Members of the Issues Management Working Group

Biofuels Position Paper

What is the issue?
IMWG approved the Group position on Biofuels in 2012. Since then there have been a number of changes both in the external environment, both market and policy, and in BP's biofuel related activities. An updated position is required to reflect these changes.

Biofuels Definitions
Universally accepted and exhaustive definitions of different classes of biofuels do not exist. Definitions vary according to prevailing biofuel regulations, and advocacy/marketing positioning of sector participants. However, the following (non-exhaustive) definitions are generally accepted and have been applied in this paper.

1st generation or conventional biofuels: Biofuels produced from sugar, starch, or fatty acids contained in agricultural crops (grains, oilseeds), using established / technically mature conversion processes, e.g. sugarcane or corn ethanol, esterification of vegetable oils to biodiesel / FAME.

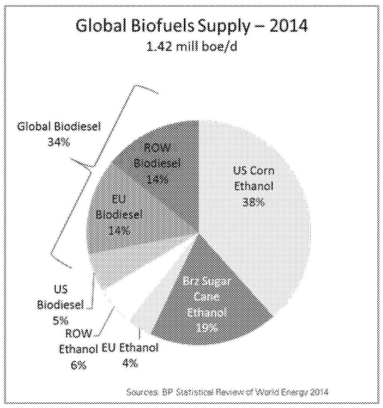
2nd generation or advanced biofuels**:** Biofuels produced from the lignocellulosic fraction from dedicated energy crops, agricultural residues, and the biogenic fraction of other wastes/residues using non-technically mature conversion processes, e.g. cellulosic ethanol, thermochemical conversion of wood feedstocks to synthetic diesel. Also included is the photosynthetic conversion of CO2 by algae to fatty acids (biodiesel feedstock).

External Market and Policy Related Developments
Market: Biofuel penetration into road transport fuels has continued, albeit at significantly reduced rates of growth than witnessed in the period pre 2012[1]. Globally, biofuels now account for 1.42 million boe/d or around 2.5%energy of global total transport demand, almost equivalent to the annual crude output of Algeria.

[1] Growth rate data point

Ethanol remains the largest biofuel type with US and Brazil dominating the sector. In contrast Europe, the world's 3rd largest market, remains heavily focused toward biodiesel, due to its high share of diesel passenger cars, but also due to its gasoline and diesel supply/demand imbalances.

The biofuel market remains almost wholly dominated by conventional or 1st generation biofuels.



Advanced Biofuels: Aspirations on the penetration and use of advanced (2nd generation biofuels) have largely failed to materialize due to a combination of technological and cost challenges and uncertainty on policy/regulatory support. Many of the advanced biofuel start-ups have either gone bankrupt (e.g. Kior), or re-positioned into non-fuels applications (e.g. Amyris).

In terms of the technology genres, photosynthetic algae routes to biodiesel are now generally considered to not to be economically viable pathways to fuels. While there is interest in thermochemical routes (BtL, pyrolysis), primarily to produce synthetic biodiesel and/or biojet molecules deployment at commercial scale has yet to occur. Cellulosic ethanol is the one advanced technology where commercial scale deployment has occurred, with 6 plants commissioned within the last 2 years (US, Brazil and Europe). However, this level falls well below previous ambitions, and in each case, each plant has been struggling with significant operational/reliability issues.

Commented [JRKP1]: Correct, or is initial commercial scale deployment imminent ?

In contrast, biofuels that have been defined as "advanced" within biofuel regulations due to their use of non-food feedstocks or feedstocks that do not directly compete with feed, rather than being truly advanced in technological terms have made material progress. For example biodiesel produced from used cooking oil, which benefits in Europe from double counting under the Renewable Energy Directive, now comprises a significant proportion[2] of the EU's biodiesel slate. In the US, biogas produced from landfill is the predominant source of cellulosic RINs[3].

[2] EU UCO data point
[3] Renewable CNG & LNG RINS made up 98% of total 2015 cellulosic D3 RIN generation, ~140 mill RINS.

HVO

Commented [JRKP2]: Anything specific to add on HVO ?

External Stakeholder Discourse

Since the 2012 paper the external discourse on biofuels has evolved with the policy debate now focusing on a couple of key issues while waning on others.

Indirect Land Use Change: From the E-NGO perspective, indirect land use change (ILUC) is now the primary cause of concern, most prominently articulated in the European policy debate.

While the science around ILUC remains complex and inherently exposed to fundamental uncertainties, the evidence set from the multiple studies point to low or potentially negative (i.e. CO2 sequestration) ILUC impacts from high yielding biofuels such as sugarcane ethanol, cellulosic ethanol, and ethanol produced from grains and sugarbeets. In contrast, studies[4] have confirmed that biodiesel produced from oilseed crops (such as palm and soya oil) has the highest ILUC factors which can in some circumstances result in a higher carbon foot print than fossil diesel. As a result, E NGOs, primarily in Europe, are focusing their critic on biodiesel produced from oilseeds. European regulation / policy is exposed on this issue given the dominance of biodiesel (vs ethanol) in Europe's biofuel mix.

