European Biomass Industry Association

Expansion of the Biogas Market Through Diversification & Technical Integration

Dr Giuliano Grassi

Secretary General

First Sino-EU 2016 Bio-Natural Gas Summit
Sinopec Conference Center, Changping, Beijing
4 November 2016

Supporting Biomass Sector at all Levels

EUBIA – The European Biomass Industry Association

Researching for Bioeconomy

EUBREN - The European Biomass Research Network

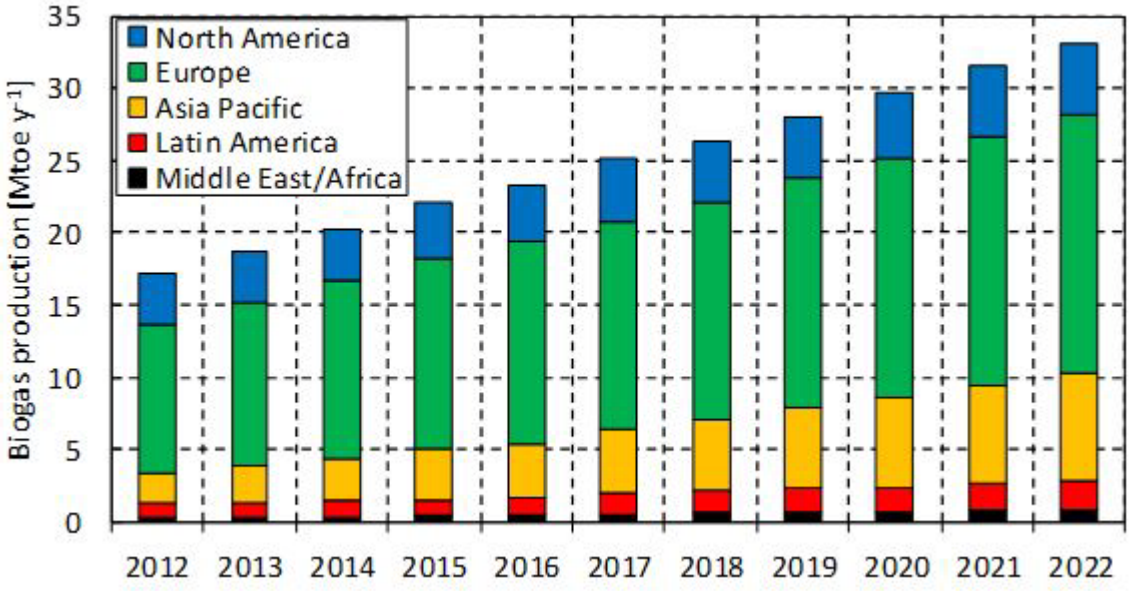
General Context

The actual world production of Biogas is considerable and estimated around 23 MTOE/year with max. potential of about 800 MTOE/y.

- A significative R&D Dem. Effort has been carried out successfully especially in the last 3 decades
- At the beginning, the major interest, for industrial countries, was due to the "environmental impact", while for developing countries, was the Energy supply for cooking/heating
- At present the world-wide commercial Biogas activity has reached an high level of market penetration (especially at small-mediium scale) in different Energy sectors: Bioelectricity- Bioheat-Biofuel for transport
- Several Financial support schemes are available in many countries to promotoe the production and efficient use of biogas from waste/residues for large industrial projects and small rural projects offering supplementary income to farmers
- Biogas activity soon may become attractive also to private investors for business in new emerging sectors.

