

Ventilation systems and building technologies for a sustainable built environment

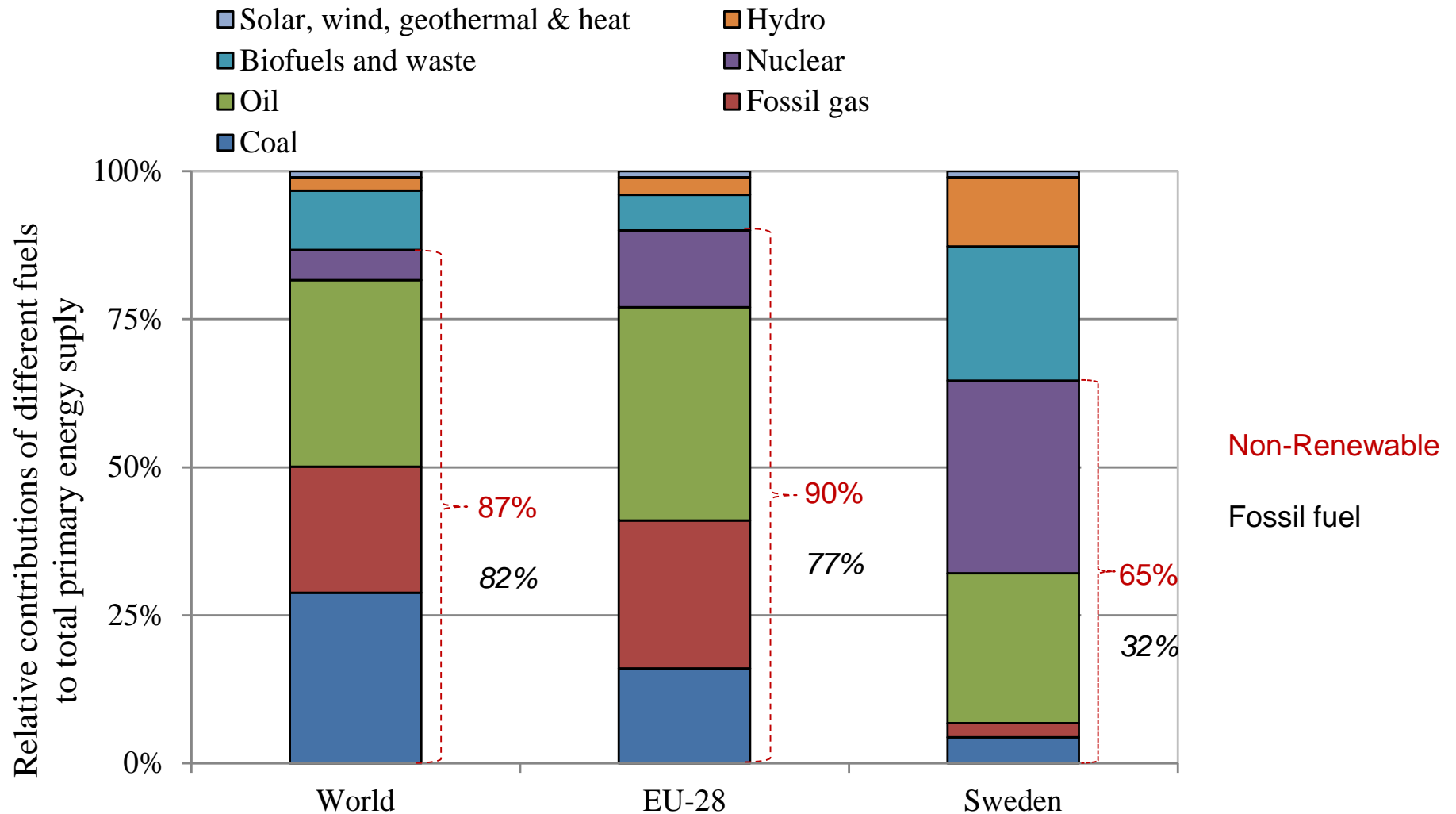
Ambrose Dodoo

Research goal and interest

To increase understanding of strategies for development of resource-efficient built environment with low environmental impacts

- Building energy systems modelling & simulation ([Ventilation and Heating systems](#))
- Thermal comfort and indoor climate modelling
- Systems analysis of building
- Economic optimization of energy efficiency measures
- Lifecycle analysis of the built environment

Relative contributions of different sources to total primary energy supply of the world, EU-28 and Sweden



