IEA Bioenergy

Biofuels Sustainability - Focus on Lifecycle Analysis (LCA)

Workshop Report

IEA Bioenergy: Task 39: 07 2019

Joint workshop of IEA Bioenergy Task 39 and the European Commission's Joint Research Centre Ispra (Italy), 16-17 May 2019

Authors: Laura Lonza, Adrian O'Connell (Joint Research Centre (JRC) of the European Commission)

Introduction

A selected audience of invited experts contributed to a lively one-and-half-day discussion on Lifecycle Analysis of Biofuels jointly organised by the Joint Research Centre (JRC) of the European Commission and Task 39 of the International Energy Agency's Technology Collaboration Program on Bioenergy (IEA Bioenergy). Task 39 deals with commercializing conventional and advanced transport biofuels. The JRC, the European Commission's in-house science and knowledge service, provide independent scientific advice and support to EU policy, and have been contributing their expertise to the activities of IEA Bioenergy Task 39 over the past few triennia of activities.

The workshop was hosted by the JRC at its premises in Ispra, northern Italy on 16-17 May 2019. It provided an opportunity to present an update on the new EU Renewable Energy Directive (RED) Recast to 2030, a European-wide piece of legislation controlling and promoting the use of biofuels (and other renewable fuels) in the 28 EU member countries. The workshop discussed aspects related to the commercialisation of biofuels; spanning from certification schemes for biofuels, feedstock availability, advanced (drop-in) biofuel developments, and lifecycle methodological aspects of biofuel greenhouse gas (GHG) emissions' performance (including considering areas where large uncertainties can arise when trying to conduct a Life-cycle analysis (LCA) for a biofuel). It also clarified some of the principle opportunities and barriers for the deployment of sustainable biofuels at commercial scale while at the same time ensuring the uptake of sustainable biofuels is based on robust LCAs of emissions. The workshop hoped to use the discussions with high-level experts to influence the work of the IEA Bioenergy Task 39 group in the next three years' planning period.

The full workshop programme is available at: http://bit.ly/WS-progr_May2019

Main comments from workshop experts

Starting from the new, more stringent, criteria for sustainability in the EU RED Recast, which calls for greater emissions savings for biofuels, produced by feedstocks that are robustly assessed as net contributors to fuels' decarbonisation, the crucial point in the expert discussion was that **what is sustainable is not universally defined and agreed**, let alone enforced. The debate on biofuels should embrace a wider scope for sustainability and not depart from considering the impacts on soil, which was described as the original non-renewable resource. **Bio-economy strategy and policies need to be based on regional specificities** to gain public acceptance: local resources should be the focus, and each country's situation is different, which allows learning from best practices. The world has lost a lot of land to desertification, therefore land recovery (especially for the Mediterranean area) is becoming of increasing importance, and then rotating the crops for food, feed and fuel. Bio and alternative transport fuels will still likely be very relevant at a mid-term horizon, therefore agronomic

progress may still be needed to help lipid crops become more efficient. The complementarity of feedstock uses should become the new standard, cascading the uses of biomass as the '4Fs'; food, feed, fibre and fuel. Providing valid rules are set up, niche feedstocks may contribute to the biofuels sector, but no one huge sustainable source can be expected.

Long-term strategies are needed which are compatible, if not homogeneous, and provide a **clear investment horizon for industrial operators** by securing volumes and qualities of feedstocks. Robust carbon pricing systems were said to start driving change in the market (the Low-Carbon Fuels Standard of California was used as an example with credits in 2019 at 145 USD/tCO2eq). The challenges of complex/integrated supply chains and feedstocks used to make several products, and complications in carbon pricing are not directly related to the process itself but rather to the upstream and downstream steps that along with choices of system boundaries determine the impacts on the market. In this respect but also in consideration of the EU targets for advanced biofuels, the **EU database on traceability**, as envisaged by EU RED Recast to be effective as of 2021, is deemed critical by industry operators to minimize fraud. It was said there is a need to launch higher biofuel blends within harmonized fuel grades across the EU, thus allowing emissions' reductions from heavy-duty vehicles, which remains an outstanding challenge ahead.

Regarding the opportunity to harmonize existing biofuel LCA modelling tools, certifiers, operators, and public authorities were said to be likely to **prefer developing their own calculator rather than using "closed" tools** requiring specific training and reliance on restricted expertise.

