Biogas and Biofuels in Europe: International Implications

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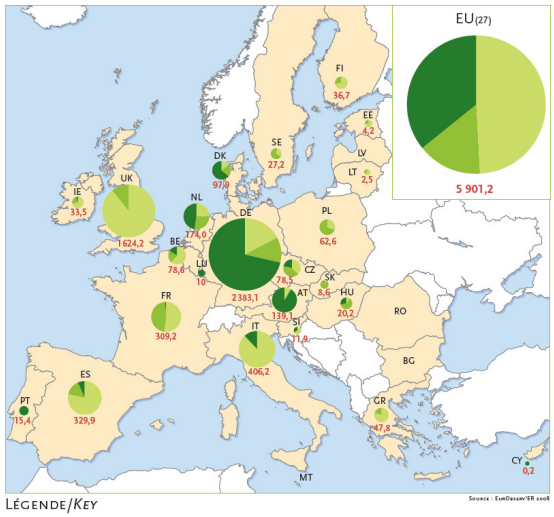
2. Liquid Biofuels in Europe: Focus 2nd Generation Biofuels
3. International Impacts of European Developments

1. Biogas in Germany and Europe

Primary Energy Production of Biogas in Europe 2007

PRODUCTION D'ÉNERGIE PRIMAIRE DE BIOGAZ EN EUROPE EN 2007*
*PRIMARY ENERGY PRODUCTION OF BIOGAS IN EUROPE IN 2007**



LÉGENDE/KEY

Production d'énergie primaire de biogaz de l'Union européenne en 2007 (en ktep)/
Primary energy production of biogas of the European Union in 2007 (in ktoe)

- Biogaz de décharges/*Landfill gas*
- Biogaz de stations d'épuration/*Sewage sludge gas*
- Autres biogaz (unités décentralisées de biogaz agricole, etc.)/*Other biogases (decentralised agricultural plant, etc.)*

5 901,2 Les chiffres en rouge indiquent la production totale en ktep/*Red figures show total production in ktoe*

* Estimation/*Estimate.*

Biogas plants in Europe

- (Landfill)
- Wastewater sewage sludge plants
- Integrated industrial biogas plants
- Agricultural biogas plants
- Centralized (agricultural) co-digestion plants
- Waste biogas plants (food waste, catering waste, MSW)

- Dry/wet fermentation
- Continuous/batch processes

Number of Biogas plants in Germany

Quellen: FNR nach DBFZ (2010), FvB (2010)

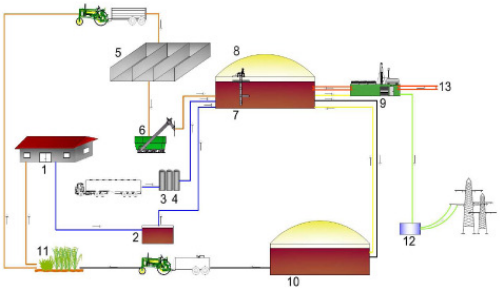
Typical agricultural biogas plant in Germany

- Average Size (2009): 500 kWel
- Average Size (2010): 430 kWel
- Biogas use: electricity
- Feedstock: mainly corn silage, but also manure, waste, etc.

Typical agricultural biogas plant in Germany

Typical Biogas Plant in Germany

- Continuous system (but also batch systems are available)
- Microbiotical processe usually simultaneous:
  - Hydrolysis
  - Acidogenesis
  - Acetogenesis
  - Methanogenesis



http://www.big-east.eu/downloads/IR-reports/ANNEX%202-39_WP4_D4.1_Master-Handbook.pdf (Lorenz 2008)

