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Tracking progress in the uptake of renewable energy: focus on bioenergy development

Biofuel quality standards: Challenges, impacts and possible pathways towards harmonization

Note by the secretariat

Summary

The harmonization of energy standards is an endeavour that aims to ensure consistent and high-quality energy production, transmission and use across different regions. As the demand for biofuels continues to grow, it becomes increasingly possible to establish internationally compatible standards to facilitate trade and promote high-quality and sustainable energy.

Efforts to harmonize biofuel quality standards have been undertaken by various entities, such as the Tripartite Task Force consisting of Brazil, the European Union, and the United States of America, which developed a Biofuels Standards Roadmap to achieve greater compatibility among existing biofuel standards. Additionally, the AEM-METI Economic and Industrial Cooperation Committee (AMEICC) developed a policy roadmap for harmonizing standards in East Asia. These initiatives reflect the possibility of harmonizing biofuel quality standards to ensure sustainable and efficient biofuel production and use. Furthermore, internationally compatible standards for biofuels promote environmental sustainability by ensuring that biofuel production and use adhere to common criteria for reducing emissions, protecting natural resources, and promoting sustainable land use practices. This fosters a level playing field for biofuel producers and users worldwide.

The harmonization of biofuel quality standards has significant implications for regional production and use. Internationally compatible standards for biofuels promote a level playing field for biofuel producers and users worldwide. These standards ensure that biofuel production and use adhere to common criteria, which can impact regional production and use by creating consistency and facilitating trade. Further promoting SDG 7, 8 and 12.

I. Current status of standards

1. This paper aims to provide a non-exhaustive overview of the current state of biofuel quality standards, analyzing the different standards across regions and the possible challenges to harmonization. It also explores the anticipated impact that harmonization will have on the uptake of biofuels.

2. This chapter discusses the continuous updates in biofuel quality standards, influenced by factors such as engine technology, emission standards, and feedstock evaluation. It explores regional variations in standards and feedstocks as well as the extent to which standards are already harmonized. Biofuel quality assurance standards are crucial for its commercialization and market acceptance.

3. The International Standard Organization (ISO) defines a ‘standard’ as a 'Technical specification or other document available to the public, drawn up with co-operation and consensus or general approval of all interests affected by it, based on the consolidated results of science, technology and experience, aimed at the promotion of optimum community benefits and approved by a body recognized on the national, regional or international level.' This is the definition in which this report follows.

4. The evaluation of biofuel quality involves determining its chemical composition and physical properties. Regional standards provide guidance on the methods of analysis of biodiesel to be used. The properties and limits specified in biofuel standards must protect the performance and durability of engines.

5. Biofuel quality specifications are dynamic and are periodically reviewed by institutions such as the European Committee of Standardization (CEN), the ISO, and the American Society for Testing and Materials (ASTM).

6. The structure of standardization bodies, particularly those that cover a regional political bloc like the CEN, is worth noting. For instance, European standards are mandatory for all 28 member states, and any national standards that contradict European standards must be withdrawn. However, if a European standard is not feasible due to the need to account for national differences, a harmonization document can be used. In such a scenario, a member state is permitted to maintain or issue a national standard related to a topic covered by the harmonization document, as long as it is technically equivalent.

7. This illustrates the complex relationship between European and national standards within the CEN framework, highlighting the advantageous ability to adapt national standards, which facilitates the harmonization of standards across the 28 members of CEN.

8. ISO standards are entirely voluntary and do not need to be adopted as national standards. Although this voluntary nature may imply challenges for harmonization, most middle-income countries produce, export feedstocks and biofuels and therefore have a vested economic interest in harmonizing their standards to align with their export destinations.

A. Biodiesel quality standards

9. The current regulations governing the quality of biodiesel in the market are influenced by a range of factors that differ from one region to another. These factors include the characteristics of existing diesel fuel standards, the prevalence of the types of diesel engines most commonly used in the region, the emissions regulations that apply to those engines, the stage of development and the climatic properties of the region or country where the biodiesel is produced and/or used, and the intended purpose and motivation for the use of biodiesel (European Commission, 2007).

10. Divergences in biodiesel standards are apparent across various nations. For instance, in Brazil and the United States, these standards encompass both fatty acid methyl esters (FAME) and fatty acid ethyl esters (FAEE), in contrast to the prevailing European standard, which exclusively pertains to FAME.

