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Incentives for deployment of biojet fuels. Benchmark of policy instruments

- Executive Summary –

ORIGINAL

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EXECUTIVE SUMMARY

Rationale for the study

The use of sustainable biojet fuels has large potential to reduce emissions. However, deploying cost-effective biojet fuel on a global scale is limited by:

1. Technical constrains: Biojet fuels are only possible as drop-in fuels in the foreseeable future; therefore their potential to reduce emissions is limited to the drop-in share.
2. High costs: In the absence of any economic incentive and with the current situation of production only at intervals, biojet fuels are significantly more expensive than fossil jet fuel.
3. Price and competing uses for feedstock: Feedstock represents the largest share of the biojet fuel price, 50% to 90%. In the current global transition to more bio-based products, competing uses appear constantly in the food, chemistry and energy industries. This drives the prices of traditional and less conventional feedstock towards commoditisation.
4. Production capacity: Existing production capacity is limited. Synergies exist with second-generation biofuels developed for road transport, and both types of fuels could be produced in the same facilities; however, biodiesel for road transport are usually more strongly subsidised, allowing for higher margins with respect to biojet fuel.
5. Non-uniform or lack of policy incentives: While incentives aiming to bring the price of biojet fuel closer to the price of fossil jet fuel are being introduced in some jurisdictions, they don't exist in others. It is also unclear if governments will keep incentives (especially the ones addressed to keep feedstock price low) when large production of biojet fuel is reached. This situation may potentially create global differences in price and availability of feedstock and biojet fuel. Producers expect that financial support is needed to make prices go down significantly below double the price of fossil jet fuel.
6. Waste and residues potential: Biojet fuels produced from waste/residues have higher greenhouse gas (GHG) emissions reduction potential; however the availability of waste/residues is limited, their potential is difficult to unlock, and the pre-treatment needed for their use with the Fischer-Tropsch technology still needs technical maturation.

Current high prices for biojet fuels causes that airlines cannot afford to buy large quantities of biojet fuel. This results in (mainly oil) companies having little incentive to invest, and consequently the cost reduction from learning effects and from scaling up production does not take place (vicious circle).

Given this situation, successful deployment of biojet fuels is difficult to achieve with market forces alone. Policy instruments are required to bridge current limitations. Some combinations of instruments have proven more effective than others to incentivize production and to narrow the price gap. IATA is proactively supporting policy developments aiming at improving conditions for the implementation of biojet fuels. This study has been performed in order to understand the advantages and disadvantages of different policy instruments by learning from the biofuels sector in general (mainly the road transport sector), and their impacts to airlines in an international context.

Contents of the study

The study comprises the following subjects:

1. State of the play of the biojet fuel industry and market: Techno-economic analysis of feasible technologies and feedstock, and price forecasts are presented. Three technologies are explored in more detail: Hydro-treatment of vegetable oils (HVO), Fischer-Tropsch (F-T), and Alcohol-to-Jetfuel (ATJ). Feedstock considered are Camelina, Jatropha, Algae, waste and residues, and woody biomass.
2. Policy instruments to support the use of biofuels in other sectors, mainly road transport, are classified in four types: 1) command and control, 2) economic, 3) co-regulation and 4) voluntary instruments. The effectiveness of policy instruments in different countries is measured by the developments of consumption, production and installed capacity for biofuels. Special focus is given to instruments applied in the two largest markets for biofuels: the US and the EU. A thorough comparison of market impacts is presented.
3. A selection of most relevant policy instruments is evaluated in depth to better understand their applicability to and the international impact on the biojet fuel market and industry. Special attention is given to the suitability of those instruments to choices of feedstock and conversion processes of interest to the aviation sector, and their feasibility for international regulation and cross country implementation. Combinations of policy instruments are analysed in view of incentivising the production and use of biojet fuel, under criteria such as acceptable economic, technical and logistic conditions.
4. An economic simulation model is developed to deliver the quantitative backbone for this analysis. The model includes IATA's forecasted demand for air travel and calculates supply and demand of biojet fuels under different combinations of policy instruments. Sensitivity analyses have been performed to demonstrate the impact of a range of blend percentages, CO_2 prices, jet fuel prices and feedstock.

Main aspects found for the success in the applicability of policy instruments

International regulation will most likely not be introduced simultaneously in all relevant countries. To be successful a long transitional period is required for success. Regulation for biojet fuel deployment cannot be seen separately from policy developments in other related sectors (agriculture, forestry, bio-based economy, road transport).

Administrative barriers can limit the production and use of biojet fuels substantially. It is important to develop international technical standards and sustainability standards from the start.