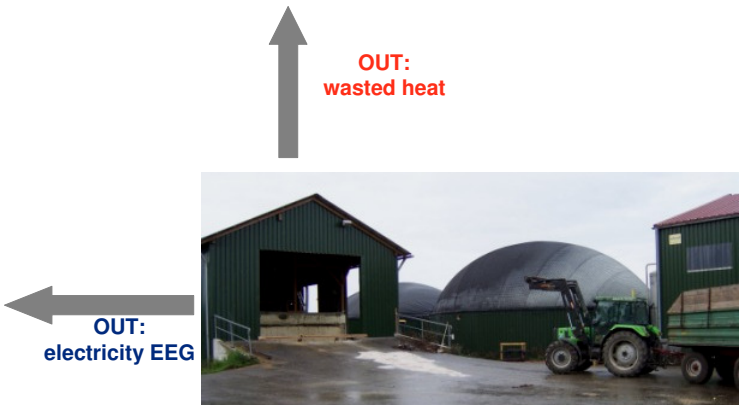
Typical agricultural biogas plant in Germany

Legislation in Germany

- **Renewable Energy Law** (EEG): Grid operators must pay a government-specified feed-in tariff to energy generators supplying energy to the grid from renewable sources.
- The historical development dates back until 2001
- The last version of the EEG entered into force on 1 January 2009
-
- **Electricity feed-in tariff** for biogas for **20 years** (2009):
  ≤150 KW → 0,1167 €/kWh
  ≤500 KW → 0,0918 €/kWh
  ≤5 MW → 0,0825 €/kWh
  5 MW - 20 MW → 0,0779 €/kWh

  Plus premiums for e.g. innovative technologies, use of manure, etc.

Learning effect: Reasons why German biogas plants struggled in 2007/2008



Drawbacks and Achievements in Germany

- Many biogas plants use corn silage as feedstock
  → increasing corn prices in 2007/08 caused economic problems
- Most biogas plants are used for electricity production
  → many biogas plants wasted the heat, causing economic problems
- Updated and new legislation in 2009 improved the economic feasibility of biogas plants
- Currently about 41 biogas plants are producing biomethane which is fed into the natural gas grid

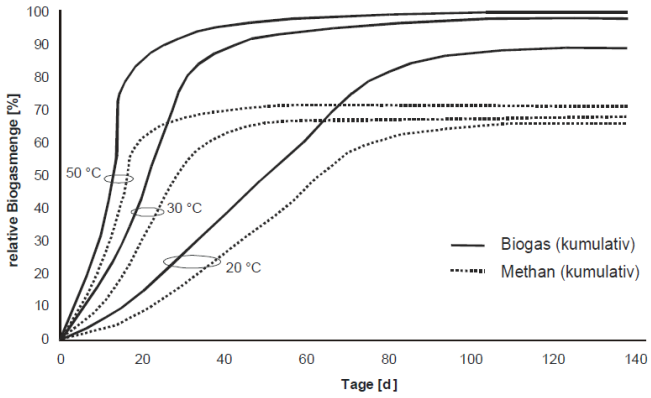
Biogas upgrading: Biomethane gas-grid injection, Germany

Currently about 41 biomethane grid-injection plants exist in Germany

Food-Waste Biogas Plant, Austria

Centralized Agricultural Co-Digestion Plants, Denmark

Biogas yield by retention time & temperature



http://www.lfu.bayern.de/abfall/fachinformationen/biogashandbuch/index.htm

Biogas development creates new markets

- Optimisation of anaerobic digestation is a key research area
- The biogas boom in Germany has created new markets in the biotechnology area:

  - micronutrients for anerobic digestion
  - enzymes, vitamins
  - laboratory monitoring of fermenter microbiology
  - laboratory monitoring of feedstock material
  - research (e.g. on hydrolysis)
  - technology development

Waste creates Biogas!

