European Industrial Bioenergy Initiative (EIBI)

Boosting the contribution of Bioenergy to the EU climate and energy ambitions

Implementation Plan 2010 - 2012[1]

25 January 2011

PREAMBLE

This document proposes an Implementation Plan for the EIBI, for the period 2010-2012. For this purpose, a number of actions are described (i.e. programme of demonstration[2] *and flagship*[3] *projects plus two complementary activities), which are considered necessary to achieve the Initiative's objectives. Further to this, some aspects of the implementation are also suggested for the different actions, which in the view of EBTP would constitute a viable approach (e.g. organisation of project selection procedures, timing of the activities).*

However, these implementation aspects still need to be streamlined and further defined, as some of the issues associated to them are currently under discussion within the wider context of the overall SET-Plan implementation (e.g. funding instruments, governance). Depending on the outcome of the ongoing work, some adaptation may be necessary. The EIBI Team is thus expected to keep working on the implementation modalities after the launch of EIBI, under the guidance of the SET-Plan Steering Group.

Given the above, the present Implementation Plan should be considered as a firm proposal from the industrial stakeholders on the actions to be carried out, and as a basis for further discussion with regard to the implementation modalities proposed.

1. BACKGROUND, SCOPE & OBJECTIVES OF THE EIBI

Bioenergy will play a key role in the EU long term energy strategy for all applications and especially the transport sector, contributing up to 14 % of the EU energy mix and up to 10 % of energy demand in

[1] The first Discussion Document from the European Biofuels Technology Platform (EBTP) on the Bioenergy Initiative was produced in March 2009 based on preliminary discussions between industrial stakeholders and EC services back in spring 2007. A number of exchanges took place in 2009 between industry, EC and Members States (MS) which led to the production by EBTP in January 2010 of the first draft of the EIBI Implementation Plan, which focuses on the priorities for the period 2010-2012. The Implementation Plan was further discussed between industry, EC and MS in 2010, notably during the two first meeting (20/09/2010 and 18/10/2010) of the specifically established EIBI Team, and then presented and endorsed by the SET-Plan Steering Group on 28 October 2010. The few comments received at this meeting have been incorporated in this version.

[2] Demonstration plants are considered the last non-economic step to demonstrate the performance and reliability of all critical steps in a value chain so that the first commercial unit can be designed and performance guaranteed from the outcome of the demo unit.

[3] Flagship plants are the first commercial units of value chains operating at an economically viable scale.

transport in 2020[4]. It is foreseeable that this EU demand will be dominated by renewable fuels substituting middle distillates for the need of the road, aviation and marine transport sectors.

The feedstocks and bioenergy production technologies which are currently deployed already provide a significant contribution, but will not be sufficient to reach these targets. **The purpose of the EIBI is to boost the contribution of sustainable[5] bioenergy[6] to EU 2020 climate and energy objectives, with a focused approach leveraging on public-private partnership to manage the risks and share the financing.**

Significant R&D and pilot activities have been going on for the past decade in EU Member States to enlarge the feedstock basis and to develop processing technologies able to deal with a wider feedstock basis, enhance feedstock conversion in valuable energy and co-products, minimize overall energy consumption and meet EU sustainability criteria. These new processing technologies cannot be developed at industrial scale on a stand-alone basis but as part of commercial "value chains", i.e. integrated process schemes, from feedstock to end products.

The scope of the EIBI is focused on innovative bioenergy value chains[7] which are not yet commercially available, and which could bring significant contribution to the bioenergy markets by large scale deployment (large single units or larger number of smaller units), whilst complying with the sustainability requirements of the RES Directive (2009/28/EC).

The **specific objectives of the EIBI** are

(1) **to enable commercial availability of advanced bioenergy at large scale by 2020,** aiming at production costs[8] allowing competitiveness with fossil fuels at the prevailing economic and regulatory market conditions, and advanced biofuels[9] covering up to 4 % of EU transportation energy needs by 2020.
(2) **to strengthen EU technology leadership** for renewable transport fuels, serving the fastest growing area of transport fuels in the world

Because of the scale of investment needed and the risks involved (technology, feedstock & end product prices, regulatory framework evolution), **financing the latest stages of development of innovative bioenergy technologies is a major obstacle for large scale industrial deployment of these technologies**. The main challenge of the EIBI is to tackle this issue by leveraging on public-private partnerships based on efficient governance and relevant funding sources and mechanisms.
The **core activities of the EIBI aim at building and operating demonstration projects and/or flagship plants** for innovative bioenergy value chains with large market potential[10].

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[4] Renewable Energy Roadmap — Renewable energies in the 21st century: building a more sustainable future, Communication from the Commission to the European Parliament and the European Council Com (2006) 848, 10 Jan 2007
[5] Throughout this document, the words "sustainability" and "sustainable" are covering three dimensions: social, environmental, economic.
[6] Bioenergy: heat and/or electricity and/or fuels produced at industrial scale from bio-resources (dedicated crops, agricultural and forestry residues, municipal and industrial wastes)
[7] Value chain: specific combination of feedstock, processing technologies and marketable end-products.
[8] Production cost of biofuels depends heavily on investment intensity, on the degree of utilization of primary energy and on feedstock price, with significant differences across geographic areas and specific feedstock types.
[9] Sustainable biofuels with a broader raw material base and/or better end product properties than the biofuels currently on the market.
[10] See pages 6 and 7 for the difference between funding mechanisms for demonstration and flagship plants.

Seven such innovative bioenergy value chains have been identified (see chapter 2.1), which could bring significant contributions to EU ambitious objectives, in addition to existing bioenergy value chains. Within each of these "generic" value chains, different paths based on different biomass feedstocks (including fossil coprocessing), conversion technologies and/or energy products are possible, leading to a wide range of options. Selecting the most relevant options cannot be achieved at a generic level, outside a specific context of locally available feedstocks and targeted end products serving clearly identified markets requesting them.