World Biogas Situation: Present & potential

Actual Production: ~ 23 MTOE/y
Potential: ~ 800 MTOE/y

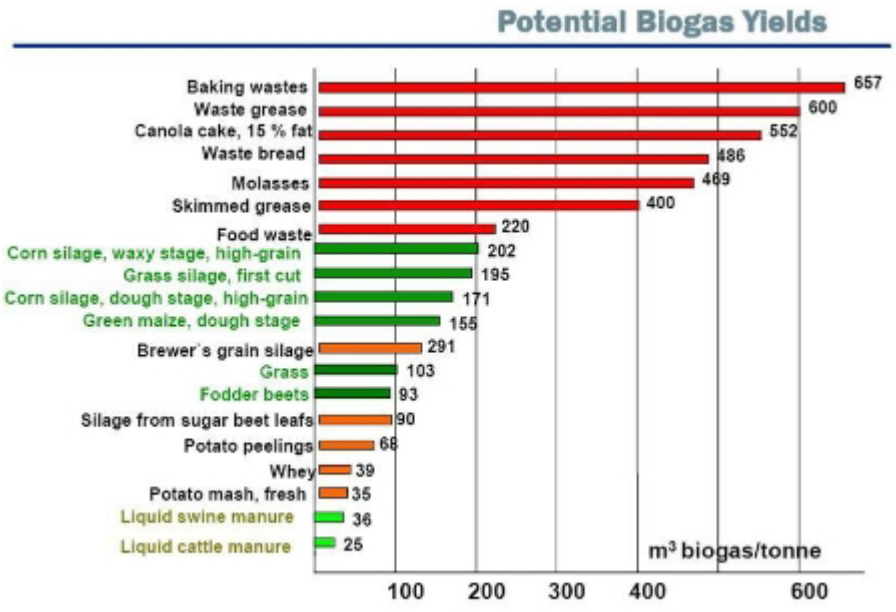


Source: http://www.scielo.br

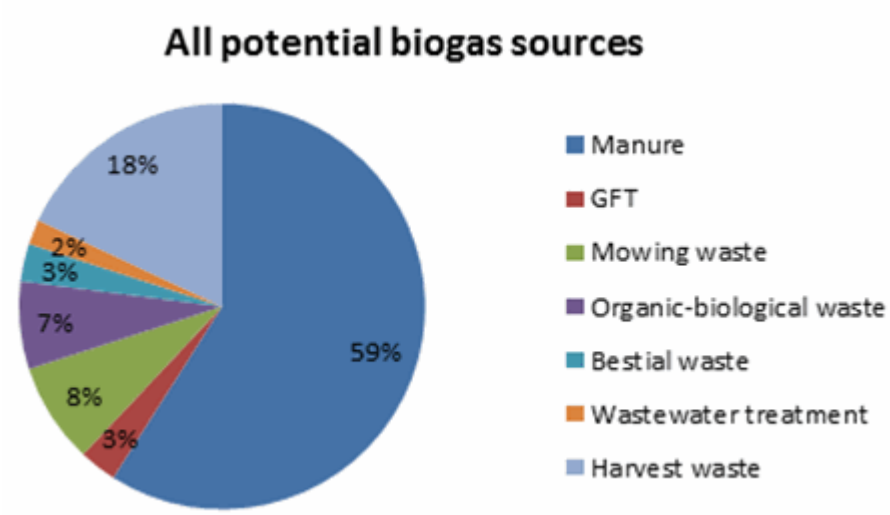
Typical composition of biogas*	
Component	% Volume
CH_4	50-75
CO_2	25-50
N_2	0-10
H_2	0-1
H_2S	0-3
O_2	0-2

***Variability depends on feedstock**

World Biogas Situation: Present & potential



Source:
http://www.renewableenergyworld.com



Source: http://energy.sia-partners.com
and Biogas-e

World Biogas Situation: Present & potential

TABLE 5: POTENTIAL FOR BIOGAS IN PJ (BILLION M³ BIOMETHANE), CH_4: EU 27, CHINA, WORLD						
Type of resource	**EU 27 [4] PJ**	**EU 27 [4] Billion m³ CH4**	**China [8,9] PJ**	**China [8,9] Billion m³ CH4**	**World [7] PJ**	**World [7] Billion m³ CH4**
Manure	738	20.5	2591	72		
Residues (straw from grain, corn, rice, landscape cleaning)	407	11.3	1152	32		
Energy crops	978	27,2	1799	50		
Total from agriculture	**2123**	**59**	**5542**	**154**	**22674**	**630**
Urban waste (organic fraction of MSW)	360	10	2591	72		
Agro-industry waste (organic fraction)	108	3	1152	32		
Sewage sludge	216	6	576	16		
Total waste, billion m³ CH_4	**684**	**19**	**4319**	**120**	**13316**	**370**
Total (agriculture and waste)	**2807**	**78**	**9861**	**274**	**35990**	**1000**
Total in EJ	**2.8**		**9.9**		**35,9**	