- Only some waste-based biogas plants exist
- The biogas **potential** of waste in Europe is estimated very high
- Waste is a **serious problem** in many countries

food waste (expired, catering, etc.)

food waste delivery

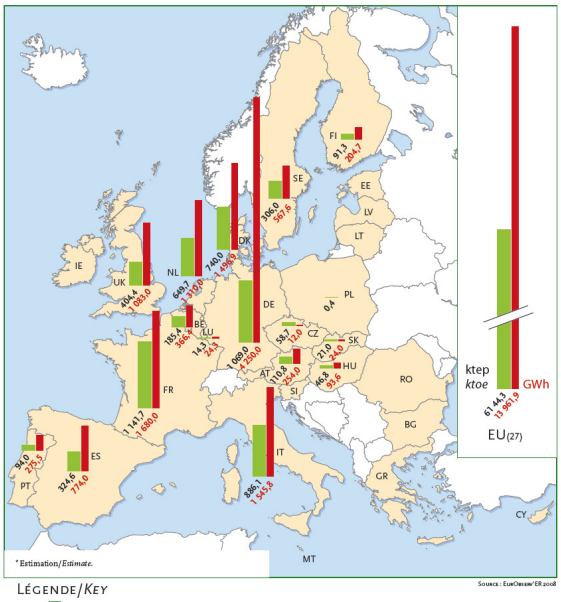
Municipal Solid Waste (MSW)

Energy Production from Municipal Solid Waste 2007 (mainly in combustion plants)

European legislation bans out landfilling of waste: energetic use or recycling

Advantage of biogas compared to combustion: decentralised, closed nutrient cycle

PRODUCTION D'ÉNERGIE ISSUE DES DÉCHETS MUNICIPAUX SOLIDES RENOUVELABLES EN 2007*
*ENERGY PRODUCTION FROM RENEWABLE MUNICIPAL SOLID WASTE IN 2007**



LÉGENDE/KEY

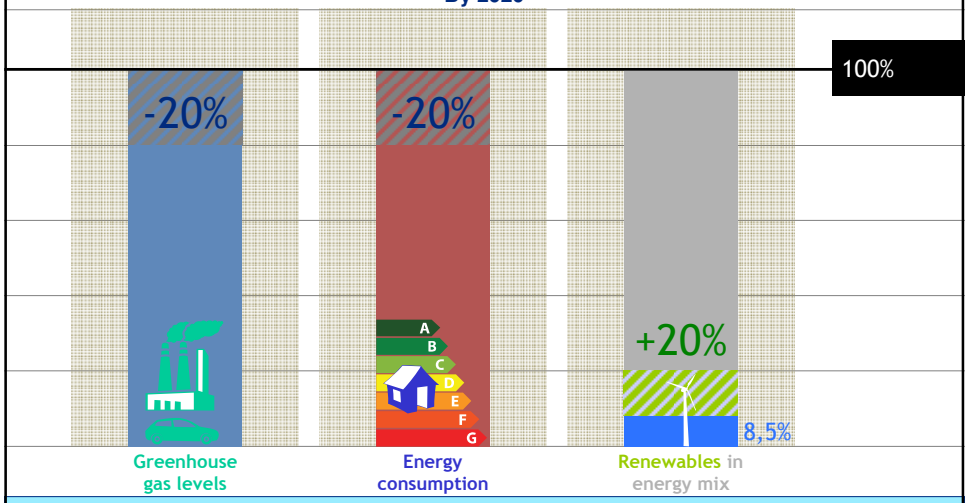
Production d'énergie primaire à partir de déchets municipaux solides dans l'Union européenne en 2007* (en ktep)
Primary energy production from renewable municipal solid waste in the European Union in 2007 (in ktoe)*

Production brute d'électricité à partir de déchets municipaux solides dans l'Union européenne en 2007* (en GWh)
Gross electricity production from renewable municipal solid waste in the European Union in 2007 (in GWh)*