The EIBI is proposing a pragmatic approach to select the most promising options, based on transparent criteria reflecting a set of key economic, environmental and social performances expected. Its flexibility will allow adjusting the programme to the priorities of the EU and of the member states willing to join forces to boost the development of innovative bioenergy in Europe, encouraging industry and technology champions to team up with the relevant European partners and reach the capability and scale to bring a significant contribution to EU climate and energy ambitions and compete on the world markets.

In line with the EU ambitions on climate and energy, sustainability aspects are central to the EIBI. Economic, social and environmental sustainability is at the heart of the criteria proposed to evaluate and select projects within this initiative (cf. section 3.2), and this along the whole value chain. Further to this, a specific complementary activity is proposed to tackle the critical issue of sustainable biomass supply (cf. section 4.1).

This paper describes the core activities needed for the project initiation phase between 2010 and 2012, in order to select, fund, build and operate demonstration projects and flagship plants for the most promising options ready for pre industrial and/or industrial deployment. The complementary measures to be initiated during the same period are also described. This document also suggests implementation modalities for the activities, for which discussions are on-going.

For these actions to be possible and to give the programme credibility, it is crucial that adequate public-private governance structures and funding mechanisms are defined as well as relevant funding secured. Activities to structure the governance according to the guidelines of the European Commission are currently ongoing. They will be defined and agreed upon in close cooperation between private and public stakeholders.

2. IMPLEMENTATION ACTIONS FOR 2010-2012

2.1 Overview of core activities

The core activity or "Implementation Actions for 2010-2012" aims at building and operating the early demonstration and/or flagship projects which are ready to be deployed. The suggested implementation approach is to organise selection procedures for demonstration and flagship plants. This document is presenting the complete scope of value chains of potential relevance to the EIBI. In principle, within each of these seven "generic" value chains, "specific" value chains have the potential to be developed to industrial scale based on existing technology and know how developed up to pilot and demonstration scale. In practise, authorities providing the public funding might decide to narrow the focus to certain value chains and/or to "demonstration only" or "flagship only" projects, depending on the sources, type and amount of funding. The EIBI is build as a coherent and flexible programme, adjusting to level and sources of funding available, as they might evolve over time.

A main challenge to select the winning options is the diversity of bioenergy value chains of potential relevance across the EU because of the diversity of feedstock situations and the different national bioenergy markets, offering different level of support for the biofuels, bioheat and bioelectricity end products. The seven value chains listed below reflect the variety of feedstocks and processing technologies that will serve the advanced bioenergy markets of 2020. Each of the seven value chains is viewed as an energy-driven biorefinery. Some of them may also produce high value by-products, e.g. chemicals. These by-products might be produced aside the main energy products (fuels, power and heat) if they contribute to the viability of a project. As indicated in the eligibility criteria, at least 70% of the bioproducts produced by the plant shall be bioenergy, calculated on the basis of energy content of the products sold.

Also significant efforts to develop processing technologies based on thermochemical and biological pathways have been ongoing in the EU for more than a decade, there is a significant variation in the level of maturity of technology options within each value chains. The few already existing demonstration projects for specific variations of certain value chains do not allow concluding that these provide the best approach and that no alternative route would deserve funding. Each value chain has the potential to present relevant candidates between 2011 and 2015. These potential demonstration and flagship plants are legitimate candidates to apply for funding under the EIBI. There is no fair, transparent and rational basis to exclude "à priori" neither any of the 7 value chains nor specific variations of any of them. Hence **the corner stone of the EIBI approach would be to evaluate and select projects on the basis of transparent selection criteria.**

Table 1: Bioenergy Value Chains and complementary measures

Generic value-chains
Thermochemical pathways
1: Synthetic liquid fuels and/or hydrocarbons (e.g. gasoline, naphtha, kerosene or diesel fuel) and blending components through gasification.
2: Bio-methane and other bio-synthetic gaseous fuels through gasification.
3: High efficiency heat & power generation through thermochemical conversion (propose limit e.g.: $\eta_{el} > 45\%$)
4: Intermediate bioenergy carriers through techniques such as pyrolysis and torrefaction
Biochemical pathways
5: Ethanol and higher alcohols from ligno-cellulosic feedstock through chemical and biological processes
6: Hydrocarbons (e.g. diesel and jet fuel) through biological and/or chemical synthesis from biomass containing carbohydrates
7: Bioenergy carriers produced by micro-organisms (algae, bacteria) from CO_2 and sunlight
Complementary measures and activities
8: Biomass feedstock for bioenergy
9: Set of activities on longer term R&D&D on emerging and innovative bioenergy value chains

2.2 Demonstration plants

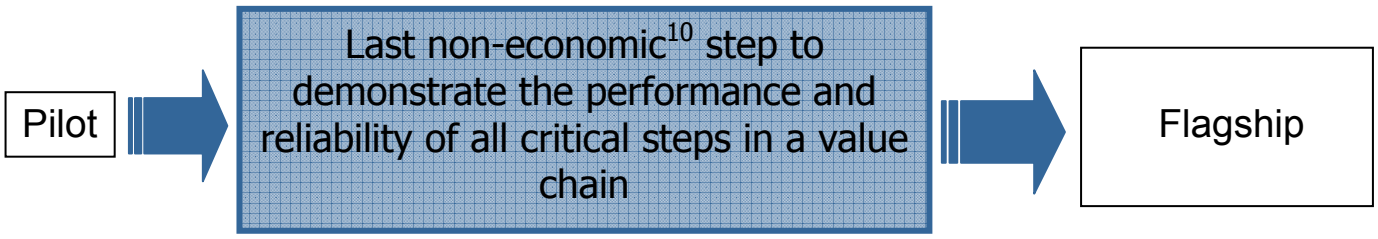

Figure 1: Generalised schematic of demonstration plants

Demonstration plants are considered the last non-economic[11] step to demonstrate the performance and reliability of all critical steps in a value chain so that the first commercial unit can be designed and performance guaranteed from the outcome of the demo unit. The suggested approach for implementation is to organise selection procedures for demonstration plants with a first one to be launched in 2011/2012 depending on funding possibilities. Additional selection procedures would follow from 2013.

