Title	Waste as a source for district heat production and greenhouse gas reduction: a case study
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Waste as a source for district heat production and greenhouse gas reduction – a case study

Waste Management conference 2014,
12th – 14th of May, Italy

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Purpose of the study

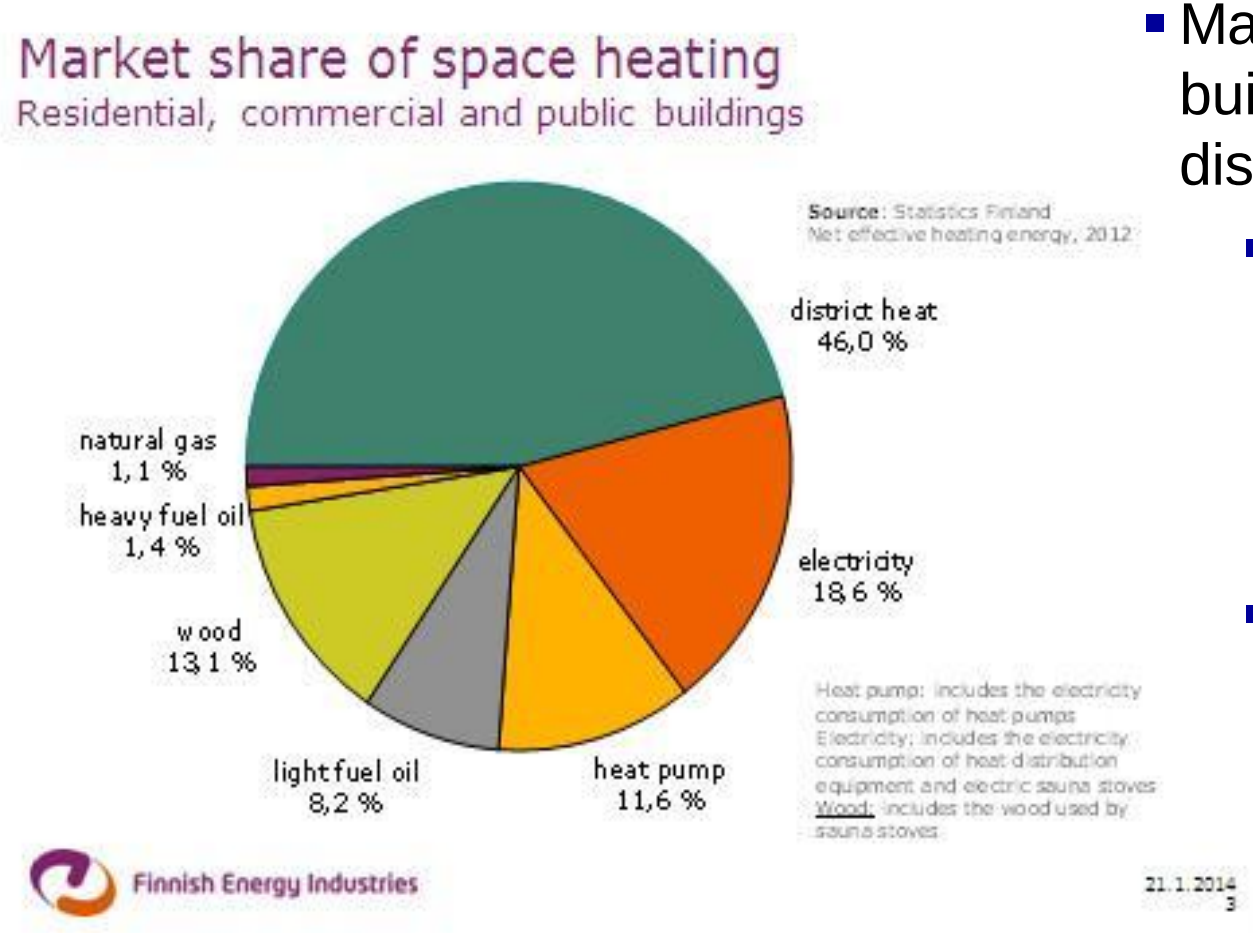
The purpose was to prove the hypotheses that utilization of solid municipal waste in energy production could help greenhouse gas reduction in detached family building operation

The result is shown for the buildings which met the current requirements and energy efficient solutions

Energy requirements for new construction

- It is clamed that Buildings consume 40 % energy and responsible from 36 % of greenhouse gases.
- To reduce such are big consumption, Energy Performance of Buildings, Directive 2010/31/EU (EPBD) requires that by 2021 all new buildings are nearly zero energy buildings
- Requirement also considers alternative energy systems – renewable energy, Combined Heat and Power production (CHP), district heating and cooling
- In Finland Total Energy consumption limit (E-value) is set according to the building types. This takes into account besides of the total energy consumption also energy production method

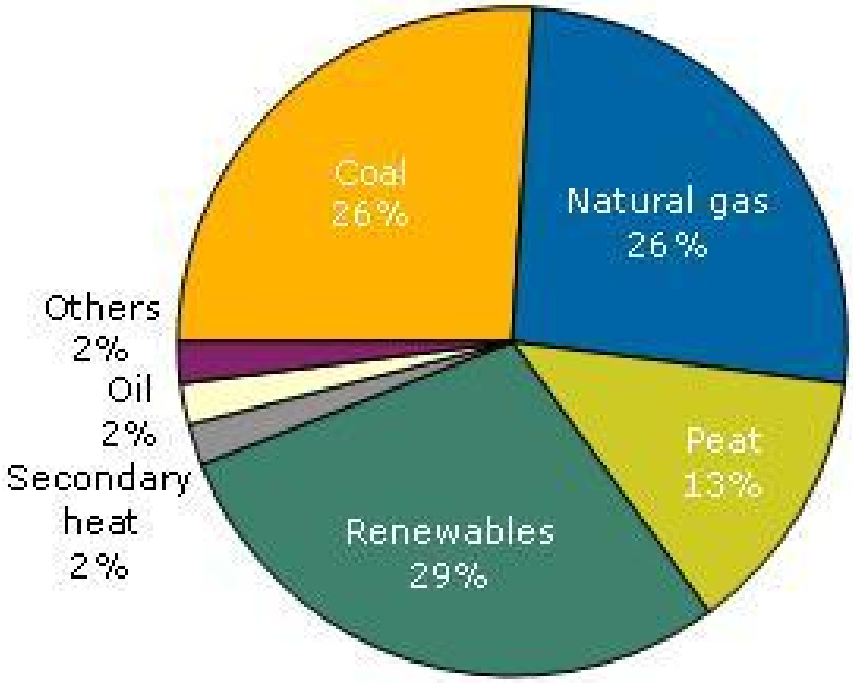
District heating, Finland



- Majority of Finnish buildings is heated by district heat (46 %)
  - 95% of residential multi-storey and office buildings is heated by centrally managed district heat
  - 7 % of single family buildings; attached and detached buildings, heated by district heat

