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RE: ICCT responses to "Advanced fuels: call for evidence"

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The International Council on Clean Transportation (ICCT) is pleased to provide these comments in response to the call for evidence on the future of advanced biofuels in the UK.

The ICCT is an independent nonprofit organization founded to provide unbiased research and technical analysis to environmental regulators. Our mission is to improve the environmental performance and energy efficiency of road, marine, and air transportation, in order to benefit public health and mitigate climate change. We promote best practices and comprehensive solutions to increase vehicle efficiency, increase the sustainability of alternative fuels, reduce pollution from the in-use fleet, and curtail emissions of local air pollutants and greenhouse gases (GHG) from international goods movement.

We would be glad to clarify or elaborate on any points made in the below comments. If there are any questions, DfT should feel free to contact Dr. Anil Baral (anil@theicct.org) and Dr. Chris Malins (chris@theicct.org).

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ICCT Comments on
Advanced fuels: call for evidence

These comments are in response to the UK's call for evidence on advanced fuels (DfT, 2013a). The background section of these comments provide several high-level comments on the prospects for advanced biofuel for transport. These comments are followed by specific responses to selected questions (i.e., 1, 2, 3, and 8) in the call for evidence.

Background

Advanced biofuels offer great potential in decarbonizing the transport sector on a cost effective and sustainable basis. The transport sector is mostly fueled by high-carbon oil-based fuels, and will be for the foreseeable future. The ICCT see the DfT's approach of simultaneously and proactively pursuing low-carbon advanced renewable biofuels and electric-drive alternatives as a sound and well-founded long-term climate change mitigation approach. Because electric-drive is limited by the roll-out of vehicle technology, low-carbon biofuels that can displace petroleum are an attractive near-term alternative. Now, as new commercial advanced biofuels are finally coming on-line, it is the right time for the UK to strategically promote the role of these fuels in reducing the transport sector's climate impact. Given the concern over first generation biofuels due to food-fuel conflicts, rise in food prices and environmental impacts such as indirect land use change emissions, the initiative shown by the UK government to focus on advanced fuels is highly commendable. The call for evidence is a timely endeavor to identify the potential advanced biofuels technologies and appropriate support mechanisms for accelerating their deployment.

Advanced biofuels produced from sustainable biomass feedstocks such as wastes (used cooking oil, municipal solid waste, etc.) and residues (agricultural and forest residues) have been shown to offer large greenhouse gas (GHG) emission reductions without causing significant environmental and resource impacts such as land use change. A recent ICCT study by Baral and Malins (2014) employs a comprehensive life cycle analysis (LCA) of advanced biofuels obtained from wastes and residues. The analysis, summarized in Figure 1, shows that GHG reductions from such fuels can be greater than 60%, and in some cases exceed 100% when compared against reference petroleum fuels with a carbon intensity of 83.8 grams of carbon dioxide per megajoule of fuel (g CO_2e/MJ). The carbon intensities of advanced biofuels from wastes and residues analyzed by Baral and Malins (2014) varied from -164 g CO_2e/MJ for MSW ethanol to 39 g CO_2e /MJ for forest slash ethanol. Such significant GHG emission reductions are possible, even when considering indirect GHG emissions and soil carbon losses from residue harvest.

These findings are similar to the conclusions of earlier work by leading researchers and organizations (Edwards et al., 2013, USEPA, 2010, ANL, 201, DfT, 2013b) that similarly suggest that a number of promising non-food-based biofuels can deliver 60% to >100% carbon intensity reductions. However, these studies were not as comprehensive in terms of GHG accounting as they generally omit soil carbon loss from residue harvest and/or displacement emissions.

