IEA Bioenergy

IEA Bioenergy Task 33

Gasification of biomass and waste

Photo: SYNCRAFT®Werk Beta / Vierschach / South Tyrol / Italy

Dr. Jitka Hrbek

University of Natural Resources and Life Sciences Vienna (BOKU))

6. CEBC, 24.1.2020, Graz

Content

- IEA Bioenergy Task 33 “Gasification of Biomass and Waste”
- Task activities in last Triennium
- Outlook

IEA Bioenergy Task 33
„Gasification of Biomass and Waste“

Task 33 is a working group of international experts with the aim to promote the commercialization of efficient, economical and environmentally preferable thermal biomass and waste gasification processes.

TRIENNIUM 2019-2021

Member countries

- Austria
- Germany
- Italy
- Netherlands
- Sweden
- UK
- USA

Task Leader:
Berend Vreugdenhil, TNO

Task Co-Leader:
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Austrian representatives
Dr. Jitka Hrbek
Prof. Christoph Pfeifer, BOKU Vienna

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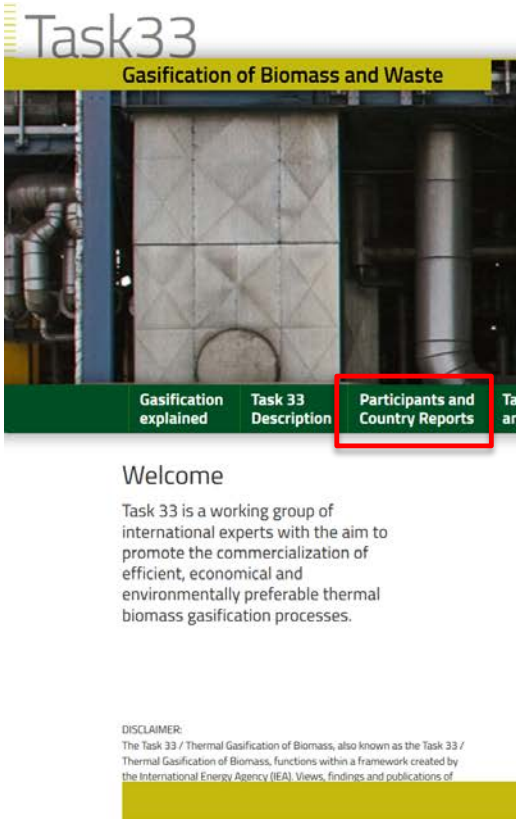

DATE	COUNTRY	AUTHOR	LAST UPDATE
2018	Austria *(pdf 2,8 MB)*	J. Hrbek, *BOKU*	25.11.2019
2019	Denmark *(pdf 2,1 MB)*	M. T. Hansen, Ea Energy Analyses	
2008	Finland *(pdf 876 KB)*	I. Hannula, *VTT*	25.11.2019
2019	Germany *(pdf 3,2 MB)*	T.Kolb, M. Eberhard, *KIT*	25.11.2019
2019	Italy *(pdf 6,8 MB)*	*Donatella Barisano, ENEA*	25.11.2019
2012	Japan *(pdf 612 KB)*	M. Morita, *NEDO*; T. Ogi, *AIST*	
2013	The Netherlands *(pdf 2,1 MB)*	B. Van der Drift, B. Vreugdenhil, *ECN*	25.11.2019
2012	New Zealand *(pdf 611 KB)*	Shu-sheng Pang, *Univ. of Canterbury*	
2015	Norway *(pdf 230 KB)*	R. Khalil, J. Sandquist, *SINTEF*	
2019	Sweden *(pdf 4.3 MB)* *Annex Report (1997-2009) (pdf 1.6 MB)*	L. Waldheim, *WAC*	25.11.2019
2015	Switzerland *(pdf 197 KB)*	M. Rueegsegger, *ETECA GmbH (Ltd)*	
2006	United Kingdom *(pdf 322 KB)*	Nick Barker, *Future Energy Solutions*	25.11.2019
2011	Turkey *(pdf 124 KB)*	S. Gul, H. Karatas, *TUBITAK*	
2019	USA *(pdf 7.83 MB)*	K. Whitty, *University of Utah*, B. Baldwin, *NREL*	25.11.2019

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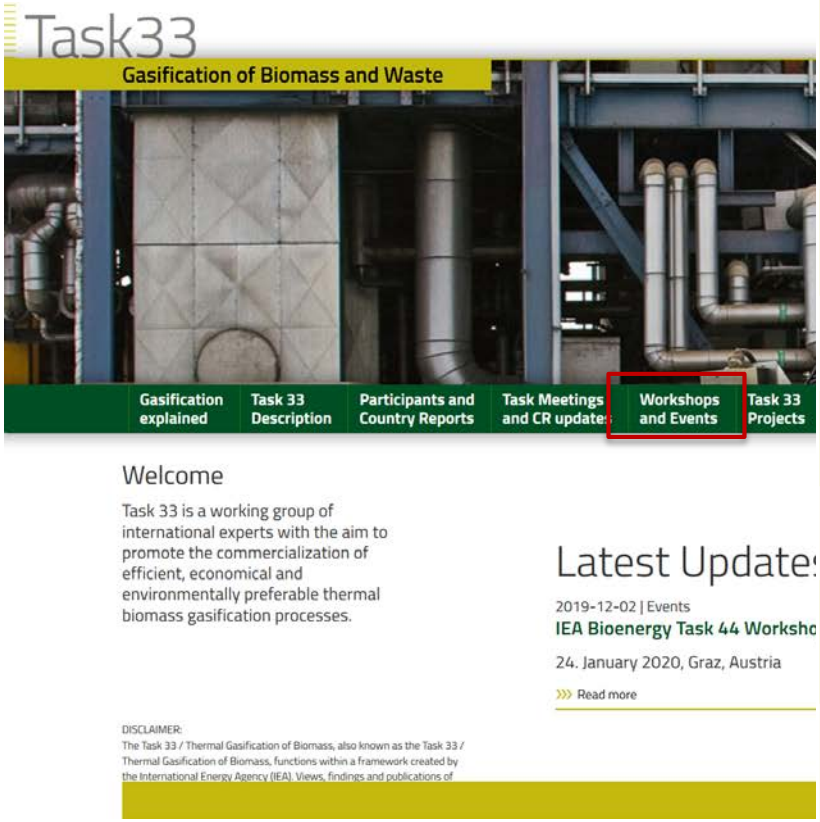
www.task33.i



