Task 33 Gasification of biomass and waste

Berend Vreugdenhil - TNO
Chair Task 33

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IEA Bioenergy TCP

Technology Collaboration Programme (TCP) functioning within a framework created by the International Energy Agency (IEA)

Goal:

• International collaboration and info exchange on bioenergy research, technology development, demonstration, and policy analysis

• Facilitate the commercialization and market deployment of environmentally sound, socially acceptable and cost-competitive bioenergy systems

Work programme carried out through Tasks and Special Projects, covering the full value chain from feedstock to final energy product
IEA Bioenergy TCP Overview

ASIA/OCEANIA/AFRICA
- China
- India
- Japan
- Korea
- Australia
- New Zealand
- South Africa

AMERICA’S
- Brazil
- Canada
- United States

EUROPE:
- Austria
- Belgium
- Croatia
- Denmark
- European Commission
- Estonia
- Finland
- France
- Germany
- Ireland
- Italy
- Netherlands
- Norway
- Sweden
- Switzerland
- United Kingdom

26 Contracting Parties

Budget in 2020:
- 2 Million US$
- Tasks: 11+ Specials Tasks
- Participation: 106
  Direct participation:
  > 200 persons
## Priorities

| Provide science-based arguments and key figures to **inform the public debate** on sustainable bioenergy (towards policy makers, media and the public) |
| Provide a **central information source**, with state-of-the-art information on bioenergy conversion technologies |
| Act as a **discussion platform** between international experts, stakeholders and policy makers |
| Provide **key figures/general information, handbooks and best practises** for entrepreneurs, industry, advisors, ... |
| Move forward **collaborative research** between international experts to bring technologies and insights forward |
| Analyse **policy frameworks/landscapes** and produce policy advice to governments/policy makers |
| Provide an overview of evolutions in the area of bioenergy in the form of **status reports, mapping, newsletters, ...** |
| Discuss local issues and **exchange experiences** in an international context, leading to new perspectives and options on bioenergy deployment |
| Provide background on **availability and mobilisation options** of sustainable biomass resources; analyse impacts of bioenergy deployment in terms of sustainability, land use, ... |
| **Analyse bioenergy markets** and get insight in deployment opportunities |
| Provide the basis for **harmonized R&D programmes** in the participating countries and prevent duplication of efforts |
Objectives 2020-2025

1. Enable the development and application of **innovative bioenergy technologies** to provide **substantial contributions to future global energy demand**; and **serve a major role in decarbonising** transport, heat, power and electricity.

2. Support **increased sustainable biomass production** and establishing efficient biomass supply chains based on transparent, science-based criteria.

3. Fully explore bioenergy’s potential to **deliver significant greenhouse gas savings** across all energy sectors, and its capacity to **deliver negative emissions**, e.g., through BECCS/U

4. Engage stakeholders and **expand collaboration** to pursue objectives and enhance and **optimise communication channels**, to disseminate outputs widely and **increase engagement with emerging and developing countries**.
Activities/Tasks in IEA Bioenergy

System perspective
- Task 45 Climate change & sustainability

Energy & product markets
- Task 39 Transport biofuels
- Task 42 Biorefining
- Task 44 Energy system / flexibility
- Task 32 Combustion & emissions
- Task 33 Gasification
- Task 36 Waste & circular economy
- Task 37 Anaerobic digestion / biogas
- Task 34 Liquefaction
- Task 43 Biomass supply
- Bio-based deployment

Conversion
- Renewable Gas

Resources
- HT heat in Industry
- Pre-treatment
- Roadmap

IEA GHG TCP
- WBZ/SDG
- BECCS/U
- IEA CCC TCP
- IEA DHC TCP
- AMF TCP
- IETS TCP
- ETSAP TCP
- IEA Hydrogen TCP
IEA Bioenergy Task 33 Gasification of biomass and waste

➢ Objectives
• Promote commercialization of biomass and waste gasification
• Monitor, review and exchange information on gasification research, development, and demonstration
• Encourage cooperation among member countries and industry

➢ Audience
• Policymakers
• Technology providers
• End users
• Researchers
• General public

➢ Outputs
• Reports
• Workshops
Gasification explained

Direct gasification

Heat + Feedstock (s) → Product (g) + Char (s)

