News and Views

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from Nordic Forest Research SNS

"High-yield forests give us more bioenergy, more wood for building purposes and more raw material to biofuels – but are decision-makers aware of the potential?" asks Palle Madsen. Photo: Mats Hannerz, Wikipedia commons (central heating plant) and News Øresund (airplane)

"We can double the biomass production at stand scale"

The joint Nordic-Baltic research project ENERWOODS is finishing after four years of research and outreach. The project has clearly demonstrated the important role of forests in the ongoing transition to a society based on renewable energy and material resources.

The Nordic and Baltic countries are already in the European frontline of replacing fossil energy with renewables. Renewable sources currently provide 46% of the total energy consumed in the region, far more than the average EU target of 20% by 2020. Bioenergy and waste materials have played key roles in this transition, accounting for between 65 and 97% of the renewable energy in Denmark, Finland, Sweden, Estonia and Latvia and it's clear that forest products totally dominate the bioenergy fraction.

However, there is still large unused potential in the forest. ENERWOODS has shown that more assortments can be extracted from the forest, more biomass can be produced per hectare, and more wood products can replace fossil fuels.

Are politicians aware of the potential?

Professor Palle Madsen has been coordinating the project. He stresses that the results confirm that wood-based biomass will continue to be the main component of renewable energy systems. But he is impatient.

– We have huge potential to increase biomass production in a sustainable manner. The key questions are whether the community is aware of these facts, and prepared to exploit the opportunities to reduce or eliminate our dependence on fossil fuels?

He believes that many politicians and large proportions of the public are unaware of the forest's current and potential roles. High-profile energy sources such as solar energy and wind power receive much attention, but still account for very minor proportions of renewable energy in the region.

Potential to increase growth

Biomass production in the Nordic forests will increase, regardless of our silvicultural efforts, as a result of climate warming. Future scenarios forecast a climate-induced increase of about 30% in the coming century. The stocking per hectare will grow dramatically, particularly given that only two thirds of the growth in the region is harvested today.

There are several ways to actively increase biomass production even more. The ENERWOODS project has studied the potential utility of fast-growing conifer species as well as poplar and hybrid aspen stands. Replacing or mixing native species

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with non-native could increase production by 25–50% in many cases. Other methods involve fertilization (providing >30% potential increases), forest tree breeding (8–50% increases) and new silvicultural practices. An example of the latter is to grow nurse crops of fast-growing species, such as poplar or larch, and let the main species gradually take over as the nurse crop matures.

Altogether, biomass production could be increased by 50–100% at stand level, and in some cases even more.

About ENERWOODS

ENERWOODS is a joint Nordic and Baltic research project with the aim to strengthen Nordic forestry's position in developing renewable energy systems.

Running from 2011 to 2015 (with researchers from Sweden, Norway, Finland, Denmark, Estonia, Lithuania and Latvia) it is one of ten projects financed by Nordic Energy Research, which contributed 14 million NOK.

The research has focussed on improving biomass production, technology and logistics to extract energy-containing biomass, and studying forests' and forest products' role in mitigating carbon emissions.

Read more on the project webpage *www.enerwoods.ku.dk*

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– This depends, of course, on the tree species and genetic material already there. If the starting point is a regular spruce, pine or beech stand, it is certainly possible to double the growth. The potential is much less if the stand already consists of e.g. genetically improved Sitka spruce or lodgepole pine, adds Palle Madsen.

Climate change needs risk prevention

Climate change poses major challenges for the forest sector, but forestry can also contribute to solutions. ENERWOODS highlights the importance of spreading the risks by using diverse tree species and silvicultural regimes.

– Our Nordic forests currently rely on two major tree species, Norway spruce and Scots pine. We don't know if this would be sustainable in a warmer climate, but indications from insect damage in North America are horrifying. Therefore, we need to spread the risks by introducing new tree species, increasing areas of mixed forests and planting more deciduous trees, says Palle Madsen.

He adds:– We should of course not replace our commonly used species everywhere; we just need to mix in other species. For example, mixing Norway spruce with Douglas fir and grand fir will increase productivity and stand stability. Broadleaves can be established as a grid to prevent windfall and support biodiversity.

Technology and logistics must be developed

Most current sources of bioenergy from forests are by-products of the pulp and sawmill industries. Today, sawdust, rejected wood and black liquor are fully utilised for energy purposes. The potential to increase forest energy comes instead from primary wood products, such as logging residues, small trees, stumps and roots. However, these energy sources are spread over large areas and costly to extract. In addition, increased use of wood products, for example the use of wood-frame

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Demonstration plots

As a part of ENERWOODS, demonstration sites displaying various silvicultural methods and tree species have been established in Denmark, Sweden, Finland and Latvia. Their purpose is to add visual impact during excursions and meetings.

The sites consist of a number of production plots with mixes of planted and seeded conifer species, such as grand fir, Douglas fir and Norway spruce, and hardwoods, such as beech and lime tree.

