



**European Cooperation  
in the field of Scientific  
and Technical Research  
- COST -**

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**Brussels, 22 November 2013**

**COST 064/13**

## **MEMORANDUM OF UNDERSTANDING**

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Subject : Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action FP1306: Valorisation of lignocellulosic biomass side streams for sustainable production of chemicals, materials & fuels using low environmental impact technologies

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Delegations will find attached the Memorandum of Understanding for COST Action FP1306 as approved by the COST Committee of Senior Officials (CSO) at its 188th meeting on 14 November 2013.

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**MEMORANDUM OF UNDERSTANDING**  
**For the implementation of a European Concerted Research Action designated as**

**COST Action FP1306**  
**VALORISATION OF LIGNOCELLULOSIC BIOMASS SIDE STREAMS FOR**  
**SUSTAINABLE PRODUCTION OF CHEMICALS, MATERIALS & FUELS USING LOW**  
**ENVIRONMENTAL IMPACT TECHNOLOGIES**

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4114/13 “COST Action Management” and document COST 4112/13 “Rules for Participation in and Implementation of COST Activities”, or in any new document amending or replacing them, the contents of which the Parties are fully aware of.
2. The main objective of the Action is to develop low impact environmentally sound and cost-effective lignocellulose valorisation technologies to be exploited in the multidisciplinary production of industrially-relevant bio-derived chemicals, materials and fuels.
3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 64 million in 2013 prices.
4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.
5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of section 2. *Changes to a COST Action* in the document COST 4114/13.

**A. ABSTRACT AND KEYWORDS**

Scientists are prompted to seek alternative methodologies for the production of materials, fuels and chemicals using low environmental impact technologies and greener methodologies with comparable efficiencies to those currently available in view of the expected resource scarcity and future oil economy. Lignocellulosic residues can constitute a highly promising (and currently largely under-utilised) feedstock with a significant potential to be converted into useful end products. However, a joint multidisciplinary effort from several disciplines including (bio)chemistry, biology, (bio)chemical and biological engineering, forest products sciences as well as environmental sciences and experts in economic assessment in liaison with industry is required to appropriately address the efficient transformation of such residues.

The main objective of this COST Action will be to develop a solid European multidisciplinary network able to provide a range of innovative alternatives to the valorisation of lignocellulosic residues to chemicals, fuels and materials making use of environmentally sound protocols from pretreatment/fractionation to conversion to valuable end products.

Thus, this Action will bridge gaps between academic disciplines as well as between academia and industry by bringing together skills and expertise that cross scientific borders interconnecting different technology hubs across Europe, overcoming technological barriers, going beyond current lignocellulosic waste exploitation/management approaches.

**Keywords:** Valorisation of Lignocellulosic Biomass Residues, Biorefinery, Forest Products, Catalysis, Sustainability

**B. BACKGROUND****B.1 General background**

The urgency to identify and develop sustainable and timely solutions for our future society has become clearly demonstrated due to the alarming trends in global energy demand, the finite nature of fossil fuel reserves, the need to dramatically curb emissions of greenhouse gases (GHG), the damaging volatility of oil prices (in particular for the transport sector) and the geopolitical instability in supplier regions. Waste lignocellulosic (i.e. from forestry or agricultural activities) or processing by-products (i.e. sawdust, etc.) are particularly interesting to fuel the non-food applications such as chemicals production. The valorisation of lignocellulosic biomass constitutes a new frontier of economically sustainable and environmentally friendly processes.

The EU has recognised that and in order to sustain our demands in energy, chemicals and food, while addressing environmental issues, we need to substantially reduce our dependence on oil by establishing a bio-based economy. Future European standards on bio-based content will encourage greater use of bio-feedstocks. Other major drivers for this topic include: increasing compliance costs to meet regulations for existing substances (e.g. REACH), favouring investment into economically and environmentally sound alternative feedstocks, growing public awareness towards environmental issues and cradle-to-grave concerns leading to industry's increasing concern over their 'green credentials'. All these important aspects makes the launch of a COST Action dedicated to the valorisation of whole lignocellulosic biomass residues highly relevant.