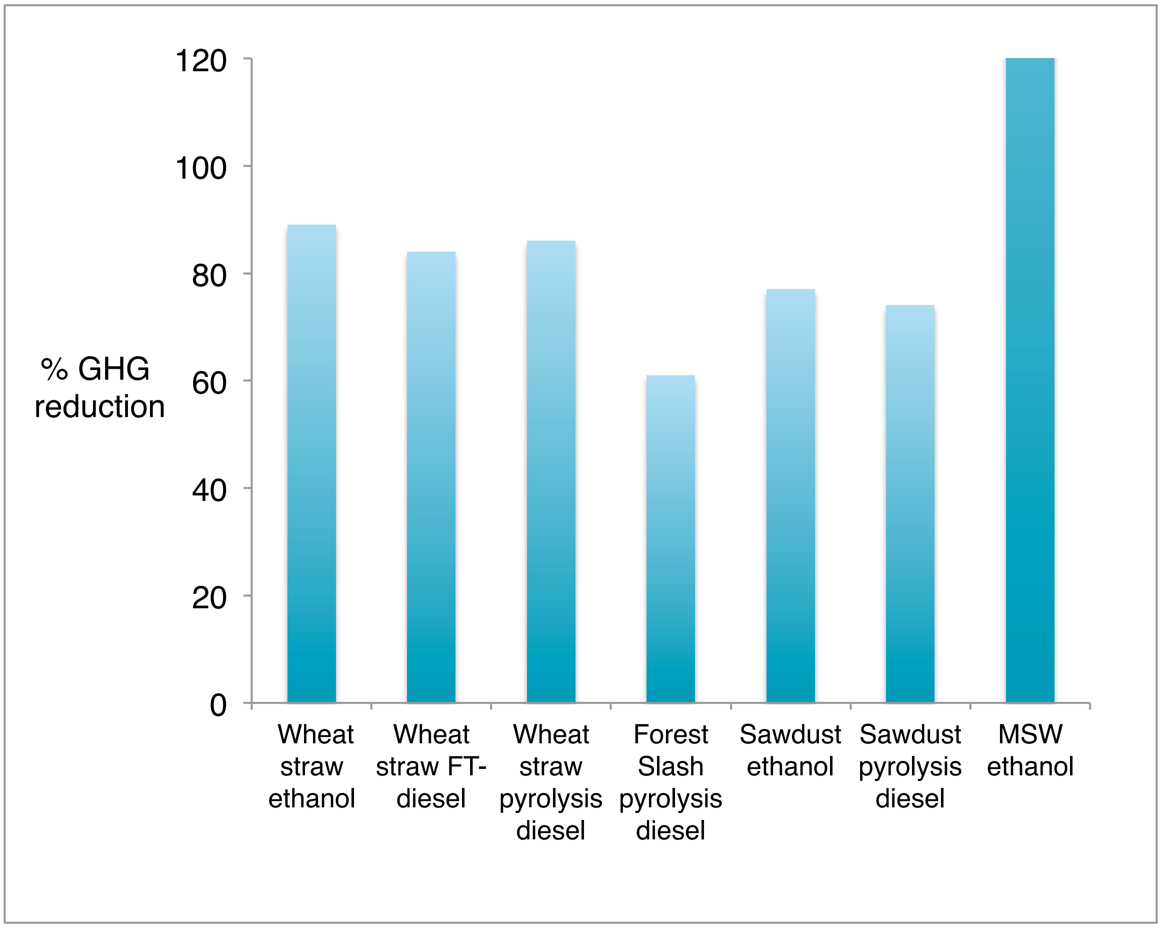

Figure 1: Percent GHG savings of advanced biofuels produced from selected wastes and residues (Source: Baral and Malins, 2014). The column for MSW ethanol is truncated because of the high GHG savings (296%) offered through avoided methane emissions.

According to an ICCT study, about 223 million metric tons of wastes and residues are sustainably available in the EU at present (Searle and Malins, 2013). These biomass feedstocks could in principle produce up to 1 million barrels oil equivalent of advanced biofuels displacing about 13% of road fuel consumption in 2020, and up to 16% by 2030. While there would be practical and economic barriers to 100% utilisation, this suggests that there is a huge opportunity for climate change mitigation and environmental protection via utilization of advanced biofuels in the transport sector.

