Forest-Based Sector
Technology Platform

Draft Call Topic Proposals for 2013 years Work Programme from the Forest-based sector ETP

Towards the NMP thematic priority (10 August 2011)

P&P8: New flexible biomass structure opening (deconstruction) technologies

Justification:
Biomass structure opening is the key step needed in fibre or chemical production from biomass. Biomass is a very complex matrix structure containing mainly lignin, hemicellulose and cellulose. Current structure opening technologies, i.e. pulping processes are high volume processes with heavy capital costs. Future biorefineries need, however, flexible and modular processes which can be integrated with existing pulp mill representing an enormous infrastructure and also be easily changed to be suitable for different biomass streams. Future bioeconomy will also require efficient use of lower quality raw materials for fibre and chemical production. The economical feasibility of the processes depends very strongly on the efficiency of the first unit operation, i.e. structure opening technology.

Scope:
The project should focus on development of a toolbox of matrix opening technologies for different raw materials (agro and wood). The processes should combine the best (capital, energy, water, flexibility, reliability are important factors) available mechanical, biotechnical and chemical unit operations to achieve efficient matrix opening. Analytical technologies to follow up the process efficiency should be developed and their suitability to process control should be assessed. Combination of suitable solid-liquid or solid-solid fractionation processes should also be combined to the matrix opening technologies. Logistic issues (partial on-site processing) should be carefully assessed. The project should combine experts from manufacturing technologies, engineering, wood chemistry, analytical chemistry and pulping, agro sector and industries in the energy, chemical and material areas.

Recommended size (instrument) and duration:

Large or medium scale collaborative project 4 years

Expected impact:

Development of business opportinities for bioeconomy. Improved competitiveness of European manufacturing, agro and forest industry. generation of new value-chains from biomass.

Proposed Programme: NMP/ KBBE

P&P5+: Self-assembly and biomimetics of lignocellulosic systems

Justification:

Much has been learned by studying the naturally occurring nanostructures found in forest biomass. Further research on how they self-assemble and developing methods that use this self-assembly will be critical to manufacturing new products from this renewable resource. Using the natural systems of woody plants as either the source of inspiration or template for developing or manipulating unique nano-, micro-, and macro-scale polymer composites via bio-mimicry and/ or direct assembly of molecules, has become of most promising field of investigations towards innovative products. Recent research showed that self-assembly of glycopolymers in nanoparticles or nano-structured films leads to inter-domain distances of 10nm far beyond the current limits of 25nm achieved with oil-based building blocs.

Most of the current functionalities were developed aiming papermaking and compatibility with hydrophobic matrices for composites. However, the demand for new materials based on renewable resources to replace oil based ones opens new opportunities for utilisation of fibres, requiring new functionalities which can be added in current process conditions, e.g. during fibre separation, bleaching or refining.

Scope:

The objective is to exploit the possibilities of natural forest resources in order to the elaborate new innovative materials for a range of added value products from wood-based building blocs, such as glycopolymers and nanocrystals. These materials will, after self-assembly at nano-scale and functionalization, present high added value properties, e.g. for flexible organic electronics, smart papers and surfaces, nanocomposites, glycosensors, etc. Research has to focus on the development of new materials through mastering the self-assembly of the elementary bricks at the nanoscale level, their properties at meso-scale and further their processing at macro-scale towards the elaboration of final products with controlled properties.

The project should target green processes and demonstrate the industrial feasibility of the new materials and/or new products with special attention on cost effectiveness with respect to the application market, from large volume sectors such as composites and surface treatments to niche markets and high added value sectors, like bio-active or stimuli responsive products for pharmaceuticals and health and safety applications.

Research can also with address how to create stimuli-responsive fibre-based materials for applications in different value chains. Stimuli responsive materials shall have specific and smart interaction with light, heat, chemical probes or other physical or chemical stimuli and have the capability to change chemical and physical properties, e.g. enhancement of fibre-to-fibre bonds via photo excitation or switch from hydrophilic to superhydrophobic character via ion exchange. Biomimetics can be used as inspiration to design stimuli-responsive properties for new fibre-based materials. Research shall result in efficient technologies for fibre functionalisation using existing fibre operations installed in Europe and new fibre-based materials with smart properties for application in packaging, electronics, medicine, biocomposites and other high-added value areas.

Moreover proposals should include LCA and risk assessment and address recyclability aspects as far as large volume applications are concerned.

Recommended size (instrument) and duration:

Small scale collaborative projects - 3 years

Expected impact:

The project should exploit nano-scale self-assembly of lignocellulosics and develop green processes until the demonstration of new materials and/or products to provide the industry with new solution to create more value for forest resources through new high added-value products meeting societal needs.

P&P10: Low energy pulp and paper manufacture and processing

Justification:

As one of the most energy-intensive branches the pulp and paper industry has a particular obligation – far beyond their intrinsic economic interests - to contribute to the industry's efforts to reduce their impact on the climate change by reducing their CO_2 footprint through more energy efficient processes. The chemical pulping process is in the most recent installations operating with an energy excess coming from biomass. This surplus is exported to society as electricity, heat and solid fuel. This excess can be significantly increased with further development.

