Bioenergy Criteria under the Climate Bonds Standard

Non-Wood Feedstocks Background Paper

May 2019

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We would like to thank all members of the Bioenergy Technical Working Group and Industry Working Group for their time and valuable expertise that helped shape these Criteria. A full list of all TWG and IWG members can be found in Appendix 1 and on our website.

Definitions

Bioenergy assets and projects: Assets and projects relating to the acquisition, installation and / or management of bioenergy facilities, which might include: biofuel preparation and pre-treatment facilities, bio-refinery facilities, electricity, heating and cooling facilities using biofuel/biomass. Plus, assets and projects related to dedicated infrastructure and/or the production of dedicated components for these facilities.

Bioenergy: Energy generated from the conversion of solid, liquid and gaseous products derived from biomass.[1]

Biofuel: Liquid fuels derived from biomass. They include ethanol, a liquid produced from fermenting any biomass type high in carbohydrates, and biodiesel, a diesel- equivalent processed fuel made from both vegetable oil and animal fats.[2]

Biogas: A mixture of methane (CH_4) and carbon dioxide (CO_2) used as fuel and produced by bacterial degradation of organic matter or through gasification of biomass.[3]

Biomass: Any organic matter, i.e. biological material, available on a renewable basis. It includes feedstock derived from animals or plants, such as wood and agricultural crops, and organic waste from municipal and industrial sources.[4]

Climate Bonds Initiative (CBI): An investor-focused not-for-profit organisation, promoting large-scale investments that will deliver a global low carbon and climate resilient economy. The Initiative seeks to develop mechanisms to better align the interests of investors, industry and government to catalyse investments at a speed and scale sufficient to avoid dangerous climate change and cope with unavoidable climate change.

Green Bond: A Green Bond is one in which the proceeds are allocated to green projects and labelled accordingly by the issuer. The vast majority of these green projects are focused on climate change mitigation or adaptation, but there is a small share of the market, which also funds green, non-climate projects, such as green spaces.

Certified Climate Bond: A green bond that is certified by the Climate Bonds Standard Board as meeting the requirements of the Climate Bonds Standard, as attested through independent verification.

Climate Bonds Standard (CBS): A screening tool for investors and governments that allows them to identify green bonds where they can be confident that the funds are being used to deliver climate change solutions. This may be through climate mitigation impact and/ or climate adaptation or resilience impact. The CBS is made up of two parts: the parent standard (Climate Bonds Standard v2.1) and a suite of sector specific eligibility Criteria. The parent standard covers the certification process and pre- and post-issuance requirements for all certified bonds, regardless of the nature of the capital projects. The sector-specific Criteria detail specific requirements for assets identified as falling under that specific sector.

Climate Bonds Standard Board (CBSB): A board of independent members that collectively represents $34 trillion of assets under management. The CBSB is responsible for approving i) Revisions to the

[1] IEA/FAO (2017). *How 2 Guide for Bioenergy Roadmap Development and Implementation.*
[2] Ibid.
[3] Ibid.
[4] Ibid.

Climate Bond Standard, including the adoption of additional sector Criteria, ii) Approved verifiers, and iii) Applications for Certification of a bond under the Climate Bonds Standard.

Climate Bond Certification: allows the issuer to use the Climate Bond Certification Mark in relation to that bond. Climate Bond Certification is provided once the Climate Bonds Standard Board is satisfied the bond conforms with the Climate Bonds Standard.

Technical Working Group (TWG): A group of key experts from academia, international agencies, industry and NGOs convened by the Climate Bonds Initiative. The TWG develops Sector Criteria - detailed technical criteria for the eligibility of projects and assets as well as guidance on the tracking of eligibility status during the term of the bond. Their draft recommendations are refined through engagement with finance industry experts in convened Industry Working Groups and through public consultation.

Industry Working Group (IWG): A group made up of potential green bond issuers, potential investors in bioenergy related green bonds, financial intermediaries in the bond issuance process, and Climate Bonds Standard approved verifiers who are responsible for assessing whether bonds meet the Criteria. The purpose of the IWG is to advise and review the Criteria being developed by the TWG, testing the practicality of the Criteria for green bond market participants and providing recommendations for further improvement.

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1. Introduction

1.1 Funding the goals of the Paris Agreement

The current trajectory of climate change, expected to lead to a global warming of 3.1-3.7°C by 2100[5] poses an enormous threat to the future of the world's nations and economies. The effects of climate change and the risks associated with a greater than 2ºC rise in global temperatures by the end of the century are significant: rising sea levels, increased frequency and severity of hurricanes, droughts, wildfires and typhoons, and changes in agricultural patterns and yields. Avoiding such catastrophic climate change requires a dramatic reduction in global greenhouse gas emissions.

Meanwhile, the world is entering an age of unprecedented urbanisation and related infrastructure development. Global infrastructure investment is expected to amount to USD 90 trillion over the next 15 years, which is more than the entire current infrastructure stock.[6]

To ensure sustainable development and halt climate change, this infrastructure needs to be low-carbon and resilient to climate change, without compromising the kind of economic growth needed to improve the livelihoods and wellbeing of the world's most vulnerable citizens. Ensuring that the infrastructure built is low-carbon raises the annual investment needs by 3–4%.[7] Climate adaptation needs add another significant amount of investment, which is estimated at USD 280–500 billion per annum by 2050 for a 2ºC scenario.[8]

According to the Task Force on Climate-related Financial Disclosures, there are two broad channels through which climate change can present risks to business activities and assets[9]:

1. Physical risk: the risk of impacts from climate- and weather-related events, such as floods and storms that damage property or disrupt supply chains and trade;
2. Transition risk: the financial risks that could result from the process of adjustment towards a lower-carbon economy. These include sudden shifts in demand; legal risk due to parties who have suffered loss or damage seeking compensation; and changes in policy favouring lower carbon technologies.

All of these could prompt a reassessment of the value of a large range of assets as costs and opportunities become apparent, and widespread inadequate information on these risks could even threaten the stability of the financial system. Risks to financial stability will be minimised if the transition begins early and follows a predictable path, thereby helping the market anticipate a smooth transition to a 2ºC warming world.

[5] According to Climate Tracker, under current policies we could expect 3.1-3.7ºC: http://climateactiontracker.org/global.html
[6] New Climate Economy (2016). *Better Growth, Better Climate.*
[7] New Climate Economy (2016). *The Sustainable Infrastructure Imperative: Financing for Better Growth and Development*.
[8] UNEP (2016). *The Adaptation Finance Gap Report.*
[9] TFCD's 'Recommendations of the Task Force on Climate-related Financial Disclosures': https://www.fsb-tcfd.org/publications/final-recommendations-report/

1.2 Green bonds are critical to mobilising the capital required

Traditional sources of capital for infrastructure investment (governments and commercial banks) are insufficient to meet capital requirement needs to 2030; institutional investors, particularly pension and sovereign wealth funds, are increasingly looked to as viable actors to fill these financing gaps.

Capital markets enable issuers to tap into large pools of private capital from institutional investors. Bonds are appropriate investment vehicles for these investors as they are low-risk investments with long-term maturities, making them a good fit with institutional investors' liabilities (e.g. pensions to be paid out in several decades).

Bond financing works well for low-carbon and climate-resilient infrastructure projects post-construction, as bonds are often used as re-financing instruments. Across investors and financial markets, different entities face different types and severities of risks related to climate change, depending on many factors including degree of long-term exposure, likelihood of negative climate impacts, and ability to mitigate impacts or shift positions.

Labelled green bonds are bonds with proceeds used for green projects, mostly climate change mitigation and/or adaptation projects, and labelled accordingly. The rapid growth of the labelled green bond market has shown in practice that the bond markets provide a promising channel to finance climate investments.

The green bond market can reward bond issuers and investors for sustainable investments that accelerate progress toward a low carbon and climate resilient economy. Commonly used as long-term debt instruments, green bonds are issued by governments, companies, municipalities, commercial and development banks to finance or re-finance assets or activities with environmental benefits. Green bonds are in high demand and can help issuers attract new types of investors.

Green bonds are regular bonds with one distinguishing feature: proceeds are earmarked for projects with environmental benefits, primarily climate change mitigation and adaptation. A green label is a discovery mechanism for investors. It enables the identification of climate-aligned investments even with limited resources for due diligence. By doing so, a green bond label reduces friction in the markets and facilitates growth in climate aligned-investments.

However, currently green bonds only account for less than 0.2% of all bonds issued globally, whereas the global bond market stands at USD 100 trillion. The potential for scaling up is tremendous. The market now needs to grow much bigger, and quickly.

1.3 The Climate Bonds Initiative and the Climate Bonds Standard & Certification Scheme

Activating the mainstream debt capital markets to finance and refinance climate-aligned projects and assets is critical to achieving international climate goals, and robust labelling of green bonds is a key requirement for that mainstream participation. Confidence in the climate objectives and the use of funds of green bonds is fundamental to the credibility of the role they play in a low carbon and climate resilient economy. Trust in the green label and transparency of the underlying assets are essential for this market to reach scale; but investor capacity to assess green credentials is limited, especially in the fast-paced bond market.

Therefore, the Climate Bonds Initiative created the Climate Bonds Standard & Certification Scheme, which aims to provide the green bond market with the trust and assurance that it needs to achieve scale.

The Climate Bonds Standard & Certification Scheme is an easy-to-use tool for investors and issuers to assist them in prioritising investments that truly contribute to addressing climate change. It is made up of the overarching Climate Bonds Standard detailing management and reporting processes, and a set of Sector Criteria detailing the requirements assets must meet to be eligible for certification. The Certification Scheme requires issuers to obtain independent verification, pre- and post-issuance, to ensure the bond meets the requirements of the Climate Bonds Standard.

The goal of the Standard and Certification Scheme is to accelerate investment in a global transition to a low-carbon economy in line with the goals of the Paris Agreement – that is, which limits warming to a global average of no more than 2°C higher than pre-industrial levels, and ideally to no more than 1.5°C, and ensures investments are fit for purpose in a changing climate. Certified bonds are required to be compatible with a highly carbon-constrained world by linking to assets and projects generating little in the way of emissions. This is referred to as 'low-carbon (or low-GHG) compatibility' throughout the document.

Other existing Sector Criteria cover Solar Energy, Wind Energy, Marine Renewable Energy, Geothermal Power, Buildings, Transport, Water Infrastructure and Forestry. Additional sector Criteria currently under development include Hydropower, Fisheries and Aquaculture, Agriculture, Waste Management and Shipping.

The Climate Bonds Initiative is an investor-focused not-for-profit organisation whose goal is to promote large-scale investments through green bonds and other debt instruments to accelerate a global transition to a low-carbon and climate-resilient economy aligned with the goals of the Paris Agreement.

As part of this, it brings together in an international consultative process a wide range of investors, issuers and key experts from academia, international institutions and Non-Governmental Organisations (NGOs). These experts participate through a Technical Working Group (TWG) or an Industry Working Group (IWG). The output of this process is a recommended set of scientifically-robust and market-ready Sector Criteria, which are subject to public consultation before being submitted to the Climate Bonds Standards Board for approval.

1.4 Developing Bioenergy Criteria for bond certification

The role of bioenergy in the transition to a low carbon and climate resilient economy depends on the extent to which its main advantages, disadvantages and competitors shape policy and commercial uptake.

On the one hand, bioenergy might have a key role to play in achieving the goals of the Paris Agreement for the following reasons;

1. Its flexibility as a potential generation technology as a well as a form of solid, liquid or gaseous fuel.

2. The view that negative emissions technologies, including biomass with carbon capture and storage (BECCS), may be required to keep global CO_2 atmospheric concentrations within acceptable limits.
3. It can play an important role in decarbonising transport sector by replacing fossil fuel, in particular for long-haul modes including aviation and shipping.

However, at the same time, the following concerns have been raised regarding bioenergy:

1. Concerns, partially due to past mistakes in policy design, that biofuels can have adverse environmental impacts through both land use change (LUC) and combustion, as well as requiring energy to transport; and decreasing food security by competing with food production for land. The issue of supply chain sustainability in particular has become a crucial one for biofuels.
2. The possibility that feedstocks may be vulnerable to physical climate risk, particularly drought, or that its production may impact on the resilience of the ecosystems in which it is situated.

In summary then, Bioenergy has the potential to be a key mitigation technology and one which, if done badly, can have no net positive impact, or even a negative impact. The Bioenergy Criteria will provide a tool for bond issuers and investors to identify and finance bioenergy assets and projects that deliver mitigation and adaptation benefits, and avoid adverse environmental impacts.

