



Profitability of drying wood chips integrated into fuelwood supply

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Sustainable Bioenergy
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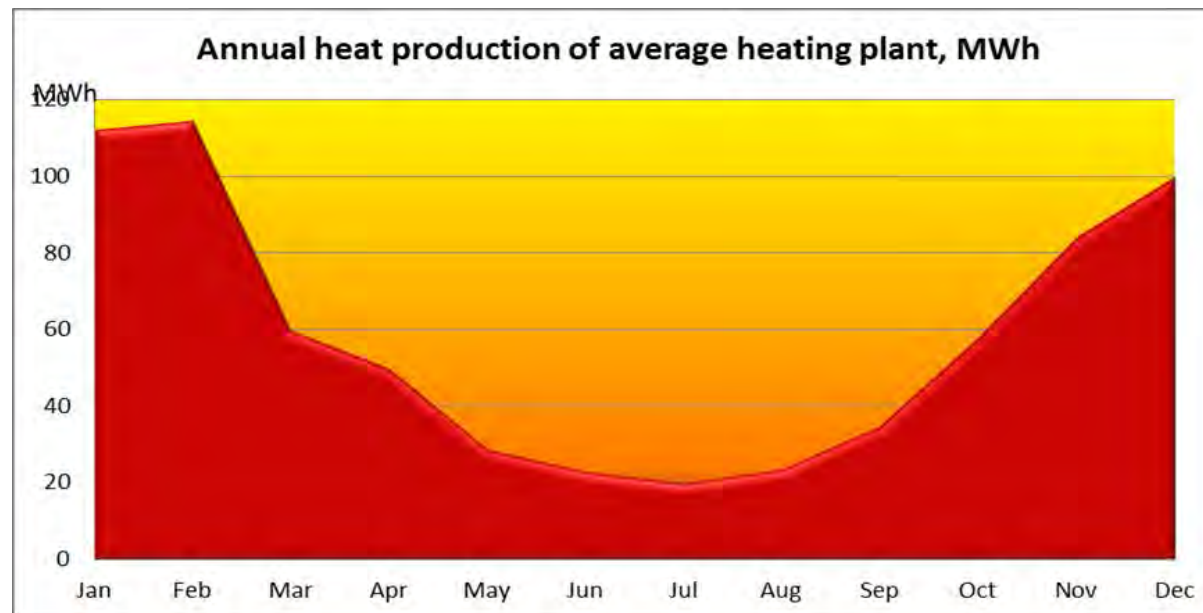


Background

- Study in Central Finland (2012)
 - Ca. 30 heating plants run by heat entrepreneurs
 - Total output of these plants 20 MW



About 1 Mm³ of wood chips could be dried with unused heating capacity



Supply costs of forest chips

Supply costs 1/3

- Case 1: Heating plant, annual heat production 5,000 MWh
 - Supply chain 1 (**contractor model**): Raw material bought at landing, chipping and transportation separately paid for (chipping with large mobile chipper, transport with 120 m³ truck)
 - Price for whole trees at landing; €13 /MWh
 - Chipping costs; €3.6 /loose-m³
 - Transport costs; €3.6 /km
 - Efficiency of boiler; 78-88% when moisture of wood chips 55-20%
 - Malfunction costs; €120 /each
 - Use of heating oil; €14,000-0 /a (wood chips 55-20%)
 - Supply chain 2 (**single supplier model**): Wood chips supplied by one supplier
 - Price of wood chips delivered at plant; €20 /MWh
 - Efficiency of boiler; 78-88% when moisture of wood chips 55-20%
 - Malfunction costs; €120 /each
 - Use of heating oil; €14,000-0 /a (wood chips 55-20 %)