The COST framework offers the best support for networking to defragment academia, interconnect technology hubs, enable collaboration between academia and industry and facilitate technology transfer, in both COST and non COST countries for the development of low impact environmental processes and feedstock agnostic technologies for lignocellulosic biomass waste valorisation.

Research groups and industries involved in this area have significant expertise but are working independently. The symbiotic organisation of a COST Action offers ideal support for networking and bringing experienced and young researchers together, with the aim to develop new concepts and technologies for the valorisation of lignocellulosic residues within a multidisciplinary and multinational collaborative network, providing critical mass to this highly topical research area of Biorefineries.

## **B.2 Current state of knowledge**

The primary objective of an advanced biorefinery is to increase the availability and use of bioenergy and bio-based products by implementing innovative, environmentally sound and cost effective production technologies for a variety of products. To maximize the benefit from the "whole biomass waste", i.e. to utilize all parts/components of biomass towards useful products, pretreatment and fractionation steps are a prerequisite in such biorefinery concept.

Lignocellulosics contain three main components, cellulose, hemicellulose and lignin. Typically, the cellulosic fraction is the desired one to be further upgraded to end-products. However, during all fractionation processes, different types of side-streams are formed, containing the non cellulosic lignocellulose components either intact, or more typically, in chemically altered forms. So far, these by-products have been generally under-utilized and many times considered as waste and/or a problem. This is one of the main issues our society is currently facing in terms of the general and most extended perception of consumers, end users, industry and scientists that overlook the

potential of by-products, residues and waste from agriculture.

In order to improve the techno-economic feasibility of lignocellulosic-base processes, it is crucial to find value-added applications for all the components, not only cellulose. Much research is already ongoing related to the alkaline process streams, as they are produced in the traditional cooking processes applied for the production of paper grade pulps. However, neutral to acidic processes are becoming increasingly interesting as pretreatments for the saccharification-fermentation route, as well as for the production of hemicellulose-lean pulps for the textile industry.

The challenge in the recovery of the dissolved components from acidic process side streams is the detrimental nature of the acidic conditions on their structures. Typically, hemicelluloses are hydrolysed to monomeric forms, and further to furanic components via complicated reaction routes. Novel valorisation techniques are therefore urgently needed that can utilize this type of modified sugar based raw materials. Lignin is not readily dissolved under non-alkaline conditions. However, due to chemical reactions, also some lignin with altered structure is found in the liquors. This type of lignin may possess interesting properties for material applications, but challenges remain both in respect to its separation from the other dissolved components, as well as understanding its chemistry, i.e. structure and potential routes for further chemical modification in order to induce the desired material properties. One target of this initiative is the utilization of hemicelluloses, derived from side-streams of biomass processing routes such as mild acid pretreatment, as a substrate for the conversion to high value-added furanic products. Furfural (F) is obtained from pentosan-rich biomass, such as hardwood, and agricultural residues of sugarcane, corn and wheat. Recently, furfural and its derivatives have been used to make jet and diesel fuel range alkanes, to serve as a gasoline blendstock, and to develop new generation of biofuels and bioplastics. The second target is the valorisationvalorisation of lignin, which is a bio-polymer consisting of phenolic monomers. Under the mild acid pretreatment conditions, a very small part of lignin can be dissolved and goes to the processed liquid together with hemicellulose sugars. In most cases, a lignin rich solid "residue" is produced, which could be used as "solid biofuel" in combustion processes to produce heat and electricity. Intensive research has focused in recent years on the conversion of lignin to high value chemicals and fuels/fuel precursors, via thermochemical and catalytic upgrading routes. However, the production of these fuels is at present not cost-competitive and therefore substantial improvements need to be achieved. In all cases, a green chemistry approach needs to be included which attempts to develop novel catalytic, solvent free and environmentally friendly processes. In this project, we aim to address the above mentioned challenges for the development of new furanic and phenolic components for novel fuel and polymer applications.