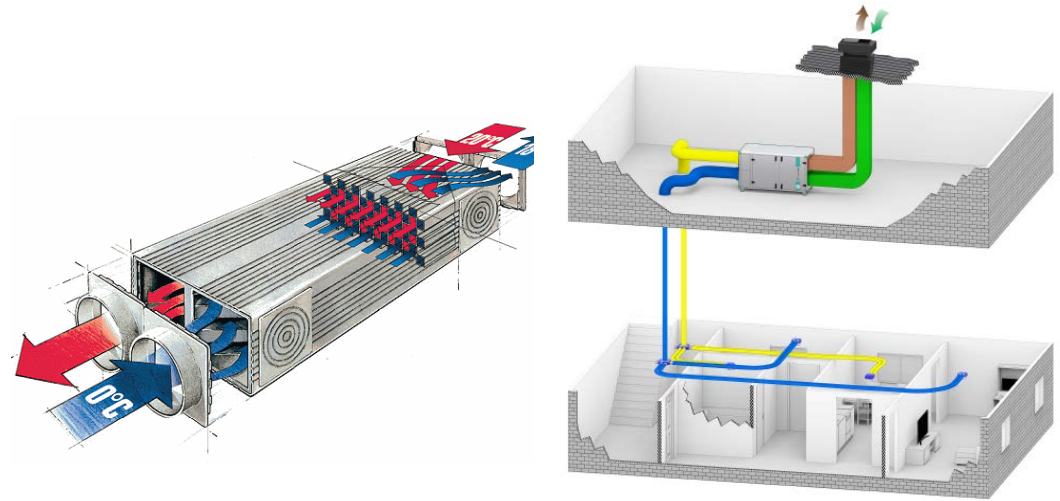
Data for the world and Sweden are from IEA (2013a; 2013b) & that for EU-28 is from BP (2012)

Design and analysis of ventilation systems

Ventilation heat recovery (VHR) systems in buildings



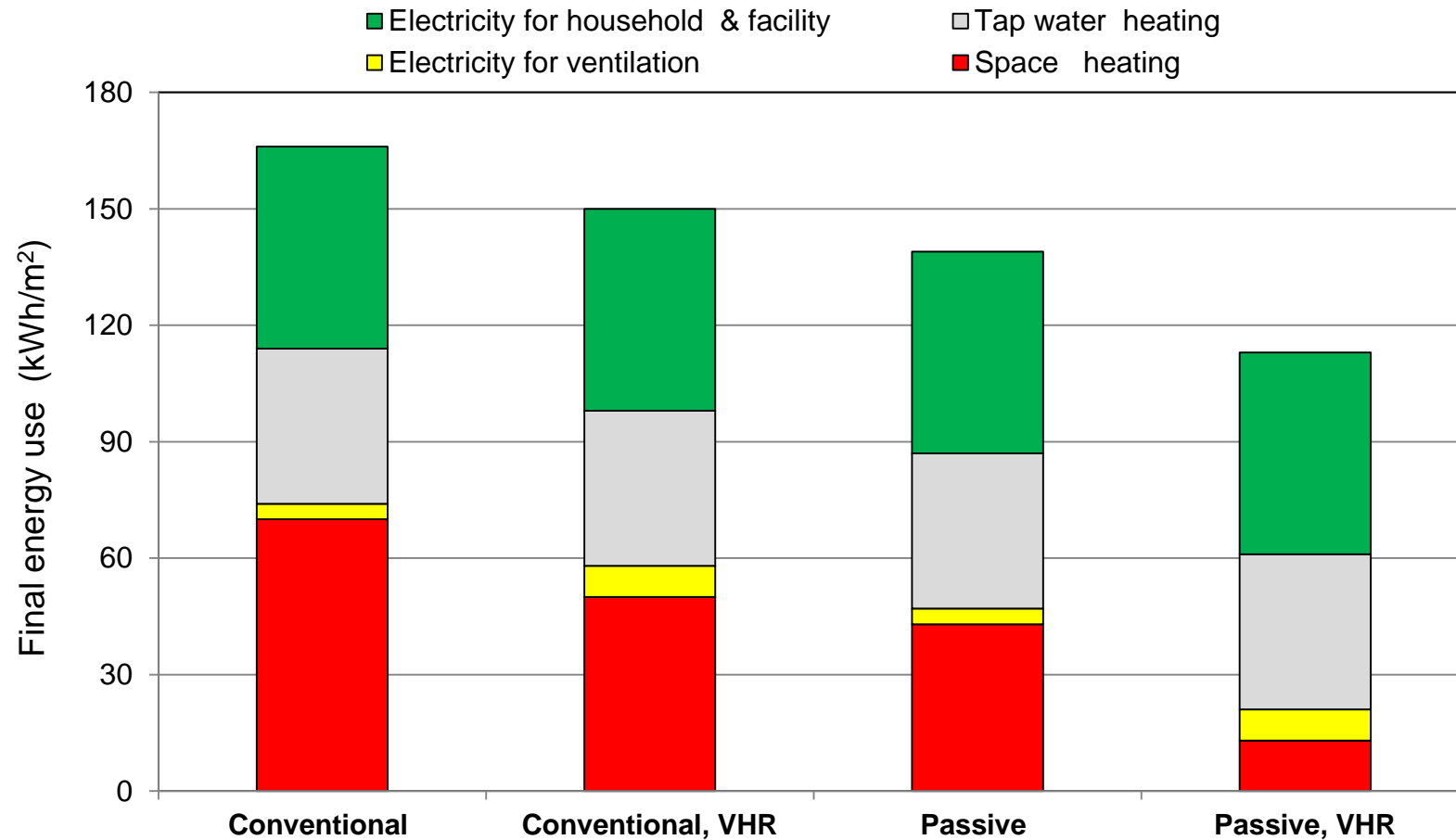
Versions of 4-storey building with mechanical exhaust ventilation



