Mini-SYMPOSIUM and TWINNING WORKSHOP

Developments in Sustainable Biomass Valorisation
EU-India R&D collaboration on Biomass and Biowaste

Utrecht, the Netherlands 28-29th October 2013

VENUE: NH Hotel (28th October); NL Agency (29th October)

Workshop Summary

SEVENTH FRAMEWORK PROGRAMME

Department of Biotechnology
Ministry of Science & Technology,
Government of India

NL Agency
Ministry of Economic Affairs

WIP

WAGENINGEN UR
For quality of life

Background information: The SAHYOG Project

The objective of the SAHYOG project is to actively and effectively link research activities implemented within EU research programmes and related programmes by Indian national institutions in the fields of biomass research and bio-waste conversion to prepare a Strategic Research Agenda and a roadmap for the advancement of RTD with mutual benefits. Within SAHYOG broad networking of respective scientific and industry communities, twinning of large sets of research projects, as well as short term exchange visits of researchers are implemented.

Based on SAHYOG findings, RTD Roadmaps are elaborated through consultation with stakeholders at the governmental, research and industrial level that present a concerted planning of future research initiatives in the area of biomass production and bio-waste conversion.

This coordination activity is of large importance to systematically bridge the on-going respective activities from India and Europe that help providing the basis for novel applications in a sustainable bio-economy of the future – the so-called knowledge based bio-economy (KBBE).

SAHYOG Mini Symposium and Twinning Workshop

In this **Mini Symposium**, specific views and insights were presented on the following topics:

- What are the major drivers in biomass utilisation and valorisation in the international context?
- What underlying policies and roadmaps can lead to more sustainable use of biomass?
- What is the industry's role and what can public-private partnerships bring to the table?
- What are major topics for collaboration, in particular with India-one of the largest growing economies in the world?

The Mini Symposium was followed by a Project **Twinning Workshop**:

SAHYOG was tasked to bring together project coordinators and other lead partners from past and on-going projects as well as international networks and industry representatives from India and Europe in order to exploit synergies and thus build up a critical mass for **future EU-India research collaboration in the Biomass and Biowaste valorisation area**. The main objective of the SAHYOG Project Twinning workshop was thus to bring together project- and programme leaders for increased networking and matchmaking, by reviewing a large set of on-going projects and (industry) initiatives from EU and India. In addition, workshop participants **will identify major areas for collaboration** through interaction and engaging in project twinning. The following activities are possible under SAHYOG project twinning: research cooperation and exchange of researchers, organisation of joint workshops/meetings; development of common trainings; common literature reviews; exchange of tools, analytical methods and databases; exchange of data, information, knowledge and material.

Target groups and Participants

Participants are key stakeholders from EU Member States and India, including

- Representatives of governments and public bodies in EU and India;
- Project and –programme leaders of international biomass research and development;
- Experts and interested participants in international biomass sourcing and valorisation;
- Industry representatives from EU and India.

Workshop Organisation

The Workshop was organised jointly by NL Agency, Wageningen UR and WIP, on behalf of the **SAHYOG** Consortium. **NL Agency** has been involved in the facilitation of projects and supplementary research since 23008, in order to gain experience in the production and certification of sustainable biomass through the Netherlands Programmes for Sustainable Biomass, as well as other programmes. Through the support of certification, research and pilot/demonstration projects, NL Agency has acquired much knowledge and experience on biomass (for bioenergy) in many regions around the world. **Wageningen UR** contributes actively to solving scientific, social and commercial problems in the field of life sciences and natural resources, and approaches these issues from the perspectives of various disciplines, with an integrated approach and in close collaboration with governments, companies, stakeholder organisations, citizens, and other knowledge institutions. **WIP Renewable Energies** has long-term experience in the field of international technology cooperation, specifically on biomass and bio-waste technologies, including close cooperation links with a large variety of stakeholders in India. Moreover, WIP has been active in high-level event management for European conferences, workshops, and campaigns.

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Workshop Details

Venue *NH Hotel Utrecht, NL Agency*

Language: *English*

Website: *www.b2match.eu/sahyog*

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Workshop Summary

Welcome address to the Mini-Symposium

Presentation by Kees Kwant, NL Agency Renewable Energies, the Netherlands

Kees Kwant from NL Agency warmly welcomed all participants to the mini symposium and workshop and especially thanked the representatives from India for coming to Europe. He gave a presentation on the "Developments in Sustainable Biomass Valorisation", in which he started with the goals of the Symposium and Workshop, namely to discuss the following questions:

- What are the drivers for sustainable biomass utilization?
- What policies and roadmaps can lead to more sustainable biomass?
- What is the role of industry and of Private Public Partnerships?
- How can we collaborate?

In addition Mr Kwant gave an explanation on how Bio-Energy is related to the Bio-Based Economy, Bio-Economy, and the Carbon-Economy (see Figure 1). The core category is biomass as feedstock. The core challenges to produce this biomass sustainably are:

- Improving yields in agriculture (with better crops, cultures, nursing, care);
- Nutrient recycling;
- Optimal use of water (drip irrigation);
- Minimal pesticide (organic pest control);
- Minimal energy use in production chains.

Within the bio-based economy the sustainable production and use of biomass will respect the following "triple P": people (food security, land rights, prosperity), planet (soil, water, air, GHG, biodiversity), and profit (business cases).

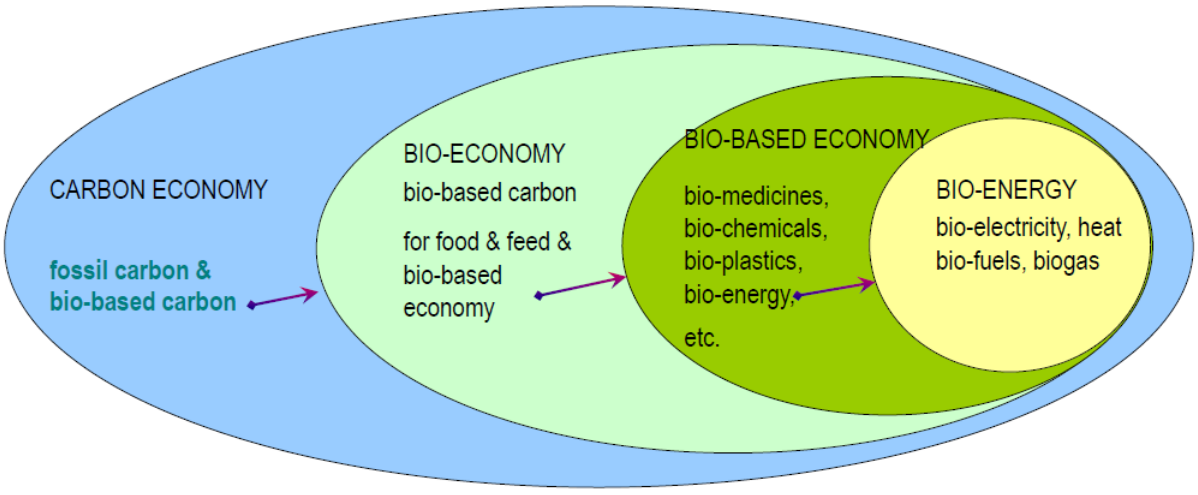

Figure 1: The Biobased Economy within the Bio-Economy

Mr Kwant further highlighted the so-called "Trias Biologica" which defines the cornerstones for an integrated production system for food, energy and materials: decarbonisation (minimising material and energy use), substitution of fossil carbon with sustainably produced bio-based carbon, and cascading (bio-refinery approach, circular chains).

Indo-European Cooperation in Research & Innovation

Speech by Philippe De Taxis Du Poet, European Commission

Philippe De Taxis Du Poet from the European Commission gave the inaugural address. He provided updated information on the recent trends in Indo-European Cooperation in Research & Innovation:

"India is attracting attention globally. Most European countries and companies have included India in their equation for research, innovation and growth. Today there is a dense and strong cooperation in science and technology between India, the EU and many of its Member States through a rich diversity of on-going bilateral initiatives, agreements and programmes. At policy level, the EU's "Innovation Union" and the Indian "Decade of Innovation" are converging strategies for achieving inclusive, sustainable and affordable innovation, towards finding solutions to growing societal challenges: India is the 3rd or 4th Third country in terms of participation in FP7, depending on counting the number of projects (more than 250) or the EC funding going to partners in India (more than 38 million EURO).

