The development situation and outlook of world biomass energy & biochemicals Market

Andrea Salimbeni, European Biomass Industry Association
## General World Context

Source: MIT, 2012

### GHG EMISSIONS

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ (Billion t)</td>
<td>38.8</td>
<td>45.7</td>
<td>52</td>
<td>57.4</td>
<td>60.9</td>
</tr>
<tr>
<td>CH₄ (Mt)</td>
<td>397.5</td>
<td>396.9</td>
<td>640.8</td>
<td>678.3</td>
<td>713</td>
</tr>
<tr>
<td>N₂O (Mt)</td>
<td>11.41</td>
<td>11.21</td>
<td>14.48</td>
<td>16.35</td>
<td>18.36</td>
</tr>
</tbody>
</table>

### GDP Growth (% / yr)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP Growth</td>
<td>1.9</td>
<td>2.7</td>
<td>2.9</td>
<td>2.5</td>
<td>2.6</td>
</tr>
</tbody>
</table>

### Population (millions)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
</table>

### Land Use (Mha)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropland</td>
<td>1808.4</td>
<td>2003.9</td>
<td>2239.5</td>
<td>2463.6</td>
<td>2659.9</td>
</tr>
<tr>
<td>Pasture</td>
<td>2800.3</td>
<td>2798.8</td>
<td>2730.3</td>
<td>2680.1</td>
<td>2631</td>
</tr>
<tr>
<td>Natural grassland</td>
<td>665.9</td>
<td>594.7</td>
<td>560.7</td>
<td>534.9</td>
<td>524.2</td>
</tr>
<tr>
<td>Natural &amp; managed forests</td>
<td>4806.6</td>
<td>4649.3</td>
<td>4505.3</td>
<td>4369.5</td>
<td>4240.8</td>
</tr>
<tr>
<td>Other</td>
<td>2997</td>
<td>2997</td>
<td>2997</td>
<td>2997</td>
<td>2997</td>
</tr>
</tbody>
</table>

### VEHICLES (millions)

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEHICLES</td>
<td>808</td>
<td>1003</td>
<td>1202</td>
<td>1384</td>
<td>1603</td>
</tr>
</tbody>
</table>
Worlds total consumption (a) and estimated total reserves (b) of Oil, Natural Gas, Coal and Uranium

- Crude Oil: 4.6 Billion TOE
- Coal: 1.08 Billion
- Natural Gas: 2.8 Billion TOE
- Uranium: 428 Million TOE

- Coal: 502 Billion TOE
- Natural Gas: 152 Billion TOE
- Uranium: 340 Billion TOE
- Crude Oil: 194 Billion TOE

Non conventional oil and gas resources recently identified must be considered:
- Oil from sands: huge new resources (i.e. Texas)
- Nat. Gas from rocks: $470 \times 10^{12}$ m$^3$
- Methane-hydrate: $100 - 500 \times 10^{12}$ m$^3$

Source: BP Statistical Review of World Energy June 2012  Adapted by EUBIA
History of energy sources consumption (1970-2010). Estimation for next 20 years. Source BP.com

+5.4%
Growth in coal consumption, fastest among fossil fuels.

-4.3%
Decline in global nuclear output, the largest on record.

2.1%
Share of renewables in global energy consumption.
Global expected Greenhouse Gas Emissions. Source: MIT

<table>
<thead>
<tr>
<th>GHG EMISSIONS</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4 (Mt)</td>
<td>397,5</td>
<td>396,9</td>
<td>640,8</td>
<td>678,3</td>
<td>713</td>
</tr>
<tr>
<td>N2O (Mt)</td>
<td>11,41</td>
<td>11,21</td>
<td>14,48</td>
<td>16,35</td>
<td>18,36</td>
</tr>
</tbody>
</table>
The target of 16 Gt CO2 emission established for 2050 will require a 42 Gt CO2 annual emissions reduction by 2050 through CO2-price and strong support policies.

Total renewables contribution to the 2CS reduction is estimated to be 21%. Biomass is the only renewable energy source that can make a contribution in all sectors, providing around 10% of total CO2 emissions reduction!
Roadmap vision of world final bioenergy consumption in different sectors.

