Profitability of short-rotation biomass production on downy birch stands on cut-away peatlands in northern Finland

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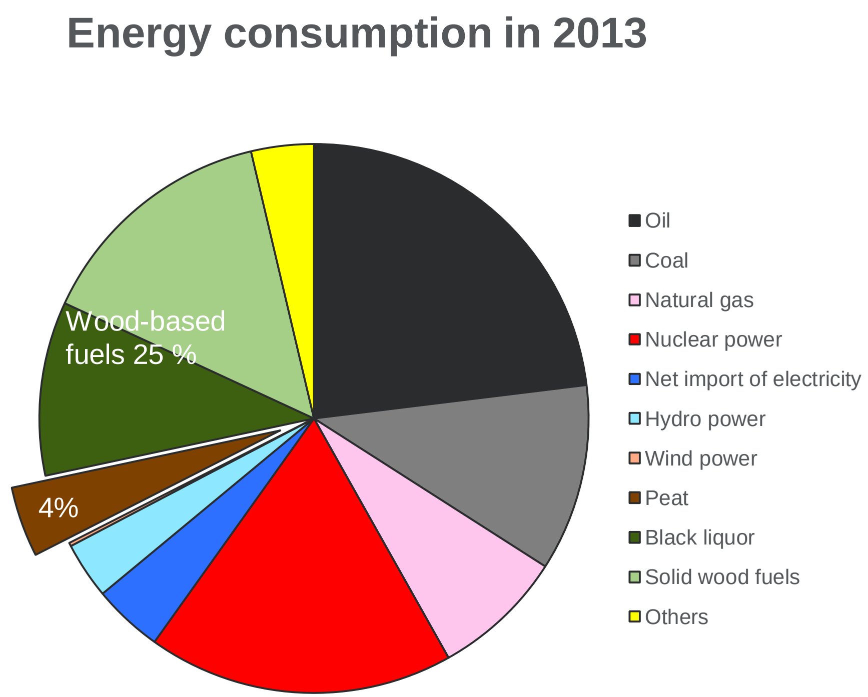
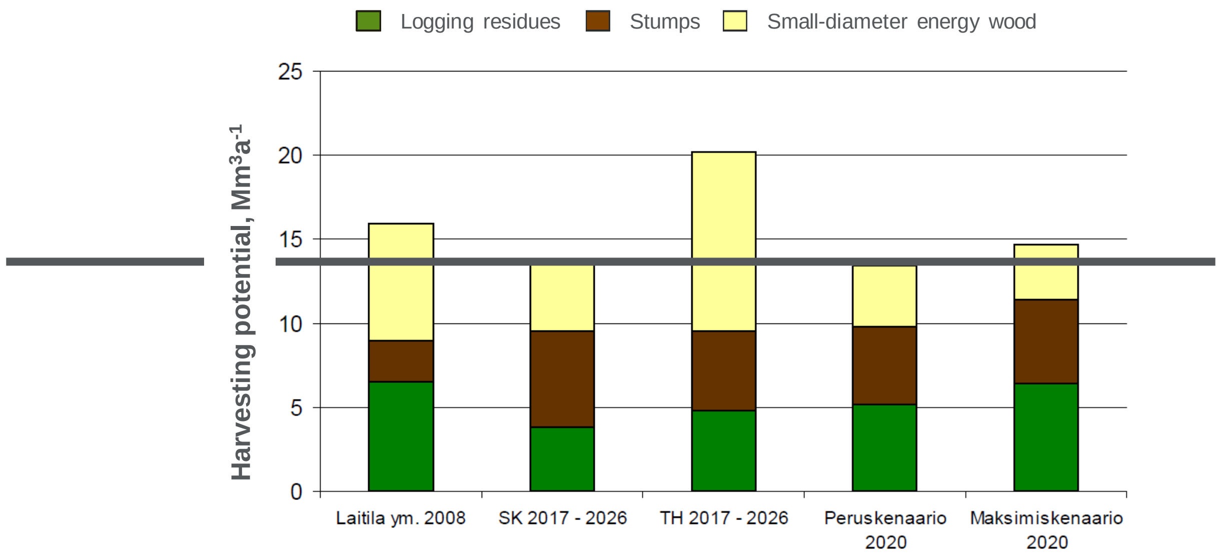
I Background

- Annually ca. 2500 ha of peat production area is released to after-use
- The need for increasing the use of renewable energy up to 38% by 2020
- Increasing wood consumption by the forest industry → competition for wood between forest and enery industries



Forest chip potential in Finland



Target for 2020

Made in Finland

The effect of new investments?