VHR (FTX) system of 85% efficiency installed for building

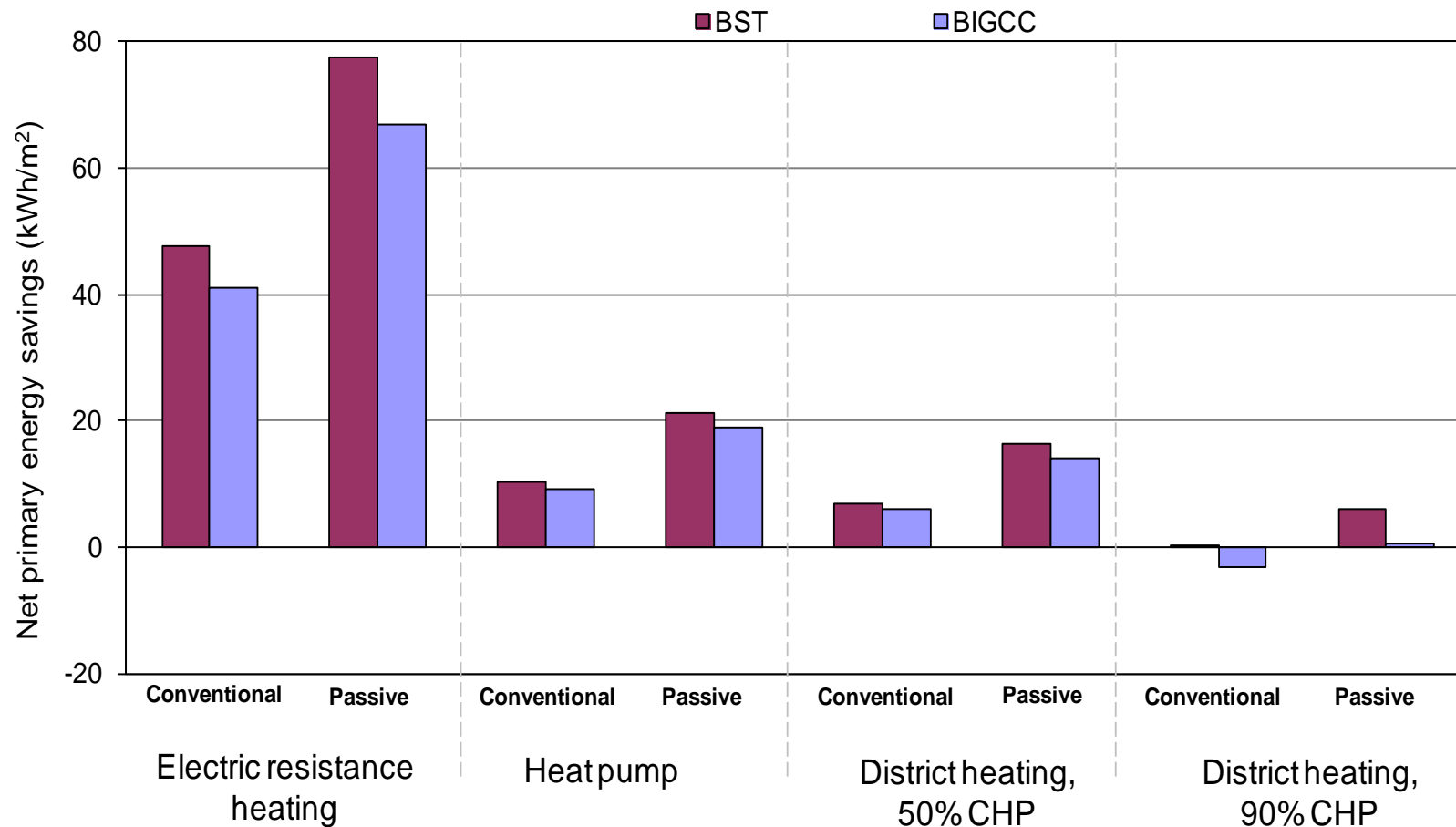
Dodoo et al. (2011). Primary energy implications of ventilation heat recovery in residential buildings. *Energy and Buildings*, 43(7), 1566-1572