Food vs Fuel and Land Grabs: Other issues connected to Indirect Land Use change such as Food vs Fuel and biofuel related land grabs have largely diminished as points of contention, as the underlying evidence base has been shown to be weak or non-existent, and specifically for the Food-vs Fuel as global agricultural commodities have fallen from 2008 highs

Blendwall: Structural declines in liquid fuel demand in OECD markets combined with continued growth in biofuel volumes, has increased the focus on current biofuel specification and vehicle compatibility limits in gasoline and diesel – the so-called blendwall. This issue is of particular prominence in the US concerning ethanol and the E10 limit in gasoline.

Electric Vehicles: The electrification of transport has become far more prominent both in terms of market activities (e.g. Tesla, BYD, etc…), and in terms of the policy debate as a perceived solution to decarbonise transport. In a number of markets the use of biofuels in passenger cars

[4] The land use change impact of biofuels consumed in the EU, IIASA, Ekofys, E4Tech, October 2015.

is seen at best as transitional before full electrification occurs.

BP's view is that while the progressive introduction of electrification into road transport, (hybrids, plug in hybrids and dedicated electric vehicles) is likely, the size and rate of turnover of the existing global car fleet means that over 90% of the cars will still be reliant in some form on the liquid fuelled internal combustion engine in 2030. In addition, electrification is difficult to achieve in certain sectors such as aviation and heavy duty trucks.

Moreover as the graphic below demonstrates, the use of sustainable low carbon biofuels produced from high yielding low input crops such as sugarcane, and other dedicated energy crops, have an important role in complementing the GHG emission reductions achieved through increasing vehicle efficiency. An efficient hybrid, fuelled with a high % blend of a sustainable, low carbon biofuel could offer similar lifecycle CO2 reduction as EVs using low carbon grid electricity, or fuel cell vehicles using low carbon hydrogen, at a substantially reduced cost to the motorist, without major changes to the infrastructure, and with a reduced technology risk.

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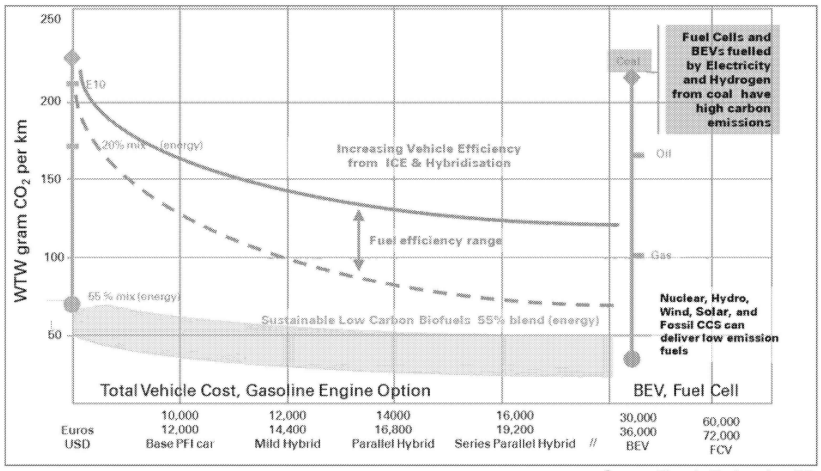