Fuel consumption in production of district heat and CHP 2013

- fuel consumption 56,3 TWh



- In 2013 Renewables took a leading position by 29% , coal and natural gas were 26 % and 26 %
- In 2012 natural gas had a leading position with 28% and renewables 23%

Finnish Energy Industries

21.1.2014
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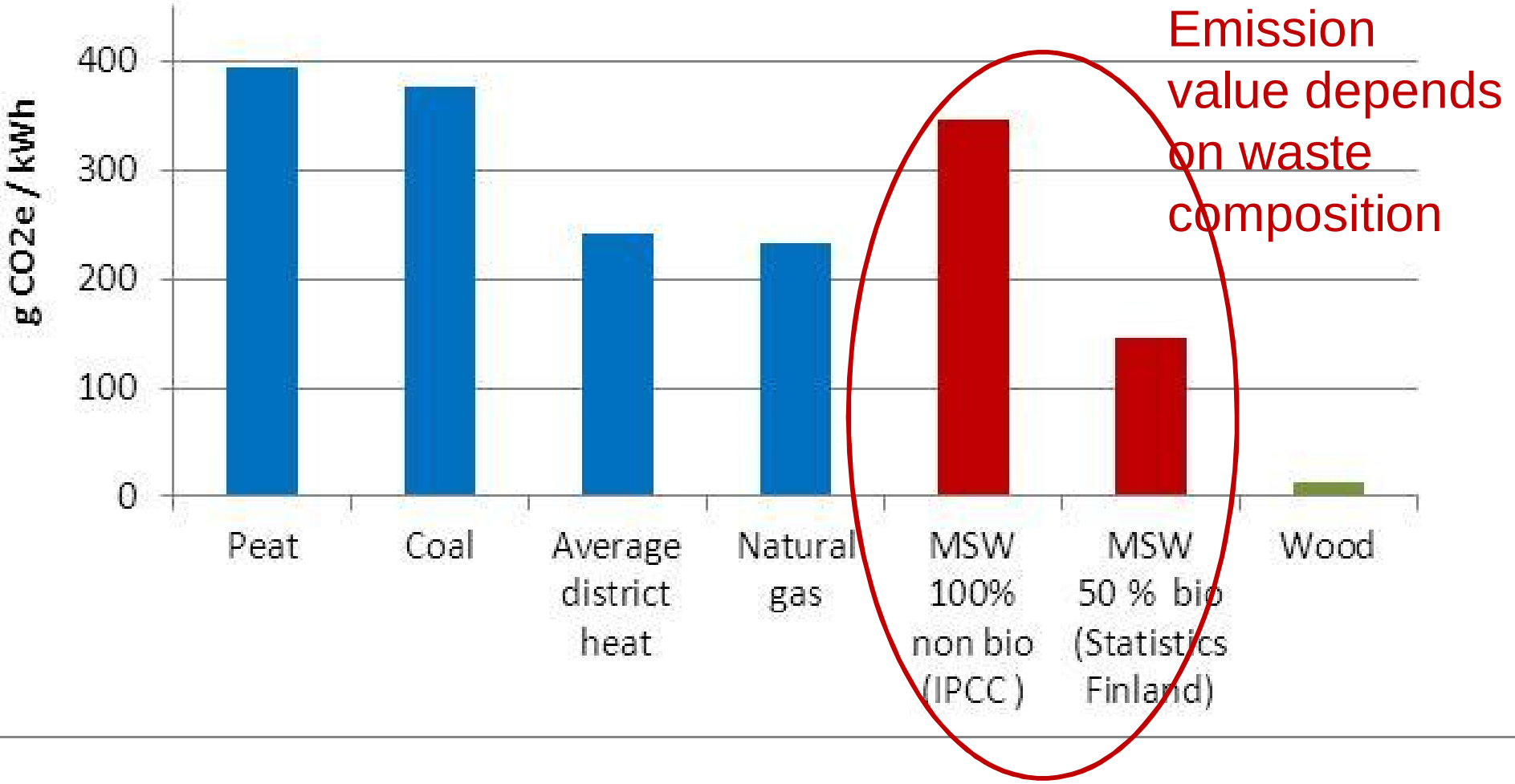
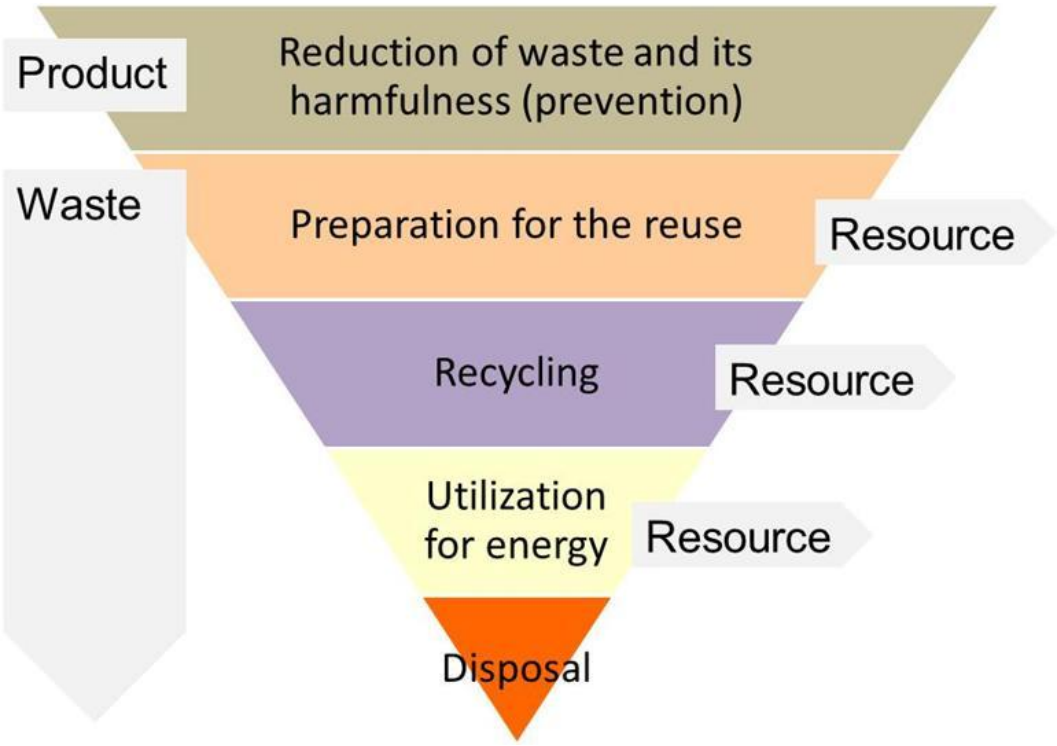
Emission factors for fuels (including acquisition and combustion)