11. Furthermore, the specifications for biodiesel standards in Australia, Brazil, India, Japan, South Africa, and the United States categorize the product as a blending component

within conventional diesel fuel. Whereas the European standard describes a product that can be used either as a stand-alone fuel for diesel engines or as a blending component in conventional diesel fuel.

12. Some specifications for biodiesel are independent of the feedstock used, while others are formulated based on the locally available feedstock. The diversity in these technical specifications is primarily related to the origin of the feedstock and the characteristics of the local markets (European Commission, 2007; National Renewable Energy Laboratory, 2009; Prankl, et al., 2004).

13. Free glycerol content for example has close alignment amongst many regions, however, density has a huge disparity, not only down to regional norms, as the European Union primarily used biodiesel as a standalone fuel rather than as a blend. But also due to differences within the processing of the feedstock.

B. Bioethanol quality standards

14. Like biodiesel, there are regional differences in bioethanol quality standards, which are mainly due to different feedstocks used. However, standards have remained mostly aligned as biodiesel is more likely to be used as a blend stock for fossil fuel-based diesel, rather than used as a 100% pure biofuel for engines.

15. This is reflected within the standards, in which water content is the only specification where alignment may be unattainable due to the European Union having a lower limit for water content than many other regions. Whilst this can be remedied through extra drying, it could drive up the cost of production (Tripartite Task Force, 2007).

II. Challenge of standard harmonisation

16. The standards for governing the quality of biofuels vary from region to region and are based on a variety of factors. These factors include the feedstock available for obtaining the oil to manufacture the biofuel, the types of diesel engines most common in the region, and the emissions regulations governing those engines. For example, Europe has a larger diesel passenger car market, while the United States and Brazilian markets are mainly comprised of heavier duty diesel engines.

17. This difference in biodiesel usage represents a considerable difficulty in establishing a common specification. The physicochemical properties of biodiesels are strongly influenced by the nature and composition of the feedstocks used in their production, leading to varying quality requirements for the marketing of biodiesel from region to region.

18. The largest differences are found in cetane number, oxidation stability, iodine value, density, and viscosity. Weather conditions also play a role, reflected in the regulations of properties describing performances of biodiesel at low temperatures.

19. In Europe, the standard for biodiesel describes a product that may be used as a standalone fuel, leading to different standards being set compared to Brazil and the United States, where biodiesel is primarily used as a blend stock for extending the volume of fossil diesel fuel. The European Union's specification for biodiesel is more extensive, and some limit values are set to different levels than those of Brazil and the United States. This difference in standards poses a challenge for a common specification for biodiesel.

III. Impact of harmonization

20. In the instance of bioethanol, trade among the three regions of the Tripartite Task Force is poised for Brazil to export to both the United States and the European Union, with the United States primarily exporting to the European Union. The probability of the European Union engaging in bioethanol exports or Brazil consistently importing substantial quantities appears remote.

21. These dynamic shifts the perspective on apparent technical disparities, given that numerous parameters in the Brazilian specifications are more rigorous than those in the European Union or United States specifications. To meet the EU's stringent water content standards, ethanol exported by the United States or Brazil would require pre-export drying, impacting production costs and potentially curbing productivity.

22. Expanding on this, it's crucial to recognize the multifaceted implications of the water content issue. The necessity for drying bioethanol prior to export introduces an additional layer of complexity to the production process, influencing both economic and operational aspects. The financial impact extends beyond the direct cost of drying, encompassing potential logistical adjustments, energy consumption, and the overall efficiency of ethanol production. Moreover, as the European Union stands out with the most demanding water content criteria among the three regions, there is a looming challenge for exporters to strike a balance between meeting regulatory standards and maintaining cost-effectiveness.

23. An additional variable warranting consideration in the context of trade pertains to the chloride ion content, a factor that may exert influence. Notably, the European Union's chloride specifications are more stringent than those of the United States, necessitating confirmatory testing for chloride in exports from the United States to the European Union. However, this is not foreseen to present an impediment, as the observed chloride levels in United States ethanol consistently fall below the European Union's requirements.

24. Furthermore, the certification of phosphorus content emerges as another requisite for ethanol exports to the European Union from Brazil or the United States. While neither the United States nor Brazil currently outlines a phosphorus specification, the United States remains open to deliberating the inclusion of such a specification.

25. Forecasts indicate that, aside from chloride and phosphorus content, none of the remaining ethanol property limits are expected to impede trade, contingent upon the harmonization of test methods for parameters currently assessed through disparate methodologies. This is subject to agreement on the acceptable values for these parameters.

