BIOFUELS CHALLENGE – THE INTEGRATION OF NEW INDUSTRY IN THE FUELS MARKET

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Abstract. *This paper is part of the proposed research topics related to the development of biofuels as an alternative energy resource. The challenge now is to deploy, integrate, and demonstrate the reliability, economics, and environmental benefits of the biofuels at a scale that can lead to a rapid commercialization.*

Keywords: *Biofuels, Fossil fuels, biotechnology, industry, integration of biofuels industry.*

1. Introduction

Biofuels are emerging in a world increasingly concerned by the converging global problems of rising energy demands, accelerating climate change, high priced fossil fuels, soil degradation, water scarcity, and loss of biodiversity.

The rate and scale of biodiversity degradation is significantly weakening the resilience of the natural world and its ability to deliver key services such as climate control, air and water purification and protection from natural disasters.

Since most current modern biofuels are made from food crops, concerns about arable land use competition, risks to food security, vulnerable communities, water resource constraints, and deforestation arise. Meanwhile new crop feedstock are being developed and advanced biofuel production methods using forest, crop, and urban residues, as well as from non-food crops, are also progressing, but have yet to be commercialized and deployed in the marketplace on a large scale comparable with the size of the energy market.

Many countries have a competitive advantage in producing biofuels. Meanwhile, many other countries are unable to meet their biofuel needs from domestic sources (Fig. 1). Therefore, increased biofuel trade holds

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promise. Also, when bioenergy displaces fossil fuels, in transport and power generation, or is produced in conjunction with soil carbon storage in the form of bio-char for example, opportunities arise for trade in carbon emission reduction units.

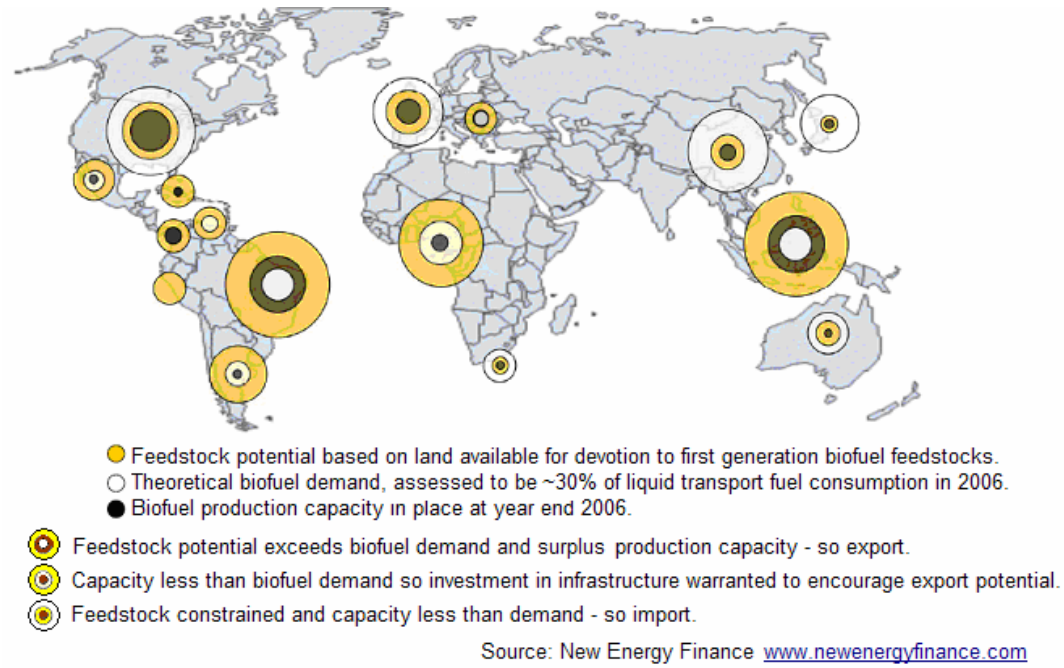

Figure 1. Indication of first generation biofuel feedstock potential s, theoretical biofuel demands and production capacities in place at end of 2006 for selected world regions.

