EUROPEAN COMMISSION
DIRECTORATE-GENERAL ENERGY

Renewables, Research and Innovation, Energy Efficiency
New Energy Technologies, Innovation and Clean Coal

Brussels, 27th June 2013
M/525 EN

MANDATE TO CEN FOR STANDARDS ON PYROLYSIS OILS PRODUCED FROM BIOMASS FEEDSTOCKS TO BE USED IN VARIOUS ENERGY APPLICATIONS OR INTERMEDIATE PRODUCTS FOR SUBSEQUENT PROCESSING

PREAMBLE

A new fuel, fast pyrolysis bio-oil, is coming into the markets very soon[1]. The bio-oil is produced by fast pyrolysis where biomass is heated rapidly under an inert atmosphere at around 500 °C and thereby converted into liquid bio-oil. Several consortia in Europe and in North America have plans for commercialisation of bio-oil production. Targeted applications are boilers, gas turbines, diesel engines, and eventually transportation fuels through upgrading and co-production at a mineral oil refinery.

1. BACKGROUND

The use of sustainably produced biomass in energy applications is one of the significant measures aimed at increasing the security of energy supply in the EU as well as contributing in meeting the obligation to reduce the emission of greenhouse gases.

The European Union is promoting the use of renewable energy as set out by the Renewable Energy Directive[2] (RED). The Directive contains a mandatory target of a 20% share of energy from renewable sources in overall EU energy consumption by 2020 and a mandatory 10 % minimum target to be achieved by all Member States specifically in the transport sector, to be introduced in a cost-effective way. In parallel, a mandatory

[1] The project EMPYRO is supported by FP7 aiming to built a flagship plant for the production and use of about 20 000 tons/a pyrolysis oils Fortum in Finland is considering of building a pyrolysis oil production of 50 000 t/a in Eastern Finland, and using oil for district heat production.

A Swedish proposal concerning production and use of pyrolysis has been submitted to the NER300 call in 2011. Green Biofuel Finland has announced their plans of building several pyrolysis production facilities in eastern Finland. Industria e Innovazione in Italy has announced their plans of building a plant that will convert 150 t/day to electricity via pyrolysis.

[2] Directive 2009/28/EC of the European Parliament and of the Council of 23/04/2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

Responsible official: Kyriakos Maniatis (kyriakos.maniatis@ec.europa.eu)

target to achieve a 6% reduction in the greenhouse gas intensity of fuels used in road transport was also introduced[3].

Traditionally, solid biomass (pellets, chips, etc) has been used for heat, power or combined heat and power (CHP) applications, while liquid biofuels (biodiesel, ethanol etc) have been mainly used for transport applications. Biogas and/or biomethane have recently been used in both types of applications either as stand-alone or, where appropriate, injected in natural gas grids.

Liquid biofuels have rarely been used for CHP applications with the exception of vegetable oils which in some cases have been used in CHP applications and several boiler manufacturers promote its use. However, given the demand for biodiesel for the transport sector little uptake has been reported for biodiesel in the CHP sector.

2. PYROLYSIS OILS

Pyrolysis is the thermal decomposition of biomass occurring in the absence of oxygen. It is always also the first step in combustion and gasification, but in these processes it is followed by total or partial oxidation of the primary products. Lower process temperatures and longer vapour residence times favour the production of charcoal. High temperatures and longer residence times increase biomass conversion to gas, and moderate temperatures and short vapour residence time are optimum for producing liquids. The table below indicates the product distribution obtained from different modes of pyrolysis. Fast pyrolysis for liquids production is currently of particular interest and is the process for consideration under this Mandate.

Typical product yields from different modes of pyrolysis of wood

Mode	Conditions	Liquid	Char	Gas
Fast pyrolysis	moderate temperature, around 500 °C, short residence time particularly vapour	**75%**	12%	13%
Carbonisation	low temperature, around 400 °C, very long residence time	30%	35%	35%
Gasification	high temperature, around 800 °C, long residence times	5%	10%	**85%**

All percentages on a dry wood basis.

In fast pyrolysis, biomass decomposes to generate mostly vapours and aerosols and some charcoal. After cooling and condensation, a dark brown mobile liquid is formed which has a heating value about half that of conventional fuel oils. While it is related to the traditional pyrolysis processes for making charcoal, fast pyrolysis is an advanced process, with carefully controlled parameters to give high liquid yields. The essential features of a fast pyrolysis process are:

[3] Directive 2009/30/EC of the European Parliament and of the Council amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland water way vessels and repealing Directive 93/12/EEC.

- very high heating and heat transfer rates at the reaction interface, which usually requires a finely ground biomass feed;
- carefully controlled pyrolysis reaction temperature of around 500 °C and vapour phase temperature of 400–450 °C;
- short vapour residence times of typically less than 2 seconds;
- rapid cooling of the pyrolysis vapours to give the bio-oil product.

