



IBTI • INTEGRATED BIOREFINING RESEARCH AND TECHNOLOGY CLUB

## **IBTI CLUB: SECOND CALL FOR GRANT APPLICATIONS**

### **IBTI CLUB BACKGROUND AND PROGRESS**

Biorefining can be defined as the fractionation and processing of renewable biomass feedstocks for industrial applications. Drawing parallels with refining fossil oils, biorefineries will have to be highly efficient, produce minimal waste streams and allow the fractionation of raw materials and recovery of multiple products. Ideally they will be able to produce as wide a range of bulk and high value chemical products as is currently available from petrochemical feedstocks. In terms of bulk supply, these feedstocks will be primarily derived from terrestrial and aquatic plants, as these are responsible for photosynthetic primary productivity and carbon fixation.

The development of biorefining into commercially viable and sustainable industrial processes is clearly a major undertaking, which will require interdisciplinary research encompassing the biological and physical sciences interface. With this in mind, three science themes have been identified for the IBTI Club.

- **Optimisation of feedstock composition**
- **Integrative bioprocessing**
- **Enhancing product value**

While it is recognised the current focus on biorefining is as an adjunct to biofuel production, the diversity of products derived from renewables could radically change this paradigm in the near future. The initiative therefore takes a broad view as to the types of desirable outputs obtainable from biorefining. For example the following products have all been identified as potentially useful outputs of future refining processes:

- Speciality oils varying in carbon chain length, desaturation and substitution
- Surfactants
- Polymers, oligomers and their monomeric precursors
- Heteroaromatic and pseudoaromatic compounds
- Flavours and nutraceuticals
- Terpenoids
- Cosmeceuticals, essential oils, vitamins
- Phytopharmaceuticals
- High-value chiral intermediates and products

While this list is not exhaustive it does illustrate the broadness in scope of the initiative.

### **Optimisation of feedstock composition**

Plant and algal biomass are heterogeneous materials from which a range of products may be derived by extraction and conversion. Sustainable biorefining requires that value be obtained from as much of the biomass as possible and while this requires efficient extraction and conversion technologies, it is also important that feedstock quality is optimised. Traits to be developed include increasing the yield of valuable components and the ease with which these components can be extracted and processed. Plant materials to be targeted include biomass

crops, or agricultural residues, for use in the bulk production of biochemicals and materials such as sugars, oils, fibres, liquid fuels or biogas. In addition, the application of biorefining will mean a range of high value products (speciality fine chemicals, bioactive compounds) are also potentially recoverable as minority by-products from plant or algal feedstocks. The range and quantity of both bulk and speciality products will be extended by manipulating the metabolism of feedstock plants through marker-assisted breeding, genetic engineering or a combination of both.

### **Integrative bioprocessing**

Biorefining will require the development of more efficient and intense microbial bioprocesses, which can be integrated both with separation technologies and with chemical transformations. In addition, significant advances in the associated engineering and scale-up will be required. The great advantage of microbial processes is the ability to resolve most of the available carbon sources and substrates in complex feedstocks to relatively small numbers of synthetically useful building blocks. Therefore, one of the most important targets for the potential user community will be met from studies which seek to promote a high degree of substrate utilization from a real or artificially constituted biorefinery feedstock, with specific substrate consumption rates, as important engineering targets. These improvements at the microbial level must be matched by the design of simple and effective product recovery and purification processes such that the added value of chemical building blocks produced can be captured.

Resolution of the bottlenecks in this area of bioprocessing will require research at the interface between chemistry, engineering, microbial fermentation, enzymology and the physical barriers to biological processes, and research projects are expected to be multidisciplinary.

### **Enhancing product value**

While it will be possible to directly tailor many products from biorefining for subsequent use in industrial applications, it is also recognised that major by-products may be of limited economic value. The processing of these bulk by-products into new higher value chemical entities with wider applications is an immediate challenge for the successful implementation of biorefining. Areas of interest include the use of novel chemical and bioprocessing as well as fractionation methods to recover high-value products.

