

Finland's experience and future plans on transition from high-emission to low-emission heating



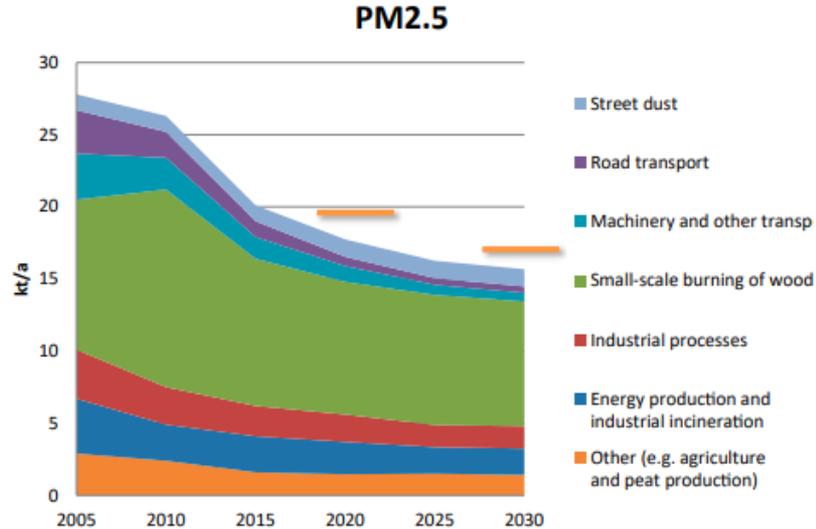
Mikko Savolahti

Finnish Environment Institute

Air quality in Finland

- WHO: Finland has the cleanest air in the world
 - PM2.5 concentrations in ambient air average $6\mu\text{g}/\text{m}^3$
- Air pollution has not been seen as a serious concern for public health
- Still, air pollution has been estimated to cause 2000-4000 deaths annually^{1,2}
 - Mostly from long-range transported pollutants though
- Increasing visibility in the media => increasing awareness and political will to deal with the issue

PM2.5 Emissions in Finland



- Residential wood combustion the largest source of PM emissions, and it's relative importance is increasing in the future
 - Includes all wood combustion in residential and recreational buildings, as well as direct wood heating of industrial, commercial and agricultural buildings

Figure 18. The development of fine particulate matter emissions in the baseline per sector. The orange lines describe the level in accordance with the emission reduction commitments.

*National Air Quality Control Programme 2030



Residential wood combustion (RWC) in Finland

- RWC has a prominent role in Finnish culture, and wood consumption has still been increasing in the last decades
- Wood used mostly for heating
- 40% of heating energy in detached houses from RWC
 - The majority of detached houses have stoves for supplementary heating (~90% of new detached houses include a stove)
 - All ~500 000 summer cottages have wood combustion appliances
- ~70% of the fuelwood estimated to come from non-commercial sources => for most people it's a free source of energy
- Has been difficult to implement any restrictions



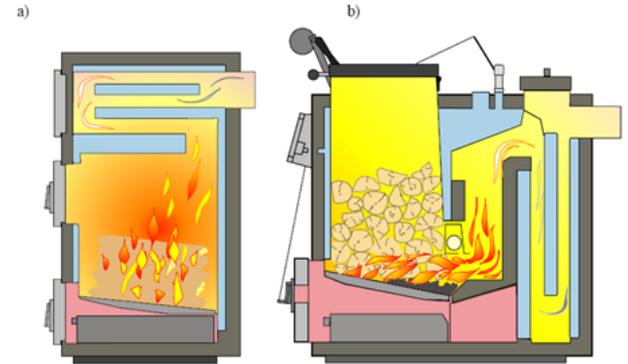
Most common appliances



Operating principle of a masonry heater



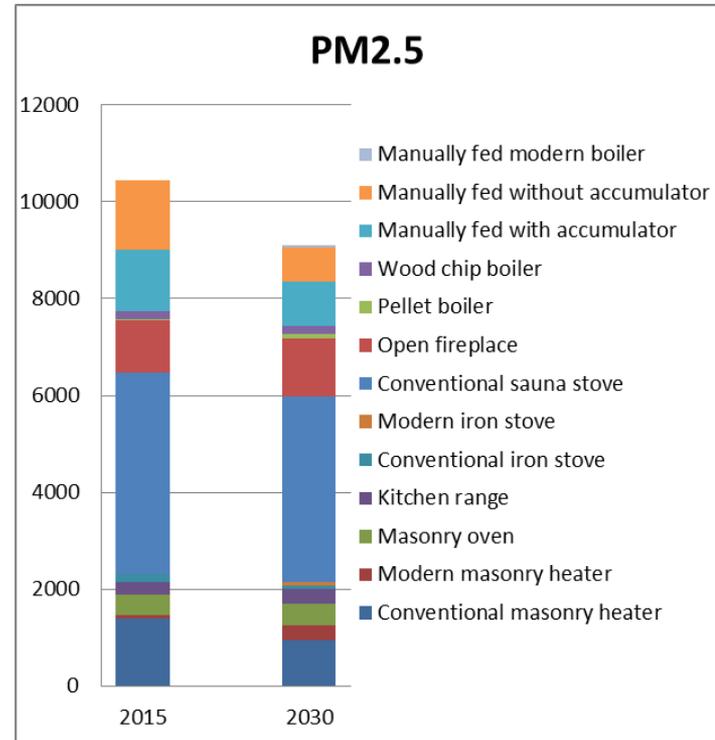
Sauna stove from a Finnish manufacturer Harvia.



