Integration of lignocellulosic plants in agriculture landscapes

1. Overview and rationale
Lignocellulosic plants can be cultivated on soils of varying qualities providing high biomass output per unit area. Plants include perennial grasses, such as switchgrass and miscanthus, and tree species such as willow and poplar grown in relatively short rotations both in coppicing systems and replanted after each harvest. They represent a promising option for producing biomass for energy and is referred to as one of the most efficient options for reducing greenhouses emissions through fossil fuel displacement. Studies that assess bioenergy potentials on the longer term consistently report that the production of biomass in dedicated plantations is a prerequisite for reaching higher end biomass supply potentials.

During the last decade, several predictions in Europe (in individual countries and also on European level) have indicated the possibility of a dramatic increase in agricultural areas dedicated to lignocellulosic plants in response to European energy and climate targets. In addition, it has been shown that cultivation at a substantial scale can also contribute positively to the social, economic and environmental objectives in the EU (e.g. EU Rural Development, CAP reform, Water Framework Directive). Similarly, lignocellulosic plants have repeatedly been identified as an attractive option for bioenergy supply in N America, also there with reference to a range of additional environmental services.

Yet, to date many of the lignocellulosic plant options commonly pointed to as important and promising future biomass supply sources are either very little used today, or they are used for other purposes such as animal feeding and pulpwood production. Thus, there is a need to get a better understanding of the barriers to large scale mobilization of these lignocellulosic plant options as bioenergy feedstocks and, based on this, to develop implementation strategies that facilitate sensible establishment and growth of lignocellulosic production systems on agriculture land that are considered attractive from both environmental and socioeconomic points of view.

This case study concerns both lignocellulosic plant options that are commercially operating on other markets (e.g., pulp and paper production) and presently little used lignocellulosic plant options - which however have much in common with already established options concerning biomass properties as well as technologies used in the production and supply chains. The
scope for the main analysis in this case study will be limited to the feedstock production and supply to conversion plant, but knowledge from the other case studies will be used to address the issue of matching feedstock quality with requirements associated with specific conversion systems.

A specific focus in this case study will be placed on the integration of lignocellulosic plants in the agriculture landscape to provide ecosystem services, e.g. enhancing biodiversity, reducing water and wind erosion, improving soil productivity and enhancing soil carbon storage, reducing eutrophication load on aquatic ecosystems and reducing negative environmental effects associated with the cultivation of conventional food and feed crops. Determining the economic value of these ecosystem services and developing ways to credit farmers providing these services are valuable to support implementation as one option for meeting current environmental objectives such as healthy ecosystems, productive soils, and clean water. This could set the ground for supporting farmers producing biomass for energy and simultaneously providing ecosystem services.

2. Structure for the work

Work Package 1: Overview of lignocellulosic plant options for agriculture

- plant type and growing conditions
  - geography
  - soil quality and water requirement (incl stress tolerance and resilience)
- associated production system: technology "readiness" and cost
  - novel bioenergy plant or used since long for other purposes?
  - custom or standard (already available) machinery?
  - production cost and cost reduction potential
  - "typical" biomass producers (individual farmers vs forest/other companies incl owners of the conversion plant, small scale vs large scale producers)
- environmental performance
  - GHG
  - other (general characteristics of lignocellulosic crop systems: not associated with any specific integration approach)
Work Package 2: Overview of specific options for integration into agriculture landscapes to obtain environmental benefits

- spatial and temporal aspects
  - landscape function: possible "plantation shapes" and localization
  - rotation length: from very short in double cropping schemes to multi-year rotations
- Environmental dimension (relates to plantation design and localization)
  - water
  - soil
  - biodiversity
- Economic evaluation of environmental service

Work Package 3: Incentives structures: policies, legislation, business models and tools supporting implementation