Date, Location	Workshop topic	Files (pdf)
26. November 2019 Birmingham UK	Waste gasification	Workshop presentations
06. June 2019 Karlsruhe **Germany**	Gas cleaning, experiences, new developments, analytics and diagnostics	Workshop presentations WS - Report
06.-09. November 2018 San Francisco **USA**	ABLC Global Conference 2018	Conference
08. May 2018 Petten **the Netherlands**	Waste gasification	Workshop presentations WS - Report
24. October 2017 Skive **Denmark**	Fluidized bed conversion of biomass and waste	Workshop presentations WS - Report Site visits presentations
03. May 2017 Innsbruck **Austria**	Small scale gasification for CHP	Workshop presentations WS - Report
26. October 2016 Lucerne **Switzerland**	Gas Sampling, Measurement and Analysis (GSMA) in Thermal Gasification Processes	Workshop presentations WS - Report
25. May 2016 Trondheim **Norway**	Aviation Biofuels through Biomass Gasification	Workshop presentations WS - Report
27.-29. October 2015 Berlin **Germany**	IEA Bioenergy Conference 2015	Conference proceedings
11 - 13 May 2015 Ponferrada **Spain**	Symposium on Renewable Energy and Products from Biomass and Waste	Workshop (Symposium presentations) Poster proceedings
03 - 05 November 2014 Karlsruhe **Germany**	"Liquid biofuels"	Workshop WS - Report

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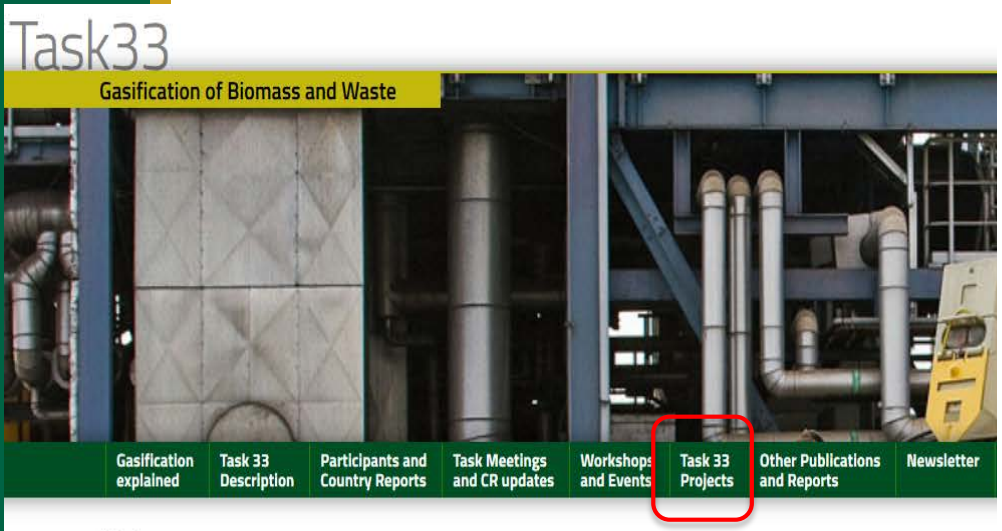

Welcome

Task 33 is a working group of international experts with the aim to promote the commercialization of efficient, economical and environmentally preferable thermal biomass gasification processes.

Latest Updates

2019-12-02 | Events

IEA Bioenergy Task 44 Workshop on Flexible Bioenergy

24. January 2020, Graz, Austria

Read more

2019-10-07 | Events

10. Internationale Anwenderkonferenz Biomassevergasung

10.12. 2019, MCI Innsbruck, Austria

The conference will be held in German language.

Read more

IEA BIOENERGY TASK 33 REPORTS

Date	Publication	Annex
10/2019	Status report on thermal gasification of biomass and waste 2019	Annex 1 - CHP operational facilites Annex 2 - CHP non operational facilities Annex 3- Fuel synthesis operational Annex 4 - Fuel synthesis non operational Annex 5 - Other gasif. technology operational Annex 6 - Other gasif. technology non operational
08/2019	Lessons learned about thermal biomass gasification	Historical documents
02/2019	InterTask project Biomass pre-treatment for bioenergy, Case study 3: Pretreatment of MSW for gasification	
12/2018	Gasification of waste for energy carriers	
12/2018	Hydrogen from biomass gasification	
11/2018	Valorisation of by-products from small scale thermal gasification	Annex 1- Market for carbon and charcoal Annex 2- Analytics Annex 3- Charcoal Annex 4- Dust, ash
10/2018	Thermal gasification based hybrid systems	
09/2018	Gas analysis guideline report - part I and part II	
07/2018	Implementation of bio-CCS in biofuels production	

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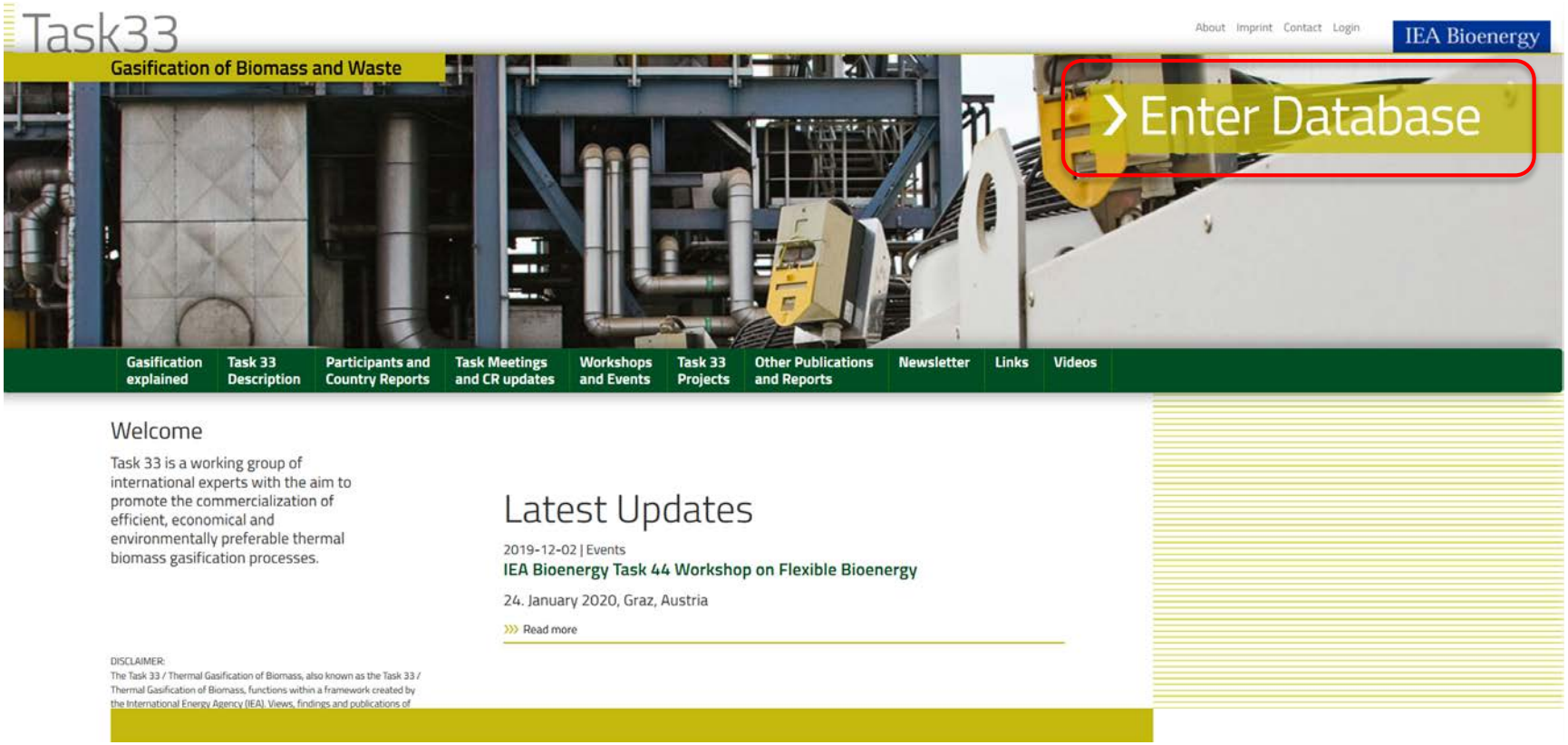