Regular EU-India coordinated calls for proposals have successfully been implemented in FP7 since 2007 in various S&T fields with a total budget of M€60 co-funded by India and the EU.

Enhanced synergies between India, the EU and its Member States are promoted via in particular the EU/MS-India group of senior officials (GSO) that was recently put in place.

However, there is too little industrial participation in the FP7 EU-India projects, and the EU/MS-India cooperation is still too fragmented. This fragmentation and the limited industrial mobilisation are good opportunities where Indo-European cooperation in R&I could be improved.

Pursuant to the EU–India Joint Declaration on Research and Innovation Cooperation signed at the 12th EU-India Summit on 10th February 2012, the EU/MS-India Group of Senior Official (GSO) was created for strengthening the Indo-European Research and innovation Partnership with enhanced coherence and complementarities between India, the EU and its Member States. The first GSO meeting took place on 8th October 2013 in Brussels where the preliminary orientations presented by three GSO Thematic Groups on water, health and energy. Two additional Thematic Groups are envisaged i.e. on ICT and the Bio-economy.

In these 5 sectors, on-going activities are implemented to (i) Narrow down the focus to a very limited number of priorities in these areas of mutual interest, (ii) Map existing EU/MS-India R&I cooperation activities in these areas of mutual interest, (iii) Identify gaps through interactions (e.g. brokerage/twinning events) bringing together project coordinators, stakeholders and programme owners in these areas, (iv) Identify EU/MS/India networking and funding schemes which should be mobilised to address the identified gaps including assessing the relevance of developing and proposing co-launch of EU/MS-India flagship initiative(s), and (v) Propose an implementation road map to be recommended by the GSO.

Regarding the above mentioned brokerage/twinning events, one was already organised at the occasion of the EU-India Science Technology and Innovation Days held in Paris on 10th - 11th October 2013 on Twinning of the Research, Innovation and Business communities in Affordable Health.

The next SAYHOG meeting that is foreseen in Delhi at the beginning of February 2014 might be an opportunity to have such a brokerage/twinning event on the bio-economy. The European Commission is discussing this idea with the Indian authorities as well as the European side (Member States).

Furthermore I would like to mention the new Coordinated India-EU ERA-NET "Inno Indigo" project to be launched in November 2013 as an additional instrument to contribute to the implementation of coordinated EU/MS-India activities in research and innovation through multilateral calls in areas of common interest.

In 2014 the EU-India innovation cluster-to-cluster mobility and exchange scheme will be jointly developed and co- launched. The organisation of the joint cluster matchmaking initiative shall stimulate SME involvement in joint innovation projects. Also to be launched in 2014 are multilateral initiatives involving several EU Member States and India such as the initiative in social sciences and the EU-India platform on social sciences and humanities."

Overview of the SAHYOG project

Presentation by Neeta Sharma, EU Coordinator SAHYOG, ENEA, ITALY

The EU Coordinator of the SAHYOG project, Neeta Sharma from ENEA, Italy, gave an overview on the SAHYOG project. At the very outset, she welcomed all the stakeholders from EU and India present at the meeting.

The objective of the project SAHYOG (Strengthening Networking on Biomass Research and Biowaste Conversion – Biotechnology for Europe India Integration) is to actively and effectively link research activities implemented within EU research programmes and related programmes by Indian national institutions. Targeted research areas concern biotechnological approaches for biomaterials and bioenergy production and sustainable conversion of biowastes.

The main activities of the SAHYOG project include inventories for biomass and biowaste resources, research projects and programmes, project twinning, short-term exchanges of researchers, summer schools, stakeholder workshops, as well as the development of roadmaps defining key RTD priorities and a Strategic Research Agenda (SRA) to facilitate concerted planning of future EU-India research initiatives in the area of biomass and biowaste.

Ms Sharma presented the various activities that have already been implemented in the project, such as:

- EU-India summer school on 9-15 June, 2013, at NTUA in Athens, Greece
- SAHYOG Expert's meeting on "EU-India Cooperation on Biomass Production and Biowaste Conversion" on 10 May 2012 in Bruges, Belgium
- SAHYOG Stakeholder Workshop EU-India Cooperation on Biomass and Bio-waste Research and Development on 6 June 2013 in Copenhagen, Denmark.

A fully searchable on-line database with European and Indian projects in the field of biomass is already available under: http://www.sahyog-projects-database.eu/. This database shall facilitate the twinning of projects.

The SAHYOG Inventory on the Biomass and Bio-waste Resource Potential in Europe and India will be integrated in a web based database, which will be launched at the end of 2013.

The Strategic Research Agenda (SRA), a core output of the project, is currently being prepared and will be published in February 2014.

The following main activities are planned during the next phase of the project:

- Short-term Exchange programme EU - India, 19-27 Nov. 2013
- Short-term exchange India - EU, March 2014
- Final conference & Brokerage event, 3-5 Feb. 2014, TERI, New Delhi, India
- Second summer school, May 2014, in India

The Netherlands Biobased Economy Policies

Presentation by Marc Nellen, Programme Direction Biobased Economy, Dutch Government, the Netherlands

Marc Nellen, Policy Advisor of the Department of Biobased Economy in the Netherlands, gave an introduction on the policies for sustainable biomass valorisation in the Netherlands. Generally, the core policy challenges are competitiveness, growing demand for resources, energy crisis, sustainability, and productivity. Thereby, more focus needs to be placed on cross sectorial collaboration and societal challenges. The main objectives for the development of a bio-based economy are:

- Optimal use of biomass (cascading) with bio refinery and development of bio materials (see Figure 2);
- Improve conditions for innovative biobased manufacturing industry;
- Criteria for sustainable production and use of biobased feedstock on EU level;
- Stimulate research innovation and room for demo projects and pilot plants;
- Remove bottlenecks in legislation and permits and create a level playing field for biobased business.

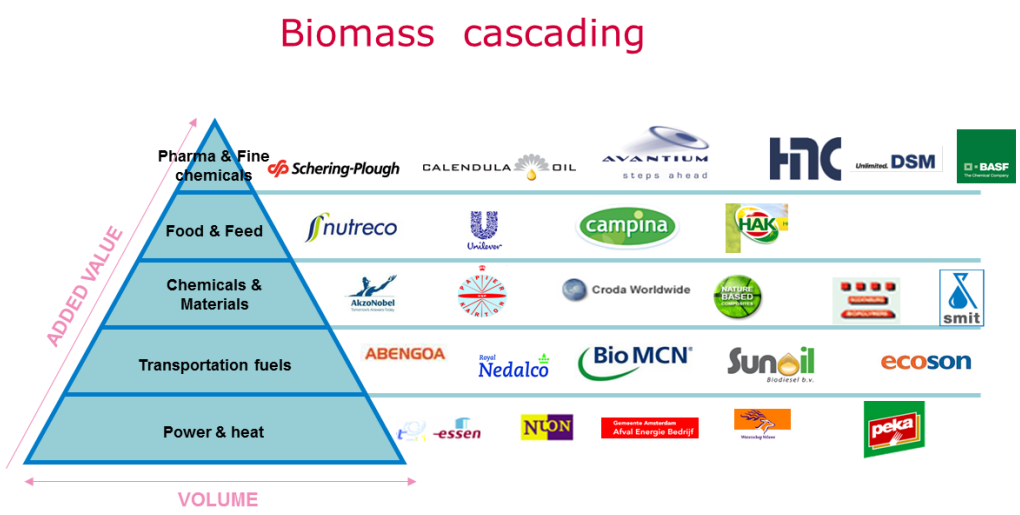

Figure 2: Cascading approach of biomass use

As an example of the certification of biobased products, Mr Nellen presented the “Green Deal” Initiative in which the Dutch Plastics and Rubber Association, Plastics Europe Netherlands and the company SABIC are involved. The ambition is to stimulate the use of renewable feedstock for the production of polymers by implementation of sustainability certificates.