(Anttila et al. 2014)

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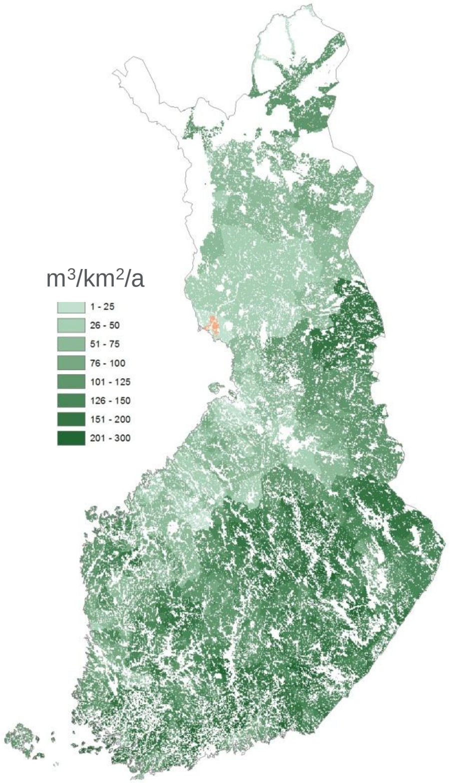
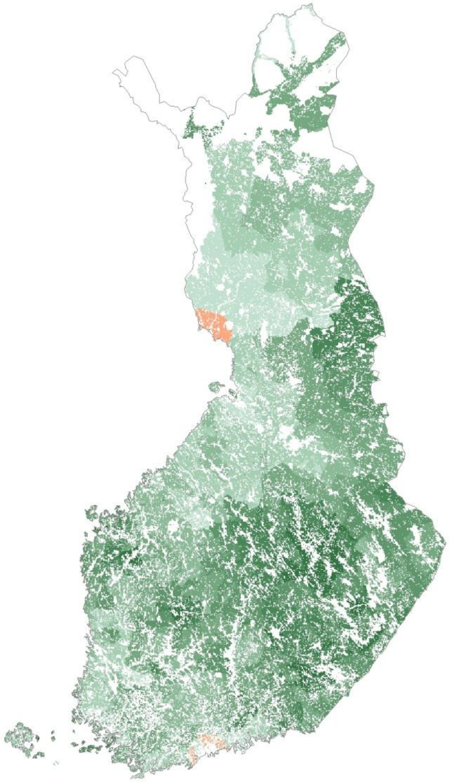
Regional forest chip potentials / maximum allowable cut

2012



2020



(Anttila et al. 2014)

There is need for intensifying wood biomass production….

- Domestic forest chip supply is sufficient for reaching the target for the use of renewable energy, if
  - Cuttings of sawlogs is increased
  - Pulpwood is used in energy generation in areas with low industrial demand
  - **Wood production is intensified and/or**
  - Procurement logistics is developed

  (Anttila ym. 2014)

II Profitability of intensive production of downy birch on cutaway peatlands

$$BLV = \left[R_S b^S - \sum_{s=0}^{S} c_s b^s \right] + \left[R_K b^K - \sum_{k=0}^{K} c_k b^{(k+S)} \right] + \left[R_L b^L - \sum_{l=0}^{L} c_l b^{(l+K+S)} \right] + F$$