Purpose	Demonstrate the performance and reliable integration of all critical steps of the value chain selected so that the first commercial unit can be designed and built with a reasonable assurance of its performance and economic viability by the end of the project.
Expected impact	Provide the backbone for subsequent flagship plants which shall deliver significant and direct contributions to the EU energy and sustainability targets for 2020.
Scope	Address one of the seven value chains identified above or any combination of thermochemical and biological processes derived from them.
Costs and types of public funding [12]	Overall costs and the number of demonstration projects to be funded will be specified once the results of the call for expression of interest (cf. section 3.1) will be available. Preliminary estimates of costs per single project per value chain are given in table 4. No more than 2 projects will be selected within a value chain. As a general rule private actors would cover at least 50% of the project cost. The remaining (public) funding will be provided **as grants to be completed with public loans**. Value chains with one or no project selected in the first selection procedure would be included in the scope of future selection procedures beyond 2012.
Specific features for the projects	Projects would have to elaborate preliminary business plans (including market deployment plan with number and size of plants and geographical distribution) and describe how access to feedstock is planned to be secured. R&D components directly supporting the demonstration activity would be eligible and get funding via existing R&D funding schemes at EU and national level.

[11] Operation of such projects for the purpose of demonstration of the critical technologies will either not generate any revenue or generate insufficient revenues to pay back capital costs and cover operating costs.

[12] Compared to the earlier version of the Implementation Plan from 24th February, the following changes were made in the current document: 1. Overall estimated costs were reworked and are presented in chapter 2.4, 2. Preliminary estimates of costs per single project per value chain are given in table 4, 3. The number of demonstration projects to be funded is not given anymore. This estimate will be specified when the results of the call for expression of interest will be available.

Projects would have to include a clear description of the rationale for public funding as well as sustainability assessment on the basis of a robust life-cycle analysis approach for the entire value chain from feedstock production to the end product.

2.3 Flagship plants

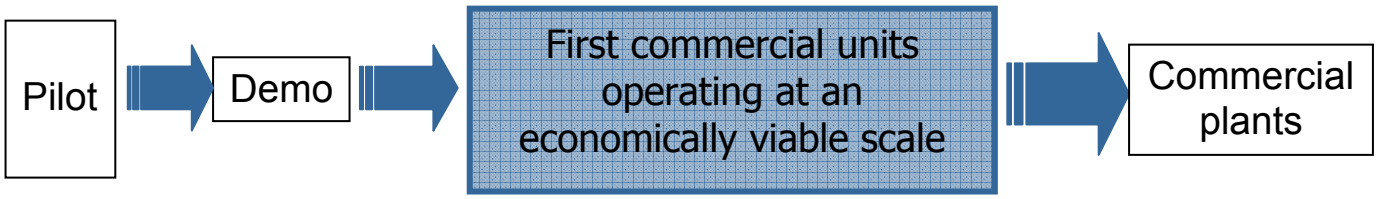

Figure 2: Generalised schematic of flagship plants

Flagship plants are the first commercial units of new value chains operating at an economically viable scale. Economically viable scale is a scale such that economic actors involved with the project (feedstock suppliers, plant constructor, plant operator, equity and loan providers ...) are ready to commit resources because they expect to make a profit. Building and running such plants entails significantly higher costs and risks than demonstration plants because of the scale and higher costs and risks than subsequent commercial plants which should benefit from learning curve and lower risks premium for the capital and loans funding the project. The support of these plants can only be awarded on the basis of detailed proposals. The support should focus on the last stage of project decision making, when investment costs can be estimated with an accuracy of +/- 30 % and when financing needs to be secured. The suggested approach for implementation is to organise selection procedures for flagship plants with a first one to be launched in 2011/2012 depending on funding possibilities. Additional selection procedures would follow from 2013.

Purpose	Support first commercial units of new value chains operating at an economically viable scale.
Expected impacts	De- risk new value chains and technologies to be deployed in the EU market Projects should enable delivering significant and direct contributions to the EU energy and sustainability targets for 2020 and provide deployable results.
Scope	Address one of the seven value chains identified above or any combination of thermochemical and biological processes derived from them.
Costs and types of public funding[13]	Overall costs and the number of flagship projects to be funded will be specified once the results of the call for expression of interest (cf. section 3.1) will be available. Preliminary cost estimates per project are given in table 4. **In contrast to public funding of demonstration plants, public funding of flagship plants (up to 50 % of project costs) would be provided mostly as loans (e.g. by the EIB) and/or public guarantees for private loans, i.e. most part of the funding will be provided by private actors**.

[13] Compared to the earlier version of the Implementation Plan from 24th February, the following changes were made in the current document: 1. Overall estimated costs were reworked and are presented in chapter 2.4, 2. Preliminary estimates of costs

Specific features for projects

Projects would have to present complete business plans (including subsequent market deployment plans with the number, size of plants and foreseen geographical distribution) as well as present commercial strategies and pre contractual commitments from credible partners for both feedstock sourcing and end product marketing.

Demonstration stage must have been passed successfully, otherwise it must be explained why the demonstration step is not necessary.

It would be mandatory for projects to include a sustainability assessment on the basis of a robust life-cycle analysis approach for the entire value chain from feedstock production to the end product.

2.4 Overall estimated costs for 2010-2012

Assuming that for each of the 7 generic value chains one demonstration and one flagship project would be selected, this would represent (public[14] and private) funding requirements of up to app. 2600 M€ (sum of the higher range of demo and flagship projects cost estimate amount to app. 2600 M€, i.e. about 30% of the total cost of EIBI over the 10 years). The outcome of the call for expression of interest (cf. section 3.1) should deliver a better estimate.

