WP3. Markets, industry and policy for bioenergy

Project leader	Contact details
PhD. Sone Ekman Swedish Institute for Food and Agricultural Economics (SLI) Box 730 220 07 Lund	**Doctoral exam:** 2002 **Pers. No:** 701002 **Tel:** 046-2220791 **E-mail:** Sone.Ekman@sli.lu.se

Deputy project leader

Karin Ericsson, Research Associate, Environmental and Energy Systems Studies, LU

Core participants

Sone Ekman (Senior Researcher, SLI,)
Karin Ericsson (Research Associate, Ph.D., IMES, LU)
Helena Johansson (Senior Researcher, SLI)
Patrik Söderholm (Professor, Economics Unit, Luleå University of Technology)
Pål Börjesson (Associate professor, IMES, LU)
Evgenia Pavlovskaia (PhD candidate, Faculty of Law)

Summary

WP3 focuses on fossil fuel substitution using biomass from the agricultural and forestry sectors. The qualitative and quantitative analyses, including literature reviews and model simulations, will result in a future oriented evaluation of the implications of alternative policy instruments. Impacts on agricultural and forestry markets and environmental sustainability under WP0 storylines will be evaluated. Taken into account are spill-over effects on food prices and impacts on other environmental quality goals. Moreover, implications for the competitiveness of the Swedish forestry and agricultural sectors, and of sectors using cellulosic and agricultural inputs, will be evaluated. The potential to commercialise Swedish know-how and innovations will be explored. The objectives are to present cost-effective and sustainable ways to reduce GHG emissions through fossil fuel displacement, recommend policies to implement them, highlight techniques and feedstocks of importance to Sweden, and identify possibilities and goal conflicts facing stakeholders and policymakers in the transition process. A central part of the work is to synthesize existing knowledge with a focus on policy implications. Qualitative analysis and sector modelling will provide new knowledge. Major research contributions are the analyses of conflict of goals/interests and of new commercial opportunities in a Swedish perspective, as well as studies of policy options and pathways.

Sammanfattning

WP3 fokuserar på användning av biomassa från jord- och skogsbruk för att ersätta fossil energi. De kvantitativa och kvalitativa analyserna, inklusive litteraturöversikter och modellsimuleringar, kommer att resultera i en framåtsyftande utvärdering av alternativa policyinstrument. Effekter på marknaderna för jordbruks- och skogsråvaror samt miljömässig hållbarhet i olika scenarier kommer att utvärderas. Påverkan på livsmedelspriserna samt andra miljömål än tvågradersmålet kommer härvid att beaktas. Därtill kommer implikationer för konkurrenskraften i de svenska skogs- och jordbrukssektorerna samt andra sektorer som använder jordbruksprodukter och cellulosabaserade inputs att analyseras. Vidare kommer potentialen att kommersialisera svensk kunskap och teknologi inom bioenergiområdet att studeras. Målen med WP3 är att presentera kostnadseffektiva och hållbara vägar för att reducera utsläppen av växthusgaser genom ersättning av fossil energi, att rekommendera åtgärder för att nå dit, lyfta fram tekniker och råvaror relevanta i ett svenskt perspektiv samt att identifiera mål- och intressekonflikter. En central del i projektet är att sammanställa och dra slutsatser utifrån befintlig kunskap, med fokus på policyimplikationer. Kvalitativ analys och sektormodellering bidrar med ny kunskap. Viktiga forskningsbidrag i projektet är analyserna av mål- och intressekonflikter och analyserna av nya kommersiella möjligheter, samt studier av åtgärdsalternativ och möjliga utvecklingsvägar.

Project idea and objectives

Competition for food, fuel and fibre becomes a critical issue with the CO_2 emission reductions and carbon prices foreseen under a 2°C target. Due to the increased oil price in the last few years, it has become evident that a shift to low-carbon energy and transport systems will have far-reaching consequences for the use of biomass from the forest and agricultural sectors. Increased bioenergy demand will give rise to important conflicts of interest concerning the allocation of feedstocks from forestry and agriculture across different sectors, but it also will provide commercial opportunities for new actors and industries. Further, there are important goal conflicts between promoting bioenergy as a means to reach the 2°C target and other environmental goals. From a policy perspective it is important that these conflicts are addressed and that the roles of new actors are recognized and anticipated (Di Lucia and Nilsson, 2007). This project is focused on how the challenges can be addressed in the empirical context of Swedish use of forest- and agricultural-based biomass.

Specifically, the objectives of this work package are:

(1) to examine the potential economic and environmental impacts of fossil fuel substitution using biomass based alternatives under high carbon prices,
(2) to identify and resolve goal conflicts arising from the greater pressure on biomass resources,
(3) to evaluate alternative policy measures to stimulate fossil fuel replacement and to analyse the impact of these measures on related markets, land use and competitiveness,
(4) to map key technologies and assess the extent to which Sweden can influence the necessary technology shifts, and
(5) to analyse the potential for commercialising Swedish bioenergy know-how.

