THE NEW GREEN DEAL IN TRANSPORTS. BIOFUELS – THE REDUCTION OF OIL DEPENDENCE IN THE TRANSPORT SECTOR

Marius CĂPĂȚÎNĂ*

Abstract. *This paper is part of the proposed research topics related to the development of biomass as an alternative energy resource. Improving automotive fuel efficiency and traffic flow is not enough to reduce CO_2 emissions in the road transport sector. An integrated approach is required, which includes the development and supply of alternative fuels and a more efficient use of vehicles. The adoption of these measures will ultimately make CO_2 reduction efforts compatible with economic growth. We need to decrease our dependence on oil, coal and gas and until now the substitution of oil fuels with biofuels is the most important measure for CO_2 reduction.*

Keywords: *transport, efficiency, alternative, biofuel, renewable energy, development.*

1. Introduction

Biofuels have been championed as an energy source that can increase security of supply, reduce vehicle emissions and provide a new income stream for farmers. In recent years, biofuels have attracted increasing attention. Their selling points are many: they are made from renewable feedstock's that can be grown by farmers, and substituting them for petroleum products reduces greenhouse gases and dependency on foreign oil. The European Union, United States and numerous other countries have set ambitious calendars for their compulsory incorporation at filling stations. Farmers are ready for action, industry is investing, and governments have opened up their treasuries to help biofuels take off.

The impact on energy security – The idea that producing biofuels at home will reduce a country's dependence on foreign sources of energy, particularly oil from the Middle East, has helped to increase the political popularity of biofuels. A wide range of biologically-derived feedstock's can be transformed into liquid fuels. The technologies used to make that transformation are also numerous. The most basic is the chemical

* National Institute of Economic Research "COSTIN C. KIRIȚESCU".

transesterification process used to convert oils and fats into fatty-acid methyl ester (FAME), commonly known as biodiesel because of its resemblance to diesel. Most commercial production of biodiesel is based on vegetable oils such as those obtained from oil palm, rapeseed, sunflower seed, and soybean, but some is made from tallow, used cooking oil and even fish oil. Ethyl alcohol, or ethanol, can be produced from any feedstock that contains relatively dense quantities of sugar or starchy crops, using nothing more than a flask. The most common feed stocks are sugarcane, sugar beet, maize (corn), wheat and other starchy cereals such as barley, sorghum and rye. Concentrating the ethanol from the 16% or so that exists in the beer to the high level of purity (typically 99.7%) required for use in spark-ignition engines requires distillation and dehydration equipment.

At present, the predominant liquid biofuels in use are ethanol and biodiesel. A much smaller amount of biomass-derived energy is converted into methane gas for use in transport.

Biofuels are thus not an easy solution for weaning the world from its dependency on petroleum. Because most liquid biofuels will be consumed as blends with gasoline or petroleum diesel, biofuels will, for some time to come, be complements to petroleum-based transport fuels, not major competitors with them. Their potential is limited and their environmental benefits rely on critical assumptions that must be met in order for biofuels to be sustainable.

Within the field of bio energy, a large number of actors are involved at different parts of various value chains, stressing the need for coordination of (pre-competitive) research. First research topics yet to be detailed, relate with biomass resources, combining thermo chemical and biochemical conversion pathways.

Brazil and the United States of America lead the production of ethanol while the European Union is at present the main producer of biodiesel.

2. Experimental conditions

We assume that the EU will consume 17.76Mtoe of bio ethanol and biodiesel by 2020 in order to achieve the mandate target of 10% renewable energy in road transport fuels. Only two biofuels with possible application in transport – bio ethanol and biodiesel – are investigated, since they appear to be the most feasible by the time horizon of the analysis. Bio

ethanol and biodiesel can be mixed with conventional gasoline and diesel. When blended in low concentrations, these two biofuels can be handled over the existing infrastructure for liquid fossil fuels and can be used in current engines without engine modifications

Well-to-wheel assessments indicate that the use of biofuels in vehicles yield definite benefits in terms of

GHG emissions compared to petroleum-based automotive fuels, although the precise amount of saved CO_2 emission depends on the specific type of raw material used, the production process for the agricultural raw materials, the conversion process and several other elements. Europe strongly believes that biofuels, and in particular second generation biofuels (such as bio ethanol or biodiesel from ligno-cellulosic biomass or biodiesel from biomass gasification) has the potential to become an attractive replacement for fossil transportation fuels for both environmental and economic (depending on the oil price) reasons, and due to its potential of creating jobs in rural areas. To reach the 10% biofuels target, the EU urgently needs to draw up a comprehensive and coherent framework comprising all relevant policy areas. This will require a realistic roadmap to implement the different policies.