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per single project per value chain are given in table 4, 3. The number of flagship projects to be funded is not given anymore. This estimate will be specified when the results of the call for expression of interest will be available.

[14] The term "public funding" used throughout this document encompasses very different tools such as grants, loans and loan guarantees. Adding them up is both meaningless and misleading.

3. SUGGESTED IMPLEMENTATION MODALITIES AND MONITORING

3.1 General principles for the project selection procedures

- EIBI stakeholders (industry, academia, NGOs), MS, EC and financing community (e.g. EIB) will work together to further define, in the last quarter of 2010 and beginning of 2011, a robust set of eligibility and selection criteria, possible modalities for supporting projects (i.e. funding mechanisms), and the selection procedures including their terms of reference.
- In order to align with the evolution of the situation at EU level and industry readiness, a call of expression of interest would be organised (cf. below). It would allow developing a clear picture of the number and types of projects ready to apply.
- Projects would be funded on a flexible basis involving MS resources, EIB loans, loan guarantee and other possible sources of funding. The selection procedures would follow specifically designed organisational modalities to be fine tuned with the authorities providing public funding.
- The EC will facilitate interactions between the EIBI, NER300, MS programmes and other funding mechanisms to avoid duplication, and optimize the use of resources and the impact of all schemes.

Objective and main features of the Calls for Expression of Interest

Calls for expression of interest would be issued in order to update the EIBI partners (Industry, MS, EC and associated members) on the actual stage of development of Bioenergy projects in the EU corresponding to the specificities of the EIBI demonstration and flagship projects. Number and intervals of Calls for expression of interest will be decided by the EIBI team.

It would follow a simplified and light procedure, involving:

- The submission of a short project description (specific templates for demo and flagship projects), presenting technology options, bioenergy end products targets, main partners, location of the plant, feedstock base, budget requirements and funding approach.

- A review process undertaken by a small dedicated working group of experts nominated by the EIBI team, with the objective to determine which of the projects meet the minimum requirements of the EIBI so that EIBI team can inform the proponents accordingly.

- CIRCA as a tool for managing the submission and review process, as well as the information flows[15].

There would be no scoring and no "Go" / "No Go" statement, the essential objective being to "inform the process" of promoting new European public/private partnership in the area of Bioenergy. It is a complement and contribution to the work of SETIS[16], with a particular focus on the requirements of the EIBI.

[15] CIRCA: Communication & Information Resource Centre Administrator. CIRCA is an EU online workspace.circa.europa.eu
[16] SETIS: Strategic energy technologiy information system, setis.ec.europa.eu

The Call for expression of interest would clearly describe the objectives of the EIBI, its implementation roadmap, the eligibility and selection criteria for projects, the foreseen further procedures for selection and support of projects, etc.

The issuing of the first call for expression of interest early in 2011 would be conditional to the consolidation of views on the actual implementation mechanisms for the EIBI demonstration and flagship projects. This should take into account the outcome of the on-going work on governance and funding tools as undertaken for the SET Plan overall.

3.2 Summary approach for project eligibility and selection criteria

A set of criteria, reflecting the key features of the EIBI, is being prepared in the last quarter of 2010 to evaluate and select the demonstration and flagship projects within the initiative.

The following key principles will shape the architecture of the eligibility and evaluation criteria:

- **EU dimension and Industrial leadership**: Consortium actors from at least 3 Member States or Associated Countries, with at least 2 industrial actors from 2 different countries and a science & technology actor[17].
- **Scale/Maturity** (for demonstration plants): the scale should be high enough to be able to prove technical and economical performance and provide enough data so that the technology can be realistically scaled-up to industrial size after successful operation of the demonstration.
- **Minimum bioenergy content**: At least 70% of the bioproducts produced by the plant shall be Bioenergy (biofuels, heat, power) calculated on energy basis.
- **Innovation:** At least one "technology brick" or the integration of "technology bricks" within the considered value chain should not have been deployed at demonstration/commercial scale.
- **Sustainability, Renewable Energy Directive and Green House Gas Emissions:** All proposals shall respect the EU Renewable Energy Directive and shall meet the specified minimum Green House Gas targets for the year 2016; being 60% reduction deducted from Life Cycle Analysis and based on RED calculation methodology.
- **Feedstock and market potential for industrial scale:** Realistic scenario for feedstock sourcing for future industrial units should be described and volume potential of corresponding bioenergy market should be outlined.
- **Timeline**: The timeline of the project and of deployment of its outcome should be realistic to bring first commercial contribution by 2015-2017 for the projects selected in first demonstration call and by 2020 for the second demonstration call.

Given these general principles, a more detailed document is being prepared based on the outcome of the EC/EBTP workshop of 25 September 2009 and on two EIBI Team workshops held on 21 September 2010 and 18 October 2010 on EIBI eligibility and selection criteria. Here is a non-exhaustive list of criteria for the eligibility, evaluation and selection process:

[17] This proposal could be aligned to the approach followed by other European Industrial Initiatives

- **Administrative requirements and eligibility criteria:** respect of deadlines, completeness of the proposals, compliance with EIBI administrative specifications etc.
- **Quality of the Consortium:** The aim is to ensure that the consortium has the operational and financial capacity needed to implement the proposed concept.
- **Quality of the Technology Concept:** Ensuring that a reliable technological concept is proposed in terms of techno-economic and environmental performance as well as in terms of working methodology and organisation.
- **Feedstock Availability:** Delivering cost-effective sustainable biomass feedstock to the plant gate and improving overall system efficiency.
- **Cost of Avoided CO2 Equivalent:** The aim is to ensure that the proposed concept has a reasonable cost of CO2 avoidance
- **Energy Efficiency to primary energy products:** Ensuring that the proposed concept has high and verifiable energy efficiency.
- **Economic performance of the commercial concept:** Assess that the economic performance of the concept is reasonable and viable in the market.

