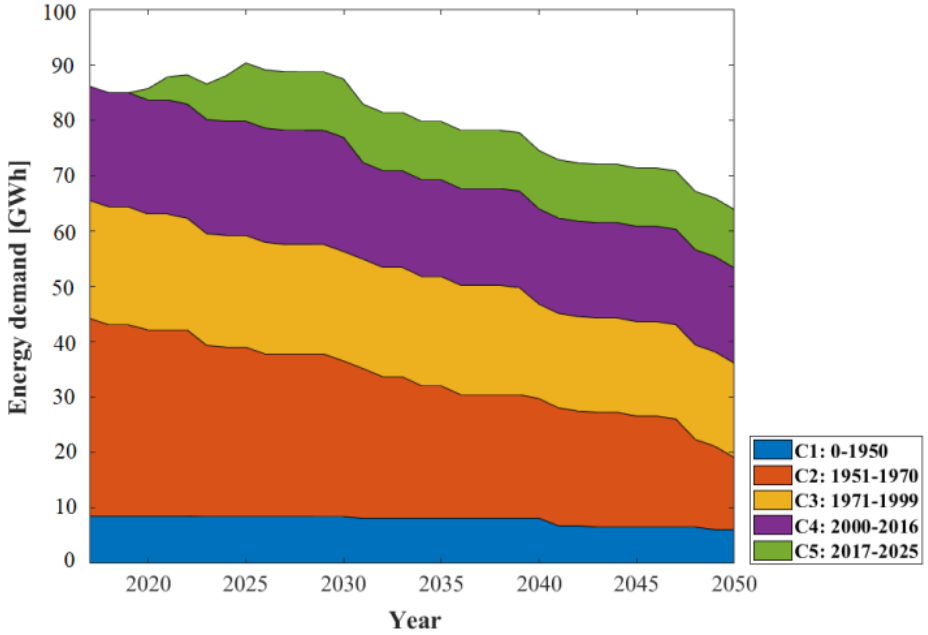


Development of total energy use at NTNU

Standard renovation



Advanced renovation



Conclusions

- Most of the buildings at the campus were built between 1951-1970
- Saving potentials were highly dependent on the construction period of the buildings
- Ambitious renovation in combination with technical improvements showed the greatest improvements
- A substantial heating energy could be saved by implementation of simple technical measures
- Improvement in the ventilation system gave the best results

Thank you for the attention!

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