# Nearly zero-energy buildings: Legislation alternatives for residential wood combustion and the impact on population exposure to fine particles


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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 = $kW_{\text{purchased energy}}/m^2$ x energy coefficient
- Arbitrary coefficients, not comparable between countries

| Heating method | Energy coefficient |
|---|---|
| Fossil fuel boiler | 1 |
| Biofuel boiler or stove | 0.5 |
| Electric heating | 1.7 |
| District heating | 0.7 |

- Proposed new value for detached houses up to 25% more stringent than the current one, depending on the size of the house

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# Finnish masonry heater

- Used mostly for supplementary heating
- ~90% of new detached houses include one
- Efficient combustion

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# The assignment

- Current Finnish legislation has a 2000 kWh/a maximum allowance of net heating energy from masonry heaters
- If this is increased to 3000 or 4000 kWh/a in
  - All houses
  - Houses with electric heating

What is the impact on the population exposure to fine particles in Finland in 2050?

- Justification: wood is being viewed as carbon neutral

  => Increasing the use of wood could substitute for smaller savings in energy efficiency

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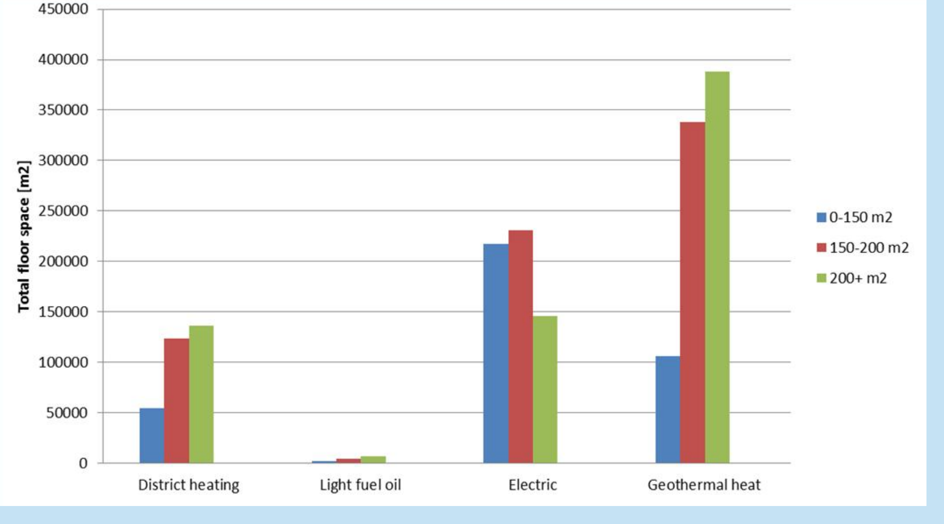
# Methods and assumptions



- We assumed that people use their masonry heater according to the maximum limit in the E-value
- The construction of new detached houses
  - 11 500 houses built annually
  - Spatial allocation based on the locations of new detached houses from the last 10 years
  - Primary heating methods from the latest registered year

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# Methods and assumptions 2/3

- Net heating energy converted to wood consumption using a coefficient of 1/0,6
- $PM_{2.5}$ emission factor for masonry heaters 48 mg/MJ
- Three scenarios:
  - a) 2000 kWh/a in all houses (Baseline)
  - b) additional 2000 kWh/a in houses with electric heating
  - c) 4000 kWh/a in all houses.

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# Methods and assumptions 3/3

- The dispersion of emissions modelled using source-reseptor matrices
- Resulting annual average concentrations in a 1km x 1km grid
- Compared to population in each grid cell