Although there is a difference between scientific LCAs and those used for policy or regulatory purposes, LCA analyses do provide indications – or at least useful differentiations – between alternative systems. Concerns about sustainability were said to be slowing the development of the bio-based economy, and one participant stated the **societal costs of postponing action** in this area are high and will be higher. The use of "Prospective LCA" (bringing in the time dimension), was suggested as being particularly important for emerging technologies. Additionally, each entry in an LCA inventory is associated with uncertainties and **results vary with location and allocation choices** making harmonized LCA modeling tools considerably distant from the realities they aim to represent, including non-CO_2 climate effects (e.g. aviation fuels' emissions at altitude). Broadly put, some of the main parameters which cause large deviations in LCA are soil, land use change (LUC), global warming potential (GWP) factors, and questions over allocation methods for CO_2 sources e.g. for so-called "electro-fuels". Very large (20-fold) deviations in soil N_2O emission projections put at stake the very effectiveness of some biofuel pathways. LUC is known to be very difficult to assess and the bandwidth of values here is very large: methodologically, **consistency is important** when considering direct and indirect emissions. For power-to-liquids the need to assess the risk of lock-in effects was outlined along with that of achieving actual net reductions in emissions rather than their displacement across production processes.

Sustainability certification based on an LCA approach varies between different jurisdictions and it is increasingly characterised by a **diversity of involved actors spanning from the energy to the chemical, food & feed sectors**. Co-processing is attracting "tremendous interest" and the urgency for a clear set of rules regarding additionality verification when certifying "low-ILUC-risk" biofuels.

Co-processing, pioneering work tracking the bio-component in fuels, and producers' industrial practices were discussed, with the Liquid Scintillation Counting (LSC) 14C method showing great improvements with regard to **tracking the bio-component** (down to concentration of about 1 vol%), with the other principle 14C method, Accelerator Mass Spectrometry (AMS), proving even more accurate, especially at low bio-concentrations, albeit taking longer and costing relatively more (about 400 USD per sample). It is important to look ahead and the question was raised how to measure the recycled carbon content in renewable fuels of non-biological origin. Pros and cons of co-processing bio feedstocks compared to stand alone (dedicated) processing set-ups were discussed, including the key importance of stable feedstock quality: but the final decision relates largely to a company's objective and geography and the relevant regulatory framework. Co-processing is interesting also because it allows existing refineries to

maintain production. Redesigning traditional refineries into biorefineries, moving from oxygenated biofuels to drop-in types, is a strategy currently deployed with HVO proving to be a very promising product due to high feedstock flexibility, and the opportunity in a complex refinery to overcome the issue of low density of hydrotreated vegetable oils (HVO) containing no aromatics. **Upgrading bio-feedstocks is raising a lot of interest** not only in Europe but also in the US, in Latin America, and in Asia, with legislation driving progress.

Considering market trends, there are **concerns over feedstock availability**: while some advanced feedstocks are coming they are not yet available at scale. The challenge for regulation to promote advanced feedstocks is one of moving from volumetric mandates to sustainability frameworks and carbon intensity targets, as the availability of advanced feedstocks requires revising and coordinating the functioning of sectors which today are regulated separately. Forestry was said to hold promise via crude tall oil (CTO) – a residue of pulp production – as a feedstock. Renewable fuels needed by 2040 to meet the 2°C scenario were said to be on the order of 300 Mtonnes for the road sector in Europe and North America and global aviation, whereas meeting the 1.5 C scenario would require atmospheric carbon removal.

Other feedstocks, such as *Brassica carinata* and pennycress in mild climates or castor oil on marginal land in dry/desert climates, were labelled as 'regenerative crops' and were claimed to contribute not only feedstocks for biofuels but also **potential benefits with respect to soil carbon**. Municipal solid waste (MSW) equally holds a big promise and pioneering sorting/pre-treatment processes to obtain standard feedstock and conversion plants are under way (using Fischer-Tropsch following gasification and gas cleaning steps) thus making liquid fuels. Large volumes of animal fats were said to go to waste in many world regions. Advanced feedstocks in the EU RED Recast need shielding from price failures to become available on the market. Over-ambitious targets do not help progress technologies and over-incentivising possible biofuels that are not practical in reality undermines the credibility of the entire sector. Advanced feedstocks such as tall oil, microbial oils from fermentation of cellulosic sugars, and algal oils are being researched but are at low market readiness levels today. Thus it was said available feedstocks should continue to be used to provide robustly assessed net emission reductions while other options mature. Regarding biojet, HVO and BTL (Biomass-to-Liquid) seem currently to be the best options although a BTL plant was said to be a factor of 2 more expensive than a GTL (Gas-to-Liquid) plant.

The JRC has been recently identifying **technological bottleneck**s which exist in advanced biofuel and alternative fuel production chains namely for drop-in fuels. For BTL pathways, process integration, gas clean-up systems and new catalysts are areas where technological improvement is necessary, along with building systems capable of operating at relatively smaller scales. For fast pyrolysis and hydrothermal liquefaction (HTL), considerable work is underway to try to co-process crude oils, thus upgrading them to transport fuel quality. For advanced alternative fuels (namely electrofuels and recycled carbon fuels), and indeed for all advanced fuels, **cost reduction of production systems remains a chief concern**. Microbial fermentation of off-gases from industry raises the question of displacement and – ultimately – additionality, or net reduction of emissions.