EU’s waste hierarchy

- Gives strategy to waste prevention
- Waste utilization for energy is the last option before final disposal
- EU countries launched regulations' for waste prevention and hierarchy implementation
- Reuse and recycling have an influence to the waste-to-energy composition but also rejects for further utilization

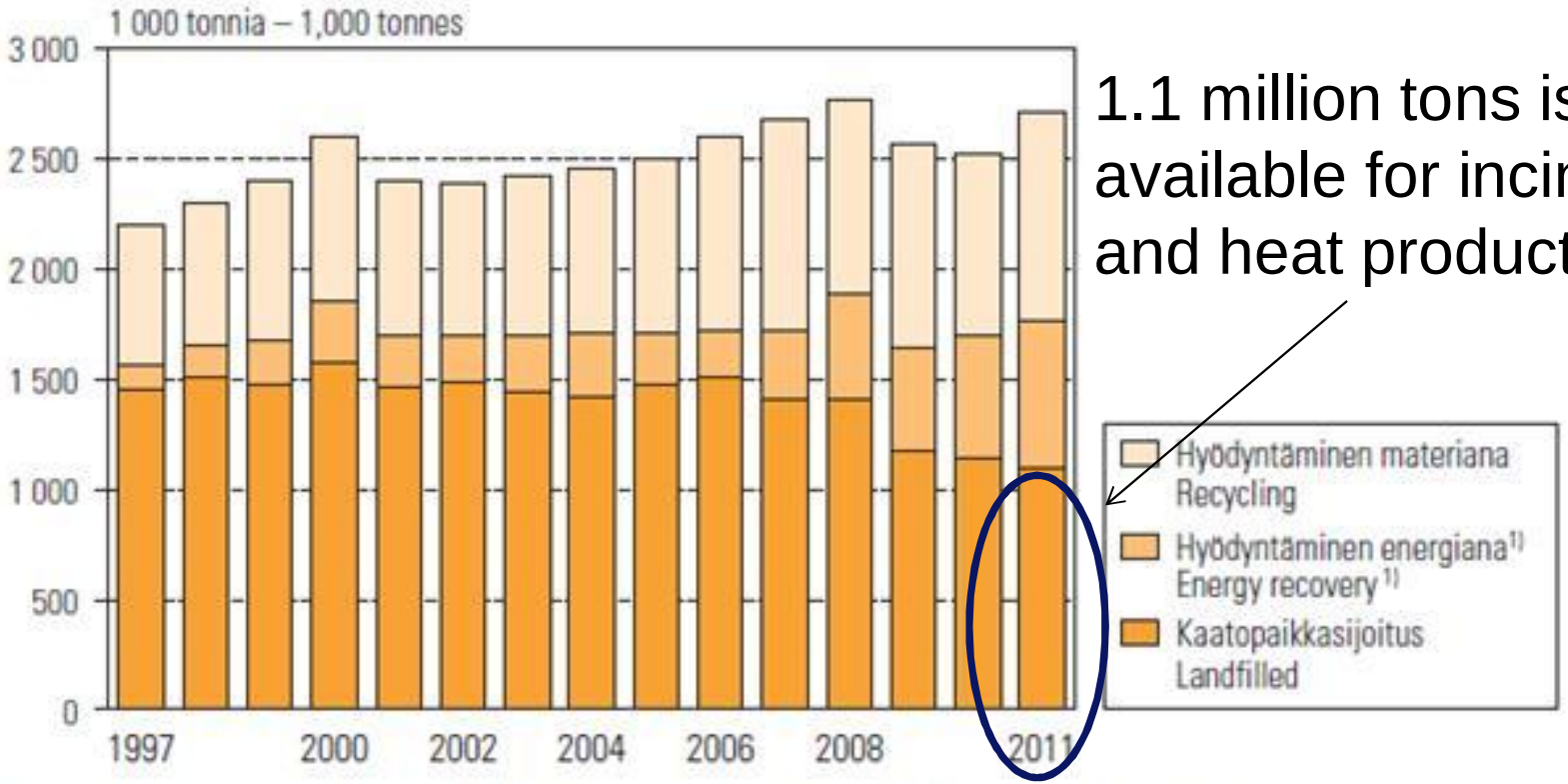


Emissions from the Municipal solid waste incineration depend on waste composition

- IPCC gives greenhouse emission values for the combustion of MSW and for the 100 % of non biomass fraction CO_2 default value is 347 g/kWh (91.7 t/TJ)
- According to the Fuel classification (Statistics Finland) MSW and mixed waste contains 50% of bio based fractions and default CO_2 emission value is 144 g/kWh (40 t/TJ) (non bio based)
- Recent study from Helsinki area shows that mixed waste composition varied: depending on age distribution of residence, household size, building type and other issues
  - Averagely mixed household waste contains **65% of bio based fractions** and thus also CO_2 emissions from non bio based fraction should be less than proposed (144 g/kWh)