Indirect gasification

Heat + Feedstock (s) → Product (g) + CO₂ (g)
Role of gasification

• Gasification is an enabling technology:
  • Gasification for heat and/or power production (for instance at coal fired power stations)
  • Gasification for the production of Substitute Natural Gas (GoBiGas or KEW)
  • Gasification for advanced biofuels production (BioTFuel in France)
  • Gasification for chemicals production (upcoming report)
  • Gasification for hydrogen production (report available)
  • Gasification in relation to CCS (report available)
Past highlights

- **Hydrogen from biomass**
  → Production costs down to 2.7 €/kg

- **Overview of waste gasification**
  → Elaborate overview of different technologies

- **Gas analysis**
  → If you need info on any type of gas analysis technique relevant to gasification

- **BECCS with biofuels production**
  → Good overview of production costs for SNG or FT w/wo CCS (transport and storage)
Upcoming highlights

• Report on emerging gasification technologies. Inventory of “high potential technologies” with un unbiased evaluation (TRL, track record, technology used etc)

• Report on the integration of gasification in (bio)refineries. Detailed case studies on how existing industrial activities could become “bio-refineries” or how existing fossil based refineries could become more bio-based / circular.
Gasification at TNO
The Role of Gasification in our Future Energy System

LONG HISTORY IN GASIFICATION / CLEANING

1980
300 kWth Downdraft gasifier on coal. Later modified for wood operations. Used for gas cleaning R&D

1995
500 kWth CFB gasifier, used for various biomasses. Technology licensed to HoSt

2004
Start of indirect gasification MILENA 25 kWth. Scaled to 800 kWth and used for SNG development

2020
New biofuel lab Gasification, cleaning, co-production (BTX), synthesis (MeOH, FT, DME and SNG)
**GASIFICATION / CRACKING R&D**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedstock flow</td>
<td>3 - 6 kg/h max</td>
</tr>
<tr>
<td>Feedstock type (range)</td>
<td>biomass – RDF – plastic waste</td>
</tr>
<tr>
<td>Supply gases</td>
<td>N₂, CO₂, Air, Steam</td>
</tr>
<tr>
<td>Trace gases</td>
<td>Argon and Neon</td>
</tr>
<tr>
<td>Heating</td>
<td>Externally traced up to 900°C</td>
</tr>
<tr>
<td>Operating T</td>
<td>550 – 850 °C</td>
</tr>
<tr>
<td>Operating P</td>
<td>Atmospheric</td>
</tr>
<tr>
<td>Analysis</td>
<td>Product and flue gas</td>
</tr>
</tbody>
</table>

TNO capabilities on thermal cracking for the lab unit

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**MILENA**
- raw product gas
- flue gas
- Plastic waste
- air
- steam
TNO gasification technology

Gasification line-up to advanced biofuels and chemicals

Indirect gasification
Low temperature (700-850°C)
Possibility to recover light tar components as products, roughly 200 gram/h (mostly naphthalene)

Water scrubbing system, capable of dosing acid/caustic for additional impurities capturing

DEA: conversion of olefins to aromatics to boost the yield of the BTX scrubber

AREA: capturing 150 – 300 gram/h of BTX
Steam reformer to produce syngas
Amine based CO\textsubscript{2} scrubber to fine tune the syngas composition
Gas booster from 5 – 100 bar
Fixed bed reactor setup
1. Methanation
2. Fischer Tropsch
3. Methanol
4. DME
Slurry bed reactor setup
1. Fischer Tropsch
Wax upgrading and Catalyst screening unit
MILENA allows complex feedstocks to be valorized in existing naphtha infrastructure
CRACKING OF PLASTIC CONTAINING WASTE

- Circular naphtha being produced from plastic waste streams via pyrolysis
- Circular olefins/aromatics produced from plastic waste streams via thermal cracking
- Biobased olefins/aromatics produced from RDF streams via thermal cracking

- Both routes need to be further developed, improved and implemented
- Both routes will face a large challenge in matching the naphtha demand
Summary

IEA Bioenergy Task 33
- Working group of countries active in the field of gasification
- Our output consists mostly of relevant studies to support deployment of gasification technology
- Open to additional countries

TNO Energy Transition
- Largest Dutch R&D organization (broad scope)
- Gasification activities towards the product of biofuels and biochemicals
- Gasification activities toward the recycling of plastic containing waste streams
Time for questions

Berend Vreugdenhil
berend.vreugdenhil@tno.nl
+31 (0) 6 10 1111 76
http://task33.ieabioenergy.com/

www.ieabioenergy.com