Small scale Lifecycle-based cultivation of energy grass in cold climate - an alternative source of income for farmers?

Glommers Miljöenergi AB and Swedish local authority Arvidsjaurs kommun have together with the Norwegian research institute, Norut Narvik, performed an Interreg EU-project where the main objective has been to study the potential of Reed Canary Grass as a new, alternative source of income for farms in the North Calotte region. A central concept in the project has been that ash from combustion, together with waste sludge, shall be re-used as fertiliser, as outlined in a presentation at the "Utilization of wood and agricultural waste"- International Conference on Bioenergy that took place in St.Petersburg, Russia on 14th of March 2007.

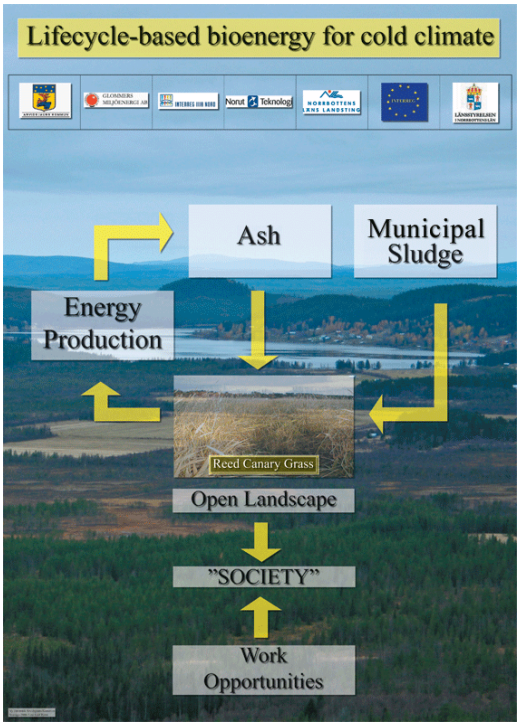
Harvesting RCG, Norrbotten Sweden

The North Calotte region is currently experiencing that many farms are being abandoned and allowed to grow over with forest. In the long term this has the potential to negatively affect the region's economy and cultivated landscape. At the same time it is desirable for society to increase the use of sustainable energy sources, and reduce the release of greenhouse gases like CO_2. While they are growing, plants take in CO_2 and convert it to hydrocarbon, which is converted to CO_2 again under combustion. By using biomass, such as energy grass, the net release of CO_2 can be close to zero. Fossil fuels (like coal, oil and gas) took up CO_2 millions of years ago, therefore these give an unbalanced release of CO_2 when burnt. The North Calotte region can benefit from the development of a source of income for farmers that contributes to environmentally friendly energy production and also preserves the rural landscape. In the municipality Arvidsjaurs kommun alone, there are almost 2000 ha of phased out farm land that today is of little or no economic value. If half of that area was re-established with energy grass, energy at a total value of 20-25 GWh per year could be produced (1000 ha*5-6 ton TS*4.3 MWh).

High yield in the North

Reed Canary Grass (RCG) is a fast growing, perennial grass that gives a high annual yield for 10-15 years after sowing. It requires only standard agricultural equipment, and occurs naturally in the Arctic area which makes it well adapted to the cold climate. The grass grows around 2 metres tall, and can be cultivated on most types of soil, but it grows very well on moist peat soils – the type of soil that traditional farming in the North Calotte region has abandoned! Reed Canary Grass has, besides its positive visual effect on the rural countryside, characteristics that suit the cold climate. The grass gives the same yield in the northern as in the southern regions of Europe; annual yields from RCG are approximately 5-6 tonne dry matter/ha/year, which is more than which is obtained from trees in the North Calotte region. Another advantage with RCG is that it is harvested in spring, and dries naturally over winter down to 10-12% moisture. The delayed harvest also means that during winter, nutrients return from the drying grass to the soil which makes the fertilizing needs moderate after the first three seasons. Finally, energy grass has lower lignin content than wood, which can be advantageous for some conversion processes like ethanol fermentation.

Recycling of ash and sludge



One aim of the project has been to investigate the possibilities of making granules from ash and waste sludge to use as fertiliser. This type of fertiliser could be part of a local economic and environmental system for farming and energy production, in accordance with Agenda 21, the UN blueprint for sustainability in the 21st century. Today, much of municipal ash and sludge in Northern Sweden is used either as in-fill or goes to waste landfill. Ash and sludge contains N (expensive to produce artificially), P(finite) K(finite) and could be used as a resource since fertiliser is a substantial part of the overall cost in farming. Benefits of making a granule from ash and sludge rather than using it directly are that sludge contains around 80% water, which then makes transport expensive. Additionally, by making granules, we get a product that can be quality checked and labelled, more hygienic and easy to use, with a slower and/or more controlled release rate. Project results show that it is feasible to make granules from ash and sludge that can be distributed. However, in this preliminary trial it appeared that some of the nutrients were not accessible for the plant. Unfortunately, the limited duration of the study did not make it possible to determine the reasons for this. Still, development of a lifecycle-based fertilizer is a very important factor in making RCG cultivation environmentally friendly and cost-effective, challenges being to apply the benefits of recycling but avoiding the buildup of undesired elements in the soil. Using artificial NPK is indefensible in the long run. The production of artificial fertiliser is a strain on the natural lifecycle as it is a very energy intensive process (1% of the world's energy consumption is used to make fertiliser) thus the energy cost of using chemical fertiliser strains the energy balance of the RCG concept. To maximise harvest is not necessarily the most important factor, *what is vital is the long term economy*, to get a balance between cost and income, in accordance with nature.