Annual final operation energy use when using ventilation systems with and without VHR



Ventilation heat recovery systems in buildings

Net annual primary energy savings



Supply system: Biomass-based steam turbine (BST) or Biomass-based integrated gasification with combined cycle (BIGCC)

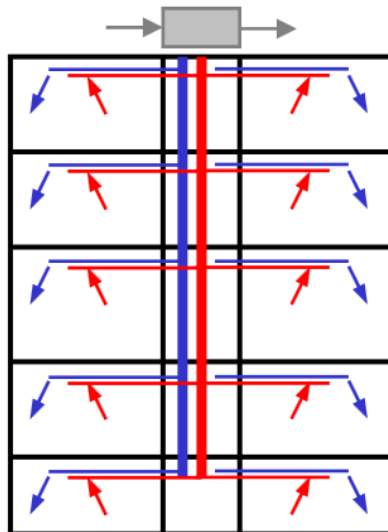
Design and analysis of ventilation systems

Centralized, semi-centralised vs. decentralized ventilation systems

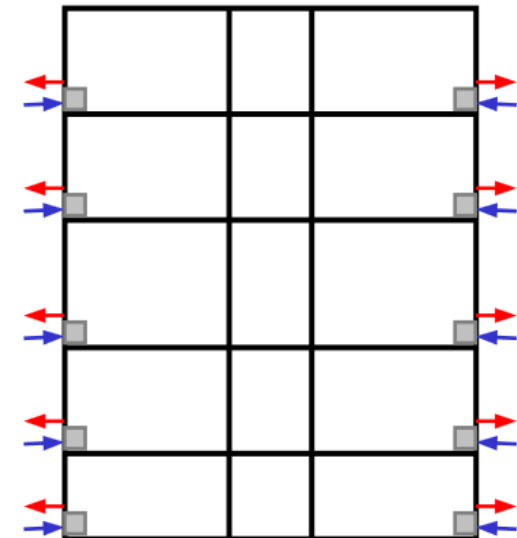


Analysed building in Ronneby

Centralised system

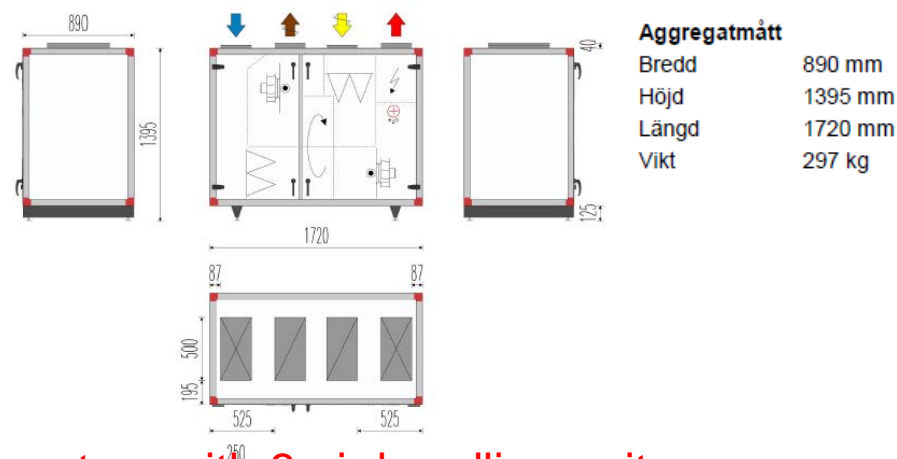


Decentralised system

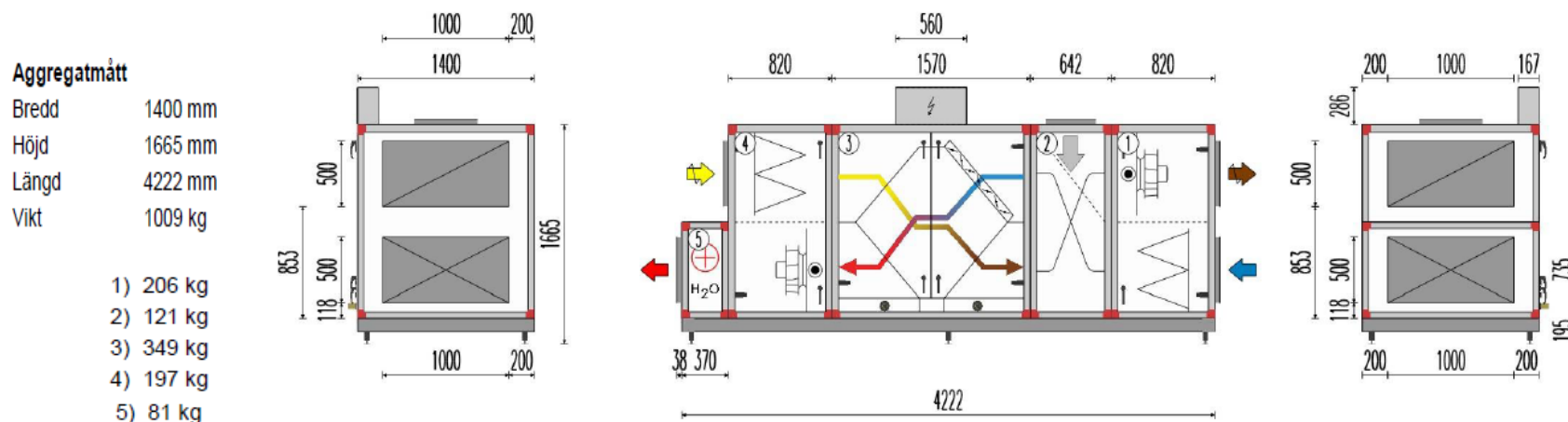


Centralized vs. decentralized ventilation systems

Designed in collaboration with InPro AB and IV produkt