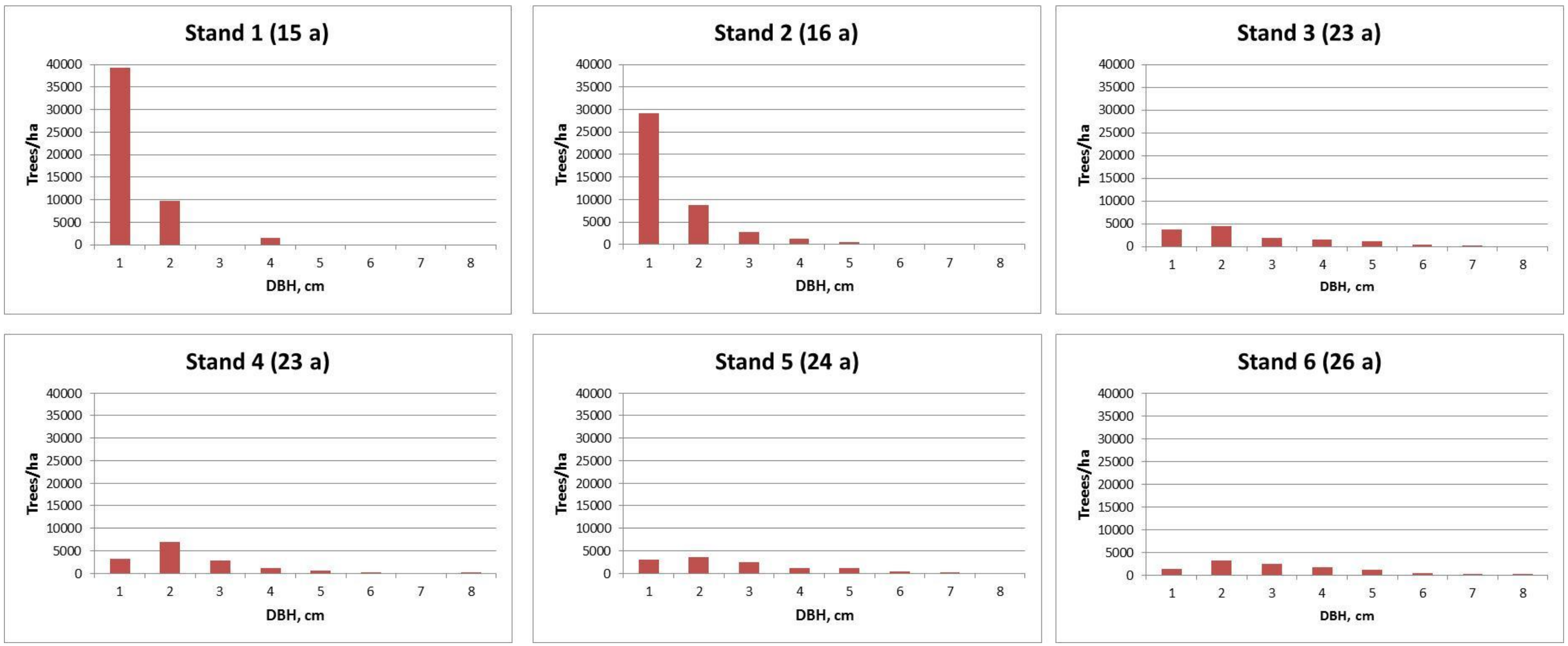
Case Hirvineva

- Profitability calculations for six mixed downy birch stands, aged 15 – 26 years
- Mounding or ash fertilisation after cessation of peat production
- Two intensity levels: natural afforestation or broadcast seeding (seeding was assumed to shorten the first rotation by one year)
- Clear-cut of the first tree generation at the age of 15–26 years
- Regeneration of two subsequent generations by coppicing, thereafter mounding and broadcast seeding
- Equal biomass production in all rotations, but coppicing and seeding shorten rotations by one year compared to the 1st generation

Stand data

Stand no.	Stand age, years	Trees ha^{-1}	Mean DBH, cm		Mean height, m		Whole-tree recovery		
			Arithm.	Basal-w.	Arithm.	Basal-w.	kg ha^{-1} 3)	m^3ha^{-1}	MWh ha^{-1}
1	15	50,567	2.1	3.5	3.8	5.1	41,663	90	208
2	16	42,500	2.1	5.1	3.6	6.3	49,129	105	246
3	23	13,667	4.1	7.4	7.2	10.0	65,354	139	327
4	23	15,333	3.8	6.6	6.2	9.0	59,989	134	300
5	24	12,167	4.5	8.0	6.9	10.2	73,584	155	368
6	26	10,475	5.0	7.8	8.2	10.8	74,840	158	374