Waste Collection and Utilization In Finland

33 Yhdyskuntajätteet Suomessa käsittelytavoittain vuosina 1997–2011
Municipal solid waste in Finland in 1997–2011

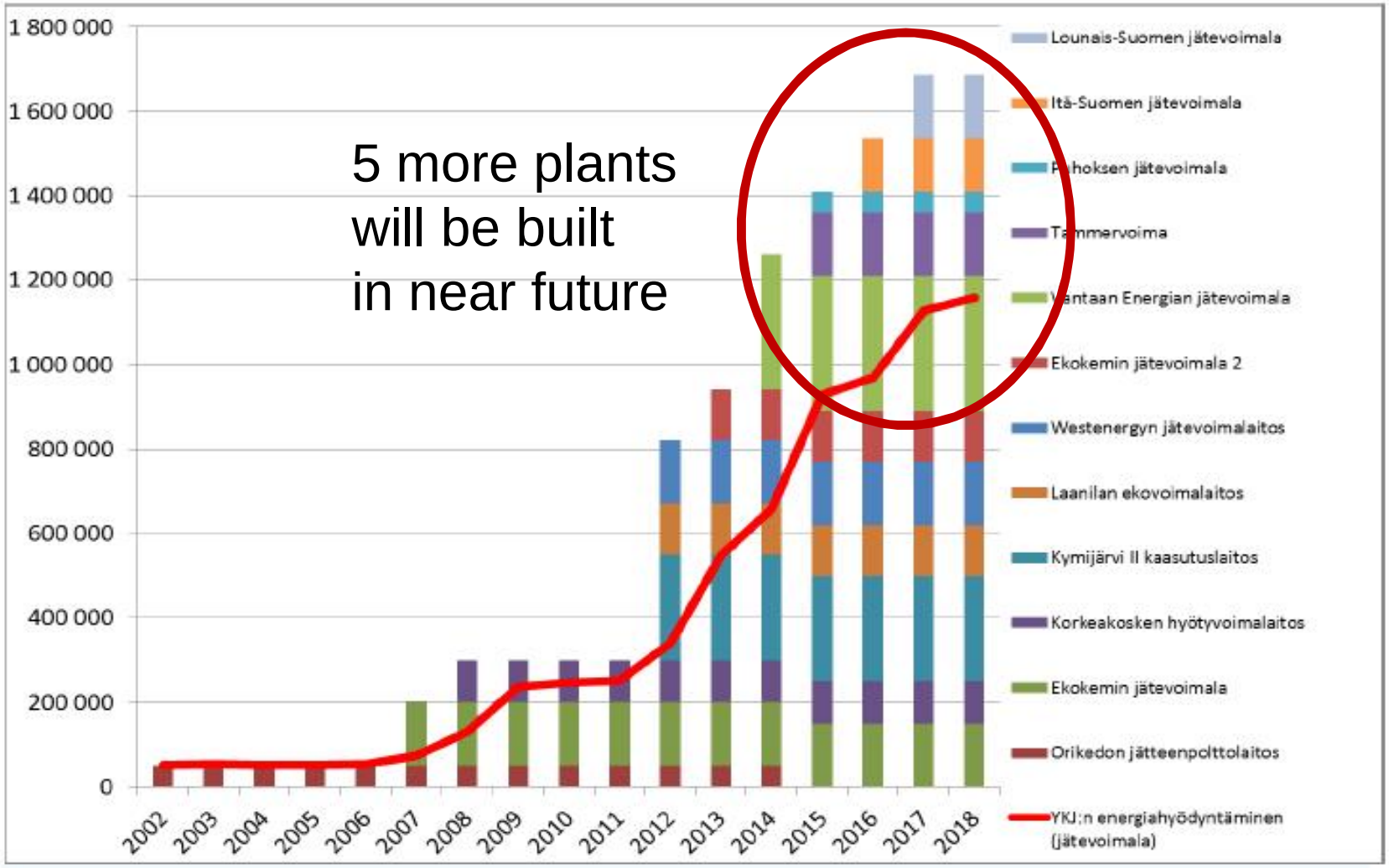


1.1 million tons is still available for incineration and heat production

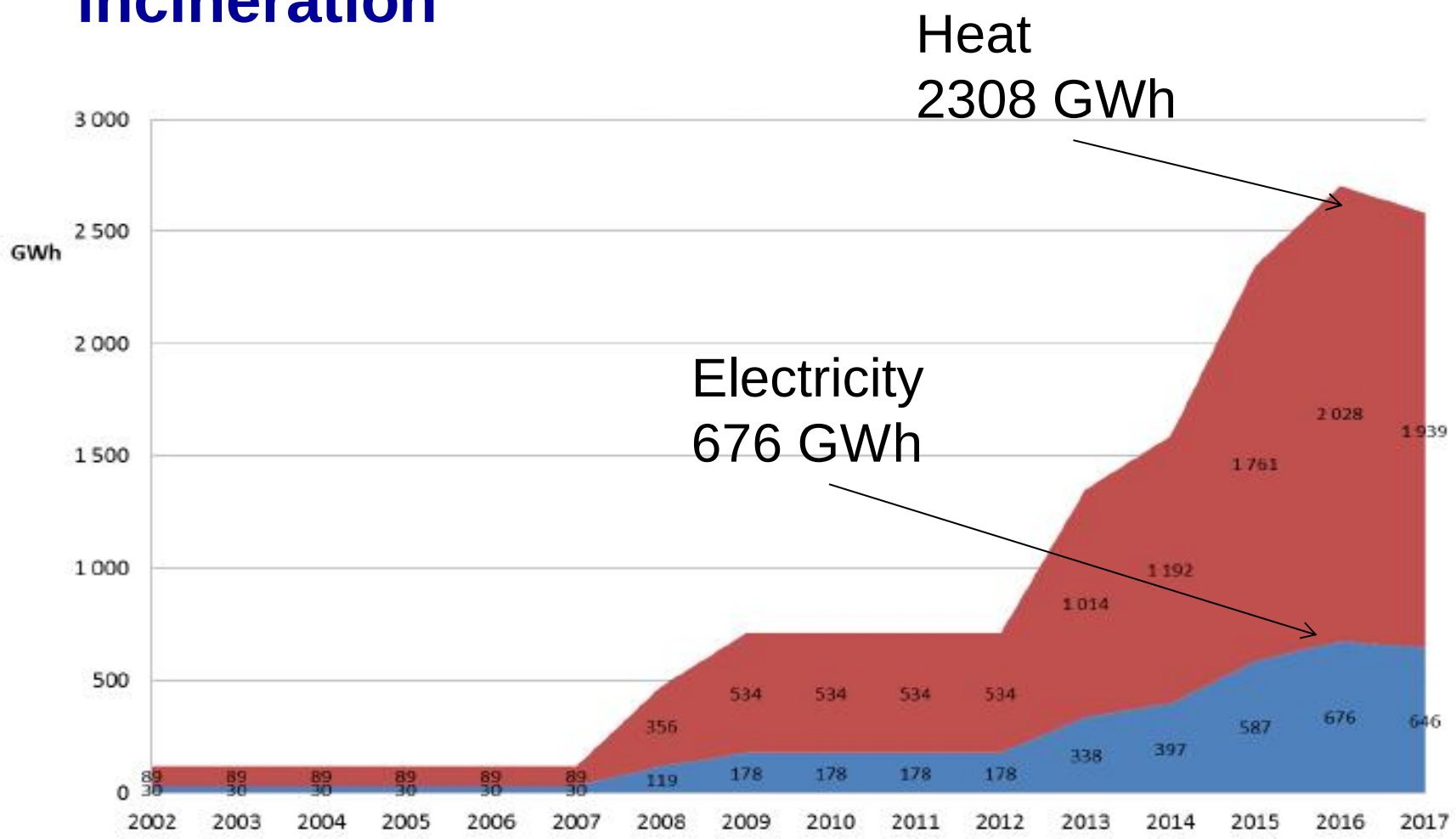
1) Sisältää myös polton jätteiden käsittelylaitoksissa. – Including waste incineration in incineration plants.