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Gasification of biomass and waste

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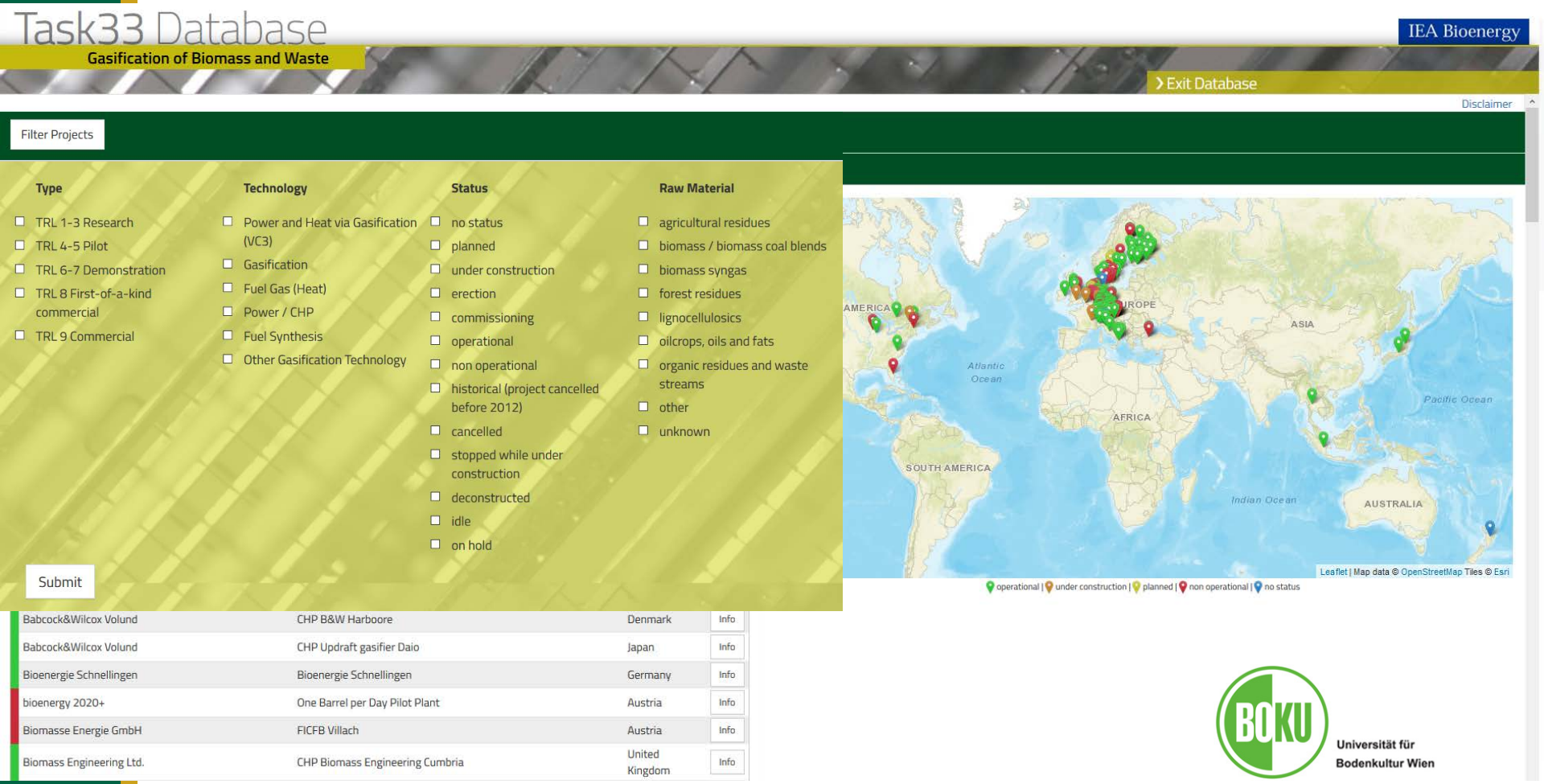

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Last Triennium Task projects (selection)

- Status report 2019
- Gasification based hybrid systems
- Gasification of waste for energy carriers
- Valorization of by-products from small scale thermal gasification

Status report 2019

Implementation of gasification projects in Task 33 member countries (last Triennium)

Countries included:

- Austria
- Denmark
- Germany
- Italy
- The Netherlands
- Norway
- Sweden
- Switzerland
- USA

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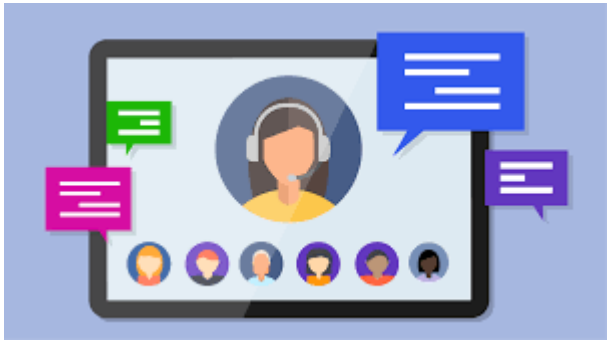
IEA Bioenergy Webinar