Stem diameter distribution



- Stand density 10 000–51 000 trees per ha (h ≥ 1.3 m)
- Whole-tree recovery 90–158 m^3/ha (42–75 t/ha)

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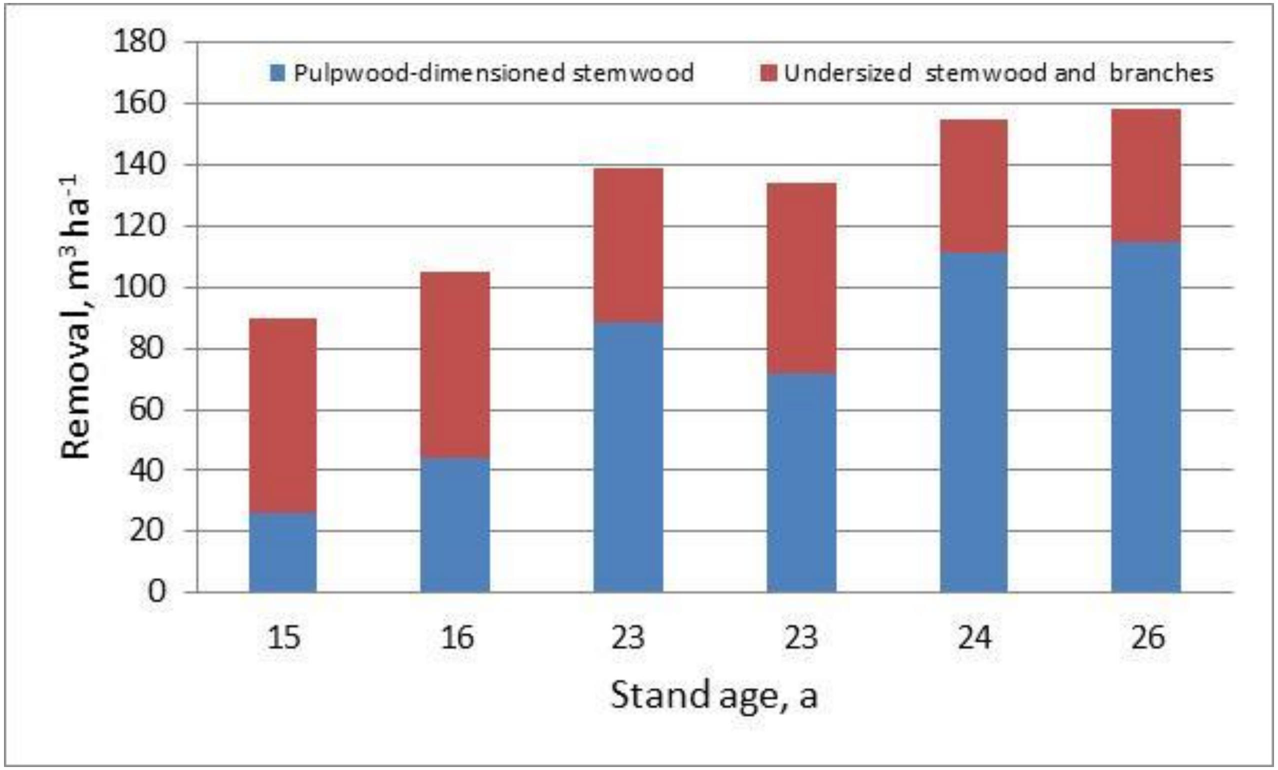
Recovery



Pulpwood-dimensioned stemwood
Undersized stemwood and branches
Removal, m³ ha⁻¹
180
160
140
120
100
80
60
40
20
0
15
16
23
23
24
26
Stand age, a

The cost of forest chip production

- Recoveries were calculated with biomass models, harvesting losses were ignored
- Cutting by a feller-buncher
  - Time consumption was calucated using the model of Fernandez-Lacruzin et al. (2013)
  - Hourly cost of a new medium-sized harvester

