



Lessons learned success stories in biofuels

Intertask project T39, T40 and T45

Tomas Ekbom

Franziska Müller-Langer

Stockholm, 8 Nov 2021

The IEA Bioenergy Technology Collaboration Programme (TCP) is organised under the auspices of the International Energy Agency (IEA) but is functionally and legally autonomous. Views, findings and publications of the IEA Bioenergy TCP do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.

Project update: Significant achievements / results

- This is an InterTask project between T39 (Project coordinator), T40 and T45 to evaluate reasons underlying the past and ongoing boom and bust cycles of biofuel technologies development, demonstration, deployment and replication.
- This study will identify technology successes and the best policy framework conditions and measures for stimulating increased future markets for production and consumption of sustainable transport biofuels.
- Well-attended kickoff meeting held 23 Sept, 2020: The project team identified markers to serve as guides to compare projects and plants. SVEBIO and Bioenergy 2020 both have databases of such plants that will be used.
- The project aims to answer two research questions: “What is required to re-stimulate vigorous biofuels development and scale up?” and “What are key factors for the success of sustainable advanced biofuel projects?”

Project update: Forthcoming activities / issues

Until next ExCo meeting, the project will work on, or have concluded, these WPs:

1. **Status quo biofuel projects:** Overview of conventional biofuel capacities, including a brief summary of the development and status of advanced fuel projects worldwide. Issues related to governance of biofuel development, e.g., mapping and inventory of existing policy instruments.
2. **Meta-analysis on existing studies:** A comprehensive summary of the main findings and lessons learned regarding successes and failures for biofuel projects in the analysed studies and according to the defined criteria.
3. **Case studies technologies:** Brazil, Germany, Sweden and the USA. Each studied for two cases, i.e., biofuel projects or plants. Analysis of each country policy in terms of successes or lessons in terms of the projects and plants.
4. **Case studies supply chains:** Success stories and insights about future potential developments with assessment thereof. Biomass fractionation methods and lessons and successes in sustainability standards and certification of international supply chains.

Project update: Activities and expected results | WPs

„Lessons learned biofuels I“ (Triennium 2019-2021)

WP 1 | Status quo biofuel projects

T39 (Lead), T45

Overview TRL, capacities of biofuels projects, Wrap up national programs
Existing sustainability / certification schemes

WP 2 | Meta-analysis existing studies

T45 (Lead), T39, T40

Inventory of studies, specifically addressing lessons learned biofuels
Screening with criteria to be defined

WP 3 | Case studies technologies

T39 (Lead)

Success stories for dedicated technologies and regions, (e.g. US, EU, Brazil)

WP 4 | Case studies supply chains

T40 (Lead), T45

Success stories for biomass supply chains

WP 5 | Synopsis / synthesis of key issues

T39 (Lead), T40, T45

Conclusions, guideline „good to know“ for decision makers, identification of required actions for „Lessons learned biofuels II“

WP 6 | Project management and dissemination

T39 (Lead)

„Lessons learned biofuels II“ (Triennium 2022-2024)

As intertask project incl. several Bioenergy TCP Tasks, (IEA AMF?)

Research question (T39):

“What is required to re-stimulate vigorous biofuels development and scale up?”

Research question (T45):

“What are key factors for the success of sustainable advanced biofuel projects?”

Time schedule (updated and prolonged)

	July	Sept		Nov		Jan		March		May		July		Sept		Nov		Jan		
Work package / project month	March	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WP 1 Status quo biofuel projects	2020					2021														
WP 2 Meta-analysis																				
WP 3 Case studies technologies																				
WP 4 Case studies supply chains																				
WP 5 Synopsis																				
WP 6 Project m. dissemination																				
Project meeting (webconf)			PM			PM			PM						PM			PM		
Workshop with external																WS				
Reports																R1	R2		R3	SR

R1, x | WP-related report; SR | summary report; WS | Workshop with external

R1 = WP 2

R2 = WP 4

R3 = WP 1 + 3 + 5

WP 1 | Work progress & reporting

Status quo biofuels projects

The draft report will be ready for review around start Nov



Author: Cecilia Ilija

Edited by:

Background

Unexpected pandemics, natural climate threats, new trends and needs in the markets, unprecedented political events, including the emergency of modern dictators and populists are all aspects impacting issues of geopolitical power and energy security in the world. As a consequence, this scenario of strong energy interdependence is influencing development, trade, international relations and diplomacy as well as global cooperation on climate. In this scenario, international agreements must be translated into goals and strategies, in which key global actors together must carry out collaborative activities for financing and follow-up agreed measures.