Lähteet: Suomen ympäristökeskus. Tilastokeskus
Sources: Finnish Environment Institute. Statistics Finland

Incineration plant capacity growth in Finland



Electricity and heat production from the MSW incineration



Waste-to-Energy production is small compared to the total energy consumption

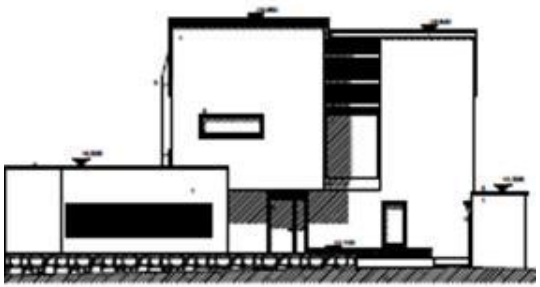
- Electricity consumption in Finland was 84 TWh

max waste-to-electricity production (estimation for 2016 was 676 GWh), it is only 0.8 % from total Finnish electricity consumption

- Heat production in Finland was 34 TWh

Max waste-to-heat production (estimation for 2016 was 2038 GWh), it is only 6 % from the total heat production

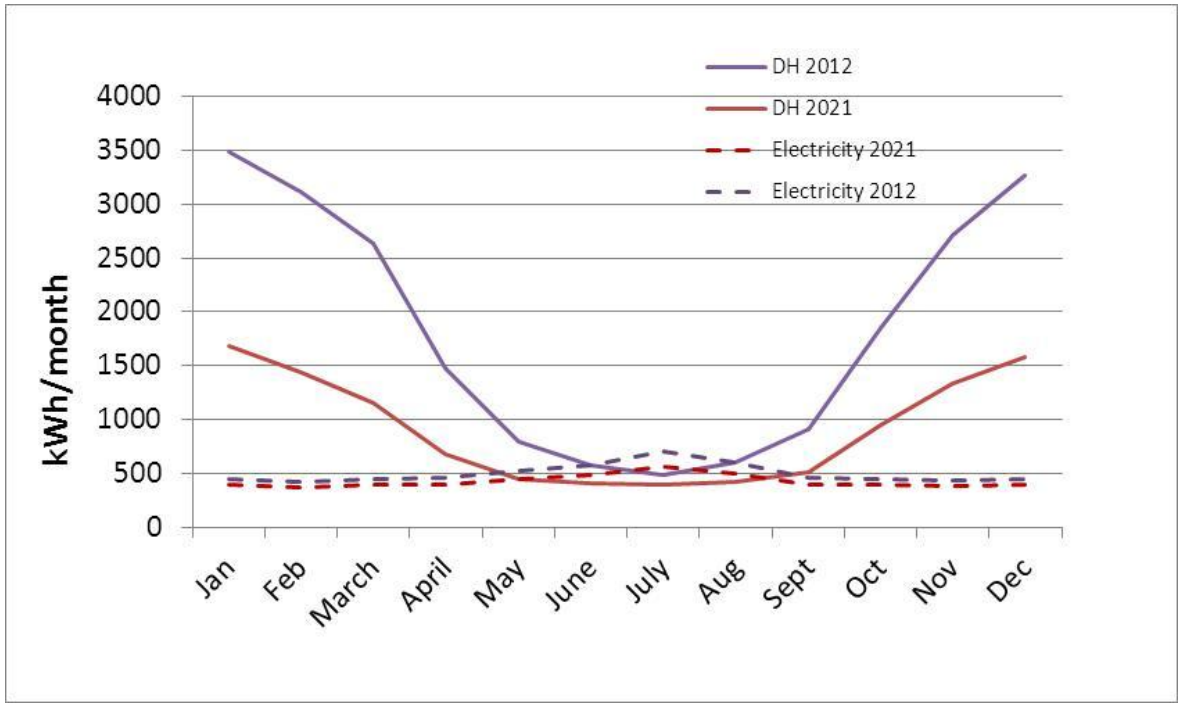
- This study shows that energy recovery from MSW in district heating reduces greenhouse gases from space heating



Building and Case area description

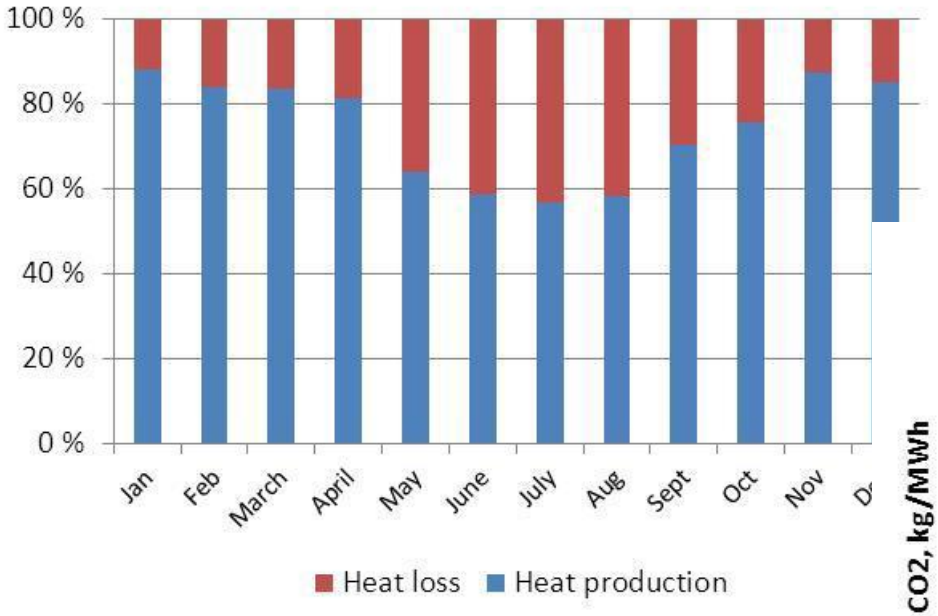
- Typical building in this case: 2-storey, 160 m^2
- Building structure: rendered facade, glass wool insulation, wooden frame, bituminous roof, concrete basement with polystyrene insulation
- Average household size: 3 persons
- Residential area: 29 family buildings,
- All buildings connected to the district heat network
- Waste incineration plant was integrated to the area heating network and waste collected from more bigger area to produce heat, average annual waste production was 192 kg/person