As mentioned above, the work on criteria is ongoing. A priori, the same type of criteria would be used both for demonstration and flagship projects, adapted to the different technology development stages and risk profiles of the projects. However, given the different types and level of risks between demonstration and flagship projects, separate selection procedures would be organised and it may be possible that a different selection of criteria from the specified above would apply for demonstration plants and flagship plants respectively.

3.3 Monitoring of demonstration and flagship projects (Key Performance Indicators)

Monitoring will be necessary on two levels: first on the level of the EIBI programme, second on the level of the individual projects. The outcome of the demonstration and flagship plants built as results of the above mentioned selection procedures will be monitored by the EIBI Team. Key performance indicators (KPIs) will be used as a measure of performance of the project which applies for funding under the EIBI. KPIs to monitor the progress of projects from a technological point of view have been developed jointly by representatives of the European Commission, including the Joint Research Centre, and the EBTP. They have been presented to and agreed with MS, EC and EBTP representatives at the first and second EIBI Team meetings in September and October 2010 respectively.

The agreed list of KPIs is presented as annex C to this Implementation Plan.

4. COMPLEMENTARY MEASURES and ACTIVITIES

4.1 Sustainable biomass feedstock for bioenergy

The core of the EIBI Roadmap consists in the implementation of demonstration and flagship plants on the currently most promising advanced bioenergy value chains. Sustainable and reliable supply of feedstock will be a critical success factor for the long-term perspective of biomass-based technologies on a large scale. This relates to efforts in assessing the biomass availability for bioenergy purposes in EU27 and also in improving productivity in these sectors, in developing reliable and sustainable supply chains that open up the feedstock potentials, certification issues, and prevention of excessive disturbances in agricultural and forest commodity markets. These challenges which are not specific to bioenergy use of biomass should be addressed in a coherent effort shared with the relevant stakeholders and initiatives. To this aim, several activities will be implemented in the framework of the EIBI.

Appropriate project eligibility and selection criteria are being developed to ensure that the above mentioned plants will be designed with a full consideration of the sustainable availability of corresponding feedstock.

In addition, a structured dialogue and continued interaction between the stakeholders of the EIBI and other stakeholder groups involved in other initiatives covering the up-stream part of the described value chains will be facilitated by the EC, in order to foster synergies between the respective strategies and programmes. This interaction will lead to joint initiatives linking several services of the Commission, but possibly also of national research and implementation programmes.

Suggested resources and financing instruments
Resources for these activities would be mainly public from the different FP7 Themes related to biomass, and/or national research programmes. The total cost in period 2010-2012 is estimated at around 60 M € per year, with a share of 75% of public source. The estimated cost per project is 5-15 M €.

EU added value
This set of activities will allow implementing joint programming of different research instruments at EC level, ensuring their coherence, maximising their synergies and results while avoiding duplication.

4.2 Set of activities on longer term R&D on emerging and innovative bioenergy value chains

The core of the EIBI Roadmap focuses on value chains that will be commercially viable in the next five to ten years, contributing to the 2020 targets of the RES Directive. But to go beyond these targets, new technologies and value chains are to be developed. A longer-term R&D programme needs to be put in place that will provide the industry with technologies that will reach commercial deployment beyond 2020 and for which a new programme of demonstration and flagship plants could be launched in five to ten years time.

This will imply both addressing R&D improvements of technologies already existing at lab scale, but not yet developed enough to be part of the EIBI targeted value-chains, and more fundamental research with the aim to develop totally new bioenergy production avenues.

In order to identify research priorities, 2 ad-hoc workshops will be organised by the EC (DG RTD/TREN/JRC) in collaboration with other EC services and bioenergy stakeholders:

- Workshop 1 "Accelerating the development of most promising existing bioenergy technologies", involving European bioenergy experts, aimed at identifying R&D needs and priorities to be addressed to improve bioenergy technologies already existing at lab scale, such as the development of bioenergy carriers, biofuels for aviation sector and technologies using algae feedstock.

- Workshop 2 "Longer term research on future breakthroughs of bioenergy technologies" involving European engineers and scientists in fundamental and applied disciplines (such as physics, chemistry, biology, genetics, engineering, bioenergy, biotechnologies), aimed at identifying the most critical gaps in the current knowledge base in view of possible future bioenergy technology breakthroughs. These could come for example from direct energy conversions using new or modified plants and micro-organisms, or new technology mimicking natural phenomena like photosynthesis. Participation to the workshop of non-EU scientists may be envisaged.

On the basis of needs and priorities identified in the two Workshops mentioned above, calls for proposals would be issued starting from 2012. This would be undertaken through FP7 in close collaboration with MS and EERA.

Suggested resources and financing instruments

Based on current project size and for maximum impact, the research activities addressing needs and priorities for technologies already existing at lab-scale would absorb around 45 M € per year, with costs in the range of 5-15 M € per project and a share of 50% of public sources. Actions on longer term research would be in the order of 30 M € per year, with costs in the range of 5-15 M € per project and a share of 75% of public sources. Financing could come from FP7, MS, EERA, and/or the private sector.

EU added value and risk

The research described above would benefit from being performed at EU level as this would permit to better exploit economies of scale and synergies.

ANNEX A: VALUE CHAINS, SUMMARY DESCRIPTION AND EXAMPLES OF ONGOING PROJECTS

Within each of the generic value chains presented in Table 1, specific variations based on different feedstocks and/or processing technologies are being developed, and are currently at different stages of development, some of them have attained the pilot scale where their technical viability has been confirmed while few have reached the demonstration phase and have ascertained their technical reliability. None of the value chains identified in Table 1 have established economic viability since none has reached the flagship plant stage. Therefore an implementation strategy based on flexible approach will be applied to ensure compliance with the key objectives of the initiative and make best use of the limited resources available.