Besides that, there are often different societal priorities and several actors involved with different interests, conditions and power resources, making international, national and local issues even more complex and difficult to separate from each other. At this point, it is important to remember that the Paris Agreement was signed in December 2015, being a global commitment in which 182 countries engaged collectively to keep the global temperature rise well below 2°C above pre-industrial level was signed. The global community also pledged to make efforts to restrict warming to 1.5°C. However, the global greenhouse gas (GHG) emissions caused by anthropogenic activities are still increasing, being a stark contrast to the ambitious targets settled through the Paris Agreement.

In face of this worrying picture, far-reaching adaptations to drive transitions in all the society are fundamental. In order to decrease emissions. In addition to that, modifications in behaviour and attitudes towards consumption are required alongside a new urban design of our societies. In this context, a new demand for products with low fossil-fuel intensity in replacement of ones with high fossil-fuel intensity are demanded. In all sectors, energy efficiency should be enhanced and fossil sources should be phased out. Changes in industry and transport in which the electrified system will play an important role as well as the use of sustainable produced biofuels are crucial. Finally, wind and solar power are also important energy alternatives.

Based on the above considerations, challenges are undoubtedly extensive. However, on the

technology Collaboration Programme



Author: Dita

Edited by: Cecilia Ilija

5 Austria

5.1 GENERAL BACKGROUND

5.1.1 Introduction

The total energy supply (TES) in Austria was 53.8 million tonnes of oil equivalent (Mtoe) in the year 2018. Renewable energy accounts for about 54% of Austria's TES, most of it in the form of biomass, geothermal water and hydroelectricity. In addition to this, around 30% of Austria's energy needs are produced domestically.

Figure 1 shows energy supply and demand in Austria in 2018, in which the national production comes to 12 Mtoe, with the rest part coming from renewals. The final energy consumption can be divided into 3 sectors: (i) manufacturing industry, (ii) transport and (iii) others including private and public applications as well as agricultural energy use. The share of transport sector in the total final energy consumption is 36%.

The TES is a national production plus imports minus exports. The TES also includes the TES from transformation and other uses.

Technology Collaboration Programme



Author: DOKKOT

Edited by: DOKKOT

4 Biofuels Production and Consumption in Germany

4.1 STATUS, ADVANCES AND CHALLENGES

4.1.1 Current Status of Transport Sector Biofuels

In 2018, Germany's transport sector energy consumption was 4.4 Mtoe with electricity was 40% (2.5 Mtoe), 20% (1.1 Mtoe) and 40% (1.8 Mtoe) for gas, oil and coal. The share of oil in the transport sector is 40%. The share of oil in the transport sector is 40%. The share of oil in the transport sector is 40%.

Germany's biofuel sector has been heavily influenced by changing political conditions in recent years. The share of biofuels in the transport sector was around 4.4 Mtoe in 2018. While the fraction of pure biofuels was around 4.4 Mtoe, the share of total renewable fuels in Germany in 2017, to 2018 it had dropped to just below 1%.

Technology Collaboration Programme



Author: Thomas Dörm and Cecilia Ilija from IVBIO

Edited by: Cecilia Ilija

3 Sweden Targets World's Highest Biofuel Blending

3.1 DRIVING A LOW CARBON SOCIETY

3.1.1 In the Beginning there was Ethanol. In 1927, there were only 100 vehicles registered in Sweden. The first ethanol was produced from the domestic grain industry. The first ethanol plant (Göteborg) in Sweden was established in 1927.