The list of Bioenergy TWG and IWG members who have participated in the development of these Criteria is provided in Appendix 1. The process of developing Sector Criteria under the Climate Bonds Standard is described in Appendix 2.

1.5 This document and supplementary information available

This document supports the proposed Bioenergy Criteria. It captures the issues raised and discussed by the TWG, as well as the arguments and evidence in support of the proposed Criteria.

Specifically, it offers an overview of the bioenergy sector, highlights opportunities for mitigation and adaptation, and outlines existing approaches on assessing them, as well as other environmental and social impacts, in the bioenergy sector. These issues have informed the development of the proposed Criteria. Readers are referred to a separate Criteria Document for the criteria themselves.

Please note that while the discussions and this paper are based on the latest scientific evidence and informed by the experts of the Bioenergy TWG, it must be recognised that there are key uncertainties. The science on indirect impacts and lifecycle analysis for bioenergy in particular continues to evolve, and our understanding of the sustainability challenges is also improving.

Supplementary information available in addition to this document include:
1. Bioenergy Criteria Brochure: a 2-page summary of the Bioenergy Criteria.
2. Bioenergy Criteria Document: the complete Criteria requirements.
3. Climate Bonds Standard V2.1: the umbrella document laying out the common requirements that all Certified Climate Bonds need to meet, in addition to the sector-specific Criteria (V2.1 is the most recent update version).
4. Climate Bonds Standard & Certification Scheme Brochure: an overview of the purpose, context and requirements of the Climate Bonds Standard & Certification Scheme.

For more information on the Climate Bonds Initiative and the Climate Bond Standard & Certification Scheme, see https://www.climatebonds.net/standards. For the documents listed above, see https://www.climatebonds.net/standard/bioenergy

1.6 Revisions to these Criteria

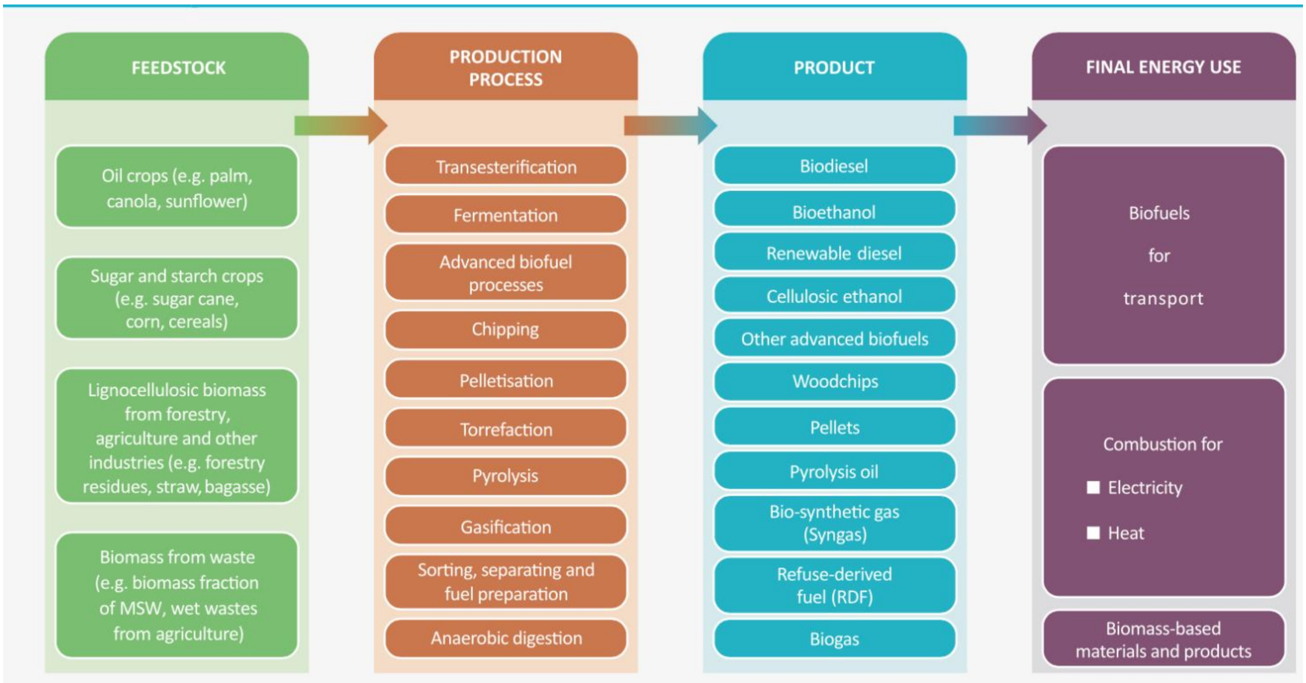
These Criteria will be reviewed two years after launch, at which point the TWG will take stock of issuances that arise in the early stages and any developments in improved methodologies and data that can increase the climate integrity of future bond issuances. As a result, the Criteria are likely to be refined over time, as more information becomes available. However, certification will not be withdrawn retroactively from bonds certified under earlier versions of the Criteria.

2. Sector Overview

2.1 What is Bioenergy?

Bioenergy is energy generated from solid, liquid and gaseous products derived from biomass, typically wood, agricultural crops, and organic waste from municipal and industrial sources.[10] While bioenergy in the form of wood, dung and peat has been a key energy source for humanity for centuries, this document refers only to modern commercial/industrial deployments for transport, industry, electricity, etc. Figure 1 shows the main different bioenergy pathways from feedstock to final energy use.

Figure 1 – Bioenergy Pathways



Source: OECD/IEA (2017). *Energy Technology Perspectives 2017: Catalysing Energy Technology Transformations.*

2.1.1 Feedstock and products

A wide range of feedstock can be used to produce bioenergy, including oil crops, sugar and starch crops, lignocellulosic biomass (wood, straw etc.), as well as municipal and agricultural wastes. Biofuel feedstocks undergo a range of different processes to maximise economic viability and/or the efficiency of energy conversion. The process involves two steps: fuel preparation and pre-treatment.

The fuel preparation process normally includes drying, size reduction, pelletisation or briquetting, and pyrolysis, improving the energy density and making feedstock easier to handle and transport. Pre-treatment changes the chemical nature of the feedstock and produces intermediate products which are more amenable to conversion. Processes include anaerobic digestion, thermochemical liquefaction, pyrolysis and gasification.[11]

[10] IEA/FAO (2017). *How 2 Guide for Bioenergy Roadmap Development and Implementation.*
[11] Ibid.

A variety of solid, liquid and gaseous products result from these processes. Liquid biofuels include ethanol, produced from fermenting any biomass type high in carbohydrates, and biodiesel, a diesel-equivalent processed fuel made from both vegetable oil and animal fats.[12] Biogas refers to a mixture of methane (CH_4) and carbon dioxide (CO_2) used as fuel and produced by bacterial degradation of organic matter or through gasification of biomass.[13] Solid biomass can be generated from a range of sources including agricultural crops and residues (e.g. maize, wheat, straw, animal manure), forestry (e.g. logs, stumps, leaves and branches), wood-processing industries (bark, off-cuts, wood chips, sawdust) and from organic waste (e.g. municipal solid waste and sewage sludge).[14]

2.1.2 Conversion and final energy use

After fuel preparation and pre-treatment, bioenergy products can be converted into final energy. Liquid biofuel can be used directly in the transport sector, and the combustion of liquid biofuel, biogas and solid biomass can generate heat and power.

Bioenergy for heating

Bioenergy can be used for cooking and space heating in buildings and industrial processes. Modern bioenergy heating technologies include efficient systems for the combustion of wood logs, chips, and pallets; municipal solid waste incineration; and use of biogas.[15] Bioenergy heat can be used for industrial applications such as in the pulp and paper sector, and cement production, as well as for domestic and commercial heating. One of the best large-scale examples is the district heating system in Sweden, where biomass provides 30% of the heat demand of Swedish buildings.[16]

Bioenergy for cooling

Instead of fossil fuel, which is dominating the cooling generation, biomass can be used as an alternative energy source. In the cooling system, biomass can be burnt in a boiler, generating heat for the absorption chillers to drive the cooling cycle. The cooling effect obtained can then be distributed by pipelines which are similar to the existing ones using fossil fuel as energy source. Biomass cooling systems can be used for both industry and households such as small-to-medium scale industrial and commercial facilities, multi-unit housing facilities, and strip malls. Biomass cooling systems are currently being used in Europe.[17]

Bioenergy for electricity

Electricity can be generated from biomass in the same way as hydrocarbons through combustion and steam turbines, either on its own or through co-firing with coal. Co-firing, or converting coal-fired power plants to operate entirely on biomass, is the most cost-effective large-scale renewables options as it only requires minor investment in biomass pre-treatment and feed-in systems within existing infrastructure.[18] CHP, or co-generation, which generates usable heat and electricity at the same time, has high energy conversion efficiency ranging from 80% to 90% in the best cases.[19]

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[12] IEA/FAO (2017). *How 2 Guide for Bioenergy Roadmap Development and Implementation.*
[13] Ibid.
[14] European Commission (2010). *Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling.*
[15] OECD/IEA (2017). *Energy Technology Perspectives 2017: Catalysing Energy Technology Transformations.*
[16] Ericsson K. and Werner, S. (2016). 'The introduction and expansion of biomass use in Swedish district heating systems', *Biomass and Bioenergy* 94 (November) 57-65.
[17] Agricultural Utilisation Research Institute (2016). *Biomass for Cooling System Technologies: A Feasibility Guide.*
[18] OECD/IEA (2017). *Energy Technology Perspectives 2017: Catalysing Energy Technology Transformations.*
[19] IEA (2015). *IEA Bioenergy Task 32 project: Techno-economic evaluation of selected decentralised CHP applications based on biomass combustion with steam turbine and ORC processes.*

Bioenergy for transport

Bioethanol has been widely used in vehicles in a number of countries, mostly blended with petrol, while the use of biofuels is increasingly mentioned as a viable option for reducing aviation and shipping emissions. However, liquid biofuels for transport have been most heavily associated with the environmental and social criticisms of bioenergy. This has increased the impetus to develop 'advanced' or 'second generation' biofuels using agricultural wastes and 'third generation' biofuels derived from algae.

Advanced biofuels are produced through biochemical or thermochemical processes. A biochemical process converts lignocellulosic materials into sugars, which are then be converted into alcohols or hydrocarbon fuels. Thermal processes turn biomass to potential fuels and chemicals: for example, syngas produced from biomass gasification can be converted into fuel and chemical products such as methane and methanol which can be then transformed into bio-gasoline, or gasoline, diesel and aviation fuels.[20]

Biomass-based materials and products

Biomass-based materials and products for non-energy use (such as food and feed ingredients, pharmaceuticals, chemicals, materials and minerals) can be generated through bio-refinery process alongside bioenergy-based products for power, heat and biofuels.[21] Bioenergy-and biofuel-based bio-refineries are becoming more common and in these, heat, power and biofuels are the main products, with both agricultural and process residues used to produce additional bio-based products.[22]

Box 1 – First-generation vs second-generation biofuels, and traditional vs modern bioenergy

First-generation biofuels (conventional biofuels) are primarily from food crops such as grains, sugar beet and oil seeds. Second-generation biofuels (advanced biofuels) are produced from feedstock from lignocellulosic materials include cereal straw, bagasse, forest residues, and purpose-grown energy crops such as vegetative grasses and short rotation forests.[23]

Traditional bioenergy refers to using solid biomass such as wood, charcoal, agricultural residues and animal dung converted with basic techniques with very low conversion efficiency (10% to 20%), such as a three-stone fire, for heating and cooking in the residential sector.[24] **It is often unsustainable, with inefficient combustion leading to harmful emissions with serious health implications.**[25] **Modern bioenergy uses solids, liquids and gases as secondary energy carriers to generate heat, electricity, combined heat and power (CHP) and transport fuels for various sectors, which has higher conversion efficiency.**[26]

[20] OECD/IEA (2017). *Energy Technology Perspectives 2017: Catalysing Energy Technology Transformations.*
[21] Ibid.
[22] Ibid.
[23] IEA (2008). *From 1st- to 2nd-Generation Biofuel Technologies: An overview of current industry and RD&D activities.*
[24] IEA/FAO (2017). *How 2 Guide for Bioenergy Roadmap Development and Implementation.*
[25] IEA Bioenergy (2017). *Technology Roadmap: Delivering Sustainable Bioenergy.*
[26] IPCC (2011). *Special Report on Renewable Energy Sources and Climate Change Mitigation.*

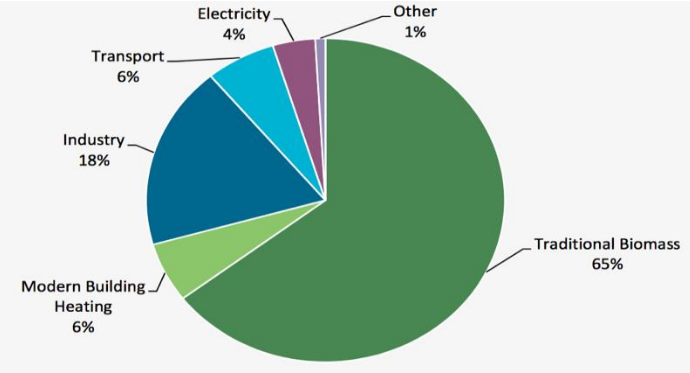
2.2 Bioenergy and Climate Change

2.2.1 Current state of bioenergy and future projections

Bioenergy already plays an important role in today's energy system, representing 11% of global final energy consumption in 2015.[27]

Traditional biomass for cooking and heating, still dominates the use of bioenergy (65%). The use of biomass in industry is the next most important use (18%), with bioenergy for electricity, transport and space heating following (see Figure 2).