Future biofuel markets could be characterized by a diverse set of supplying and consuming regions.

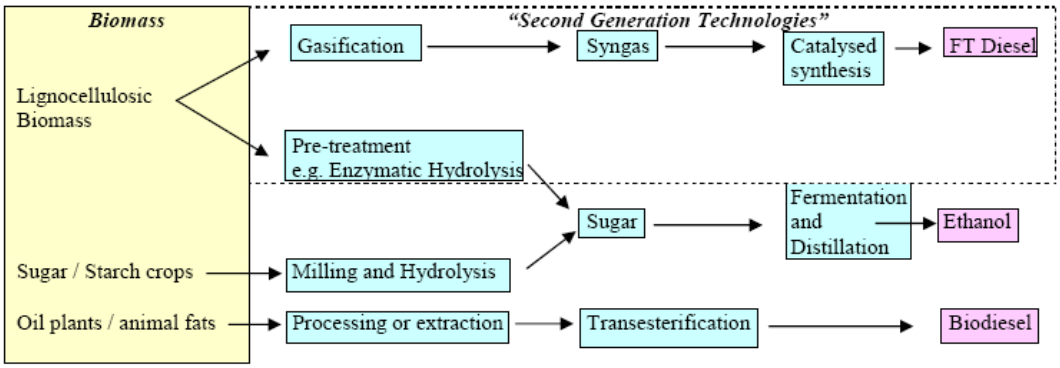
From the current fairly concentrated supply (and demand) of biofuels, a future international market could evolve into a truly global market, supplied by many producers, resulting in stable and reliable biofuel sources. This balancing role of an open market and trade is a crucial precondition for developing biofuel production capacities worldwide

Liquid biofuels was around 1-2% of global transport fuels in 2005 and currently supply 4% of global transport. The potential exists to significantly increase this share in coming decades. But, substantially displacing petroleum fuels will only happen with strong and credible drivers.

The conclusion of the European Council to establish a 10% biofuels target in 2020 for the EU was made "subject to production being sustainable, second-generation biofuels becoming commercially available and the Fuel Quality Directive being amended accordingly to allow for adequate levels of blending". This therefore seems appropriate.

A key question is how to ensure that production will indeed be sustainable. One answer currently being explored intensively is to certify the conformity of biofuels with minimum environmental and social

standards on a life-cycle basis. Second generation biofuels are those, which utilize ligno-cellulosic biomass, the most abundant source of renewable carbon on our planet.



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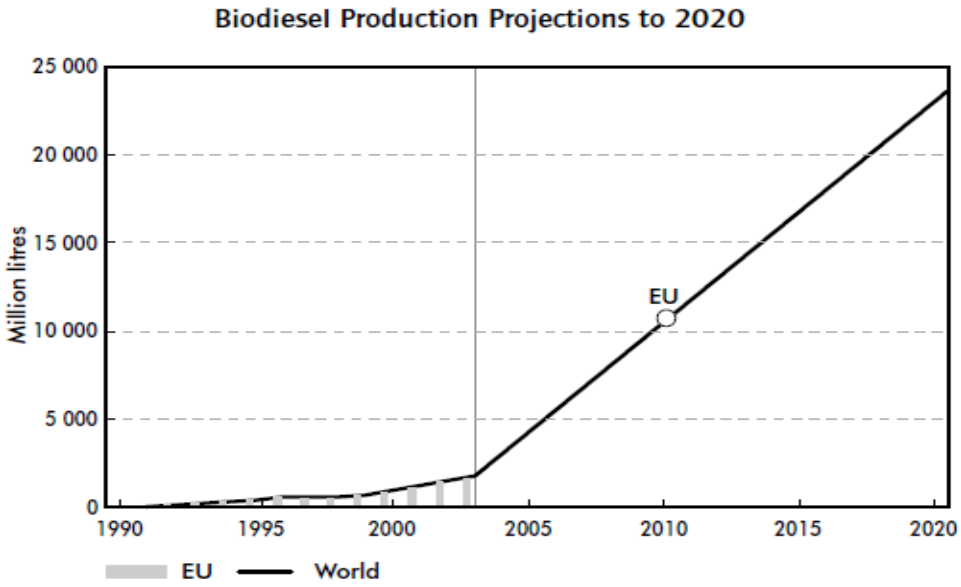
The relative share of biofuels could be increased if a range of demand-side efficiency measures effectively reduce total fuel demand growth in the transport sector.