Ethanol was a readily available domestic raw material, thus, a so-called 'drop-in' spirit for product from the domestic grain industry. The first ethanol plant (Göteborg) in Sweden was established in 1927.

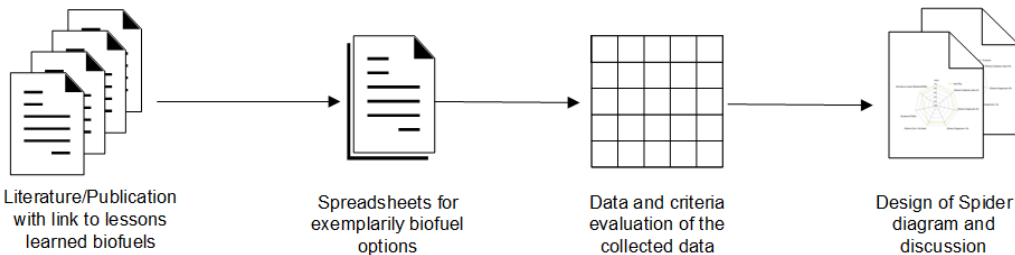
The word *bioetanol* is taken from the German language, meaning petrol.

Technology Collaboration Programme

WP 2 | Work progress & reporting

Meta-analysis existing studies

- Preparation of template from spreadsheet for biofuels evaluation
- Literature review and biofuels evaluation
- Defining of criteria for integrated evaluation
- Creation of spider diagram for the evaluation