The state of the art of their processes is the result of a long-lasting and very successful evolutionary development aiming at better performances and improved economics rather than energy efficiency. In particular stock preparation techniques, quite some of which were adopted from other industries long ago, have been systematically adapted to the specific needs of the paper industry and further developed over many decades. Such mature technologies, though, usually do only bear very limited potentials for further improvements and virtually no potential at all for real break-through innovations. In view of the urgency of the climate change menace incremental improvements, however, would not be sufficient to meet the objectives and expectations from society and governments in Europe with respect to climate change mitigation.

Scope:

Significant improvements or even breakthrough developments for more energy efficient stock preparation techniques for paper manufacturing will in many cases require entirely new research approaches – and the ability to look outside the many traditional paper-makers' boxes. Corresponding activities should in all cases be based on thorough definitions of the specific objectives of traditional processes or parts of process chains and to which extent and at what specific energy input they are currently met. Simultaneously theory-based studies should give a clearer picture concerning the minimum energy consumption which - irrespective of any existing process and irrespective of any feasible process in the short or medium run – might lead to the desired results. The comparison of the results achieved by these different approaches should allow for setting up of a list of priority processes which deserve particular attention in terms of energy efficiency. This list should then be used as a basis for further investigation aiming at

- assessing the potential of techniques employed in other industries for similar objectives
- developing entirely new process solutions.

Recommended size (instrument) and duration:

Large scale collaborative project - 3 to 4 years

Expected impact:

The results would address urgent needs of the whole industry. A successful project work would require joint activities between research partners (universities as well as public and private research organisations) and industrial companies from both the paper industry and the supplying industry. It would in particular provide important contributions to improve the environmental compatibility of paper based, i. e. renewable raw material based products and to maintain and strengthen their competitiveness.

Proposed Programme: NMP

F11 Development of 3-D dynamic forest modelling using combined terrestrial and airborne Laser based technologies based on optical and SAR data for spatial forest resource modelling under changing environmental conditions.

Justification:

Airborne Laser Scanning (ALS), also known as LiDAR (Light Detection And Ranging) is a highly promising remote sensing technology for qualitative and quantitative description of forest resources at a very high spatial resolution. With respect to other RS techniques (optical and multispectral images from airborne or satellite platforms), Lidar data provide immediate and reliable information about the "3rd dimension" of the forest (tree height and the "thickness" of tree canopy), and on its vertical and horizontal distribution at both single tree and forest stand level. Due to fast development of laser scanning technology the opportunities for dynamic 3-D modelling of forest resources has enormously increased. A dynamic 3-D modelling of forest is of interest for many forest related eco-services, programs and conventions, like CO2 modelling, biomass modelling, habitat condition, modelling, biodiversity modelling, water resource modelling or wood production modelling. But for innovative LiDAR based modelling in the forest sector the optimization of algorithms and processing procedures, and their implementation into commonly shared software, especially GIS is required. This issue is critical for the advancement of innovation into monitoring of forest ecosystem structure and functioning. Europe has a leading position in the development of laser technology for environmental applications and needs to use this opportunity for more and better focused forest resource and benefit assessment. At the same time optical and SAR based options to determine 3D information evolved in parallel and justify a parallel that analysis of 3D information based solutions for forest information systems from local to national scales.

Scope:

The research should be oriented to study and carry out LiDAR applications for:

1. automatic and semi-automatic discrimination of forest areas from other land uses;

2. identification of species composition (through integration of Lidar and multispectral data);

3. description of the vertical and horizontal structure of the forests and automatic extraction of homogenous polygons (stands);

4. Lidar-based estimation models of timber volume and wood biomass;

Lidar-based (ground based and/or airborne) derivation of forest condition indicators

5. spatializing data of ground sampling forest inventories;

6. multitemporal analyses to estimate forest area changes and amount;

7. forest interventions planning and logistic (forest roads, exploitation lines, …);

9. identifying hydrogeological sensitive situations;

10. development of ready-to-use GIS procedures to process (ground based and airborne) Lidar data, with a particular sight to mobile-GIS and augmented-reality applications to make Lidar data and analysis available in the field.

In parallel, options arising from optical and SAR technologies shall be examined aiming at applications from local to national level as well as the examination of synergies of the various scales of 3D forest information systems. The study shall include an economic analysis of the efficiency of 3D information based forest information systems (cost efficienty and markets) and shall take into account user requirements at the various scales from operational users to policy and general public.

Recommended size (instrument) and duration:

Large scale collaborative project - 3 to 4 years

Expected impact:

3-D structures of forests and the terrain below can be assessed with an accuracy which is not possible with any other measurement technology today. For the variety of forest information needs from local to national level the integration of the development of solutions both from Lidar, optical and SAR is vital. This will have impact on the utilization, valuation and projection of forest resources in respect to environmental and economical issues, e.g. nature conservation, wood production, climate impact, hazard protection, woody bio-energy volume assessment. It will also provide innovative feed-back to the laser technology industry for adaptive developments. Information system solutions from local to national scale, addressing the need for sustainable use of forests, better information on potentials (material use & energy), Natura 2000 monitoring, REDD and other forest related policies. The project will developed with stakeholders, users, and SME's.