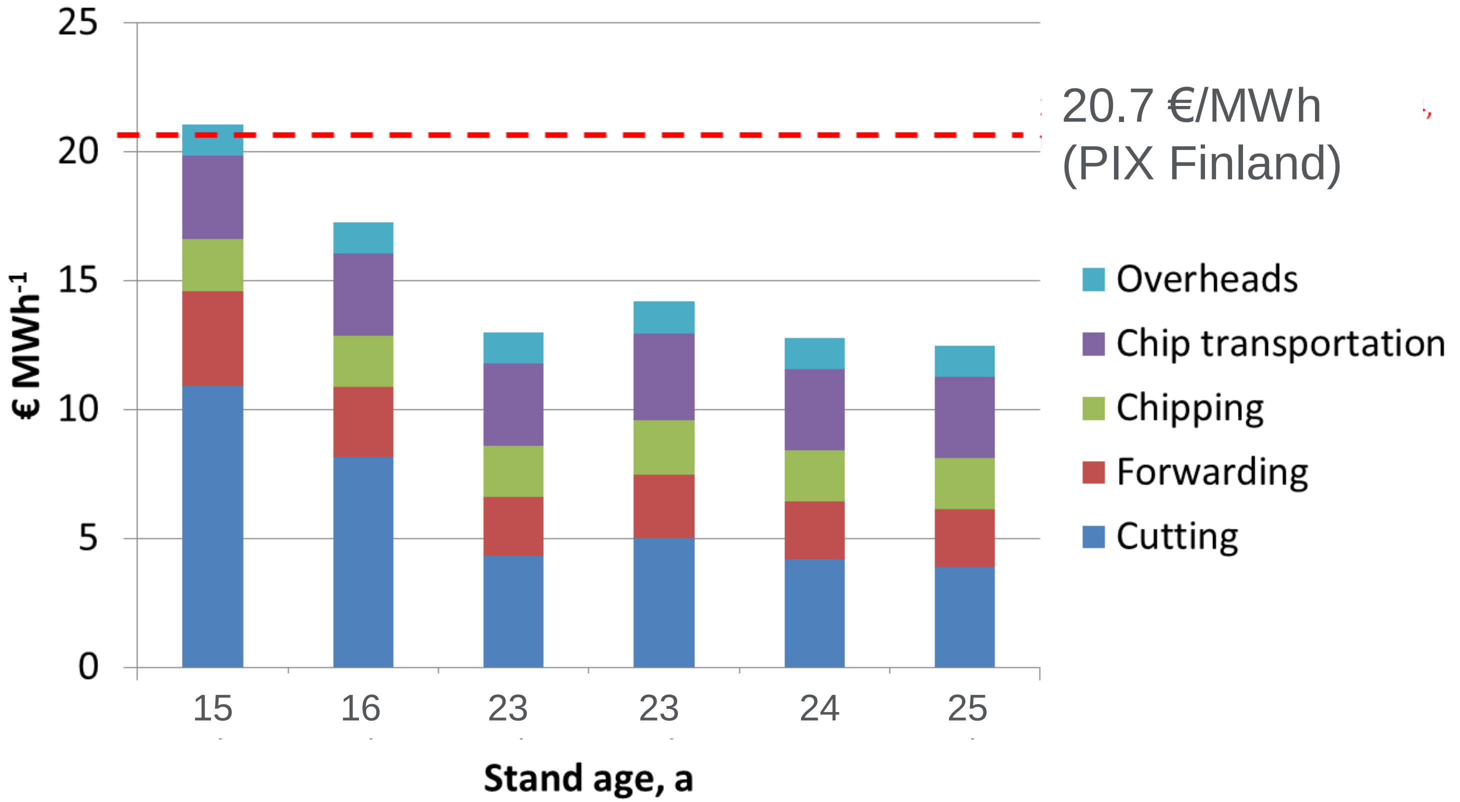
- Forwarding with a new middle-sized forwarder equipped with a grapple saw
  - Time consumption was based on the modified model of Kärhä et al. (2006) for thinnings
- Roadside chipping and chip transportation to the end-use facility located 60 km from the stands