Ethanol (Sugarcane 1G)	Answer	Unit	Space for commentary / annotations	Literature for specific information
Biofuel/Biofuel Technology:	Technology used to produce the liquid biofuel	Ethanol (Sugarcane 1G)		
Source:	Please indicate from the OneNote file which article/publications is/are the source of information	11	Link to the file	
Location:	Country, region, city where it is considered a success	Brazil	9	7 multiple, please indicate which may apply to other countries that produce sugarcane
TRL (Technology Readiness Level)	Success story should at least be TRL 7 TRL 7 - system prototype demonstration in operational environment TRL 8 - system complete and qualified TRL 9 - actual system proven in operational environment	9		
Biofuel main use		Light vehicle		
Principle feedstock:	Type of feedstock Please indicate if domestic or imported Feedstock availability Feedstock yield Planted area Soil-climate requirements	Sugarcane Domestic High High Medium		If more information available, please indicate here 80 t stock/ha 10 Mha (approximately half to produce sugar and half to produce ethanol) Sugarcane requires at least 1000 mm of rain (or need irrigation). Feedstock production requires proper agronomic practices, such as fertilization, weed control etc.
Products:	If commercial production include output (m ³ /yr, t/yr, other) Biofuel yield (per unit feedstock, land, etc.) Co-products - low value Co-products - medium value Co-products - high value	33.2 million m ³ /yr 6.8 m ³ /ha Yes Yes Yes		Vinasse (fertilization, biogas) Bagasse, harvest residues (heat, electricity) Chemicals (citric acid, ethanol)
Economics:	Economics considered? Biofuel production costs (or sales cost)? CAPEX available? OPEX available?	Yes Yes Yes Yes		0.53 US\$/L (New 2020) (24.2 US\$/GJ) At the mill 0.33 to 0.39 US\$/L (15.09 US\$/GJ) to 7.8 US\$/GJ (2020) Source: UNICA (Sugarcane Industry Association) www.unica.com.br. Accessed on 30dec2020. --> The ethanol density and net
Public policies:	Does any mandate supported the introduction? Does it require subsidies? Are relevant laws and regulations? Does it have public acceptance?	Yes Yes Yes Yes		At least 27% of ethanol in gasoline in all Brazil. 100% ethanol also available at gas stations. Consumer tax lower than that of gasoline in most States in Brazil. Minimum requirement of ethanol in gasoline (see above). Taxes (see above). Renewable rewards biofuel producers that prove to reduce GHG emissions. Ethanol is available at all gas stations in Brazil. ~40% of biofuel used in light vehicles.
Environmental impact:	GHG Emissions (g CO ₂ e/MJ or another unit) Competition with food? Land requirement? Air quality impact? Water usage? Land impact? Sustainability issues; additional remarks	23 g CO ₂ e/MJ No Medium Yes Yes Yes		Crude to wheel LCA. Avoided 70 to 90% GHG emissions compared to gasoline. Recent legislation (Renovabio, 2017) stimulates reduction of GHG associated with biofuels. Although land could be used to produce other things and sugar is a food, the amounts of land available in Brazil makes food competition irrelevant high-yielding crop. Negative impact due to pre-harvest burning, now legally phasing out; Positive: cars using ethanol decreases urban air pollution. Feedstock production is mostly rainfall irrigated in Northeast Brazil and partially in Central Brazil). Water is also required for sugar/ethanol production but amounts are being reduced. Water use in industry is regulated in some parts of Brazil. Large farms: risks of erosion during some stages of feedstock production. Proper agronomic practices are required to control negative impacts. The Brazilian Forest Code establishes that at least 20% of the land is private properties must be set aside as legal reservation (native species) promoting biodiversity, land and water preservation. Zoning establishes areas in which sugarcane cannot be cultivated. Many positive issues: cycling of by-products (vinasse, industry residues) in the field are common practices in the sugarcane industry. Retention of harvest residues (8-15 t dry matter per hectare) helps to recycle nutrient in increase soil C sequestration.
Employment:	If available, please describe jobs created and/or indication of employment number related to a project	Yes Direct jobs: more than 1 million jobs in the sugar/ethanol mills (2012). 27% of the agriculture jobs (2012) (Meeus et al., 2015) Yes Indirect jobs: heavy (7) jobs created in the whole chain		According to IREMA in 2018 there were 216 500 jobs in sugarcane cultivation and 158 Source: Moraes, A. A. F. D., Oliveira, F. C. B., and Diaz-Chavez, R. A. (2015). Socio-
Implementation potential:	Please indicate if it is low, medium or high and if this is at local/regional, national or international level	High		Implementation viable in many countries of the tropical/subtropical zones. More than 100 countries in the world cultivate sugarcane to produce sugar. The same industry, with few modifications, can produce ethanol.
Replication potential:	Please indicate if it is low, medium or high and if this is at local/regional, national or international level	High		The technology to produce ethanol is not complex and can be replicated in countries that produce sugarcane. The large scale of the Brazilian model may not be replicated in all countries.
Scale-up potential:	Please indicate if it is low, medium or high and if this is at local/regional, national or international level	High		Is it feasible to scale-up this technology/ biofuel? (If presently used in small scale or pilot plants)
Contribution to Sustainable Development Goals:	Please indicate the contributions to SDGs	High		Is it feasible to scale-up this technology/ biofuel? (If presently used in small scale or pilot plants)
Additional remarks:	Any additional information or constraints that should be mentioned here?	??		We can comment on the reasons why ethanol is not used in Guatemala (Horta)
Who filled in this template?	Who filled in this template?	Helena Cantarella & Others, 3 Feb 2021		

WP 3 | Work progress & reporting

- Specific case studies will be made for Brazil, Germany, Sweden and the USA. For each country minimum two cases (biofuel projects/plants).
- Preparation of templates done by DBFZ
- Sending of draft case studies to project and/or network partners
- Explanation of development of the technology

IA Bioenergy
Case studies biofuel technologies
IA Bioenergy - Lessons learned biofuels

bio1iq®
Karlsruher Institut für Technologie

CURRENT STATUS (2020)

Location:
Technology:
In-house facilities:
Production:
Technology readiness level (TRL):
Short description:

Important steps along the innovation chain to current status

Development and Testing
Scale-up
Commercialization

Current Status (2020)
The project is located in Karlsruhe, Germany, at the Institute of Technology (KIT). The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq. The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq. The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq.

Important steps along the innovation chain to current status
The project is located in Karlsruhe, Germany, at the Institute of Technology (KIT). The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq. The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq. The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq.

Development and Testing
The project is located in Karlsruhe, Germany, at the Institute of Technology (KIT). The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq. The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq. The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq.