Energy consumption of the detached residential building (Finnish current requirement and energy efficiency solution)

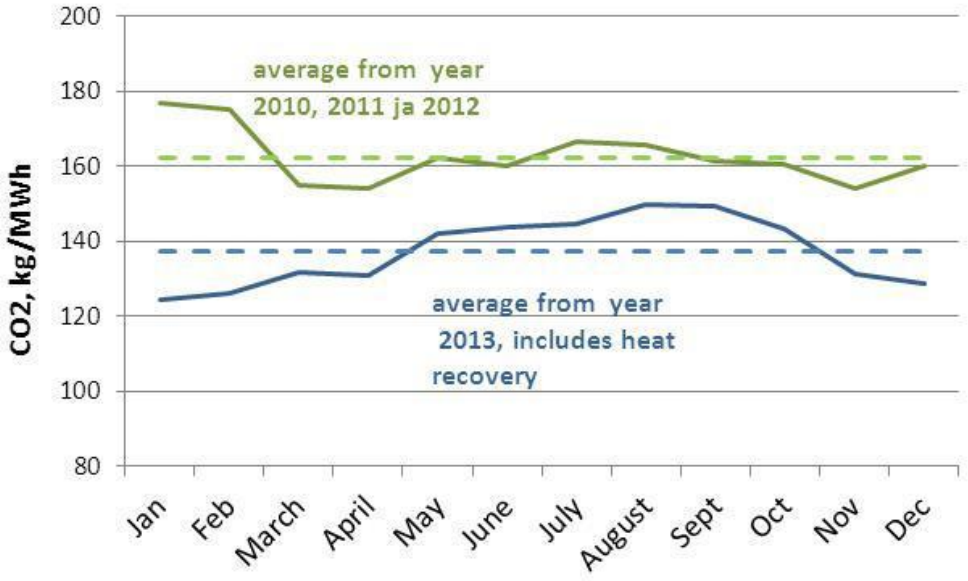


- Current requirement building (2012) consumes annually 131 kWh/m^2 heating and 38 kWh/m^2 electricity
- Energy efficiency building (2021) consumes half a less space heating and 15 % less electricity

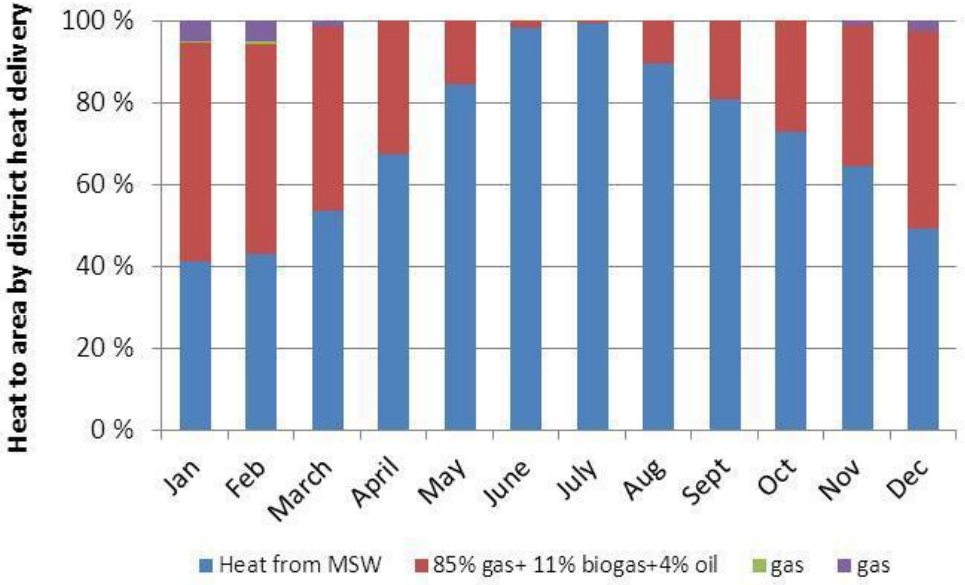
Carbon footprint of the heat production in CHP waste incineration plant (including fuel acquisition and heat recovery)

