

## **Final Report (non-confidential) of TKI project Economie, Beleid en Duurzaamheid**

*This final report includes a management summary of the results achieved, conclusions and recommendations of the TKI Biobased Economy (TKIBE 01004 project (called EBD project), funded by Ministry of Economic Affairs and coordinated by BE Basic foundation with a start date 1-12-2012 and an end date 1-12-2018). In the annexes you will find the annual progress reports of the period 2012-2018 which have been delivered to RVO at an earlier date..*

### **Characteristics of the EBD project**

|                      |   |
|----------------------|---|
| Project number:      | TKIBE 01004   |
| Project title:       | BE-Basic Economie, Beleid en Duurzaamheid   |
| Project acronym:     | EBD   |
| Project coordinator: | BE Basic Foundation   |
| Project partners:    | TU Delft<br>Tertium<br>Stichting Vrije Universiteit<br>Universiteit Utrecht<br>Wageningen Universiteit & Research Centrum-LEI<br>Platform BioEnergie<br>Stichting Natuur & Milieu |
| Start date project:  | 01-12-2012  |
| End date project:    | 01-12-2018  |
| Date final report:   | 28-02-2017  |
| Subsidy:             | € 1.200.000   |
| Own contribution:    | € 1.063.097   |
| Total Program        | € 2.263.097   |

### **Management summary**

#### **Original mission, problem definition and program development**

The overall mission of the TKI-BBE program Economie, Beleid en Duurzaamheid (EBD), coordinated by BE Basic foundation, as stated in the original project submission documents in 2009 was: “to identify industrial needs for social embedding of BE-Basic results and develop a societal roadmap for biobased innovation; support this by a macro-economic study and a public survey to develop policy advice and develop an international portfolio of collaboration to support the transition to a biobased economy.”

Following approval of the EBD program in 2012, its adjustments and refinement in the following years, a number of study reports and adjacent documents have been delivered which created public profile for BE-Basic and supported the introduction of biobased innovation in a variety of sectors. The international activities supported the contribution of Dutch institutions to the International Energy Agency and the development of international collaboration with Malaysia and Brazil.

The program was organized in 4 larger projects led by different institutions; an international contribution to IEA and the internationalization project.

All achievements were finalized and reported in annual reports (see annexes).

In 2017 an extension to 1-12-2018 was granted to finalize the activities for internationalization in agreements with RVO. The final results are presented in the last annex.

### **Result Highlights & Conclusions**

*Here we just present a summary list on results highlights achieved.*

Overall results were obtained on how to best implement biobased innovation in society, based on the identified public issues and concerns. We also delivered a large macro-economic study showing the macro-economic and environmental impacts of such social implementations. These results were broadly shared with politicians (o.a. Stientje van Veldhoven) and at large International meetings.

Together with NGOs, a standard for sustainable sourcing of woody biomass was developed and the Netherlands contribution to the IAE guaranteed our influence in the European scene.

The Committee Corbey was supported with expertise from the program and together an influential International portfolio was developed and rolled out. The latter led a.o. to the opening of a BE-Basic office in Brazil by our King Willem Alexander and a joint research fund for call for projects with the overall BE-Basic community with equal support from the Sao Paulo Research Organization. This resulted in 13 joint research projects and an extensive joint education project with 15 advanced courses and 15 Dual Degree PhD students.

The overall joint value of these International activities rose to 11 M Euro. We are very convinced, (supported by our International Peer Review Committee (IPRC)) of the important contributions of these results for furthering, debottlenecking and enabling economically feasible biobased value chains for production of biorenewables (chemicals, materials, fuels) now and in the future. In this respect the results of BE Basic - EBD are contributing well to the original mission and problem definition.

### **List of major results achieved in a nutshell:**

Results were achieved on all aspects leading to a better understanding of:

- Economic and sustainability criteria and feasibility results for various biobased value chains
- Public concerns about a biobased economy
- International targets and political support

Societal impact, contribution to (inter)national policy, accreditations achieved

- Macro-economic study for The Netherlands on biobased economy
- Macro-economic study for Malaysia on biobased economy
- Societal Roadmap on social embedding of biobased products
- Agreed standard for sustainable sourcing of solid biomass
- Significant contribution to IAE documents and policy papers
- Significant contribution to scope report on Bioenergy & Sustainability: bridging the gaps
- Instrumental to Lorentz biopanel document Bridging Technological and Societal Innovation for a Biobased Economy
- Significant contribution to developing Federation BioEconomy
- Example function for focused international collaboration
- Development of experts on multidisciplinary fields related to biobased economy

### **Options for Spin-off and follow-up activities**

Parties continue their activities in the indicated fields through additional (International) projects & subsidies and contributions to International for a Societal Impacts of Biobased Economy & Climate Change

### **3. Possible changes, or problems encountered during execution of the Project**

**. No significant technical or organizational problems** were encountered during execution of the projects within EBD;

**. Some changes were made regarding the execution of the project plan;**

Firstly, the establishment of a leadership Team for EBD, which was envisioned in the original project plan, where phase 2 and 3 were projected, was not established due to the fact that the required subsidies for phase 2 and 3 were not granted by RVO. As a consequence the projected in kind contribution of CSG, an intended partner in the LT of the EBD program, to the EBD budget was cancelled. Besides, also the LT-budgets for WUR and TUD have been reallocated in order to keep the total budget unchanged. These budgets were all in kind contribution of the partners to the EBD-program.