2. Experimental conditions

Improving automotive fuel efficiency and traffic flow is not enough to reduce CO2 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 make CO2 reduction efforts compatible with economic growth.

We need to decrease our dependence on oil, coal and gas. Not just electricity, but heating, transport and our food system is dependent upon a non-renewable, climate-change causing energy source. The vulnerabilities that are present must not distract attention from the policies and actions that matter most for economic prosperity and well-being in the long-term.

The world has a unique opportunity to develop a next-generation bio product industry in the next two decades. There could be major benefits in terms of job creation, the economy, reduction of greenhouse gases and energy security. The regular supply of agricultural residue can underpin the development of this industry. It is a resource that can be sustainably harvested without altering current agricultural land use patterns. In supplementing food production, this resource theoretically can be turned into a variety of bio products from transport fuels to chemicals and plastics.

We should consider the mix of future transport fuels to have the potential for:

- Full supply of the transport energy demand by 2050;
- Low-carbon energy supply to transport by 2050;
- Sustainable and secure energy supply to transport in the longer term, beyond 2050.

Alternative fuels are the ultimate solution to decarbonize transport, by gradually substituting the fossil energy sources, which are responsible for the CO2 emissions of transport. Other measures, such as transport efficiency improvements and transport volume management, play an important supporting role.

Energy carriers as transport fuels should be given particular attention, as they can be produced from a wide range of primary energy sources. They allow transport to take full advantage of the expected gradual decarburization of the energy system, resulting from a steady increase in the share of non-CO2 emitting energy sources. Energy carriers as fuels also ensure the security of energy supply to transport by providing diversification of energy sources and suppliers, whilst allowing for a smooth transition from fossil to renewable energy sources.

Compatibility of new fuels with current vehicle technology and energy infrastructure, or alternatively the need for disruptive system changes should be taken into account as important determining factors influencing the introduction of alternative fuels.

Demand for road transport is expected to grow dramatically in Emerging Economies. While EU demand is not expected to increase significantly, developing countries, including population rich countries like China and India, are entering their most energy-intensive phase of economic growth as they industrialize, build infrastructure, and increase their use of transportation. These demand pressures will stimulate more

efficiency in energy use and alternative supply, but these alone may not be enough to offset growing demand tensions completely.

Alternative fuels such as electricity, hydrogen, biofuels, synthetic fuels, methane or LPG will gradually become a much more significant part of the energy mix. No single substitution candidate, however, is seen. Fuel demand and greenhouse gas challenges will most likely require the use of a great variety of primary energies. There is rather broad agreement that all sustainable fuels will be needed to resolve the expected supply-demand tensions.

Technical and economic viability, efficient use of primary energy sources and market acceptance, however, will be decisive for a competitive acquisition of market shares by the different fuels and vehicle technologies. Any new fuels should demonstrate their availability, affordability and reliability. Compatibility with existing fuels and vehicle technologies would facilitate a smooth market transition and optimize the total system cost and customer acceptance.

Political and regulatory support will be decisive in the first phase to support the development and market entry of alternative fuels able to respond to the de-carbonization objectives.

Liquid hydrocarbon fuels are expected to remain predominant over the next decades. But the use of electricity, hydrogen, biofuels, synthetic fuels, methane and LPG will steadily increase.

The two main reasons for research into renewable energy sources as an alternative to oil are:

- the significant contribution of transport to emissions of greenhouse gases. Emissions resulting from transport account for 21% of the total emissions of greenhouse gases. As a result, it is necessary to use fuels that are less polluting than oil;
- needs to guarantee the security of energy supplies by diversifying fuel sources. The limited quantity of available oil and the increase in prices of fossil fuels represent increasingly urgent challenges for the transport sector and for national economies.

Fuel demand from the transport sector will climb 20% by 2020 and 46% by 2030 on 2010 levels, according to Bloomberg New Energy Finance projections. This implies a slightly lower annual growth rate compared with the historical average of 2% per year in the last decade. The slight slowdown is caused by the rapid penetration of electric vehicles and

continuously higher efficiencies, all driven by high fuel prices and environmental regulations.