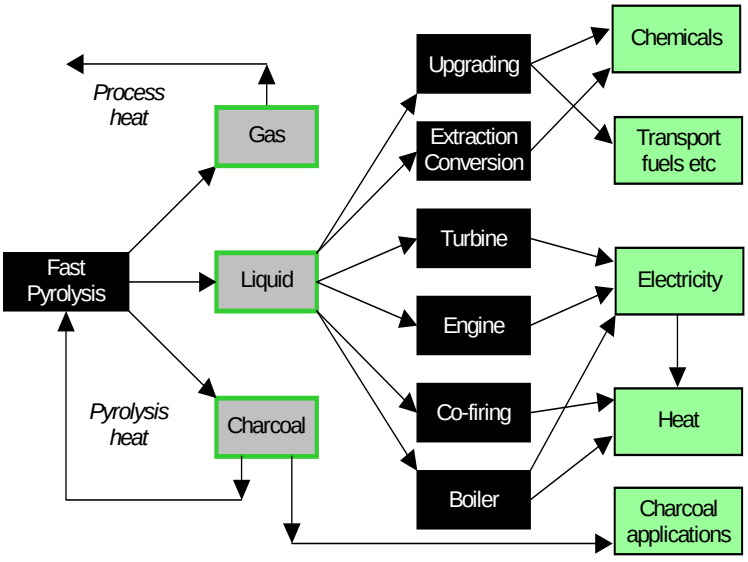
The main product, pyrolysis oil, is obtained in yields of up to 75 wt% on a dry-feed basis, together with by-product char and gas, which are used within the process to provide the process heat requirements so there are no waste streams other than flue gas and ash.

In the context of this mandate it is understood that pyrolysis refers to a thermochemical process that results in the conversion of biomass into a liquid.

3. APPLICATIONS FOR PYROLYSIS OILS

Pyrolysis oils can substitute for fossil fuels in many stationary applications including boilers, furnaces, engines and turbines for electricity generation. The figure below summarises the possibilities. A range of chemicals including food flavourings, specialities, resins, agro-chemicals, fertilisers, and emissions control agents can also be extracted or derived from pyrolysis oils. As noted above, upgrading pyrolysis oils to transportation fuels is feasible but not currently economic.

A range of chemicals can also be produced from specialities such as levoglucosan to commodities such as resins and fertilisers. Food flavourings are commercially produced from wood pyrolysis products in many countries. Chemicals are always attractive possibilities owing to their much higher added value compared to fuels and energy products, and this suggests a bio-refinery concept in which the optimum combinations of fuels and chemicals are produced.



Applications of bio-oil.

Market assessments for integrated pyrolysis plants (i.e. fast pyrolysis connected to boilers in forest industries) have been carried out for EU and North- America. Initial economically viable applications are replacing heavy and light fuel oil in heating. Use of bio-oil to replace heavy fuel oil has already been proven and the next step is to replace light fuel oil. Other applications such as upgrading to transport fuels are being developed.

4. THE RENEWABLE ENERGY DIRECTIVE

In several recitals of this Directive (67, 68, 69, 74, 75, 76, 80, 82, 84, 92, 94, 95) reference is made to biofuels and bioliquids especially on issues related to their sustainability characteristics.

Article 2, "*Definitions*" of RED[4] specifies:

(h) 'bioliquids' means liquid fuel for energy purposes other than for transport, including electricity and heating and cooling, produced from biomass;

(i) 'biofuels' means liquid or gaseous fuel for transport produced from biomass;

Article 17 "Sustainability criteria for biofuels and bioliquids", Article 18 "Verification of compliance with the sustainability criteria for biofuels and bioliquids" and Article 19 "Calculation of the greenhouse gas impact of biofuels and bioliquids" specify the various criteria and methodologies that have to be met and/or applied for all biofuels and bioliquids used in the Member States for the purpose of the RED.

Annex V of RED specifies the rules for calculating the greenhouse gas impact of biofuels, bioliquids and their fossil fuel comparators.

In order to provide for clarity and assist the Member States and economic operators in the implementation of the RED related to biofuels and bioliquids the Commission issued two Communications, 2010/C 160/01[5], 2010/C 160/02[6] for biofuels and bioliquids.

In Article 3.2 "*Future updates and addition of default values*" of Communication 2010/C 160/01 it is stated:

"*The Commission intends to include default values for additional general pathways if:*

- these have significance in the EU market and at least one plant/pathway exists; or it is a general pathway reliably expected to come into use for the near future, and,

- there are relevant data available of a satisfactory quality and certainty as judged by the independent experts."

In Article 2.3 "*Materials covered*" of Communication 2010/C 160/02 it is stated:

[4] References to biofuels in the context of the Renewable Energy Directive also apply to the Fuel Quality Directive

[5] Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme, 2010/C 160/01, 19/06/2010.