Figure 2 – Bioenergy consumption in 2015



Source: http://www.iea.org/statistics/

Modern bioenergy (i.e. non-traditional biomass) for heating has been growing, and accounted for 70% of renewable energy for heating in 2015. The provision of heat for industrial processes was the largest end user (63%), followed by buildings (34%) and agriculture (3%).[28] It is expected that modern biomass for heating will grow at 2% per year by 2021.[29]

Electricity from biomass has more than doubled since 2005, providing 2% of global electricity generation. Different bioenergy production practices are linked to electricity generation in different countries. For example, the UK relies heavily on importing wood pellets for large-scale power generation; Sweden uses bioenergy for electricity via co-generation systems, bioelectricity production for industry and district heating in Brazil is mainly from agriculture wastes.[30] Globally, bioelectricity production is expected to grow at an annual rate of 6%, reaching 670TWh per year by 2021.[31]

Liquid biofuels consumption has experienced exponential growth from 16 billion litres in 2000 to more than 100 billion litres in 2011, stimulated by biofuels mandates and the introduction of flex-fuel vehicles in 2003. In 2015, biofuels accounted for 3% of all transport fuels (4% of road transport fuels) with bioethanol making up three-quarters of this, and the rest from biodiesel.[32] The US and Brazil dominate the production and consumption of liquid biofuels, with other producers including the EU, Argentina and Indonesia. Further growth of both ethanol and biodiesel are expected. The production of biofuel has slowed down with an average annual growth rate of 4% over 2010-16 due to economic

[27] IEA (2017). *Energy Technology Perspectives 2017.*
[28] IEA Bioenergy (2017). *Technology Roadmap: Delivering Sustainable Bioenergy.*
[29] IEA (2017). *Energy Technology Perspectives 2017.*
[30] Ibid.
[31] www.iea.org/statistics/
[32] IEA (2017). *Energy Technology Perspectives 2017.*

and structural challenges, and policy uncertainty in key markets. The global growth in conventional biofuels output is expected to slow further still over the next five years.[33]

It is estimated that over 60 countries have enacted regulations and national plans on promoting the use of bioenergy production and use. For example, the revised Renewable Energy Directive (RED II) that come into force in December 2018 establishes an overall target of at least 32% renewable, including bioenergy, in the final energy consumption in the EU by 2030, and sets up sustainability criteria for bioenergy.[34] Brazil plans to increase the share of sustainable biofuels in the energy mix to approximately 18% by 2030, as indicated by its Nationally Determined Contribution (NDC).[35]

The EU, US and Brazil are the largest producers and consumers of biofuels. The US is also a significant producer of wood pellets for heat and electricity production (most of this is however consumed in the EU). Many of the issues described in this paper are linked to EU policy developments which has largely driven the promotion of voluntary sustainability standards.

2.2.2 The role of bioenergy in addressing climate change

Given its potential for electricity, heating and transport sectors, IEA modelling suggests that an expanded role of bioenergy is required for the transition to a low carbon economy, as a lower GHG alternative to fossil fuel based energy. Its 2DS scenario (restricting global warming to 2 °C by 2100), as set out in the 2017 Energy Technology Perspectives, suggests a rise in biomass consumption from the current level of 63EJ per annum to 145EJ in 2060 could be necessary.[36] This includes[37]:

- A contribution of 30% of all transport fuels by 2060 (30 EJ in 2060, 10 times today's level), with a particular contribution to aviation and shipping fuels;
- Industrial heating using bioenergy increasing 2.5 times by 2060 compared to 2015
- A contribution of biomass to electricity generation at around 7% compared with 4% today.

On these assumptions, bioenergy would provide about 18% of the total annual savings in GHG emissions required by 2060 (5.7 $GtCO_2$ out of 31 $GtCO_2$), and would account for 17% of the cumulative reduction in GHG emissions to 2060 (128 $GtCO_2$ out of the total of 763 $GtCO_2$).[38]

In scenarios aiming to go beyond the 2°C level, namely the IEA Beyond 2DS (B2DS), it is suggested that bioenergy should provide 20% of additional annual emission saving required in 2060, contributing 20% of the cumulative GHG emissions reduction needed by 2060 (188 $GtCO_2$ out of the total of 1,022 $GtCO_2$). Bioenergy with carbon capture and storage (BECCS) is mentioned as important in B2DS, providing annual emissions reductions of 4.9$GtCO_2$ and cumulative emission reductions of 72$GtCO_2$ by 2060.[39]

[33] IEA Bioenergy (2017). *Technology Roadmap: Delivering Sustainable Bioenergy.*
[34] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG&toc=OJ:L:2018:328:TOC
[35] http://www4.unfccc.int/submissions/INDC/Published%20Documents/Brazil/1/BRAZIL%20iNDC%20english%20FINAL.pdf
[36] Note that the IEA's 2DS model is not a prediction, but an analysis of the energy system deployment pathway which is consistent with at least a 50% chance of limiting the average global temperature increase to 2°C.
[37] IEA Bioenergy (2017). *Technology Roadmap: Delivering Sustainable Bioenergy.*
[38] Ibid.
[39] Ibid.

2.3 Low Carbon and Climate Resilient Bioenergy

Bioenergy can only play a role in helping meet the temperature rise limit agreed by the international community if its applications are aligned with these aims. CO_2 emissions are generated when biomass is combusted and, if not done with care to replace the combusted stock, bioenergy assets/projects can generate net GHG emissions. Likewise, high emissions can be generated where land with pre-existing high carbon stocks is converted for feedstock cultivation, and/ or where feedstocks are transported long distances from cultivation sites to bioenergy facilities, and/ or the production of bioenergy leads to significant indirect land use change (iLUC) for the production of food and fibre.

Feedstock production can also impact on the resilience of ecosystems to climate change through changes to water quality, biodiversity and soil carbon, etc. And conversely, climate change can influence the resource potential and cultivation of feedstocks through changes in temperature and water availability.

For these reasons, bioenergy has faced a number of controversies over its potential environmental and social impacts which the Bioenergy Criteria must address to be credible. These include:

- The fact that an equivalent amount of new biomass must replace any biomass which is combusted in order to retain carbon neutrality, and this can take time.
- The unintended consequences of biofuel production in terms of direct and indirect land conversion (creating its own emissions) and ecological impacts.
- Displacement of food production which has in the past been linked to food price volatility and social unrest.

These impacts and issues are discussed in more detail below.

2.3.1 Greenhouse gas emissions from bioenergy

Bioenergy assets and projects emit GHG emissions over various points in their lifecycle, from land conversion, feedstock production, transport and distribution, and the energy or fuel production process. Different feedstocks and conversion pathways will have significantly different GHG profiles.

For example, land use change can create GHG emissions in many ways, including use of fire to clear land; land management practices affecting soil carbon stocks (such as peatland drainage); and permanent conversion of land from higher to lower carbon content vegetation.[40]

More broadly, direct land use change (LUC) occurs when biomass for energy purposes replaces other crops, pasture or forests; Indirect land use change (iLUC) describes a knock-on effect where biofuel feedstock production results in the conversion of lands somewhere else in order to produce the crops displaced by the biofuel feedstock.[41] Quantification of GHG emissions from land use remains a key uncertainty in lifecycle estimates.

Notwithstanding that uncertainty, lifecycle GHG emissions from bioenergy for electricity vary from 15 to 650 gCO_2e/kWh (4.2 to 181 gCO_2e/MJ) depending on feedstock[42], where the majority of lifecycle

[40] Ibid.
[41] Edenhofer et al. (2014). *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*
[42] Amponsah et al. (2014). *Greenhouse gas emissions from renewable energy sources: A review of lifecycle considerations.*

GHG emissions range from 16 and 74 gCO_2e/kWh, i.e. 4.4 and 21gCO_2e/MJ (excluding land use-related carbon stock changes and land management impacts).[43]

2.3.2 Impact of bioenergy on the resilience of the ecosystem to climate change

The production of bioenergy feedstock has impacts on surrounding ecosystems such as changes to water quality, biodiversity and soil. This may affect the resilience of these ecosystems to climate change. For example, the conversion of natural ecosystems into bioenergy plantations (or changed forest management) directly impacts wild biodiversity. Habitat and biodiversity loss may also occur indirectly through land use change. Pesticide and nutrient loading can further impact aquatic biodiversity.
Likewise, biofuel feedstock production can result in considerable soil impacts including soil carbon oxidation, changed rates of soil erosion, and nutrient leaching.[44] Like conventional agriculture and forestry systems, bioenergy can exacerbate soil and vegetation degradation associated with overexploitation of forests, intensive crop cultivation and forest residue removal, and water overuse.[45] Using agricultural residues without proper management can lead to detrimental impacts on soil organic matter through increased erosion, depending on management, yield, soil type and location.[46]

In particular, the production of certain feedstocks has been associated with environmental impacts such as deforestation, biodiversity loss and net GHG emissions, and high levels of indirect land use change (iLUC). For example, rising demand for palm oil has contributed to extensive deforestation in parts of Southeast Asia[47] and palm oil plantations support significantly fewer species than the forest they replace.[48] Large areas of tropical forests and other ecosystems with high conservation values have been cleared to make room for palm oil plantations. The clearing of forests has destroyed critical habitat for many endangered species, including Asian rhinos, Asian elephants and tigers. Intensive cultivation methods may also result in soil pollution, erosion and water contamination.

The subsequent processing of the feedstock into biofuels and electricity can increase chemical and thermal pollution loads from effluents and generate waste to aquatic systems.[49] For example, smoke pollution from burning of sugar-cane fields is leading to further acidification of the already poor tropical soils in Brazil.[50] Water use during feedstock production, e.g. fermentation of ethanol will affect water resources, and the emission of air pollutants from burning of biofuels potentially impacts water quality mostly via precipitation.[51]

The table below from IPCC provides an overview of risks and impacts related to bioenergy feedstock production.
Table 1 Emergent risks related to bioenergy feedstock production as a mitigation strategy

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[43] IPCC (2011). *Special Report on Renewable Energy Sources and Climate Change Mitigation.*
[44] IPCC (2011). *Special Report on Renewable Energy Sources and Climate Change Mitigation.*
[45] Koh, L.P., and J. Ghazoul (2008). *Biofuels, biodiversity, and people: Understanding the conflicts and finding opportunities*; Robertson et al. (2008). *Sustainable biofuels redux.*
[46] IPCC (2011). *Special Report on Renewable Energy Sources and Climate Change Mitigation.*
[47] UNEP (2008). *UNEP Year Book 2008: an Overview of Our Changing Environment.*
[48] Fitzherbert et al. (2008). *How will oil palm expansion affect biodiversity?*
[49] IPCC (2011). *Special Report on Renewable Energy Sources and Climate Change Mitigation.*
[50] Martinelli, L.A., and S. Filoso (2007). *Polluting effects of Brazil's sugar-ethanol industry.*
[51] http://www.wgbn.wisc.edu/conservation/ecological-and-environmental-impacts-bioenergy