Production of gasoline substitutes, mainly ethanol, is projected to increase from 100bn liters in 2010 to 190bn and 300bn liters in 2020 and 2030 respectively. Production of diesel substitutes will double by 2020, reaching 100bn liters from roughly 50bn today, and will double again by 2030 reaching 200bn liters. These forecasts are relatively conservative: high fuel prices may force countries to remove the free trade constraints and relax their current sustainability criteria.

Total production of biofuels, diesel and gasoline substitutes will nearly double this decade and rise a further 72% over the next, according to our analysis. The historically big biofuel markets and producers – the USA and Brazil – will boost their domestic production by some 60% up to 2020 and then an extra 35% by 2030. While small at present, other markets like China, India and Africa will increase their production at significantly higher rates. As a result, the aggregate share of Brazil and the US will shrink to 45% by 2030 from 67% today. In absolute terms, however, Brazil will still add 26bn and 23bn liters of capacity over the next two decades, and the USA and Canada will together increase capacity by some 35bn in each decade. This is corresponds to 35% of the total cumulative growth of the sector.

Food scarcity has already forced international bodies to put in place tough sustainability criteria for biofuels production. As countries continue to impose tough sustainability standards and the production will shift towards next-generation biofuels (from wood, straw, waste etc.). These technologies are relatively immature and expensive but we expect higher adoption levels to accelerate learning and bring down costs quickly. Hence, we expect first-generation biofuels production to grow slowly until 2020 and remain steady thereafter. In contrast, next-generation biofuels production is forecast to climb more than 10% on average every year between 2010 and 2030.

With regard to investment, small and immature markets such as Africa and Latin America are expected to attract the most asset finance due to abundant resources and strong domestic demand. Over the next 20 years, only 30% of investment on biofuels will be spent in Brazil, the US and Canada. Europe will see significant investment between 2015 and 2020 mainly driven by its Renewable Energy and Waste Directives.

However, financing levels will then decline due to falling demand for transport fuels. Emerging sustainability standards and the need to address food scarcity will mean that some 95% of the total investment ($510bn) on biofuels infrastructure will target next-generation facilities over 2013-2030.

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.

While domestic mandates ensure the existence of markets, they can also further distort markets for energy and agricultural products. The co-existence of mandates with other policy instruments such as subsidies, tariffs, import quotas, export taxes and non-tariff barriers have not always resulted in effective deployment and efficient production and can restrict the opportunities that biofuels present.

The current negative image of biofuels in some quarters, provoked in part by a rather complex set of national public support schemes, is threatening the fulfillment of their promise and must be addressed. Paramount to a solution is an orderly and defined schedule for elimination of subsidies, tariffs, import quotas, export taxes and non-tariff barriers in parallel with the gradual implementation of sustainable biofuels mandates. These measures will provide the necessary conditions to reduce risks and to attract investment to develop and expand sustainable production. Several different efforts to reach these goals are ongoing including multilateral, regional, and bilateral negotiations, as well as unilateral actions. Ad-hoc public and private instruments such as standards and product specifications and certification may also prove useful for addressing technical and sustainability issues. In addition, the development of a global scheme for sustainable production combined with technical and financial support to facilitate compliance will ensure that sustainability and trade agendas are complementary.

The potential of biofuel production from both traditional crops and energy crops is determined by the area of land, which can be made available, the yield of that land, and the use of biomass and co-products in

other sectors. The production of second generation biofuels from wastes and residues is limited by the availability of these materials.

Sustainability considerations, including life cycle aspects constrain the technical potential in all cases. The extent of the greenhouse gas emissions saving with biofuels depends on the biofuel pathway. According to Directives 2009/28/EC and 2009/30/EC, the CO2 saved from the use of biofuels must be at least 35% of that produced from using fossil fuels. However, this does not include the impact of indirect land use change, which has to be addressed according to the legislative mandates in the Directives.