Secondly, partly as a consequence of above, more activities have been performed on Internationalization. This was mainly due to the additional options that were available for more intensive cooperation and co-funding opportunities with the Brazilian partners of BE-Basic mostly in the fields of biomass supply chains and conversion to e.g., biofuels; Part of the personnel costs of the TUD-budget for sub-project 1, were also transferred to the Internationalization program.

Thirdly, Utrecht University, contributed more activities towards the sub-projects 2 (MacroEconomische Verkenning II) and sub-project 3 (Sustainable wood chains) with special emphasis on the impact on land use change.

**. Changes between budgeted and actual costs of the EBD program:**

As a consequence of the above changes and some other reasons, there were several significant changes to the original budget, and a revised budget was handed in twice for approval.

#### First change of budget:

The internationalization budget and the IEA contribution was presented in the budget of WUR and TUD. However, the IEA-budget belonged to BE-Basic Foundation while the internationalization budget belonged to the TUD except for an amount of €6.400. This budget was the internationalization budget for WUR .

#### Second change of budget

1. Budgets per partner were adjusted to reality (shifts from one cost category to another cost category within the budget of a partner).
2. Budgets per partner were adjusted to reality (some shifts between the budget of partners).
3. Budget for Partners involved in the Leadership team, were reallocated mostly to internationalization. These budgeted amounts were all in kind contributions.
4. The budgets of the partners PBE and SNM were erroneously presented as if they were one and the same partner.

The differences between actual costs and the adjusted final budget are given below in Table 1.

Table 1. Differences between actual and final budget per category per partner.

| <b>Werkelijke kosten</b>                               |                  |                  |                  |                 |                  |                  |                  |                |                    |
|--|------------------|------------------|------------------|-----------------|------------------|------------------|------------------|----------------|--------------------|
| Kostencategorie  | BE-Basic         | TU Delft         | Tertium          | VU              | UU               | WUR              | PBE              | SNM            | Totaal             |
| 1. Loonkosten  | € 68.624         | € 440.436        | € 79.200         | € 30.416        | € 256.519        | € 365.447        | € 113.174        | € 8.100        | € 1.361.917        |
| 2. Kosten van machines en apparatuur                   | € 0              | € 0              | € 0              | € 0             | € 992            | € 0              | € 0              | € 0            | € 992              |
| 3. Kosten van te verbruiken materialen en hulpmiddelen | € 0              | € 0              | € 0              | € 0             | € 0              | € 0              | € 0              | € 0            | € 0                |
| 4. Kosten derden                                       | € 361.499        | € 427.535        | € 35.500         | € 0             | € 50.014         | € 25.271         | € 368            | € 0            | € 900.187          |
| <b>Totale projectkosten</b>                            | <b>€ 430.123</b> | <b>€ 867.971</b> | <b>€ 114.700</b> | <b>€ 30.416</b> | <b>€ 307.526</b> | <b>€ 390.718</b> | <b>€ 113.542</b> | <b>€ 8.100</b> | <b>€ 2.263.096</b> |
| <b>Begrote kosten</b>                                  |                  |                  |                  |                 |                  |                  |                  |                |                    |
| Kostencategorie  | BE-Basic         | TU Delft         | Tertium          | VU              | UU               | WUR              | PBE              | SNM            | Totaal             |
| 1. Loonkosten  | € 76.050         | € 438.075        | € 68.000         | € 33.540        | € 256.375        | € 355.100        | € 82.800         | € 8.000        | € 1.317.940        |
| 2. Kosten van machines en apparatuur                   | € 0              | € 0              | € 0              | € 0             | € 0              | € 0              | € 0              | € 0            | € 0                |
| 3. Kosten van te verbruiken materialen en hulpmiddelen | € 0              | € 0              | € 0              | € 0             | € 0              | € 0              | € 0              | € 0            | € 0                |
| 4. Kosten derden                                       | € 361.757        | € 359.318        | € 41.500         | € 900           | € 48.665         | € 25.300         | € 450            | € 0            | € 837.890          |
| <b>Totale projectkosten</b>                            | <b>€ 437.807</b> | <b>€ 797.393</b> | <b>€ 109.500</b> | <b>€ 34.440</b> | <b>€ 305.040</b> | <b>€ 380.400</b> | <b>€ 83.250</b>  | <b>€ 8.000</b> | <b>€ 2.155.830</b> |
| <b>Vershil in euro</b>                                 |                  |                  |                  |                 |                  |                  |                  |                |                    |
| Kostencategorie  | BE-Basic         | TU Delft         | Tertium          | VU              | UU               | WUR              | PBE              | SNM            | Totaal             |
| 1. Loonkosten  | € 7.426          | -€ 2.361         | -€ 11.200        | € 3.124         | -€ 144           | -€ 10.347        | -€ 30.374        | -€ 100         | -€ 43.977          |
| 2. Kosten van machines en apparatuur                   | € 0              | € 0              | € 0              | € 0             | -€ 992           | € 0              | € 0              | € 0            | -€ 992             |
| 3. Kosten van te verbruiken materialen en hulpmiddelen | € 0              | € 0              | € 0              | € 0             | € 0              | € 0              | € 0              | € 0            | € 0                |
| 4. Kosten derden                                       | € 258            | -€ 68.217        | € 6.000          | € 900           | -€ 1.349         | € 29             | € 82             | € 0            | -€ 62.297          |
| <b>Totale projectkosten</b>                            | <b>€ 7.684</b>   | <b>-€ 70.578</b> | <b>-€ 5.200</b>  | <b>€ 4.024</b>  | <b>-€ 2.486</b>  | <b>-€ 10.318</b> | <b>-€ 30.292</b> | <b>-€ 100</b>  | <b>-€ 107.266</b>  |