Some of the technologies that could be deployed in the 7 generic value chains are already supported by various actions at national, local, industrial and EC level. The EIBI is aiming to support the projects for which the existing local, national and EU programmes could not bring enough funding because of the magnitude of funding required.

In the following section, each value chain is briefly described and examples of ongoing projects are given. However, this list is not exhaustive. Preliminary estimates of costs per single project per value chain are presented in table 4. It should be noted that because demonstration and flagship plants are by definition "first ever built" the costs cannot be accurately estimated, until a basic design engineering study (+or – 30 % estimate) or a detailed engineering study (+ or – 10 % estimate) have been performed. It is suggested that **only a limited number of demonstration and flagship projects is selected in a specific selection procedure, depending on the availability of public budget, the matching budget from the private sector and the project eligibility and selection criteria.**

Thermochemical pathways
1: Synthetic liquid fuels and/or hydrocarbons (e.g. gasoline, naphtha, kerosene or diesel fuel) and blending components through gasification.
Main Feedstocks: Forest and agricultural residues, waste wood, energy crops, black liquor **Main Products:** FT diesel and naphtha, DME, Methanol **Level of Maturity:** 1-2 (1= Demo exists / next step: flagship plant; 2= Pilot exists / next step: demo or flagship plant) **Examples of EU ongoing[18] projects:** (italicised projects are at planning stage) Pilots: BioDME (Sweden), Bioliq (Germany), Güssing, FT (Austria), BioTfueL (France) Demo: CHOREN Beta Plant (Germany), Neste Oil & Stora Enso Joint Venture "NSE Biofuels Oy) (Finland), *BioDME/Biomethanol (Sweden)* Flagship: *UPM (Finland), Neste Oil & Stora Enso Joint Venture "NSE Biofuels Oy" (Finland)* **Main technology challenges:** Feeders, gas cleaning, catalysts **Technical challenges for all value chains**: Feedstock flexibility, energy and carbon efficiency, reliability & maintenance, capex efficiency

[18] Ongoing means investment decision made and project at engineering, procurement, construction (EPC) stage.

Thermochemical pathways
2: Bio-methane and other bio-synthetic gaseous fuels through gasification.
Main Feedstocks: Forest and agricultural residues, waste wood, energy crops **Main Products:** Synthetic Natural Gas (SNG), H2, CO **Level of Maturity: 2** (2= Pilot exists / next step: demo or flagship plant) **Examples of EU ongoing projects:** (italicised projects are at planning stage) Pilots: *ECN (Netherlands),* GAYA (France) Demo: Flagship: **Main technology challenges:** Feeders, gas cleaning, catalysts **Technical challenges for all value chains:** Feedstock flexibility, energy and carbon efficiency, reliability & maintenance, capex efficiency

Thermochemical pathways
3: High efficiency heat & power generation through thermochemical conversion
Main Feedstocks: Forest and agricultural residues, waste wood, energy crops, **Main Products:** Power, Heat **Level of Maturity:** 1 (earlier demonstrations in the '90s in UK, FI, DK, SE) (1= Demo exists / next step: flagship plant) **Examples of EU ongoing projects:** Pilot: Demo: Värnamo (Sweden), Carbona SKYVE (Denmark), Güssing (Austria) Flagship: **Main technology challenges:** Biofeedstock compatible materials, high share of power production **Technical challenges for all value chains:** Feedstock flexibility, energy and carbon efficiency, reliability & maintenance, capex efficiency

Thermochemical pathways
4: Intermediate bioenergy carriers through techniques such as pyrolysis and torrefaction
Main Feedstocks: Forest and agricultural residues, wood waste, energy crops **Main Products:** Bio-oil for light / heavy fuel oil applications **Level of Maturity:** 1-2 (1= Demo exists / next step: flagship plant; 2= Pilot exists / next step: demo or flagship plant) **Examples of EU ongoing projects:** Pilots/Demos: Bioliq (Germany), PYTEC (Germany), BTG (Netherlands), 2G_Bio-oil project /UPM (Finland) Flagship: **Main technology challenges:** Handling/stability of bio-oil, materials, specifications of intermediates **Technical challenges for all value chains:** Feedstock flexibility, energy and carbon efficiency, reliability & maintenance, capex efficiency

Biochemical pathways	
5: Ethanol and higher alcohols from ligno-cellulosic feedstock through chemical and biological processes	
Main Feedstocks:	Sugars containing biomass: energy crops, agricultural and forest residues, food industry and municipal biowaste …
Main Products:	Ethanol, butanol
Level of Maturity:	**1-2**
(1= Demo exists / next step: flagship plant; 2= Pilot exists / next step: demo or flagship plant)	
Examples of EU ongoing projects:	
Pilots:	SEKAB (Sweden), Futurol (France), Inbicon/DONG Energy Fredericia (Denmark), Abengoa (Spain),Chemtex (Italy)
Demo:	Inbicon/DONG Energy Kalundborg (Denmark), Süd Chemie (Germany), Abengoa (Spain), FibreEtoH (Finland), Chemtex (Italy), BornBioFuel (Denmark)
Flagship:	
Main technology challenges: preparation of feedstock, enzymes	
Technical challenges for all value chains: Feedstock flexibility, energy and carbon efficiency, reliability & maintenance, capex efficiency	