Commercial biofuels markets could become a major factor in raising the economic viability of rural enterprises, especially in developing countries. Increased investment in infrastructure for biofuels processing, distribution and transport would also result. At least some of this infrastructure will also contribute to the overall development of the agricultural sector

"Second generation" biofuels technologies produced from non-food ligno-cellulosic feedstock's are expected to become commercially viable on large scale, and hold considerable promise, compared to "first generation" biofuels, particularly for expanding the energy base and providing significant GHG emission reductions.

The demand side of the transport fuel problem should receive proportionally more attention than the supply side. If historical trends were to continue, annual growth rates in the future would be about 7% for Europe, 2.5% for North America and Brazil, and 2.3% for the whole world. This would lead to a global increase from about 30 billion litres in 2003 to over 40 billion by 2020. However, given recent policy initiatives and changes in trends, a very different picture could emerge: a quadrupling of world production to over 120 billion litres by 2020.



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Bioenergy encompasses a chain of technologies from the production of biomass in a sustainable manner, meaning cultivation, harvesting, transportation, storage and eventually pre-treatment before use in a conversion process to produce the final energy, biofuels or chemical feedstock. While many technologies in use are quite mature, there is still considerable work to ensure that a minimum sustainability threshold is exceeded. Combined production of heat and electricity (CHP) is moving to wide commercial exploitation in co firing systems with fossil fuels, particularly coal, while efficiency and scale of operation in purely biomass fired systems still needs some development before optimum efficiencies may be achieved. Production of biofuels from ligno-cellulosic biomass is only at the pilot scale, although demonstration projects will be on line by 2015. Biorefineries are some way behind ligno-cellulosic biofuels production and are unlikely to be fully demonstrated by 2015. Cost of investment is steadily being reduced for all bioenergy systems. Only approximate figures for ligno-cellulosic biofuels production can be given in the absence of large-scale demonstration performance data. With the exception of biomass co-firing in fossil power plants and biogas production from agricultural residues, all other technologies still require considerable research and development

A recent FAO report on food security concluded that there is enough land to accommodate additional food crops and biomass production to be transformed in biofuels. A similar conclusion was reached by a report

prepared by the European Environmental Agency. José Graziano da Silva, FAO's representative for Latin America has commented that the real problem is not arithmetic but social. In most cases, as already mentioned, people are not hungry on account of food scarcity, but because they lack purchasing power to buy food. There are at least five ways to reduce the competition for scarce agricultural land between biofuels and food crops:

- By concentrating the production of biomass for biofuels on waste and deforested land, leaving prime agricultural land to food crops;
- By promoting integrated food-energy systems (integration of biofuels production with dairy cattle, crop association and crop rotation, agro-forestry systems) which result in higher global yields per hectare and release pastures for crop production; 47
- By shifting, as quickly as possible, to second generation cellulosic biofuels, produced from non-edible parts of food crops, forest residues, wild grasses, tree crops, animal fat and all sorts of green residues;
- By promoting further increases in yields per hectare of both food and biofuel crops, resorting to agro-ecological practices predicated on the concept of 'evergreen revolution'48 seeking knowledge and labor-intensive, yet land, water and capital saving production functions accessible to small farmers, and characterized by low fossil energy inputs;
- Finally, by supporting research aimed at identifying new oil producing plants (with special reference to different very promising kinds of palm trees), improving the productivity of the biofuels crops already in use and expanding the spectrum of biofuels.