Decentralised system with 3 air handling units, one on each stairwell



Centralized system with 1 air handling unit, on roof

Centralized vs. decentralised ventilation systems

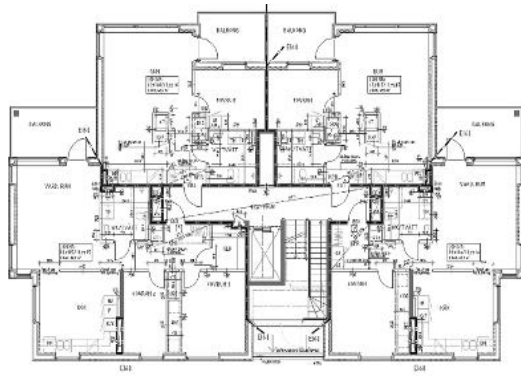
Energy performance & cost-effectiveness

Ventilation system with heat recovery	Space heating use (MWh/yr)	Peak Heating load (kW)	Final heat savings (MWh/yr)	Increase electricity use (MWh/yr)	Total investment cost (k€)
Reference	228.2	95	-	-	-
Centralised	186.4	79	41.8	2.2	129.1 ^a /132.7 ^b /138.5 ^c
Decentralised	185.0	79	43.2	1.4	146.4 ^a /152.3 ^b /162.1 ^c

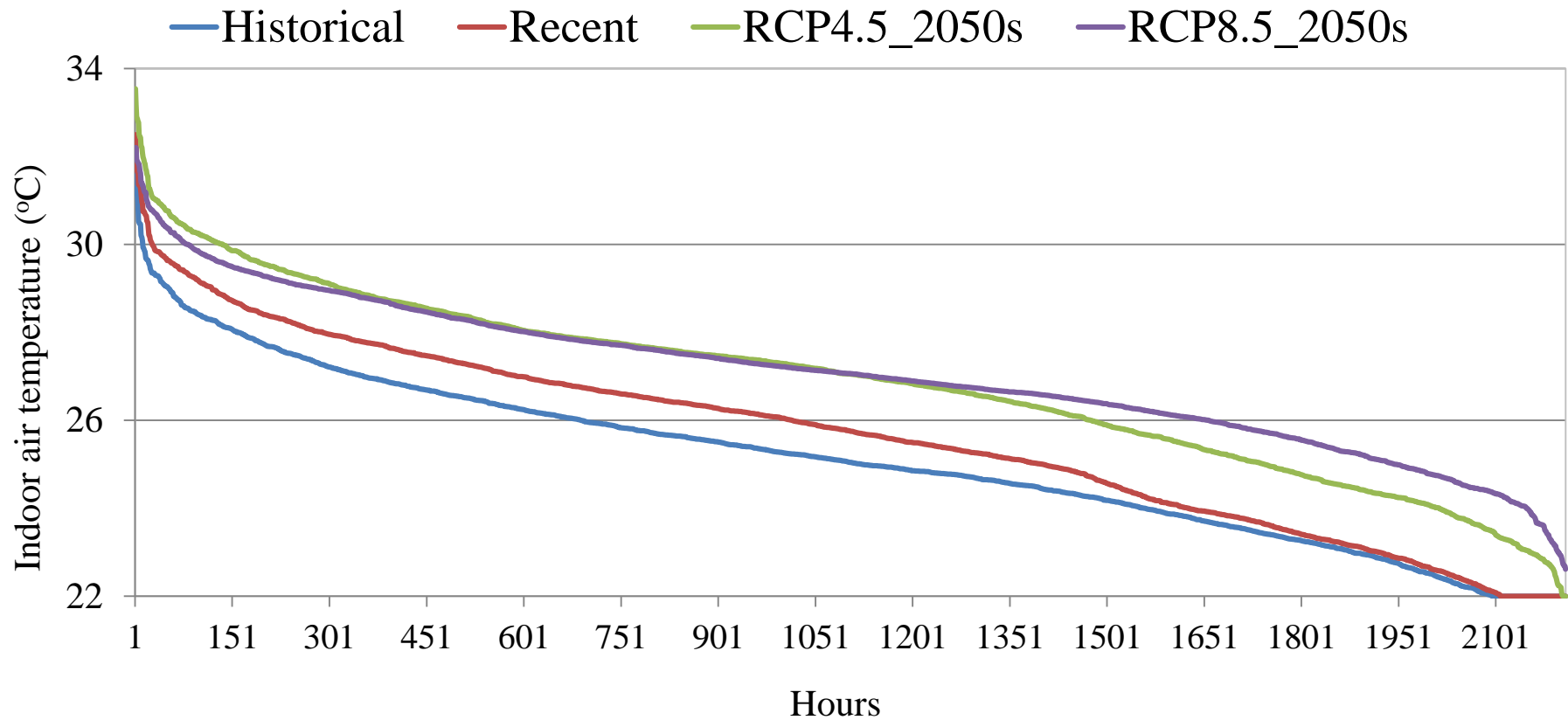
^a BAU scenario with 5% discount rate; ^b intermediate scenario with 3% discount rate; ^c sustainability scenario with 1% discount rate.