Allied to biofuel production, a topical example is the recovery of useful molecules from ethanol fermentation residues. This represents a considerable biological and chemical challenge with the residues composed primarily of lignin, which is highly recalcitrant to biological conversion to useful monomeric species. Finding the way to control the decomposition of lignin could provide a future renewable source of small aromatic units. Alternatively, unlocking the industrially useful organic entities in these polymers will require the development of enzyme and chemically mediated free-radical reactions to open the aromatic rings to yield molecules that can be used as fermentation feedstocks. Similarly, in other industries such as sugar refining and paper production current by-product streams contain potentially useful chemical feedstocks. Unlocking the economic potential of these chemical intermediates requires specific bioprocessing and/or chemical conversion. In an alternative strategy, the biotransformation of low-value products into fine chemicals by retaining synthetically useful functionality represents a further mechanism for adding value to biorefining.

### **Currently supported research**

The first call for research proposals from the IBTI Club provided support for four research projects totalling £1.8M. Summaries of the projects supported through the first call can be found on the web here: [www.bbsrc.ac.uk/ibticlub](http://www.bbsrc.ac.uk/ibticlub).

## THEMES FOR THE SECOND CALL

Grant applications are invited for the second call of the IBTI Club. The closing date for applications is 5 November 2009. There is a two stage application procedure. Initially, proposals must be submitted on the Outline Application form. Approximately £3M is available for grant awards in this round. The funding is from a common pot with contributions from the BBSRC, EPSRC and Industry. Further details on specific guidelines for the call are in Annex 1.

All applications must focus on the research themes of the IBTI Club (i.e. optimising feedstock composition, integrative bioprocessing, enhancing product value). The call should be of interest to scientists with either a biological (e.g. plant science, biochemistry/enzymology, microbiology) or physical (e.g. chemistry, engineering, separations technology) science background.

Feasibility studies (with a maximum of one year's funding) and standard grant applications of up to a maximum of five years' funding are invited. There are insufficient funds to support major programme grants from large consortia, therefore we envisage funding smaller multidisciplinary approaches. It is recognised that applicants may need extra skills and expertise, and applications from researchers exhibiting complementary skills are particularly welcomed. It is possible that individual applicants may not be able to identify particular partners with specific expertise in advance of submission of the outline applications. In such cases, this should be indicated on the application form. Partnerships and consortia may be built after the outline stage and through other IBTI Club activities. Developing a UK biorefinery community composed from both academia and industry is part of the aims of the club.

Proposals in this round should not focus on biofuels as the primary output of the application, rather proposals that enhance biofuel processes are of interest, including improved production of platform chemicals, added-value products and biomaterials, although it is recognised that in biorefineries that biofuels are usually the primary product.

Applications should refer to the schematic diagram of a biorefinery process given with this call (see Annex 2). The applications must highlight how the proposed research will fit into the biorefinery process, and how the outcomes will enhance product generation, process intensification, productivity or process simplification, resource and energy minimisation, minimisation of carbon footprint, etc. Robustness, adaptability and flexibility are also important considerations. Applicants may suggest alternative flow paths for a biorefinery. **An integrated approach to projects is important, including multidisciplinary approaches and integration across processes**, though it should be borne in mind that integrated projects do not have to tackle the whole biorefining process.

As relevant, the applicants need to indicate the type(s) of feedstock(s) that can be used in their proposed system, the applicability to UK based or more international biorefineries, and the degree of flexibility in terms of substrate acceptability and in the operation of the biorefinery plant. In addition, where possible, the environmental sustainability and CO<sub>2</sub> minimisation/capture should be indicated.