Boeing and NASA are sponsoring research on biokerosene derived from babaçu nuts carried out by Professor Expedito Parente from Fortaleza, Brazil, a distinguished scientist who runs a successful biodiesel industry Tecbio. Parente used biokerosene in a plane in 1984, but no attention was given to his discovery until 2005, when he received the Blue Sky Award at a UN conference. According to G. Bisignani, Director General of IATA, aviation today is only responsible for 2 percent of global CO2 emisssions with a total climate change impact of 3 percent. Projections for 2050 speak of 3 percent of global CO2 emissions with a total climate change impact of 5 to 6 per cent. With 28 per cent of costs coming directly from fuel, the airline industry has a strong incentive to keep fuel consumption low. Airlines are investing heavily in more fuel-efficient aircrafts. In the last 40 years, fuel efficiency increased by 70 percent and will improve another 25 per cent by 2020. Biofuels are part of the game.

Producing biofuels is thus only a part of a comprehensive energy strategy. The addition of ethanol to gasoline and of biodiesel to diesel can reduce the consumption of oil-based liquid fuels in the near term and for assisting in the reduction of exclusive dependency on oil-based liquid fuels at a later date.

The coming of age of biofuels is happening against the background of growing awareness of the urgent need for changing the present unsustainable pattern of energy use, characterized by a profligate (mis)use of abundant and cheap fossil fuels. It is helped by the recent sharp increase in oil prices. With oil barrel traded at 70 to 90 dollars, some biofuels become competitive. Furthermore, the imminent 'oil peak' is likely to keep the oil prices fairly high.

This brings us to the second generation biofuels such as cellulosic ethanol, that can be processed from lignocelluloses, using the inedible parts of food crops, wild grasses, forest residues, and trees.

Different industrial processes are being explored: enzymatic hydrolysis, thermochemical fuels obtained via gasification (Fisher-Tropsch liquidds, methanol, MTBE, gasoline, dimethyl ether, mixed alcohols, hydrogen), hydrothermal upgrading oils and pyrolysis oils. The first industrial plants are being set-up and it is hoped that within a few years some cellulosic biofuels will be brought to the market cost-effectively, significantly reducing, if not eliminating altogether, the conflict for land with food crops.

At the same time, research is being conducted on biofuel from power plant CO2. At the heart of the technology is a plastic cylinder full of algae, which literally sucks the CO2 out of a power plant's exhaust. The algae can in turn be converted into biofuel.

3. Risks and opportunities

Beyond energy security reasons, the main interest of biofuels as opposed to petroleum products thus lies in the reduction of CO_2 emission, and consequently air pollution. While burning gasoline is a net CO_2 emissions, burning bioethanol results in emitting CO_2 which was previously captured by the plants.

Biofuels aim to be carbon neutral, that is, to provide a zero sum balance between the carbon release generated by the burning of the fuel and the carbon absorption provided by the growing of the plant which will be used for the production of fuel.

Two key benefits of biofuels for transport are global in nature: oil savings and greenhouse gas emissions reduction. In both cases, reductions

occurring in one country can provide global benefits. With oil savings, reduction, in global demand for petroleum could lower world oil prices and improve security of supply. Greenhouse gases have roughly the same impact on the global climate wherever they are emitted.

For more than a hundred years we have been living in an oil-age, which is now being put on check. According to many geologists, production of oil will soon reach its peak, and will be declining afterwards. The newly discovered reserves of oil do not match the current demand prospects; hence the trend towards depletion and higher prices. These high prices and projected shortages make biofuels increasingly competitive.

The question of how to organize an orderly transition from the oil-age to the post oil-age and how to cope with the volatile and often explosive geopolitics of oil will certainly dominate the international scene throughout the 21st century.

Biofuels production potential can be compared to projections of transport fuel demand, to determine the share of biofuels in total transport fuels, and how this may vary by region. Regions where the potential to produce biofuels is high relative to expected transport fuel demand may be interested in exporting biofuels to regions in the opposite situation.

Total production of biodiesel in EU-27 for 2010 was over 21.9 million metric tons, an increase of 384.21% from 2007 figures.