Issue	Issue description	Nature of emergent risk
Direct and/or indirect land use change	Potential for increase in greenhouse gas emissions	Mitigation benefit of biofuels reduced or negated
Policies targeting only fossil carbon	Biofuel cropping competes with agricultural systems and ecosystems for land and water	Mitigation benefit of policies reduced; harmful interactions with other key systems
Food/fuel competition for land	Competition for land driving up food prices	Emergent risk of food insecurity due to mitigation-driven land use change
Biofuel production affects water resources	Competition for water affects biodiversity and food cropping	Emergent risk of biodiversity loss and food insecurity due to mitigation-driven water stress
Biofuel production affects biodiversity	Competition for land reduces natural forest and biodiversity	Emerging risk of biodiversity loss due to mitigation-driven land use change
Land conversion causes air pollution	Potential for increased production of tropospheric ozone from palm/sugarcane- induced land use change	Emergent risk of greenhouse gas-mitigation-driven plant and human health damage caused by tropospheric ozone
Fertilizer application	Potential for increased emissions of N_2O	Offsets some benefits of other mitigation measures
Invasive properties of biofuel crops	Potential to become an invasive species	Unintended consequences that damage agriculture and/or biodiversity

Source: IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability.*

2.3.3 Climate change impacts on bioenergy

Climate change continues to cause unprecedented changes in temperature, irradiation and soil moisture, which impact on agricultural production including the cultivation of feedstocks/ biomass for bioenergy. Overall, the magnitude and pattern of climate change effects remain uncertain. Detrimental impacts on productivity may occur in many important regions, though positive effects on plant growth, e.g. improved land productivity due to elevated atmospheric CO_2 may also exist.[52]

As crop production is projected to mostly decline with warming of more than 2°C, particularly in the tropics, biomass for energy production could be similarly affected.[53] Overall, the effects of climate change on biomass technical potential are found to be smaller than the effects of management, breeding and area planted, but they can be strong in specific regions[54]. Which regions will be most affected remains uncertain, but tropical regions are most likely to see the strongest negative impact.[55]

[52] IPCC (2011). *Special Report on Renewable Energy Sources and Climate Change Mitigation.*
[53] Ibid.
[54] German Advisory Council on Global Change (WBGU) (2009). *World in Transition – Future Bioenergy and Sustainable Land Use.*
[55] IPCC (2011). *Special Report on Renewable Energy Sources and Climate Change Mitigation.*

3. Green bonds and bioenergy

To achieve the 2°C global warming target, the IEA estimates that investment in bioenergy needs to rise from current levels of around USD25 billion per year to USD60 billion per year by 2030, and to around USD200 billion per year between 2050 and 2060. The total investment in bioenergy required under 2DS is expected to reach USD 6.1trillion, with USD1.6trillion in bioelectricity and USD4.5 trillion in transport biofuels production. The B2DS will require a further investment of USD1.7trillion in bioenergy.[56]

The USD93trillion global bond market has a huge potential to provide capital for bioenergy investment. Green bond has proven to be a useful tool to mobilise debt capital market for climate change solutions. The green bond market has been growing rapidly over the last three years with the global issuance totalling USD155bn in 2017.

However, the rapid growth in the green bond market has been met with questions around the environmental claims of these bonds. In the absence of clear and widely accepted definitions and standards around what is green, many investors have raised concerns about 'greenwashing', where bond proceeds are allocated to assets that have little or uncertain environmental value. This can both shake confidence in the market and hamper efforts to finance a transition to a low carbon economy.

The Climate Bonds Standard Bioenergy Criteria define what are low carbon and climate resilient bioenergy assets and projects by setting up requirements of climate change mitigation and adaptation impacts in the bioenergy sector. The Criteria provide guidance to the market on what types of bioenergy projects should be included in the green bonds, and ensure the robust growth of the market.

4. Key considerations in the development of Bioenergy Criteria for the Climate Bonds Standard

This document is not intended to provide a complete overview of the environmental impacts of bioenergy production, but rather to set out the key areas that the proposed eligibility criteria should address for qualifying bioenergy investments under the Climate Bonds Standard.

4.1 Guiding principles for the Criteria

The Climate Bond Standard needs to ensure that the bioenergy assets and projects included in Certified Climate Bonds deliver on GHG mitigation potential and climate resilience benefits, in line with best available scientific knowledge and compatible with the goals of the Paris Agreement. At the same time, the Bioenergy Criteria need to be pragmatic and readily usable by stakeholders in the market, to maximise engagement and use. High transaction costs run the risk of reducing uptake of a Standard in the green bond market. Keeping the costs of assessment down while maintaining robust implementation of the criteria is important. Table 2 sets out the principles guiding the development of the Bioenergy Criteria to meet and balance on these two goals.

Table 2 Key principles for the design of a Climate Bond Standard Bioenergy Criteria

[56] IEA Bioenergy (2017). *Technology Roadmap: Delivering Sustainable Bioenergy.*

Principle	Requirement for the Criteria
Level of ambition	Compatible with meeting the objective of 2º or less temperature rise above pre-industrial levels set by the Paris Agreement, and with a rapid transition to a low carbon and climate resilient economy.
Robust system	Scientifically robust to maintain the credibility of the Climate Bond Standard.
"Do not reinvent the wheel"	Harness existing robust, credible tools, methodologies, standards and data to assess the low carbon and climate resilient credentials of any technology, endorsed by multiple stakeholders where possible.
Level playing field	No discrimination against certain groups of producers (such as smallholders) or geographies.
Multi-stakeholder support	Supported by key stakeholders; those within the relevant industry, the financial community and broader civil society.
Continuous improvement	Subject to an evolving development process with the aim of driving continuous improvement and credibility in the green bond market.

4.2 Scope of the Bioenergy Criteria

4.2.1 Setting boundaries between the Bioenergy Criteria and Forestry/Agriculture Criteria

The Climate Bonds Standard uses the asset-based approach, that is, the decision of which Sector Criteria to apply depends on what types of assets issuers have.

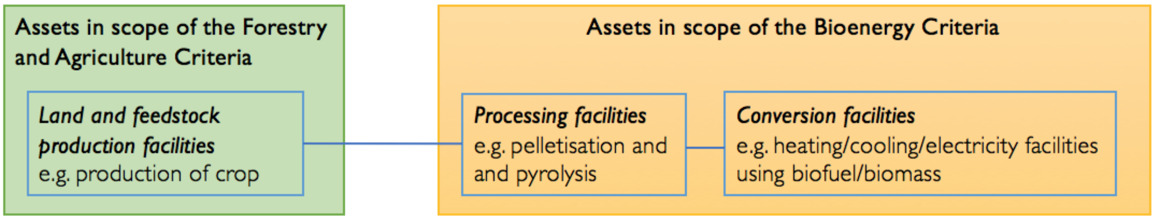
The production of bioenergy feedstock such as energy crops involves the use of land, i.e. the assets of feedstock producers are the land they are using and associated machinery and infrastructure for that cultivation. Therefore, the production of bioenergy feedstock using land will be covered under the Forestry/Agriculture Criteria which apply to land use and land management including production of food, fodder, feed and fibre, etc.

Instead, these Bioenergy Criteria cover bioenergy assets including processing facilities converting feedstock into biofuel/biomass, and conversion facilities converting biofuel/biomass into electricity and heat. Further information on this is given in the sub-sectors below.

It is noted, however, that the mitigation requirements in these Bioenergy Criteria (see Section 4.3 for more details) require bioenergy producers to conduct a life cycle assessment of the GHG emissions in order to meet mitigation threshold. This assessment includes accounting for emissions associated with the production of those feedstocks. .

Figure 3 illustrates the boundary between Bioenergy Criteria and Forestry/Agriculture Criteria. Details of assets covered by the Bioenergy Criteria can be found in Section 4.2.

Figure 3. Boundaries between the Bioenergy criteria and Agriculture/Forestry Criteria



4.2.2 Feedstock in scope

As a basic principle, the Criteria have been developed using a feedstock-neutral approach.

Based on the various energy scenarios reviewed for this paper, it is likely that the future bioenergy mix will be based on a variety of feedstock and technologies. While certain technologies, such as second generation biofuels, are in most cases considered environmentally and socially less risky than first generation technologies, their performance will largely depend on where and how the feedstocks are produced and converted into useful energy carriers.

Thus, in the main, the Criteria will *not* express a preference for certain feedstocks but it will rather propose a framework that will promote responsible production in any instance. This means that the Bioenergy Criteria will cover bioenergy generated from different types of feedstock, including residues, energy crops and lignocellulosic biomass such as straw.

This includes bioenergy production from palm oil, which is potentially eligible for certification. As discussed in Section 2.3.2, the production of palm oil can have negative environmental impacts such as deforestation and biodiversity loss and indirect land use change. But so can the production of many other feedstocks. Conversely, palm oil also has developmental benefits such as high productivity and yield.[57] Development banks have financed projects to develop sustainable sourcing and conversion for palm oil. It is the view of the TWG that adverse environmental impacts associated with palm oil are not inherent to palm oil as a crop, but the way it can be produced. Therefore, the Bioenergy Criteria do not rule out palm oil en mass, but, like all feedstocks, will allow only palm oil related bioenergy facilities where stringent climate and sustainability requirements are met. Details about these requirements can be found in Section 4.4.

That said, the Criteria do have a number of exclusions in eligible feedstocks. These are explained below.

Woody biomass

Woody biomass as a bioenergy feedstock requires sector-specific considerations to be taken into account, and will therefore be dealt with under a separate Bioenergy Criteria document that addresses only woody biomass feedstock.

[57] WWF (2015). *Sustainable Sourcing Guide for Palm Oils.*

Traditional biomass
The focus of the Bioenergy Criteria is on "modern bioenergy".[58] Traditional biomass use (see Box 1 for details) is *not* included in the scope of the paper due to the very different nature of the drivers and supply chains. Traditional biomass also represents no or very little relevance to financial bonds.

Third generation biofuels (algae)
The TWG acknowledges that this is a technology with potential, but notes that technology for algae-derived biofuels has not been well developed yet. Hence, it is difficult to set up specific environmental requirements with limited knowledge of the process. For this reason, algae as a bioenergy feedstock is not included in the scope of the Bioenergy Criteria at this stage. As the Bioenergy Criteria will be reviewed on a regular basis, future iterations will reconsider the inclusion of algae biofuels when the technology and market is more developed and better information is available.

Biodegradable Municipal Solid Waste
The process of producing energy from biodegradable municipal solid waste (MSW), including sewage sludge and food waste is covered by the Water Infrastructure Criteria and the Waste Management Criteria, respectively under the Climate Bonds Standard. However, wastes such as manure and wet wastes (farm and crop wastes) are in the scope of the Bioenergy Criteria.

4.2.3 Uses of bioenergy in scope

Bioenergy can take various forms. These Criteria are intended to cover facilities which use eligible feedstocks (as described above) to produce any of the following forms of bioenergy.

Electricity and heat
As discussed in Section 2.2.2, bioenergy is already playing an important role in power generation and the heating sector. The IEA's 2DS model projects bioelectricity providing 7% of generation in 2060 for a 2ºC compatible scenario, and heating for industry of over 2.5 times current levels by 2060.[59] As electricity and heat are some of the main applications of bioenergy, they are within scope.

Cooling
As discussed in section 2.1.2, biomass can be used as an alternative energy source for cooling, which is produced dominantly by burning fossil fuel. Biomass cooling systems can be used for both industry and households. The world's demand for cooling is increasing exponentially: for example, worldwide power consumption for air conditioning alone is expected to surge 33-fold by 2100.[60] It is important to reduce GHG emissions from cooling generation through options such as using biofuel instead of fossil fuel.

Transport
As discussed in Section 2.2.2, according to the IEA's 2DS scenario, biofuels for transport are projected to make a significant contribution in a 2ºC-compatible scenario, accounting for as much as 30% of all transport fuels by 2060.

For aviation and shipping, i.e. long-distance transport modes, biofuels play an important role in decarbonisation by replacing fossil-fuel driven high-energy-density liquid fuels, as these modes are

[58] Refers to biomass converted to higher value and more efficient and convenient energy carriers, such as e.g. pellets, biogas, and biodiesel.
[59] IEA (2017). *Energy Technology Perspectives 2017.*
[60] https://www.theguardian.com/environment/2015/oct/26/cold-economy-cop21-global-warming-carbon-emissions

more difficult to be electrified in the absence of improved battery performance and cost. Therefore, long-distance transport modes must be decarbonised through improvements of energy efficiency and shift to low-carbon energy carriers including biofuels.[61]

For road transport, the TWG has discussed whether the electrification of the road vehicles is a preferred alternative for rapid decarbonisation in road transport, to the extent that biofuels for road transport should be outside of the scope of these Criteria. However universal electrification may not be feasible given that large parts of the developing world still do not have access to electricity. More broadly, electrification is in its early stages. It may also still be more feasible for heavy vehicle types such as trucks and buses to run, at least in part, on liquid biofuels at least for the short to medium term.[62]

On this basis, biofuels for road, shipping and aviation are within the scope of the Bioenergy Criteria.