### **B.3 Reasons for the Action**

The COST Action aims to establish a multidisciplinary EU based cooperation network related to forest based Biorefineries for the development of lignocellulosic biomass valorisation using novel green technologies to obtain bio-derived chemicals, materials and fuels that could be integrated into new industrial supply chains. This Action will thus strengthen the European state-of-the-art knowledge and hence also the economic dimension in the Biorefinery area. The European forest-based, bioenergy-based and Pulp and paper industries as well as the SMEs enterprises will benefit from the Action through the development of sustainable and environmentally benign solutions for valorisation of lignocellulosic biomass using cost effective and sustainable processes. This approach has the potential to significantly enhance Europe's drive towards the formation of a bio-based economy via the creation of an alternative renewable carbon feedstock based on waste, and will offer a more profitable and environmentally valuable alternative to current residues. The ultimate outcome will thus include novel, environmentally sound, and efficient processes and products from renewable waste materials. The Action will be aimed primarily at scientific and technological advancement, but will also have direct relevance to European economic and societal needs. The environment will also benefit from these sound solutions.

### **B.4 Complementarity with other research programmes**

Several EU research projects and the 7th Framework Program have lately dealt with biorefineries and biofuel in order to upgrade and valorise biomass. Also few European projects are ongoing in the area of biomass valorisation, which however are not focused on the very critical issue of the upgrading of waste streams and by-products coming from various biomass utilization processes. The proposed Action is related but does not overlap with previous or currently running actions: COST Actions FP0602, FP0901, which focus mainly on some other aspects. The Action is however open to every kind of cooperation on this subject with other COST Actions and partners from inside and outside of Europe.

## **C. OBJECTIVES AND BENEFITS**

### **C.1 Aim**

The main objective of the Action is to develop low impact environmentally sound and cost-effective lignocellulose valorisation technologies to be exploited in the production of industrially-relevant

bio-derived chemicals, materials and fuels. An additional goal of the Action is to strengthen the scientific excellence in the area and to disseminate this information to European scientists, industry and other key stakeholders. The measurable deliverables will include Short Scientific Missions (exchanges) of young researchers, Workshops and Training Schools and joint publications in the focus areas. The scientific impact will have a long term effect on the transformation of the European industry towards bio-based products as a base for a European BioEconomy.

## **C.2 Objectives**

The main objective of the Action will be achieved by reaching the following secondary objectives:

- Formation of a multidisciplinary scientific European community with common interests in the valorisation of lignocellulose biomass side/waste streams.
- Development of new environmentally friendly methods for pulp and paper industry to improve the quality of products, to facilitate processing and to save energy at different stages of manufacturing.
- Design of novel biological and chemical methods for sustainable valorisation of waste biomass streams and incorporation in integrated industrial processes.
- Contribute to the concept of Biorefining with regard to maximizing biomass utilization potential.
- Consolidating new working groups within Europe to attract and apply for additional funding opportunities, disseminate in layman's terms to the society, training of young researchers and dissemination of results through joint research publications.
- The development of novel fractionation and hydrolysis processes of the parent lignocellulosic biomass in order to selectively obtain the targeted "by-product" or "waste" stream.
- The development of novel (bio)chemical methods with low environmental impact for the efficient and selective conversion of the waste stream components to high value fuels, chemicals and products.

- The development of novel stable and selective (bio)catalytic systems, able to overcome the complexity of the chemical-l composition and other physicochemical properties of the waste streams.
- The design of technically sound process schemes that can be further evaluated by the participating industry.

### **C.3 How networking within the Action will yield the objectives?**

The research and technological objectives of the Action will be accomplished via the ongoing projects of the participants funded by their national authorities, EU sources (FP7, Horizon, etc.) or private/industrial contracts. In order to facilitate the networking and the exchange of information and knowhow the activities of the Action will be divided in four Working Groups (WGs), the three first dealing with R&D activities, i.e. fractionation/pretreatment of biomass, valorisation of xylan "waste" streams, valorisation of lignin "waste" streams, and the fourth focusing of life cycle analysis (LCA) and techno-economic issues. The WGs will also work synergistically in order to ensure the objectives of the Action are attained due to the highly multidisciplinary nature of this research field. Short term scientific missions-exchanges (STSMs) for early stage researchers (ESRs) between collaborating institutions and the organisation of Training Schools will comprise important tools for sharing of expertise and will facilitate technology transfer while promoting training of young researchers. Furthermore the involvement of key industry stakeholders in fuel, chemicals, and other related sectors will ensure that the coordinated research is towards industrially relevant products and processes, thereby satisfying the overall objective of the Action.