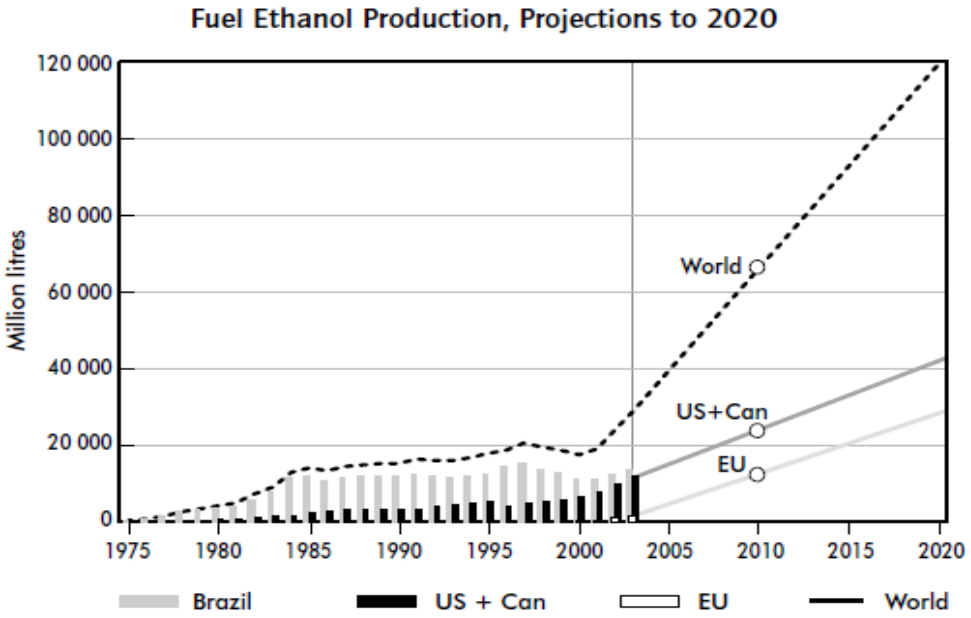
2010 Production Capacity

COUNTRY	'000 TONNES*
Austria	560
Belgium	670
Bulgaria	425
Cyprus	20
Czech Republic	427
Denmark	250
Estonia	135
Finland*	340
France	2,505
Germany	4,933
Greece	662
Hungary	158
Ireland*	76

COUNTRY	'000 TONNES*
Italy*	2,375
Latvia	156
Lithuania	147
Luxemburg	0
Malta	5
The Netherlands	1,036
Poland	710
Portugal	468
Romania	307
Slovakia	156
Slovenia	105
Spain	4,100
Sweden	212
UK	609
TOTAL	**21,904**
Calculation based on 330 working days per year, per plant. The above figures represent an overall picture of the EU-27 biodiesel capacity on July 1, 2009.	

Source: http://epp.eurostat.ec.europa.eu/statistics.

Reliable information on cropland and conversion efficiencies is needed to estimate the potential for global biofuels production. Optimally, one would need to know on what type of land various feedstock's can be grown and how much of that land is available, after taking into account various other required uses for that land. It would also be useful to know the extent to which these feedstock's could be dedicated to biofuels production (as opposed to food, clothing and other materials production, and production of other types of energy such as electricity) and the efficiency of biofuels production per unit land area (taking into account crop production efficiency and biofuels conversion efficiency).