Biomass-based materials and products for non-energy use

As discussed in Section 2, biomass can also be converted into a range of marketable food & feed ingredients, chemicals and materials for non-energy purpose, which have the potential to contribute to the circular economy. These products are not covered by the Bioenergy Criteria as they are not for energy purpose. However, facilities which produce biomass-based materials for energy use and other materials for non-energy purpose such as food and feed ingredients, chemicals and materials as co-products will be potentially eligible for certification, subject to meeting the eligibility requirements in Section 4.2.4 below.

4.2.4 Bioenergy assets in scope

Taking into account the discussion above on eligible feedstocks and eligible bioenergy use, Table 3 summarises the assets that are potentially eligible for certification, subject to: using one of the eligible feedstocks per section 4.2.2, and meeting the Criteria described in the rest of this document. Table 4 summarises the assets which cannot be certified under these Criteria, and explains why.

Note that the scope of eligible bioenergy assets are set up based on the 2° C or well below 2° C global warming target and climate modelling. To reduce the risk of including bioenergy assets that are not compatible with the long term climate target, the scope will be reviewed and updated when necessary if the latest climate science suggests.

As a general note, as discussed in section 2.2.2, the TWG recognises the potential of bioenergy carbon capture and storage (BECCS) in achieving the 2°C and well below the 2°C global warming targets. Therefore, assets in scope will include bioenergy assets with and without carbon capture and storage.

Table 3 Assets covered by Bioenergy Criteria

Assets covered	Notes

[61] IEA (2017). *Energy Technology Perspectives 2017.*

[62] Note that, contrary to some media reports, those countries and cities which have announced policies to ban sales of petrol and diesel vehicles have not specified that electric vehicles must be used instead.

Facilities producing biofuel/biomass using feedstock in scope	
Fuel preparation process facilities such as those for drying, size reduction, pelletisation or briquetting, and pyrolysis	The product from the fuel preparation process facilities may not be the biomass ready for energy conversion. However, the Criteria still require them to meet the GHG thresholds for biomass/biofuel. See details in Section 4.3.
Pre-treatment facilities such as those for thermochemical liquefaction, pyrolysis and gasification	
Bio-refinery facilities	Facilities which produce both bioenergy-based products for power and heat, and biomass-based materials and products for non-energy use (such as food and feed ingredients, pharmaceuticals, chemicals, materials and minerals), are potentially eligible for Certification under the Criteria, subject to specific requirements (Section 4.3 and 4.4). However, facilities producing less than 50% of the biomaterial for energy use will not be eligible under the current iteration of the Bioenergy Criteria, due to the challenges to determining appropriate eligibility Criteria for such projects and facilities.
Energy production facilities	
Heating/cooling facilities using biofuel/biomass	Not including energy production from biodegradable municipal solid waste (MSW), including sewage sludge and food waste, which are covered by the Water Infrastructure Criteria and the Waste Management Criteria, respectively under the Climate Bonds Standard. However, wastes such as manure and wet wastes (farm and crop wastes) are in the scope. Not including energy production from algae.
Electricity generation facilities using biomass, including those with CCS	As above
Supporting infrastructure	Dedicated transmission lines from an eligible bioenergy facility to the main grid

Table 4: Assets *not* covered by the Bioenergy Criteria

Assets not covered	Reason
Facilities producing bioenergy from biodegradable municipal solid waste (MSW), including sewage sludge and food waste.	Covered by the Water Infrastructure Criteria and the Waste Management Criteria under the Climate Bonds Standard.

Facilities producing bioenergy from third generation biofuels (algae)	Future iterations will reconsider the inclusion of algae biofuels when the technology and market is more developed and better information is available.
Traditional biomass use, such as a three-stone fire for heating and cooking in the residential sector.	Traditional biomass has very low conversion efficiency (10%-20%), with inefficient combustion leading to harmful emissions with serious health implications. And it represents no or very little relevance to financial bonds.
Land and land management assets for the cultivation/ production of feedstocks and biomass for bioenergy	Covered under appropriate sector criteria, e.g. Forestry for timber, Agriculture (in development) for various other feedstocks.
Transportation assets to transport biomass to pre-treatment or bioenergy or bio-refinery facility	Covered by the Climate Bonds StandardLand Transport Criteria. Vehicles need to follow the GHG emissions trajectory compatible with the 2ºC global warming target, i.e. they need to meet specific GHG emissions thresholds in terms of gCO_2/km/passenger or gCO_2/km/tonnes of freight.[63]
Vehicles used in the process of the production or transportation of bioenergy, e.g. flexi-fuel vehicles, or that run on biofuels.	Covered by the Climate Bonds Standard Transport Criteria. Vehicles need to follow the GHG emissions trajectory compatible with the 2ºC global warming target, i.e. they need to meet specific GHG emissions thresholds in terms of gCO_2/km/passenger or gCO_2/km/tonnes of freight.[64]
Facilities for the manufacture of aircrafts and ships that run on biofuels, and those aircraft and ships themselves.	Covered by the Climate Bonds Standard Aviation Criteria and Shipping Criteria to be developed, whereas the Bioenergy Criteria cover biofuel used for shipping and aviation.
Blending facilities mixing with biofuel and fossil fuel	The TWG has explored the option of putting a minimum blending rate as a threshold for blended fuel/facilities in order to achieve significant emissions reduction. However, the blending rate will depend on the transport sector (road, shipping and aviation) where the biofuel is being used, which is beyond the scope of biofuel production. Therefore, this iteration of the Bioenergy Criteria will not include blended fuel and blended facilities, nor set up any requirement on blending rate. The Climate Bonds Standard will keep watching this space and set up requirements for blending facilities with further investigation in transport sector.
Facilities dedicated to the production of biomaterials (food, feed, chemicals, etc.)	See Table 3 for more information on when these facilities will and will not be eligible.

[63] Climate Bonds Initiative (2016). *Low Carbon Land Transport and the Climate Bonds Standard.* https://www.climatebonds.net/standard/transport
[64] ibid.

4.3 Mitigation Requirement

As discussed in Section 2, bioenergy use in most cases is driven by GHG mitigation objectives. However, bioenergy assets/projects also generate GHG emissions over their lifecycle from land use change, feedstock production and processing, blending, transport and distribution. Therefore, to deliver a net mitigation benefit, these emissions need to be less than those generated by conventional fuels. How much less is determined by the rapid decarbonisation trajectories implied by the transition required to meet the Paris Agreement target.

In addition, different feedstocks and conversion pathways for different bioenergy outputs will have significantly different lifecycle GHG emissions. Therefore, it's important to set net GHG emission thresholds for different bioenergy assets/projects in order for the sector to deliver actual and sufficient emission reductions, according to need and opportunity.

All of which means that under the Bioenergy Criteria, issuers are required to conduct a life cycle assessment of GHG emissions from their bioenergy facility to demonstrate that they meet the appropriate GHG emissions threshold for that type of facility.

Discussed below are: Section 4.3.1 the scope of GHG emissions to be included in this assessment; Section 4.3.2 the methodology/tool to be used to estimate these GHG emissions; Section 4.3.3 - 4.3.8 the appropriate GHG emissions threshold to use as a screening Criteria for eligibility for certification under the Climate Bonds Standard; Section 4.3.9 requirements on reduce risk of carbon stock reduction to address carbon debt issues; Section 4.3.10 requirements to address iLUC; and Section 4.3.11 discussions on material displacement effect.

4.3.1 Scope of GHG emissions threshold: life cycle assessment

The Criteria require issuers to conduct a life cycle assessment of the GHG emissions from bioenergy production. Aligning with RSB, EU RED and other calculation tools (Section 4.3.2), the scope of the GHG emissions LCA is from cradle to the use of biomass/biofuel, and it should include direct emissions from:

- Feedstock production (including emissions from direct land use change)*
- Feedstock processing
- Biofuel/bioenergy production
- Biofuel storage and blending
- Intermediate and final transport steps: transportation of feedstock to processing facilities to fuel production facilities, and transportation of fuel to the point of consumption

Each GHG Calculation Tool (Section 4.3.2) contains details of the boundary of the LCA.

Emissions from indirect land use change (iLUC) are normally beyond the control of the actors involved in the bioenergy supply chain and the actions to reduce indirect emissions are difficult. Quantifying GHG emissions from iLUC is also challenging. Therefore, indirect emissions from land use change will not be in the scope of the LCA. iLUC is therefore addressed separately. See Section 4.3.10 for more details on requirements in respect of iLUC.

Embedded emissions such as emissions from producing farm equipment (e.g. tractors), fossil feedstock production equipment (e.g. drilling equipment), fuel production equipment (e.g. refineries), and others are normally very small. So they will not be included in the scope of LCA. This is also consistent with the approach in other renewable energy sectors. As a result, transmission lines dedicated to bioenergy, of which the emissions fall into the embedded emissions of facility construction, will be automatically eligible without the need to check its emission performance.

GHG emissions from carbon stock changes other than those from direct land use change are not required to be included in the LCA. Additional requirements are set up to address the risks of reduced carbon stock (see Section 4.3.9).

4.3.2 Methodology for GHG emissions calculation

There are a lot of debates about how to do the GHG emissions calculation, what approach should be taken for allocating GHG emissions to products, how long the life time should be over which you can average carbon emissions, and so on. As with all sector Criteria under the Climate Bonds Standard, the Bioenergy TWG suggests that we do not invent a new methodology for LCA but instead adopt one that has already been tested and approved. The Bioenergy TWG proposed the issuer can use existing methodologies approved by legislative system or voluntary standards. In terms of legislative systems, the EU, US and Canada have different systems. RSB attempts to take the best part of all of those. Which tools are therefore to be used to estimate GHG emissions for the purposes of certification are specified below.

Tools for LCA

The TWG believed that the five tools (see Table 5) below are robust tools for calculating GHG emissions from bioenergy. BIOGRACE[65] is recognised by the European Commission as a voluntary scheme, and is in line with the EU RED sustainability criteria. RSB GHG Calculator[66] is developed by RSB in collaboration with EMPA, the Swiss Federal Laboratories for Materials Science and Technology, and HTM Berlin. It has been used by RSB's certification scheme. UK Solid and Gaseous Biomass Carbon Calculator[67] is provided by the UK's Office of Gas and Electricity Markets (Ofgem) to operators under the Renewables Obligation scheme (RO), and the Non-Domestic Renewable Heat Incentive scheme to calculate their GHG emission savings. GREET[68] is developed and maintained by Argonne National Laboratory under the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE), which is to fully evaluate energy and emission impacts of advanced vehicle technologies and new transportation fuels.

Issuers are required to choose one of these tools for GHG emissions calculation. Where using one of these tools is not a viable option, issuers may use other tools to calculate GHG emissions. However, in this case, issuers must submit details of the calculation, the tool being used and the underlying methodology and assumptions (if any) to the Climate Bonds Initiative in advance of an application for certification. The Bioenergy TWG will review the information provided, and decide whether the tool used by the issuer is robust. If so, the tool will be included as one of the endorsed GHG calculation tools for issuers to use under the Bioenergy Criteria.

[65] http://www.biograce.net/home
[66] http://rsb.org/services-products/ghg-calculator/
[67] https://www.ofgem.gov.uk/publications-and-updates/uk-solid-and-gaseous-biomass-carbon-calculator
[68] https://greet.es.anl.gov/

Table 5 Endorsed GHG Calculation Tools

Name	Technical scope	Origin
BIOGRACE I	Liquid biofuels	EU
BIOGRACE II	Biomass for electricity, heating and cooling	EU
RSB GHG Calculator	Liquid biofuels	International
UK Solid and Gaseous Biomass Carbon Calculator	Solid biomass and biogas used for heat and electricity generation	UK
GREET	Alternative fuels in transport	US

Allocation of GHG emissions

As discussed in Section 2.1.2, biomass-based materials and by-products other than bioenergy, such as food and feed ingredients, pharmaceuticals, chemicals, materials and minerals can be generated during the process of bio-refinery. The TWG has agreed that GHG emissions should be allocated to different products. Only GHG emissions allocated to electricity, heat, cooling and/ or fuel production are required to meet the GHG emissions threshold are required to meet GHG emissions threshold (see details in Section 4.3.4 and 4.3.5).

The TWG has explored allocation methodologies including energy content based allocation, mass content based allocation and system expansion (market price based allocation). The TWG thinks that energy content based method is robust and less complicated than system expansion approach, and is being used by most of the bioenergy GHG emissions calculation tools. Therefore, the TWG has decided that under the Criteria, issuers are required to allocate emissions based on energy content of the biomass-based products.

