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Climate change impacts on energy demand for heating and cooling of buildings in Finland

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BACKGROUND

- In the building sector, both climate change adaptation and mitigation are needed.
- In 2007, heating and electricity use in buildings accounted for 38% of the final energy use and 32% of the CO_2-eq. emissions in Finland. [1]
- The most crucial climatic variable for building energy demand in Finland, i.e., air temperature [2], is projected to increase by 2-6°C by the end of this century [3]. (Fig. 1)

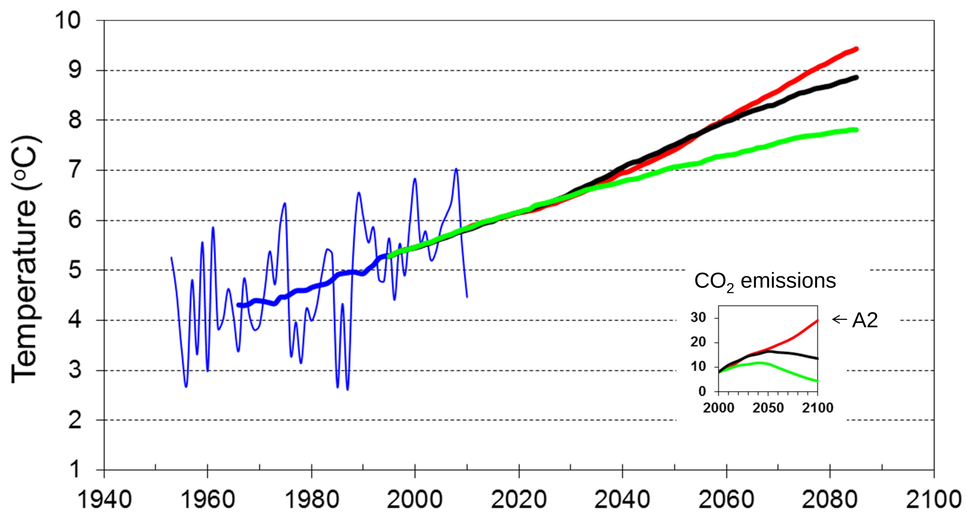

Fig.1. Mean air temperature in Vantaa, southern Finland. The thin blue curve shows the observed annual values; the thick curves depict 30-year running means. The projections are 19-model average responses to three emission scenarios, respectively (see the right corner).

MATERIALS & METHODS

- Current climate: the new Finnish test reference year for building energy demand, separately for southern, central and northern Finland. ⇦ past months having typical weather conditions. [2, 4]
- Future climate: Estimates for typical weather conditions around the years 2030, 2050 and 2100 ⇦ Climate model projections for the SRES A2 scenario and special tailored methods to produce future hourly data [4].
- Simulations of energy consumption for a detached house and an office building (Fig. 2) using the IDA Indoor Climate and Energy algorithm [5].
- The current value of future savings due to climate-induced changes in energy demand ⇦ the average price in 2011 for electricity and district heating, together with three alternative discount rates. [6]

Fig. 2. A detached house and an office building used in the simulations. The example buildings are assumed to be alternatively located at three sites in Finland, representing different climatic conditions (Vantaa in southern Finland, Jyväskylä in central and Sodankylä in northern Finland).

PROJECTED CHANGES IN BUILDING ENERGY DEMAND

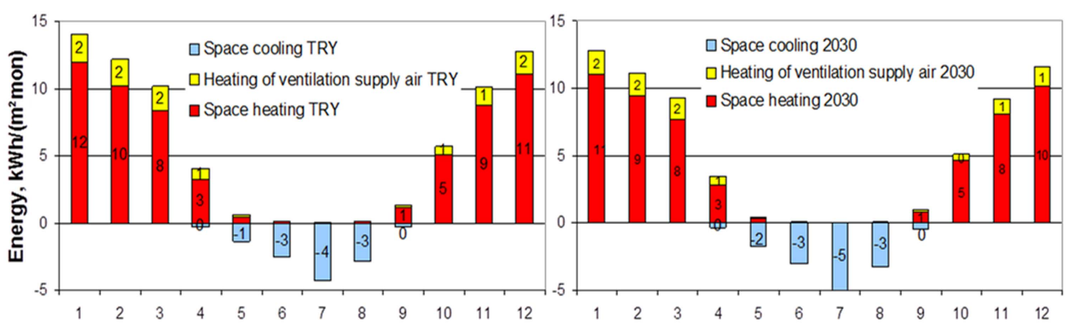

Fig.3. Monthly heating and cooling energy demand of a detached house (Fig. 2, left) in Vantaa, southern Finland, in the current climate (left) and in typical future weather conditions, projected for the year 2030 (right). [4]

- Consumption of energy for heating of spaces and ventilation is projected to decrease (Fig. 3 and Table 1).
- In parallel, demand for space cooling will increase.
- Since space cooling electricity accounts for a minor proportion of the total delivered energy of the example buildings, the total building energy use is projected to decrease by 4-7% by 2030.
- Assuming the current prices for energy in buildings, energy bills are projected to decrease only slightly by 2030 due to changes in climate variables alone (Table 2).

Table 1. Projected changes (%) in annual heating and cooling energy amounts of the example buildings, assuming the SRES A2 emission scenario. The values are for Vantaa, southern Finland, except that for 2030 a range is given across the three study sites. [4, 7]

	Detached house			Office building		
	2030	**2050**	**2100**	**2030**	**2050**	**2100**
Heating	-10	-15	-33	-13	-18	-36
Cooling	17-19	21	53	13-15	28	76

Table 2. Savings accumulated by 2030 (per m^2), in present time value of money, due to decreased energy consumption in the example buildings. A range is given across the three study locations in Finland, in accordance with Table 1.

Discount rate	Detached house	Office building
2 %	6.1 - 7.9 €	2.6 - 5.7 €
5 %	4.2 - 5.5 €	1.8 - 4.0 €
10 %	2.5 - 3.2 €	1.0 - 2.3 €

DISCUSSION

- In spite of the warming trend, buildings in Finland should be equipped with proper heating systems also in the future.
- Energy efficient heating and cooling systems and passive cooling solutions are needed in order to reduce CO_2 emissions.

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