Source: IEA, 2012 (Adapted by EUBIA)
The key role of biomass as oil substitute in future energy market

Conventional fuel, in addition to a limited availability, have so an high impact on environment health. **In addition, now its price is higher than the past years.**

• The breakeven price of the major world oil producers (S.Arabia/Emirates/Oman-Russia-Venezuela) are respectively:

  87 $/bbl - 115 $/bbl - 87$/bbl assumed to balance the country budget.

• The considerable production of Oil from sands (Canada), which is now 3,2 million bbl/d and is expected to increase until 4,7 million bbl/d by 2020, has an actual production cost of about 90 $/bbl

**Bioenergy & bioproducts production can become competitive at a price of 100 $/bbl**

Biomass has a capacity of penetration of numerous sectorial markets (Heat, power, transport, chemicals) with:

1. A potential substitution of many of the 73,000 products now derived from fossil fuels
2. New employments increase = 1 job for 400-500 ton of biomass).
3. Diversification and increase of incomes for farmers
Future perspectives. Biomass availability and environmental challenges

Estimated global energy potential of biomass expected from 2020 and 2050:

<table>
<thead>
<tr>
<th>Year forecast</th>
<th>World potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>2 Billion TOE/y</td>
</tr>
<tr>
<td>2030</td>
<td>4,2 Billion TOE/y</td>
</tr>
<tr>
<td>2050</td>
<td>10,4 Billion TOE/y</td>
</tr>
</tbody>
</table>

Estimated available land for biomass production in 2050

<table>
<thead>
<tr>
<th>Land management</th>
<th>Now (Billion ha)</th>
<th>2050 (Billion ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Crop Land</td>
<td>1.8</td>
<td>2.65 (9.3 Billion people)</td>
</tr>
<tr>
<td>Forest Natural + managed Land</td>
<td>4.8</td>
<td>4.24</td>
</tr>
<tr>
<td>Pasture &amp; grass land</td>
<td>3.46</td>
<td>3.1</td>
</tr>
<tr>
<td>Others (desert, palude...)</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
WORLD BIOMASS SOURCES. General context

As defined above, there are several biomass sources depending on land use.

1. Forests:
   - Natural (wood residues, etc..)
   - Managed (Short rotation plantations (Willow, Poplar, wood for paper)

2. Crop lands:
   - Food dedicated crops: Considerable amounts of residues (straw)
   - Biofuels dedicated crops: Sugarcane, S. Sorghum, Rapeseed, Sunflower,…

3. Pasture and grass land. Mixed with manure in anaerobic digesters

4. Food and agricultural organic wastes: Feedstock with great moisture content as manure, sludge, etc..

5. Peat Lands: some countries consider these source of long scale renewable biomass

6. Water ponds and sea: Microalgae, Seaweed, other water plants (water hyacinth, etc..)
Biomass resources valorization Technologies

Solid biomass
Starch & Oil crops
Micro & Macro-Algae
Organic wastes

Co-firing | Gasification | Fractionation | Pyrolisys | Hydrolysis & fermentation | A. Digestion
---|---|---|---|---|---
I.G.C.C. Plant | F.T. plant | C\textsubscript{5} | C\textsubscript{6} | Lignin |

Heat & Power
Biochemicals & polymers
Biofuels for transportation
Biofertilizers
BIOMASS FOR ELECTRICITY GENERATION

Commercial technologies, current development in World regions and future market perspectives
Biomass for Electricity. Commercial technologies and future market perspectives

Bio-electricity generation expected growth in different world regions. The share of renewable electricity will increase from 19% in 2009 to 50-60% in 2050.

Bioenergy Share in total electricity generation increases from 1.5% today, to 7.5% in 2050
Global Biomass and waste installed capacity and annual investment per country. Source: IRENA 2012

The total capacity of proposed biomass power generation projects that are either under construction or have secured financing and will be completed by 2013 is 10 GW. 87% are for combustion technologies, (BNEF, 2011).
Biomass for Electricity. Commercial technologies and future market perspectives

Bioelectricity is expected to have a constant growth in the next years and represents one of the most promising market for biomass sector.

Among the different technologies, co-firing is the most developed at commercial scale. Followed by stoker boiler combustion and Anaerobic digestion CHP plants.