Biofuels are expected to provide the main contribution for achieving the targets of 10% renewable energy use and 6% greenhouse gas reductions in transport sector by 2020. Bioethanol production in the EU could increase to about 25 Mtoe by 2020, 50 Mtoe by 2030 and 100 Mtoe by 2050 according to biofuel industry estimations (see Fig. 2).

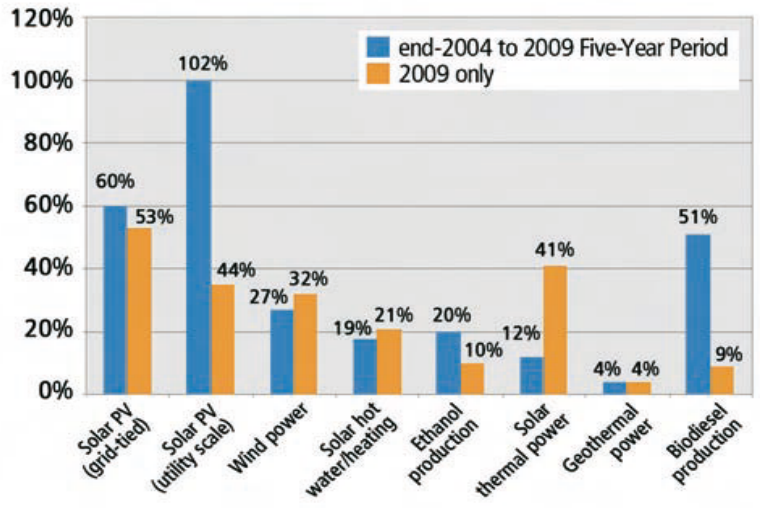

Figure 2. Average Annual Growth Rates of Renewable Energy Capacity, end 2004 to 2009.
Source: http://bioenergy.ornl.gov/resourcedata/index.html

3. Risks and opportunity

We identify two key benefits of biofuels for transport are global in nature: oil savings and greenhouse gas emissions reduction. Behind of this we need for the biofuels industry to identify the opportunities and the risks.

3.1. Opportunities

• Agricultural residues can be harvested with existing techniques and grown again and again each year in perpetuity. Try to use a renewable and sustainable feedstock: Residues from wheat, sugarcane, maize, rice and soybean crops make up the bulk of this resource.

• Increase and diversify farmers' income: Harvesting a sustainable amount of agricultural residue will not interfere with the food chain, but it will provide rural economies with an additional revenue source that will help to increase and diversify farmers' income.

• Create new job opportunities. If the agricultural residues available are converted into next-generation ethanol, then the new employment could be created from today until 2030. Jobs will come from constructing the necessary bio refining capacity, operating these bio refineries and delivering agricultural residues to these plants.

• A smaller crude imports bill: In an Europe scenario, these regions could produce enough to replace around 20% of the forecast 2020 diesel demand, which will provide an important step towards energy independence.

• Generating additional revenues: The Europe who has the potential to generate additional revenues of $2.3 trillion between today and 2020, resulting from the production of next-generation biodiesel when assuming oil is at $100 per barrel. Revenues, under this scenario conditions, climb to approximately 3.4 $ trillion in the same period.

• Reducing greenhouse gas emissions: Looking at overall, biodiesel is responsible for lower emissions by 50% for CO, CO2 78% respectively. Biodiesel contains fewer aromatic hydrocarbons, many of them carcinogens, present in the composition of diesel. Also, particulate emissions are reduced by 20% compared with low sulfur diesel.

• Reducing emissions is not negative engine power loss. That's because biodiesel has cetane number (a qualitative similar octane gasoline) high oil. In fact, many vehicle manufacturers are excited by the prospect of using biodiesel, including relying less engine wear.

• Develop a bio-based economy: the development of a biofuel industry in rural areas could constitute the first step away from a petroleum dependent economy. It will lead towards a more diversified future where renewable agricultural residues become a significant feedstock for both fuel and chemical production (see Fig. 3).