Connect to the webinar at: https://meet80114613.adobeconnect.com/rim08cdsh89u/

Date: 30. January 2020

Time: 4-5 pm (Centr.Europ.time)



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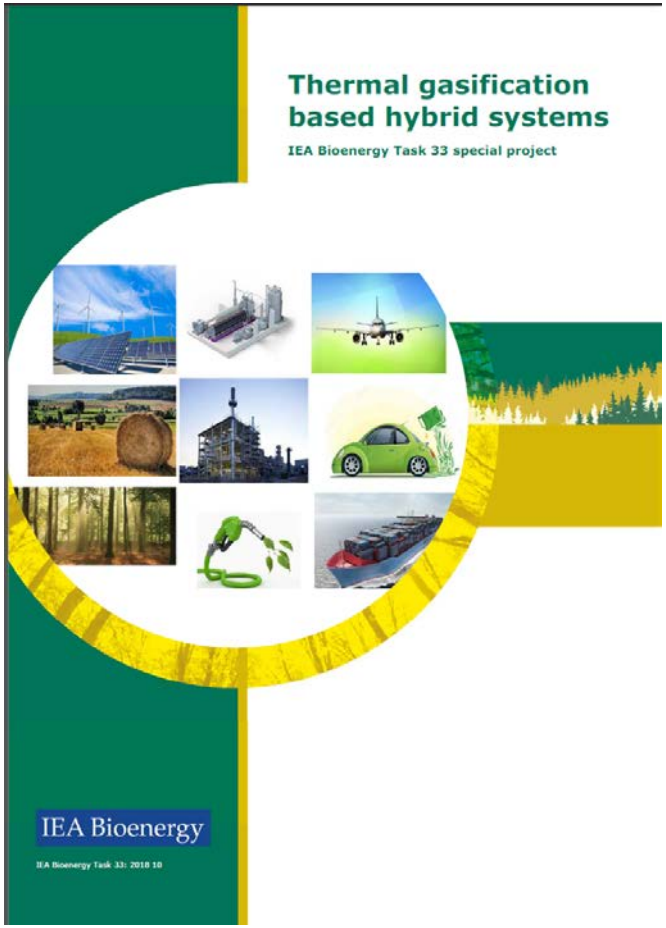
Gasification based hybrid systems PtG & PtL



1. Energy Strategy 2020, 2030, 2050
2. Future potential of biomass
3. Thermal gasification explanation
4. Solar and wind power energy
5. Storage of fluctuating energy
   - Power to Gas
     - -explanation+economics
     - -projects
   - Power to Liquids
     - -explanation+advantages
     - -projects

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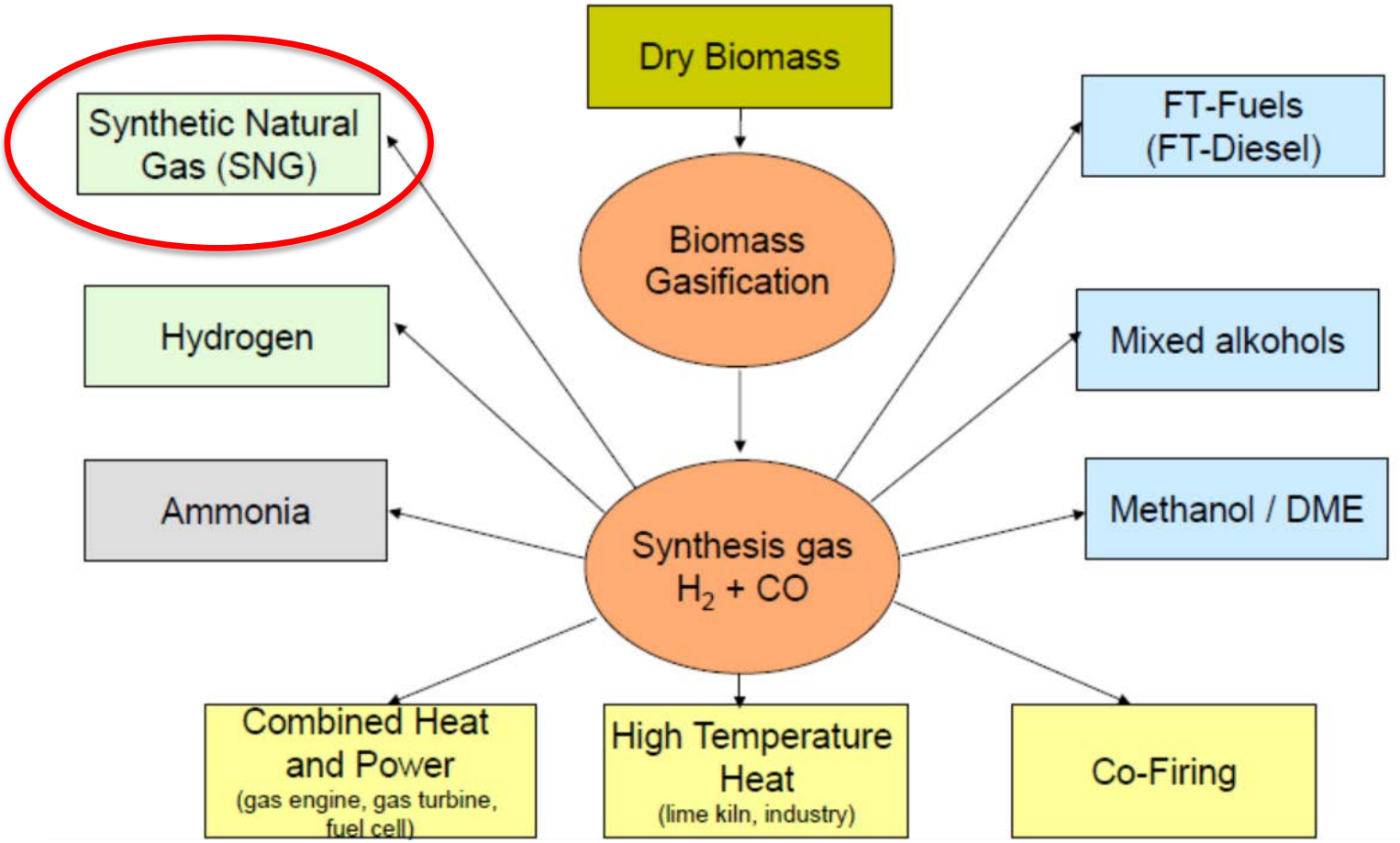
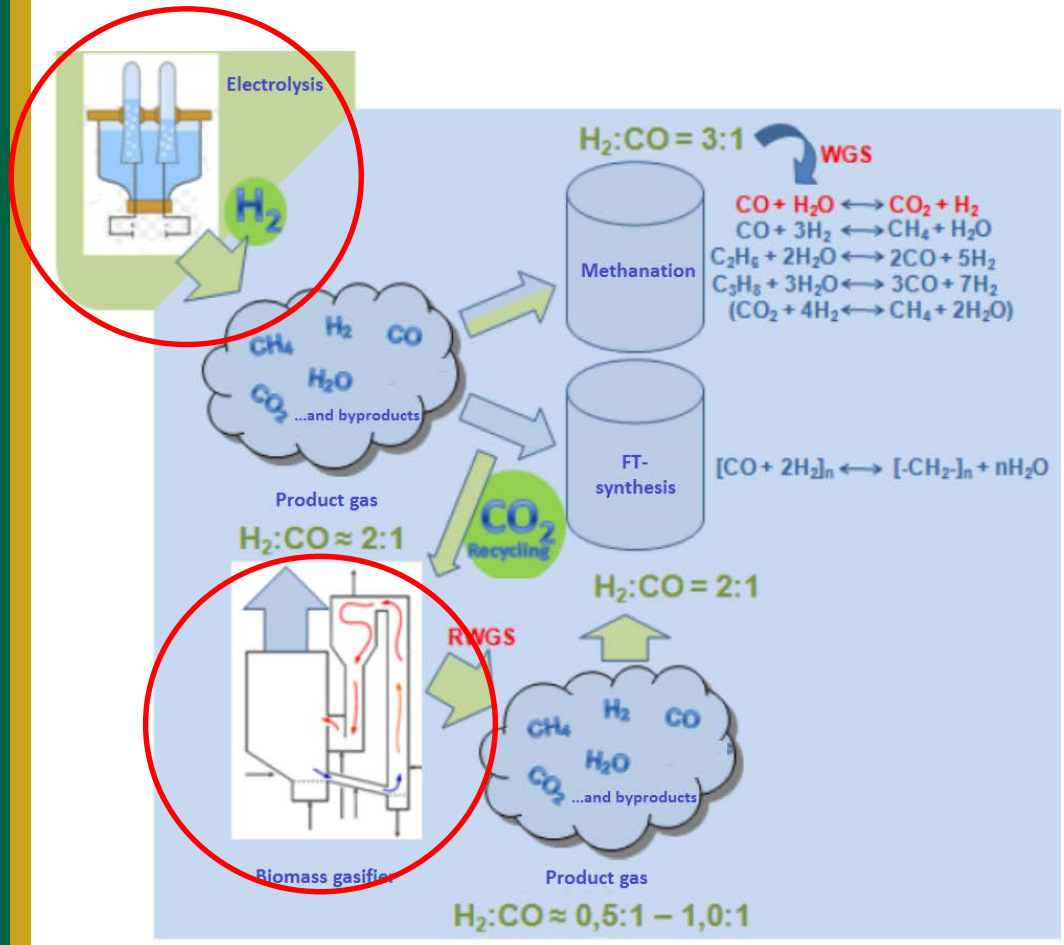
Power to Gas


