



## Ricardo-AEA

# Trends influencing energy recovery from waste

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IEA Bioenergy Task 36 – Joint workshop with Task 37 on Issues relating to AD

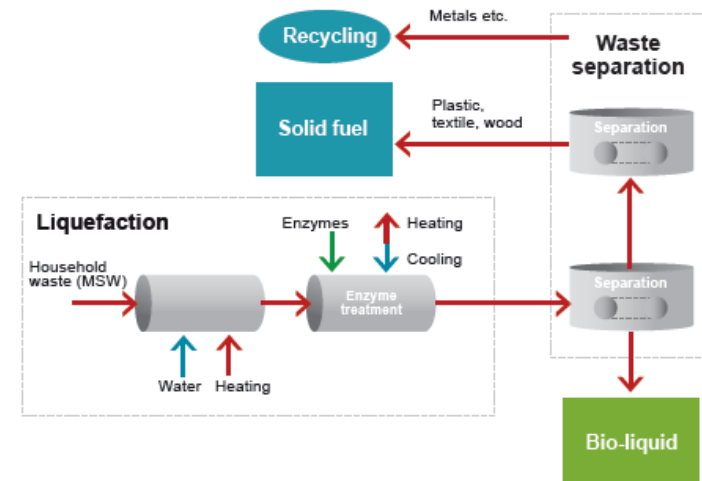
- Some interesting trends
- Open discussion of trends from today's workshop
- Conclusion to workshop.

- **Food waste and biogenic waste separation and treatment**
  - Topic 2 report from last triennium showed that this was an energy efficient way of treating this fraction, particularly if heat could be used
- **Metals recovery**
  - Discussed in Topic 4 report from last triennium
  - Metal recovery is increasingly feasible due to rise in demand for and prices for metals
- **Biofuels production**
  - N American plants
  - Dong Energy
- **Gasification**
  - Three UK plants, Lahti 2
- **MBT/RDF**
- **World trends**
  - Zero waste to landfill
  - Increasing waste in emerging economies

## □ Dong energy REnescience technology

- Process uses enzymes to liquefy biodegradable material in MSW ('Renescience' technology). Operates at atmospheric pressure and below 100C
- Enzymes convert biodegradable material to liquid biomass, which is then easy to separate
- Liquid biomass is suitable for biogas production (Yield: 100-120 Nm<sup>3</sup> CH<sub>4</sub>/t MSW)
- [www.inbicon.com](http://www.inbicon.com) [www.renescience.com](http://www.renescience.com)
- Current scale: 10t/hour

Process



- **Solena Fuels** (500,000t MSW to 50,000 t aviation fuel) Plasma gasification with BA, London (in permitting) and SAS, Arlanda, Stockholm

- US DOE have provided \$millions in grants & loan guarantees

## Ineos Bio

- Hybrid gasification and fermentation
- Vero Beach (yard, vegetative waste & citrus waste to 8 Mgal ethanol, 6MW electricity) Construction (AMEC) started in 2012.

## Bluefire

- Renewables organic part of post sorted MSW – cellulosic ethanol using acid hydrolysis process.
- 2 plants in planning - Fulton, MS – 19Mgalls/y

## Fiberight

- Pre-sort waste in MBT, pulp organic fraction
- Fermentation of bio-organic waste to ethanol.
- Pilot plant in operation, 4 full scale plants proposed.  
<http://Fiberight.com>

## Enerkem

- Methanol and ethanol from non recyclable and non compostable MSW. Edmonton: 100,000dry t sorted MSW. (38Mgal ethanol) 2014
- Mississippi - sorted MSW and wood residues to ethanol.

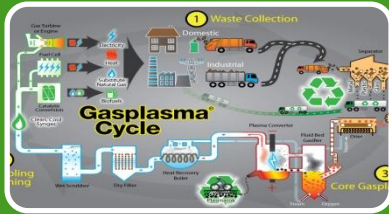
Also: Paradigm BioAviation , Bloomington 2014.





# Gasification of waste in EU

Photos courtesy APP, Metso, Energos. Air Products



APP - demonstration of waste (RDF) to bio-substitute natural gas. FB gasifier with plasma conversion of syngas. National Grid, Advanced Plasma Power and Progressive Energy – Feasibility complete. Demo plant in construction. Production in next year or so. [www.advancedplasmawater.com](http://www.advancedplasmawater.com)

See also: NNFCC 10-009 Analysis of GHG for thermochemical BioSNG production.



LAHTI - FB gasification of 250,000t/y SRF (residual non-recyclable waste, mechanically processed by waste companies prior to pre-treatment at Lahti to remove contaminants that would damage the gasifier.) 50MWe, 90MWth, € 160M. Operation: 2012. 6000h operation

[www.lahtigasification.com/power-plant/fuel](http://www.lahtigasification.com/power-plant/fuel)



ENERGOS -2 stage combustion, designed for small-scale (30-78ktpa) and control of combustion to decrease air pollution control needs. First combustion stage 'gasification'; 2<sup>nd</sup>: 'high temperature oxidation'. In operation.

[www.energ-group.com/energy-from-waste/](http://www.energ-group.com/energy-from-waste/)



Teeside – Air Products

- Two plants taking 300-250,000 t each. Second plant has PPA with UK Government Cabinet Office
- Westinghouse Alter-NRG technology

### Typical composition of residual waste:

- Main components: contaminated paper, card, plastics, textiles. May contain organic food waste.
- Minor components: combustible materials e.g. wood, metals and others.
- Moisture content ~15-25%.
- Ash: 10-20%

Type of waste	Calorific value (MJ/kg)	Comments
Mixed MSW	8-11.7 (Av: 10.3)	Data from CEWEP
Refuse derived fuel (RDF)	10-25	Higher values for waste containing higher proportion of plastics
Solid recovered fuel (SRF)	15-25 (top 3 categories)	SRF produced to specification for user e.g. cement kiln (see EN15359, CEN TC 343). Classified by: CV, Cl, Hg



# What does RDF look like?



- **Key issues in EU:**
  - Over capacity & trans-boundary shipment of RDF
  - Drop in gate fees
  - Public perception
- **Increase in waste production world wide**
  - China and India building EfW plants
  - Increased waste as urban populations increase



- Source separation is important to AD of waste and one of the major costs is the collection system
- Substrates can make a major difference to the economics – but local conditions are also important.
- There is evidence that source separation to AD is energy and carbon efficient but the use of nutrients in residue is important to this
- Microbiology is complex and important in influencing the yields. In particular inhibition can make a big difference to performance. Trace elements are a key but so is understanding exactly what is happening.
- Quality control is important.

# What will energy from waste look like in the future?

- Is AD an enduring trend?
- What difference does AD make to energy recovery of residue?
- Is there an alternative to biogas production for biodegradable content of waste?
- What about MBT & AD? Is this the right way forward?

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