As mentioned in the consultation document, advanced biofuel technologies are in various stages of development and few commercial-scale plants have come into operation in the US and Europe. Each type of advanced biofuel conversion technologies for lignocellulosic feedstocks has unique advantages and challenges as shown in Table 1. Research and development efforts are ongoing to improve biofuel yields and costs. These include the use of genetically modified organisms for fermentation of difficult to degrade pentose sugars, improved pretreatments, use of genetically modified biomass with lower lignin content, etc. It is noted that the projected costs of advanced biofuel production have come down considerably in recent years with technological advancements. It has been projected that it may be possible to produce cellulosic biofuels at the cost of about $0.5/liter using current technologies (Foust & Bratis, 2013).

Table 1 Technical opportunities and challenges for advanced biofuel technologies

	Fast Pyrolysis	Gasification	Enzymatic Hydrolysis	Consolidated Bioprocessing
Opportunities	Drop-in fuels w/out blend-wall issues; High use of standard industry equipment	Feedstock & Product flexibility; Use of established gasification equipment	Potentially lower CAPEX per gallon of fuel; Equipment & feedstock synergies w/ corn ethanol plants	Potentially further reductions in CAPEX per gallon of fuel capacity; Flexible products
Key Challenges	Bio-oil quality issues; Catalytic upgrading costs & efficiencies	Achieving reliable reactor operation; Cleaning & upgrading syngas	Improving pretreatment, and total process efficiency; Enzyme & fermentation platform improvements	Demonstration of process at-scale and industrial reliability of microorganisms

ICCT believes that there are technical challenges as identified in Table 1 as well as the market barriers that must be overcome to accelerate the deployment of advanced biofuels, in particular from sustainable feedstocks such as wastes and residues. Hence, government support is crucial in overcoming these barriers and driving the transport sector in a sustainable pathway.

Below we provide our responses to some of the key evidence questions posed by the UK Department of Transport.

1. Should the government focus support for advanced fuels in certain transport sectors? If so, why?

We do not see any compelling reasons to differentiate support for advanced biofuels between transport modes. It would seem appropriate therefore to make biofuel incentives equally available to light and heavy-duty vehicles, rail, ships, and aviation, insofar as this is administratively possible. Some biofuel technologies will naturally be better suited to specific modes, and allowing fuels to be used in those modes would avoid imposing unnecessary extra costs and energy expenditures. Other technologies, in particular drop-in biofuel technologies, will be similar across modes. For instance, the same processes that would be required to produce jet kerosene would generally be applicable to producing road diesel, and vice versa.

The consultation document states that, "In future, it seems likely that advanced fuels will need to be used increasingly in sectors which are hard to decarbonise by other means, such as aviation and shipping." We note that from a resource efficiency perspective, there is no compelling reason to focus on aviation and marine fuels over road fuels in the near future. As Figure 2 in the consultation documents indicates, the road transport sector is likely still to be using a large volume of fossil fuel by 2040. In that context, given that the lifecycle carbon intensity of road fuel is similar to that of aviation or marine fuel there is no clear environmental benefit from displacing fuel from one mode rather than the other. Any technology and infrastructure developed to produce drop-in diesel could be repurposed in future to prioritise aviation fuel production. Until the road sector has been entirely electrified (or otherwise decarbonised), we believe that a level playing field between modes is the preferable approach to allow resources to be used in the way that delivers the highest carbon savings at the lowest cost.

That said, we note that some research has suggested that the use of synthetic fuels could result in some reduction in the degree of contrail formation by aviation. If it could be robustly demonstrated that reduced contrail formation would offer additional climate impact reduction benefits from using biofuels in the aviation sector, this would represent a clear environmental case to consider enhanced support for biofuels in that sector. However, significant additional work would be required to substantiate this result.