Sustainable development of Biomass in an International context

Presentation by Daan Dijk, Rabobank SUSTAINABLE BUSINESS DEVELOPMENT, the Netherlands

Daan Dijk from the Rabobank presented the development of a biobased economy from the viewpoint of a bank. The strategy of Rabobank is (1) to accelerate sustainable agriculture and food supply, (2) to support the self-organisation of local communities through our local banks and through the Rabobank Foundation, and (3) to promote the transition to a circular economy.

Mr Dijk presented the current trend of companies that were traditionally mainly involved either in the chemical industry or in the food and agro industry, to get more and more involved in both sectors through activities on biomaterials development (Figure 3). He illustrated this development by various examples.

Figure 3: Involvement of companies in the chemical industry as well as in the food and agro industry

Industry's Perspectives on Biomass and Bioenergy Development

Presented by Priyangshu Sarma, TERI, India, on behalf of R. Chandihok, Director - Energy, Confederation of Indian Industry, India

Ms. R. Chandihok, Director - Energy, Confederation of Indian Industry, India, invited at the meeting to speak on the "Industry's Perspectives on Biomass and Bioenergy Development", was unexpectedly unable to join at the workshop. The Indian Coordinator of the SAHYOG project, Mr Priyangshu Sarma from TERI gave the presentation on her behalf.

The presentation included details on the Power Scenario in India. The Indian power market is coal based. Hydro and gas are playing an important role as well, while renewable power has grown sharply. With an 8-9% GDP growth target as part of the 12th Five Year Plan (2012-17), the energy supply will need to grow by a significant 6.5% annually. India will need to support economic growth by providing a secure and environmentally sustainable supply of energy. The energy related challenges in India are presented in Figure 4. They are influenced by the following factors:

- Domestic output of the primary energy resources, coal, oil and natural gas is seen declining over the medium-to-long term;
- The country's oil import dependence has crossed 80%;

- In 2012-13, the oil and energy import bill was the highest at $120 billion of which $98 was for crude oil and petroleum products and about $9-10 billion was for coal and gas;
- Current levels of import accounts for 8% of the total GDP-almost among the highest energy import bills globally and have an adverse impact on the current account deficit. (CAD);
- Rupee's fast depreciation, making oil imports in rupee terms more expensive;
- Rapidly rising share of oil to CAD owing to rising oil imports;
- Increase in oil prices, due to on-going geopolitical tensions.

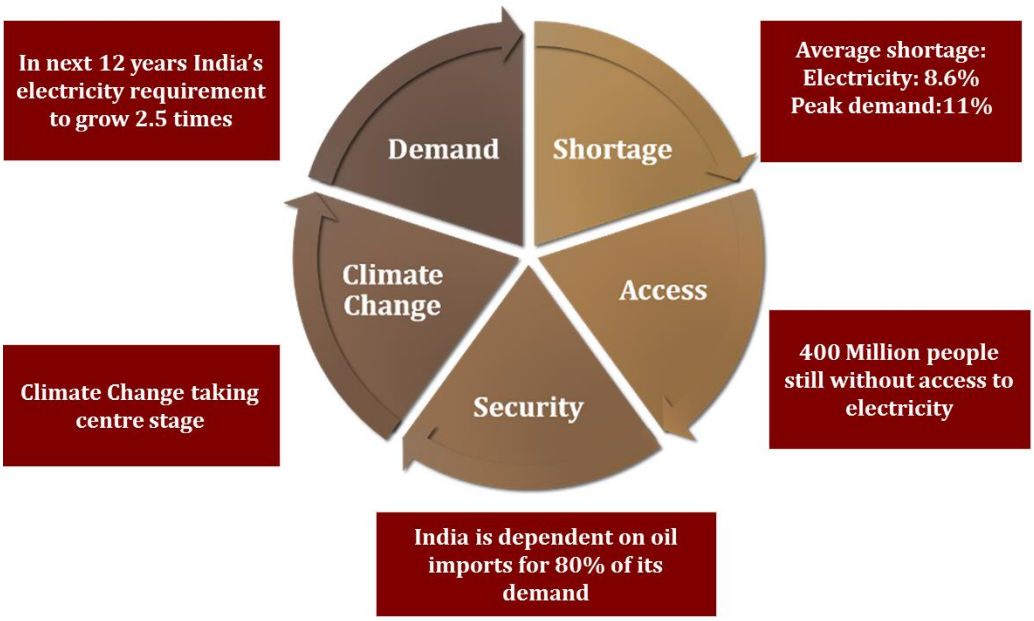

Figure 4: Energy challenges in India

Therefore, domestic energy production with safe & clean forms of energy urgently needs to be increased in order to meet the energy demand. Bioenergy constitutes a suitable alternative source of energy for India, as large amounts of raw material are available to be harnessed. Bioenergy in India is characterised by the following factors:

- As available agro-residues, forest waste and municipal waste can be used for biomass generation, the food versus fuel debate can be avoided;
- The biomass to bio energy model can become a significant contributor to the rural economy, if collection of these sources is addressed effectively;
- A Bio-based economy will help in reducing dependency on the rising fuel imports;
- The strategic shift in energy sourcing will enhance energy security by developing an alternative technology security;
- Biomass based power production extremely relevant primarily because of its potential to provide distributed power at the rural level;
- On the cooking front, over 70% of India's rural population depends upon biomass for cooking;
- The Government has put in place policies (tariff support) and financial incentives (capital and interest subsidies) for bioenergy development;

- There are challenges related to commercial sustainability, availability of appropriate technologies and market linkages.

A strategic agenda for mainstreaming Bioenergy and integrating it with energy infrastructure is shown in Figure 5. Measures need to be taken across the bioenergy value chain to achieve sustainable, low-carbon Bioenergy deployment in India.

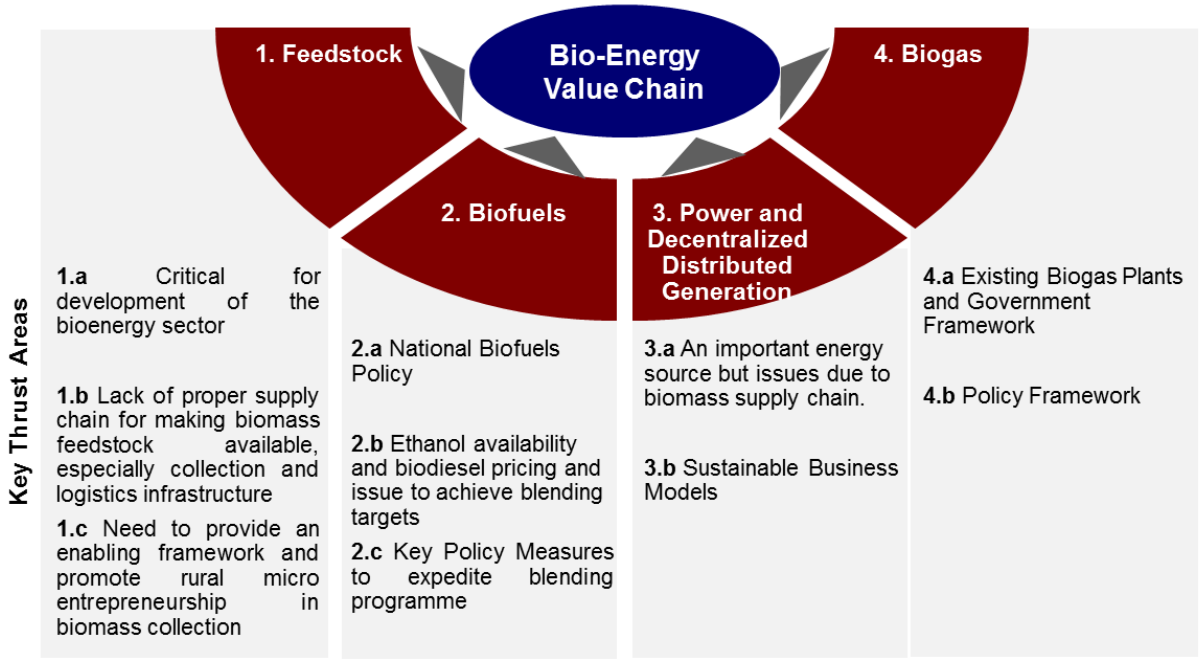

Figure 5: Strategic agenda for mainstreaming Bioenergy and integrating it with energy infrastructure