<table>
<thead>
<tr>
<th>Power Technology</th>
<th>Investment cost USD/kWe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stoker Boiler</td>
<td>1880-4260</td>
</tr>
<tr>
<td>Bubbling and circulating fluidised boilers</td>
<td>2170-4500</td>
</tr>
<tr>
<td>Fixed and fluidised bed gasifiers</td>
<td>2140-5700</td>
</tr>
<tr>
<td>Stokers CHP</td>
<td>3550-6820</td>
</tr>
<tr>
<td>Gasifiers CHP</td>
<td>5570-6545</td>
</tr>
<tr>
<td>Landfill gas</td>
<td>1917-2436</td>
</tr>
<tr>
<td>Anaerobic digestion</td>
<td>2574-6104</td>
</tr>
<tr>
<td>Co-firing</td>
<td>140-850</td>
</tr>
</tbody>
</table>

Biomass Co-firing & combustion competitiveness is limited by the feedstock cost, as wood pellets cost is still to high compared to coal or Nat. Gas.
Bioelectricity Market. Co-Firing future market perspectives

Investments in different forms will be needed to achieve a total bioenergy electricity capacity of 575 GW in 2050 as defined by International Energy Agency.

Global investment volumes sum up to USD 290 billion during 2010-30.

The highest absolute investments during this period will be required to refit coal-fired plants for higher co-firing rates in China, OECD Americas, as these countries are consuming alone the 61% of the global coal consumption.

<table>
<thead>
<tr>
<th>Coal global consumption</th>
<th>2010: 2.6 billion TOE/y (3,710 power plants)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2020: 2.9 billion TOE/y (4,215 power plants)</td>
</tr>
</tbody>
</table>

Co-combustion of biomass with coal is the most efficient way for bioelectricity production. A world-wide pellets co-firing activity will require.

<table>
<thead>
<tr>
<th>T. of biomass for co-firing</th>
<th>20% of biomass = 1,5 billion tons pellets/y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40% of biomass = 3,0 billion tons pellets/y</td>
</tr>
</tbody>
</table>
Biopower generation target for next decades. Investment estimation (Billion USD).

<table>
<thead>
<tr>
<th>Region</th>
<th>2010-20</th>
<th>2021-30</th>
<th>2031-50</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD Europe</td>
<td>21</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>OECD Americas</td>
<td>13</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>OECD Asia Oceania</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Africa and Middle East</td>
<td>7</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>China</td>
<td>39</td>
<td>99</td>
<td>54</td>
</tr>
<tr>
<td>India</td>
<td>14</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Central and South America</td>
<td>16</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Other developing Asia</td>
<td>12</td>
<td>15</td>
<td>52</td>
</tr>
<tr>
<td>Eastern Europe and FSU</td>
<td>3</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>World</td>
<td>130</td>
<td>160</td>
<td>202</td>
</tr>
</tbody>
</table>

Note: Numbers might not add up due to rounding.

Investment needs in Billion USD in bioelectricity generation capacity, including co-firing, in different world regions.
Agropellets in Large Co-Firing power plants

With this huge amount of solid biomass demand and the expected increase within the next 20 years, utilization of agropellets must be considered for fuelling both co-firing and full biomass power plants. Many trials have confirmed the possibility of pelletizing a very wide range of biomass mixtures even with peat and mineral coal powder.

In the present absence of international agreed standards for pellets Utilities adopt specific criteria as i.e. The Italian Utility ENEL uses the following formula for acceptance of a given quality (type) of Biomass for Co-firing to avoid also corrosion problems:

IR (Index of risk)= Na₂O + K₂O/LHV < 0,35 kg/kj

Na₂O : 20kg/t ashes
K₂O : 150kg/t ashes

Here below typical values of the I.R

<table>
<thead>
<tr>
<th>Type of residue</th>
<th>LHV</th>
<th>Index of risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forestry residues</td>
<td>2,500 Kcal/kg</td>
<td>0,12</td>
</tr>
<tr>
<td>Straw</td>
<td>1,8-3,500 Kcal/kg</td>
<td>0,7</td>
</tr>
</tbody>
</table>

Typical fuel characteristics for Co-Firing operation:

<table>
<thead>
<tr>
<th>Type of fuel</th>
<th>LVH (MJ/Kg)</th>
<th>Density (Bulk)</th>
<th>Volumetric Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chips</td>
<td>10-10.5</td>
<td>250-350 kg/m³</td>
<td>2.6-3.6 GJ/m³</td>
</tr>
<tr>
<td>Coal</td>
<td>25-29</td>
<td>800-900 kg/m³</td>
<td>20-26 GJ/m³</td>
</tr>
<tr>
<td>Agropellet</td>
<td>15.7 MJ/Kg</td>
<td>~700 kg/m³</td>
<td>~11 GJ/m³</td>
</tr>
<tr>
<td>Torrif. AP.</td>
<td>20.9 MJ/Kg</td>
<td>~800 Kg 1m³</td>
<td>~16 GJ/m³</td>
</tr>
</tbody>
</table>
Gasification: endothermic reaction with carbon and steam/CO₂

\[ C + H₂O \rightarrow CO + H₂ \]
\[ C + CO₂ \rightarrow 2CO \]

Unfortunately synthesis-gas from wood contains tars (mixture of hydrocarbon compounds) and traces of HCl, HF, NH₃ and alkaline metals; their concentration depends on nature of biomass and type of reactor.

**Tar gas-cleaning cannot yet be considered a solved problem!**
GASIFICATION AND SYN-GAS PRODUCTION

Gasification of conventional fuels (mainly coal) has reached a considerable volume worldwide, 70,800 MWth/ year, and is now expected to grow up to 131,000 MWth by 2016 (58 new plants).

Shell is the dominating Organization followed by G.E., Sasol, Lurgi, etc..

The present gasification markets are:

- Production of Chemicals dominate the total gasification outputs: **35%**
- Fisher-Tropsch Liquid fuels: **13%**
- **Electric Power generation by I.G.C.C. plants: 38%**
- Synthetic Natural Gas production: **14%**
MAJOR WORLD SYNGAS PRODUCING COUNTRIES:

**China**: Dominates market. 29% of world capacity and 56 operating plants (coal)

**North America**: Capacity of 34,450 MWth (10% of world total). Largest planned capacity increase (27 plants in 2016) utilising coal, natural gas, for the production of chemicals, power, fertilizers (ammonia), Nat.Gas

**Central-south America**: 648 MWth syngas capacity (1%) in S. Domingo for chemicals and gaseous fuel production

**Asia-Australia**: Syngas capacity of 20,810 MWth

**Europe**: 11,422 MWth of capacity (6%). 42 operating plants: 5 petroleum, 3 coal IGCC plants, 25 chemicals (Nat. Gas), 9 Biomass/waste

**Africa/Middle East**: 25,138 Syngas capacity (36%)

- Shell has 18 gasification plants for 10,938 MWth
- Sasol produces Fisher Tropsch fuels & chemicals
BIOFUELS PRODUCTION TECHNOLOGIES.

Environmental Sustainability, market competitiveness and new advanced technologies
World Biofuels production. General Context

- The two dominant liquid biofuels are bioethanol and biodiesel. 80% and 20% of the market, respectively.
- Together they meet about 3% of the global transport fuel demand and are produced using 2-3% of the global arable land.
- IEA estimates that the use of liquid biofuels could grow reaching a level of 9% (11.7 EJ) of the total transport fuel (126 EJ) by 2030 and about 27% by 2050.
- Biodiesel is mainly produced and consumed in Europe (78%).
- Ethanol is largely produced in tropical regions and in USA from Sugarcane, Sweet Sorghum, Maize, etc.
- Natural Gas Vehicles started developing at fast rate in the last two decades in both developed and under development world regions. These vehicles can be fed easily with Bio-Syngas and biomethane upgraded biogas.
- This new market seems to have promising perspectives due to the lower cost of biomethane compared to BTL, F.T. diesel, and advanced lignocellulosic biofuels.
Advanced biofuels are still under research and not competitive due to the lignocellulosic biomass pretreatment high costs both when thermochemical and in biochemical cases.

Biochemical fractionation of woody biomass is a promising technique but enzymes costs make it still not competitive with fossil fuel in transportation sector.
Decreasing market perspectives of conventional biofuels

Due to the Indirect Land Use Change challenge and to the flexibility of crops price, first generation biofuels will decrease their contribution to the biofuels market.

Lignocellulosic biofuels represent the valuable future substitute:

1. Much more biomass available due to the utilization of all biomass wastes and residues
2. Higher GHG emissions mitigation (on a par of sugarcane ethanol)
3. Higher yields of bioethanol per given land area

However, problems related to high costs and to the research stage of technologies make lignocellulosic ethanol still not a commercial competitive biofuel:

The US Government has reduced its mandate for second generation biofuels from 500 million gallons to 8.65 million gallons.
Expected growth of biofuels global market: 2010 to 2050.

