Energy wood production and carbon sequestration on cut-away peatlands

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Content

• Background
• Peat and wood in energy production
• Properties of peat cut-away areas
• Cost efficient establishment
• Biomass production and carbon sequestration
• Coppicing
• Conclusions

Fotos: Jorma Issakainen, Jyrki Hytönen, Olli Reinikainen, Seppo Vihanta & Erkki Oksanen
Use of peat in Finland

- 6% of energy consumption
- 20% of energy used by district heating plants
- About 100 heating and power-plants use peat
- Used in electric production and heating
- Peat and wood are used for heating of homes of about 1 million people
Wood energy in Finland

Wood-based fuels in 2011
• 22% of energy (386 TWh) was produced by wood-based fuels

Wood-based energy production:
• Wood chips produced mostly from logging residues, stumps and small-diameter trees
• Interest in dedicated biomass plantations increasing

Target 2020: 13.5 Mm$^3$
Consumption in 2011: 6.8 Mm$^3$
Stages in peat production

Milling

Harrowing

Ridging

Loading

Stockpiling
Different land use options after peat production
How to establish cost efficiently biomass energy plantations?
How to manage nutrition?
What is the biomass production?
Carbon balance?
Fertilization – increase of production?
Can second rotation be established by coppicing?
Properties of cut-away peatlands for wood production

2500 ha released from peat production annually

Important properties

• Good drainage (hydrology)
• Peat thickness (limit for tree roots 30 cm)
• Low pH in residual peat
• High N content of bottom peat
• Small amounts of P and K in peat in bottom peat
• Properties of mineral subsoil important
Ash?

- Power plant ash contains P, K and micronutrients > potentially suitable for cut-away peatlands
- Low peat depth > ash for first rotation (15-20 years) > tree roots to bottom peat
Cost effective establishment methods
- Tree species?
- Fertilization?
- Peat thickness?
- Pests and deceases?

Cut-away peatland (2500 ha/year)

Ash fertilization/
Soil preparation

Woody biomass production chains
Cost efficient establishment

Preliminary experiment 2010 at Haapavesi, Piipsanneva

Treatments
1. Untreated control
2. Reed canary grass
   The area (3.1 ha) was limed and fertilized in spring 2010 and in spring 2011. Reed canary grass was sown on the 30th of June 2010
3. Short-rotation willows
   (clones Klara and Karin) (4.0 ha). Cuttings (8300 cuttings ha⁻¹) planted in late May 2010 on limed and fertilized peat. Sprouts were cut back to 10-30 cm stump in November 2010.
4. Natural regeneration of downy birch
   (7ha) on
   a. ash (6t ha⁻¹) fertilized peat,
   b. ditch mounted peat,
   c. ploughed peat and
   d. intact cut-away peat (control, treatment 1)
5. Broadcast sowing of downy birch
   on ash fertilized (6 t ha⁻¹) peat. Seeding in late May 2010
6. Broadcast sowing of aspen, grey alder, Scots pine and Norway spruce
   on ash fertilized (6 t ha⁻¹) peat.

Main experiments in 2011-2012 at three locations

Main treatments
1. Untreated control
2. Natural regeneration of downy birch on Ash fertilized peat
   Different soil preparation treatments
3. Broadcasting seeding of birch
   Ash fertilized peat
   Different soil preparation methods
4. Special tree species, sowing
   Aspen
   Silver birch
   Alder, others
5. Planting of fast growing species
   Hybrid aspen
   Larch
Untreated control

2010 May

2010 August – 1st year

2011 August – 2nd year

2012 August – 3rd year

2013 August – 4th year
Reed canary grass

2010 August

2010 September – 1st year

2011 July – 2nd year

2012 August – 3rd year

2013 August – 4th year

Biomass in
2011: 6.3 t/ha
2012: 4.0 t/ha
2013: 2.0 t/ha

Fertilization and management ended
Energy willows

2010 May

2010 August – cut back

2011 August – 1 year

2012 August – 2 year

2013 September 3 year

Leafless above-ground biomass, kg ha⁻¹

0
1000
2000
3000
4000
5000
2nd growing season
1st growing season

Clone

Klara

Karin

2011 August – 1 year

2010 August – cut back

2010 May
Ash fertilization and natural regeneration of birch

2010 July – 1st year

2011 August – 2nd year

2012 August – 3rd year

2013 August – 4th year
Ash fertilization and broadcast seeding of birch

2010 May: seeding

2010 July – 1st year

2011 August – 2nd year

2012 August – 3rd year

2013 August – 4th year
Ash + sowing better than natural regeneration

Number of seedlings in different treatments in 2010 and 2011

- Downy birch
- Scots pine
- Norway spruce
- Aspen

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<td>Ash + seeding</td>
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- Number of seedlings/ha
Cut-away peatland (2500 ha/year)

Ash fertilization → Seeding or natural regeneration of birch → Development of stands?
Biomass production?
Carbon?
Rotation length?
Biomass production of downy birch stands on cut-away peatlands – Hirvineva case

Hirvineva (at Liminka, south of Oulu) is one of the oldest peat production areas in Finland.

We located naturally regenerated different (10-28 a) aged downy birch stands (18 stands).

Biomass measured

Limitations:
• History of the stands not known
• Fertilization?

Biomass production lower than on our ash fertilized areas?
Mean annual leafless biomass production of different aged dense birch stands

Above-ground leafless biomass

Above-ground leafless biomass + stump + root biomass

Annual heterotrophic C efflux from peat and C bound in downy birch stands (no leaves)

Soil CO\textsuperscript{2}–C emissions due to decomposition of the peat from 15-43 years old stands in afforested cutaway peatland area (381 g C m\textsuperscript{-2} a\textsuperscript{-1}, Mäkiranta et al. 2007)

Hytönen & Aro 2012
Hytönen & Saarsalmi 2009, planted
Cut-away peatland (2500 ha/year)

Woody biomass production chains

- Clear cutting
  - Second rotation by coppicing?
  - Sprouting?
  - Risks?
  - Fertilization of coppice?

- Ash fertilization

- Seeding or natural regeneration of birch
Clear cutting dense birch stands: possibilities for coppice management?

We clearcut several stands aged 11 to 25 years

Example
- 15 years old stand
- 30 200 stems/ha clearcut,
  - dry-mass 56 t/ha

Pictures taken from same place

Mother stand

First summer 29.7.2011

Stumps 9.5.2011

Second summer 10.8.2012

Third summer 18.9.2013

Researcher
Sprouting of birch

Leafless above-ground biomass production of birch sprouts

Mean age of the mother stand before clear-cutting, a

kg/ha

2011 2012
Woody biomass production chains

Cut-away peatland (2500 ha/year)

Ash fertilization

Seeding or natural regeneration of birch

Clearcutting

Coppicing
Conclusions

GENERAL
Bioenergy production after peat harvesting could be continued on same site

ESTABLISHMENT
• Downy birch thickets can be established using several methods (natural regeneration, brodcast seeding, planting)
• Ash fertilization
• Other tree species need more experimentation

GROWTH AND ROTATION
• Only preliminary results available
• Natural stands in northern Finland > 3 t/ha/a
• Fertilization at establishment will increase production?

COPPICING
• Second rotation establishment cheap
• Coppice vigour > shorter 2nd rotation
• Preliminary results promising > more experimentation needed
• Risk of animal damage (moose, hare)?

CO₂ SEQUESTRATION
• Wood energy production could offset soil CO₂ emissions due to increase in sequestration of atmospheric CO₂-C into the growing biomass.

Economy?
Thank you