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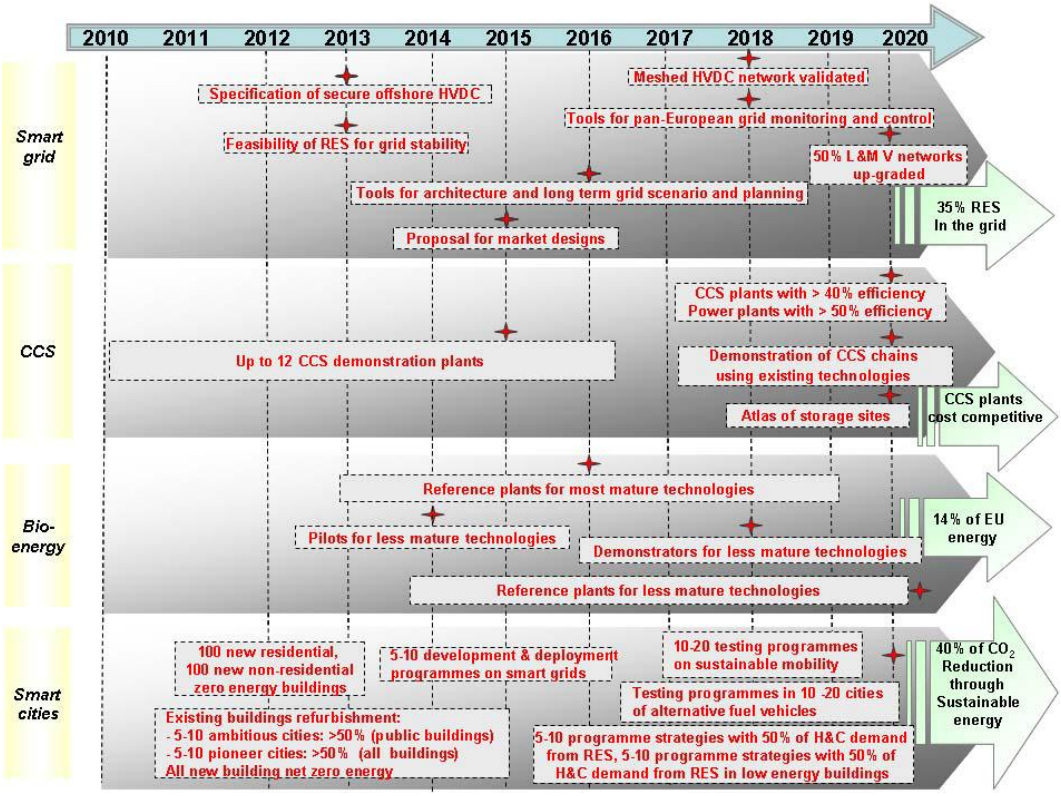
The EII proposes to carry out an ambitious demonstration programmmed of different bio-energy pathways at a scale appropriate to the level of their maturity – pilot plants, pre-commercial demonstration or full industrial scale. Up to about 30 such plants will be built and operated across Europe to take full account of differing geographical and climate conditions and logistical constraints. A longer term research programme will support the bio-energy industry development beyond 2020. The cost of such a European programmed is estimated at €9 billion over the next ten years.

The expansion of biofuels production should rest on four pillars:

- innovation,
- capacity expansion,
- infrastructure;
- building of a global market.

It is suggested that a fifth pillar is equally relevant: biofuels production should be predicated on institutional settings and production models capable of inducing a new cycle of rural development, aimed at creating a fair amount of opportunities for decent work. These would include the production and processing of biomass for fuel, productive uses of by-products and waste, as well as technical services and transport. As for innovations required, they ought to be knowledge and labour intensive, yet land, water and capital saving.



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To ensure at least 10% biofuels in the EU energy mix by 2020, and at the same time to guarantee GHG emission savings of 60% for bio-fuels and bio-liquids under the sustainability criteria it's necessary to bring to commercial maturity the currently most promising technologies and value-chains through the development and optimization of feedstock-flexible thermo chemical pathways and biochemical pathways, in order to promote large-scale, sustainable production of advanced biofuels and highly efficient heat & power from biomass. This will require scaling up and optimization of process integration, with focus on the improvement of feedstock flexibility, energy and carbon efficiency, capex efficiency, reliability and maintenance of plants; to contribute to a set of activities in the field of biomass feedstock availability assessment, production, management and harvesting in support of the up-scaling of promising technologies. Biomass availability, production and harvesting are not specific to the bio energy use of biomass and are to be addressed in a coherent effort shared with relevant stakeholders and initiatives and to develop a longer term R&D programme to support the Bio energy industry development beyond 2020.

Optimization of the most promising value chains within thermo-chemical (characterized by the use of high temperature transformations) and biochemical (characterized by the use of biological and chemical processes) pathways. Several technology options have shown promising performances at pilot scale, this calls for a collaborative programme of demonstration and first-of-this-kind industrial-size plants depending on the level of maturity of each specific value chain.