- Land Use conflict with food crops will eliminate first generation biodiesel from the market.
- Expected growth from 2.5 EJ today to 32 EJ in 2050.
- Biofuels share in total transport fuel increases from 2% today, to 27% in 2050.
- Trade will be needed to balance supply and demand for feedstocks and biofuels.
Gasification technology: Competitiveness of Bio-Syn-Gas

1. The Bio-Syn-Gas production became of large interest for global market.
2. The processing technology is now approaching the “Commercial” quality level.
3. The Syngas production represents already the 14% of gasification market

### Bio-Syn-Gas competitiveness in comparison with Nat. Gas and conventional Syn-Gas:

<table>
<thead>
<tr>
<th>CONVENTIONAL FUEL</th>
<th>Bio-Mass (60 $/dT)</th>
<th>$/bbl</th>
</tr>
</thead>
<tbody>
<tr>
<td>PETROL OIL</td>
<td>LOW QUALITY SYNGAS</td>
<td>100</td>
</tr>
<tr>
<td>NATURAL GAS</td>
<td>(Steam reforming of carbonized pellets)</td>
<td>75</td>
</tr>
<tr>
<td>SYN GAS</td>
<td>HIGH QUALITY SYNGAS</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>(advanced gasification-DOE target)</td>
<td>90</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONVENTIONAL FUEL</th>
<th>$/bbl</th>
</tr>
</thead>
<tbody>
<tr>
<td>PETROL OIL</td>
<td>100</td>
</tr>
<tr>
<td>NATURAL GAS</td>
<td>75</td>
</tr>
<tr>
<td>SYN GAS</td>
<td>107</td>
</tr>
<tr>
<td>NATURAL GAS</td>
<td>75</td>
</tr>
</tbody>
</table>

**Comparative Table**

- **PETROL OIL**
  - Bio-Mass: LOW QUALITY SYNGAS
  - Price: 100 $/bbl

- **NATURAL GAS**
  - Steam reforming of carbonized pellets
  - Price: 75 $/bbl

- **SYN GAS**
  - High Quality SYNGAS (future)
  - Price: 107 $/bbl
General Estimation of Biofuels cost perspectives compared with petroleum gasoline within the next 40 years

“A valuable Solid Biomass supply chain, with efficient collecting, harvesting and storage systems, could make solid biomass thermochemical processes more competitive and efficient”

- The syngas production, as well as biogas upgrading to biomethane are cheaper than the BTL, 2° generation Cellulosic Ethanol, DME, etc..

- Gasification is already a well known technology largely used in many developed countries for coal gas production and it is going to reduce its installation and operating costs.

- BIO-SYN-GAS can become the cheapest transportation biofuel in the next decades
Sustainability of liquid and gaseous biofuels. Indirect Land Use Change

- Land requirements to produce biofuels increases from 30 Mha to 100 Mha in 2050, in addition to 1 billion tons of residues.

- The world produces residue biomass that could be sustainably harvested and converted into nearly 1.2 Billion TOE/yr.

- The global potential from residue biomass is estimated to be approximately 1.9-2.3 Billion TOE/yr by mid- to late-century.
Sustainability of liquid and gaseous biofuels. CO2 Emissions and Indirect Land Use Change

Greenhouse gas emissions for supply chains including consequential impacts (indirect land use change and fertilizer replacement). Source: Imperial College
BIOCHEMICALS AND BIOPLASTICS INDUSTRY.

An Emerging competitive Market for future biomass valorization
Currently the most used feedstock in North America, south america and Russia is Natural Gas, while coal and Oil are used mainly in Middle East countries and China.

Biomass can partially replace the conventional raw materials (Coal, Oil, Nat.Gas) without increasing production costs. Biobased products market is $46 billions and is expected to more than treble by 2020.

“Biomass is the only renewable carbon based feedstock to produce chemicals.”
The concept of Biorefineries: Biofuels from lignocellulose and bio-based chemicals

Large integrated Biorefineries represents the future of chemicals and energy production from Biomass, in order to avoid wastes, and to diversify the marketable products.

Two different approach can be identified:
- Energy based biorefinery (often thermochemical treatment)
- Biochemicals based biorefinery (often biochemical pretreatment).