### **C.4 Potential impact of the Action**

The potential application areas and benefits to the European forest-based and bioenergy-based industries as well as agro-industries are numerous, such as improvement of traditional manufacturing processes to save energy or chemicals, development of sustainable and low environmental impact solutions for the utilization of forest and agro-industrial resources, design of novel efficient catalytic systems for more efficient hydrolysis of lignocellulosic carbohydrates into sugars, and novel transformation processes of intermediates into fuels, energy and chemicals. Through this Action the potential of the European forestry-agro sector is not only to become the

major player in the field of European biofuel production, but also to develop and provide novel biorefinery technology on a global scale. Novel biorefinery concepts would expand the existing value chains resulting in new business opportunities in different fields. This will contribute to the preservation of pulp and paper industry in Europe and will increase the share of biofuels in the transportation sector being one of the most important goals of current EU policy. A successful development and implementation of biorefineries will provide the basis for expanding the impact of biomass utilisation on environment and energy supply, as well as on employment, well beyond the current targets set by the European Commission. The scientific outcome of this COST Action will contribute to the development of new environmentally friendly processes for industries upgrading lignocellulosic raw materials for fibres, composites, chemicals and energy carriers. The Action will also support SMEs that have limited research facilities to develop and adapt bioprocesses. Adapting of new technologies is important for the competitiveness of the sector with respect to *e.g.* the USA and Japan. The Action will especially benefit the forestry sector (Pulp and paper) by creating new knowledge and new synergistic approaches for biorefineries, helping to preserve this industry in Europe. Presently, pulp and paper companies evaluate traditional or nonconventional pulping methods to take advantage of the potential carbohydrate streams for ethanol production. The chemical industry has started to consider lignocellulose as a source for “platform chemicals”. The Action will also benefit the agricultural sector as value-added products can be generated from the lignocellulosic waste raw materials. During the life-span of the Action, know-how on new benign methodologies will be delivered to academia and industry through annual workshops, conferences and publications. The Action is expected to lead to various innovations; *i.e.* development of novel heterogeneous catalytic systems and their application in biorefineries.

### **C.5 Target groups/end users**

The Action aims to form strategic partnerships with industry, but also with key government and non-governmental organisations to create research projects that have a commercial application, recognising the vital importance of collaboration between academia and industry. A wide range of stakeholders have been consulted during the preparation of this proposal and have also agreed to be involved in the Action. This will be of particular benefit when considering potential applications of the resulting research outcomes and will provide direction for a more effective coordination of the research activities within the WGs of the Action. The results of the Action will also be of importance for stimulating policy-makers involvement (both at local, national and EU levels) in the development of low environmental impact technologies for lignocellulosic biomass valorisation

procedures.

## **D. SCIENTIFIC PROGRAMME**

### **D.1 Scientific focus**

The scientific focus of the Action is formulated to be open and flexible but will include some key topics essential for future advanced biorefineries. Innovative research will be carried out on several sectors in different research groups/institutes and stakeholders to be brought together by the Action. The programme of this COST Action comprises, however, three major topics resulting in different types of deliverables:

- Development of novel low impact environmental methodologies for the valorisation of hemicellulose/xylan and lignin as derived from lignocellulose pretreatment or fractionation. Focus will also be placed on pretreatment/fractionation methods, since they determine the nature and capabilities of the side streams that are produced.
- Production of valuable distillable fuels from lignin containing pulping waste liquors into transportation fuels. The substantial energy surplus of a modern pulp mill allows the chemical modification of the excess Sulfur-free alkali lignin to produce transportation fuels, high value-added chemicals and related products.
- Exploration of novel/advanced highly selective biomass conversion routes using new customized catalytic systems and energy-efficient downstream processes with diffusion of results.

The manpower and equipment needed to achieve the objectives of the Action already exist therefore the Action will be in compliance with the general rules of the COST scheme and will include following:

- Exchange of experts, scientists and young researchers for training, especially in the form of STSM (Short-Term Scientific Missions).
- Exchange of reports, joint publications and experimental procedures.

- Attendance at relevant international conferences in the field, organization of workshops, symposia and training schools on cutting edge techniques for lignocellulosic biomass residue valorisation.
- Report the results of the Action in a non-technical format for dissemination to the general public.