Activities will include the optimized use of advanced catalysts and the improvement of gas cleaning technologies and quality/stability of bioliquids.

Production of synthesis gas (syngas) as an intermediary to create liquid fuels (e.g. gasoline, naphtha, kerosene or diesel fuel) and chemicals; production of bio-methane and other bio-synthetics gaseous fuels through gasification; optimization of syngas combustion to produce heat and electrical power; optimization of the production of bio energy carriers such as bio-oil and solid intermediates; co-processing of biomass and bio-energy carriers with petroleum oil.

Within the biochemical pathways, the following three value chains will be optimized for the production of gas and liquids from biomass, including the optimization of feedstock pre-treatment and downstream processing and the optimized use of advanced enzymes, ensuring the optimum production of valuable co-products where possible.

While increased crop demand may trigger an increase in crop prices, as well as in other related markets, there are also important potential "macro" benefits from increasing the domestic production of biofuels.

The full benefits are difficult to measure, requiring general equilibrium modelling and assumptions regarding the costs and risks of oil import dependence, such as the risk of supply disruption or sudden spikes in prices.

Biofuels production in developing countries can also have a positive impact on agricultural labour employment and rural development, particularly when conversion facilities are smaller-scale and are located near crop sources in rural districts. In Brazil for example, it is estimated that 700 000 jobs have been created in rural areas to support the additional sugar cane and bioethanol industry. The development of multi-product "bio refineries" could further spur the development of related secondary Industries. In addition to employment benefits, domestic biofuels production enhances the security of national energy supply and improves the balance of trade, since many countries spend large percentages of their foreign currency reserves on oil imports.

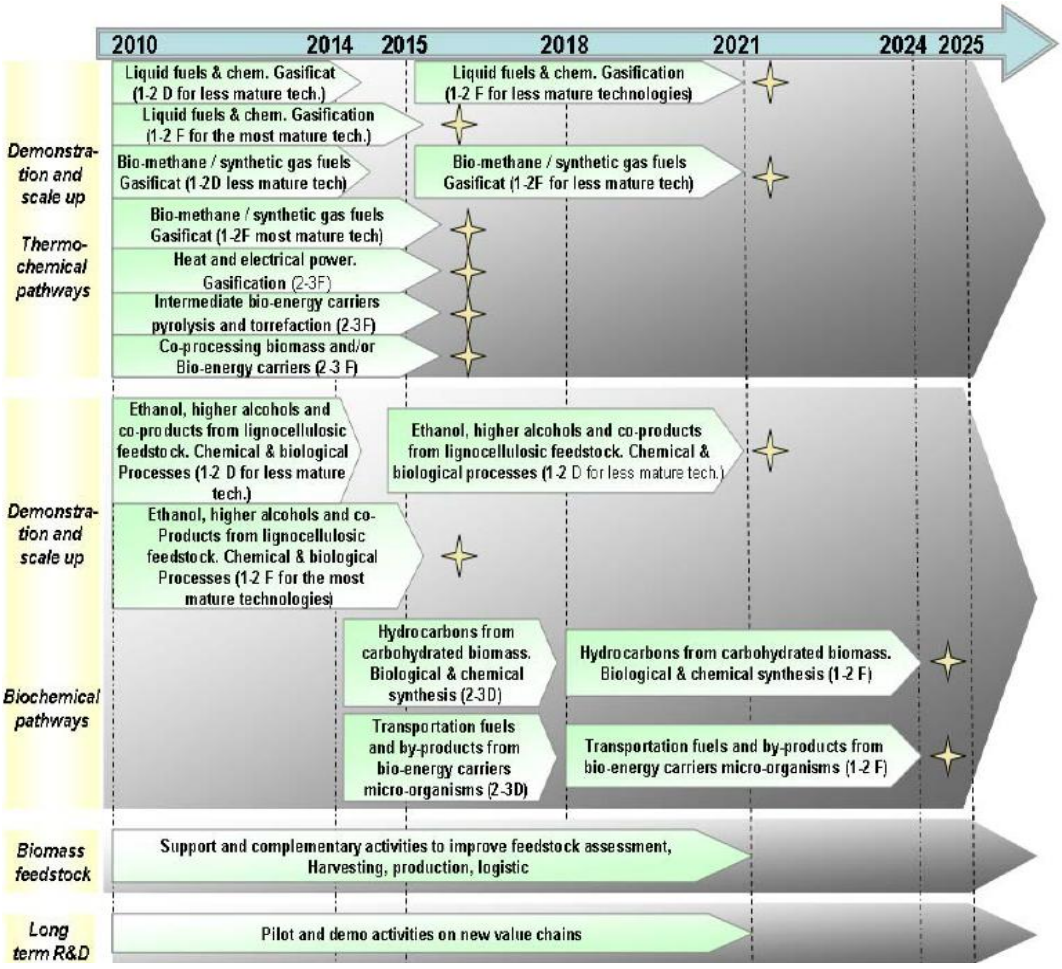
The potential economic benefits from developing biofuels must be weighed against the costs of producing the biofuels, and the negative economic impact these higher costs have on government budgets and economic growth. Such effects must be carefully assessed before the broader macroeconomic benefits are used as justification for biofuels production.