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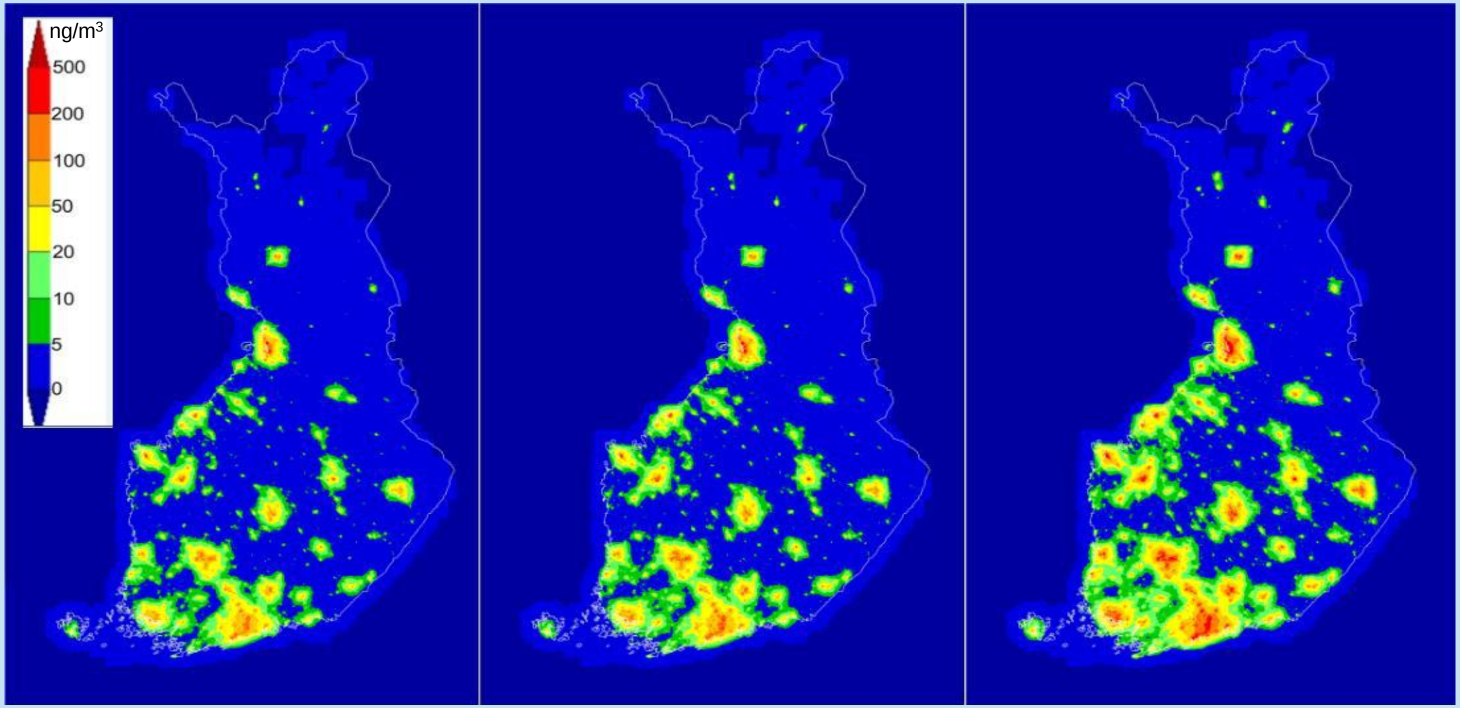
# Results: modelled $PM_{2.5}$ concentrations

- Concentrations mostly < 0.5 µg/m3 in case a) and <1.3 µg/m3 in case c)
- Currently measured background concentrations in Finland are typically 7 – 10 µg/m3




a) 2000 kWh/a in all houses
b) Additional 2000 kWh/a in houses with electric heating
c) 4000 kWh/a in all houses

## Results: population exposure

- Total annual $PM_{2.5}$ emissions in the scenarios: a) 225t, b) 275t, c) 450t

  => Up to 5% of Finnish total RWC emissions in 2014
- Emissions in the outskirts of major population centers

  => 93% of population exposure in areas classified as urban
- Average annual $PM_{2.5}$ emission concentrations in these areas increase by 1-10%
- Currently exposure to fine particles in ambient air is estimated to cause ~1800 annual deaths in Finland

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# Observations

- The maximum allowance for a masonry heater's net heating energy does not translate directly to the actual wood consumption
  - It could increase the number of houses where supplementary heating by wood combustion is necessary
- Efficiency of combustion appliances is increasing, but so is the popularity of stoves
- In addition to fine particle emissions, wood combustion also produces climate-warming gases and pollutants (e.g. black carbon)
  - Impact in the Arctic area especially strong because of deposition of particles to snow and ice

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# Conclusions

- Even the use of modern, efficient stoves causes a notable increase in $PM_{2.5}$ concentrations in urban areas

  => Invariably results in detrimental heath effects
- Increasing of residential wood combustion not justified on environmental grounds
- Legislation should focus on improving energy efficiency of houses

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Thank you

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