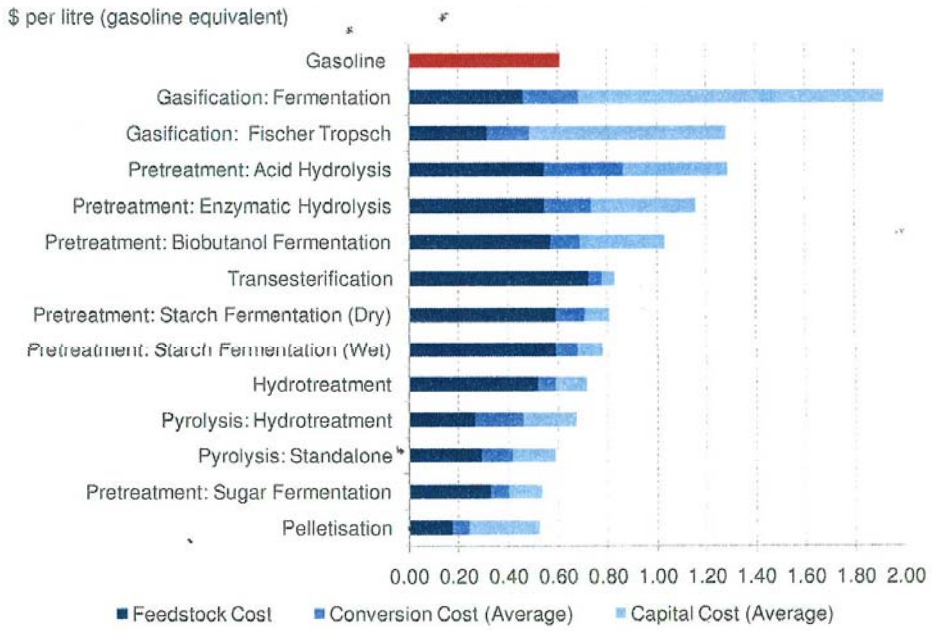

Figure 3. Biofuel pathway total operating costs, December 2009.

Source: Bloomberg New Energy Finance Note: The final biofuel product from each pathway, and its associated conversion cost, has been compared (or levelised) with the energy content of a litre of gasoline; the gasoline price accounts for crude oil at $75 per barrel

4. Risks

There are however few risks witch represent real barrier preventing the industry from unlocking the value of this agricultural residue resource. There are some actions that could be taken by policymakers and other stakeholders to address risks and unlock this potential. However already taken steps to promote a next-generation ethanol industry – the US and Brazil particularly stands out and a biodiesel industry – the UE and China.

We identified the following risks:

• Feedstock supply risk: Temporary incentives for farmers to collect agricultural residue could facilitate the development of a next-generation ethanol value chain.

• Fragmented supply chain: Helping to create a framework for large agricultural residue suppliers, that can aggregate different feedstock streams, will reduce some of the supply risk and instill greater confidence in the eyes of the capital providers.

• Insufficient infrastructure: Investment in rural roads, from the fields and orchards, will facilitate efficient agricultural residue transport and reduce costs.

• High capital costs: Governments support in the form of loan guaranties is vital to reduce the capital costs associated with constructing next-generation bio-refineries.

• Technology risks: Incentives must be locked in for the lifetime of the plant, giving a premium to the first-movers. Investors will then become more comfortable with the project risks, which will mitigate any wait-and-see strategies.

• Product delivery risk: It is imperative to provide stable demand to attract capital to the farming and next-generation bioproduct sectors. It will also give the financial community a long-term market, which will considerably ease raising debt and equity capital.

• Market access limitations: Allow ethanol and biodiesel, both first and next-generation, to replace 20% of the fossil gasoline and diesel supply, which will help remove a "blend wall" that is impeding industry growth, promote flexible fuel vehicles and encourage long-term off take agreements (see Fig. 4).