2. Liquid Biofuels in Europe

The 20-20-20 EU policy

By 2020



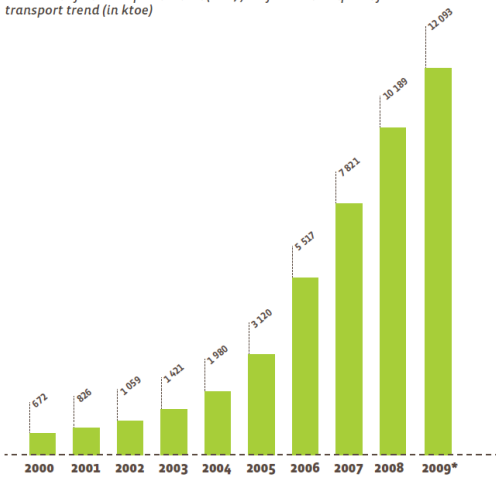
RED Directive (2009/28/EC) "on the promotion of the use of energy from renewable sources"

- Scope: Common framework for the promotion of energy from renewable sources

- Mandatory national targets
- 20% overall target for renewable energy in 2020
- **10% target for renewable energy in transport in 2020**
  - Biofuels 1st generation
  - Biofuels 2nd generation **counts double**
  - Renewable electricity / hydrogen
    - Renewable electricity in cars: bonus of 2.5

- Measures to achieve these targets:
  - Support schemes
  - Measures of co-operation

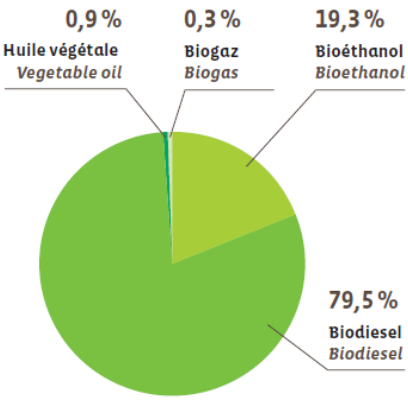
Evolution of the European Union (EU27) biofuel consumption for transport trend (in ktoe)



** Estimations. – Sources: EurObserv'ER (année 2008 et 2009) et Eurostat (2000-2007)./EurObserv'ER (for years 2008 and 2009) and Eurostat (2000-2007).*

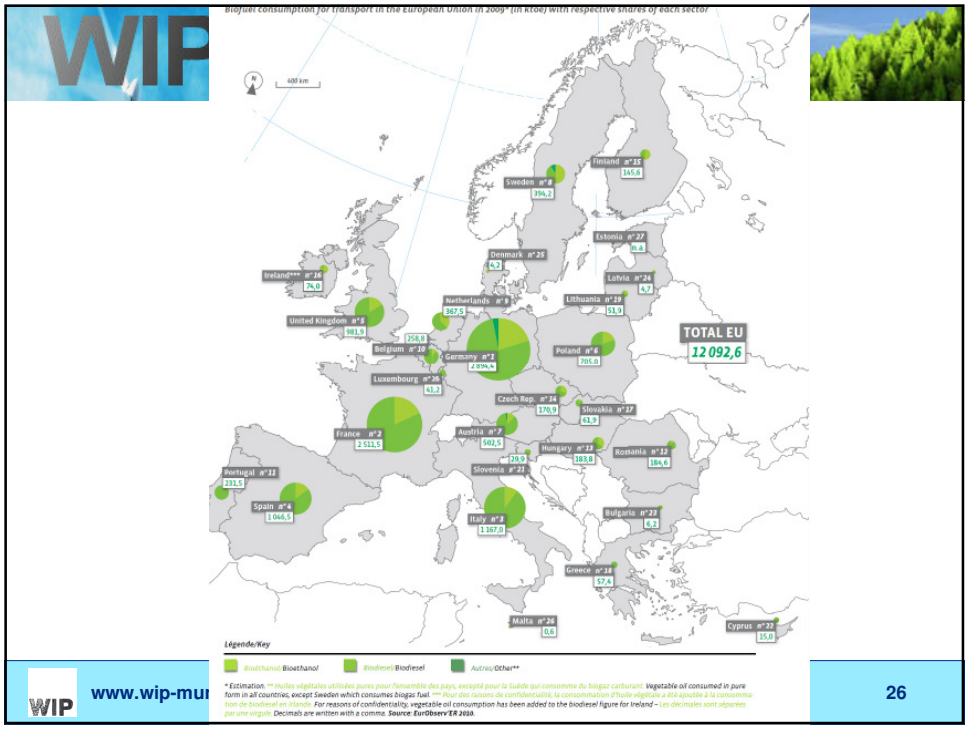
http://www.eurobserv-er.org/pdf/baro198.pdf