26. In summary, there exists no specification deemed a technical barrier insurmountable without recourse to additional processing or testing. The imperative lies in the harmonization of test methods and consensus on parameter values. The measures are relevant for ensuring a seamless and efficient ethanol trade framework among the regions.

27. The potential for the scalability of biofuel standards encounters impediments in adhering to a multitude of international requisites, presenting significant challenges. For example, Brazilian bioethanol, where the utilization of distinct pH electrodes specified in American, Brazilian, and European standards resulted in substantial variations in pH values, underscoring the imperative for standardization.

28. Similarly, the growth of halal industries has encountered limitations due to the absence of a universally recognized halal standard, accentuating the need for harmonization. Moreover, the establishment of sustainability standards for global biofuel production emphasizes the significance of standardization in bolstering public and stakeholders' confidence in biofuels. These instances illuminate the intricate challenge of harmonizing biofuel standards, as they must align with diverse international requirements, thereby hindering their broad scalability.

29. Additionally, the intricate landscape of biofuel production, encompassing technical and economic complexities such as the optimization framework for identifying key management strategies and the hurdles associated with microalgae-based biofuel technology, further underscores the inherent non-scalability of biofuel standards.

30. Hence, the multifaceted nature of biofuel production and the array of international standards demand a comprehensive approach to harmonization, considering the intricacies of distinct regulatory frameworks and technical requirements. This underscores the inherent non-scalability of biofuel standards.

IV. Conclusions and recommendations

31. The notable lack of comprehensive information on quality standards for biofuels poses a significant challenge despite its pivotal role in meeting future energy needs. Assessments by esteemed organizations like Renewable Energy Policy Network for the 21st Century (REN21), International Energy Agency (IEA), and International Renewable Energy Agency (IRENA) underscore biofuel's substantial contribution to renewable energy usage, offering cost-effective pathways for increased adoption by 2030. However, the challenge of establishing standardized quality parameters is evident, particularly given the widespread use of biofuels to enhance regional energy access, especially in the global south.

32. Therefore, biofuel policies should factor in the diverse conditions across continents, emphasize biodiversity preservation, and promote multiple ecosystem benefits in landscapes, as suggested by IRENA. In light of these conclusions, recommendations for future action include a prioritized focus on developing comprehensive and universally applicable quality standards for biofuels. This is crucial to avoid replicating issues seen in the fossil fuel sector, where high-quality fuels became financially inaccessible for local populations. Prioritizing accessibility and affordability alongside the expansion of biofuel applications will be pivotal for fostering sustainable energy practices, especially in regions where biofuels play a crucial role in advancing energy access.

33. The viability of establishing a harmonized quality standard for biofuels is a crucial consideration in the context of biofuel trading. To address challenges related to predictability in biofuel prices and supply, the proposal suggests the creation of a biofuel exchange—an electronic platform designed for biofuel trade. This exchange would serve as a centralized hub for stakeholders, streamlining and transparently facilitating biofuel trade. Its dual-purpose functionality not only promotes equitable competition but also incentivizes adherence to quality benchmarks, enhancing the overall efficiency and reliability of biofuel transactions. Importantly, the biofuel exchange introduces regulatory measures to ensure accountability, contributing to the reliability and credibility of the biofuel market.

34. Additionally, it plays a pivotal role in implementing mandatory quality requirements, fostering trust among market participants and aligning with broader environmental sustainability objectives. In essence, the biofuel exchange presents a comprehensive solution, merging market dynamics with regulatory oversight to promote reliability, accountability, and sustainability in the biofuel industry.

35. The significant disparities in global biofuel standards pose a considerable challenge to the prospect of harmonization, thereby affecting international biodiesel trade and the automotive industry. This discrepancy is exemplified by the contrasting regulations between the United States, permitting both FAME and FAEE, and the European Union, allowing solely FAME. This divergence not only hampers the smooth flow of biodiesel imports and exports across regions but also presents challenges for automotive producers striving to adapt their engines to varied biodiesel quality requirements in different markets.

36. While the aspiration for global harmonization remains ideal, these substantial differences underscore the need for meticulous consideration and international cooperation to navigate and address the practical implications for the biofuel industry. In light of this complexity, it becomes imperative for stakeholders to engage in collaborative efforts towards finding pragmatic solutions that promote consistency and sustainability within the biofuel global landscape.