Source: http://biomassmagazine.com and World Bioenergy Association

1 EJ = 23,88 MTOE

For comparison the Total Bioenergy Contribution (World):

- Present: 13% of energy consumption (1,5 Billion TOE/y)
- Potential: 5,6 Billion TOE/y (for the year 2050)

with actual total primary world Energy consumption: ~ 12 Bill TOE/y

Increasing interest of private investors of Biogas Activities

There are 3 new emerging sectors of Business for private investors (enclosing Major investors) involving Biogas Activities:

1. **New smart-urban-district, smart-city Business** (MSW-sludges-Water re cycling & Purification-Urban vegetation residues, etc) requiring important infrastructures (hundreds of M$) and A.D. processing.
2. **Bio-refineries enclosing crops-plantation** (1,000-50,000 ha) involving co-processing up to 5÷10 million tons of fresh-biomass per year with a large volume of solid-liquid wastes to be submitted to anaerobic digestion process. Investment for large biorefineries: 0,5-1 Billion $.

Increasing interest of private investors of Biogas Activities

3. **Production of Biofertilisers replacing Synthetic Fertilisers** (major interest for N) for Bio-food production and for intensive future industrial crops plantation.

Motivations

• Biofertilisers show better-quality, higher productivity, higher resistance (less pesticides) products.

• Intensive utilisation of Biofertilisers in large-scale annual Energy/industrial plantations (sweet-sorghum-miscanthus etc could reduce-elimininate (?) crops rotation with a large impact of Financial needs for land use. From very preliminary assessments it seems that for sweet sorghum plantations the AD sludge of 15% of residues (and of the processing wastes) could balance the N_2 output loss.

• Biofertilisers coproduction in Biorefineries seems viable and competitive with synthetic fertiliser.

• Small scale (decentralised) production is feasible. Investment are reasonable. Thre is a need of the establishment of a a normative-legal frame.

Requirements for major Private Investors

Beyond the usual required environmental sustainability of the activity (water, wastes, emissions), the long–term operation (20-30 y) the respect of biodiversità for biomass plantations, the most important basic requirements for private investors are:

- The economic viability (reasonable R.O.I. ~ 10%);
- Low financial risk (covered by insurance);
- Adoption of sound-consolidated processing technologies;
- Flexibility in processing different types of feedstocks;
- Use of modular commercial plants for scale-up of repeated investments (cost-reduction);
- Integration of Biogas A.D. process with other co-processing technologies for simultaneous productin of Bioenergy-Biochemicals-Biomaterials.

Examples of Envisaged supply of Biogas co-products

Some potential large volumen co-products:

- Bio-electricity/Bioheat/Biocooling/Biofreezing
- Clean Biogas for tran sport
- Biomethane
- Biogas eriched with Bio-H_2
- Biogas eriched with Bio-syn-Gas (very large volume applications)
- Biomethanol production (small-scale)
-
- N_2 Biofertilisers
- Desalinated sea-water
- Liquid CO_2 (purified)
- Bioceramics