### Priority Topics

The topics for which grant applications are invited in this round are based on feedback from the first call and the resulting recommendations of a recent IBTI consultation exercise, designed to discover the grand challenges for biorefinery development and the hurdles that must be overcome. These topics are of interest to industrialists within the Club, based on their analysis of market needs. Examples of science areas relevant to the second call could include:

1. Feedstocks: Engineering of multiple or single feedstocks

2. Upstream Processing: Separation and fractionation of components, water removal, lignocellulose degradation including biotreatments, and separation of lignin, feedstock handling, other methodologies for treatment of feedstocks
3. Bioprocesses: Enhanced fermentation (including anaerobic digestion) and chemical processes, better understanding of microbial consortia for feedstock degradation and product generation, rapid bioprocess design and scale-up
4. Downstream Processing: How can all/most components of the feedstock be utilised? Separation of products, water removal and recycling, optimisation of product recovery, by-product recovery and utilisation
5. Product Formation: Can new products be identified and formed? Novel pathways to established or new products, enhanced yields of known platform and higher value products, links to end-user requirements
6. Process Integration: How can processes be integrated efficiently in a biorefinery? Integration across and at the interfaces of engineering, chemical and biological sciences

### **Other Important Considerations**

- Skills and Training: Biorefineries will require interdisciplinary skills in biology, chemistry and engineering, therefore grant applications must clearly indicate the skills and training elements of the project.
- Economics: For biorefineries to be feasible, the technology must be scalable and economically viable, and applicants are expected to demonstrate the feasibility of their projects from this perspective.
- Social and Environmental Considerations: New technologies for biorefining must be socially and environmentally acceptable and sustainable. Tools like life cycle analysis could be applied to assess the environmental impact of new processes and products.

At the Outline stage, applicants should be clear on how they will address these issues in the Full Application stage. As applicable, full grant applications will be required to indicate that the research outcomes fit these criteria.

Grant applicants may, if they so wish, consult the Academic Coordinator of the IBTI Club, Professor Christopher Knowles (chrisjknowles@btinternet.com), about the application process.

## GUIDELINES FOR CALL

- The objectives of the proposed research must fit with the scientific challenges detailed in this document and the science proposed must fall within the remit of BBSRC and EPSRC.
- Outline proposals must be submitted in the first instance.
- Research proposals are sought for feasibility studies (with a maximum of one year's funding) and standard grant applications of up to a maximum of five year's funding.
- There are insufficient funds to support major programme grants from large consortia, therefore we envisage funding smaller multidisciplinary approaches. It is recognised that applicants may need extra skills and expertise, and applications from researchers exhibiting complementary skills are particularly welcomed.

## CRITERIA FOR ASSESSMENT

The primary criteria for assessment are the quality of science proposed and the strategic relevance to the IBTI Club. It is expected that any proposal that goes on to be funded through the Club will be competitive against comparable international work and will demonstrate alignment with the Club's aims. Proposals will be assessed against the following criteria:

- **Scientific Excellence**  
The extent to which the proposal meets the highest international standards of current research in its field. High performance against this factor will indicate a project of the highest standard, competitive with the best activity anywhere in the world, demonstrating originality and innovative potential.
- **Strategic Relevance to the IBTI Club**  
Demonstrated alignment with science themes and priority topics, relevance to the biorefining industrial sector, and balance of overall Club research portfolio.
- **Economic and Social Impact**  
The extent to which the output of the research will contribute knowledge that shows direct potential for economic return or societal benefits to the UK.
- **Timeliness and Promise**  
The extent to which the proposal is particularly appropriate at the present time, or offers longer-term benefits over and above the direct value of the research.
- **Cost Effectiveness**  
The extent to which the resources requested, relative to the anticipated scientific gains, represent an attractive investment of BBSRC funds.
- **Staff Training Potential of the Project**  
Where resources are requested for postdoctoral or other research staff, please comment on the extent to which the proposed project will provide research training and development opportunities of benefit both to the individual(s) employed, and to the wider science base beyond the completion of the specific project.