4.3.3 Principles for GHG emissions thresholds

Consistent with the overarching principles of the Climate Bonds Standard, the Bioenergy TWG aims to establish a GHG emission threshold(s) for bioenergy projects/assets consistent with the 2°C or below global warming targets. These thresholds might potentially vary according to different types of facilities and different bioenergy products – reflecting the substitutes available in different circumstances, and the different options available in terms of a rapid decarbonisation trajectory.

It has also been heavily influenced by key legislation focused on the ensuring the sustainability of bioenergy, most notably the EU Renewable Energy Directive II (EU RED II) published in December 2018, the provisions of which must be transposed into national legislation by 30 June 2021.

Under EU RED II, compared to fossil fuels alternatives, biofuels and bio-liquids produced in installations starting operation on or before 5 October 2015 should achieve at least 50 % emissions reduction; those produced in installations starting operation from 5 October 2015 should achieve at least 60 % emissions reduction; those produced in installations starting operation after 1 January 2021 should achieve at least 70 % emissions reduction. And emissions reduction should be at least

75 % for electricity, heating and cooling production from biomass fuels used in installations starting operation after 1 January 2021 and 80% for installations starting operation after 1 January 2026..

With this in mind, the TWG decided to adopt as an underlying principle governing the Bioenergy Criteria the requirement that for biofuel/biomass inputs, emissions thresholds will be 80% lower than fossil fuel baselines.

With respect to **bioenergy output (final energy) for electricity**, the TWG determined that a common threshold (using a metric of $XgCO_2e$/kWh for example) for all types of power generation would represent a consistent 'low carbon power' threshold which recognises the importance of all renewable energy sources for achieving rapid decarbonisation in the power sector, while also prohibiting the certification of individual bioenergy facilities which have significant associated emissions and are therefore not in alignment with the necessary decarbonisation trajectory for the power sector indicated by the latest climate modelling. The Bioenergy TWG, therefore, explored the idea of using similar metrics for bioenergy as other renewables with Climate Bonds Criteria. For example, under the Climate Bonds Standard Geothermal Criteria and Hydropower Criteria, electricity generated from geothermal facilities and hydro facilities need to not exceed a GHG emission threshold of 100gCO_2/kWh (see Section 4.3.5 for rationale of using 100gCO_2/kWh to define low carbon power) to be considered as low carbon and eligible for certification.

The GHG emissions thresholds for electricity generation from biofuels therefore marry a requirement for a consistent 'low carbon power' threshold, with the principle of emissions thresholds for biofuel/ biomass inputs being 80% lower than fossil fuel baselines.

The TWG also explored options for establishing different GHG thresholds for existing and new electricity generation facilities. This is explained further in the description of selected emissions thresholds below.

For **bioenergy output (final energy) for heating/ cooling**, the possibility of electrified heating is an active discussion in climate policy circles. However, the large-scale electrification of the heating sector is likely to come after energy efficiency improvements and could compete with hydrogen and biogas for heating. The heating market is also complicated due to segmentation. There are huge differences among industrial process heat, space heating, heating for cooking, or heating for water, metropolitan areas with distributed heating works and rural areas. So benchmarking heating output from bioenergy with electricity is problematic.

For these reasons, for bioenergy for heating/cooling and co-generation, in addition to a GHG emission threshold for biofuel/biomass itself, the TWG has considered a requirement on energy conversion efficiency to make sure biofuel/biomass input will be in a good use to deliver carbon emissions reduction. Some biofuel/biomass might be able to meet a GHG emissions threshold even with very low conversion efficiency. Efficiency will vary depending on the use of bioenergy (electricity, heating and transport) and types of technology (e.g. co-firing and CHP). Details of energy efficiency threshold can be found in Section 4.3.6.

For transport, the TWG thinks that in the long-term (up to 2050 and beyond), the decarbonisation of the transport sector will rely to a large extent on electrification, at least for road transport, but this is not widespread at present, hence an interim option for biofuels for road transport to replace fossil fuels. For shipping and aviation sector, it is not believed electrification is a viable long-term strategy.

For these reasons, thresholds for the production of biofuels for transport are also based on the requirement that biomass inputs represent a reduction of 80% compared to a fossil fuels baseline.

How these principles play out for specific eligibility Criteria and thresholds for different bioenergy assets is explained below.

4.3.4 GHG emissions thresholds for electricity facilities using biofuel/biomass

It would be ideal to be able to derive a simple emissions intensity benchmark for the global power sector from the Integrated Assessment Models (IAMs) used to model climate scenarios. To this end, the latest climate modelling which aims to map out 2ºC decarbonisation scenarios has been reviewed to see what guidance or framework parameters it can provide on the scale of decarbonisation required across the power sector.

However, using these models is problematic due to the following challenges:

- Most climate models do not separately identify different technologies within the power sector, but provide indicators in the form of budgets or average carbon intensities across the power sector more broadly.[69]
- These indicators are at global levels. In reality, each country will have specific considerations driving their optimal energy mix, and the associated emissions from that.
- These indicators are subject to the uncertainties inherent in modelling. Therefore, they should be interpreted loosely and not as hard and fast limits.[70]
- Due to the uncertainties inherent in climate modelling, scenarios are generally presented as having a probability of limiting warming to 2ºC (or some other temperature). Generally, a 2°C scenario is considered to be one that limits warming to below 2°C with a probability of at least 66%, though some models use a probability of at least 50%. Further, some scenarios do not match the objective of limiting warming to 2°C, but instead denote the degree of radiative forcing or atmospheric concentration of CO_2 which they result in.

Therefore, the approach taken has not been to pick a power sector emissions intensity benchmark from any one IAM and use it as a rigid threshold for bioenergy. Instead, the approach has been to be guided by the sense of direction and scale of reductions in power sector emissions described by climate models as well as the IEA's Energy Technology Perspective[71] model (IEA ETP) on the scale of emissions reductions required from the global power sector, using this as a starting point to set an emission intensity threshold compatible with the bioenergy sector as a whole that contributing to achieving this, while also recognising some diversity in individual circumstance according to the alternative capacity and political choices at play. A number of clear and consistent messages can be taken from these models and analysis:

- The GHG budget for the global power sector is very low, and this needs to be reflected by the Criteria.

[69] Many models do not disaggregate by technology; those that do often focus on primary energy supply, in which case fossil fuels used for power generation are included in the same category as those for transport, industry, etc.

[70] Integrated Assessment Models are subject to large uncertainties because by their very nature they are reducing a complex real world process with social, economic, technological and physical science dimensions to a limited set of quantitative inputs and outputs. This means that any GHG budget or emissions intensity pathway they describe for the power sector is indicative only and should not be treated too rigidly

[71] Discussed in its annual Energy Technology Perspectives reports

- The models indicate a clear direction of travel for the global power sector, namely: drastic and rapid decarbonisation across the sector within just three decades.
- Reducing power sector emissions is often seen as one of the cheapest and most politically acceptable mitigation options, hence power sector reductions are much steeper than for global emissions as a whole.
- This needs to happen in spite of increasing global demand for electricity. Low carbon technologies in the form of renewables, nuclear power and CCS need to expand rapidly not only to replace fossil fuels, but also to meet this increased demand.
- Overall, the models indicate a clear direction of travel for the global power sector, namely: drastic and rapid decarbonisation across the sector within just three decades.
- The vast bulk of power sector emissions reductions will obviously come from a switch away from thermal energy sources. However, the tight GHG budget suggests a high degree of ambition is required, and therefore that it is reasonable to place precautionary limits on even relatively low-emitting power sources such as hydropower, particularly as they are so long-lived.

These precautionary limits need to strike a balance which set us on the right path in terms of overall decarbonisation, but allows flexibility due to the different political, technical and geographic circumstances of individual countries.

To achieve this, an emissions intensity threshold of 100gCO_2e /kWh for bioenergy is proposed for facilities commissioned up to and including 2021, based on the following reasoning:

- A threshold of 100g CO_2e/kWh would lead to the average sector performance improving, while not being so stringent as to produce the perverse result of discouraging a large number of projects which would be preferable to thermal alternatives. This is because: lifecycle GHG emissions from bioenergy for electricity vary from 15 to 650 gCO_2e/kWh[72], where the majority of lifecycle GHG emissions range from 16 and 74 gCO_2e/kWh (excluding land use-related carbon stock changes and land management impacts).[73]

Whether different thresholds should be set for new and existing bioenergy facilities was also considered, specifically, a lower threshold for new facilities. IEA analysis has previously suggested average emissions intensity of new-build electricity capacity should be ~50 gCO2e/kWh over the period 2020-2040.[74] There is certainly appeal in making new builds more ambitious as they will exist longer into the future, and this will help to bring the industry average down. The TWG decided to set just such a lower threshold for 'new' facilities, using recent changes to the UK Government's Department for Business, Energy and Industrial Strategy Contracts for Difference Scheme for Renewable Electricity Generation as a precedent. In line with this, the TWG decided to adopt a lower threshold of 29 kg CO2e / kWh for plants commissioned after 2021..[75]

[72] Amponsah et al. (2014). *Greenhouse gas emissions from renewable energy sources: A review of lifecycle considerations.*
[73] IPCC (2011). *Special Report on Renewable Energy Sources and Climate Change Mitigation.*
[74] https://www.iea.org/media/ebc/13thebcmeetingjune2015/Gagne.pdf
[75] In August 2018, a government consultation on proposed amendments to the Scheme and follow-up consultation on implementation, contract changes, and a revised CHPQA standard took place. In response to that, the UK Government decided that in light of the responses to the consultation, and the new data that has become available since the consultation period, a revised GHG threshold would be used, based on a central value for bioenergy production (the median - equivalent to the 50th percentile). This value lies between the two GHG threshold options which the government consulted on in the

On a case-by-case basis, these thresholds threshold would then meet the main objectives of:

- Reducing or limiting bioenergy's average emissions, thereby demonstrating a strong contribution to reducing the global power sector GHG budget;
- Being unlikely to result in instances of bioenergy projects which are clearly preferable to fossil fuel alternatives being ineligible for certification; and
- Being unlikely to result in low performing bioenergy projects which would significantly raise the sector average being certified;
- Being consistent with the mitigation criteria already adopted by the Climate Bonds Standard for other forms of renewable energy.

As with all of the Climate Bonds Standard Sector Criteria, we will revisit our assumptions, data and proposed Criteria on a regular basis. Our first review will be no more than 1 year from release of the Criteria, less if significant new knowledge or tools emerge before then, or if experience in the market demonstrates the need for review. For example, the imminent release of 1.5 degree warming scenarios will be reviewed as a matter of priority to determine whether these scenarios imply a significantly different decarbonisation trajectory for the power sector.

4.3.5 GHG emissions thresholds for facilities producing biofuel/biomass

As discussed in section 4.3.3, for facilities producing biofuel/biomass as bioenergy input, the biofuel and biomass produced needs to achieve 80% emissions reduction compared to fossil fuel baseline.

This approach requires the agreement of appropriate fossil fuel baselines. One option is that fossil fuel baseline would be decided by methodologies or benchmarks in either national regulations or existing voluntary standards, and issuers would adopt the baselines set for their jurisdictions. However, this approach would create inconsistency among bioenergy assets/projects in different jurisdictions or those using different voluntary standards due to different baseline calculation methodologies.

As climate change is a global issue, and the decarbonisation pathways required to meet 2ºC or 1.5ºC goals are globally relevant, a uniform emission reduction target and baseline for issuers around the world with the same level of ambition is more logical. For this reason, the TWG has decided to use fossil fuel baselines under the EU RED II as the EU RED II represents a global effort to drive the development of bioenergy, and the science behind these baselines has improved compared to the existing EU RED. These baselines are also aligned with other standards such as the EU Fuel Quality Directive, US EPA RFS and California Low Carbon Fuel Standards.

Table 6 summarises the fossil fuel baselines under EU RED II[76], that it is therefore proposed are embedded in the Bioenergy Criteria under the Climate Bonds Standard.

Table 6 Fossil fuel baseline under the EU RED II

December 2017 consultation, and was considered to strike a suitable balance between ensuring new plants are demonstrably 'low carbon' and ensuring that developers are able to build plants that can comply with this new GHG criteria value (threshold). This value supports solid and gaseous biomass plants that have low GHG emissions compared with currently operating plants. - UK Department for Business, Energy and Industrial Strategy, (2018). *Contracts for Difference Scheme for Renewable Electricity Generation.* Available online.