The following conclusions were given:

- Dependence on biomass is expected to continue in India, due to the projected increase in rural population in absolute terms and continued lack of access to commercial fuels in rural areas particularly for cooking
- Despite the enormous potential for bio energy in India, actual on ground execution of Bio energy technologies is falling short.
- Overall, the policies and programmes instituted have led to only sporadic success and have not succeeded in achieving their optimum technical potential.
- Need to evaluate and ascertain the availability of feedstock in the country and ensure that bottlenecks across the feedstock supply chain are eliminated
- Bioenergy holds a huge potential in the country given the current prices of liquid fuels
- Replacing 5 per cent of liquid fuels by biofuels could lead to savings of $5-6 billion annually.
- Need for a focused approach on bio-energy
- Growth of the bioenergy sector in India will greatly benefit from the formation of a Task Force in this area which can develop the policy levers across all segments of the biomass

Role of Public-Private Partnerships in International Collaboration

Presentation by Bram Brouwer, BE-Basic Foundation, The Netherlands

Bram Brouwer from the BE-Basic Foundation gave a presentation on the role of Public-Private Partnerships (PPP) in international collaboration.

BE-Basic is a foundation which focuses on R&D and innovation in biobased processes and has a budget of 45 M€ per year. Flagships in the BE Basic Foundation consisted in 2013 of the following topics:

- Carbon-based building blocks;
- Nitrogen-based specialties;
- Sustainable soil management and upstream Processing;
- Bio-construction materials;
- Microbial production of biofuels and bio-renewables;
- Synthetic biology;
- High-throughput experimentation & (meta)genomic mining;
- Environmental impact of chemicals, bio-based molecules and processes;
- Societal embedding of a biobased economy;
- Genomics for Industrial (Food) Fermentation;
- Energy, Policy & Sustainability;
- IsoButanol Platform Rotterdam.

Mr Brouwer presented various examples of these flagship initiatives and invited the audience, especially participants from India, to get in contact with him in order to define further PPP projects. Further information is available from the website at www.be-basic.org.

Twinning Workshop Objectives

Presentation by Dominik Rutz, WIP Renewable Energies, Germany

Dominik Rutz from WIP Renewable Energies gave an overview on the SAHYOG activities on project twinning between the European and Indian partners which is the main focus of the workshop.

After presenting the general policy background on renewable energies and international cooperation in Europe and India, Mr Rutz described the concept of Project Twinning. It is based on the exchange of research that goes beyond exchange or research results at regular scientific conferences and workshops. Through facilitating and coordinating Project Twinning, SAHYOG brings together Project Coordinators and other lead Partners from past and on-going projects as well as international networks in order to consolidate R&D results, exploit synergies and thus build up a critical mass for future EU-India research collaboration in the biomass and biowaste valorisation area. In addition, funding programme managers from selected countries are mobilized.

By twinning of projects, project participants discuss potential areas of scientific cooperation with their counterparts, based on pre-agreed identified priority subject areas. The Twinning is finalised upon approval of the joint work plan between the on-going projects and research networks. Furthermore, project leaders are asked to go beyond the scope of their project and identify new areas for collaboration in their field of work.

The SAHYOG Consortium defined seven research themes which are relevant for the development of a biobased economy in India and Europe, and in which twinning actions are foreseen:

- Feedstock production and genetic improvement of plants;

- Bioethanol production from lignocellulosic biomass;
- Thermochemical conversion technologies (pyrolysis, gasification);
- Anaerobic digestion technologies (biogas, biomethane, hydrogen);
- Algae production and conversion systems;
- Biomass to chemicals – the biorefinery approach;
- Sustainability and life cycle assessment.

As an important tool which shall facilitate the twinning activities, Mr Rutz highlighted the fully searchable on-line database which is available under: http://www.sahyog-projects-database.eu/. The projects have been categorised with respect to the focus of research (i.e. biomass resources, agricultural activity, conversion technology, end products), the involved stakeholders (type of research, type of organisation), as well as the drivers for research. With this database, twinning of specific research activities between actors from Europe and India, as well as the general EU-India cooperation for the realisation of a sustainable biobased economy shall be supported.

Figure 6: SAHYOG project database under http://www.sahyog-projects-database.eu/

Panel Discussion on EU-India R&D Collaboration: Areas for collaboration in Project Twinning

Moderator: Rob Bakker, Wageningen UR

Panellists:

- *R. P. Gupta, Department of Biotechnology, Bioenergy Center, India*
- *Kathy Elst, VITO, Belgium*
- *V. Sivasubramanian, Phycospectrum Environmental Research Centre (PERC), India*
- *Reeta Goel, GB Pant University of Agriculture & Technology, India*

In the panel discussion on EU-India R&D collaboration, the panel (Figure 7) as well as the audience defined areas for collaboration in project twinning. In conclusion, the following statements were given:

- Agricultural crops and their varieties are influenced by historical uses of commodities. This involves mainly food, feed and fibre production. The use of biomass for modern energy and by-products, such as chemicals is still rather new. Therefore breeding efforts have to be made in order to develop new varieties with specific characteristics for new purposes. At the same time they must be affordable for large scale commodity production.
- In the future, the production of algae may contribute to biomass supply. Especially for macro algae grown in the open sea, environmental impacts need to be minimised.
- A core focus of biomass use shall be placed on different types of waste.
- The proposal for the amended European Renewable Energy Directive (RED) puts emphasis on the use of waste materials. However, bioenergy plants that have only waste materials as input are often lacking economic feasibility.
- Projects in Europe need to be streamlined and synergies need to be used. European research is often fragmented due to various national research initiatives in the Member States.
- A major bottleneck is the transfer of research results into implementation by industry.
- Industry involvement is therefore important for the development of the biomass sector. However, the short-term focus of industry is to sell products. Industry is thus often reluctant to get involved in longer-term research and demonstration projects. Industry is often “buying” only ready-made technologies and start-up companies.
- The definition of “sustainability” can vary. The definition influences how sustainability shall be implemented.
- For EU-India cooperation, sustainability aspects shall be included in each project.

Figure 7: Panel Discussion on EU-India R&D Collaboration: Areas for collaboration in Project Twinning

Brokerage event: EU-India Twinning

Each participant had the opportunity to meet other participants to discuss opportunities for cooperation in more detail. For arranging the bi-lateral meetings advance online registration was used where participants could upload their short profiles to facilitate the selection of the brokerage face-to-face meetings (Figure 9). The profiles are still available under www.b2match.eu/sahyog (Figure 8) and can be used for the identification of twinning activities.

For more information on how to promote yourself, your project or organisation, see the last page of the agenda!

Figure 8: Workshop website (www.b2match.eu/sahyog) with profiles of the participants for twinning

Figure 9: Selected pictures of the bi-lateral meetings

Twinning Session 1: Feedstock production and genetic improvement of plants

Presentations by *M.N.V. Prasad, University of Hyderabad, India*

El Kasimoui Ouafik, University of Antwerp, the Netherlands

Report by *Rob Bakker, Wageningen UR, the Netherlands*

The first Twinning Session was attended by 14 partners, with about equal participation from EU and India. During the first presentation, M.N.V. Prasad from the University of Hyderabad gave an extensive overview of research and demonstration work on phytoremediation crops in India. Some highlights of this presentation:

- There are many different species grown in India for this purpose. They include sunflower, *Prosopis juliflora*, bamboo, and *Pistia stratiotes* (water lettuce). Each of these plants could be grown for different purposes, including energy generation;
- In general municipal solid waste could benefit from both energy generation and phytoremediation, in particular where leachate treatment is concerned;

- Besides annual and perennial crops, the speaker also touched upon growing algae in wastewater ponds, which is already done in a number of States in India. In addition, there is an opportunity to harvest “floating biomass” such as water hyacinth;
- A discussion was held about proper management for biomass production in wastewater ponds: in order to keep biomass a sink for nutrients and contaminants, removal rates for biomass should be balanced with the need to take up contaminants;
- At the end of the presentation an important comment was made: there is a textbook available produced by GB Pantt University with an overview of different species grown in India.