Biofuels production

– Biofuel production cost < 0.6 € /litre gasoline equivalent

– Capital investment and operation costs in line with fossil industry refinery costs

Indicative costs (2010-2020).



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4. Conclusions

Biofuels may well play a part in expanding the range of energy sources available in the future. The extent of their penetration will be limited by the opportunity cost of biofuels feedstock's being applied to competing end uses, and the extent to which second-generation technologies can significantly lower the costs of production.

Organizing the international markets for biofuels by:

• fostering the dialogue among all the stakeholders for an orderly transition from the oil age to a less carbon intensive era;

• developing guidelines for long term contracts between producers and consumers of biofuels, with special reference to cooperatives acting on both sides (fair trade);

• promoting non-discriminatory social and environmental certification at the international level; and

• simplifying the procedures for the emission of in accessing carbon credits linked with carbon reductions achieved with biofuels projects.

Finally, steps must be taken for the organization of the emerging international markets of ethanol and biodiesel. The world economy is entering a long transition from the oil to the post-oil age, likely to extend itself for many decades. All the efforts ought to be made to make it as orderly as possible, seeking the cooperation of all the protagonists, including oil producers.

REFERENCES

[1] Garten Rothkopf, *A Blueprint for Green Energy in the Americas*, Interamerican Development Bank, Washington, 2007.

[2] Hayes, D., Ballentine, R. and Mazurek G., Harvesting Fuel, *Blueprint Magazine*, April 23, 2007.

[3] IEA, Biofuels for Transport – An International Perspective. OECD Publications, Paris, 2005.

[4] IEA, Energy Technologies Perspectives. Chapter 5, Road Transport Technologies and Fuels, OECD Publications, Paris, 2006a.

[5] IEA, 2006b. World Energy Outlook 2006. Chapter 14, The Outlook for Biofuels, OECD Publications, Paris.

[6] IPCCC, Intergovernmental Panel on Climate Change, Climate Change, Mitigation. Contribution of Working Group III to the Fourth Assessment Report, Draft, 2007.

[7] Mittelbach, M. and Remschmidt, C., *Publisher: Biodiesel: the comprehensive handbook*, Martin, Mittelbach, 2004.

[8] United Nations, UN-Energy, *Sustainable Bioenergy: A Framework for Decision Makers*, New York, 2007.

[9] Peter Hazell and R. K. Pachauri (eds), *Bioenergy and Agriculture Promises and Challenges*, 2020 Focus no. **14,** IFPRI/TERI, Washington/New Delhi, 2006.
[10] UN-Energy, Sustainable Bioenergy: A Framework for Decision Makers. Food and Agriculture Organization of the United Nations, 2007.
[11] The European Parliament and the Council, Directive on the promotion of the use of biofuels or other renewable fuels for transport, Nr. 30/2003/EC, 2003.

http://www.mnp.nl/ipcc/pages_
http://www.responseonline.com/thumb.htm
http://www.bbiethanol.com/news/view.cgi?article=401
http://www.grida.no/climate/ipcc/tectran/336.htm
http://www.biodiesel.org/resources/reportsdatabase/reports/gen/19970901_gen-190.pdf
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