The picture shows a plot with alder in Latvia. Photo: Lars Rytter

instead of concrete-frame buildings, results in more biomass residues from wood processing, construction sites and building demolition.

Intense efforts have been made to develop efficient procurement and transport chains for wood energy assortments. Case studies in Finland, Norway and Estonia included in the ENERWOODS project have identified various potential ways to improve efficiency, including optimised transport and storage, and better control of the moisture content in collected material. Using larger transport vehicles could also reduce costs and climate impacts – the larger the better.

Active forestry is better for the climate

Some authors believe that forest conservation is the optimal means to reduce climate impact, but ENERWOODS' analyses show that active forestry, particularly if growth increases, can more strongly reduce greenhouse gas emissions.

For example, one study from Sweden shows that the forest growth and use of forest products compensate for all anthropogenic carbon emissions in the country. With increased growth, some 40 million more tons of CO_2 can be saved.

Shortcuts from ENERWOODS

Potential to extract more energy

A survey shows that Sweden, Norway, Denmark, Finland, Estonia and Latvia have a total forest area of 61 million hectares with an annual increment of 275 million cubic metres of stemwood. The potential for primary forest bioenergy (logging residues, stumps and small wood) amounts to between 230 and 410 TWh after accounting for technical and ecological restrictions. Only a small proportion of these fractions are used today.

There is also potential to increase the forest area by 1.6–2 million hectares through afforestation of abandoned farmland. Denmark has particularly high potential in this respect, with a large gap between the current 14% of forested land to the political target of 20–25%.

The study also summarises the growth potential of more intensive forestry. Fertilisation, new species, tree improvement and new silvicultural concepts can lead to substantial growth improvements.

Read more: Land areas and biomass production for current and future use in the Nordic and Baltic countries. A report from Nordic Energy Research.

Replacing coal has immediate climate benefits

One study shows the climate change effects when using logging residues or stumps to replace fossil energy for electricity or heat production, or in the transport sector. The results show that the climate benefits depend largely on the type of fossil fuel to be substituted, and on the effectiveness of the bioenergy conversion technologies. Using biomass to substitute fossil coal provides greater climate change mitigation benefits than substituting oil or fossil gas. Some bioenergy substitutions result in increased carbon emissions during an initial period. This occurs for relatively inefficient bioenergy conversion pathways to substitute less carbon intensive fossil fuels, e.g. biomotor fuel used to replace diesel. More helpful bioenergy substitutions, such as efficiently replacing coal, result in immediate climate benefits.

Read more in: Gustavsson et al. Climate effects of bioenergy from forest residues in comparison to fossil energy. Applied Energy 138, 36-50.

Photo: Mats Hannerz

Shortcuts from ENERWOODS cont.

More options with second generation hybrid aspen

After harvest, a hybrid aspen stand will regenerate immediately through root suckers. The new stand is usually dense and grows quickly. A study of four clear-cut stands in southern Sweden found on average 63 000 suckers per hectare and impressive growth – 36 tons dry matter per hectare after only 4 years.

A thinning study in one of the stands showed that repeated early thinning will lead to thicker and more fast-growing individual stems, leaving an option to choose between timber production and bioenergy assortments.

Read more in Mc Carthy and Rytter, Productivity and thinning effects in hybrid aspen root sucker stands. Forest Ecology and Management 354, 215-223.

Photo: Lars Rytter

Intensive forestry saves more carbon

Should we preserve the forest and store carbon "on root", or manage the forest and use wood to replace fossil-based products? One study compared carbon balances of traditionally managed, intensively managed and unmanaged forests, taking into account all carbon impacts of forest management and life-spans of the products.

In the managed scenario, large-diameter stemwood was used in wood-frame multi-story buildings with a life-span of 50 years, after which the wood were used for bioenergy. Biomass residues from forest harvest and wood processing were also used for bioenergy.

In the unmanaged scenario concrete-frame buildings and fossil coal was used instead of the forest-based products.

The results demonstrate that the managed alternative contribute to climate benefits. The carbon storage in an unmanaged forest reaches a dynamic equilibrium where decay and growth become about equal, and since no wood is harvested, fossil fuel and concrete must be used instead of forest products.

Among the managed scenarios, intensive forestry provides the highest climate benefits through higher biomass production, and hence more material and energy substitution. The additional emissions from intensive management, including the manufacturing and application of fertilizer, have very minor effects on the climate benefits. The climate benefits of fertilization are largely proportional to the increased rate of biomass production resulting from shortened rotation lengths and increased harvest volumes.

Read more in Haus et al. Climate mitigation comparison of woody biomass systems with the inclusion of land-use in the reference fossil system. Biomass and Bioenergy 65, 136-144.

An unmanaged forest like this is not as good for the climate as a managed forest, according to an ENERWOODS study. Photo: Mats Hannerz

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