Dry Biomass
Synthetic Natural Gas (SNG)
FT-Fuels (FT-Diesel)
Biomass Gasification
Hydrogen
Mixed alkohols
Ammonia
Synthesis gas H_2 + CO
Methanol / DME
Combined Heat and Power (gas engine, gas turbine, fuel cell)
High Temperature Heat (lime kiln, industry)
Co-Firing

PtG



A system consists of double-bed steam gasifier and electrolyser for production of methane (PtG)

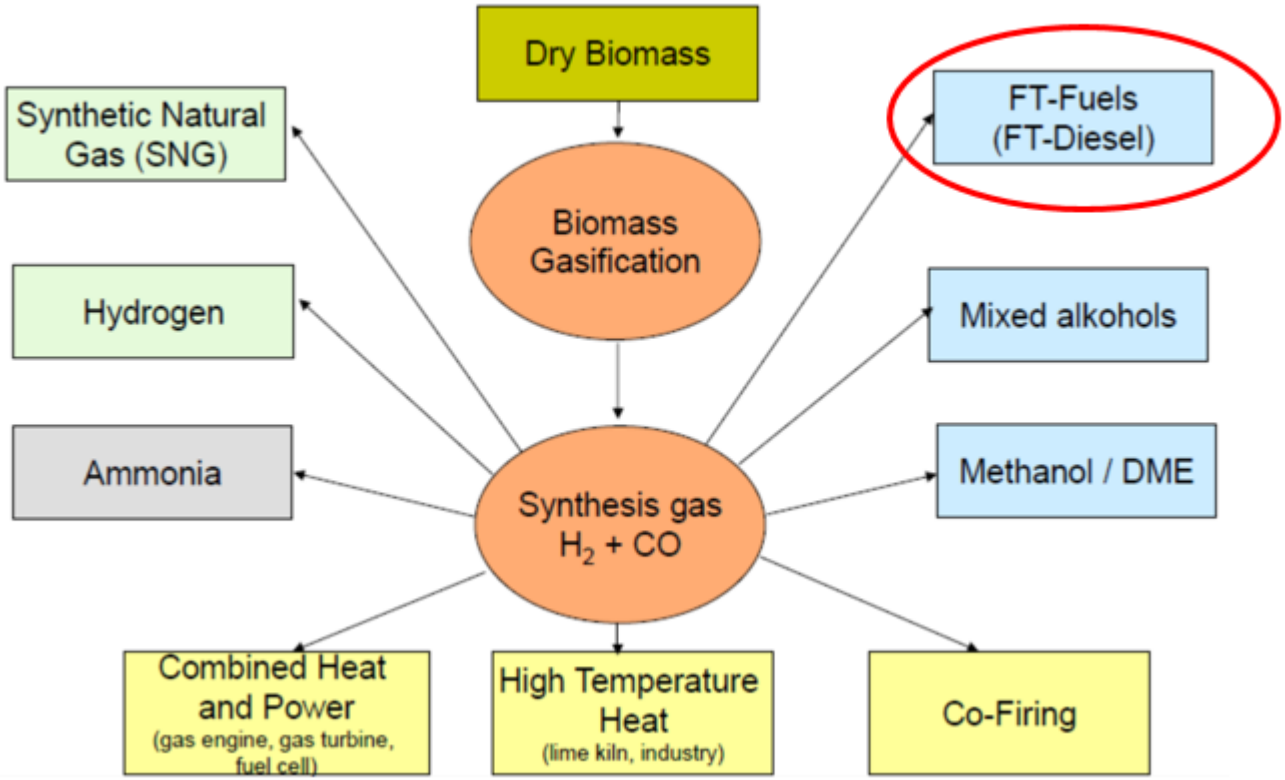
During the steam gasification a gas with H_2 : CO = 2 ratio is produced, but for methanation a gas with ratio H_2 : CO = 3 is necessary, it means further hydrogen from electrolyser is needed.