Annex I

Table 1
Biodiesel Standards

Country/ Area	*Specifications*	*Title*
EU	EN 14213	Heating fuels - Fatty acid methyl esters (FAME) - Requirements and test methods
EU	EN 14214	EN 14214 Automotive fuels - Fatty acid methyl esters (FAME) for diesel engines - Requirements and test methods
U.S.	ASTM D 6751	ASTM D6751 - 11a Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels
Australia		Fuel Standard (Biodiesel) Determination 2003
Brazil	ANP 42	Brazilian Biodiesel Standard (Agência Nacional do Petróleo)
India	IS 15607	Bio-diesel (B 100) blend stock for diesel fuel - Specification
Japan	JASO M360	Automotive fuel - Fatty acid methyl ester (FAME) as blend stock
South Africa	SANS 1935	Automotive biodiesel fuel

Table 2
Different properties of Biodiesel

Category A Parameters Misalignment Impact (MI)	*Category B Parameters Misalignment Impact (MI)*	*Category C Parameters Misalignment Impact (MI)*
Sulfated ash MI: very minor	Total glycerol for limit value for method MI: minor	Sulfur content MI: medium to major
Alkali & alkaline earth metals MI: very minor	Phosphorus content MI: medium	Cold climate operability MI: very minor
Free glycerol MI: minor	Carbon residue MI: very minor	Cetane number MI: major
Copper strip corrosion MI: none	Ester content MI: very minor	Oxidation stability MI: medium
Methanol & ethanol content MI: medium	Distillation temperature MI: very minor	Mono, di-, tri-acylglycerides MI: minor
Acid number MI: very minor	Flash point MI: minor	Density MI: very minor
	Total contamination MI: minor	Kinematic viscosity MI: very minor
	Water content & sediment MI: medium/major	Iodine number MI: major
		Linolenic acid MI: major
		Polyunsaturated methyl ester MI: major

Annex II

Biofuels Task Force – Terms of Reference

Draft for discussion

I. Introduction

1. In the last years, several ECE countries had substantially increased the pace of adoption of renewable energy technologies. Their expansion mainly took place in the power sector, whereas progress in the transport sector, as well as in the heating and cooling sector was slower. Data show a clearly positive trend in the last decade, which seems to maintain the conditions to continue this positive trend.

2. Nearly all ECE countries have significant potential for the deployment of solar, wind, hydropower, and/or bioenergy and other renewable energy technologies. Trends differ across end-uses with the largest increase in the share of renewables continuing to be in the generation of electricity, while the transport and heat sectors only saw very limited progression. Nonetheless, most countries are still heavily dependent on fossil fuels, with relatively smaller shares of renewables in their total final energy consumption.

3. Although access to electricity and the use of clean fuels for cooking, heating, and lighting is widespread in the ECE region – and reliance on renewable energy and energy efficiency had also been improving until the recent energy crisis – the rate of progress has not been high enough to enable achievement of the SDG 7 targets. An immediate acceleration of efforts is therefore critical to ensure access to affordable, reliable, sustainable and modern energy for all.

4. Renewable energy developments and trends have been discussed in the context of the mid-term review of SDG7 and key outcomes of the High-level Policy Forum (HLPF), giving particular attention to renewable energy development in the ECE region. UN-Energy members and other relevant organizations are continuing to contribute directly or indirectly with their work to discussions on the progress made to develop renewable energy in the ECE region, including in the recent review of tracking SDG7 and its Energy Progress Report.

5. Taking into account key findings of the REN21 ECE Renewable Energy Status Report 2022 and the reviewing of the renewable energy progress in-going global processes, bioenergy development is considered relevant in supporting the achievement of SDG7 and to mitigate climate change.

6. Biofuels refer to combustible materials derived from non-fossilized biomass (mostly cellulose, various fats, starch, sugar and similar carbohydrates). Biofuels can be gaseous (biogas, biomethane), liquid (bio-methanol, bio-ethanol, bio-diesel) or solid (pellets, charcoal). Gaseous and liquid biofuels can be used as a feedstock for production of synthetic liquid fuels (such as aviation fuel or diesel) that are easier to handle and store.

7. The harmonization of energy standards is an endeavor that aims to ensure consistent and high-quality energy production, transmission and use across different regions. As the demand for biofuels continues to grow, it becomes increasingly important to establish internationally compatible standards or harmonize existing ones to facilitate trade and promote high-quality energy through environmental sustainability.

8. ECE may support the work of a Task Force on Biofuels Quality under the auspices of the Group of Experts on Renewable Energy (GERE) for the harmonization or development of regulations for quality biofuels standards that can promote a level playing field for biofuel producers and users worldwide, in line with the policy guidance of the Committee on Sustainable Energy for a resilient energy system.