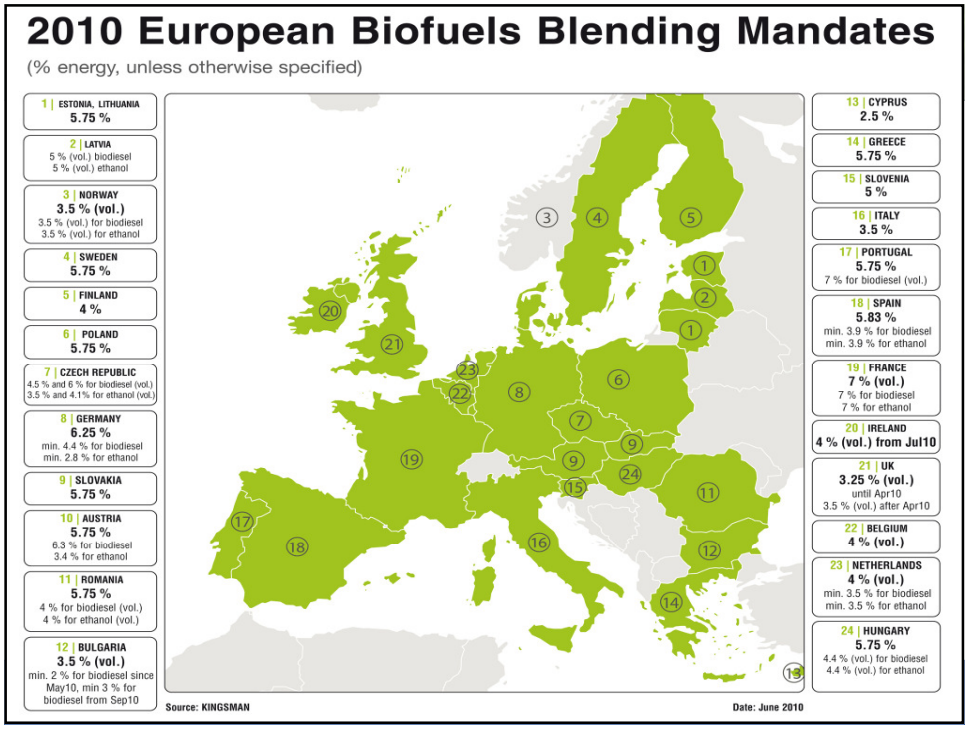
Breakdown of total EU 2009 biofuel consumption for transport by biofuel type and energy content*



** Estimations. – Les décimales sont séparées par une virgule. Decimals are written with a comma.* ***Source: EurObserv'ER 2010.***

http://www.eurobserv-er.org/pdf/baro198.pdf



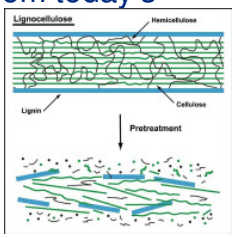


Europe's strategic interest in 2nd generation biofuels

- 2nd Generation biofuels are increasingly supported by EU policies
- However, there is no volume-based target for 2nd GB in the EU
- In general 2nd GB are promoted by many research programs and by the RED
- 2nd GB count twice towards the targets of the RED
- Germany: BtL fuels and E85 (also from lignocellusose) is tax exempted until 2015

What are „Second Generation Biofuels“?

