Nearly zero-energy buildings: Legislation and impact on emissions in Finland

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Energy performance of buildings directive

- All new buildings need to be nearly zero-energy (nZEB) by the end of 2020
- nZEB = “very high energy performance, and the low amount of energy they require comes mostly from renewable sources”
- Member states can determine their own national legislation to achieve this goal in a cost-efficient way

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National nZEB proposal in Finland

- Energy performance of houses measured by energy efficiency rate (E-value)
- E-value = $kW_{purchased\ energy}/m^2$ x energy coefficient
- Arbitrary coefficients, not comparable between countries

Heating method	Energy coefficient
Fossil fuel boiler	1
Biofuel boiler	0.5
Electric heating	1.7
District heating	0.7

- Proposal for nZEB values

	Proposed E-value vs current
Detached houses	0…-25%, depending on the size
Apartment buildings	-11%
Office buildings	-47%
Commercial buildings	-40%
Others	-7%...-39%

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Evaluating the environmental impacts of the proposed legislation

- Goals
  - Assess the change in air emissions (CO_2, PM, SO_2, NO_x) and their environmental impact
  - Analyze the option, where selling self-produced renewable energy to the grid would compensate a higher E-value

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Methods

- Projection of new construction production and heating methods, based on recent history
- Impact of new E-values in total purchased energy per source
- Emission factors for district heating, electricity production and residential boilers in 2020 and 2030
  - Emission factors for public power production according to projections in the national Energy and climate strategy

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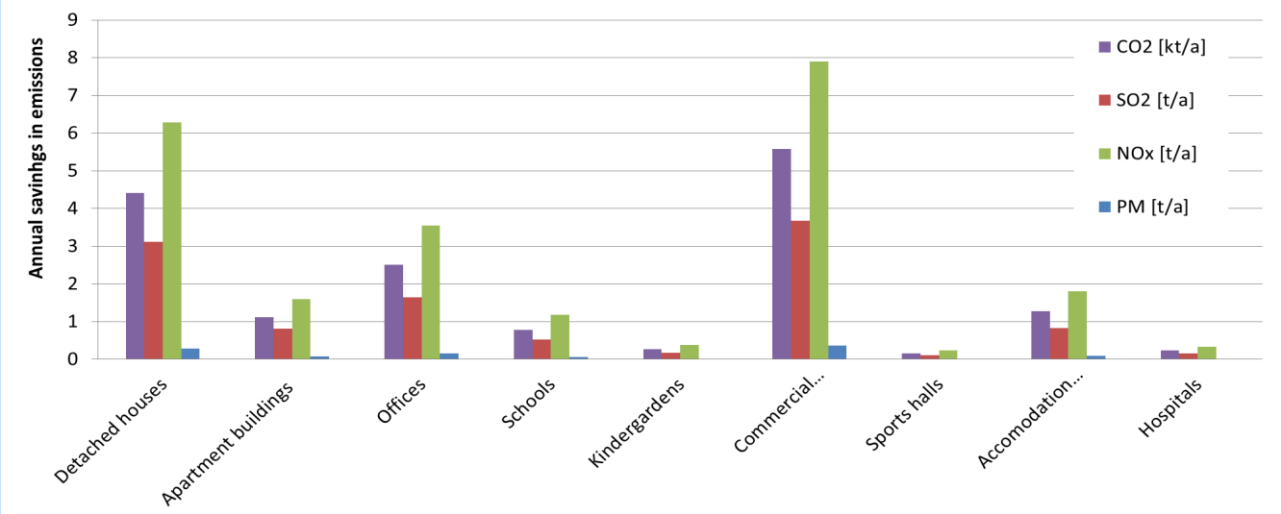
Results

- Total annual energy savings in new buildings ~18%

Savings in purchased energy	
	GWh/a
Electricity	45
District heating	37
Wood pellets	0,2
Natural gas	1,1
Light fuel oil	0,2

- Total annual emission savings in new buildings ~16-18% (2020)



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Environmental impacts in 2030

- Annual reduced emissions compared to business as usual

Emission	Reduction from BAU
CO_2	86 kt/a
SO_2	34 t/a
NO_x	130 t/a
PM	6 t/a

- Savings ~ 0.1 % of estimated Finnish emissions from all sectors
- Savings in CO_2
  - Equivalent to current housing emissions of 25 000 Finns
- Savings in air pollutants
  - Too small to evaluate health or environmental impacts