Ventilation system with heat recovery	NPV of total energy savings (k€)			NPV of total energy savings (k€) / total investment cost (k€)		
	BAU	Intermediate	Sustainability	BAU	Intermediate	Sust
Centralised	63.8	115.1	248.3	0.5	0.9	1.8
Decentralised	68.8	124.0	267.5	0.5	0.8	1.7

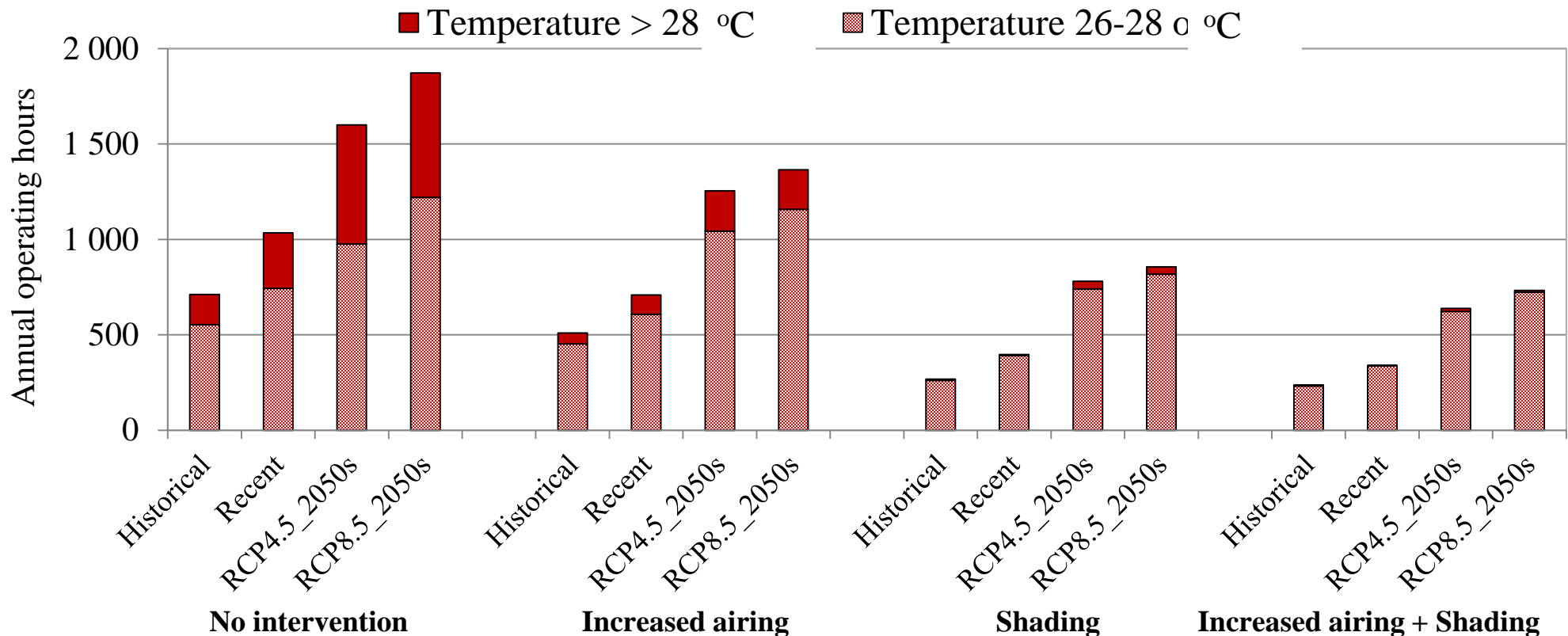
Climate change implications for Swedish buildings