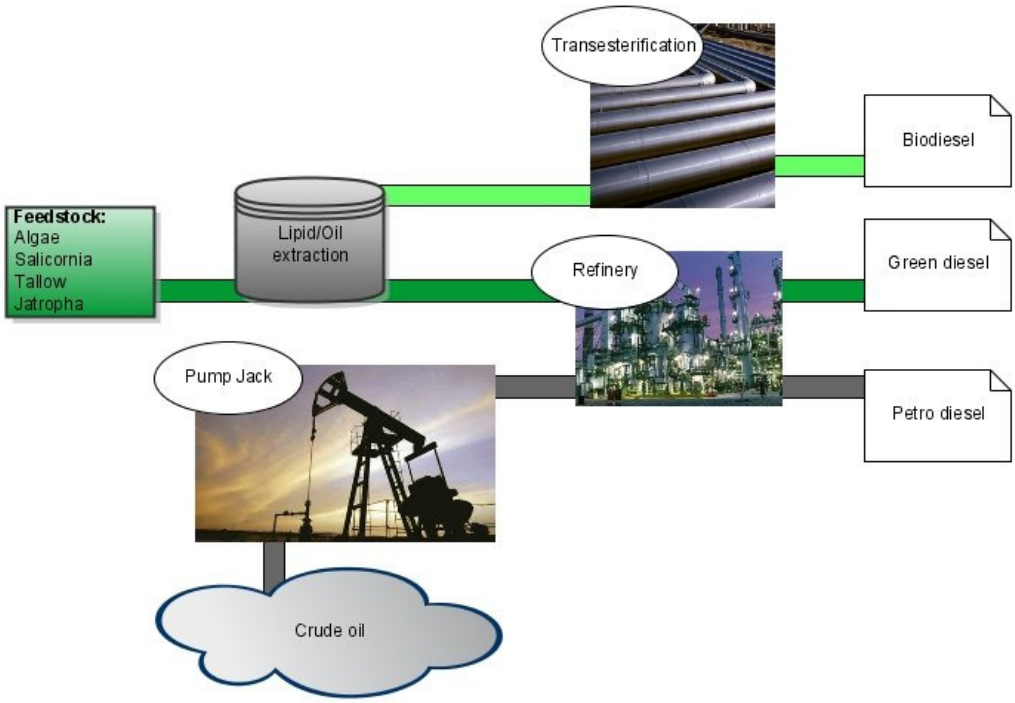

Figure 4. Biodiesel, green diesel and petro diesel.

Source: http://newenrgyfinance.com.

5. Conclusions

The global energy system is entering a phase of rapid transition with potentially far-reaching implications that will unfold in the next decades. Europe has to act before the window of opportunity closes.

During the transition period to 2050, it will also be important to actively manage the change in demand from traditional refineries and to channel fossil fuel products to those transport modes and petrochemical production having the greatest needs. Research will be needed to develop plants and process technologies to utilize biomass for applications that have traditionally been supplied by fossil fuel refineries.

Market developments of biofuels also should take into account the existing and still growing preponderance of diesel over gasoline in the European fuel market, with a split of 65% diesel and 35% gasoline. The resulting strong imbalance of refinery output and market demand in Europe presently is compensated by exporting large amounts of gasoline from Europe, and importing the missing quantities of diesel into Europe. Additional production of gasoline equivalent bioethanol products in Europe exacerbates this imbalance in the fuel market. This imbalance may be reduced by equalizing the excise duty on petrol and diesel fuels and by modifications to refineries to increase the diesel/petrol production ratio.

Biodiesel could come from significant EU potential of feedstock and land available for oilseed crops production. According to present forecasts for EU diesel demand by 2020, a 10% share in total diesel consumption would represent the production of at least 20 Mtoe of biodiesel (probably FAME type). This production could theoretically be obtained from about 4% of the total EU agricultural area. In volume terms, more biodiesel (8.2 Mtoe in 2008) is consumed in Europe than bioethanol (2.2 Mtoe), which is different with regard to the world's major biofuel consumers, the US and Brazil, where the domination of spark ignition engine cars supports a larger share of bioethanol substituting gasoline

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