Figure 10: Participants of Twinning Session 1

During the second presentation, El Kasimoui Ouafik from the University of Antwerp gave an overview of the research and demonstration on short rotation coppice (SRC) in Belgium, for bioenergy production. The research includes a full analysis of economic feasibility and environmental impact of growing SRC in Europe, which includes actual measurement of greenhouse gases within the 18 ha plantation in Flanders. A few highlights of the presentation include:

- Overall, the production of SRC led to a positive energy balance and reduction of greenhouse gases
- The economic feasibility of the system is affected strongly by the yield of the crop, as well as size of harvesting machinery. Importation of relatively small harvest machines from Denmark led to a much more favourable collection cost, compared to the machinery available in the region
- In Belgium, the main bottleneck for further expansion of energy crops is the non-availability of agricultural land. Furthermore, it is difficult to convince farmers to willingly commit larger acreage of land for energy crops for extended periods of time (up to 21 years needed in some cases to break even)

After the presentations, each participant was asked to name two most prominent topics for an Indo-European Joint Research Agenda. The topics that were named more than once are included below:

- Biomass growth in wastewater plants; bioremediation in sewage systems, etc.
- Using existing wastes (agro-forestry, municipal, industrial) as feedstock for bioenergy or biobased products more effectively
- Microalgae and Seaweed Production. For Seaweeds, it was mentioned that a study should be done to investigate the real potential for seaweed production in India, given its extensive coastline.
- Sustainability and economic profitability assessment for full systems analysis: as the speaker from Belgium showed, there are a number of very extensive models available, these could be applied to biomass production in India
- Capacity building of farmers should be done, both at EU and India levels. In particular, provide farmers with proper tools to evaluate investing in energy crops
- A comment was made that the forest sector was missing e.g. forest residues were not discussed

The following organizations, which were not participating in the workshop, could be approached: IICT Mubai, NWST, NBRI and CSTFR. Furthermore, those organisations responsible for maintaining the energy grids should be included.

Twinning Session 2: Bioethanol production from lignocellulosic biomass

Presentations by *Pramod Kumbhar, Praj Industries, India*

Johan Thevelein, KU Leuven, Belgium

Report by *Kees Kwant, NL Agency, the Netherlands*

This session was attended by 11 participants. Pramod Kumbhar from Praj Industries, India, gave the first presentation. The following topics were presented:

- Builds equipment for breweries, ethanol plants, wastewater, 500 references in 50 countries
- Innovation Centre, 25 M$ in 2008 labs and 1tpd pilot plant -> Centre of Excellence
- Expertise: Agro-feedstock, Microbiology and Bioprocess
- India: Oil import bill: 100 Billion $ BUT 165 Mton lignocellulosic residues
- Opportunity: Lignocellulosic ethanol
- Challenges: Feedstock, OPEX, CAPEX, blending mandates
- Critical: Feed for Cattle versus Fuel, Land, Supply chain, Pricing, Handling, Sustainability
- Hydrolysis:

  acid + enzyme: DSM, Praj, Abengo, moderate on OPEX

  alkali + enzyme: Dupont, high on OPEX

  steam explosion + enzyme: Chemtex, moderately, high on opex

  ALL: high on enzyme cost
- Fermentation with C5/C6 sugars (Terranol, DSM,)
- cost: Praj: 5 – 7 $/gal, POET /DSM, 10 $/gal, Beta Renwables /Clariant: 5$/gal ref: Daily Biofuels Digest, January 2013
- Praj: best class, No discharge

- Demonstration to be commissioned in 2014, 100 ton dry matter/day, 30 kliter EtOH/day, lignin goes to boiler.
- Enzymes supplied by producers from abroad (Novozymes, etc.)
- NEXT Biorefinery
- Collaboration model: Joint Development OR in kind Venture Capital

Figure 11: Participants of Twinning Session 2

The second presentation was given by Johan Thevelein from KU Leuven, Belgium. The following key messages were provided:

- Flanders Institute of Biotechnology, (VIB), 1200 researchers, headquarters Ghent,
- Yeast for 2nd gen bioethanol, Xylose and Arabinose C%
- NEMO project: Start with industrial yeast strains.
- Xylose fermentation, slow, gene modification,
- Stable strain developed, but negative side effects, NOW, new strain, in evaluation
- GOAL: get a strain to be used in industry
- Joint program with Praj is already existing
- Follow up: NEMO, new consortium
- cellulose isomerase was introduced, but needs to be improved
- screening different strains could be interesting
- yeast as
- yeast strains exchange between India/EU is possible
- this yeast should follow the bacterial way and not the fungal way
- isomerase pathway is the best
- Biodegradation, by lignin degrading Paecilomyces sp.

After these presentations, various approaches for concrete collaboration between EU and India in the field of lignocellulosic ethanol were discussed. An opportunity would be the new

Horizon 2020 call for proposals in which various workshop participants could be involved. Proposals for a Joint Research Agenda could include:

- Development of more active, cheaper enzymes
- Development of smart enzyme systems for simultaneously conversion of cellulose and lignins
- Development of yeasts that can produce cellulases and convert sugars in a range of products (EtOH, Butanol etc.)
- Development of smart processing equipment
- Valorisation of lignin by converting them into bioaromatics by biological and thermal catalysis

Twinning Session 3: Biorefinery: chemicals and materials from biomass

Presentations by *P. Sarma, TERI, India*
Rob Bakker, UR, the Netherlands
Deepak Pant, VITO, Belgium

Report by *Rob Bakker, Wageningen UR, the Netherlands*

This session was attended by more than 20 participants, with roughly equal participants from EU and from India. Within this session, three presentations were held:

Priyangshu Sarma from TERI gave an overall view of the approach in India regarding Biorefineries. Given the strong focus on Bioenergy and biofuel production, as emphasised in India's National Biofuel Policy, the first biorefinery's in India will be energy-driven. Examples of current development are the recent MoU between ONGC and the company Chempolis which aims to build a number of biorefineries in India based on agricultural residues.

Rob Bakker from Wageningen University and Research Centre (WUR)gave an overview of current biorefinery and biochemicals research at Wageningen. Currently, the biomass-to-chemicals programme is focused on a two-pronged approach: both existing chemicals are produced from biomass for drop-in in existing processes (Examples are BTX and aromatic compounds from lignin) as well as new chemicals to produce biobased intermediates (Examples are organic acids through fermentation, and sugar-based carboxylic acids based on chemical catalysis). He also highlighted recent work on biorefinery of seaweeds, to produce chemicals, materials, and bioenergy.

Figure 12: Participants of Twinning Session 3

Deepak Pant from VITO gave an overview of the Water4Crops project, as well as further activities with reference to volatile fatty acid platform. The advantage of this technology is that relatively dilute organic waste streams can be used to produce a host of biomass intermediates and chemicals/fuels.

After the presentations, a number of priority research topics for twinning were discussed by the participants. The most prominent topics in the discussion included:

- Refinery of micro- and macro algae
- Waste valorisation through VFA platforms
- Conversion and valorisation of lignin, by-product from lignocellulosic ethanol production
- Combining thermochemical and biochemical conversion pathways within one biorefinery
- Pyrolysis oil platform.
- In regard to plant-based oil refinery, there may be options to interest the Aviation sector for producing and refining non-food plant oils in India
- Finally, a comment was made that before prioritizing to any specific platform or chemical intermediate, a proper market study should be done for India, including an estimation of economic potential. Studies from other regions in the world, including EU, are available as reference

Twinning Session 4: Thermochemical conversion technologies

Presentations by *S. Dasappa, Indian Institute of Science, India*
D. Chiaramonti, University of Florence, Italy
Report by *Rupam Kataky, Tezpur University, India*

This session was attended by only 7 participants. S. Dasappa from the Indian Institute of Science presented the concept of an open top gasification reactor for multi fuel loads. The following details were presented:

- Cummins INDIA is selling the equipment of an open top gasification reactor with guarantees for 100,000 hours of operation
- The electric efficiency is between 25 and 30%
- An atlas for bioenergy in India is available at: http://lab.cgpl.iisc.ernet.in/Atlas
- A SWOT analysis was conducted for the open top gasification reactor
- Strengths: decentralized, locally
- Weaknesses: large scale not proven, the costs are eventually high
- Opportunities: costs came down
- Drivers: focus on priority sectors
- A key opportunity is the use of waste materials including Municipal Solid Waste (MSW)
- cooperation with the University of Florence helped to develop the gasification technology

Figure 13: Participants of Twinning Session 4

The second presentation was given by David Chiarmonti from the University of Florence, Italy. The following messages were presented:

- The University of Florence is conducting research on pyrolysis, gasification and bioethanol
- The BioLyfe project developed and set-up a bioethanol plant with BETA Renewables in Tortona
- Research and demonstration on gasification is implemented jointly with the Indian Institute of Science
- Pre-treatment of the feedstock is a crucial step in the gasification process: The fuel shall be already pre-treated during harvest to be suitable for conversion
- As the Capex is 6,000 €/kWel incentives are needed
- Standards for procurement of gasifiers would allow easier financing

In the joint discussion, opportunities, bottlenecks and challenges were discussed in the field of thermo-chemical conversion technologies. The following recommendations were discussed:

- More research is needed on pre-treatment of biomass for gasification
- Pyrolysis and gasification are processes that could be included in various biorefinery concepts
- Pyrolysis oil as well as syngas needs to be valorised. The use of these substances in the chemical and processing industry shall be investigated, in addition to energy generation.
- An inventory of project failures (due to technical and non-technical reasons) and the lessons learnt could help in future projects.

Twinning Session 5: Algae production and conversion systems

Presentations by *V. Sivasubramanian, Phycospectrum Environmental Research Centre (PERC), India*

L. Sijtsma, SPLASH

M. Prussi, University of Florence, Italy

Report by *Deepak Pant, VITO, Belgium*

In the session on algae production and conversion systems, three presentations were given. An extensive overview was given by V. Sivasubramanian from PERC in India about algae research in India. The speaker serves on the review committee of most proposals in India, and has also been in contact with Industries in India. The following statements were given:

- For Algal biomass most conversion technologies (biochemical, thermochemical and direct combustion) are available but availability of biomass is itself limited.
- Most projects are funded by MNRE, DBT, CSIR, private industries; not much large-scale projects and most are at lab-scale.
- Macro algae has some advantages; main work at CSMCRI in Bhavnagar but limited to 4 species only.
- India has large coastline (7,500 km) and 841 species of macro-algae are there
- Some real cases shown from India; Onshore in Tamil Nadu
- There are Salt tolerant species; yeast fermenting mannitol and galactyose is also a challenge
- Microalgae (freshwater algae) include mainly Botryococcus
- University of Madras is running a project with ABAN (a private company) in raceway ponds
- Dry weight of 1.75 g/L was achieved on 12th day of Botryococcus
- Harvesting done by Electro flocculation, chemical flocculation & filter press
- ICGEB is the only group in India working on genetic modification of algae (Chlorella, Chlamydomonas)
- Project in thermal power plant in Kolkata (50 kL raceway pond); Harvesting by auto- and chemical flocculation; 100 to 500 mg/kL flocculates
- Capex for tank- 40 Lakh INR; < 30 cent/kg of dry weight for it to be economic
- Pulsed magnetic field in improving the algal biomass by giving them stress; improves both biomass and oil content
- Phycoremediation at SNAP at Ranipet, India; reduced sludge and pH correction by adding algae; Aquaculture feed and biofertilizer are two products made by this algae
- Also at Leather industry, confectionary industry, detergent industry phycoremediation algae ponds carried out
- Petrochemical waste can also be treated (Rubiales oil company in Colombia)
- The National Institute of Ocean Technology (NIOT) also working in this area.
- NIIST, Trivendram has program on growing marine alage
- Best pilot plant in India in IIMT, Bhubaneshwar; has best raceway pond
- IIT Kharagpur developing process for dewatering
- NCl Pune is working on Electroflocculation

- IIP, Dehradun are integrating algal biofuels with lignocellulosic biomass
- BITS Pilani to fix CO2 via algae
- IBST, and one in Trichy supports a central culture collection (DBT supported)
- Dr Prasad asked about *Dunalilella* but it is for carotenoids
- Do you focus only on cultivation or also on extraction? – So far the focus has been on cultivation only but industries are already producing some products.
- Anything coming from waste is not taxed in India

The second presentation was given by Lolke Sijtsma from Wageningen UR, explaining theobjectives and results of the FP7 SPLASH project.

- Objective of Splash: Develop a biobased platform using *Botryococcus* as an example
- AlgaePARC in Wageningen: pilot research facility
- Cost estimate of microalgae production; 1 ha (10€/kg); 100 ha (4€/kg); 0.6€/kg (possible)
- Make it more economic by focusing on high value product first
- Product driven project
- Sugar hydrocarbons→ yarns, biobased plastics and some building blocks
- 10,000 tonnes of algae produced globally per year
- Challenge is to **improve production by 10X and reduce costs by 10X**
- Mainly work in closed photobioreactors
- Two aspects- Biotech production and Chemical Conversion
- Transferring the gene of Botryococcus into Chlamydomonas or improve the original strain
- Production & in-situ extraction of products from living algae
- PET (terephthalic acid) → FDCA based plastics
- Fuel4Me- production of biofuel from microalgae
- Challenges are scale-up, production costs and energy balance
- Algae genomics

In the third presentation Matteo Prussi from the University of Florence, Italy, presented activities of Re-CORD and provided the following details:

- Renewable Energy consortium for R&D (RE-CORD)
- A lot of pilot plants ongoing/in development
- Involved in Microalgae research as well
- Leading the design phase of several plants (BIOFAT FP7 project; ALGAEFUELS from Chile)
- 1 ha Pilot plant; 10 ha Demo plant; 90 tonnes/year of biomass (Targets)
- The layout of the plant was shown in the presentation: Camporosso green house
- Since the location is far from ocean, the main aim is to recover as much water as possible; looking at ultrafiltration
- Carbonate salts can be an issue

- Exhaust gases of vegetable oil (having 8% CO_2)
- Energy assessment (net energy ratio)
- The big energy consumption is for Harvesting and blower (for CO_2) for feeding
- Trying to increase the concentration of CO_2 in the flue gas
- Pushing on UF for pre-treatment
- In Chile, a plant of 0.7 ha (biofuel) and 1 ha (protein and fish feed)
- Why did you put the plant so far from sea if there are issues with water? They had no choice in the project; It also give opportunity to work on water saving
- Feeding flue gas will be a problem as it is at high temperature (140 °C); so it has to be scrubbed with water before feeding
- Will use centrifuge, UF for harvesting

In the final discussion, the following topics were named as priority topics for Indo-European collaboration on microalgae:

- Algae feedstock and large scale genotype from India (for Europe) and Harvesting downstream processing of Europe
- Harvesting, Refining of final product
- Harvesting, Biorefinery for few important products
- Salt tolerance, using mannitol and galactose
- Potential of algae strains available in India
- Find the best spots in India in order to reduce costs (lowest production costs)
- Integrate wastewater treatment with algae; bioenergy and products
- Macroalgae & Microalgae cultivation, harvesting , biorefinery (of interest for India) from Europe
- Prospecting for value added specific products from the culture collections; large scale reactors
- Screening of cultures; process analysis and LCA
- Heterotrophic algae; pentose sugars as feed for heterotrophic algae
- Focus on small scale systems; going step by step
- Jet fuels (aviation industry) for producing fuels; possible places to establish pilot plants
- Industrial effluent treatment; biorefinery
- Use of proteins for algae; animal feed is a good market in India.

Twinning Session 6: Anaerobic digestion technologies (biogas, biomethane, hydrogen)

Presentations by *S.V. Mohan, CSIR-Indian Institute of Chemical Technology, India*

Richard Blanchard, Loughborough University, UK

Report by *Dominik Rutz, WIP Renbewable Energies, Germany*

This session was attended by about 10 participants. S.V. Mohan from CSIR-Indian Institute of Chemical Technology gave a presentation about anaerobic digestion technologies for treating waste materials and producing biohydrogen.