Hourly indoor air temperature profiles in summer, (1st June to 31st August) without control strategies



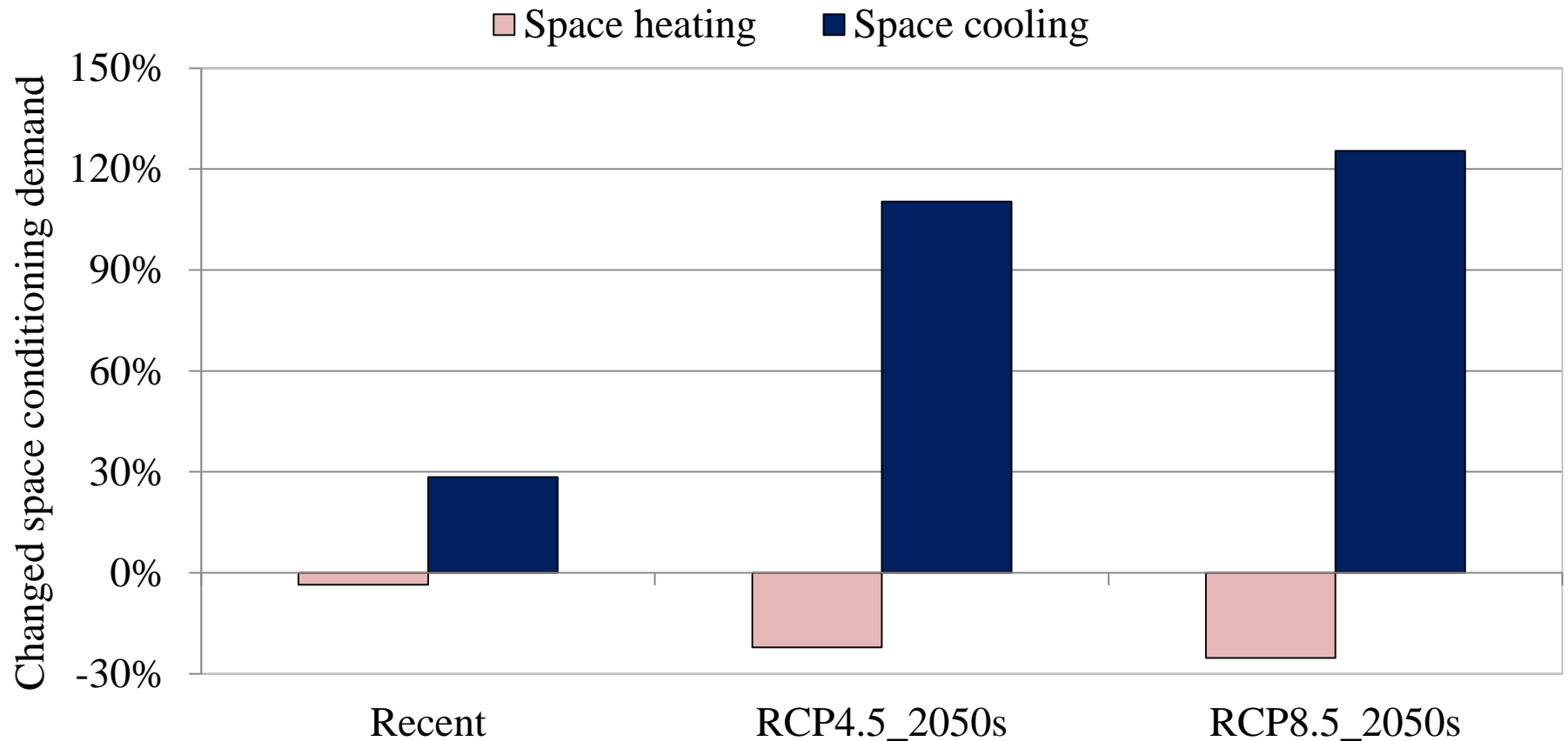
Hours per year with and without control strategies with indoor air temperatures between 26-28 °C and over 28 °C



CIBSE guide: a building is overheated if indoor temperature exceeds 28 °C in living areas or 26 °C in bedrooms for more than 1% of the occupied time within a year



Changed annual space heating and space cooling demands compared to historical data



Implementing of work at LNU

- Cooperations with surrounding society, e.g.
 - Goda-hus,
 - InPro AB
 - IV produkt AB
 - Conservator AB
 - Wikells Byggberäkningar AB
 - Växjö & Ronneby Kommuns
 - Hållbart Byggande i Syd, Malmö