Overall, the observed difference between actual and budgeted costs stay within the 25% except the “third party costs” of the VU and the labour costs of PBE, see Table 2. The VU had budgeted an amount for the third party costs, but in reality no costs for this category have been reported. PBE have spent more labour costs than envisaged, part of these additional costs were subsidized (+ 8k), the other 22 k€ are additional in kind contributions to the EBD-program.

Table 2 Percentual differences between actual and budget costs per category and partner

| <b>Vershil in %</b>                                    |              |               |               |               |               |               |                |               |              |
|--|--------------|---------------|---------------|---------------|---------------|---------------|----------------|---------------|--------------|
| Kostencategorie  | BE-Basic     | TU Delft      | Tertium       | VU            | UU            | WUR           | PBE            | SNM           | Totaal       |
| 1. Loonkosten  | 9,76%        | -0,54%        | -16,47%       | 9,31%         | -0,06%        | -2,91%        | -36,68%        | -1,25%        | -3,34%       |
| 2. Kosten van machines en apparatuur                   |              |               |               |               |               |               |                |               |              |
| 3. Kosten van te verbruiken materialen en hulpmiddelen |              |               |               |               |               |               |                |               |              |
| 4. Kosten derden                                       | 0,07%        | -18,99%       | 14,46%        | 100,00%       | -2,77%        | 0,11%         | 18,18%         |               | -7,43%       |
| <b>Totale projectkosten</b>                            | <b>1,79%</b> | <b>-8,13%</b> | <b>-4,53%</b> | <b>13,23%</b> | <b>-0,81%</b> | <b>-2,64%</b> | <b>-26,68%</b> | <b>-1,23%</b> | <b>4,98%</b> |

The actual costs for the EBD-Program are in total 2.263 k€. This is 107 k€ more than the budgeted costs. In total an amount of 1.200 k€ is subsidized and the in kind contribution is 1.063 k€. The distribution of the subsidy and the in kind contribution, is given in Table 3.

Table 3. Distribution of subsidy and in kind contribution per partner

| Partners   | Total costs        | Subsidy            | In kind contribution |
|--|--------------------|--------------------|----------------------|
| Stichting BE-Basic   | € 430.124          | € 410.996          | € 19.128             |
| TU Delft   | € 867.971          | € 321.700          | € 546.271            |
| Tertium  | € 114.700          | € 50.000           | € 64.700             |
| Stichting Vrije Universiteit                                   | € 30.416           | € 16.900           | € 13.516             |
| Universiteit Utrecht   | € 307.526          | € 130.000          | € 177.526            |
| Wageningen Universiteit Research- Wageningen Economic Research | € 390.718          | € 179.124          | € 211.594            |
| Platform BioEnergie  | € 113.542          | € 87.280           | € 26.262             |
| Stichting Natuur & Mileu                                       | € 8.100            | € 4.000            | € 4.100              |
| <b>Total</b>   | <b>€ 2.263.097</b> | <b>€ 1.200.000</b> | <b>€ 1.063.097</b>   |

In Annex 7. The detailed budgeted versus the actual costs per partner are presented.

. **Knowledge transfer and PR** was achieved through International peer reviewed papers, lectures and presentations at (inter)national symposia and fora; contributions to discussions in (Inter)national committees, position papers and contributions to regulatory documents e.g., like MacroEconomische Verkenning

## Annexes

1. Report EBD June 2013-June 2014
2. Report EBD June 2014-June 2015
3. Report EBD June 2015-June 2016
4. Report EBD June 2016-June 2017
5. Report EBD June 2017-June 2018
6. Report EBD June 2018-December 2018
7. Detailed final budget versus actual costs per partner.