Advantage:
<u>Coupling</u> the thermal gasification of biomass with hydrogen from electrolysis <u>can doubled the production of renewable fuels</u> in comparison if only product gas from gasification is used.

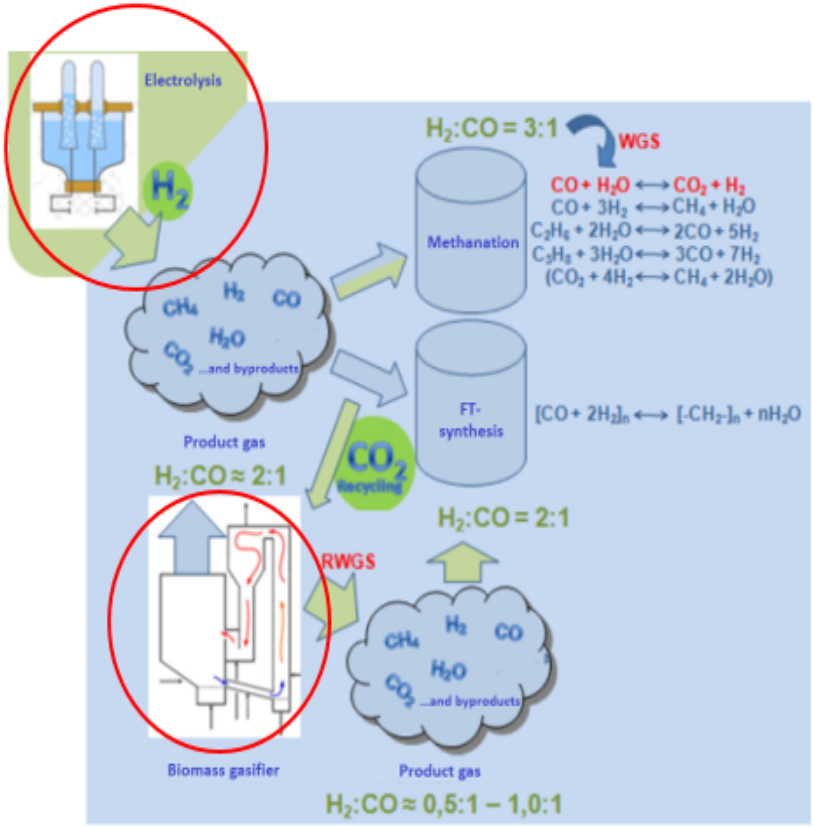
Advantages of gasification integration into PtG systems

- Total carbon exploitation from biomass can be more than doubled
- Higher overall process efficiency (larger product yield and possibility of heat integration)
- O_2 from electrolysis can be used for gasification
- By adding hydrogen from electrolysis, the use of the water-gas shift reaction can be avoided
- Large H_2 storage can be avoided
- By non-available surplus electricity, the methanation can be operated with synthesis gas from gasification only

Power to Liquids



PtL (FT products)



Compound		Air gasification Fixed bed	Oxygen gasification Entrained flow	Steam gasification Fluidized bed
CO	Vol. %	13-18	45-55	25-30
CO_2	Vol. %	12-16	10-15	20-25
H_2	Vol. %	11-16	23-28	35-40
CH_4	Vol. %	2-6	0-1	9-11
N_2	Vol. %	45-60	0-1	0-5
Calorific value	MJ/Nm^3	4-6	10-12	12-14

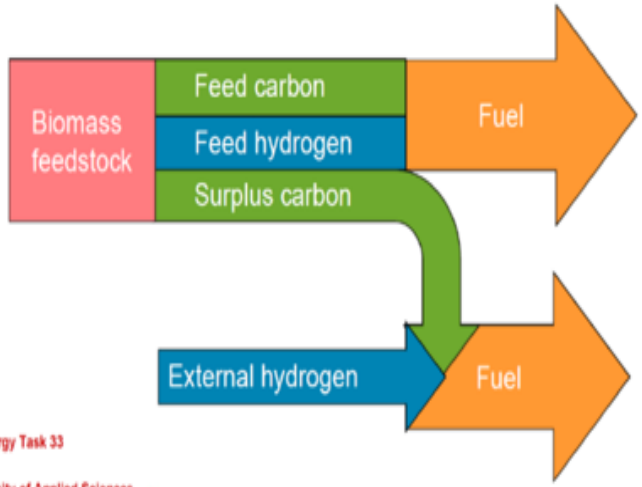
Source: A.V. Bridgwater, H. Hofbauer, S. van Loo: Thermal Biomass Conversion, 2009, ISBN 978-1-872691-53-4

A system consists of two bed steam gasifier and electrolyser for production of methane (PtG) or FT-products (PtL).

During the steam gasification a gas with H_2 : CO = 2 ratio is produced, which is optimal for FT-synthesis.

By FT synthesis is the usage of additional hydrogen from electrolyser a little bit different. The principle is based on CO_2 recycling, it means, the inert CO_2 will not be released to the atmosphere, but it will serve as an additional fluidizing agent in the gasification unit as a carbon source for further reactions with hydrogen from electrolysis.