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Observations 1/2

- New legislation mostly affects houses with electric heating, offices and commercial buildings
- Environmental impacts minor in the studied time span
  - Energy consumption of buildings 30% of all energy end-use in Finland -> considerable potential for savings
- Savings mainly in electricity and district heating -> impacts depend on the production methods
  - Big impact on PM emissions if the legislation affects residential wood combustion

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Observations 2/2

- Selling self-produced renewable electricity to the grid to compensate a higher E-value
  - Environmental impacts very situational, no clear benefits
  - Negative impacts if peak consumption increases in winter
  - If self-produced electricity can be used to increase the flexibility of the market and to improve the meeting of supply and demand, the impacts are more beneficial

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Case: nZEB legislation and residential wood combustion 1/3

- Due to coefficients, use of masonry heaters can lower the E-value of some buildings, most importantly those with electric heating
- Plans to increase current maximum allowance (2000 kWh/a of net heating energy from a masonry heater)
- Doesn’t transfer directly into actual wood use, but can increase the number of houses where supplementary wood heating is required

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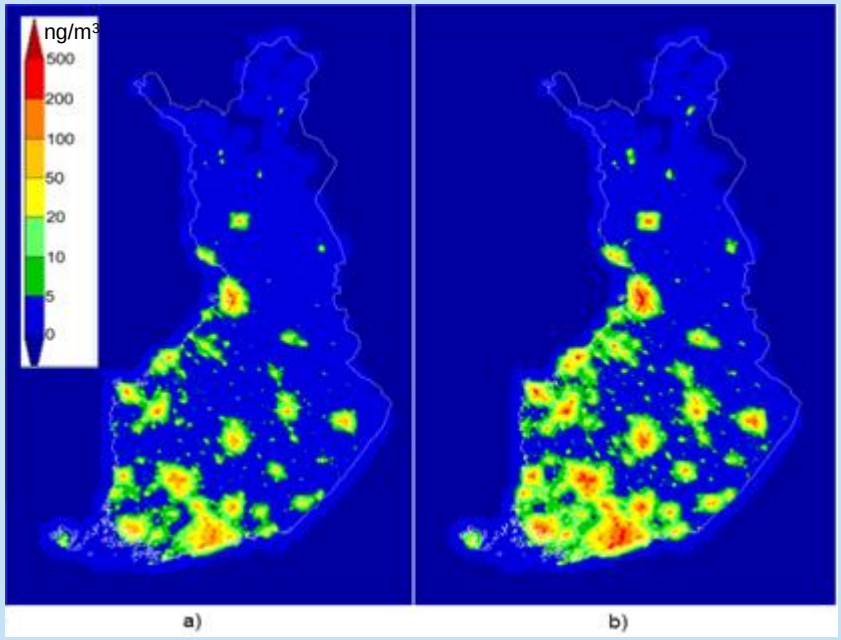
Case: nZEB legislation and residential wood combustion 2/3

- We modelled primary $PM_{2.5}$ emissions from masonry heaters in 2050, and the resulting concentrations
  - ~15 000 new detached houses built annually
  - 90% include a masonry heater



- a) 2000 kWh/a b) 4000 kWh/a

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Case: nZEB legislation and residential wood combustion 3/3

- Emissions in the outskirts of major population centers
- Average annual $PM_{2.5}$ concentrations in these areas increase by 1-10%
- Currently residential wood combustion estimated to cause ~1800 deaths annually in Finland
- Efficiency of combustion appliances is increasing, but so is the popularity of RWC
- Even with efficient modern masonry heaters, fine particle emissions from RWC cause notable detrimental health effects
- In addition to fine particle emissions, wood combustion also produces climate-warming gases and pollutants (e.g. black carbon)
- Increasing of RWC not justified on environmental grounds, should be addressed in legislation

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Future projects on co-benefits/trade-offs of climate & air policy

- Sustainable energy and climate policy and the role of renewables in Finland
  - Evaluating the environmental impacts of the renewed national energy and climate strategy

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Thank you

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