Richard Blanchard from Loughborough University, UK, presented the status of the European biogas market, including several European funded projects. He highlighted the following research fields for twinning with India:

- Feedstock mapping
- Feedstock characterization
- Pilot plants
- Solar-biogas hybrid
- Digester optimisation
- Biogas quality
- Remote monitoring

These two presentations were followed by a general discussion about cooperation opportunities and research needs. The following conclusions were drawn::

- Anaerobic digestion (AD) is generally a mature technology in Europe and in India. However, its potential is much larger than its current application. Research must focus on improving the overall efficiencies and on reducing costs.
- Anaerobic digestion involves very different scales ranging from household biogas plants with small digesters of few cubic metres to large-scale industrial plants in the multi-megawatt range. The related technologies must be addressed separately.
- A major focus of feedstock shall be placed on various types of waste, including waste water, municipal solid waste, agricultural waste and industrial waste. Research is needed on both, mono-digestion for single types of feedstock or co-digestion in which multiple feedstock is used. Special focus of research must be placed on the microbiology of the AD process.
- Research on the microbiology including pre-treatment (e.g. separate hydrolysis), collaboration of different bacteria, use of enzymes and micro-nutrients is needed for different feedstock types.
- Research on AD process parameters and efficiency is needed, e.g. to reduce the retention time and to increase process stability.
- The integration of AD in a biorefinery with multiple products needs to be investigated. This includes the production and use of hydrogen, volatile fatty acids (VFA) and the use of digestate (e.g. for further processing).
- The use of digestate as fertilizer substitute needs to be investigated, depending on the different framework conditions, as its use is influenced by legal definitions and aspects: fertilizer, waste, hygienic aspects etc. Therefore digestate from different feedstock must be characterized.
- Remote monitoring and control systems need to be developed, especially for plants in rural areas.

- Various uses of biogas need to be investigated. Especially gas cleaning (sulphur removal), gas storage and compression, gas logistics (transport in containers) and upgrading to biomethane quality (>95% CH_4 content) needs to be investigated. Cost reduction of upgrading technologies for biomethane production and injection into the natural gas grid or for use in transport is an important research topic.

Figure 14: Participants of Twinning Session 6

Twinning Session 7: Sustainability and life cycle assessment

Presentation by
- Aksay Patel, Utrecht University

- Indu Shekhar Thakur, J. Nehru University, India

- Rocio A. Diaz-Chavez, Imperial College London, UK

- L. Pari and E. Alexopoulou, FIBRA Project, Italy

Twinning sessions 1/2, 3/4 and 5/6 were parallel sessions in which the participants had to choose one topic. As sustainability is a horizontal topic that addresses all biomass projects and all steps of the value chains, twinning session 7 on "Sustainability and life cycle assessment" was a general session which was attended by all participants.

In the beginning of this session four presentations were given. The first presentation was made by Aksay Patel from Utrecht University. He gave a general introduction into sustainability and life cycle assessment aspects. He highlighted the following cooperation opportunities:

- Data from India show various uncertainties. Especially human health and water stress needs to be considered.
- Research may include an Ex-ante analysis for industrial processes and for consulting governments.
- Methodologies need to be developed in collaboration with industry as this increases data availability.

Figure 15: Participants of Twinning Session 7

Indu Shekhar Thakur, from J. Nehru University, India, presented his research activities which focus on pollutants, bioremediation and bioconversion. Especially pollutants from pulp & paper industry, tannery, and landfilling need to be considered as they have impacts on soil and water. Synergies could be created if pollutants are reduced by biomass production for bioenergy. He suggested following research topics for India-EU cooperation:

- Inventories, data generation and characterization of lignocellulosic and man-made biowaste generated from municipal and industrial sites in India and EU.
- Development of effective microbial cell factories by isolation and characterization of micro-organisms (fungi, bacteria and microalgae) from indigenous sources and continuous enrichment (molecular breeding/bioaugmentation) and enzymatic cocktail based methods, and optimisation of processes parameters for recovery of bioethanol, biomethane and biohydrogen (biofuel) and chemicals for zero waste at laboratory scale in batch reactor.
- Pilot scale demonstration of the methods for production of biofuels (biogas, bioethanol and biohydrogen) and chemical for zero waste.
- Testing of techno-economic viability of the above technologies by life-cycle assessment (LCA) method to evaluate the performance of the developed technologies building upon existing and on-going LCA activities in the field of bio-based products and processes.

Rocio A. Diaz-Chavez presented research activities on sustainability at Imperial College London, UK. She gave a summary of case studies of the Biocore project with 2 regions in India (http://www.biocore-europe.org). Her conclusion and recommendations included:

- A combined methodology for social assessment demonstrates to be better than considering only sLCA due to the multiple synergies of the sector
- It is possible to mitigate or prevent some of the possible negative impacts.
- Willingness to sell the feedstock and the possible competition with other sectors particularly other agro-industries and forestry associated sectors main considerations
- Policies need to consider the activities of stakeholders and create an environment for investment
- Job creation needs to be addressed for particular cases to avoid creating expectations and consider other stages in the supply chain
- Skills may be possible to improve from existing sectors

- Multiple products will need to look for standards (particularly in the EU) that are not yet available (mainly C content)
- Research and rural development need to be pushed further for a biorefinery to be set up.
- For the establishment of a biorefinery a proper feasibility study along with social and environmental impact assessment will be required, for the whole supply chain.
- Large investments should consider the application of the Equator Principles to comply with international sustainability standards.

Efi Alexopoulou and Luigi Pari gave a joint presentation on the Fibra Project: Europe and China connection on fibre crops (www.fibrafp7.net), which includes twinning activities that are similar to the SAHYOG activities. The FIBRA networks main target is to link the research activities carried out on both EU and China and to provide a long term vision on future common research activities on fibre crops and will improve researchers' training opportunities. The expected impact of FIBRA project is the establishment of an effective and wide co-ordination of the research activities on fibre crops in Europe and China thus to stimulate a broad stakeholders' participation and generate common research programmes to fulfil the international EU policy targets.

Annex 1 – Workshop Agenda

Monday, 28th October 2013

Location: NH Hotel Utrecht, Jaarbeursplein 24, 3521 AR Utrecht

09:00 *Registration*

09:30 **Welcome address to the Mini-Symposium**

KEES KWANT, NL AGENCY RENEWABLE ENERGIES, THE NETHERLANDS

09:45 **Indo-European Cooperation in Research & Innovation,**
PHILIPPE DE TAXIS DU POET, EUROPEAN COMMISSION

10:00 **Overview of the SAHYOG project**

NEETA SHARMA, EU COORDINATOR SAHYOG, ENEA, ITALY

10:15 **Governmental Policies on Biomass Valorisation**

THE NETHERLANDS BIOBASED ECONOMY POLICIES
MARC NELLEN, PROGRAMME DIRECTION BIOBASED ECONOMY, DUTCH GOVERNMENT

Coffee/Tea Break

11:00 **Sustainable development of Biomass in an International context**

DAAN DIJK, RABOBANK SUSTAINABLE BUSINESS DEVELOPMENT

11:30 **Perspectives on Biomass valorisation in International context**

INDUSTRY'S PERSPECTIVES ON BIOMASS AND BIOENERGY DEVELOPMENT
R. CHANDIHOK, DIRECTOR – ENERGY, CONFEDERATION OF INDIAN INDUSTRY, INDIA

ROLE OF PUBLIC-PRIVATE PARTNERSHIPS IN INTERNATIONAL COLLABORATION,
BRAM BROUWER, BE-BASIC FOUNDATION, THE NETHERLANDS

12:30 *Lunch*

13:45 **SAHYOG Twinning Workshop Objectives**

DOMINIK RUTZ, WIP RENEWABLE ENERGIES, GERMANY

14:00 **Panel Discussion on EU-India R&D Collaboration:**
Areas for collaboration in Project Twinning

MODERATOR: ROB BAKKER, WAGENINGEN UR

PANELLISTS:

- R. P. GUPTA , DEPARTMENT OF BIOTECHNOLOGY, BIOENERGY CENTER, INDIA
- KATHY ELST, VITO, BELGIUM, EUROPE
- V. SIVASUBRAMANIAN, PHYCOSPECTRUM ENVIRONMENTAL RESEARCH CENTRE (PERC), INDIA
- REETA GOEL, GB PANT UNIVERSITY OF AGRICULTURE & TECHNOLOGY, INDIA

15:00 *Coffee/Tea Break*

15:45 ***Brokerage event: EU-India Twinning***

Each participant will have the opportunity to meet other participants to discuss opportunities for cooperation in more detail. For arranging the bi-lateral meetings advance online registration is needed. Prior to the workshop, short profiles of registered participants are shown online to facilitate the selection of the brokerage face-to-face meetings. Please add your profile for the brokerage event under: www.b2match.eu/sahyog

For more information on **how to promote yourself, your project or organization**, see the last page of the agenda!