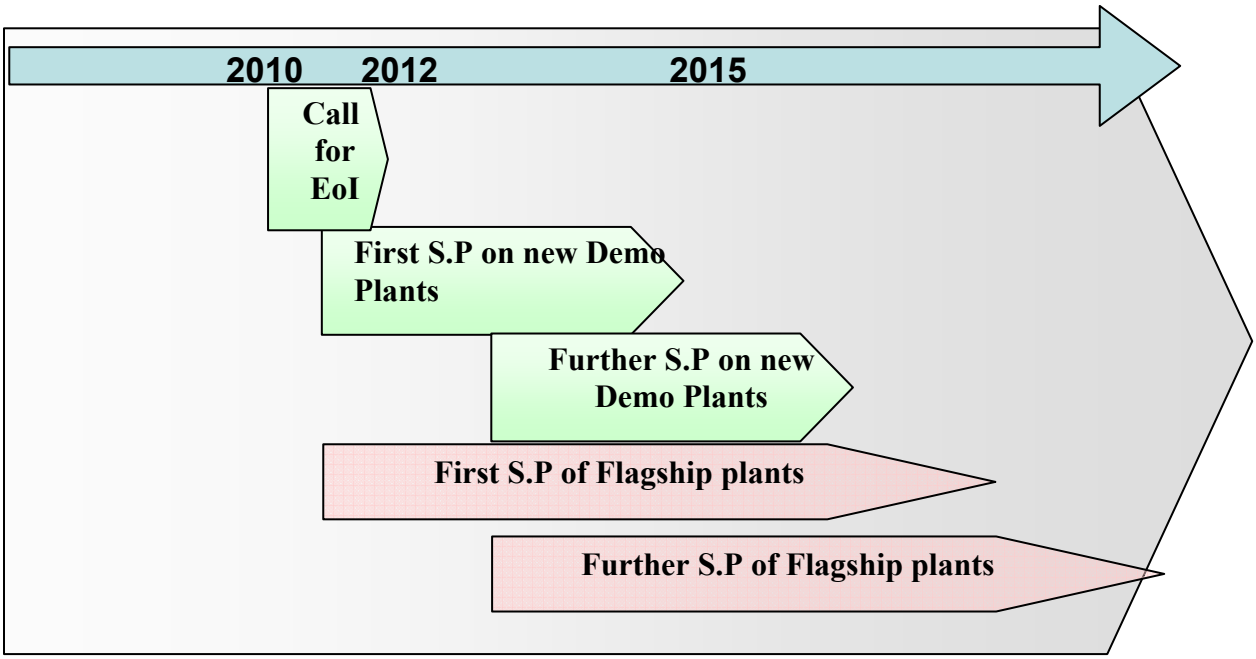
Biochemical pathways
6: Hydrocarbons through biological and/or chemical synthesis from biomass containing carbohydrates
Main Feedstocks: Sugars containing biomass: energy crops, agricultural and forest residues, food industry and municipal biowaste … **Main Products:** Renewable Hydrocarbons for transport fuels **Level of Maturity: 1*-2* (*** US and Brazil) (1= Demo exists / next step: flagship plant; 2= Pilot exists / next step: demo or flagship plant) **Examples of ongoing pilot/demo projects (US and EU):** - Virent (USA) - LS9 (USA) - Amyris (USA) - Gevo (USA) - Solazyme (USA) - Avantium (The Netherlands) Flagship: **Main technology challenges:** Microorganisms, catalyst performance, bioprocessing **Technical challenges for all value chains:** Feedstock flexibility, energy and carbon efficiency, reliability & maintenance, capex efficiency

Biochemical pathways
7: Bioenergy carriers produced by micro-organisms (algae, bacteria) from CO_2 and sunlight
Main Feedstocks: CO_2, sunlight **Main Products:** renewable transport fuels for diesel and jet engines **Level of Maturity: 2** (2= Pilot exists / next step: demo or flagship plant) **Examples of ongoing pilot/demo projects:** - ENI / UOP (Sicily) - Necton / Algafuel (Portugal) - Biomara (UK) - SBAE (Belgium) - IGV (Germany) - Algatec (Israel) - Ingrepro (Netherlands / Malaysia) - Clean Algae (Spain) - Algae demonstration facility funded under FP7 (DG ENER) consortium to be built (All Gas Oil project and BioFat project) Flagship: **Main technology challenges:** Selection of strains, process design, water treatment, scale up **Technical challenges for all value chains:** Feedstock flexibility, energy and carbon efficiency, reliability & maintenance, capex efficiency

Annex B. TIME TABLE OVERVIEW

B.1 Overview of the timetable concerning the call for expression of interest (EoI) and the selection procedures (S.P) of demonstration and flagship plants

Table 3: Overview of the timetable concerning the calls on demonstration and flagship plants



B.2. COSTS OVERVIEW

Table 4: Preliminary estimates of costs per single project per value chain*

Value chain	Description	Indicative costs per project (M€)
DEMO PLANTS		
1	Synthetic liquid fuels and/or hydrocarbons (e.g. gasoline, naphtha, kerosene or diesel fuel) and blending components through gasification.	40-100
2	Bio-methane and other bio-synthetic gaseous fuels through gasification.	20-40
3	High efficiency heat & power generation through thermochemical conversion (propose limit e.g.: $\eta_{el} > 45\%$)	20-40
4	Intermediate bioenergy carriers through techniques such as pyrolysis and torrefaction	20-40
5	Ethanol and higher alcohols from ligno-cellulosic feedstock through chemical and biological processes	20-40
6	Hydrocarbons (e.g. diesel and jet fuel) through biological and/or chemical synthesis from biomass containing carbohydrates	5-20
7	Bioenergy carriers produced by micro-organisms (algae, bacteria) from CO_2 and sunlight	20-40
FLAGSHIP PLANTS		
1	Synthetic liquid fuels and/or hydrocarbons (e.g. gasoline, naphtha, kerosene or diesel fuel) and blending components through gasification.	400-1000
2	Bio-methane and other bio-synthetic gaseous fuels through gasification.	200-300
3	High efficiency heat & power generation through thermochemical conversion (propose limit e.g.: $\eta_{el} > 45\%$)	150-250
4	Intermediate bioenergy carriers through techniques such as pyrolysis and torrefaction	50-100
5	Ethanol and higher alcohols from ligno-cellulosic feedstock through chemical and biological processes	100-200
6	Hydrocarbons (e.g. diesel and jet fuel) through biological and/or chemical synthesis from biomass containing carbohydrates	50-100
7	Bioenergy carriers produced by micro-organisms (algae, bacteria) from CO_2 and sunlight	100-300

* Including private and public resources. It should be noted that because demonstration and flagship plants are by definition "first ever built" the costs cannot be accurately estimated, until a basic design engineering study (+or – 30 % estimate) or a detailed engineering study (+ or – 10 % estimate) have been performed. See p. 9 and 13 for more explanation on project selection.