2. Is UK government support necessary to commercialize advanced fuel technologies? If so, why?

While in the long term advanced fuels offer a cost effective means of decarbonizing the transport sector, they are mostly in the research and development phase, with only a few cases of commercial production reported to date, and none in the UK. Advanced biofuel markets are not fully developed yet and hence investors perceive the market and technology risk as high. Robust policy support through some combination of utilisation targets, tax incentives, and direct fiscal support are likely to be necessary preconditions for deployment of advanced biofuel production technologies in the UK in the near future. An additional discussion on market risks is provided below in response to question 8.

2a. What should ‘advanced’ mean? What role should process, feedstock and sustainability have in this definition?
In the context of ‘advanced biofuels’, ‘advanced’ should be taken to imply a combination of new technologies and strong performance on key sustainability metrics. Regulatory measures intended to support advanced biofuels should be targeted at fuels derived from non-food feedstocks, using technologies developed to allow the conversion of materials to fuel that cannot currently be readily utilised – in particular cellulose and lignin, as opposed to starches, sugars and oils. In a basket of regulatory measures, it should be recognised that different fuel pathways will raise different commercialisation challenges. For instance, the deployment of cellulosic technologies currently requires support targeted at raising investment because of high capital expenditure requirements. The measures necessary to support a cellulosic biofuel industry once the key technologies have been commercialised will be different than the measures needed to get the first few plants operational, as the investor risk will be substantially diminished once the business model has been demonstrated in practice. In the U.S., the ICCT has proposed temporarily complementing the cellulosic mandate under Renewable Fuel Standard (RFS2) with a production-limited investment/production tax credit, available to the first billion gallons of production capacity and then phased out (Miller et al., 2013). The eligibility criteria for support under different measures may need to be different, so that appropriate instruments are available for each fuel. For instance, support through the Renewable Transport Fuel Obligation has been successful in increasing the use in the UK of used cooking oil (UCO) biodiesel, which would not meet a technology-focused definition of advanced fuel. It would not be appropriate to include UCO biodiesel in fiscal support measures designed for high-capex advanced technology biofuels, but it may well be appropriate to credit advanced and non-advanced fuels together under a mandate. The California Low Carbon Fuel Standard (LCFS), for instance, credits all fuels by carbon performance, thus supporting both advanced technologies and existing technologies.

In any regulatory measure to support advanced fuels, sustainability criteria will be important. Key criteria should be that advanced biofuels would cause little or no indirect land use change, and exert little or no impact on food markets. The UK Government should also consider criteria on soil, water, air, and biodiversity, and on social sustainability such as land rights and workers’ rights. The RTFO meta-standard remains a useful guide to key sustainability considerations, but it should be recognised that mandatory European sustainability criteria under Renewable Energy Directive (RED) are not comprehensive and provide only limited environmental protection.

2b. What economic opportunities are there for the UK in developing this industry?
The economic opportunities provided by the UK advanced fuel industry can be substantial. In addition to direct job creation at the production facility during construction and operation phases, jobs will be created indirectly in the supply chains such as

production, harvest, and transport of feedstocks. Except for MSW, other sustainable biomass feedstocks will come from rural areas thereby helping the rural economy.

According to a recent study by the National Non Food Crop Centre (NNFCC), UK, advanced biofuel production from available wastes and residues in Europe alone would generate €15 billion of additional revenues for the rural economy and up to 30,000 additional jobs would be created by 2030 (NNFCC, 2013).

3. What could advanced biofuels deliver, and by when?

Advanced biofuels, if produced sustainably from feedstocks such as wastes and residues can deliver more than 50% of GHG savings, in some cases exceeding 100% if credits for avoided emissions are accounted for (see Fig. 1). The timescale to deployment of advanced biofuels will be dictated as much by the efficacy of policy support as by technological considerations. Without additional support, it is unlikely that any large number of facilities will be in place in Europe by 2020, but with clear measures and a framework laid out for post-2020, this could be changed.