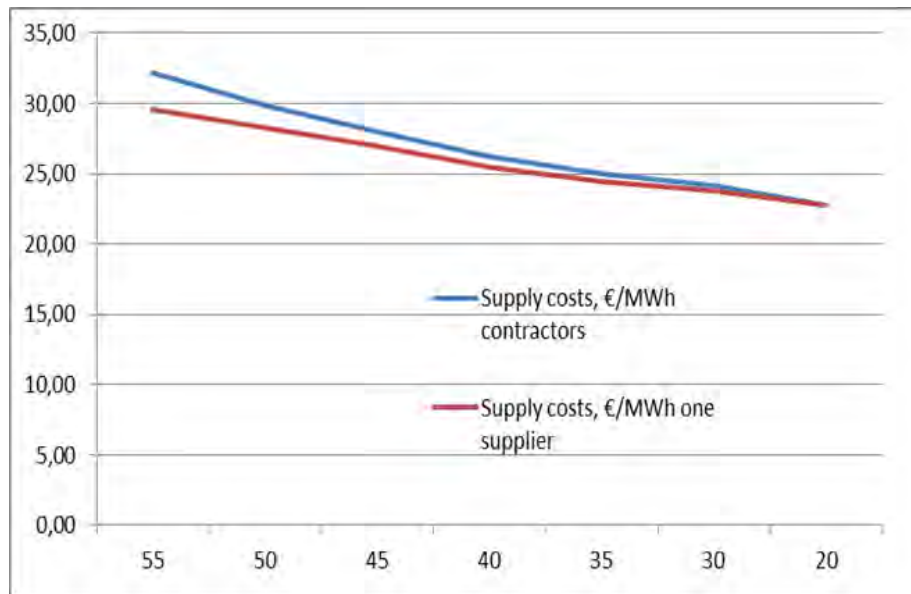
- Case 2: Heating plant, annual heat production 1,500 MWh
 - Supply chain 1 (**contractor model**): Raw material bought at landing, chipping and transportation separately paid for (chipping with tractor powered chipper, transport with tractor – load space 20 m³)
 - Price for whole trees at landing; €25 /solid-m³
 - Chipping costs; €4.5 /loose-m³
 - Transport costs; €2 / loose-m³
 - Efficiency of boiler; 78-88 % when moisture of wood chips 55-20%
 - Malfunction costs; €120 /each
 - Use of heating oil; €5,200- 0 /a (wood chips 55-20%)
 - Supply chain 2 (**single supplier model**): Wood chips supplied by one supplier
 - Price of wood chips delivered at plant, €20 /MWh
 - Efficiency of boiler; 78-88 % when moisture of wood chips 55-20%
 - Malfunction costs; €120 /each
 - Use of heating oil; €5,200- 0 /a (wood chips 55-20%)