## **D.2 Scientific work plan methods and means**

The implementation of this Action will be based on the cooperation of 4 Working Groups (WG) that will be fully interconnected and supply information to each other, ensuring an integrated impact. All WGs will have the common objective of strengthening cooperation between academia and industry to drive forward research in the field by jointly defining the appropriate R&D routes and support product development and final market implementation.

### **WG1: Preatreatment/fractionation of lignocellulosic biomass**

Hydrothermolysis (e.g. steam explosion, mild acid under hydrothermal conditions, etc.) of local wood chips will be conducted to ensure high and selective solubilisation of hemicellulose. The resulting aqueous solution of oligo-, monosugars and acetic acid will be analysed and prepared for subsequent conversion reactions. In processes different than chemical pulping, where the aim is to selectively hydrolyse hemicellulose and cellulose to xylan/xylose and glucan/glucose respectively, the use of novel solid acid catalysts with tuned properties and enhanced hydrothermal stability will be also applied during the hydrothermal (pre)treatment for a controlled and stepwise implementation of the above two process steps. WG1 will also focus on recent advances made on the deconstruction of lignocellulosic biomass assisted by non-thermal activation such as ball-milling and non-thermal atmospheric plasma. In spite of sufficient developments to be conducted at a large scale, these methods are highly selective and require a limited amount of water as compared to traditional chemical pre-treatments, with heat provided by the dissipated energy in the systems.

### **WG2: Valorisation of hemicellulose derived streams (xylan/xylose)**

Dehydration of xylose derived from hemicellulose hydrolysis to furanic compounds in high yields (more than 75 % F): The pretreated hydrolysate is pumped into a continuous biphasic reactor together with an organic solvent to facilitate the in situ recovery of furanic derivatives and prevent their further degradation to humins. Suitable solvents such as THF, 2-butanol or alkylphenols could

potentially be synthesized directly from biomass. Wasteful and energy-inefficient mineral acid catalysts are replaced by solid acid catalysts such as mesoporous carbon catalysts, nanostructured mixed oxides based on transition metals and hybrid zeolites and related aluminosilicates. Hydrothermal stability of the catalysts, accessibility of active sites, as well as the role of Brönsted/Lewis acidity highly overlooked previously, will be important research topics to address.

### **WG3: Valorisation of lignin derived streams**

Depending on the origin of the lignin-rich waste stream, different catalytic and thermochemical downstream processing will be applied. The main target will be the selective formation of high value chemicals (i.e. phenols). The catalytic processes of interest that can apply in the valorisation of lignin towards chemicals are the catalytic hydrogenolysis, the fast pyrolysis to produce bio-oil rich in phenolics and the hydrodeoxygenation of lignin to hydrocarbon fuels. Novel catalysts and optimized process conditions will be applied in order to develop sustainable processes that could be integrated in a biorefinery.

### **WG4: Life cycle analysis & techno-economical perspective**

Life cycle analysis (LCA) and establishment of metrics that can predict any potential "measurable" benefit of the proposed valorisation of waste biomass streams are always necessary and should complement the research and technology activities. These activities will be based on systematic gathering and analysis of information on local, national and European level, and on the conduction of related studies by dedicated sub-working groups focusing on the most important processes/products in the whole biomass valorisation scheme. Furthermore, the objective of this WG is to identify a promising, competitive process concept for further development work, considering the whole chain from feedstock processing to fuels, chemicals and materials. This will be accomplished via techno-economical study of the main integrated processes that be developed within this Action.

