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Procurement of biobased fuels: importance of quality

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Solid fuels and emissions

- Fuel combusting (i.e. energy production) always form emissions, so the use of renewable fuels
  - E.g wood fuel contains 395 kg/CO2/MWh, peat 370 395 kg/CO2/MWh, heating oil 270 395 kg/CO2/MWh
- In case of wood fuels it`s important to remember small particle emissios.
- The emissions can be influenced by
  - The quality of fuel (particle size, moisture content, contamination
  - Combustion techniques
  - Developing combustion equipments
- In practise most important thing is the right quaility of fuel

Importance of moisture content

- Moisture has of a significant adverse impact to the combustion. The water (i.e. steam) complicates the combustion process and evaporation of water requires a large amount of energy.
- Heating and evaporation of one kilogram water requires about 2600 kJ (2.6 MJ or 0.72 kWh). If the fuel is mixed with the snow, melting requires 333 kJ / kg.
- Moisture reduces the combustion temperature (flame temperature), which can arise incomplete combustion (small particle emissions, unburnt carbon monoxide, reduced efficiency)

Influence of the moisture content to the net calorific value

Moisture content of fuel (wood chips) , %	Net calorific value MJ/kg	Net calorific value kWh/kg
60	6,25	1,74
55	7,34	2,04
50	8,43	2,34
45	9,52	2,64
40	10,60	2,95
35	11,69	3,25
30	12,78	3,55
25	13,86	3,85
20	14,95	4,15
15	16,04	4,46
10	17,13	4,76
5	18,21	5,06
0	19,30	5,36

Effect of moisture on plant sizing

- Increased moisture content will cause higher particle emissions, the fuel consumption is higher and a thermal efficiency decreases.
- This in turn leads to the fact that the thermal plant has to be oversized, so as to be able to generate sufficient heat using too moist wood chips.
- Oversizing increases the investment cost and impacts to the profitability.

Small size CHP (Combined Heat and Power)

- In case of micro-CHP moisture of wood chips is a critical factor to the functioning of the plant.
- In existing installations, the chips must have moisture content under 18 %, preferably 15 % or less, and at that moisture content of wood chips can only be achieved by artificial drying.
- In contrast to the thermal plants, in small-scale CHP plant the chip size, its homogeneity and amount oh fine particles has very big importance to the functioning of the small size CHP-plant

Drying

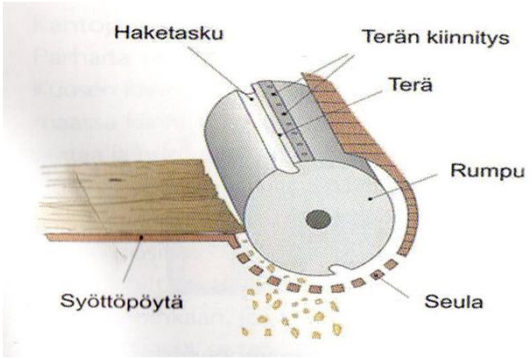
- Produced through the natural drying process dried chipped wood chips can have moisture content of 20 – 25 %, but under normal conditions moisture content would be approximately 35 (In Finnish climate conditions). Drying woods are at the mercy of nature and the final moisture content is not always predictable.
- Artificial drying of wood chips is essential, when moisture content should be under 25 %,
- or consumer (heat entrepreneur) wants to speed up the circulation of energy and avoid storage time (from 5 months to 18 months) and reduce capital costs