17:45 *Networking drink*

Tuesday, 29th October 2013

Location: NL Agency Offices; Croeselaan 15, 3521 BJ Utrecht

9:00 **Twinning Session 1: Feedstock production and genetic improvement of plants**

- M.N.V. Prasad, UNIVERSITY OF HYDERABAD, INDIA
- MR EL KASMIOUI OUAFIK, DEPARTMENT OF BIOLOGY, UNIVERSITY OF ANTWERP

Twinning Session 2: Bioethanol production from lignocellulosic biomass

- PRAMOD KUMBHAR, PRAJ INDUSTRIES, INDIA
- JOHAN THEVELEIN, KU LEUVEN, BELGIUM

10:30 *Coffee/Tea Break*

11:00 **Twinning Session 3: Biorefinery: chemicals and materials from biomass**

- P. SARMA, TERI, INDIA
- ROB BAKKER, WUR; DEEPAK PANT, VITO

Twinning Session 4: Thermochemical conversion technologies

- S. DASAPPA, INDIAN INSTITUTE OF SCIENCE, INDIA
- D. CHIARAMONTI, UNIVERSITY OF FLORENCE, ITALY

12:30 *Lunch*

14:00 **Twinning Session 5: Algae production and conversion systems**

- V. SIVASUBRAMANIAN, PHYCOSPECTRUM ENVIRONMENTAL RESEARCH CENTRE (PERC), INDIA
- L. SIJTSMA, SPLASH; SUSTAINABLE POLYMERS FROM ALGAE SUGARS AND HYDROCARBONS
- M. PRUSSI, UNIVERSITY OF FLORENCE, ITALY

Twinning Session 6: Anaerobic digestion technologies (biogas, biomethane, hydrogen)

- S.V. MOHAN, CSIR-INDIAN INSTITUTE OF CHEMICAL TECHNOLOGY, INDIA
- RICHARD BLANCHARD, LOUGHBOROUGH UNIVERSITY

15:30 *Coffee/Tea Break*

16:00 **Twinning Session 7: Sustainability and life cycle assessment**

- AKSHAY PATEL, UTRECHT UNIVERSITY
- INDU SHEKHAR THAKUR, J. NEHRU UNIVERSITY
- ROCIO A. DIAZ-CHAVEZ, IMPERIAL COLLEGE LONDON, UK
- L. PARI, FIBRA PROJECT, ROME

16:45 **Twinning Round Table:**

Collaboration and follow-up actions – Reports from the twinning sessions
CHAIR: DOMINIK RUTZ, WIP RENEWABLE ENERGIES, GERMANY

17:30 **SAHYOG Twinning: Summary and Follow up**

ROB BAKKER, WAGENINGEN UR, NETHERLANDS

18:00 *Closure of Workshop*

The SAHYOG Project

The objective of the SAHYOG project is to actively and effectively link research activities implemented within EU research programmes and related programmes by Indian national institutions in the fields of biomass research and bio-waste conversion to prepare a Strategic Research Agenda and a roadmap for the advancement of RTD with mutual benefits.

SAHYOG is supported by the European Commission within the 7th Framework Programme (FP7-289615) and by the Department of Biotechnology (DBT) of the Indian Ministry of Science and Technology. It is coordinated by the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) and The Energy and Resources Institute (TERI) from India, and the consortium includes 7 partners from Europe and 6 partners from India.

More information is available at the SAHYOG project website: www.sahyog-europa-india.eu

The SAHYOG Consortium

- ENEA – Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Italy (EU Coordinator)
- TERI – The Energy and Resources Institute, India (Indian Coordinator)
- ARTI – Appropriate Rural Technology Institute, India, Pune
- CSIR – Council for Scientific & Industrial Research, India
- CSIR – Council for Scientific & Industrial Research – Indian Institute of Chemical Technology (IICT)
- DLR – Deutsches Zentrum für Luft – und Raumfahrt e.V., Germany
- GB Pant University of Agriculture & Technology Pantnagar, India
- Jawaharlal Nehru University, India
- National Technical University of Athens, Greece
- NL Agency – Ministry of Economic Affairs, The Netherlands
- Tezpur University, India
- VITO – Vlaamse Instelling voor Technologisch Onderzoek, Belgium
- Wageningen University and Research Centre – Food and Biobased Research / Wageningen International, The Netherlands
- WIP Renewable Energies, Germany

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Annex 2 – List of Participants

First Name	Last Name	Organisation	Country
Efhymia	ALEXOPOULOU	Center for Renewable Energy Sources and Saving / CRES / Biomass Department	Greece
Robert	BAKKER	Wageningen UR - Food & Biobased Research	Netherlands
Richard	BLANCHARD	Loughborough University	United Kingdom
Tomas	BRANDBERG	Boras University	Sweden
Christine	BUNTHOF	Wageningen UR	Netherlands
Rasika Chandihok	CHANDIHOK	Confederation of Indian Industry	India
David	CHIARAMONTI	RE-CORD (Univ.of florence)	Italy
S.	DASAPPA	Indian Institute of Science	India
Peet	DE BRUIJN	De Bruijn Advice & Practice	Netherlands
Rocio A	DIAZ-CHAVEZ	Centre for Environmental Policy, Imperial College London	United Kingdom
Ludo	DIELS	VITO	Belgium
DIEYE	EL HADJI AMADOU	GROUP MBAYJAH	Others
Ouafik	EL KASMIOUI	University of Antwerp	Belgium
Kathy	ELST	VITO	Belgium
REETA	GOEL	GOVIND BALLABH PANT UNIVERSITY	India
Ravi Prakash	GUPTA	Bioenergy Center	India
Emmanuel	KOUKIOS	National Technical University of Athens (NTUA)	Greece
Pramod	KUMBHAR	PRAJ Industries Ltd.	India
Kees	KWANT	NL Agency, Ministry of Economic Affairs	Netherlands
S Venkata	MOHAN	CSIR-Indian Institute Of Chemical Technology	India
Kees	MOKVELD	NL Agency	Netherlands
Luis Antonio	NIETO DE LA FUENTE	FUNDACION CIDAUT	Spain
Sylvestre	NJAKOU DJOMO	University of Antwerp	Belgium

Deepak	PANT	VITO	Belgium
Electra	PAPADOPOULOU	CHIMAR Hellas S.A.	Greece
Luigi	PARI	ENTECRA	Italy
Matteo	PRUSSI	re-cord (University of Florence)	Italy
Foluke	QUIST-WESSEL	Biomass Research	Netherlands
Fee	ROMEIN	TERI European Head Office	Netherlands
Dominik	RUTZ	WIP Renewable Energies	Germany
Priyangshu	SARMA	The Energy and Resources Institute	India
Neeta	SHARMA	ENEA Research centre	Italy
Lolke	SIJTSMA	Wageningen UR	Netherlands
V	SIVASUBRAMANIAN	Phycospectrum Environmenatl Research Center - PERC	India
Indra	TE RONDE	Nederlands Normalisatie-instituut (NEN)	Netherlands
Indu Shekhar	THAKUR	Jawaharlal University	India
Johan	THEVELEIN	KU Leuven/VIB	Belgium
Rebecca	VAN LEEUWEN-JONES	NL Agency, Ministry of Economic Affairs	Netherlands
Roderik	VAN NIEUKERKEN	MERIT Advisory	Netherlands
Majeti Narasimha	VARAPRASAD	University of Hyderabad	India
Leon	WIJSHOFF	AgentschapNL	Netherlands