The agricultural and forestry sectors have a potential to help mitigating climate change risks by providing biomass based alternatives to fossil fuels. However, the recent growth in the worldwide use of agricultural commodities for biofuels has made it increasingly clear that sustainable bio-energy use requires careful consideration of many conflicting matters. As large volumes of food crops have been shifted into bioethanol and biodiesel production, land-use competition between food, fuel and fibre production has contributed to drive food prices to unprecedented heights. Increasing oil prices has created a new interdependency between agricultural and energy markets. This raises ethical questions regarding the conflicting needs of food security, energy security and environmental goals. Higher food prices harm many poor people in developing countries.

The forest sector is also facing new challenges due to increased bioenergy production. Increased demand and resulting higher prices for bioenergy may weaken the international competitiveness of the Swedish pulp, paper and wood industries. It becomes useful to identify how industrial competitiveness and environmental sustainability can be balanced (e.g., as discussed in the biorefinery case).

Furthermore, changes in national and global land use following increased demand for agricultural and forest products may have far-reaching consequences for biodiversity and the environment at large, including indirect effects on GHG emissions. Hence, there are many indirect effects of increased bioenergy production and use, which should be taken into account when prioritising sources and technologies.

The bioenergy sector is particularly important for Sweden due to the large production potential, in particular with cellulosic materials as feedstock. Sweden also has a comparably high share of renewable energy in the present energy consumption mix. Sweden's long experience from bioenergy production creates opportunities for commercialising Swedish

know-how and technology, but it still remains unclear how – and to what extent – climate and energy policies can be successfully combined with policies targeting innovation systems and commercialization processes for plant breeding, 2:nd generation biofuels, etc.

The current and future importance of bioenergy and the inherent complexity of the issue motivate our focus on a comprehensive, future oriented study from a Swedish perspective addressing the costs and benefits of bioenergy use, the barriers and opportunities that lie ahead, and the implications for policy formulation.

Practical relevance, outcomes and results

The project will address the needs of policy makers, national authorities and industry by:

- providing knowledge needed to select appropriate sources and technologies for bioenergy production and use,
- modelling and analyzing the consequences of increased reliance on biofuels, including an assessment of market interactions and potential conflicts of interest between different sectors and users,
- giving advice on efficient policy measures which contribute to sustainable bioenergy production and use, taking restrictions/opportunities given by international agreements and EU common policies into account, and
- identifying measures to promote technology innovation and commercialisation of Swedish know-how in the bioenergy field.

List of deliverables		
D3.1	Sept 2009	Workshop on environmental, resource and market impacts of increased bioenergy use
D3.2	Dec 2009	Publication: Overview of developments in Swedish and international bioenergy markets
D3.3	June 2010	Publication: Food and bioenergy – goal conflicts and impacts of high carbon prices and increased bioenergy production on food markets
D3.4	Nov 2010	Publication: Climate policy and the development of the pulp and paper industry in Sweden
D3.5	Oct 2011	Publication: Governing fuel production – sustainability criteria for biofuels
D3.6	Dec 2011	Publication: Model results for the forest sector
D3.7	June 2012	Publication: Commercialisation of Swedish know-how in the bioenergy sector
D3.8	Dec 2012	Publication: Appropriate policies for bioenergy production and use
D3.9	Oct 2012	Final LETS workshop for key stakeholders and the scientific community

How the project relates to the programme objectives and other projects

The analyses in this work package assess the potential to reach the 2°C temperature target by fossil fuel displacement using biomass from the agricultural and forestry sectors. Impacts on economic, environmental and social sustainability will be accounted for. WP3 serves as a complement to WP2 and 4, which analyse other ways to reduce GHG emissions. Storylines from WP0 have strong implications for WP3 due to the importance of international markets for food, forestry products and carbon permits. Close interaction with WP1 on governance, policy and implementation issues is envisioned through joint research and publications.

Review of the research field

Several studies have assessed the potential of bioenergy production internationally (e.g., IEA 2006 and FAO 2007). The potential of bioenergy from agriculture in Sweden has been estimated in SOU 2007:36, and production costs in EU by Ericsson et al (2008). In general these studies focus on existing crops and technologies. Another shortcoming is their limited analysis of goal conflicts and conflicts of interest arising from increased bioenergy production. However, other studies investigate various goal conflicts, for example Ignaciuk et al. (2006). FAO has ongoing projects analysing the conflicts between bioenergy and food security. In this respect it can be noted that projections by OECD/FAO (2007) conclude that rapid growth of the biofuels industry is likely to keep food prices high. Problems related to land use competition and impacts on land use in foreign countries have for example been studied by Johansson and Azar (2007) and Lee et al. (2007).