Annex C

October 19, 2010

European Industrial Bioenergy Initiative

Key Performance Indicators

Draft working document

Drafting of the KPIs follows the principles established in the SET-Plan Information System (SETIS), with both over-arching and specific key performance indicators adapted to fit the needs of the bioenergy value chains identified by the EIBI. The KPIs are drafted in parallel with the formulation of project eligibility criteria. Data for KPIs would be collected and reported annually.

Over-arching KPIs

In line with other EIIs, account must be taken of cost. EIIs for Wind and Solar require calculation of the "levelised cost of electricity" (LCOE), while the Grid EII measures capital and operating costs. The CCS EII uses the cost of CO_2 abatement.

1. Proposed Over-arching KPIs for EIBI

Bioenergy is used in direct competition with fossil energy and transport fuels (energy carriers) and as such in most cases savings in greenhouse gas (GHG) emissions are used as a comparator to assess "how good" bioenergy is in terms of environmental protection. It makes sense, therefore, to consider GHG savings, and also the cost of achieving the savings. Cost of the energy or energy-carrier product is a necessary KPI. Given the EU 20% target for renewable energy by 2020, bioenergy production as a consequence of the EIBI is included. Hence, 3KPIs are proposed:

- **GHG savings compared to fossil equivalents**
  The GHG methodology and data behind the sustainability scheme in the renewables directive (2009/28/EC) will be used as a reference for biofuels. For other energy products, reference data will be, as far as available, obtained from the JRC Well-to-Wheels study.
- **Maximum and minimum cost of bioenergy product (€/MWh) per value chain**
- **Total bioenergy produced by EIBI projects (TWh/year)**

2. KPIs for EIBI

To assess the progress of the portfolio of European projects and follow the success of the EIBI two types of KPIs are foreseen, General KPIs and Value Chain Specific KPIs :

Information and data on the General on the Specific Value Chain KPIs are to be collected in common by the EIBI Team in plenary configuration, and communicated to the Steering Group

2.1 General KPIs for the EIBI

- Cumulative number of Final Investment Decisions (FID) (i.e. approved projects of Demonstration scale or Flagship scale) based on technologies specified in the EIBI for all value chains
- Cumulative number of Final Investment Decisions (FID) (i.e. approved projects of Demonstration scale or Flagship scale) per value chain specified in the EIBI
- Gross installed output capacity of bioenergy plants based on the EIBI value chains across Europe, in HJ/y,
- Gross installed output capacity of plants based on the EIBI value chains and supported by the EIBI across Europe, in HJ/y
- Accumulated capital investment on projects based on the EIBI value chains across Europe since 2010
- Availability of plants in operation at commercial scale including Flagship plants

2.2 Value Chain Specific KPIs:

To assess the progress of the portfolio of European projects and follow the success of the value chains four types of KPIs are foreseen, Technology Specific, Resource Specific, Health & Safety and Socio-Economic.

2.2.1 Technology-Specific Value Chain KPIs

- Plant at demonstration/flagship scale capable of achieving planned output capacity (while meeting quality specifications of products[19], or meeting sales contract specifications)
- Plant at demonstration/flagship scale capable of product output at planned cost
- Availability of demonstration/flagship during agreed final period of project.
- Greenhouse gas saving compared with fossil fuel reference
- Net efficiency (based on LHV) of conversion of biomass feedstock from plant gate to commercially marketable bioenergy product
- Cost of capital investment of bioenergy products (e.g. €/litre, €/MWh)
- Cost of bioenergy production (e.g. €/litre, €/MWh)
- Cost per tonne of greenhouse gas saving (e.g. €/CO2 equivalent)

2.2.2 Resource-Specific Value Chain KPIs

- Cost of biomass resource delivered at the plant gate, (e.g. €/MWh)
- Price of biomass resource at farm, forest, market gate (e.g. €/MWh)
- Annual quantity of biomass consumption delivered at the plant gate (e.g. MWh/y)
- Net efficiency from biomass production to commercially marketable bioenergy products
- GHG emissions of value sub-chain “resource production to plant gate” (e.g. CO2 equivalent per MWh biomass feedstock delivered)

[19] Quality specifications may be CEN standards, CEN Workshop Agreements and in their absence national or ISO standards

2.2.3 Health, safety and environment KPIs

- Demonstration and flagship plants consistently complies with prevailing emissions regulations along the whole value chain (judged by number of deviations, license suspensions)
- Number of accidents and near-accidents[20]

2.2.4 Socio-economic KPIs

- Public awareness and support of the value chain (via Eurobarometer pole)
- Number of permanent jobs created by demonstration/flagship project, including the plant itself and in the biomass supply and product chains (data broken down indicating the location of the jobs, local, within a radius of x km, elsewhere in the EU, elsewhere in the world).

[20] Computed as Lost Workday Injury Frequency (LWIF) of all workers (own staff and contractors), where LWIF is calculated from the number of Lost Workday Injuries (LWI) divided by the number of hours worked expressed in millions and as Total Recordable Case Frequency (TRCF). TRCF is calculated from the sum of fatalities, LWIs, RWIs (Restricted Workday Injury) and MTC (Medical Treatment Cases) divided by the number of hours worked in millions. These definitions are standard key performance indicators of the oil industry sector, ref. CONCAWE Report 7/09 (September 2009).