- Derived from lignocellulosic biomass
- Use of whole crop plants instead of only parts (seeds, stalks) of the plants
- Today not yet commercially available
- 1st generation biofuels are usually made from today’s agricultural products (food commodities)



http://www.ethanolproducer.com/article.jsp?article_id=4160

- Thermo-chemical conversion
- Biological conversion

Biofuels by thermochemical conversion

Characteristics of „advanced“ thermochemical conversion

- Limited injection of oxygen in the process (oxygen deficit)
- Application of high temperature (and pressure)

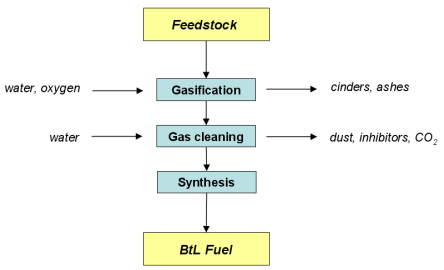
Parameters of thermochemical conversion

5 main parameters influence the thermo-chemical conversion process:

- temperature
- duration of the process
- pressure
- type and amount of added oxydizing agent
- design of the reactors

Processes of thermochemical conversion

- Torrefaction
- Carbonisation
- Slow pyrolysis
- Intermediate pyrolysis
- Fast pyrolysis
- Microwave pyrolysis
- Gasification
- Hydrothermal carbonisation
- Steam gasification
- Supercritical water gasification



Products of thermochemical conversion

- Syngas = mixture of gaseous C-H-O compounds
- Biochar = solid fraction of thermochemical conversion
- Bio-oil = mainly condensate (tar)
- Slurry = mix of solid char and liquid condensate
- BtL fuel = Transport fuel obtained by thermochemical conversion and gas synthesis

Biofuels by biological conversion

- Methanogenesis: Methane production (biogas) by microorganisms
- Alcoholic fermentation (ethanol) by yeast or bacteria
- Main parameters: availability of microorganisms and growth conditions for these microorganisms (acidity, temperature, alcohol content, presence/absence of oxygen, etc.)

Biological vs. thermochemical conversion

Biological routes

+ Experience with starch and sugar
+ Low temperatures and pressures
+ Wet feedstock can be used

- Slow processes
- Highly selected feedstock
- Limitated final product only (ethanol)
- Water consumption

Thermochemical routes

+ Rapid processes
+ Broad range of usable feedstock
+ Large variety of end-products can be created (designer fuels)

- Dry feedstock is usually needed
- High temperatures and/or pressures needed
- Less control of by-products

Examples for 2nd Generation Biofuel Plants in Europe

Bioliq, pyrolysis/gasification (Germany)

CHOREN, gasification (Germany)

EMPYRO BV, BTG-BTL, pyrolysis (The Netherlands)

ABENGOA, 2nd gen. ethanol (Spain)

3. International Impacts of European Developments in the field of Biogas and Biofuels

International Impacts of *Biogas* Development in Europe

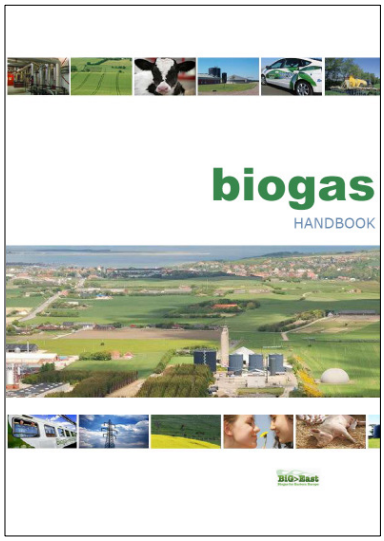
- Current status: globalised biofuel market
- Export/Import of Technology
- Export/Import of Know-how
- Contributions to GHG mitigation in other countries (Emission certificates)
- Import of Biomethane in the long-term (Eastern-Europe, Russia)

International Impacts of *Biofuels* Development in Europe

- Current status: globalised biofuel market
- Export/Import of Technology
- Export/Import of Know-how
- Application of sustainability criteria required by EU legislation for biofuels
  (independently if domestic or imported)

BiG>East Biogas Handbook

Available (free download) at:
www.big-east.eu



Happy Birthday!

Muchas Gracias!!

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