- No subsidies

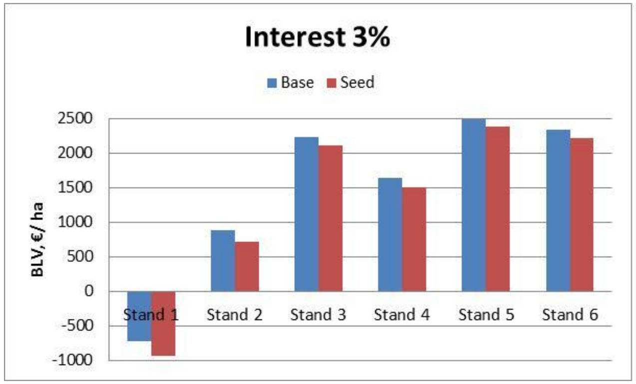
Costs and revenues

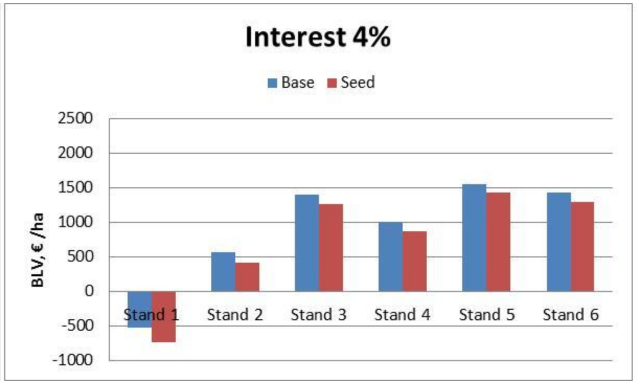
	€/ha					
	Stand 1	Stand 2	Stand 3	Stand 4	Stand 5	Stand 6
Costs						
Ash fertilisation	310	310	310	310	310	310
Mounding	310	310	310	310	310	310
Broadcast seeding	195	195	195	195	195	195
Cutting	2 277	2 006	1 411	1 498	1 546	1 453
Forwarding	760	665	753	740	826	845
Chipping	422	490	648	627	725	738
Chip transportation	678	787	1 040	1 007	1 164	1 185
Overheads	252	293	387	375	433	441
Revenues						
Sales of forest chips	4 377	5 164	6 867	6 294	7 734	7 864

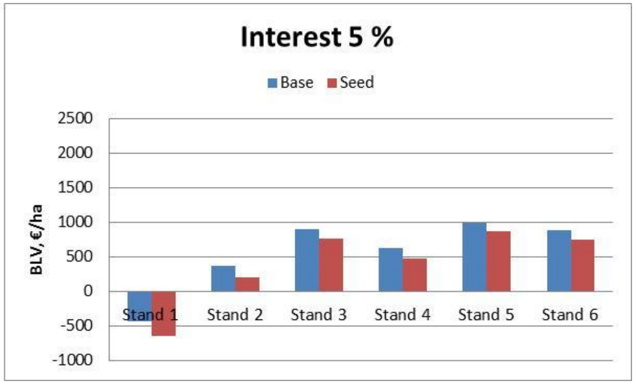
Unit costs of forest chip production



Profitability of bionmass production/ bare land value (BLV)







Bare land value (or soil expectation value) is the present value of all future costs and revenues of a productive asset. It is the value of bare land.