Schematics of a) updraught and b) downdraught boilers

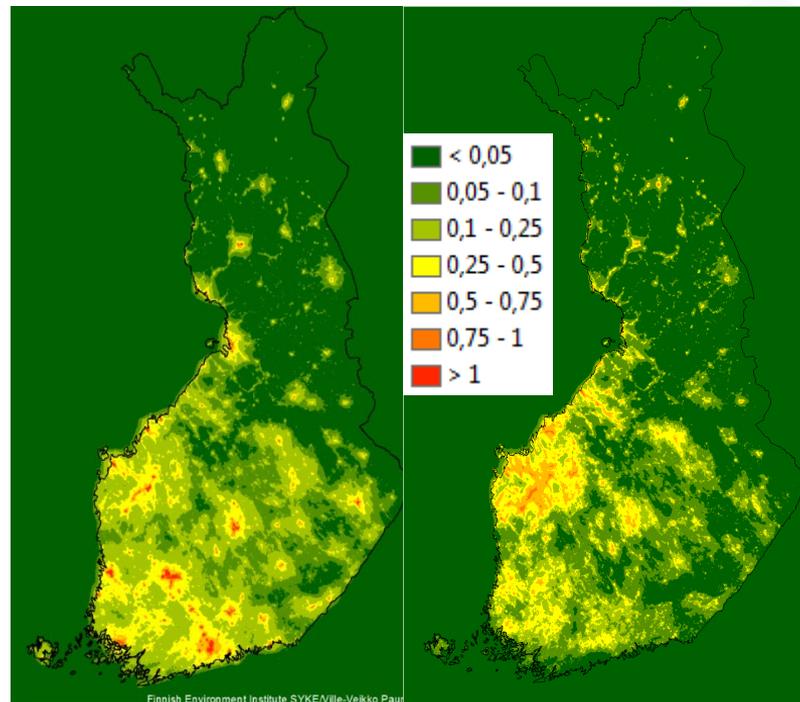
Research made on RWC emissions

- Detailed emission inventory
 - 5 boiler types, 9 stove types
- Emission factors based on national measurements
 - Measured from cool flue gases over the whole combustion cycle => "real life" emissions
 - Separate emission factors for normal and poor combustion for each appliance and pollutant
- Sauna stoves in a key role
 - However, latest measurements indicate that new stoves have notably lower emissions



Research made on RWC emissions

- Emissions spatially distributed into a 250m x 250m grid
 - Allocation of fuel use based on Building register, degree of urbanization, climate conditions
- Resulting concentration ($\mu\text{g}/\text{m}^3$) modelled with dispersion models
- Population exposure calculated in the same grid
- Estimated to cause ~200 attributable deaths annually³
 - ~70% from stoves in residential buildings (incl. sauna stoves)



PM2.5 concentrations from stoves

PM2.5 concentrations from boilers



Research made on RWC emissions

- Wood combustion has been promoted as a climate change mitigation measure, but it can't be viewed as climate neutral
- RWC is by far the largest source of black carbon emissions in Finland
- Wood combustion releases CO₂ into the atmosphere, reducing the carbon storage of the forest **and also it's ability to sequest carbon**
 - 1 ton of harvested C can reduce the carbon sink by 2 ton in a 25-year time frame⁴
- Our recent study⁵ concluded that RWC is the least climate-friendly heating method by a wide margin



Controlling emissions from RWC

- No national regulation on PM emissions from boilers or stoves
 - CE-marking for stoves (makes sure that the appliance is safe to use and fits to its intended purpose), as in all EU countries, no limits for PM
 - National standard SFS 7021 for stoves determines some qualities, such as maximum temperature of the flue gases, but not PM emissions
- Ecodesign requirements for solid fuel local space heaters (2015/1185) and solid fuel boilers (2015/189), will enter into force in 2020 and 2022
 - Estimated to decrease PM2.5 emissions by only 6% in 2030
- Nordic Swan Ecolabel
 - Sets emission limits for PM, OGC and CO
 - Expensive, not popular



Research on RWC emission reduction

- We studied four mitigation measures to explore reduction potentials by 2030

Informational campaigns	Training stove users in good practices of a stove. Assumed to decrease the share of poor combustion
Legislation on new sauna stoves	National regulation similar to Ecodesign, but covering only sauna stoves (which are excluded in Ecodesign): Only modern sauna stoves allowed to be sold after 2022. We assume modern sauna stoves to produce 50% fewer emissions than conventional ones
ESP installations	Requirement to install end-of-stack electrostatic precipitators (ESP) in residential wood boilers. Implemented to all boilers in the country. ESPs were assumed to have reduction efficiency of 80%
Urban combustion bans	Prohibiting of wood combustion in urban areas of municipalities with a population centre of 20 000+ inhabitants