Ash-sludge granules

Fertilizer trials

Field trials with different combinations of fertiliser and RCG cultivars have been carried out in this project; fertilisers included fish sludge, hen manure, ash/waste sludge and artificial NPK, and cultivars of RCG included Lara, Palaton, Chiefton, Rival, and Bamse. The test plots are located in Sweden (inland, peat soil) and Norway (coastal peat soil). Not surprisingly, the trial plots fertilized with artificial NPK had the highest yield after the first 4 months growing period, probably because of its considerably higher content of N. However, the plot treated with ash/sludge gave no increase in yield compared with the reference plot with no fertiliser at all. Reasons for this are likely to be that the ash/sludge test plots were over-packed by the heavy cart with wide tyres used for spreading the sludge making much of the soil deficient in oxygen contributing to delayed growth. Furthermore, compared to the fast-

RCG Field trials

working artificial NPK, ash and sludge give a gradual effect during a longer period of time. Additional factors which might have an effect on the long term results are that peat soil contains more N than for example mineral soil. Hence, differences in fertiliser applications may not be apparent within the limited period of the study. The peat soil N content suggests that there might be an advantage for these types of soil. Nonetheless, more research needs to be carried out to find the right combination for a lifecycle-based, long term, cost-effective fertiliser.

Economy

The project has focussed on investigating what factors are important for the profitability of Reed Canary Grass as a bio-energy product. Project results show that handling and transport are central for cost effectiveness. RCG has low energy density (0.6-0.7MWh/m3 for bales), and each handling procedure undermines the profitability. Processing in close proximity to the fields is preferable. Liquid fuel has high energy density, and Reed Canary Grass is interesting as a raw material particularly because of its low lignin content, the natural low moisture content and the ease of reduction to small particle size. Many Biomass to Liquid processes require low moisture content and small particle size, so RCG gives an advantage for these. Processes evaluated within the project for the production of liquid fuels include catalytic depolymerisation Alfakat KDV synthetic diesel, variants on the Fischer-Tropsch process, and small scale fast pyrolysis. At this early stage of the growth cycle insufficient RCG biomass has been available for performing tests with these processes, but small scale pyrolysis of RCG has been reported from research at Aston University in England. In the North Calotte region, small farms and long distances are common. Solutions like small scale pelleting/briquetting plants, or mobile plants for making liquid fuel, could drastically reduce transport costs.

Glommers Miljöenergi AB is situated in Arvidsjaurs kommun in the inland of Northern Sweden. The company has performed field trials on RCG on peat soil, and investigated the production of pellets and their combustion properties since 1998. **Norut Narvik** is situated in Northern Norway and is a research institute which carries out applied research within the fields of Materials Technology and Structural Engineering.
The company specializes in Cold Climate Technology

Challenges

What makes Reed Canary Grass different from wood fuel is primarily the inorganic content which also determines fuel behaviour like the melting temperature of the ash and total ash. The inorganic content varies according to the soil type, fertiliser application and proximity to the sea. Alkali metals like K have a catalytic impact on pyrolysis of biomass, leading to a lower liquid yield. A high level of K is also the main factor for low ash melting point which can cause combustion problems. Elements like Cl and S also have negative impacts on combustion and the environment. However, the inorganic content can be reduced by the delayed harvest technique due to leaching of K, Cl and S over the winter, and the effectiveness of this leaching is an important factor for RCG as a bio-energy product. An advantage for RCG cultivated on peat soil, is that it can reduce ash forming elements down to 2% total ash because of its lower Si content, compared to up to 10% total ash for cultivation of RCG on heavy clay soil. It is also possible to modify the combustion conditions to avoid problems with the ash, and boilers for industrial- and household-use that can cope with RCG combustion exist in the market.

Nevertheless, there are today in Sweden and Norway few incentives from the government for cultivating RCG, and a changeover from phased out farm land to energy grass cultivation is slow. In reality, many farmers in Sweden today have a more secure income from just receiving subsidies for keeping the landscape open, i.e. cutting back growth every other year, rather than starting to grow Reed Canary Grass. If there is going to be a demand for RCG briquettes or pellets for heating, there has to be a stable and predictable production of the raw material, since using RCG products require customers to invest in a different boiler than one for wood products. The development of new technique that could cut transport or production costs would increase motivation for

farmers to grow energy grass, thus increasing the possibilities for an established RCG production.

Growth, yield, fertilizing requirement and ash and moisture content changes with local conditions and can also vary between seasons. It is important to confirm results locally to be able to make reliable economic calculations for RCG cultivation and utilisation. The North Calotte region has potential of becoming large producers of bio-energy, considering the amount of phased out farm land and the current development in agriculture. Using Reed Canary Grass for production of a renewable and environmentally friendly energy resource could create employment opportunities and become an important alternative source of income for farmers in the North Calotte region.

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For more information about cultivation of RCG, go to: www.bioenerginord.com