## **E. ORGANISATION**

### **E.1 Coordination and organisation**

The organization and management scheme of the Action will comprise: a) The Management Committee (MC) consisting of regular and substitute members from each participating country, b) The Short-Term Scientific Mission (STSM) manager, c) The Dissemination manager, d) The Working Group (WG) coordinators, and d) The Steering Committee (SC) consisting of the Action Chair and Vice-Chair, the STSM and Dissemination manager and the Working Group (WG) coordinators. The MC will be responsible for all coordination and management issues, such as

approval of the addition of a new member (group) either in the MC and/or in the WGs, approval of expenses and yearly budget, reporting to COST authorities the progress of the Action, approval of the organization of training schools and workshops, monitoring of the progress of the approved workplan and milestones and suggestion of "correction measures" if necessary, etc. The STSM manager will be responsible for the adoption of selection rules which will be approved by the MC and will ensure a fair selection of the early stage researchers that will participate in the STSMs, and also will be responsible for handling and monitoring the whole procedure from the point of application to its completion with the submission of the final scientific report by the trainee. The Dissemination manager will be responsible for the organization of workshops (annually) open to all scientific and industrial community, as well as for the design of a dedicated website which will be constantly updated with information coming from the Action's activities. The creation of an interactive public website is also an important task for improving the dissemination of results and activities to broader scientific community as well as to general public. The WG coordinators will be responsible for organizing the networking activities within each WG and for promoting the effective collaboration between the WG members (their role is described below with more detail). The SC will have the role of deciding on "every day" issues that don't require the whole MC assembly, such as the approval of the selected STSM candidates, will be responsible for a closer monitoring of the scientific and administration activities will provide consultation support to the organisers of workshops and training schools, etc. The SC will also be responsible for the organization of the training schools and workshops, in collaboration with the local organisers, bringing these activities to the MC for discussion and approval. The MC meeting will take place once a year, together for example with the annual workshop. WG meeting can also take place once a year separately from the Workshop or MC meeting.

## **E.2 Working Groups**

As already described above the activities of the Action will be organised in four WGs (detailed in Section D.2). Each WG will be assigned a leader plus deputy (nominated to MC), who will report to the MC and their role will be to:

- Gather information regarding the expertise of each team participating in the WG and disseminate this information amongst the rest of the teams and to the other WGs

- Identify the topics of common interest that are also in line with the scope and objectives of the Action
- Coordinate the interaction between the WG members, ensure the smooth exchange of information amongst them, encourage the STSMs of early stage researchers (in collaboration with the STSM manager), as well as joint publications between the WG participants.
- Prepare reports on the WGs activities with information provided by all WG participants to be approved by the MC
- Participate in the SC activities.

### **E.3 Liaison and interaction with other research programmes**

As discussed also in B.4 the Action is complementary to COST Action FP0901 (Analytical techniques for Biorefineries) and to previous COST Action FP0602 (Biotechnology for Lignocellulose Biorefineries), both of them dealing with biomass valorisation but focusing on different topics, as is reflected by their title). Of course our proposed Action can benefit from the different expertise of these Actions and thus there will be a systematic interaction and communication in terms of exchanging information, results, methods and is possible organizing joint events. The present Action is also related to the COST Action CM0903 (Utilization of biomass for sustainable fuels and chemicals) which is ending this year (2013) and is also generally dealing with different types of biomass valorisation compared to the present Action which focuses on the valorisation of lignocellulosic biomass waste streams. Nevertheless, the knowledge and networking generated in UBIOCHEM can be also utilized in the present Action and serve as a starting point for many of the processes under development. In the same way, the Action will also establish collaboration with IEA Bioenergy Task42 Biorefining, an international biorefining knowledge building and exchange programme and joint activities.

### **E.4 Gender balance and involvement of early-stage researchers**

Both ESRs and female researchers will be strongly encouraged to participate in training schools and STSMs, to present their work in scientific conferences and workshops. The aim is to strongly

support and boost their scientific and professional career development via improving their existing knowledge and skills. In the long-term, Europe as well as national economies will also benefit from such highly trained and skilled young scientists. This, combined with the sharing of knowledge and expertise between organisations and institutions engaged throughout the Action will realise capacity building on a European level.

## F. TIMETABLE

The total duration of the Action will be four years, calculated from the date of the first meeting of the Management Committee (MC). The timetable of the Action is given in the table below.

Meetings and seminars in the Working Groups will be held according to the plan every year. The seminars will be common for the four WGs. The MC meetings and the seminars will be held at the same time. Additionally, at least two Training Schools concerning state-of-the-art techniques will be arranged in conjunction with European or national courses and summer schools.