1. *Command and control instruments*. Command and control instruments are defined as the regulation establishing what is permitted and what is not permitted in a specific industry or activity. The command part establishes the obligations to be complied with, and the control part establishes the sanctions that result from non-compliance. Examples include blending and emissions mandates. In order to make these instruments more effective in the deployment of biojet fuel, they would need to be designed as flexible and tradable across countries to create sufficient international scope. Feasibility of obligations is complicated

when they are not agreed upon between countries (airlines potentially regulated under different types of mandates).

2. *Economic instruments*: Economic instruments use markets, price, and other economic variables to provide incentives to a specific industry or activity. Examples include taxes (or the exemption of them), charges, incentives, subsidies, public loans and emissions trading. For a successful global biojet fuel deployment, these instruments should provide long-term certainty and avoid international incoherence for the successful deployment of biojet fuel. Ideally, these instruments shall be developed to maximize synergies with biofuels for road transport and potentially other relevant sectors. International approaches that safeguard a level playing field for airlines shall be required.
3. *Co-regulation instruments*: Co-regulation refers to the recognition of industry voluntary initiatives or programs as part of the public regulation. Co-regulation is especially useful when there is a need to regulate economic activities performed across the geographic borders of different countries. While co-regulation builds upon the combined strengths of public regulation and industry initiatives, it also requires extensive negotiations and finding agreement between conflicting interests from all participating stakeholders and governments.
4. *Voluntary and collaborative instruments*: These instruments refer to voluntary and collaborative programs within the private sector or between the private and public sectors. These instruments are classified as either "supply-push" (supporting research, development and demonstration of technologies) or "demand-pull" (changing market conditions like voluntary private procurement). For the effective deployment of biojet fuel, these instruments should have an international scope and be an integral part of airlines' long-term strategic vision. Cooperation between competitive sectors, such as biofuel for road transport, bio-refineries, bio-chemistry industry, the so-called bio-based hubs, is desired to strengthen innovations and promote coherence in regional development

Options of policy instruments and scenarios studied

Four options with different combinations of policy instruments were selected based on discussions with IATA and lessons learned from other biofuel sectors:

1. Price driven option: Direct financial support for R&D, production capacity build up, and feedstock.
2. Obligation driven option: Blending mandate as cornerstone instrument.
3. Co-regulation and carbon trading option: International industry initiative to set blending targets and rules for accomplishment at supranational level, translated into national regulation.
4. Voluntary driven option: Voluntary agreements are set by the aviation sector itself.

Four market scenarios establishing jet fuel and CO_2 prices were also selected, three of them are based on the IEA global energy outlook 2012:

1. Current policies scenario (IEA): Regulations will not change, small role for renewable energy.
2. New policies scenario (IEA): Current plans will be implemented, role for renewables grows.

3. 450 scenario (IEA): All efforts to maintain global CO_2 emissions below 450 ppm, renewables play a large and increasing role
4. Forward market prices scenario: Based on today's market prices and extrapolations where markets don't provide data.

These scenarios were complemented with three different levels (low, base, high) for future feedstock price and rates of learning curves for the conversion processes.

The study presents a selection of results for eight combinations of scenarios and policy options. This selection is made for illustration purposes to cover the broadest set of impacts possibilities:

Policy option instruments		Market scenario	Feedstock prices	Learning curves	Carbon market	Investment incentives	Feedstock incentives
Option 1: Price driven	1A	Market forwards	High	High	No	50%	50%
	1B	New policies	High	High	Yes		
Option 2: Obligation driven	2A	Market forwards	Low	Base	No	25%	None
	2B	New policies	Base	Base	Yes		
Co-regulation and carbon trading	3A	450	Low	Base	Yes	None	None
	3B	450	High	Base	Yes		
Voluntarily driven	4A	Market forwards	Low	Base	No	None	None
	4B	New policies	Base	Base	Yes		

Conclusions and recommendations

1. Production of biojet fuels is considerably more expensive than production of fossil jet fuels. Feedstock price represents the largest share in the final cost of biojet fuel (50%-90%); technology related fixed cost is the next important component. Large cost reductions, especially on feedstock, are needed to make biojet fuels feasible.
2. There is no clear winning technology. Cost reductions in capital investments may be achieved through learning and up-scaling. Secure demand (a market) is needed to create an investment environment that supports innovation and large scale facilities. No one single instrument can produce these benefits by itself. A well thought combination of instruments is needed to deal with all barriers.
3. Key to realise competitive production of biojet fuels is:

- Sufficient supply of feedstock at low cost in order to maintain reasonable prices. Competition for feedstock from other industries is large (food, feed, chemicals, power, road transport) and this competition is expected to keep increasing.
- Economies of scale benefits will be enhanced with continued research and development.
- Significant incentives, in combination with low feedstock prices, are expected to be necessary for biojet fuels to be competitive until economies of scales effects have reached a sufficient level.