3a. Do you agree with E4Tech's assessment of the technology readiness of different advanced fuel technologies?

Overall we agree with E4Tech's technology assessment, which tells us that hydro-treated vegetable oil (VGO), fatty acid methyl ester (FAME) biodiesel, and biogas upgrading technologies have already been commercialised whereas cellulosic ethanol technologies are still largely in pilot and demonstration stages with few exceptions. Recently two commercial-scale cellulosic ethanol plants have come online in the USA and Europe. Likewise, various thermochemical conversion technologies such as pyrolysis and gasification are also in pilot and demonstration phases.

3b. Do you agree with E4Tech's assessment on the availability of waste and residue feedstocks, and their estimated costs of advanced fuels?

E4tech's estimates are the total potential supply of waste and residue feedstocks without taking into account their competing uses. Hence their estimates are on the higher side. A recent study carried out by ICCT (Searle and Malins, 2013) suggests that 225 million metric tonnes (MMT) of wastes and residues are sustainably available annually for advanced biofuel production in the EU, after excluding wastes and residues currently used for other purposes. The availability includes 40 MMT of forest residues, 122 MMT of crop residues, and 61 MMT of waste consisting of paper, wood, and food and garden waste. For the same categories of wastes and residues, the E4Tech study estimate, which does not protect competing uses, is 521 million tonnes. While the ICCT's estimate of the available resource is somewhat lower than the value given by E4tech, the most important conclusion to draw from both studies is that there is a substantial resource available, and that resource availability should not be a limiting factor on advanced biofuel production from wastes and residues in the near to medium term.

8. What support mechanisms could effectively support the deployment of advanced fuels?

With regard to advanced biofuel technologies, despite their huge potentials there are stories of setbacks such as delays in construction, technological hurdles in scaling up and abandoning of the projects altogether. For example, in 2011, Range Fuels, Inc. was forced to shutdown after failing to produce the desired advanced biofuel as a result of a technical problem.

To accelerate the commercialisation of advanced biofuel technologies, the industry must be enabled to secure the required financing. There are two types of financing: debt and equity. In order to attract either type of financing, it is crucial for firms to establish sound risk-management practices. Given below are some examples of risks and barriers to investment in the advanced biofuel industry.

- Firm level: Credit (default) risk, price risk, resource availability and supply risk, operational risk
- Macroeconomic level: Regulatory policy measures, exchange rate risk, interest rate risk, political uncertainty

A recent ICCT study found that the stocks of (U.S. based) companies that are either producing or have significant ownership in cellulosic or algal biofuels are more volatile than the stock market as whole (Miller et al., 2013). This market risk is likely to compound the perception of technology risk, and will deter potential investors. The consequence is that investors are likely to ask for a higher expected rate of return (>15%) from the first group of advanced biofuel installations than for other less risky investments. The role of government in this picture is to take action to mitigate investment risks (such as loan guarantee programs) and/or to provide a higher value of support measures to early market entrants than will be required in the longer term.

When considering the value of support measures to companies looking for investment, it is vital that government should consider not only the realised value of support, but its predictability and reliability from the point of view of those being asked to invest in a plant that will not commence production for two years or more. An incentive such as a tax differential that has a guaranteed value of 25 pence per litre in 2018 will generally have more value in raising investment than a variable incentive such as an Renewable Transport Fuel Certificate (RTFC) that has an expected value of 25 pence per litre in 2018. If fundamental changes to policy are considered possible, the value of an incentive may be effectively reduced to zero for the purposes of investment planning – the ICCT has argued (Miller et al. 2013) that this has been the case with the U.S. second generation biofuel producer tax credit, which has to be renewed annually. For government, the scenario in which tax expenditures have minimal value as a driver of investment but will represent a significant cost if investments happen anyway is the worst of both worlds.