Scale-up
The project is located in Karlsruhe, Germany, at the Institute of Technology (KIT). The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq. The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq. The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq.

Commercialization
The project is located in Karlsruhe, Germany, at the Institute of Technology (KIT). The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq. The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq. The project is a joint venture between the Institute of Technology (KIT) and the company bio1iq.

Assess successes and lessons learned for biofuels deployment

The main objectives are:

- Provide insight about future potential developments of international (advanced) biofuel trade and its interaction with local/domestic markets (linked to IEA Bioenergy Task 40 Regional Transitions project).
- Assess successes, failures and learnings of existing feedstock supply chains (linked to T40 Regional Transitions project). Compare the failures of large-scale mobilization and utilization of agricultural residues by pioneer biorefineries and successes of plantations supplying woody biomass to large pulp mills in Brazil.
- Assess potential development of biomass fractionation methods to provide conversion-ready feedstocks and co-products.
- Lessons and successes in sustainability standards and certification of international supply chain (insights from IEA Bioenergy Task 40 and H2020- ADVANCEFUEL)

Synopsis synthesis of key issues

- Providing a synopsis of this study based on the WP 1 - 4 results -> Conclusions about “successes and lessons learned on biofuels deployment” Link to WP 6/workshop in 11/2021
- Answer the project key questions:
“What is required to re-stimulate vigorous biofuels development and scale up?”
“What are key factors for the success of sustainable advanced biofuel projects?”
- From WP 3 e.g. “Important steps along the innovation chain to current status” incl. driving frame conditions, driving factors
- Developing a kind of “guideline/good to know” brief for decision and policy makers
>> key messages of the WP are important
- Additional outlook-oriented parts of this work package include identifying objectives for further - and in terms of dedicated questions - more detailed aspects of “Assessing lessons learned for renewable fuels”.
- Possibility to extend and continue work in WP 2 Meta-analysis for Phase II, not excluding HVO-based biofuels for case studies of lipids supply chains, as this increases rapidly.

Project management / Reporting

- The project has had five progress meetings including this one and is scheduled for one or two more thereafter.
- The project has made three progress report presentations to ExCo with latest in October 2021. These have been given by Jim McMillan.
- ExCo88 - Intertask Lessons learned biofuels 1-page status report
- The project have had three internal workshops (WP 2)
- We have had several Project management meetings.
- The project is planning for one external workshop 25 Nov 2021.
- The deliverables will be three reports (R1-3) and one Summary (S)

External workshop 25 November 2021

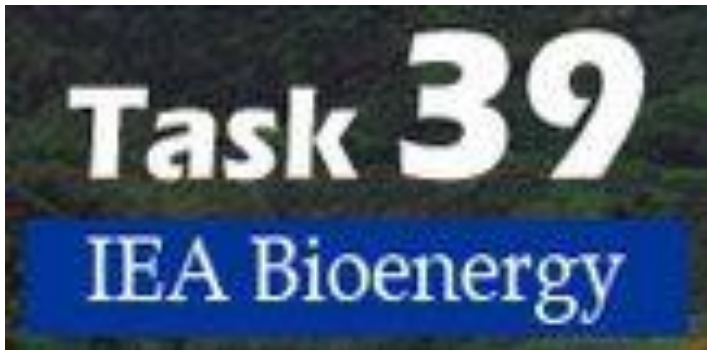
Goal: provide workshop among industry and decision-makers presenting and discussing project results for WP 5

1. Format: Co-organizing with IEA TCP Task 33 and Swedish Centre for Gasification with physical and digital participation, aim: 80-100 people
2. Location and time: Saltsjöbaden, Stockholm prel. 09:30 -17:00
3. Marketing and invitation and registration done by SVEBIO assisted by others
4. Tentative program: introduction and series of presenters of projects followed by work groups discussing laid out questions and final presentation with general discussion and conclusions.

Thanks! Questions?

Tomas Ekbom

Franziska Müller-Langer



www.task39.ieabioenergy.com



IEA Bioenergy

Technology Collaboration Programme

www.ieabioenergy.com

Technology Collaboration Programme

by **iea**