## **Annex 1.**

### **Progress report EBD June 2013 – June 2014**

#### **Deelproject 1 Innovatie en Maatschappelijke Roadmap**

Status: ongoing

In 2013 the project approach has been defined and the methodology has been chosen. The kick off meeting has been organised and the vacancy selection procedure has started. In the first 5 months of 2014 the project was fully operational.

The **overall objective of this project** is to provide insight into the societal preconditions for economic and sustainable introduction of biorenewable chemical and energy production.

*The project aims to describe and prioritize the actions needed for the development of a based economy on economical, political and sustainability aspects as well as to create civil society support for the biobased economy. The project will do so based on a number of descriptive cases, that are selected by the project partners.*

The project will deliver its results beginning of 2015.

#### **Deelproject 2 Maatschappelijk economische Verkenning II**

Status: Toewijzing 2012 and toewijzing 2013 are coupled in 1 project proposal.

The project has been reviewed by international peers and started. The **Macro-Economic Study** approached well. Beginning of 2014 the various production routes for energy and chemistry were selected, validated and implemented in the Dutch and Global macro-economic models and the assumptions of four scenario's (low tech versus high tech and global versus regional development) were set and discussed with stakeholders. Use of biomass for production provide a clear added value above fossil use, per unit of product.

#### **Deelproject 3: Duurzame houtketens**

Status: project ongoing and near completion (end of 2014).

The project started with a kick-off meeting November 2012 with project team. Project started with a signing of confidentiality agreement.

The project team developed a questionnaire to gather information on the carbon debt and iLUC risks of existing wood-energy supply chains. A methodology was developed to assess the results on iLUC and C-debt risks. In total 3 "real life cases" were described a number of hypothetical cases were described and assessed on iLUC and C-debt risks.

The frequent meetings and discussions in the project team have led to a progressive insight into C-debt and iLUC mechanisms between science, business and NGO's. The tool to assess C-debt and iLUC risks needs further refinement and cannot be made accessible in the public domain yet. There is a need to develop the tool and methodology further as

the Energy Agreement states that additional criteria for Carbon debt and iLUC should be established by December 2014.

**Deelproject 4: My 2030s – Citizens in a Biobased Economy**

Status: finished end of 2013 (as reported in first half year report), report available at <http://www.tertiem.nl/my2030s/> . Follow up with CSG: quantitative analysis of public opinion and knowledge.

Publications:

Inventory of biomass conversion pathways. Energy & Resources, Copernicus Institute, 2014

Evaluating the MacroEconomic impacts of biobased applications in the EU. JRC publication 2014

## **Annex 2.**

### **Progress report EBD June 2014 – June 2015**

#### **Deelproject 1 Innovatie en Maatschappelijke Roadmap**

Status: completed

The **overall objective of this project** is to provide insight into the societal preconditions for economic and sustainable introduction of biorenewable chemical and energy production.

*The project aims to describe and prioritize the actions needed for the development of a based economy on economical, political and sustainability aspects as well as to create civil society support for the biobased economy. The project will do so based on a number of descriptive cases, that are selected by the project partners.*

The first conclusions on the participative multi-criteria analysis and focus workshops showed that people do not automatically perceive a transition to a biobased economy as beneficial. The higher the involvement, the more likely people are to support; people prefer the use of bioplastics (in which they have choices) over biokerosine (which will be implemented without their involvement). Stakeholders however conclude that biokerosine one of the only options is to make aviation sustainable, but that implementation requires organised collaboration to get economic business cases. Reduction of the carbon footprint is seen as the most important factor to achieve in a biobased transition. Communication and engagement should focus on higher involvement of citizens and consumers. The project was granted additional funds to collaborate with Brazil as the joint proposal in the BIOEN-BE-Basic program was approved. The linked NWO (Netherlands Research Organisation) project KINESIS on bioenergy implementation delivered a well-received final report showing that trust is an important factor in societal embedding and that naturalness is closely related to sustainability in people's mind. For example a small scale biorefinery or gasification unit in a farm, may be perceived as industrial activities in a 'natural' farm landscape. Such perceptions may trigger high opposition in planning permissions in local communities, in spite of the sustainability intentions of the activities. These issues need attention early in the trajectory of deployment of novel innovation.

The final report is being written (some delay due to changes in staff).

#### **Deelproject 2 Maatschappelijk economische Verkenning II**

Status: Toewijzing 2012 and toewijzing 2013 are coupled in 1 project proposal.

The Markal bottom-up technology model has been extended with a detailed number of potential biobased and renewable energy technologies, and with a detailed number of potential biobased and chemical technology pathways. The identification of likely deployed novel production routes (and new products) proved difficult, due to sensitivity



of this information. To overcome these problems and to help in the translation of the results to policy, industry and investor audiences the BE-Basic Board installed a 'Klankbordgroep' (Sparring group) of high level stakeholders in 2014. A first meeting is held in February 2015 and a second will be organised in the summer period.

The Magnet top-down macro-economic model has been extended with potential biobased and renewable energy cost-return structures (in monetary terms), and with most important biobased chemical cost-return structures (in monetary terms). The results will be validated by the industry, government and academic world in the summer period to be able to finalise the project end of 2015.