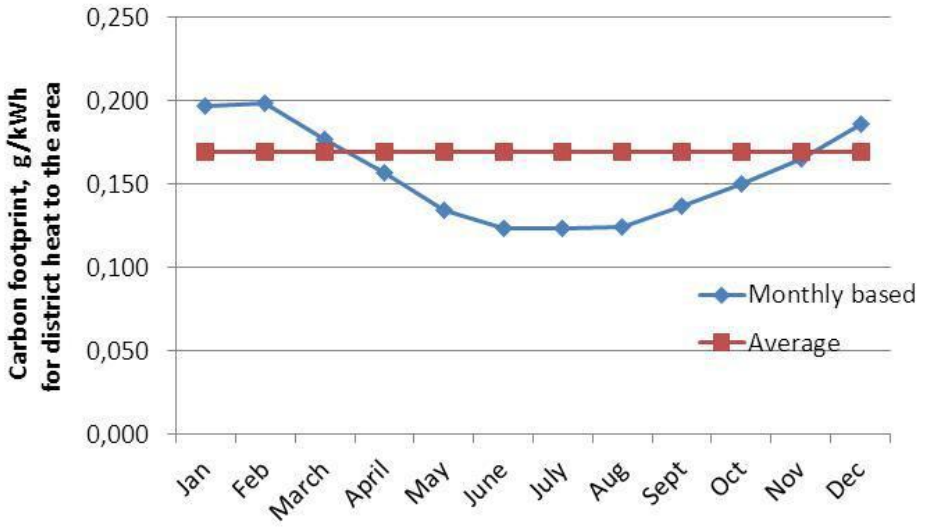


Heat losses are 10% - 40% depending on season



Carbon footprint is 122 - 150 g/kWh depending on not utilized heat





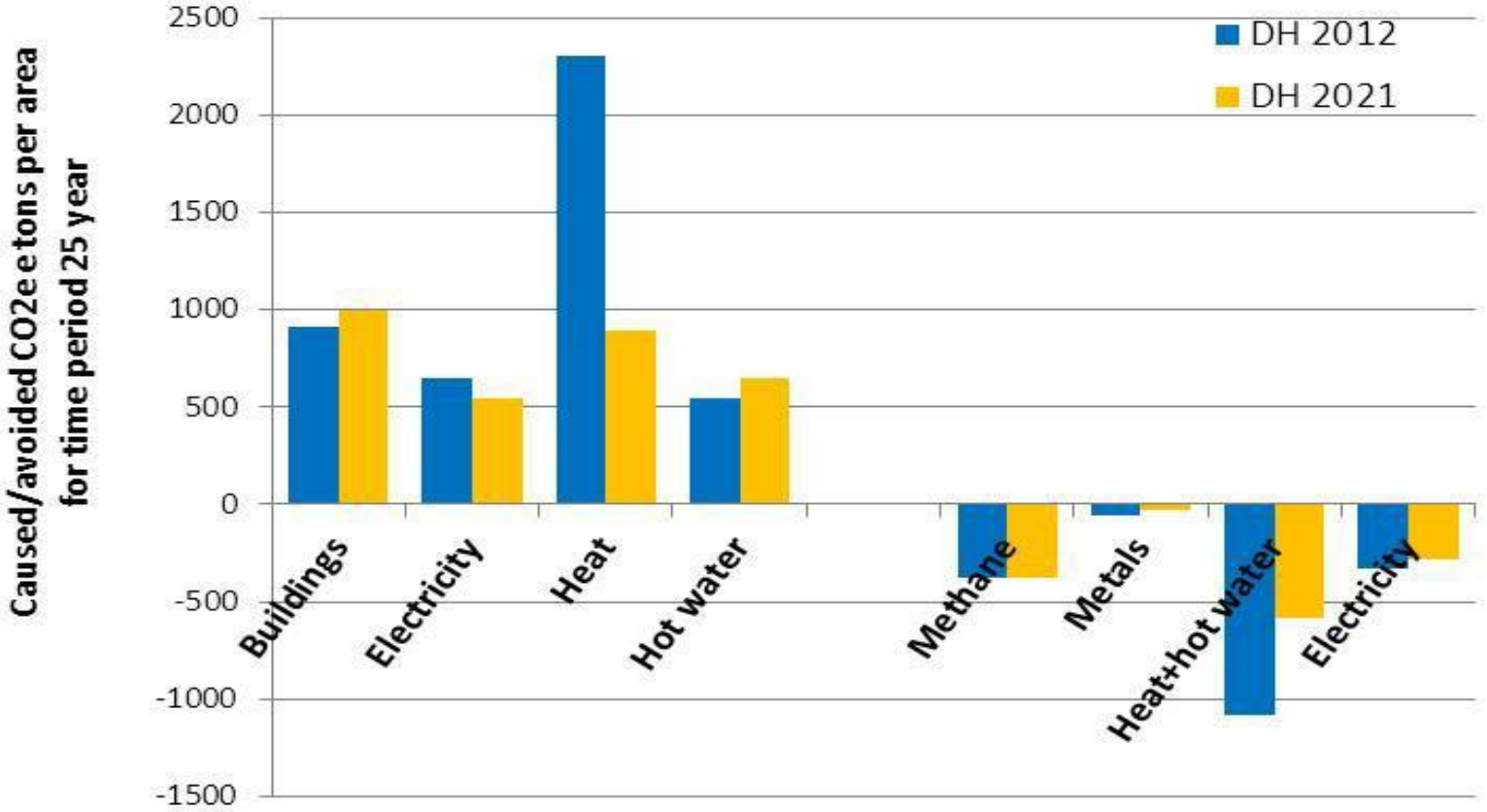
Heat production and carbon footprint for the case area

- Area heating demand covered by 60% from CHP waste incineration plant and 40% from natural gas driven district heat plant
- Carbon footprint for district heating and hot water varied from 200 – 123 g/kWh

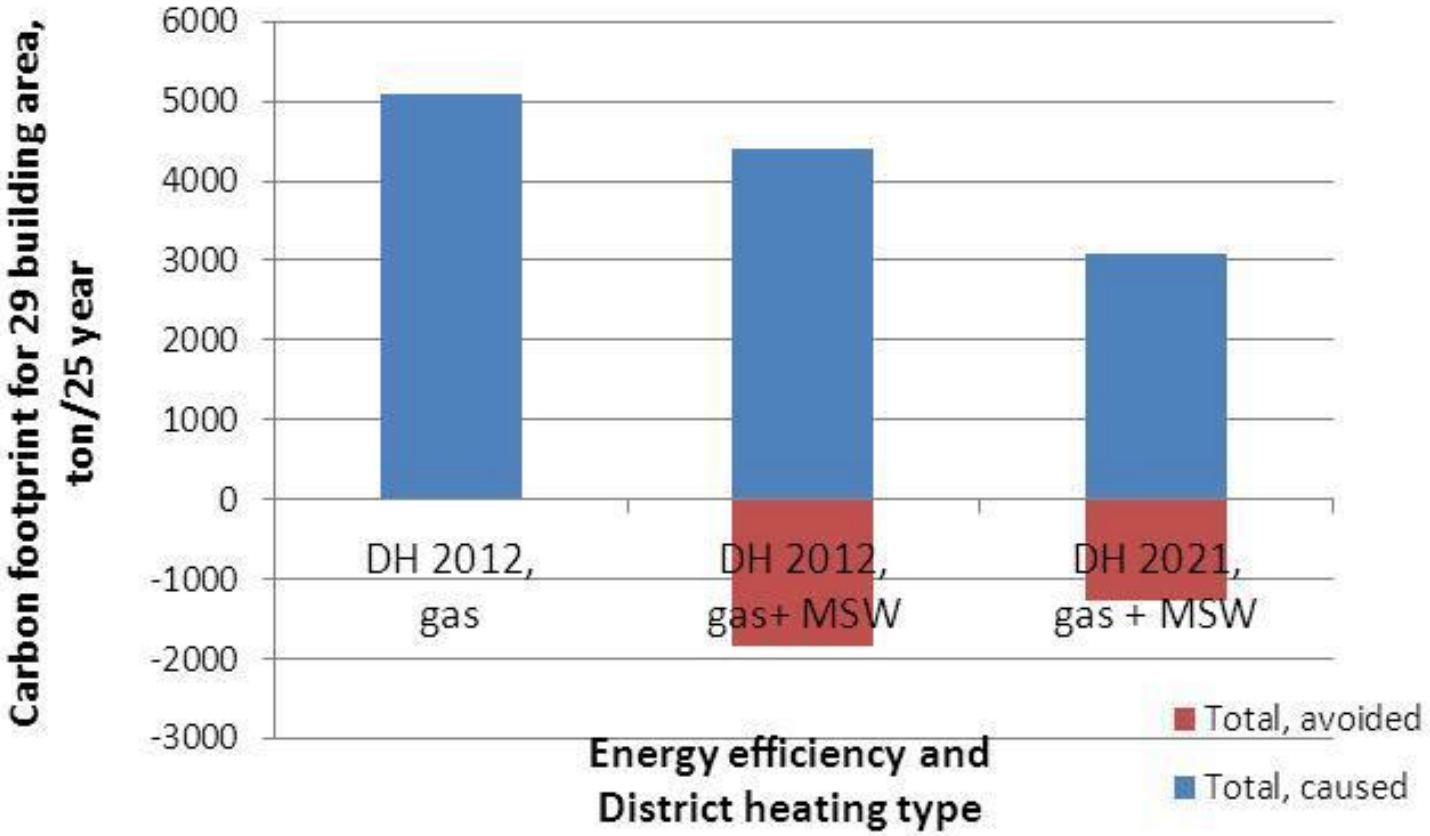
Benefits achieved by using waste in Energy production