Advantages



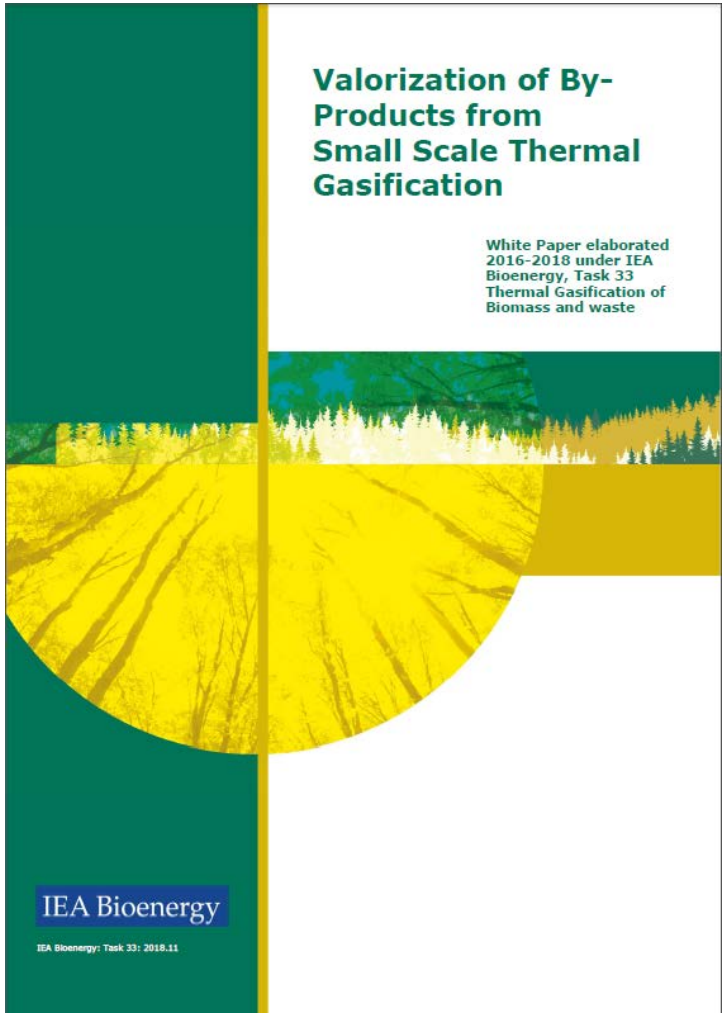
Workshop IEA Bioenergy Task 33
26. October 2016
HSLU Lucerne University of Applied Sciences
Dr Ilkka Hannula

Using of additonal (external) hydrogen the FT products amount could be doubled

Advantages:

- Conversion of surplus electricity and surplus carbon to high valuable products
- Higher carbon utilization
- Biomass acts as base load (8000 oph/y possible), no start-stop operation, only load change

Byproducts from thermal gasification



Annex 1 October 2018

Market for Carbon, Charcoal activated Coal
Valorization of by-products from small scale gasification

Annex 2
Analytic, Checks, Tests and Examples of Coal containing residues and by-products out of small-scale thermo-chemical wood gasification CHP plants

Annex 3

CHP small-scale CHP Unit examples build for charcoal production October 2018

Annex 4 **Research Activities**

Valorization of by-products from small scale CHP thermal gasification

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Charcoal market

Carbon utilization	Production by	Coming from	Raw material	General expretions	Brand names
Filter absorber	gasification pyrolyze	biomass	wood	Activated carbon	Donaucarbon Silcarbon
Agriculture Gardening Soil improvement	gasification pyrolyze lignite grinded	biomass «Biochar» fossil		(Pflanzenkohle) **BIOCHAR***	Verora Egos
BBQ	gasification pyrolyze lignite grinded and pressed		wood fossil coal	BBQ coal charcoal	
Metal production	gasification pyrolyze lignite grinded	biomass fossil	Wood Coal lignite	Lignite Carbon	
Energy	gasification lignite	fossil biomass	biomass all type of carbon Lignite	Biomass Coal	
Animal food	pyrolyze	biomass			
Medical human	pyrolyze	biomass			

Waste gasification for energy carriers

Comprehensive review

- Waste as a feedstock (Charakterisation and Standards)
- Waste in EU, Japan, USA - overview
- Waste policy (EU, Japan, USA)
- Gasification technologies
- Gas cleaning
- Facilities examples
- Products from waste gasification

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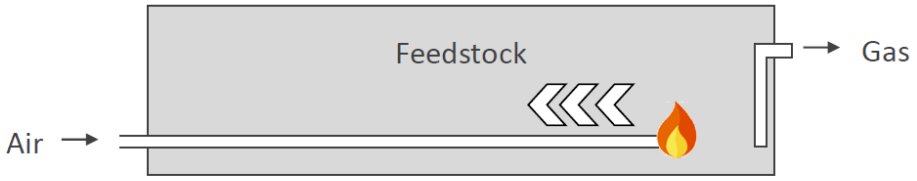
MIHG: A New Concept

WILDFIRE ENERGY

➢ MIHG is fundamentally different to all existing designs

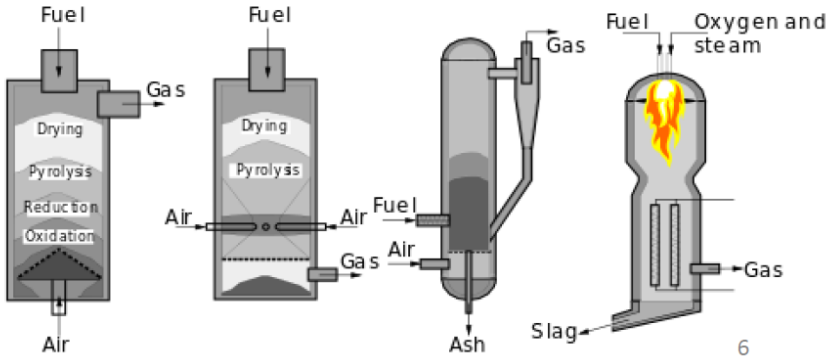
- Move the Air to the Feedstock

Moving Injection Horizontal Gasification (MIHG)



- Move the Feedstock to the Air

Existing Gasification Technologies



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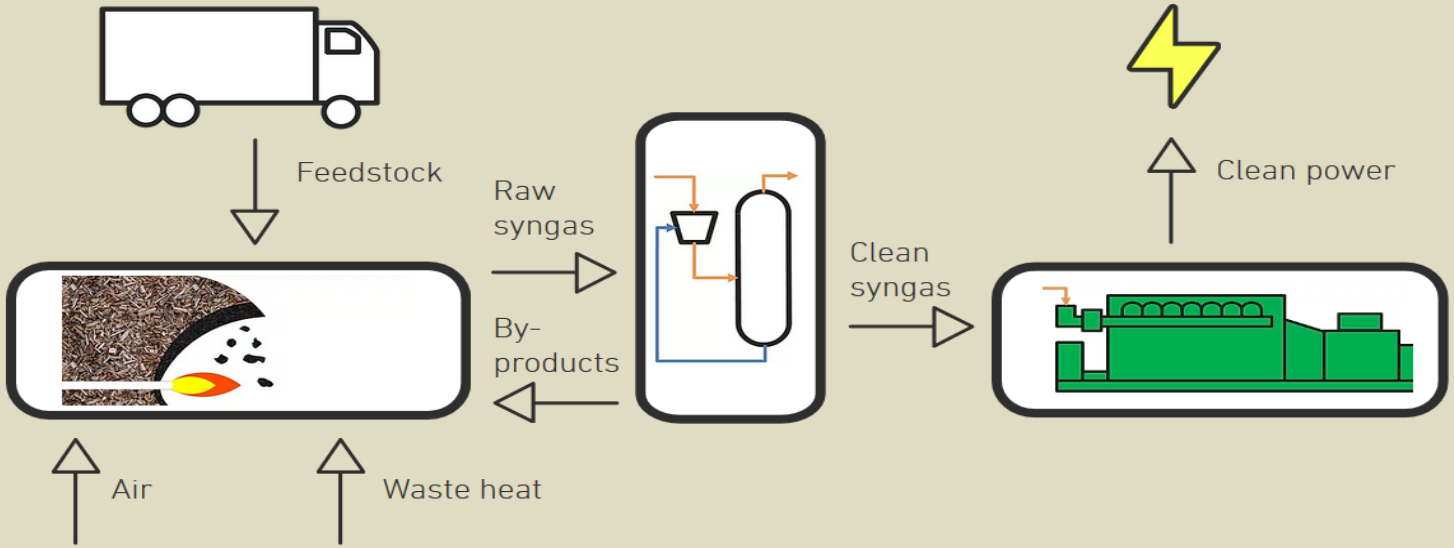


