Biogas for energy production

The state of the French situation & stakes

Olivier THEOBALD
French Agency for Environment & Energy Management (ADEME)
Soils and Waste Dept.
olivier.theobald@ademe.fr
Tel. : +33/241 204 312
Fax : +33/241 204 348
French Agency for Environment and Energy Management (ADEME)

Public Body

with industrial and commercial nature

under the joint supervision of

✓ Ministry of Ecology and Sustainable Development
✓ Ministry of Industry
✓ Ministry of Research
A new charter agreement on objectives structuring relations between ADEME and the State

Objectives set for each of the agency’s four types of activity

✓ Acquire Knowledge
   By expanding the technology and innovation knowledge and covering industry branches and costs

✓ Convince and mobilize
   Through communication, information, education and training

✓ Advise
   By developing advisory services, disseminated directly or via relay structures

✓ Help in decision-making and to achieve execution
   Through accompanying action and funding
A new charter agreement on objectives structuring relations between ADEME and the State

Action and results to be reach in four domains

ADEME's mandate is to accompany and assist actors in the society and the economy in the process of reducing and eliminating their environmental impacts and managing energy, in the following domains:

✓ Waste and soil
✓ Energy
✓ Air quality and noise pollution
✓ Cross-sectored action
Since the end of 1999, ADEME give subsidies and have relationship with the French society for biogas (called Club Biogaz) with many objectives:

- develop biogas industry in France
- develop a privileged bridgehead with the French State
- animate the relationship between French State and sectors concerned by the biogas technology (agriculture, industry or municipalities)
- make technical studies
- give technical and economical data to industries or manufacturers
Plan

- Governmental laws and regulations
- Incentives and development
- The state of the situation and its evolution
- Conclusion
Plan

- Governmental laws and regulations
- Incentives and development
- The state of the situation and its evolution
- Conclusion
The new French regulation

A French program law for orienting energetic policy called “POPE Law”, instated the 13th of July 2005

- **RE**: satisfy 10% of needs from RE resources in 2010
- **RE-electricity**: from 15% in 1997 to 21% in 2010  
  [directive Electricité 27/09/2001]
- **RE-heat**: increasing to 50% in 2010
- **Biofuels**: to aim for 5.75 (and 7)% in 2010  
  [directive Biocarburants 08/05/03]
- **Greenhouse gases**: reducing emissions by 3%/yr in 2050  
  [plan climat, 04]
- **Energy autonomy**: decreasing fossil fuel importation from 10 Mtep in 2010 and replacing with biomass for heat production & biofuels
Waste & Biogas
in final consumption of energy (2005, in Mtep)

275.4 MTep

Biogas energetic valorisation: 8.8 TJ – 0.21 Mtep
• 1.3% of RE (674 TJ – 16.1 Mtep)
• 0.08% of final consumption (11.5 PJ – 275.4 Mtep)

Source: french ministry of energy, mars 2006

- Wood & wood waste: 30 PJ - 716 ktep
- Waste incineration: 15 PJ - 358 ktep
- Biofuels: 17.5 PJ - 419 ktep
- Heat pumps: 13.2 PJ - 316 ktep
- Crop waste: 7.9 PJ - 190 ktep
- Geothermal: 5.4 PJ - 130 ktep
- Biogas: 2.3 PJ - 55 ktep
- Solar: 1.3 PJ - 32 ktep

| Source: French ministry of energy, may 2006 |
| 1 kTep = 41.86 TJ |

<table>
<thead>
<tr>
<th></th>
<th>ktep</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill</td>
<td>6</td>
<td>11%</td>
</tr>
<tr>
<td>m. sludge</td>
<td>30</td>
<td>55%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>2</td>
<td>4%</td>
</tr>
<tr>
<td>Industry</td>
<td>17</td>
<td>31%</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>100%</td>
</tr>
</tbody>
</table>

Berlin – 09/05/2007  IEA TF 37 – Energy from biogas and landfill gas
Biogas in French RE-electricity production (2004)

excepting hydraulic production (242 PJ - 67 369 GWh)

| Source: à partir du Bilan détaillé, DGEMP, Observatoire de l’énergie, mai 06 |

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>GWh</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill</td>
<td>380</td>
<td>85.2%</td>
</tr>
<tr>
<td>M. sludge</td>
<td>60</td>
<td>13.5%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>2</td>
<td>0.4%</td>
</tr>
<tr>
<td>Industry</td>
<td>4</td>
<td>0.9%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>446</td>
<td>100%</td>
</tr>
</tbody>
</table>