## SPECIAL CONDITIONS

Recognising the financial support for the programme from industrial members of the Club, it should be noted that special conditions will be attached to any research grants from the IBTI Club. A letter from the institution's technology transfer office or equivalent, acknowledging that the institution is able to accept those conditions relating to IP, will be requested at the full application stage. The conditions are as follows:

### Early Access

Commercial parties are entitled to early access to results from research funded by the Club. To ensure this grant holders must:

- Give at least 28 days notice of an intention to publish, outside of the Club, results from research funded by a Club grant. The material for proposed publication should be submitted to the Industrial Liason Coordinator along with the notice of intent to publish. The Coordinator will distribute a copy of the same to each of the Commercial Parties who shall have fourteen (14) days from receipt of such copy to inform the Coordinator if in their view the proposed publication may
  - (i) dilute or prejudice the value of proprietary information of a Commercial Party or
  - (ii) jeopardise the application for Resulting IPR protection or
  - (iii) otherwise inhibit future exploitation of the results and whether a Commercial Party has an interest in exploiting those results.
- Produce annual progress reports. A form will be available on the IBTI Club website for Grant Holder to complete and Grant Holder will be notified in advance when the final report will be due.
- Attend and present the results and progress of Club funded research at 6-monthly Club Dissemination Events. Grant holder will be notified of the dates and format of their presentation.
- Give advance notification of any opportunities to exploit intellectual property arising from their grant to the Commercial Parties.

### Access to Resulting IPR

Commercial Parties are entitled, if they wish, to engage in good faith negotiations with the Research Organisation for terms of access to the Resulting IPR to allow further development or commercial exploitation of results, such access rights preferably to include the right to sublicense. This must be offered before access to Resulting IPR can be offered to third parties outside the Club. An interested Commercial Party can exercise its option right by giving notice to the Grant Holder within one month of the date of receipt of notice of Results or Resulting IPR.

### Good Faith Negotiations

Good faith negotiations would imply a willingness to reach agreement with Commercial Parties on the terms and conditions of a commercial licence, to desist from publishing the Results or making offers to third parties while negotiation with Commercial Parties are ongoing and, if such agreement is not reached within a reasonable period (for example four months from the exercise of the option) that the Research Organisation would not seek to enter into negotiations with third parties on terms substantially more favourable to such third parties.

### APPLICATIONS PROCEDURE

There is a 2-stage application process:

- Outline Applications will be submitted through Je-S. The closing date for outline applications is **5 November 2009, 4pm**.
- Successful applicants will be invited to write a full application in December 2009 for submission by February 2010 (dates to be confirmed).

- Impact statements will be required for grant applications that are selected for the second stage, full grant applications, and should be formulated to meet the needs of biorefinery processes. A workshop for applicants successful in the Outline stage will be held in January 2010 to facilitate collaborations and explain requirements for impact statements.

## **ASSESSMENT**

Outline applications will be assessed by the IBTI Club Steering Group and will not be externally reviewed. Full applications will be externally peer reviewed prior to final assessment by the IBTI Club Steering Group. The decision to fund full applications will be announced in May 2010. Further details on assessment are as follows:

- The criteria of scientific excellence and strategic relevance are given equal weight in the assessment of proposals and applications must pass on both criteria to be considered fundable
- The Steering Group consists of 7 academic members (nominated by BBSRC and EPSRC) and 7 industrial representatives (chosen by the industrial Club members).
- For assessments conducted by the Steering Group, each full proposal has two Introducing Members (IMs). One IM is from academia and the other is from industry.
- The procedure for dealing with conflicts of interest (e.g. where a Steering Group member has pre-existing links to an applicant) is the same as for other BBSRC Research Committees. Conflicted individuals leave the room while the proposal is being discussed.

## **ELIGIBILITY**

UK Higher Education Institutions, Independent Research Organisations and BBSRC-sponsored institutes are eligible to apply.

## **CONTACTS**

For further information contact:

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GENERIC DIAGRAM OF A BIOREFINERY PROCESS