Supply costs 3/3, €/produced MWh



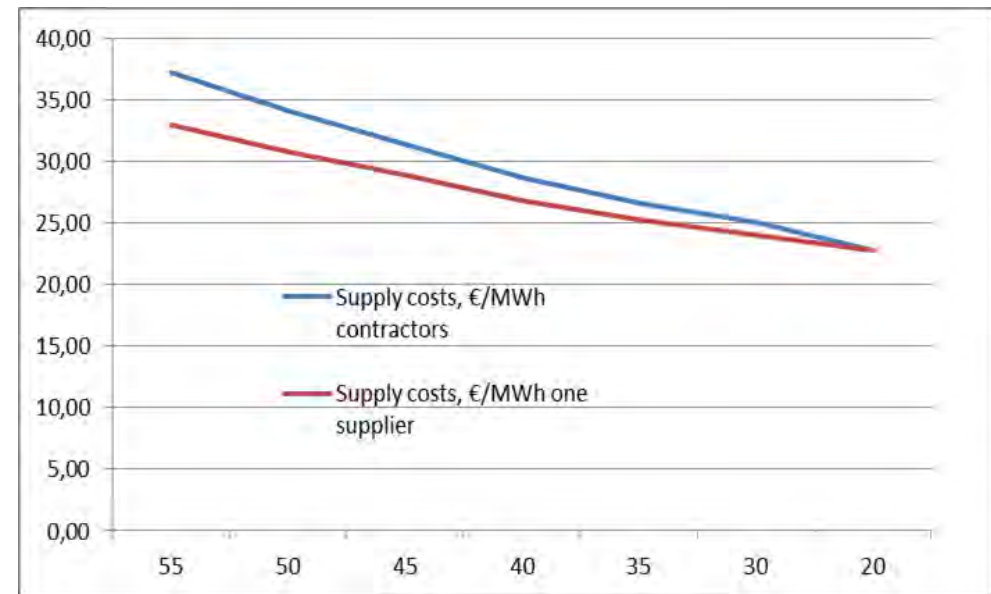
Case 1

- Transport and chipping costs of wet wood make contractor model more expensive



Case 2

- Raw material and chipping significantly more expensive when wood is wet



Cost difference of dry and wet chips



Case 1

- Cost difference between *supply models* max 2.7 €/MWh, if moisture is 55 %

Case 2

- Cost difference between *supply models* max 4.3 €/MWh, if moisture is 55 %

	Contractor model	Single supplier model
55% → 20%	€8.9/MWh	€6.8/MWh
45% → 20%	€5.3/MWh	€4.3/MWh

	Contractor model	Single supplier model
55% → 20%	€14.6/MWh	€8.7/MWh
45% → 20%	€10.2/MWh	€6.2/MWh

Conclusion 1: In contractor model wood chips should not be wet

Conclusion 2: You can afford paying more for dry wood chips , €/MWh – pricing based on quality!

Conclusion 3: On the other hand, you can afford paying for drying

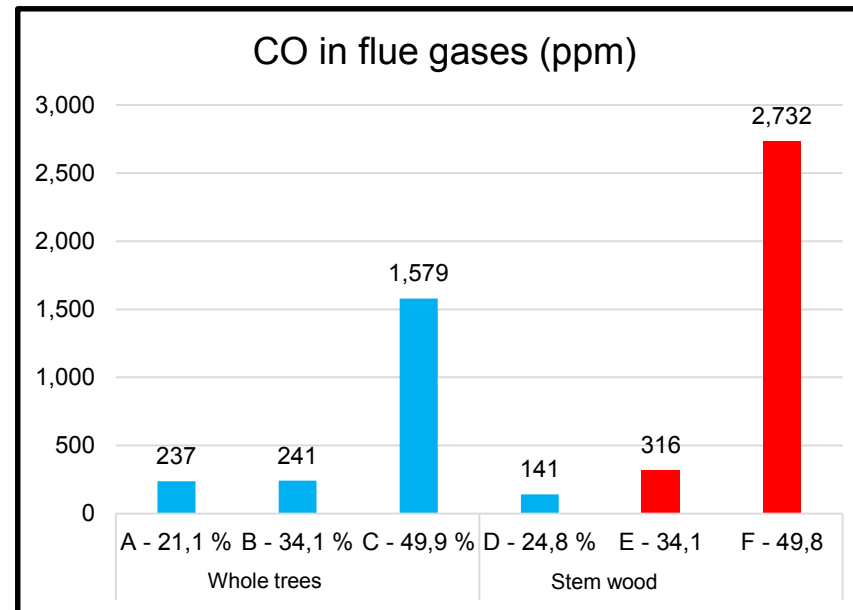
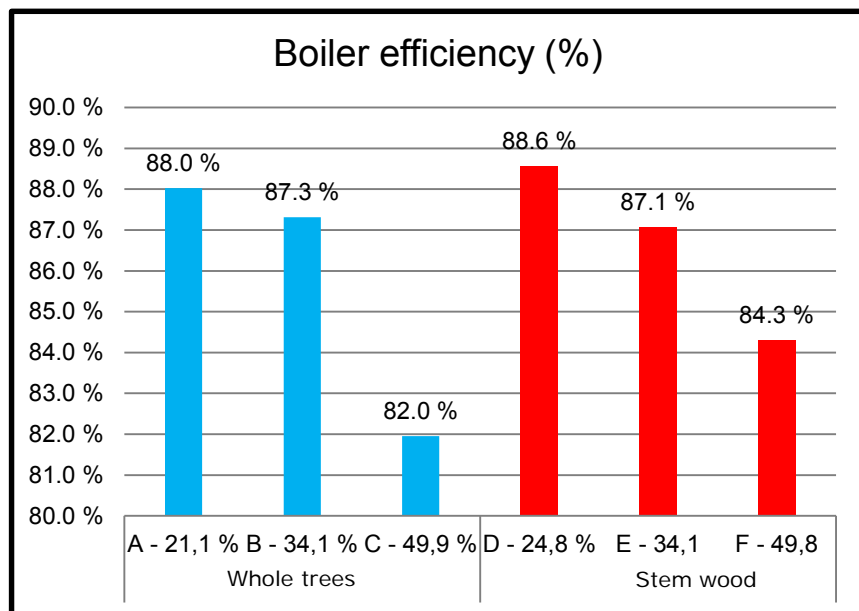
Drying of wood chips