9. Since its first session (November 2014), the Group of Experts on Renewable Energy has been implementing concrete activities to help significantly increase the uptake of renewable energy in the region and therefore support member States to fulfil their obligations

under the Paris Agreement on Climate Change and achieve their goals and targets under the 2030 Agenda for Sustainable Development.

10. Based on the Work Plan 2024-2025 (ECE/ENERGY/2023/8), the Group of Experts on Renewable Energy can work to assess opportunities for more sustainable and environmentally friendly renewable energy, including bioenergy and hydro, through inter-sectoral synergies (nexus), in cooperation with relevant activities of other ECE subprogrammes, notably with the Task Force on Water-Food-Energy-Ecosystem Nexus and the Team of Specialists on Wood Energy as well as with the Global Bioenergy Partnership of FAO.

11. The Task force would operate in line with the principle of the joint statement on sustainable bioenergy for climate and development goals developed by the Cross-Initiative coordination group on bioenergy convened by the Global Bioenergy Partnership (GBEP). Representatives of the Clean Energy Ministerial Biofuture Platform Initiative, the Food and Agriculture Organization of the United Nations (FAO), the Global Bioenergy Partnership (GBEP), the International Energy Agency (IEA), the IEA Bioenergy Technology Collaboration Programme, the International Renewable Energy Agency (IRENA), the European Biogas Association, the United Nations Environment Programme (UNEP), the United Nations Economic Commission for Europe (UNECE), the United Nations Development Programme (UNDP), and the United Nations Industrial Development Organization (UNIDO) participated in this process.

12. Other actors may participate in the Task Force on Biofuels Quality, including the International Energy Agency (IEA) considering its role in the Global Biofuel Alliance launched at the G20 in 2023 with the aim of boosting supply and demand for biofuels.

13. The 11th session of the Group of Experts on Renewable Energy on 16-17 September will discuss various aspects related to bioenergy development and will consider the possible launch of the dedicated Task Force on Biofuel Quality, involving several subsidiary bodies of the Committee on Sustainable Energy and raising extrabudgetary funds for concrete activities and for the harmonization of standards or the agreement of recommendations on quality biofuels.

II. Areas of Work

14. The Task Force catalyses dialogue on biofuels, with emphasis on quality standards, at all levels in the ECE region.

III. Concrete activities

15. The Task Force will:

- Promote and facilitate policy dialogue on biofuels and foster cooperation on it within the ECE region and beyond
- Support current and future extrabudgetary projects on biofuels managed by the Sustainable Energy Division
- Further develop a paper on challenges, impacts and possible pathways towards harmonization of biofuels quality standards in the ECE region and beyond, to avoid duplication
- Prepare, for the Group of Experts and/ or Committee’s consideration, a work plan for future biofuels activities aiming to:
    - Identify biofuel-related activities to be carried out using the regular budget
    - Propose new biofuel-related activities that would require extrabudgetary resources
    - Pursue available resources to provide clarity on biofuel quality standards and its potential viable applications.

- Conduct regular meetings, including ad hoc discussions and workshops in close cooperation with the FAO and the IEA. In collaboration with the Group of Experts on Gas, other Groups of Experts as well as other relevant subsidiary bodies of other ECE Committees to discuss, develop, and promote good practices and recommendations on:
    - Quality standards for blending biofuels with fossil fuels to reduce emissions from these fuels
    - Biofuels quality requirements for its life cycle from raw material extraction to production, transportation, use, and end-of-life treatment
    - The role of existing infrastructure in accelerating development of biofuel projects.
- Help develop project proposals on any of the aforementioned items that may require extrabudgetary resources for presentation to potential donors.

IV. Membership

16. The Task Force is led by two Co-chairs, agreed on by the Bureau of the Group of Experts on Renewable Energy. In its work, the Task Force engages government experts, the private sector, academia, civil society, international organizations, and other stakeholders from ECE member States. Task Force members will be selected by the two Co-chairs, in consultation with the Bureau of the Group of Experts on Renewable Energy and the Bureau of the Group of Experts on Gas.

V. Reporting

17. The Task Force reports to the Group of Experts on Renewable Energy and to the Group of Experts on Gas annually and to their Bureaux between annual sessions as needed.

VI. Duration

18. The Task Force is established for a period of two years. Its term is renewable, subject to the approval of the Group of Experts or its Bureau and the Committee.