8a. If government intervention is necessary, should the focus be on 'market pull' or 'technology push'?
A successful strategy for advanced fuel deployment requires government intervention that provides both market pull and technology push. Government grants for research and development and credits like investor tax credits/production credits invite investment in advanced fuel technologies creating a technology push. On the other hand, by implementing feasible mandates and price support, the government can create a market pull to create demand for advanced fuels. Some of the examples of market pull are the mandates already in place such as the RTFO and RED, multiple credits for advanced biofuels under the RED, and which have already been used by regulated parties under the RTFO. The fixed price support and rewarding fuels on the basis of GHG savings as mentioned in the consultation document are other examples of the government mechanisms that can create a demand for advanced fuels. The most efficient approach to accelerating advanced biofuel deployment is likely to require a combination of a long-term market signal with immediate technology pushing measures.

8b.Which of the listed mechanisms would be most effective? What alternatives have we missed?
Four options for policy support are identified in the consultation:

- A sub-target
- Fixed-price support
- Multiple certificates within a supply obligation
- A carbon-linked supply obligation

A sub-target for advanced biofuels under the broader RED framework would provide a clear market, and an expected value of support in excess of the value of 'standard' RTFCs. The two primary challenges to a sub-target would be setting the appropriate level (to provide robust market pull while at the same time remaining achievable) and helping industry understand the likely value of the incentive. It might be appropriate to provide a buy-out option within a sub-target to provide clarity about the consequences of a period in which the fuel supply falls short of the mandate. Multiple certificates should provide a similar value signal to a sub-target, of course dependent on the level of multiple counting. Such a scheme similarly suffers from a degree of value uncertainty (the uncertainty in the base certificate value, multiplied proportionately up). Indeed, coupling the value of advanced biofuels to the value of a 'standard' certificate injects another level of variability for investors to confront when considering projects. On the positive side, such a system would not share the risk with a sub-target that deployment of the fuel would be inadequate to meet obligations.

Fixed price support would have an advantage over a sub-target in that it would provide a relatively well defined value signal to producers, but as the consultation notes price setting may be challenging. For a smaller initial volume of fuel, it might be acceptable to set a relatively high fixed price for a defined period/production volume. As such a price arrangement could become expensive for larger volumes, a transition could then be planned towards a mandate system better suited to a more established industry.

Finally, a carbon-linked supply obligation would have the advantage of being performance based in principle, and therefore in an ideal system would provide the best value possible carbon savings. One issue is the question of carbon accounting – without some allocation of indirect emissions to existing fuels (e.g. iLUC factors), advanced fuels could be under rewarded. A second is, again, the fact that advanced biofuels need significant upfront capital investment. Because of value uncertainty of any carbon credits, investors would likely discount the expected value. In contrast, existing facilities adjusting production levels would have (more or less) immediate access to the certificate value. This is likely to make such support less valuable to advanced technology fuel producers than to existing ones. Again, it might therefore be appropriate to consider complementary measures to drive initial commercialisation.

An alternative not discussed in the DfT document are tax credit schemes such as investor tax credits and production tax credits, which can be equally useful drivers, especially in the early stage of commercialisation. As mentioned above, we describe several such-fiscal mechanisms in our US-focused report (Miller et al., 2013), and these concepts could be adapted to the UK context.

8d. Are you aware of any risks, problems or unintended consequences which could arise from introducing these market mechanisms?

In any system, setting appropriate criteria for eligibility will be important to preventing poor outcomes and maximising good ones. For instance, any multiple crediting should consider the GHG mitigation potential of wastes and residues as determined by comprehensive life cycle analysis, including potentially important emissions not included in the RED LCA. (cf. Baral and Malins, 2014). Even wastes and residues can have substantial indirect emissions if they have other existing uses, hence their GHG savings can be lower in certain cases.

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