MIHG Reactor

- Feedstock is loaded
- Reactor is closed
- Feedstock is ignited
- Air injection point is slowly retracted to gasify the fuel
- Reactor is opened and reloaded

Gas Cleanup

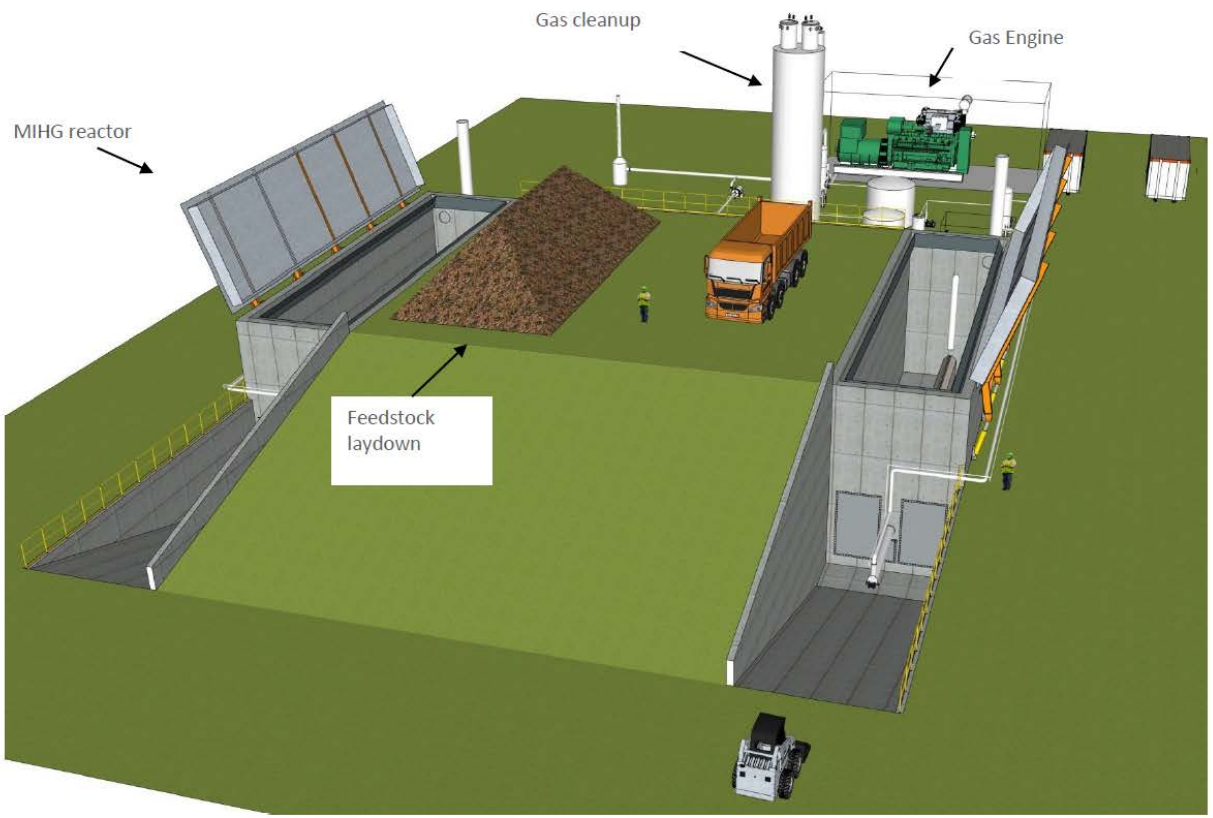
- Raw syngas is cleaned using proven technology
- By-products are recycled to MIHG reactor

Gas Engine

- Clean syngas is converted to power using proven gas engine technology
- Renewable baseload power is supplied to customer or grid
- Optional cogeneration of heat and power or production of hydrogen and biofuels

MIHG: 2 MWe Plant

WILDFIRE ENERGY



Benefits of MIHG

(moving injection horizontal gasification)

WILDFIRE ENERGY

- No feedstock pre-treatment
  - Batch loading avoids the need for pre-treatment
  - Attractive to waste management operators
- Reliable operation
  - Batch loading eliminates problematic feeding and ash removal systems
  - Long run time between batch changeover
  - Moving injection provides stable, high efficiency gasification
- Reduced costs
  - Simple construction using low cost materials
  - Combined storage, drying and gasification in the MIHG reactor
  - Moving injection enables recycling of byproducts

Outlook

Planned Task projects for actual Triennium 2019-21

- **Emerging technologies for biomass and waste**

  (molten bath gasification, reforming gasication, thermal plasma, etc.)

  - Sweden leading

- **Status Report**

  update of the Report 2019, also non-member countries incl.

  - Austria leading

- **Bioenergy for high temperature heat in industry**

  Intertask Projekt mit T 32, 34, 36, 40

  Case study on ESKA gasifier

- **Gasification for the application in biorefineries**

  - Austria leading

Gasification for the application in biorefineries

(actual Task 33 project)

Content

- Overview on biorefinery scenarios
- Definition of feedstock streams available
- Definition of gasification concepts
- Techno-economic assessment of most promising scenarios
- Decision making tool available – a clear overview
- Definition of open questions and interfaces to other IEA Bioenergy Tasks (e.g. Task 42)

Conclusions

- Gasification of waste became more important, but research in this field is still needed
- Byproducts from gasification e.g. charcoal offer great benefits
- The combination of gasification with other technologies (e.g. PV, wind power) could be the way for the future

Thank you!

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