This project will be finished end of 2015.

### **Deelproject 3: Duurzame houtketens**

Status: completed end of 2014

End of 2014 the final report of the project on '**Sustainable wood-chains**' was presented. The project aimed to analyse the impacts of existing biomass supply chains on ILUC (Indirect Land Use Changes) and carbon debt and to develop a method for energy companies to identify and minimise risks. The resulting tool was evaluated by the participating energy companies and NGOs and regarded useful as a bottom-up, project based semi-quantitative risk evaluation on limited amount of information. However it has limitation when by-products are used and it would benefit from further calibration improvements and real-life testing. The approach to involve NGOs, industry and academia from the start in the project was regarded as very useful.

### **Deelproject 4: My 2030s – Citizens in a Biobased Economy**

Status: finished end of 2013 (as reported in first half year report), report available at <http://www.tertium.nl/my2030s/> . Follow up with CSG: quantitative analysis of public opinion and knowledge.

## **Annex 3**

### **Progress report EBD June 2015 – June 2016**

#### **Deelproject 1 Innovatie en Maatschappelijke Roadmap**

Status: completed

The **overall objective of this project** is to provide insight into the societal preconditions for economic and sustainable introduction of biorenewable chemical and energy production.

*The project aims to describe and prioritize the actions needed for the development of a based economy on economical, political and sustainability aspects as well as to create civil society support for the biobased economy. The project will do so based on a number of descriptive cases, that are selected by the project partners.*

The final report is being written and will be available in September 2016.

#### **Deelproject 2 Maatschappelijk economische Verkenning II**

Status: Toewijzing 2012 and toewijzing 2013 are coupled in 1 project proposal.

This project ended end of 2015. The final scientific report and a public version are available at:

<http://www.be-basic.org/downloads.html>

#### **Deelproject 3: Duurzame houtketens**

Status: completed end of 2014

#### **Deelproject 4: My 2030s – Citizens in a Biobased Economy**

Status: finished end of 2013 (as reported in first half year report), report available at <http://www.tertium.nl/my2030s/> . Follow up with CSG: quantitative analysis of public opinion and knowledge.

## **Annex 4**

### **Progress report EBD June 2016 – June 2017**

#### **Deelproject 1 Innovatie en Maatschappelijke Roadmap**

Status: completed

The **overall objective of this project** was to provide insight into the societal preconditions for economic and sustainable introduction of biorenewable chemical and energy production.

The final report is available.

#### **Deelproject 2 Maatschappelijk economische Verkenning II**

Status: completed

This project ended end of 2015. The final scientific report and a public version are available at:

<http://www.be-basic.org/downloads.html>

#### **Deelproject 3: Duurzame houtketens**

Status: completed end of 2014

#### **Deelproject 4: My 2030s – Citizens in a Biobased Economy**

Status: finished end of 2013. Report available at <http://www.tertium.nl/my2030s/>.

### **Internationalisering**

Het EBD programma heeft een bijdrage geleverd aan de deelname vanuit Nederland aan het IEA programma en activiteiten over de periode 2013-2015. In 2016 heeft de rapportage van het triennium plaatsgevonden. In het kort (en in het Engels vanwege het internationale karakter):

The focus area for the Netherlands is Bioenergy: Tasks 32, 33, 34, 40 and 42), represented by respectively Jaap Koppejan (Procede), Berend Vreugdenhil (ECN), Bert v/d Beld (BTG), Peter-Paul Schouwenberg (RWE) en Martin Junginger (UU) en René van Ree (WUR) en Ed de Jong (Avantium).

The Dutch participations is coordinated by Kees Kwant (RVO.nl), Patrick Todd (EZ), Peter-Paul Schouwenberg (RWE), Patricia Osseweijer (project leader TKI-BBE program EBD).

IEA Bioenergy's Strategic Vision is for biomass to provide a substantive contribution to future global energy demands by accelerating the production and use of environmentally sound, socially accepted and cost-competitive bioenergy on a sustainable basis, thus

providing increased security of supply and reducing greenhouse gas emissions from energy use.

Briefly, the objectives of this plan are to promote deployment of bioenergy; to raise public awareness of benefits and advantages; to increase and strengthen communication and outreach efforts; and to increase dissemination of useful and credible information.

The Dutch industry and research institutes are involved via an Implementing Agreement, financed by the TKI-BBE (with matching industrial contribution 40/60). The Dutch parties (e.g. Procede/DNVKema, ECN, BTG, UU, Essent, WUR, DAK, DGAgro, Avantium, EZ and RVO.nl) are involved in 10 Tasks: Combustion/cofiring, gasification, pyrolysis, waste treatment, digestion & green gas, GHG, biofuels, trade, biorefinery and biomass production.