Biochemical biorefineries success is dependent by the advanced technologies for solid biomass fractionation (enzymatic, organosolv, steam explosion, Ammonia explosion, alkaline acid hydrolysis etc..). In addition, GHG emission contribution of Enzymes is a big part of advanced biofuels treatment.
MAIN BIO-CHEMICALS FROM SYNTHESIS GAS

SYNTHESIS GAS FROM BIOMASS CO + H2

- Hydrocarbons (olefins, paraffins, aromatics) + Oxygenates
- CH4
- Styrene
- Toluene
- H2
- Ammonia
- N2
- Ethylene glycol (Methanol)

Fisher-Tropsch

- Ni

Cracking of naphtha

- Ethylene
- Ethanol
- Methanol

Bifunctional catalysts

- HCHO

Zeolites

- C5 + aromatics
- Chemical BTX
- Acetic Acid

Iso-Synthesis

- ThO2

Isobutane

- C5-C8, branched
Biobased chemicals market perspective

From 2006 to 2011 bioplastic production grew by 1,500 percent to an aggregate capacity of 470,000 tons and a 10.9 percent share of all biobased materials.

Biobased chemicals and materials industry capacity is expected to double in market potential to $19.7 billion in 2016 as global manufacturing capacity increases by 140 percent. Lux Research, 2012.
Chemical production from biomass. Market opportunities.

- According to the report, titled “Global Bio-based Chemical Capacity Springs to Scale,” the global capacity for 17 major biobased materials doubled to 3.8 million tons this year. Over the next five years, capacity is expected to climb to 9.2 million tons.

- Glycerin and lactic acid accounted over two-thirds of the bio-based chemical market by value in 2011.

- By 2021 this market share will shrink to 53% as the emerging markets for bio-based polyethylene (PE) and epichlorohydrin (ECH) achieve 10-fold growth through the decade.

<table>
<thead>
<tr>
<th>Bio-Based Chemical</th>
<th>Reference petrolchemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ehyl lactate</td>
<td>Ethyl acetate</td>
</tr>
<tr>
<td>Ethylene</td>
<td>Ethylene</td>
</tr>
<tr>
<td>Adipic Acid</td>
<td>Adipic Acid</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>Acetic Acid</td>
</tr>
<tr>
<td>n-Butanol</td>
<td>n-Butanol</td>
</tr>
<tr>
<td>PTT</td>
<td>PTT &amp; Nylon 6</td>
</tr>
<tr>
<td>PHA</td>
<td>HDPE</td>
</tr>
<tr>
<td>PLA</td>
<td>PET and PS</td>
</tr>
<tr>
<td>FDCA</td>
<td>Terephtalic acid</td>
</tr>
<tr>
<td>Succinc Acid</td>
<td>Maleic Anhydride</td>
</tr>
</tbody>
</table>

Biobased chemicals assessed for market penetration and reference materials

- SBI Energy expects the bio-based chemicals market to grow to $12.2 billion by 2021, accounting for 25.4 billion pounds of bio-based chemical production at the end of the decade.
The worldwide capacity of biobased plastics is expected to increase from 0.36Mt to 2.3Mt in 2013 and to 3.5Mt in 2020. This is equivalent to average annual growth rates of 36% between 2007 and 2013 and 6% between 2013 and 2020.
A new intelligent and efficient biomass supply chain and sustainable valuable technologies will be the key solution for a future global sustainable biomass based market.

Biomass environmental sustainability must represent a strength of this renewable energy source and not a challenge.

The Integration with other renewable energies and fossils is a core aspect for the next future development of bioenergy sector.

Current bioenergy commercial technologies are more developed due to the easier approach and integration with old energy market (co-firing, waste anaerobic digestion, etc.).

Different bioenergy production technologies can become profitable and competitive depending on the world areas needs and available resources, both in OECD and non-OECD countries.

Bioenergy and biochemicals market have grown at fast rate in last decades and, thanks to the needs of GHG mitigation and of new renewable energies, this sector is going to grow even more in the next years. Biomass market has still to show its potentials.
THANK YOU FOR YOUR ATTENTION

Andrea Salimbeni. andrea.salimbeni@eubia.org

EUBIA – The European Biomass Industry Association
Rond Point Shuman, 6
1040, Brussels,
Belgium.
www.eubia.org