Drying in a show case dryer

- Built in freight container, drying heat from a wood chip boiler, 40-60 kW output needed (Case 2: 1,500 MWh/v)
- Calculation parameters:
 - Max drying volume; 2,500 loose-m³/a, 25 m³ each drying batch
 - Needed heat energy – calculated with a model - 445 MWh (55% moisture) ja 268 MWh (45% moisture)
 - Price of heat; €40 /MWh (prime cost for entrepreneur) ja €24 /MWh (fuel costs only)
 - Dryer investment; 35,000 €
 - Electricity and maintenance; €1,300 /a
 - Repayment; 10 a
 - Interest; 5%



Moisture of wood chips and boiler efficiency



- In small boilers (<1MW) moisture of wood chips affects the performance of the boiler significantly, particularly when MC is bigger than 35%

Drying wood chips for sale



- Entrepreneur dries wood chips at a plant he operates
- Enough heat available
- Drying costs based on example:

	Heat price 24 €/MWh	Heat price 40 €/MWh
55% → 20%	6.5 €/loose-m ³	9.3 €/loose-m ³
45% → 20%	4.8 €/loose-m ³	6.6 €/loose-m ³

- To be profitable, dry wood chips should be this much more expensive if sold

Drying wood chips to be used at own plant

- Dry (20%) wood chips needed 2,100 loose-m³
- Profitability of drying was evaluated by net present value (NPV) method
 - NPVs of benefits and costs were compared
 - Annual costs were drying and capital costs
 - Benefits (cost savings):
 - Less wood chips are needed, less raw material costs
 - Transportation costs decrease because of smaller volume
 - Chipping cost decrease because of smaller volume
 - Boiler efficiency increases
 - Fewer malfunctions of boiler and feeding system occur
 - Less heating oil (additional fuel) is needed



Profitability of drying in different alternatives

Initial moisture	Drying heat 40 €/MWh		Drying heat 24 €/MWh		Drying heat 40 €/MWh + storage		Drying heat 24 €/MWh + storage	
	Con-tractor model	One supplier	Con-tractor model	One supplier	Con-tractor model	One supplier	Con-tractor model	One supplier
55%	14,792	-36,170	60,196	9,234	-775	-51,738	46,683	-6,334
45%	-8,159	-37,222	19,407	-9,655	-23,727	-52,789	5,894	-25,223

- Additional storage investment needed if there is no other storage available
- Drying more difficult to make profitable in single supplier model
- Cost of drying heat is crucial for profitability

Effect of increased heat sales



	Drying heat 40 €/MWh		Drying heat 24 €/MWh		Drying heat 40 €/MWh + storage		Drying heat 24 €/MWh + storage	
Initial moisture	Con-tractor model	One supplier	Con-tractor model	One supplier	Con-tractor model	One supplier	Con-tractor model	One supplier
55%	162,462	101,792	216,514	155,845	146,894	63,779	203,001	140,277
45%	135,139	100,541	167,956	133,358	119,571	61,724	154,443	117,790

- Possible to dry 400 loose-m³ 'extra', then heat sales could be increased by 300 MWh (due to increased heating value + efficiency of boiler)
 - If heat is sold for €60 /MWh, 18 000 € annual gross income is earned
- In the least profitable option about half of the increased potential (=200 loose-m³) would ensure profitability
- In contractor model drying 50 loose-m³ more would be sufficient

Conclusions

- Heating plants operated by entrepreneurs usually have plenty of unused heating capacity that could be used for drying wood chips or firewood
- Moisture of wood chips should not fluctuate if most operation costs in the supply chain are based on volumes
- Basis for 'quality pricing = higher price/MWh for dryer wood chips, win-win possible





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