#### Per Task:

All individual task reports are available on the website: [www.ieabioenergy.com](http://www.ieabioenergy.com). A full report in English is also available. In short:

#### **Task 32: Biomass Combustion and Co-firing**

Task 32 aims to stimulate the expansion of cost effective and clean biomass combustion and co-firing for the production of heat and power. Some key reports published in the previous triennium:

- n Status overview of Torrefaction Technologies – A review of the commercialisation status of biomass torrefaction. Commercialisation of torrefaction technologies has been more difficult than anticipated a few years ago. However, companies involved have significantly improved their ability to produce high quality torrefied biomass products, with pellets of comparable durability and supply costs to conventional wood pellets, yet with superior handling and combustion characteristics.

- n The technical report Sensitivity of System Design on Heat Distribution Costs in District Heating, shows that district heating networks are generally overdimensioned, and should be installed with smaller diameters as the resulting increment in pumping energy is more than compensated by reduced investment costs, particularly in a situation where load densities are only reducing further due to better insulation.

- n The publication ‘The status of large scale biomass firing – The milling and combustion of biomass materials in large pulverised coal boilers’ describes the practical experiences and commonly accepted approaches for biomass co-firing in pulverised coal fired power stations, including a number of case studies.

#### **Task 33: Thermal gasification of Biomass**

In the 2013-2015 triennium Task 33 monitored and reported on the status of new and existing commercial biomass gasification processes, identified technical hurdles limiting broader deployment, and explored opportunities to improve operational reliability and costs associated with biomass gasification systems. Main achievements:

- n A Status report on thermal biomass gasification in the countries participating in Task 33 provides an overview of 86 commercial, demonstration and pilot facilities in these

countries. Details about these thermal biomass gasification facilities are also available via an interactive online database.

n A performance test protocol (PTP) for small scale biomass gasifiers was developed and published. As a guideline during a project for a gasifier CHP unit, this white paper can help improve project execution by providing guidance for objectively measuring performance after commissioning.

n A series of eight 1- to 2-page factsheets about biomass gasification was developed and published on the Task 33 website. The factsheets provide an overview of gasification technology, opportunities, challenges and development status and are targeted towards non-experts interested in knowing more about biomass gasification.

n Five public workshops were organized in this triennium on lessons learned, system and integration aspects, small scale gasification, liquid biofuels, and energy and products from biomass and waste.

### **Task 34: Pyrolysis of Biomass**

The objective of Task 34 is to improve the rate of implementation and success of fast pyrolysis for fuels and chemicals by contributing to the resolution of critical technical areas and disseminating relevant information, particularly to industry and policy makers.

The Task members undertook a review of the potential applications for bio-oil within existing markets. The group identified the leading applications and the technical and non-technical barriers to commercialization.

### **Task 40: Sustainable International Bioenergy Trade – Securing Supply and Demand**

The core objective of Task 40 is to support the development of sustainable, international bioenergy markets and international trade, recognising the diversity in resources and biomass applications. Several publications and workshops were prepared, including the following:

n A book on “International Bioenergy Trade: History, status & outlook on securing sustainable bioenergy supply, demand and markets” was published by Springer in 2014, and is in essence a synthesis of 10 years work of Task 40. For this period, Task 40 has monitored the developments in international bioenergy trade, including the organization of about 20 workshops on trade-related topics, and the publication of over 100 studies, country reports, newsletters, etc.

n A technical report on the impact of promotion mechanisms for advanced and low-iLUC biofuels on markets. In this report, four case studies are presented where promotion mechanisms for advanced biofuels have had an impact on markets and trade (used cooking oils and animal fats, sugarcane ethanol), or may be anticipated to impact markets and trade in the future (straw, wood pellets). However well intentioned these policy measures, some may create unintended effects.

n A book entitled “Developing the global bio-economy. Technical, market and environmental lessons from bioenergy” brings together expertise from three IEA Bioenergy Tasks on international trade, biorefineries and pyrolysis to review the bioenergy sector and draw useful lessons for the full deployment of the bioeconomy.

### **Task 42: Biorefining – Sustainable Processing of Biomass into a Spectrum of Marketable Bio-based Products and Bioenergy**

The aim of Task 42 is to facilitate the commercialisation and market deployment of environmentally sound, socially acceptable, and cost-competitive biorefinery systems and technologies, and to advise policy and industrial decision makers accordingly.

Task 42 started its activities by the set-up of a biorefinery definition, i.e.: biorefining is the sustainable processing of biomass into a portfolio of marketable biobased products and bioenergy. Then the Task developed an understandable biorefineries classification system based on raw materials, platforms, and products. A method to calculate a biorefinery complexity-index (BCI) and a biorefinery-complexity-profile (BCP) was developed to give industry, policy makers and investors some additional information to assist them in developing biorefinery implementation strategies at minimal technical and economic risks. A biorefinery fact sheet (BFS) methodology/set-up was developed/defined with the goal to clearly present the advantages of biorefining in a uniform way to help overall understanding of the principle and final market deployment. Meanwhile 13 biorefinery factsheets have been produced.

Biorefining/bio-cascading is always the approach to use to maximise full sustainability. Bioenergy can be the main driver (biofuel/energy-driven biorefinery approach) or a secondary product (product-driven biorefinery approach), but will always be part of the optimised biomass valorisation path.