1 GWh = 3.6 TJ
Objectives of electricity power installation  
[instated 07/07/06]

<table>
<thead>
<tr>
<th>RE</th>
<th>2010 (MWe)</th>
<th>2015 (MWe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>biogas</td>
<td>100</td>
<td>250</td>
</tr>
<tr>
<td>biomass</td>
<td>1000</td>
<td>2000</td>
</tr>
<tr>
<td>MSW</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>geothermal</td>
<td>90</td>
<td>200</td>
</tr>
</tbody>
</table>
## Potential objectives of heat production

<table>
<thead>
<tr>
<th>RE</th>
<th>2005</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>geothermal</td>
<td>180 kTep</td>
<td>260 kTep</td>
<td>500 kTep</td>
</tr>
<tr>
<td>biogas</td>
<td>56 kTep</td>
<td>90 kTep</td>
<td>160 kTep</td>
</tr>
<tr>
<td>MSW</td>
<td>351 kTep</td>
<td>450 kTep</td>
<td>700 kTep</td>
</tr>
<tr>
<td>biomass</td>
<td>8,93 MTep</td>
<td>11,5 MTep</td>
<td>15,7 MTep</td>
</tr>
<tr>
<td>TOTAL</td>
<td>9,69 MTep</td>
<td>12,8 MTep</td>
<td>18,4 MTep</td>
</tr>
</tbody>
</table>
Plan

- Governmental laws and regulations
- Incentives and development
- The state of the situation and its evolution
- Conclusion
Device implementation

- New conditions for buying RE electricity from biogas [instated 10/07/06]

- New call for tender from the National Committee of Electricity Regulation [response in July 07]

- New regulations:
  - “white certificates”
    - PNAQ
    - Energy management (POPE law instated July 05)
  - “green certificates”
New fixed prices for buying RE electricity from biogas

- Estimation of the over costs for energy valorization
- Base price
  - Increasing price for low powers
  - AD bonus = +2 c€/kWhe

- Combined heat and electricity production
  - Bonus for combined heat and electricity production, from 0 to 3 c€/kWhe
  - Depending of the V rate
  - $V = (\text{sell or consumed electricity & heat}) / \text{primary energy entering in the energy production unit}$
New fixed prices for buying RE electricity from biogas (10/07/06)

![Graph showing the new fixed prices for buying RE electricity from biogas. The graph compares different energy sources and power levels, with prices ranging from 7.5 to 14.0 c€/kWh.](image)

- **AD - P ≤ 150 kWe**: Prices range from 9.0 to 12.5 c€/kWh.
- **AD - P > 2 MWe**: Prices range from 10.5 to 14.0 c€/kWh.
- **Landfill - P ≤ 150 kWe**: Prices range from 7.5 to 10.5 c€/kWh.
- **Landfill - P > 2 MWe**: Prices range from 9.5 to 12.0 c€/kWh.

*Berlin – 09/05/2007  IEA TF 37 – Energy from biogas and landfill gas*
Others buying prices for electricity from RE

- **wind [10/07/06]**:
  - on land: 8.2 €/kWh lasting 10 yrs & 2.8 €/kWh lasting 5 yrs
  - offshore: 13 €/kWh lasting 10 yrs & from 3 to 13 €/kWh lasting 10 yrs depending on locations

- **photovoltaic [10/07/06]**:
  - 30€ to 40 €/kWh depending on locations + bonus for good building integration 25€/kWh

- **geothermal [10/07/06]**:
  - 12 €/kWh + bonus from 0 to 3 €/kWh
  - island territories: 10 €/kWh + bonus from 0 to 3 €/kWh

- **biomass except biogas [16/04/02]**:
  - 4.9 €/kWh + bonus from 0 et 1.2 €/kWh
New call for tender from the National Committee of Electricity Regulation

- **First call in 2003, December** – aimed for 250 MWe
  - Aim: 200 MWe for biomass and 50 MWe for biogas
  - Results biogas: *1 landfill gas of 16 MWe* (86 €/MWh)

- **Second call 2007, Aug.** - aimed for 300 MWe
  - 220 MWe for power units > 9MWe
  - 80 MWe for power units included between 5 and 9 MWe
  - Starting before the 1\textsuperscript{st} of July 09
  - Cogeneration unit only (with a V rate ≥ 50%)
New regulations

- PNAQ Directive and C quotas for units $P > 20$ MW

- Domestic Projects (around 10 €/T CO$_2$ ?)
  - Units $P < 20$ MW
  - Sectors concerned
    - On-farm AD
    - New systems of landfill gas canalization
    - Production or saving of heat energy to decrease the consumption of fossil fuels in a new or existing unit from biogas or biomass

- White certificates: Energy management for house heat valorization (around 2c€/kWh ?)
Aids of ADEME