- Municipal waste utilization prevents equivalent gas releases to the atmosphere in the case of uncontrolled landfilling.
  - 1 ton of waste causes 100 – 200 m^3 gas releases, in which 50 % is methane. Methane is 25 times stronger greenhouse gas than CO_2
- Waste incineration plants also working in the material recovery field. The amount of recovered metals could be substantial
- Waste-to-energy saving fossil fuels that would otherwise be used in energy production
  - In electricity production it saves mainly coal based power and in district heat production natural gas

Carbon footprint for the studied area (buildings built according to the current requirements versus energy efficiency solution)



Total caused and avoided carbon footprint from the studied area



Conclusions

- Finland has 1.1 million ton of not utilized municipal waste from which it is possible to produce CHP heat and electricity, recovered fuels or biogas – which is the most efficient way should be discovered by process optimization?
- According to the prediction it is possible to produce annually 2 TWh heat (6 % from total consumption) and 0.6 TWh electricity (< 1% from total) from MSW. This is a small amount compared to the total energy consumption,
- The use of district heat from waste lowers greenhouse gases from building operation in the case of local community

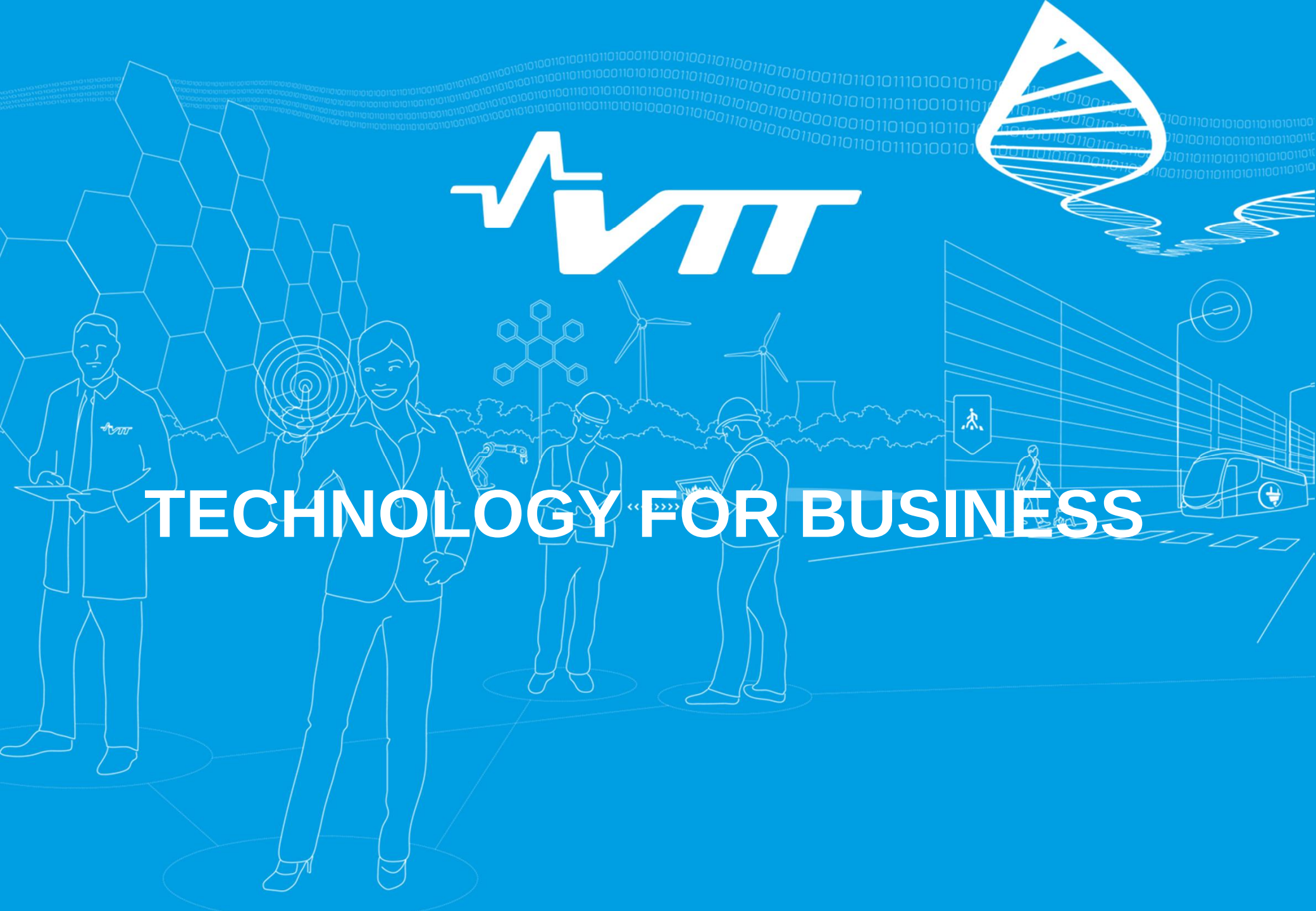
…Conclusion

- When a proportion of district heat is produced by waste incineration then the carbon footprint for detached residential building area during a 25-year time frame is 14% less than in natural gas driven district heat plant
- 39 % decrease in greenhouse gas emissions would have been achieved if all the buildings would have filled the energy efficiency requirements set for 2021

…Conclusion

- Waste utilization gives also other benefits e.g.
  - prevention of uncontrolled landfill emissions,
  - acquisition of recovered metals
  - avoided otherwise used fossil fuels for heating
- When these benefits are taken into account then the result improved even more:
  - Greenhouse gas emissions are 36 % less compared to the case of natural gas heating and 50 % less in the case of energy efficient buildings.

THANK YOU!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