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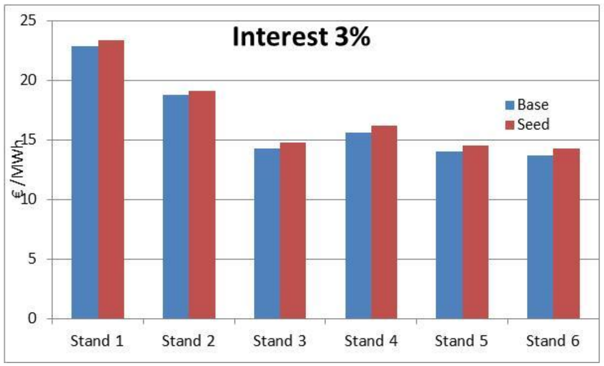
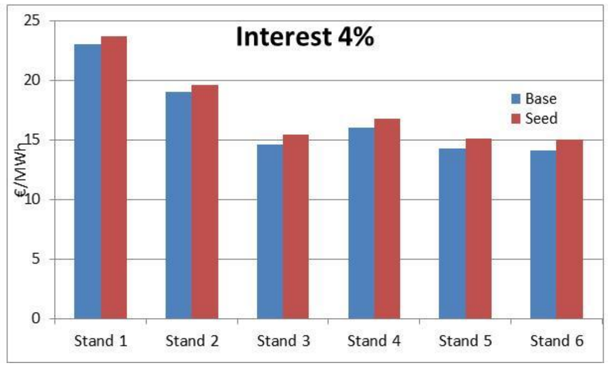
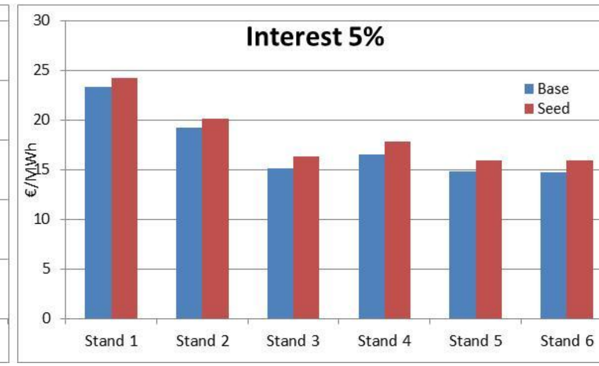
Unit price of energy wood, BLV = 0

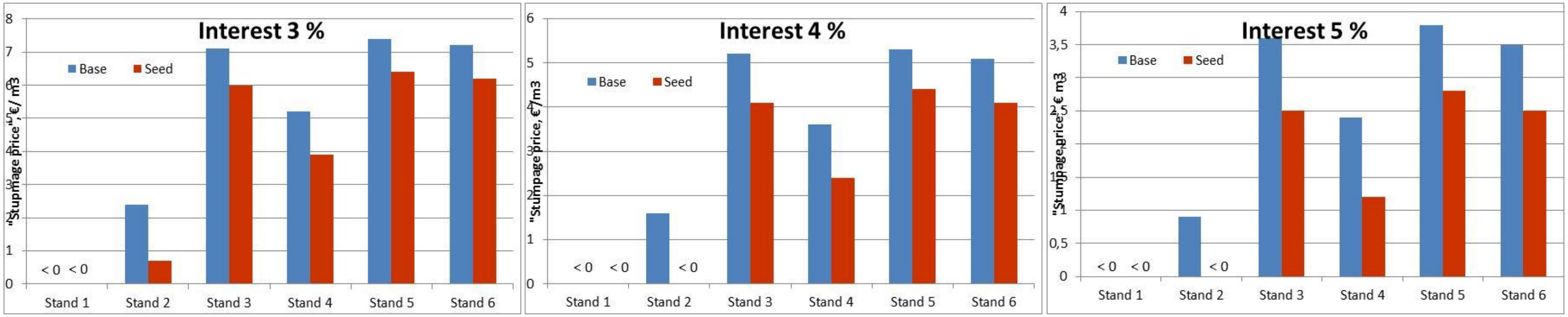






Production of energy biomass is profitable, if the prices in the graph above are lower than expected price of forest chips (in this study ca. 21 €/MWh). Production is unprofitable, is the price is higher than expected sales price.

Sensitivity analysis / 1 st rotation



The ”stumpage prices” above are discounted surplus (profit), the allcocation of with among stakeholders is not defined. This concept of stumpage price is not analogous to ”normal” stumpage price!

- In the first half of 2014 mean stumpage price of whole-tree energy wood was 1.7 €/MWh , and majority of wood was subsided by 7 €/m^3. In the present study residual value at stump was 7.5–17.1 €/MWh (without subsidies!). In stands older than 20 years residual values were at the same level with pulpwood (Metla)