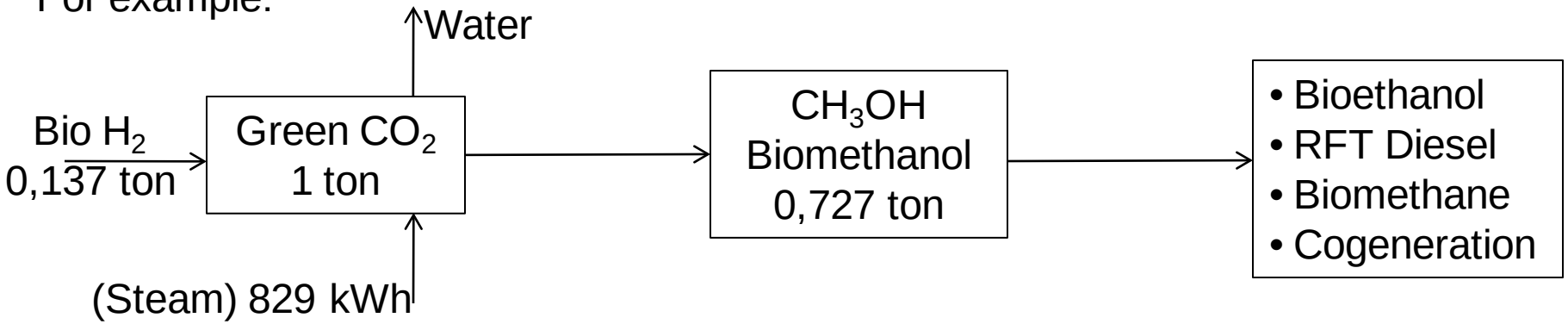
Synergy of Biogas with Bio-H_2

- Hydrogen is not available in nature (is not an energy source) but an energy vector.
- Hydrogen is an expensive gas with a total world production of ~ 50 million t/y, most utilised for petroleum-refining (10.000-50.000 t/y plants), for N_2-fertilisers and for methanol production.
- Bio-H_2 could be produced commercially from biomass by a less efficient 4-steps conversion process (see following slide) at relative high cost: 2,000 €/t (min.).
- Advanced gasification under intensive R&D Dem. Effort should improve the efficiency and the Bio-H_2 prod.cost.
- A relative simple way is to use the "Electrolysis of water" process (75-80% efficiency) with the supply of Renewable Electricity. Unfortunately the H_2 high cost is due to the high capital cost, complicated for upscaling (too numerous cells).
- 78% of H_2 is obtained from natural gas, 18% from coal, 4% by electrolysis of water. With considerable amount of CO_2 emissions (7 tCO_2/tH_2 and total loss of 45% for natural gas).

Synergy of Biogas with Bio-H_2

- Simultaneous Electrolysis of H_2O and CO_2 (from biogas) will produce on one electrode (anode) syngas ($CO+H_2$) and on the other (catode) oxygen (it can be used for oxygen combustion).
- Green CO_2 (recovered from biogas-bioethanol-biomass combustion) could be upgraded to several Biofuels with Bio-H_2:

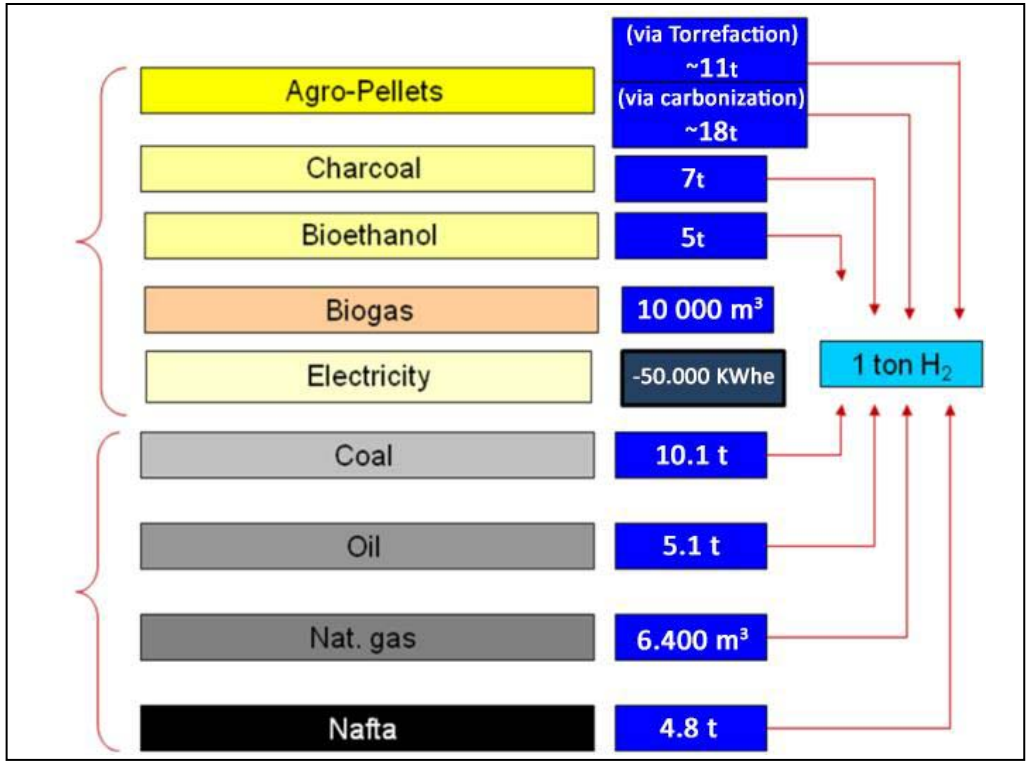
For example:



- At present the world Methanol market is ~ 100 Mton/y.