Publication:

C.M. Alves, M. Valk, S. de Jong, A. Bonomi, LAM van der Wielen & S.J. Mussatto. Techno-economic assessment of biorefinery technologies for aviation biofuels supply chains in Brazil. *Biofuels, Bioproducts & Biorefineries* 2016, vol: 11, pp 67-91

## Annex 5.

### **Voortgangsrapportage TKI programma Economie, Beleid en Duurzaamheid (EBD) 20-6-2017 to 20-6-2018**

Within the BE-Basic EBD program which started in 2012, the part projects Societal Roadmap, Macro-Economic Study, Sustainable Woodchains and Microsociety2030 and the Dutch participation to the IEA (International Energy Agency) were all finalised before June 2017 and reported previously. In 2017 the part project “Internationalisation” was extended to be completed before 1 December 2018. This report concerns the activities in this part program over the period June 2017 to June 2018.

#### **Part project Internationalisation Corbey Committee**

The Corbey Committee called on the Dutch government to make developing a biobased economy a much higher priority with the publication of its vision document ‘*Naar een duurzame bio-economie*’ (‘*Towards a sustainable bioeconomy*’) in October 2015. The document points out the advantages of a bioeconomy in which biomass is a resource: fewer CO<sub>2</sub> emissions; less dependency on fossil fuels and more employment opportunities. It explains that the biobased economy would be lucrative for the Netherlands, but that it requires ambitious integral policymaking and a stronger government role to drive it forward. The results of two BE-Basic research projects on the availability of national biomass and the import of biomass into the Netherlands were included in the report. Supported by BE-Basic a new network was launched by Dorette Corbey and Roel Bol “Federatie Bioeconomie Nederland” (<http://www.bio-economie.nl/>).

In order to support the global impact of the projects of the BE-Basic FES programme international relations were focussed on Brazil and Malaysia. An international public private consortium was established in Malaysia in 2011 to address sustainable value chains using biomass of the oil palm industry for chemical and energy production, which was supported by the Malaysian government. This resulted in a business plan for residue usage of oil palm supported by a macro-economic study carried out by BE-Basic partner WUR. In 2013, as a result of the economic and political developments in Malaysia this business plan was aborted. Simultaneously a dedicated network with academia and industry was set up in Brazil to jointly address the energy and chemical production through sugar cane agriculture. This led to the establishment of a BE-Basic – TU Delft office in Campinas at UNICAMP university in 2012, opened by King William Alexander. The office developed a dedicated business plan including joint research and education programs supported by Brazilian and BE-Basic funds. In the reporting period the development of a dedicated value add program for biomass value chains in Campinas “Agropolo-Campinas” was supported through joint coordination of a series of thematic workshops and participation of BE-Basic partners in the Roadmap which resulted from the workshops (<http://www.agropolocampinasbrasil.org/>).

The joint PhD program for Dual Degrees established in November 2013 provided the opportunity for enrolment of 14 students with an extensive Dutch study period (minimal one year). The first Dual Degree doctorate was awarded in May 2017, the second is planned for November 2018.

The extensive contacts in Brazil led to intensive collaboration of BE-Basic researchers within the Brazilian led global effort to inform academia, politicians and publics on bioeconomy and sustainable bioenergy within the UN connected SCOPE program (Scientific Committee of Problems of the Environment). After participation in several workshops BE-Basic partners took responsibility for authorship of chapters of the volume “Bioenergy and Sustainability: bridging the gaps” and policy briefs. BE-Basic experts contributed to 9 of the 21 Chapters with contributions from Hans van Meijl (Wageningen University), Luuk van der Wielen and Patricia Osseweijer (Delft University of Technology), and Andre Faaij (University Utrecht, presently Energy Academy Europe and Groningen University) (see <http://bioenfapesp.org/scopebioenergy/index.php>). The volume also led to thematic publications.

In August 2018 the latest Scope policy brief was launched (<http://bioenfapesp.org/scopebioenergy/index.php/policy-brief/2018>).

In order to stimulate business development a global competition was set up “Global Biobased Business Competition – G-BIB” which hold its first finals in October 2017 in Campos do Jordao in Brazil. G-BIB is an initiative of the BioInnovation Growth mega-Cluster ([BIG-Cluster](#)), and teams from Germany, the Netherlands and Brazil competed on Wednesday 18 of October 2017 during the 3rd Brazilian BioEnergy Science and Technology ([BBEST](#)) in Campos do Jordão, Brazil for an international jury for the 10.000 Euro made available by BE-Basic partner Corbion to further develop the business plan. N-Chroma from Wageningen University, SANergy from the University of Taubaté and Bicomer from the University of Bielefeld won the national finals of the first edition. They were chosen from a total of 14 teams, existing of Master and PhD students from the Netherlands, Germany and Brazil. A second edition with national finals is presently being prepared.