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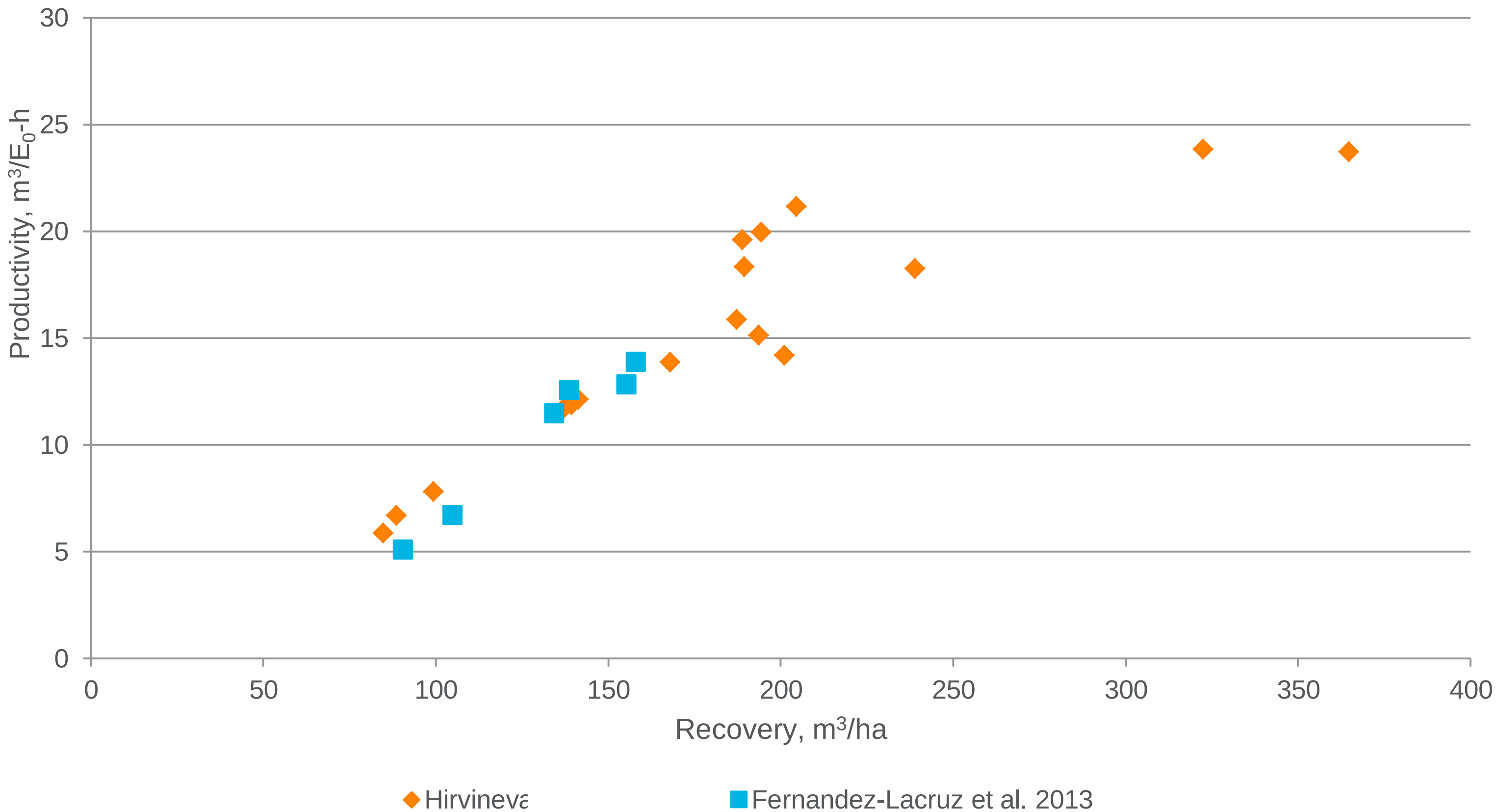
III Preliminary results of harvesting experiment

Productivity of cutting



Harvesting loss was excluded → actual productivities were higher!

Problems associated with operating on cutaway peat bogs

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IV Conclusions

- Intensive biomass production with downy birch on cutaway peat production is profitable when rotation exceeds ~ 20 years
- Shortening of rotation by one year did not balance the cost of broadcast seeding at stand establishment phase
- Limitations of the tested harvesting method
  - Seasoning of unbarked birch?
  - Harvesting on unfrozen soil?
  - The feller-buncher is not ideal for integrated harvesting of pulpwood and energy wood, as well as for harvesting delimbed energy wood
- Cutaway peatlands have high production potential
  - Profitability of energy biomass production should be compared to other production alternatives
- An option to produce industrial roundwood