Doctoral candidate student

- Cooperations with Goda-hus on doctoral research
 - Focus on nearly zero energy building
 - Involves energy balance simulation, energy systems modelling, energy monitoring, analysis of energy profiles in existing buildings, and visualisation of energy use, production and supply in buildings
 - <https://lnu.se/en/meet-linnaeus-university/work-at-the-university/>

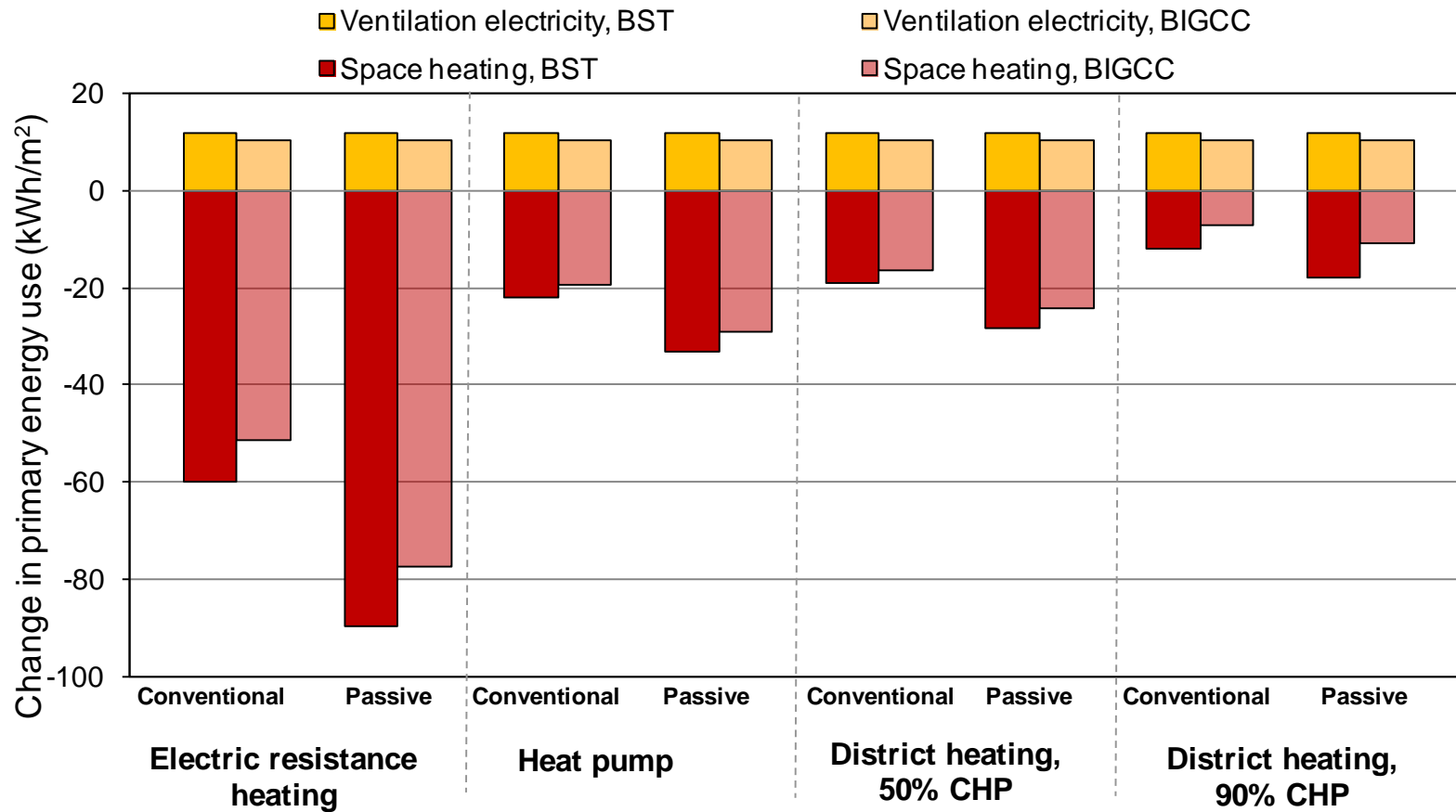
Analysis of ventilation systems

Centralized, semi-centralised vs. decentralized ventilation systems

- Performances of mechanical ventilation retrofit solutions for Swedish multi-storey residential buildings
 - Primary energy use
 - Cost-effectiveness
 - Indoor environment
- LCA of ventilation systems

Ventilation heat recovery systems in buildings

Change in annual primary energy use for space heating and ventilation



Supply system: Biomass-based steam turbine (BST) or Biomass-based integrated gasification with combined cycle (BIGCC)