Year 1	Year 2	Year 3	Year 4
START: 1st MC Meeting	1st Training school on selected topic	WG1/WG2/WG3/WG4	WG reports to Action Chair
WG1/WG2/WG3/WG4	STSMs promotion and organization	2nd Training school or related Seminar	STSMs organization
STSMs promotion and organization	2nd Workshop combined with the 3rd MC meeting	3rd Workshop combined with the 4th MC meeting	5th MC meeting and Final Symposium
Proposals for the organization of the 1st Training School in year 2	Publication of a Special Issue dedicated to the 2nd Annual Workshop	Special Issue dedicated to the 3rd Annual Workshop	Special Issue dedicated to the Final Symposium
1st Annual Workshop and the 2nd MC meeting	WG1/WG2/WG3/WG4	STSMs organization	Dissemination of the research activities
Report to COST for the first year	Mid-term Report to COST	Mid-term Report to COST	END: Final Action report to COST

## G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, CZ, DE, DK, EL, ES, FI, FR, IT, NL, PL, PT, RO, SI, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 64 Million € for the total duration of the Action. This

estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

## **H. DISSEMINATION PLAN**

### **H.1 Who?**

The most important results from this Action will be to provide improved alternative and low impact environmental technologies for various Biorefinery processes for the production of renewable products derived from lignocellulosic residues. To ensure maximum impact of the outcomes of the Action, the following main target audiences have been identified: Forest, Pulp and paper, Agro-industrial Industries as well as Chemical and Energy Companies. Academic community, persons working with environmental and energy issues, as well as the general public are also important target groups for the Action. The MC will also maintain an active contact to the COST Forests, their Products and Services (FPS) domain.

### **H.2 What?**

The Action will develop tailored dissemination activities, educational material and training packages incorporating the Action results for the target audiences to ensure maximum impact in the exploitation of results by the participants of the Action.

These will be delivered via a series of activities including: workshops, conferences, joint publications, training schools, active website.

The programme of dissemination activities will encourage cross-country, cross-company and cross-sector transfer of knowledge and will provide a regular flow of information from the Action.

Industry people will be invited to participate in the seminars and workshop of the Action.

The general scientific community will be informed by presentations given by Action members at relevant national and international conferences, symposia, workshops and by joint publications in international peer reviewed journals.

Establishment and maintenance of a dedicated Action website not only for those participating in the Action with a section dedicated to active members (password protected for posting the protected documents and reports) but also for those research institutes and universities who work in related areas and can get easily access to all the public general information.

Furthermore, efforts will be put to also publish selected results in non-technical, popular science, publications to reach outside the scientific community.

### H.3 How?

The dissemination methods of the Action (listed in H.2. section) are aimed to reach a wide audience raising awareness concerning the progress of European Scientific Community and Forest Industries with regards to the efficient valorisation of lignocellulosic biomass residues towards renewable chemicals, materials and fuels by utilising environmentally friendly technologies.

STSMs and training schools will support training and education, and the Action will organise an exchange programme (via a series of STSMs) and training schools particularly for young researchers (including PhD students). This will serve to promote greater interconnectivity between the individual WGs and enhance understanding of various technologies and new developments within the partnership.

The consortium as a whole provides young researchers with excellent networking opportunities and training on new tools and technologies. At each annual meeting, there will be a special session focussed on the needs of young researchers. Especially, they will benefit from strengthening their future networks as well as their scientific capabilities by the use of STSMs and Training schools offered within this COST Action.

In addition to standard WG meetings, workshops will be organised by the MC with parallel sessions tailored to the needs of individual stakeholders including training activities, knowledge transfer and partnering opportunities and towards the End of the Action an International Conference participation will be organised to widely disseminate the Action outcomes. Wherever possible these events will be run in collaboration with other relevant organisations/initiatives, for example, the Action could have a yearly interaction (joint seminar/workshop or training school) with the annual *International Conference on Renewable Resources and Biorefineries* (RRB), which focuses on bringing together academic researchers, industrial experts, policy makers and venture capital providers to discuss challenges emerging from the transition towards a biobased economy and present new developments in this area.

Publications in international peer reviewed journals and presentations given by Action members at relevant national and international conferences and events will disseminate information to the academic and industrial communities, and will acknowledge the support of COST and directly promote the Action to other potential members. Direct engagement of Action members with the media will be strongly encouraged.