In addition to above described activities business trips were supported to extend the international activities of BE-Basic, increase the impact of the BE-Basic results and prepare for novel joint international activities. In the reporting period over 10 presentations were given in international conferences and meetings.

#### Publications:

Souza, G. M., Ballester, M. V. R., de Brito Cruz, C. H., Chum, H., Dale, B., Dale, V. H., Fernandes, E. C. M., Foust, T., Karp, A., Lynd, L., [Osseweijer, P.](#), [Van der Wielen, L.](#) & More Authors 1 Sep 2017 In : Environmental Development. 23, p. 57-64 8 p.

#### [Reconciling food security and bioenergy: Priorities for action](#)

Kline, K. L., Msangi, S., Dale, V. H., Woods, J., Souza, G. M., [Osseweijer, P.](#), Clancy, J. S., Hilbert, J. A., Johnson, F. X., McDonnell, P. C. & Mugera, H. K. Mar 2017 In : Biomass & Bioenergy. 9, 3, p. 557-576 20



[Integrated 1st and 2nd generation sugarcane bio-refinery for jet fuel production in Brazil: Techno-economic and greenhouse gas emissions assessment](#)

Neves Ferreira Dos Santos, C., de Magalhaes Cornélio da Silva, M. C., Mussatto, S. I., [Osseweijer, P.](#), [van der Wielen, L. A. M.](#) & [Posada, J. A.](#) Jan 2017 In : Renewable Energy.

[Production of bulk chemicals from lignocellulosic biomass via thermochemical conversion and syngas fermentation: a comparative techno-economic and environmental assessment of different site-specific supply chain configurations](#)

[Benalcázar, E. A.](#), Deynoot, B. G., [Noorman, H.](#), [Osseweijer, P.](#) & [Posada, J. A.](#) 1 Sep 2017 In : Biofuels, Bioproducts and Biorefining.11, 5, p. 861-886 26 p.

[Hydrous bioethanol production from sugarcane bagasse via energy self-sufficient gasification-fermentation hybrid route: Simulation and financial analysis](#)

de Medeiros, E. M., [Posada, J. A.](#), [Noorman, H.](#), [Osseweijer, P.](#) & Filho, R. M. 2017 In : Journal of Cleaner Production. 168, p. 1625-1635 11 p.

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## **Annex 6.**

### **Voortgangsrapportage TKI programma Economie, Beleid en Duurzaamheid (EBD) 20-6-2018 to 1-12-2018**

#### **Agropolo, Brazil**

In the final reporting period the support to the development of a dedicated value add program for biomass value chains in Campinas “Agropolo-Campinas” was continued through overseeing the results from the series of thematic workshops and participation of BE-Basic partners (<http://www.agropolocampinasbrasil.org/>). Discussions were held about the joint value which led to the discontinuation of BE-Basic in the program due to the lack of funds from BE-Basic and the low level of interest.

#### **Joint PhD program, Brazil**

The joint PhD program for Dual Degrees established in November 2013 provided the opportunity for enrolment of 14 students with an extensive Dutch study period (minimal one year). The first Dual Degree doctorate was awarded in May 2017, the second was awarded in November 2018. The program facilitated amongst others the contribution of Brazil colleagues in the PhD defence committees and the work of the PhD students.

#### **Scope**

The extensive contacts led to intensive collaboration of BE-Basic researchers within the Brazilian led global effort to inform academia, politicians and publics on bioeconomy and sustainable bioenergy within the UN connected SCOPE program (Scientific Committee of Problems of the Environment). After the publication and launching events of the book on Bioenergy and Sustainability (see earlier reports) and first policy paper, a second policy paper was launched on biobased economy in SS Africa. (<http://bioenfapesp.org/scopebioenergy/index.php/policy-brief/2018>). This was accompanied by several academic papers. In meetings it was agreed that BE-Basic experts would be welcome to join renewed activities related to joint publications in the framework of UN/SCOPE.

#### **Continuation international collaboration Brazil**

During the final reporting period agreements were made for continuation of the BE-Basic office under the leadership of TU Delft at UNICAMP, Brazil. Also Fapesp (Research Organisation Sao Paulo State Brazil) agreed to continue to collaborate under the leadership of TU Delft. Osseweijer was appointed University Ambassador Brazil to overlook and steer further development.

Further agreements for (continued) collaboration were made in relation to the bi-annual conferences ECO-BIO and BBEST.

In addition to above described activities business trips were supported to extend the international activities of BE-Basic, increase the impact of the BE-Basic results and prepare for novel joint international activities.

In the reporting period circa 5 presentations were given in international conferences and meetings.

Two papers were published:

Assessing social sustainability for biofuel supply chains: the case of aviation fuels in Brazil. Z. Wang, P.Osseweijer, J.A. Posada Duque. Sustech IEEEinc., vol 2018 p 1-5.

Towards social sustainability: Screening potential social and governance issues for biojet fuel supply chains in Brazil. Pashaei Kamali F., J.A.R. Borges, P. Osseweijer, J.A. Posada Duque. In: Renewable and sustainable energy reviews. 92, p.50-61