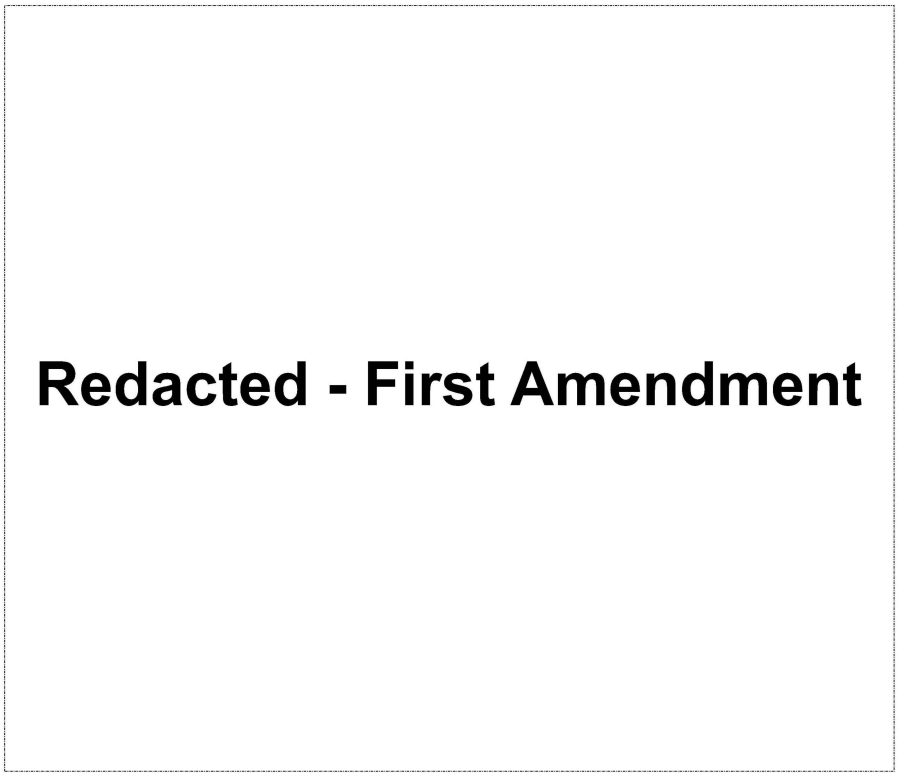
Source: Ricardo Engineering, BP

Short and longer-term Biofuels Policy: The current failure of advanced biofuels to match with aspirations has created disconnects between the short-term regulation and longer term policy aspirations. Longer-term the deployment of bioenergy forms an integral part of many low emission (<2^{0}C) pathways (e.g. IEA 450 and 2DS scenarios). This includes the use of biofuels in "hard to electrify" transport sectors (e.g. aviation and heavy duty vehicles), and also the combination of biofuels/bioenergy

with Carbon Capture and Storage (BeCCS) to provide negative carbon energy options, which will be necessary if the net zero emission ambition is to be achieved post 2050. While recognising the longer-term role that biofuels and bioenergy have to play in any low emission pathway, many policymakers have struggled to incorporate this aspect into their shorter-term policy developments.

Regulatory Developments

Europe: The issue of ILUC has had its greatest impact on biofuel policy development in Europe. After a lengthy and protracted debate the EU ILUC issue was "resolved" in 2015 with an amendment to the Renewable Energy Directive imposing a cap on food-based biofuels. However, the impact of the debate was to remove any support for an EU wide biofuel target post 2020 within the EU's 2030 Energy and Climate Package. Individual member states are likely to continue with their existing biofuel regulations post 2020, but with increasingly divergent levels of ambition. At an EU Institutional level there remains a desire to support advanced biofuels (non-food based biofuels), but with no clarity or consensus on how this might be achieved.



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Internal Developments
BP business activities have also evolved in the light of changes in the external environment and as a consequence of the lower oil price environment.

BP Biofuels
BP Biofuels has consolidated and expanded its position in Brazil, with 3 large operating sugarcane mills, with total productive capacity of 11 kboe/d. This business now forms the core element of BP's renewable energy business, a business that is the largest operated renewable energy business within BP's O&G peers. BP is also continuing to develop and prepare for commercialization of biobutanol, in conjunction with DuPont.

However, BP sold its stake in Vivergo (a UK wheat ethanol plant) to its former JV partner, ABF, in the face of a tough EU ethanol margin environment.

Technology
In 2014, BP has ceased its activities in cellulosic ethanol due to the sharp fall in crude price, and US regulatory uncertainty around cellulosic ethanol targets. Associated with this exit, BP also wound down its activities with the Energy Bioscience Institute (EBI).

Likewise the re-structuring of CTC (Conversion Technology Centre now the Centre of Applied Physics and Chemistry) saw the winding down of BP's activities in BtL and ethanol to diesel programs.

BP transferred some its capabilities from the cellulosic ethanol program and the teams supporting the EBI into the Bioscience Centre. This team is now driving BP's longer-term biotechnology interests, and is currently conducting a study to identify wider biotechnology opportunities across all of Downstream's businesses.

Downstream
BP's Fuels Value Chains remain active in the sourcing and blending of

biofuels in response to biofuel regulations in the markets where BP operates. Within this Downstream, in conjunction with IST origination continues to seek advanced biofuel supply options to optimize biofuel mandate compliance.

Air BP is also actively exploring biojet opportunities in response to airline interest. Following the acquisition of SFRA (Statoil Fuel and Retail Aviation), Air BP is supplying biojet volumes (hydrogenated vegetable oil sourced from Neste) into the Oslo Airport.

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Recommendation

Despite the some significant changes both in the external and internal environment the fundamentals of BP's overall position on biofuels are sound and therefore should remain fundamentally unchanged.

There are however some nuances in the positioning and messaging that should be considered, as follows:-

- BP participatory biofuel activities are now focused on BP's Brazilian sugarcane ethanol operations.
- There is wider biofuel/bioscience activity set evolving within BP, extending beyond BP's fuel business to Air BP, and the investigation of other bioscience applications.
- The electrification of transport, deployment of electric vehicles, has gained increased prominence in the policy discourse on road transport. This increases the importance to articulate the role that biofuels, and hence liquid transport fuels, have to play in combination with further vehicle technology developments going forward.

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14 July 2016