The increased use of forest-based biomass for energy production purposes and the potential conflicts between other sectors in the economy (e.g., pulp and paper) has been raised by large number of studies internationally (Sedjo 1997; Lundmark 2006; Cowie and Gardner 2007). Nevertheless, these studies typically focus on the direct economic (often incremental and short-term) consequences of extended bio fuel use and therefore often neglect the dynamic consequences and the role of new industries and products (e.g., forest raw materials replacing fossil fuels in the production of chemicals). In addition, there is also a need for additional research highlighting policy processes and policy instrument selection in the presence of land use and procurement competition.

Much of the current literature suffers from being myopic in the sense that issues are looked at one at the time and isolation. What does it cost to produce energy crops? How does current biofuels policy impact food prices? What is the most cost-effective use of limited biomass resources? In reality, an ambitious climate policy target is likely to have profound and dynamic effects on relative prices, international trade, land-use, etc., for agricultural and forestry products.

Description of work: Implementation, Research Approach and Methodology

The work is divided into four interlinked themes covering different dimensions; markets, sustainability, commercial opportunities and policy recommendations. The proposed research is unique in taking a highly integrative and future oriented approach to studying the role of bioenergy in all four dimensions.

An introductory research task is to give a critical overview of cost-effective strategies to reduce greenhouse gas (GHG) emissions by replacing fossil fuel with bioenergy from agriculture and forestry. As a first step, the future potential role for bioenergy production will be evaluated based on a review of existing knowledge, covering the following aspects:

- developments in Swedish and world bioenergy markets,
- potential future sources, technologies and uses of bioenergy, and
- their net GHG contribution in the lifecycle from production to use.

The 2°C target implies high carbon prices and resulting effects on markets through the willingness to pay for bioenergy. The development of markets and prices under different storylines is an important determinant of the sustainability challenges, commercialization opportunities, and policy implications involved in governing the transition to increased use of bioenergy. A subsequent step is therefore to study existing and potential future market related conflicts of interests and goal conflicts, including:

- price linkages between fossil fuel, bioenergy, fibre and food products, using a combination of partial equilibrium modeling tools and back-of-the-envelope analyses to explore implications of high carbon prices.
- impacts on food markets in developed and developing countries,
- impacts on the development and competitiveness of the Swedish pulp and paper industry,
- increased competition for land, in Sweden and elsewhere,
- the problem that domestic (bioenergy-based) GHG emission reductions may be offset by market price induced changes of land use in other countries or sectors (e.g. rainforests are turned into agricultural land), and
- impacts of agricultural and trade policies on bioenergy markets.

Environmental goal conflicts (and synergies), and ways of addressing them, will be assessed based on the analyses above and synthesizing other knowledge. The Swedish EQO:s are clearly in focus but global impacts will also be investigated, leading, for example, to advice on the development of sustainability criteria.

The opportunities for commercializing Swedish know-how and innovations against this broader market background will explored. Included is a study of technology innovation and the processes of diffusion with a strong element of policy analysis. Opportunities are partly identified and informed by analyses in the theme above. An important component of this research is to address the role of policy in combining environmental and industrial development goals.

The proposed research is highly policy relevant in terms of analysing supply and/or demand oriented policy instruments for bioenergy, as well as flanking measures to contain the risks of unacceptable side effects such as lower biodiversity, carbon leakage, etc. Swedish policy options will be addressed in a broader international market and policy context.

Research approach and Methodology

Synthesizing existing knowledge is a central part of the project. A vast literature on the prospects for and the problems with increased bioenergy production and use has emerged over the last years. Therefore, current research and knowledge will be synthesized using literature reviews. These literature reviews will cover e.g. markets, technologies, goal conflicts and sustainability. Policy implications and relevance for public policy are important to highlight.

Qualitative analysis, informed by the literature reviews, is also an important part of the work. Theoretical foundations include microeconomic theory, international trade theory, welfare economics, conservation biology and environmental economics. Methods for environmental systems assessment will be employed to analyse sustainability. In addition, the qualitative analysis includes interviews with stakeholders. Areas where the qualitative analysis will provide new knowledge include the various potential goal conflicts or conflicts of interest, commercialisation of know-how/technology and the appropriateness of different policy measures.

The quantitative analysis involves the use of partial equilibrium models of the forest and agricultural sectors. The agricultural sector model CAPRI (Britz 2005, Ekman and Tezic 2007) will be used to quantitatively evaluate the market impact of increased energy crop cultivation in the EU and elsewhere. Different policy options, like biofuel targets, will be evaluated. Correspondingly, the world bioenergy market will be analysed for the forest sector, by modelling interactions between forestry industry sectors (e.g. Lundmark, 2007), to gain an understanding of how goal conflicts can develop. This also provides the basis for simulating impacts of climate policy instruments as well as R&D and technology support policies.

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