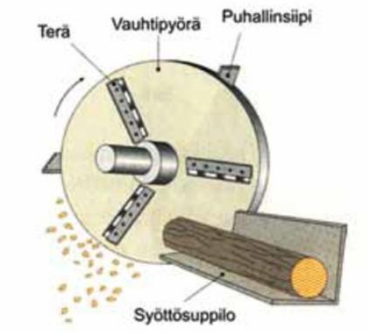
Cost on drying wood

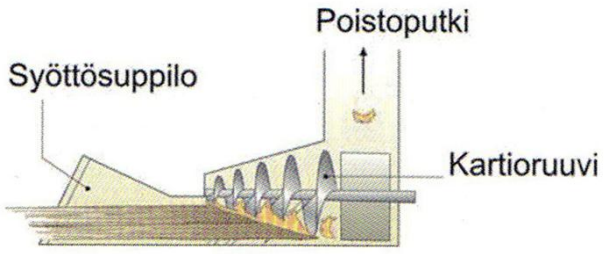
- The 5 % interest expenditure accounts for around 1.5 € / m3 interest payments, and in the large stock that accumulates a significant item of expenditure to entrepreneur.
- Circulation of energy wood can be sped up by chipping energy wood as fresh as possible and using artificial drying methods

The effect of chip size to the productivity of chippers

- Chip particle size is one significant factor which affects to the price of wood chips
- Chip size affect directly to the productivity of chipper
  - Disc chipper, blade distance 20 mm and 30 mm, difference in productivity 30 %
  - Conic screw chipper, two different size conics, difference in productivity 32 %







Cost on drying wood

- Evaporation 1 kg water needs 0,71 kWh energy (theoretic).
  - In practise evaporation of 1kg water needs 1 kWh energy
- According theoretical calculations drying one solid cubid meter wood chips from 55 % moisture to 15 % moisture takes 280 kWh energy and 396 kg water will evoporate.
- In Finland case 1 that means: When using district heat (67 €/MWh) drying cost would be 18,80 €/solid cubid meter or 9,4 €/MWh
  - Why district heat? Includes the lost sold energy and investment cost
- In Finland case 2 that means: When using average prize of wood chips (35 moist%) 25 €/MWh heating cost would be 7,0 €/ solid cubid meter or 3,5 €/MWh

Cost calculation , different procurement/upgrading chain, raw material pine stem wood

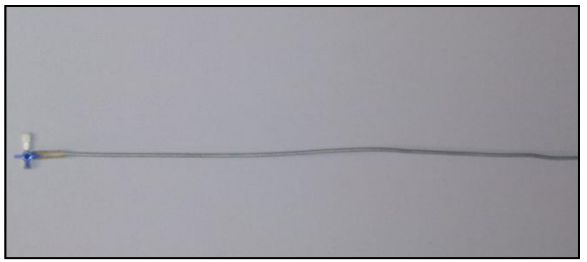
Chipper	Without bark, moisture 55 %, cost of barking 4 €/m³, 2 €/MWh		Drying 55% →15 %, chips with bark (drying cost) 8 - 23 €/m³, 4 – 12 €/MWh		Drying 55% →15 %, Chips without bark	
	€/m³	€/MWh	€/m³	€/MWh	€/m³	€/MWh
Drum chipper	44,3	24,6	48,3 - 63,3	26,6 - 34,6	52,3 -67,3	28,6 - 36,6
Disc chipper	49,9	27,6	53,9 - 68,9	29,4 - 37,4	57,9 - 72,9	31,4 - 39,4
Conic screw chipper, smaller chip size	56,2	30,6	60,2 - 75,2	32,5 - 40,5	64,2 - 79,2	36,5 - 44,5
Conic screw chipper, bigger chip size	51,6	28,5	55,6 - 70,6	30,3 - 38,3	61,6 - 74,6	32,3 - 40,3