- Financial aid for decision-making
- Direct subsidies for project realization
  - Demonstration plants
  - Best conception practices?
    - To define
    - Maximizing energy valorization: V rate > 65 %?
    - Including energy crop in few quantity: 15 % of total dry matter?
    - Including territorial waste management
    - Economic aspects
Conclusion (1/2)

- New stakes
- Incentive prices for buying RE-electricity
- Opportunity for the new call for tender
- New experimental instruments
  - Green and White certificates
  - Domestic projects
- Governmental (and regional) and UE aids
Plan

- Governmental laws and regulations
- Incentives and development
- The state of the situation and its evolution
- Conclusion
Food industry

- 103 industrial sites (127 digesters)
- Treatment capacity : 853 T DCO/d
- Energy Production (auto-consumption on site)
  - Heat : 196 GWh
  - Electricity : 4 GWh

- Tendency : + 3 to 5 units/yr [AND, 04]

- Vital numbers
  - Investment costs : 2,500 €/T DCO
  - Treatment costs : 170 €/T DCO
  - Company support :
    - France : Ondéo-Degremont, OTV-Véolia, Proserpol, Naskéo
    - Other countries: Biothane, Biotim, ENTEC, GWE, LINDE KCA, Paques
Urban sludge

- 68 treatment units
- treatment capacity : 17.7 Még habitants
- Energy Production
  - Heat : 345 GWh
  - Electricity : 45 GWh
- Tendency : - 3 to 5 units/yr [French Ministry for Energy, 2006]
- Aim 2014 : + 60 units [AND, 2004]
  - Electricity & Heat : + 4 to 19 MWe, + 28 to 140 GWhe, +111 to 223 GWhth
- Vital numbers
  - Investment costs : 500 to 3,000 €/T de MS
  - Treatment costs : 300 to 400 €/T de MS
  - Company support : Degrémont-Lyonnaise des Eaux, OTV-Véolia, SOGEA-Vinci, Stéreau-SAUR-Bouygues
On-farm AD and co-digestion

- 5 on-farm units
- Many projects of AD co-digestion
- Treatment capacity (2006): 27,000 T/an
- Energy Production
  - Heat: 3300 MWh
  - Electricity: 1300 MWh

- Tendency: +10 on-farm units/yr
  - electricity & Heat: +7 MWe/an, +22 GWhe/an, +22 GWhth/an

- Vital numbers
  - Investment costs: 3,000 to 8,000 €/kWe
  - Company support: from a few enterprises
MSW-AD

- 3 units: Amiens, Varennes-Jarcy, Le Robert (Martinique, besides sea)
- Treatment capacity: 195 000 T/an - (161 000 T treated)
- Energy Production:
  - Heat: 32 000 MWh
  - Electricity (aim): 30 500 MWh
- Tendency 2007-2012: + 2 units/yr
- 2012: + 15 units of which 6 will start up between 2007 and 2009
  - 1,366 Mt in total capacity (258 000 T/yr of biowaste)
  - Electricity: 150 GWh (20 MWe)
  - Heat/Biogas as vehicle fuel: 250 GWh
- Vital numbers:
  - Investment costs: 600 € HT/T (€: 7,000 – 9,000 €/kWe)
  - Treatment costs: 80 €/T
  - Company support: Vinci, Valorga, LINDE KCA - OWS, etc.
Landfill Biogas

- 26 biogas valorization units (2003)
- Energy Production:
  - Heat: 69 GWh
  - Electricity: 350 GWh

- Tendency before new price: stagnation
- Aim 2014 - electricity: 800 GWh (P: 100 MWe)

- Vital numbers
  - Investment costs: 1,320 – 1,700 €/kWe depending on power
Recent studies of ADEME (1/2)

- R & D studies to increase knowledge about AD technologies
- R & D studies to increase knowledge about AD and aerobic mixed technologies

- Economical & technical study on AD in UE for little and large scale units (2003 & 2004)
- Potential market of AD in France (2004)
- Overview on bacterial components in biogas (2005)
Current studies of ADEME (2/2)

- LCA for biogas as vehicle fuel
- Economical & technical study on biogas as vehicle fuel
- UE Biogasmax Project (Lille city)
- Biogas upgrading: expertise by the French Agency for Work, Health and Environment (AFFSET)
  - Missing a biogas screening of xenobiotic and bacterial components
- Siloxanes: reference methodology for analysis in biogas and treatment systems + test (Veolia Co.)
- Energy crops in France: interest of LCA?
CONCLUSION (2/2)

- **AD**: Important sector which should not be neglected that permits:
  - Energy substitution
  - Decreasing greenhouse gases emissions

- **In France**: Biogas & AD, 2 news sectors,
  - Building knowledge
  - Developing know-how

- Incentives in building