Bio-H_2 Production

Hydrogen yield from different En. Sources

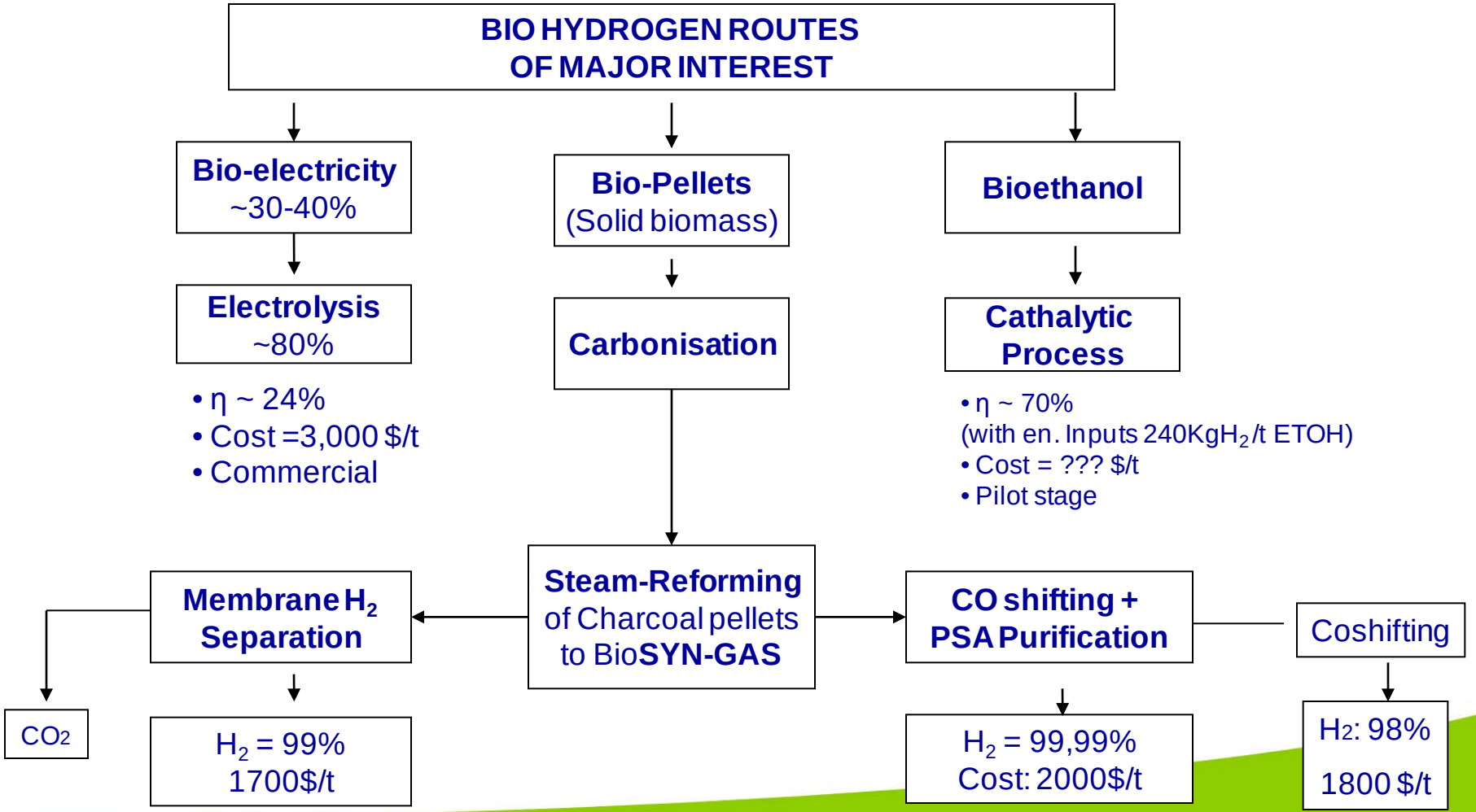


Bio-H_2 from solid biomass appears the most attractive:

- Agro-pellets: ~ 2.200 \$/tH_2
- Wind (5 c\$/kWh): ~ 4.000 \$/tH_2
- PV (30 c\$/kWh): 24.000 \$/tH_2

Bio-H_2 Production (via steam reforming of charcoal pellets)

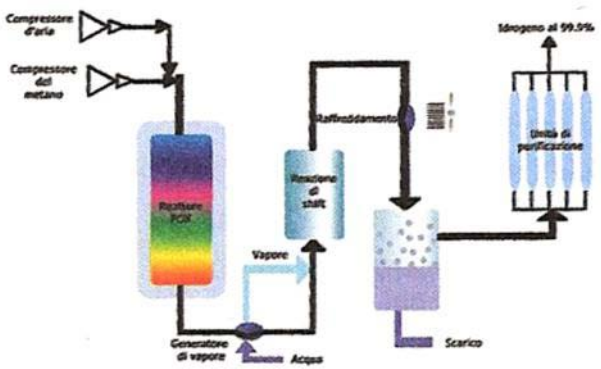
Advanced bioenergy technologies



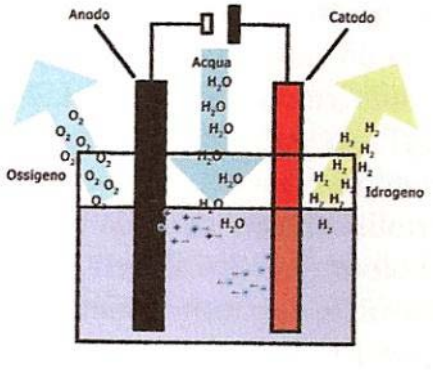
Bio-H_2 Production

PRESENT COMMERCIAL PRODUCTION OF H_2

Steam reforming of natural gas or coal



electrolysis process



The cost of small electrolysis plant (capacity of 1 Nm^3/h) is high; 50,000 € + 12,000 € for 350 bar compressor.

Purity of H_2 is very high: 99,99%.

Conclusion

• Biogas is providing at world-level a significative renewable energy contribution of 25 MTOE/year.

• Biogas is of considerable interest for rural development (supplementary, diversified income) and for reduction of the impact on the environment.

• Co-products of major interest are (at present):
  - Bio-electricity
  - Bio-heat
  - Biofertilisers

• In future expansion of biogas market could derive by the co-utilisation biogas-biohydrogen (low cost).

Thank you for your attention!

Giuliano Grassi
EUBIA Secretary General
giuliano.grassi@eubia.org
www.eubia.org