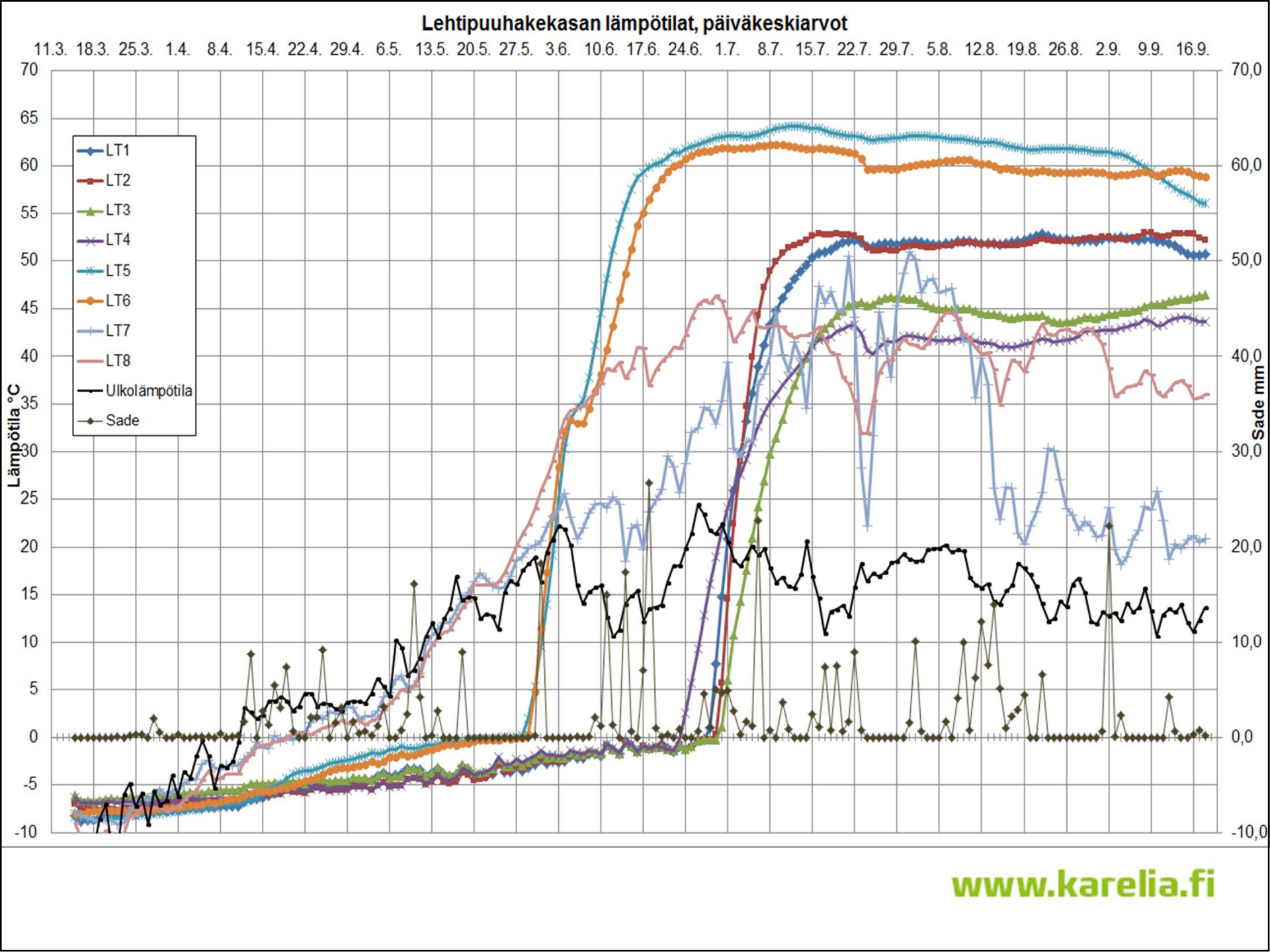
Research frame

- Soft wood pile
  - 440 i-m3
  - Moisture 51 %
- Hard wood pile
  - 520 i-m3
  - Moisture 48 %
- 8 thermoelemets

Measuring methods

- Gaseous emissions (CO_2 ja CH_4) were measured from the top of pile:
  - Static ventilated chamber
  - Pipe samples from ½ m depht
- Inside of the piles:
  - Trought 4 m long pipes to gas bags

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Lämpötila °C
Sade mm
LT1
LT2
LT3
LT4
LT5
LT6
LT7
LT8
Ulkolämpötila
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Preliminary results

- Time of chipping may have big effect
- Big losses of the dry matter

Thank`s for your attention!

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