[6] Communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels, 2010/C 160/02, 19/06/2010.

"*Although many types of biofuel are mentioned in the Directive, these listings are to facilitate the implementation of the Directive and are not exhaustive. Biofuels and bioliquids that are not listed can also count towards the Directive's targets*".

However, in all recitals, articles and sections, tables and footnotes of the RED/FQD the term "pyrolysis" or "pyrolysis oils" or "bio-oil" or "pyrolytic oils" can not be found. This is due to the fact that the technologies for producing pyrolytic oils for energy purposes only recently reached market readiness and reliability. By the time of drafting the RED/FQD there was no commercial operation with pyrolysis oils and therefore little information was available on their quality in order to incorporate them in the various sections and tables especially of Annex V/Article IV.

The above Directive of the Parliament and the Council and the absence of standards for pyrolysis oils, an existing renewable fuel that can be either used in transport applications (after upgrading) or used in CHP applications, provided the impetus for the Commission to submit this mandate to CEN.

5. REASONS FOR GIVING A MANDATE TO CEN FOR DEVELOPMENT OF STANDARDS ON PYROLYSIS OILS

In order to achieve the ambitious targets of the Renewable Energy and Fuel Quality Directives it is necessary to maximise the production and use of pyrolysis oils since these can be used in numerous application in all the three energy markets, heat, power and transportation fuels. Owing to current low exploitation of pyrolysis oils in the EU, their desired accelerated deployment necessitates the development and adoption of standards in order to ensure the high quality of fuels used in the EU market.

Given the very large unexploited potential of feedstock materials for pyrolysis oils production, their increased production and use will also facilitate the energy security of the European Union and contribute significantly to meeting the Kyoto objectives.

Pyrolysis oils are entirely different from conventional liquid fuels. These highly polar pyrolysis oils have a heating value of about half of that of mineral oil, contain significant levels of water, higher density and viscosity, low pH, and poorer storage stability. Information on suitable quality classes and specifications would promote the acceptance of fast pyrolysis oils and encourage their market introduction as a fuel.

Therefore European Standards are needed to facilitate the market penetration of pyrolysis oils either for power and/or heat applications or as a transport fuel after upgrading.

A first set of fuel specifications has been approved by ASTM as burner fuel standard ASTM D7544. However, this is considered very limited as it addresses only one application of pyrolysis oils.

6. MANDATE

CEN is given the mandate to develop:

a) A European Standard for a quality specification for pyrolysis oil replacing heavy fuel oil in boilers.

b) A European Standard for a quality specification for pyrolysis oil replacing light fuel oil in boilers.

c) A Technical Specification for a quality specification for pyrolysis oil replacing fuel oils in stationary internal combustion engines[7].

d) A Technical Specification for a quality specification for pyrolysis oil suitable for gasification feedstock for production of syngas and synthetic biofuels.

e) A Technical Specification for a quality specification for pyrolysis oil suitable for mineral oil refinery co-processing.

The first 3 (a-c) documents above are to be given precedence and be developed as soon as possible. The last two (d & e) are to be given lower priority and developed at a later stage or as market developments dictate.

The European Standards on pyrolysis oils will include no unnecessarily restrictive requirements, as long as the proper functioning in the intended applications can be guaranteed.

The work to be conducted will respect the current requirements of the RED/FQD Directives. If in the course of the work conflicts arise with the requirements in the RED/FQDs Directive then these should be highlighted to the Commission Services.

CEN shall provide the Commission within 4 months after the acceptance of this standardisation mandate with a Work programme specifying the work to be carried out. In the detailed Work Programme, for points a) and b) the development of intermediate deliverables (i.e. Technical Specifications) could be anticipated.

7. BODIES TO BE ASSOCIATED

The elaboration of the standards should be undertaken in co-operation with the broadest possible range of interest groups, including international and European associations. Those invited to contribute to the work should include stakeholders from the relevant industries, ANEC[8] and ECOS[9], the relevant representatives of SMEs, ETUI[10], and ENTSOG[11].

[7] The Technical Specification C) excludes vehicle engines

[8] European Association for the Co-ordination of Consumer Representation in Standardisation

[9] European Environmental Citizens Organisations for Standardisation

[10] European Trade Union Institute

[11] European Network of Transmission System Operators for Gas

8. EXECUTION OF THE MANDATE

8.1. This mandate is issued after consulting the Article 5 Committee under 98/34/EC Directive in December 2012.

8.2. CEN must provide the EC with a detailed Work programme and a timetable for the adoption of the standards needed to cover the work highlighted in section 4. CEN will execute the Work programme agreed with the European Commission.

8.3. The European standards adopted will have to be transposed into national standards and divergent national standards will have to be withdrawn from the catalogues of the Member States' national standardisation bodies within six months of the adoption of the European standards.