[76] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/sustainability-criteria

Bioenergy	Baseline (gCO_2e/MJ)
Biofuels for transport	94
Bio-liquids used for heat production	80
Solid and gaseous biomass for heating/cooling production	80 (heat/cooling)

Note that for solid and gaseous biomass for heating/cooling, the EU RED II has set up fossil fuel baselines for heat/cooling produced (final energy), but not for the biomass itself (primary energy). Given the baseline for bio-liquids used for heat production is the same as that for heat/cooling produced from solid and gaseous biomass, the TWG has decided that the baseline for heat/cooling produced from solid and gaseous biomass (final energy), which equals to the baseline for bio-liquids, will be used as the baseline for solid and gaseous biomass itself (primary energy).

The TWG did however decide to set up a separate threshold for biofuel/biomass for electricity. This is to ensure the consistent level of ambition along the supply chain, and to ensure the electricity producer can meet the $100gCO_2e/kWh$ threshold for facilities commissioned pre-2021. Given the maximum energy efficiency of converting biofuel/biomass is about 40%[77], the necessary threshold for biofuel/biomass primary energy would be 11.1 or $3.2gCO_2e/MJ$ respectively.[78] This is also aligned with the requirement that biofuel/biomass input should achieve 80% emissions reduction compared to fossil fuel baseline.

The resulting GHG emissions thresholds for input biofuel/biomass are shown in Table 7 below. Facilities producing biofuel/biomass need to meet these thresholds.

Table 7 GHG emissions thresholds for facilities producing biofuel/biomass

Assets	Thresholds	Notes
Facilities producing liquid biofuel, solid and gaseous biomass for electricity production	$11.1/3.2gCO_2e/MJ$	To achieve $100gCO_2e$ /kWh (existing) or $29gCO_2e/kWh$ (new) for electricity generated with energy efficiency of 40%.
Facilities producing liquid biofuel, solid and gaseous biomass for heating and co-generation	$16.0gCO_2e/MJ$	To achieve 80% emission reduction to $80gCO_2e/MJ$ baseline
Facilities producing biofuel for transport	$18.8gCO_2e/MJ$	To achieve 80% reduction to $94gCO_2e/MJ$ baseline

[77] Joint Research Centre (JRC), (2017). Solid and Gaseous Bioenergy Pathways: Input Values and GHG Emissions. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/solid-and-gaseous-bioenergy-pathways-input-values-and-ghg-emissions-calculated-according-0

[78] (100gCO2e/kWh) / (3.6MJ/kWh) $\times$40% (efficiency) = $11.1gCO_2e/kWh$
(29gCO2e/kWh) / (3.6MJ/kWh) $\times$40% (efficiency) = $3.2gCO_2e/kWh$.

4.3.6 Requirements for heating/cooling, and co-generation facilities using biofuel/biomass

As discussed in Section 4.3.3, in addition that biofuel/biomass being used needs to meet 80% GHG emissions thresholds compared to fossil fuels, heating/cooling, and co-generation facilities using biofuel/biomass are required to meet energy efficiency thresholds as well. The TWG has set up these energy efficiency thresholds for using biofuel/biomass for heating/cooling based on the best practices in the industry. The TWG has checked data about energy efficiency of bioenergy for heating/cooling and co-generation (see Table 8), and decided to set up 80% as energy efficiency threshold. Based on the data about the current practices in the industry, 80% is ambitious but achievable with current technologies.

Note that some CHP facilities may not always be in CHP mode. For example, in winter CHP plants would be in CHP mode to produce heat and power as the demand for heating is high; while in summer the CHP plants may only generate electricity as the demand for heating is low. Under the Criteria, CHP facilities need to meet requirements when they are in CHP mode.

Table 8 Energy efficiency of bioenergy facilities for heating, cooling and CHP

Bioenergy facilities	S2Biom database[79] (solid biomass)	EU average[80]
Heating/cooling	60% (min) - 85% (typical) - 90% (max)	81%
CHP	*Heating* 30% (min) - 62% (typical) - 80% (max) *Electricity* 15% (min) - 32% (typical) - 42% (max)	*Heating* 67% *Electricity* 19%

4.3.7 Summary of GHG emissions thresholds

Based on the discussion above (Section 4.3.1 – 4.3.6), a summary of GHG emissions thresholds under the bioenergy sector is demonstrated in Table 9 below.

In summary, for electricity facilities, the electricity generated from biomass/biofuel is required to meet 100gCO_2e/kWh emissions threshold for facilities commissioned during or prior to 2021, and 29gCO_2e/kWh emissions threshold for plants commissioned after 2021. For heating/cooling and co-generation facilities, their biofuel/biomass used is required to achieve 80% emission reduction compared to fossil fuel, and meet the appropriate energy efficiency threshold. These principles are summarised as below in Box 2.

Table 9 Summary of GHG emissions thresholds under the Bioenergy Criteria

Assets	Principle	Thresholds for biofuel/biomass produced/used	Energy efficiency thresholds	Electricity threshold

[79] http://s2biom.alterra.wur.nl
[80] BASIS (2015). *Report on conversion efficiency of biomass*. http://www.basisbioenergy.eu/publications/basis.html

Facilities producing liquid biofuel, solid and gaseous biomass for electricity production	80% GHG reduction compared to fossil fuel baseline, and consistent with the electricity generation GHG threshold	11.1/3.2gCO_2e/MJ	N/A	N/A
Facilities producing liquid biofuel, solid and gaseous biomass for heating and co-generation	80% GHG reduction compared to fossil fuel baseline	16.0gCO_2e/MJ	N/A	N/A
Facilities producing biofuel for transport	80% GHG reduction compared to fossil fuel baseline	18.8gCO_2e/MJ	N/A	N/A
Electricity facilities using biofuel/biomass	Consistent with 'low carbon power' goals across whole power sector to enable 2D targets to be met	N/A	N/A	100gCO_2e /kWh (existing) or 29gCO_2e/kWh (new)
Heating/cooling, and co-generation facilities using biofuel/biomass	80% emissions reduction compared with fossil fuel baseline; and energy efficiency threshold	16.0gCO_2e/MJ	80%	N/A

4.3.8 Implications of proposed GHG thresholds for input biomass/biofuel

To test whether the thresholds for biofuel/biomass are too stringent or too loose, the TWG has examined data about typical values of lifecycle GHG emissions from bioenergy provided by the EU RED II, and has found that: biofuel and bio-liquid such as biodiesel, hydrotreated oil and pure oil from waste cooling oil and wheat straw ethanol are likely to meet the biofuel input thresholds proposed above. In fact, many bioenergy pathways can have much lower supply chain emissions than fossil fuels, in the best cases over 90%.[81] This suggests that the GHG emissions threshold for biomass/biofuel is practical to achieve, though may seem ambitious in the industry. However, the lower threshold for new plants commissioned from 2021 sends a clear signal regarding the need to

[81] IEA Bioenergy (2017). *Technology Roadmap: Delivering Sustainable Bioenergy.*

take all opportunities to support bioenergy and biofuel production that is in line with the goals of a net zero carbon power sector by 2050.

Table 10 provides examples of potentially eligible biofuel/biomass with typical value of lifecycle GHG emissions based on the EU RED II. Table 11 provides a summary of default values of GHG emissions reductions of different bioenergy pathways under the EU RED II.

Table 10 Examples of potentially eligible biofuel/biomass based on EU RED II[82]

Biofuel/biomass production pathways	Typical GHG emissions (gCO_2e/MJ)
waste cooling oil biodiesel	16.0
hydrotreated oil from waste cooking oil	9.4
pure oil from waste cooking oil	2.0
wheat straw ethanol	13.7
waste wood Fischer-Tropsch diesel/petrol in free-standing plant	13.7
waste wood dimethylether (DME) in free-standing plant	13.5
waste wood methanol in free-standing plant	13.5
Fischer-Tropsch diesel from black-liquor gasification integrated with pulp mill	10.2
Fischer–Tropsch petrol from black-liquor gasification integrated with pulp mill	10.4
dimethylether DME from black-liquor gasification integrated with pulp mill	10.2
methanol from black-liquor gasification integrated with pulp mill	10.4
woodchips from forest residues	5 – 22
woodchips from short rotation coppice	8 – 25
woodchips from stemwood	5 – 22
woodchips from industry residues	4 – 21
wood briquettes or pellets from forest residues	6 – 34
wood briquettes or pellets from short rotation coppice	6 - 41
wood briquettes or pellets from stemwood	5 - 34
wood briquettes or pellets from wood industry residues	3 - 22
agricultural Residues with density <0.2 t/m^3	4 - 29
agricultural Residues with density > 0.2 t/m^3	4 - 15
straw pellets	8 - 10
bagasse briquettes	5 - 9

Table 11 Summary of default values of GHG emissions reduction of bioenergy under EU RED II[83]

[82] Source: European Commission (2016). Proposal for a Directive of the European Parliament and of the Council on the use of energy from renewable sources. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016PC0767R%2801%29
[83] Source: IEA Bioenergy (2017). *Technology Roadmap: Delivering Sustainable Bioenergy.*

Bioenergy option	No. of routes	Max. saving %	Min. saving %
Conventional biofuels	35	98	24
Advanced biofuels	14	89	78
Biomethane for transport	12	179*	17
Electricity – agricultural residues	15	90	33
Electricity – wood chips	21	90	35
Electricity - wood pellets	57	93	-2
Electricity - biogas	18	219*	14
Heat – agricultural residues	15	93	11
Heat – wood chips	21	93	57
Heat – wood pellets	57	94	32

* In cases where direct methane emissions to the atmosphere are reduced, emission savings can exceed 100% of those associated with fossil fuel use alone, as methane is a significantly more potent GHG than CO_2.

4.3.9 Indirect land use change (iLUC)

Indirect land use change (iLUC) refers to a knock-on effect where biofuel feedstock production results in the conversion of lands somewhere else in order to produce the crops displaced by the biofuel feedstock.

While direct impacts are usually under the direct control of the actors involved in the bioenergy supply chain, and can therefore be estimated and incorporated in any LCA (as is proposed above), indirect impacts can act beyond the farm gate, borders or across crops and can be very difficult for an individual operator or bond issuer to robustly estimate or mitigate.

In some countries, such as the USA (certain states, such as California) have enacted legislation to address indirect impacts, under which the iLUC is included in the LCA and models have been built to estimate iLUC. However, these models have been built specifically to the jurisdictions they are operated and thus not applicable to the Bioenergy Criteria which aim to setting requirements for a global green bond market. Results from iLUC model may also have high uncertainty and variation due to insufficient understanding on global economic dynamics including trade patterns, land-use productivity, fuel prices and by-product utilisations, and the selection of specific policy models, etc.[84]

In the EU, EU RED II addresses the risk of iLUC by limiting the extent to which member states can count energy from feedstocks associated with a high risk of indirect land use change towards reaching their renewable energy targets. By 2021, such feedstocks will be capped at 2019 levels, and by 2030 such feedstocks will not be able to be counted at all. However, EU RED II does not go so far as to ban these high risk crops in the EU. In March 2019, the European Commission adopted a Delegated Act[85] which determined that high iLUC-risk fuels are fuels that are produced from food and feed crops that have a significant global expansion into land with high carbon stock such as forests, wetlands and peatlands.

Two additive conditions are specified to identify this circumstance:

[84] IPCC (2011). *Special Report on Renewable Energy Sources and Climate Change Mitigation.*
[85] europa.eu/rapid/press-release_MEMO-19-1656_en.htm

a. The global production area of the feedstock has increased annually by more than 1% and 100,000 hectares after 2008.

This criterion verifies whether the feedstock is actually expanding into new areas. Feedstock for which no, or only very limited, expansion of the production area is observed (mainly because production increases are generated by improving yields rather than expanding the production area) do not cause significant deforestation and, therefore, do not give rise to a very high level of GHG emissions from ILUC.

b. More than 10% of such expansion has taken place on land with high carbon stock.

Currently, none of the voluntary standards address indirect impacts as a mandatory component. That said, some of the voluntary standards such as the Roundtable for Sustainable Bioenergy (RSB) are continuing to work on a practical mechanism to address indirect impacts risks.

The RSB in particular has developed a module for operators willing to demonstrate that their operations have a low indirect land use change risk *on a voluntary basis.* It has identified three approaches to mitigate indirect land use change impact, including yield increase (e.g. through upgrading land), use of waste and residues and cultivation of unused or degraded land.

RSB optional module: low iLUC risk biomass criteria and compliance indicators

- *Yield increase*: operators demonstrate that additional biomass was produced through an increase in yield compared to a reference date, without any additional land conversion. The biomass that is produced above the baseline scenario is eligible; or
- *Unused/degraded land*: operators demonstrate that biomass was produced from land that was not previously cultivated or was not considered arable land; or
- *Use of waste / residues*: operators demonstrate that the raw material use is derived from existing supply chains and does not require dedicated production out of arable land. Note that guidance on definitions of waste and residues can be found under RSB.