Research on RWC emission reduction

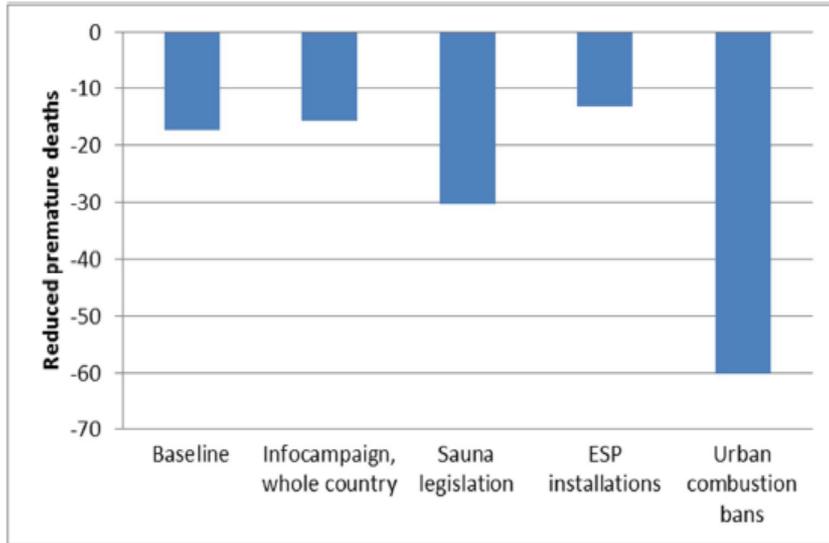


Figure 4. Reduction of annual deaths attributable to RWC in each scenario in 2030, with respect to the previous one, as new measures are added.

- Combustion bans not expected to interest policy makers
- Informational campaigns clearly the most cost-efficient measure, even if the assumed impact is low!



Effect of informational campaigns

- Emissions from a typical Finnish stove can be 6 x higher with poor combustion practices⁶
- All appliances have two emission factors, one for *normal* and one for *smouldering* combustion
 - *Smouldering* combustion represents typical user mistakes: restricted air supply, firebox loaded too full, poor quality fuel etc.
 - Emission factors for *smouldering* combustion 1-6 times higher



Effect of informational campaigns

- Users divided into categories and the initial share of *smouldering* combustion estimated

Estimates based on info from chimney sweeps

User profiles	Share of users	Share of smouldering combustion
Good use of heater	55 %	0 %
Decent use of heater	30 %	10 %
Poor use of heater	15 %	50 %
Total share of smouldering combustion for wood-fired room heaters		10.5%

- The share of *smouldering* combustion determines the applied emission factor
- Informational campaigns assumed to decrease the share of *smouldering* combustion
 - Maximum assumed effect => smouldering combustion is halved
- **Does not take into account other possible effects!**
 - Decreased combustion due to increased awareness or increased heating efficiency

National Air Pollution Control Programme 2030

- Projected emission development in the baseline scenario fulfills the NEC reduction goals
 - No new emission regulation to be enforced
- Ministry of the environment wanted to increase the ambition level in improving air quality
- Only “soft measures” politically feasible
 - Programme included additional measures, notably on RWC and traffic emissions



Additional measures to reduce emissions from RWC in the NAQCP2030

- Improved guidance to citizens and stakeholders
 - Increased awareness, spreading of good practises, new means of communication to increase reach, integration to climate policies
- Possible market incentives for less polluting sauna stoves
 - Currently no common method to measure emissions from sauna stoves => no way to classify their environmental performance
 - A new standard for measuring is being explored
- Improved ability for authorities to react to high-emitters
 - Updated interpretation of the Health protection act, portable measurement devices, piloting good practices in building regulations and instructions for preventing smoke hazards



Conclusions

- Informational campaigns the only measure currently in use
 - Looking from any angle, they always seem to be worth doing, despite their limited reduction potential
- If we wan't to stop emissions from RWC, people have to be provided with cheaper, more convenient and less polluting options for heating and cooking
- In situations where wood needs to be combusted regularly, it should be done with proper knowledge and state-of-the-art equipment



Thanks!

contact:

mikko.savolahti@ymparisto.fi

+358 29 5251595

Finnish Environment Institute

References:

- 1: Lehtomäki et al. 2018. Health Impacts of Ambient Air Pollution in Finland
- 2: Lelieveld et al. 2019. Cardiovascular disease burden from ambient air pollution in Europe reassessed using novel hazard ratio functions
3. Savolahti et al. 2019. Residential wood combustion in Finland: PM2.5 emissions and health impacts with and without abatement measures
4. Pingoud et al. 2016. Carbon balance indicator for forest bioenergy scenarios
5. Savolahti et al. 2019. Near-term climate impacts of Finnish residential wood combustion
6. Tissari et al. 2008. Fine particle and gaseous emissions from normal and smouldering wood combustion in conventional masonry heater
7. Savolahti et al. 2016. Black carbon and fine particle emissions in Finnish residential wood combustion: Emission projections, reduction measures and the impact of combustion practice