- Assessment of relevant policies and legislation that might create incentives for implementation of specific lignocellulosic crop systems (e.g., soil C sequestration credits, land use restrictions to protect groundwater, eutrophication reduction programs targeting specific watersheds, biodiversity programs in agriculture landscapes)
- Assessment of barriers against implementation of lignocellulosic crop systems
- GIS-based analysis frameworks for assessment, design and localization of lignocellulosic plantations in agriculture landscapes addressing specific environmental challenges
  - Germany (Busch BALSA model supporting regional planning and stakeholder dialogue to establish implementation plans for lignocellulosic plantations)
  - Sweden (Dimitriou, Berndes, Börjesson et al on integration of willow systems in agriculture landscapes to provide environmental services)
  - USA (Klein, Dale et al BLOSM model and Gopalakrishnan et al. Argonne Lab models to support landscape level land use planning including lignocellulosic plantations)
  - Additional cases under discussion

The case study will involve colleagues from a diverse disciplinary background, primarily from Europe and North America. Many participants are expected to contribute in-kind based
on data and knowledge gained in earlier and/or presently running activities. A collaboration structure will be developed that facilitates effective data collection and gathering of information to support the work. A workshop is planned in 2014 that will serve the purpose of gathering participants for presentation and discussion of preliminary results. The plan is also to publish a special issue in addition to the reports produced within the project. A project proposal has been developed within the Intelligent Energy Europe programme, which will add significant demonstration and outreach capacity if approved.

3. Team

Team leader:
Göran Berndes, Department of Energy and Environment, Chalmers University of Technology, Sweden

Team members (tentative):
Pål Börjesson, Environmental and Energy Systems Studies, Lund University, Sweden
Jannis Dimitriou and Martin Weih, Department of Crop Production Ecology, Swedish University of Agricultural Sciences
Gerald Busch, Buro for Applied Landscape ecology and Scenario Analysis, Germany
Uffe Jörgensen, Department of Agroecology - Climate and Water, Aarhus University Denmark
Andrea Monti, Department of Agroenvironmental Science and Technologies, University of Bologna, Italy
Hans Langeveld, Bioenergy Research, The Netherlands
Jan van Esch, Ministry of Agriculture, Nature and Food, The Netherlands
Marilyn Buford, National Program Leader, Silviculture Research, USDA FS R&D, USA
Virginia Dale and Keith Kline, Oak Ridge National Laboratory, USA
Gayathri Gopalakrishnan, Cristina Negri and Seth Synder, Energy Systems Division, Argonne National Laboratory, USA
Tim Volk and Lawrence Abrahamson, Department of Forest and Natural Resources Management, State University of New York, USA
Andy Gordon and Naresh Thevathasan, School of Environmental Sciences, University of Guelph, Canada
Julije Domac, North-west Croatia Regional Energy Agency, Croatia
Ger Devlin and Kevin McDonnell, Biosystems Engineering, Bioresources Research Centre, University College Dublin, Ireland
5. **Budget requirements from the Intertask Project**

The budget allocation to different tasks and contributors is presently under discussion, based on a tentative contribution from the inter-task project at 40500 USD. The money will be used to cover costs for salaries, travel to workshop, various costs associated with case study workshop, and publication.

Costs will partly be covered based on other funds available in the participating organizations.
6. Milestones

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<th>Activities</th>
<th>2013</th>
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<th>2015</th>
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<tr>
<td></td>
<td>June</td>
<td>Q3</td>
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<tr>
<td>Final scoping of case study including definition of publications and other outreach. Agreement on individual responsibilities</td>
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<td>Work Package 1 (including publications)</td>
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<td>Work Package 2 (including publications)</td>
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<td>Draft report in WP1 circulated for internal review, revision and subsequent publication</td>
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<td>Draft reports in WP2 and WP3 available</td>
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<td>Workshop to discuss draft WP2 and WP3 reports</td>
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<td>Reports available for synthesis work in inter-task project</td>
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<td>Presentation at IEA Bioenergy Conference 2015</td>
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<td>Publications submitted to Special Issue in suitable scientific journal</td>
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