4. A recent study performed by the Midwest Aviation Sustainable Biofuels Initiative (MASBI) "Fueling a Sustainable Future for Aviation" shows that an economic incentive of US$ 2 per gallon of biojet fuel would be needed for bringing HEFA biojet fuel to a US$ 2.92 per gallon which is cost competitive with current fossil jet fuel price. This calculation is under the assumption of a relatively optimistic price of feedstock. The model developed in our project produces a similar result (incentive of around US$1.50 per gallon of biojet fuel) when modelling under similar assumptions. Our model estimates that for a more conservative cost development of feedstock, the incentive needed would be of US$ 2.7 per gallon of biojet fuel. A 3% blend would thus increase the blended jet fuel price by 2.5% if the underlying biojet fuel price is 40 US$ per ton.
5. Main quantitative results from our model show that for a conservative forecast of feedstock price, the US market would require incentives amounting US$ 540 million annually for each 1% of blending (on the basis of an annual consumption of 20 billion gallons of jet fuel a year by the US military and commercial aviation, MASBI report). A global blending of 1% would require annual incentives of the order of US$ 1.8 billion. The relevant question from everyone in the industry is the likelihood of assumptions, e.g. feedstock price, technology cost, and jet fuel price. While comparing our research with the MASBI report, it gets clear that the most sensitive assumption is future feedstock price just because of the growing other competing uses for biomass in the many different industries (food, chemistry, biofuels for road transport). This is where it lays the largest risk for the competitiveness of biojet fuel prices. For technology costs, basically the assumptions in this study and the assumptions made by MASBI are quite similar.
6. Analysis of policy combination options:
    - Option 1 (price driven) establishes how much economic incentives are needed for an optimal market start-up and global deployment of biojet fuels with a 2% blending mandate reached in a time horizon of 10 years (2015-2025). This option shows that 50% of direct incentives for the construction of production plants (regardless feedstock/conversion technology) would be required for initial up-scaling. Additionally, for Camelina/Jatropha HVO biojet fuels up to 66% of subsidies to feedstock would be needed in the first 10 years of deployment (depending on the price of feedstock). The Fischer-Tropsch route would require less subsidies to feedstock (up to 40%), but more subsidies to technology development as Fischer-Tropsch plants are still very expensive.
    - Option 2 (obligation driven) is seen by various governments as effective and easy to implement. However, this option does not take care of financial burden for airlines. Blending mandates cannot be applied upfront to a nascent market in which biojet fuel prices have not yet reached certain stability. Stability of prices usually comes after learning and certain up-scaling has already happened. Mandates should therefore not be implemented as long as up-scaling and price stabilization at a competitive level has not been achieved by economic

incentives alone. Mandates should in no case be introduced abruptly, otherwise the risk of excessive economic pressure on airlines and final users even more.

- Option 3 (co-regulation) gives the aviation sector the possibility to demonstrate commitment and to receive economic support. In essence the economic incentives to make this option viable are similar to option 1 as well, but the pace and place of their introduction would be first discussed by the aviation sector. This option may also include an international trading mechanism for biojet fuels certificates. This mechanism may also involve other sectors (such as road transport), similar as RINs in the US or the biotickets in the Netherlands. Trading and compliance rules can be tailor made to accommodate the aviation industry specifics, e.g. the global perspective which risks level-playing field issues.

  This option can partially build on voluntary agreements. With the co-regulation option, the aviation sector retains control in the setting of its own targets and compliance rules, opposite to the obligation driven option in which those are established by governments. The difficulty of this option is the complexity of its negotiations as they involve different interests from several parties.

- Option 4 (voluntary driven) is basically the business as usual case. It has become clear by now that voluntary agreements alone are not sufficient to break the vicious circle of market start-up and cost reductions. There will always be airlines that are leading the deployment of biojet fuels. They will use more biojet fuels than committed to. They voluntarily go one step further than the majority with innovative solutions and new forms of cooperation. Examples are the KLM Corporate programs, and procurement initiatives or the formation of strategic alliances. These types of initiatives can well exist next to the other policy options and have minimal financial risk.

7. A consistent international framework to maintain a level-playing field for the international aviation sector is very much required. This framework should preferably be based on international negotiations. The risk of creating a strongly disturbed market for biojet fuels exists if a non-consistent set of diverging policy instruments are implemented. This would result in a fragmented market with regions with potentially very different feedstock price, different levels of incentives to technologies and/or operations, scattered blending mandates, etc.
8. While all researched options would bring different advantages and disadvantages for the deployment of biojet fuels, the order of implementation of instruments is crucial. A market start-up will only happen if firm support to technology development and technology commercialisation is given (in the way of economic incentives). Only then, other policy instruments will be effective in shaping the biojet fuel market and its evolution. It is especially relevant to mention that blending mandates would cause more harm than benefits if they are applied in an immature market when biofuel prices have not yet reached stability.