TWG selected approach to address iLUC risk

The TWG believes the requirements under the RSB iLUC optional module are detailed and comprehensive requirements to address iLUC risk. They are also compatible with the EU RED II proposals for identifying high iLUC risk but have the advantage that they apply on a case-by-case basis for each operator, rather than across the feedstock as a whole globally. This keeps open the option of certification under the Climate Bonds Standard to those individual facilities that are meeting the Criteria described here, and are not penalised by the impacts of the use of that feedstock in aggregate.

Therefore, the TWG propose that issuers should either get certified by the RSB iLUC optional module to demonstrate their projects have low indirect land use impact; or provide evidence and documentation to demonstrate that they meet the criteria under the RSB iLUC optional module and thus have low iLUC. Details of the RSB iLUC model can be found here: http://rsb.org/the-rsb-standard/standard-documents/low-iluc/

4.4 Adaptation and Resilience Requirement

4.4.1 Framework for Criteria addressing Climate Adaptation and Resilience

As discussed in Section 2.3, bioenergy feedstock production can impact on the resilience of ecosystems to climate change through changes to water quality, biodiversity and soil carbon, etc. And conversely, climate change can influence the resource potential and cultivation of feedstocks through changes in temperature and water availability.

Therefore, the TWG proposed specific requirements about climate change adaptation and resilience to ensure that: bioenergy feedstock is being produced in such a way that is not damaging the resilience of the ecosystem, and is resilient to climate change; bioenergy generation facilities are resilient to climate change; and bioenergy assets/projects have no negative impact on climate resilience of areas in/beyond which they are operated.

The TWG agreed that the climate risk posed to the bioenergy sector is more about sustainable feedstock production and hence the siting of facilities. The TWG discussed the possibility of requiring bioenergy facilities to have a model that shows they will be able to have sustainable feedstock sources in the climate change scenario. However, there is high uncertainty of modelling. For large scale facilities, as they rely on international feedstock sources, they will need to do global analysis and modelling which is very challenging. And modelling is difficult, and in most cases not applicable to small scale facilities.

Therefore, instead, the TWG decided to require bioenergy assets and projects to:

1. Conduct a climate risk assessment and have an adaptation plan where high risks are identified – assessed via the Adaptation and Resilience Checklist; and
2. Demonstrate that their source feedstocks are compliant with established and approved best practice standards for the industry to make sure feedstock production is environmentally sustainable without negative impact on ecosystem resilience; and
3. Identify food security risk, if any; and have a plan to address it when the risk is significant.

The Adaptation and Resilience checklist is complementary to the best practice standards as currently these standards do not explicitly address climate risks nor require climate risk mitigation.

4.4.2 Requirement 1: Adaptation & Resilience checklist

The Adaptation & Resilience checklist focuses on the processes the issuer should demonstrate they have been through to determine if the issuer is asking and evaluating the right questions at the right stages of development and if the issuer is monitoring and reporting appropriately.

To meet the requirements, issuers must demonstrate that:

- Climate related risks and vulnerabilities to the asset are identified; and
- Impacts in, and beyond the asset to ecosystems and stakeholders are identified; and
- Strategies to mitigate and adapt to the climate risks and vulnerabilities identified to protect the asset.

The checklist (Table 12) is a tool to verify that the issuer has implemented sufficient processes and plans in the design, planning and decommissioning phases of a project to ensure that the operation and construction of the asset minimises environmental harm and the asset is appropriately adaptive and resilient to climate change and supports the adaptation and resilience of other stakeholders in the surrounding environment.

All elements of this checklist must be addressed with appropriate evidence that these requirements are being met, or are not applicable in respect of the specific assets and projects linked to the bond. It is expected that their evidence will encompass a range of assessment and impact reports and associated data, including but not limited to those reports required to meet national and local licensing and approval processes. This might include Development Consent Orders, Environmental Impact Assessments, Vulnerability Assessments and associated Adaptation Plans.

Table 12 Checklist for evaluating the Issuer's Adaptation & Resilience performance in respect of a bioenergy facility

Item	Proof given	Overall assessment
Section 1: The issuer identifies the climate related risks and vulnerabilities to the asset/ site		
Processes are in place (as part of both the asset design and ongoing management) to assess key risks to the assets from a changing climate. These key risks should include the following, plus any others felt to be of concern for the operation of these assets. The risks should be identified and interpreted in terms of the impact on the asset and the related effects for the business – e.g. impact on operating feasibility and schedules and potential system outages, impact on maintenance requirements etc. N.B. This list taken from World Banks Climate and Disaster Risk Assessment Tool • Temperature changes, and extremes in temperature • Extreme precipitation and flooding • Drought • Sea level rise and storm surge • Strong winds How these affect the asset or site in question will be highly variable and will be for the issuer to identify and relate to their operations. These assessments should use climate information, modelling and scenarios from a peer reviewed source. **This assessment should be done regularly. The frequency of the assessment will depend on the nature of the climate related risks and vulnerabilities, and should be specified by the issuer and reporting against in subsequent annual reporting.**		

<table>
<tr><td colspan="3">Section 2: The issuer identifies the impacts in larger context (spatially and temporally) beyond the asset/site (i.e. the impacts of the underlying assets and projects on the broader ecosystem and stakeholders in that ecosystem)</td></tr>
<tr><td>Processes are in place (as part of both the asset design and ongoing management) to assess the impact of the bioenergy asset on the climate resilience of other stakeholders in the social, economic and environmental system in which it operates and how to mitigate or reduce any negative impacts

These assessments address:
• Any ways in which bioenergy facilities might affect the climate resilience of other users/stakeholders?
• Any ways in which bioenergy facilities improve the adaptation capacity of other users/stakeholders?

For example, they may include:
• Impact on water quality and quantity for other users in the basin
• Waste and pollution emitted
• Fire hazards</td><td></td><td></td></tr>
<tr><td colspan="3">Section 3: The issuer has designed and implemented strategies to mitigate and adapt to these climate risks and vulnerabilities</td></tr>
<tr><td>An adaptation plan has been designed and is being implemented to address the risks identified in the assessments above

The issuer has designed or amended assets and designed or amended asset maintenance plans to ensure that scheduled maintenance is sufficient to cope with the ongoing impacts of climate change and a plan has been established to govern how they approach emergency maintenance needs arising from sudden climate change impacts (e.g. extreme storms)

The issue has training, capacity and governance arrangements in place for how the organization will deal with the impacts of exception events (e.g. droughts, floods, severe pollution events, extreme storms, winds etc.)

The issuer has monitoring and reporting systems and processes to identify high risk scenarios

The issuer has contingency plans to address disruption to operations or loss of the asset and any resulting environmental or social damage

The issuer has processes for feeding risk assessment back into decision making.

The issuer has a budget allocated to implementing the adaptation plan and has a named member of staff responsible for its implementation.</td><td></td><td></td></tr>
</table>

The issuer complies with any existing broader or higher-level adaption plans, such as NAPAs.		

4.4.3 Requirement 2: Adherence to approved best practice standards

For bioenergy producers such as biomass power plant and biofuel based heating facilities who are simply purchasing biofuel and biomass in the market, it is important to make sure that their source biofuel and biomass is low carbon and environmentally sustainable.

Approach

The main aspects of environmental impacts to consider when addressing the climate resilience impacts of bioenergy feedstock production are the previous land use, species selection and the management practices used to produce those feedstocks. While most of the focus is on land, one should not forget that water is likely to become an even more limited resource in the future. Depending on these variables, the environmental performance of the various bioenergy supply chains will be very different.

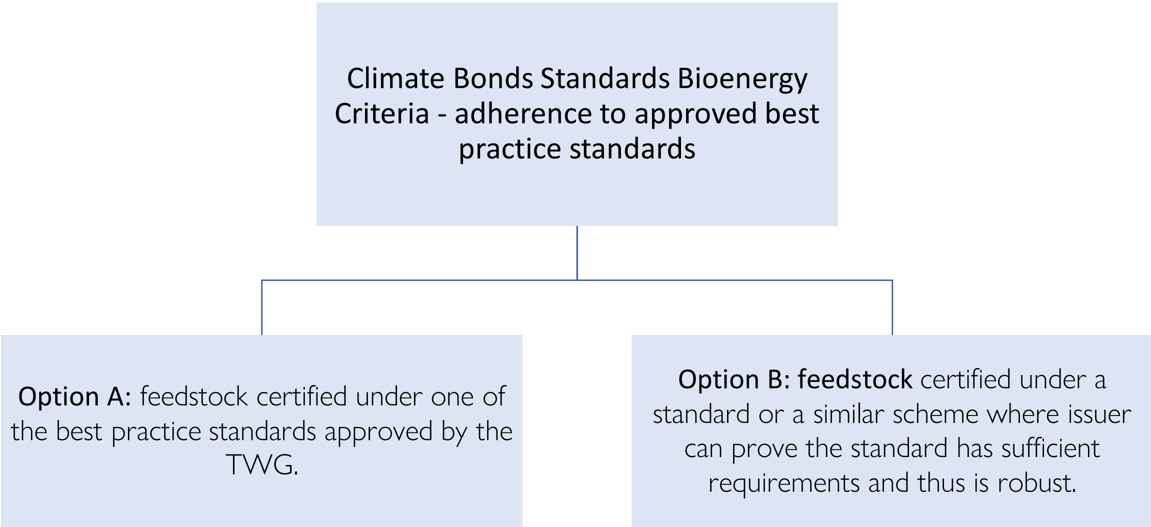
Considering the “Do not reinvent the wheel” principle under the Climate Bond Standard, and the results of the Bioenergy TWG discussions and public feedback received, it is proposed that leveraging existing, credible proxies is the best path forward when developing criteria to address environmental impacts of bioenergy feedstock production. Also, as it is challenging for verifiers to check environmental impacts of bioenergy supply chain in all aspects, therefore, it makes sense for issuers to use standards and accreditation that already exist.

The TWG has reviewed a number of best known and most used voluntary standards covering the production of bioenergy feedstocks to check their robustness and credibility as approved best practice standards (details in Option A - approved voluntary standards). Reference option A in Figure 4 below.

However, many standards exist, particularly in local contexts, and it is not possible for TWG to review them all in advance. Furthermore, the previous public consultation period following the TWG process highlighted that to list only a few selected voluntary standards as eligible proxies would restrict many stakeholders in accessing the market. Therefore, it is proposed that when certification under one of the approved best practice standards is not an option, the Climate Bonds Standard will accept other standards or mechanisms of compliance as outlined below. Reference option B in Figure 4 below.

As Figure 4 shows, the Bioenergy Criteria therefore provides two options for issuers to demonstrate their sourcing biomass is environmentally sustainable.

Figure 4 Options in Climate Bonds Standard Bioenergy Criteria – adherence to approved best practice standards



Option A – feedstock certified under one of the best practice standards approved by the TWG
There are a number of legally binding and voluntary tools that could be considered. Given the fragmented legislative landscape, relying on legislation as a proxy, is considered not only insufficient but a potential risk to the credibility of the Climate Bond Standard. Therefore, it has been proposed by the TWG that credible voluntary standards, independently verified by credible third party organizations are the most efficient to provide a robust framework for the Climate Bonds Standard.

The best practice standards that will be considered acceptable proxies under the Bioenergy Criteria must have sufficient requirements in the following areas shown in Table 13 (more details in Appendix 3). The requirements regarding environmental impacts such as soil and water management are to make sure bioenergy feedstock production is environmentally sustainable, that is, not damaging the resilience of the ecosystem and being resilient to potential climate change. The requirements about governance aim to ensure the standards are robustly developed and implemented.

Table 13 Areas to be considered for determining the robustness of standards

Areas	Requirements
Environmental	Priority areas protection Chemical use Pest management Nutrient management Soil management Water management Genetic diversity management Sustainable resource extraction Waste management
Governance	Compliant with ISEAL's code of good practice Multi-stakeholder in involvement in standard development process Multi-stakeholder participation in the standards system

	Scientific input Transparency Complaints and appeals process Regular reviews and revisions of the standards Standard gives accreditation Stakeholder consultation in certification and auditing process Audits required annually Audit sample size specified Sanction mechanisms in place Training of auditors Training opportunities for users of the standard

Source: adapted from 1. WWF (2011) *The 2050 Criteria Guide to Responsible Investment in Agricultural, Forest, and Seafood Commodities*; 2. WWF (2013) *Searching for Sustainability Comparative Analysis of Certification Schemes for Biomass used for the Production of Biofuels.*

Note that the GHG emission performance of the bioenergy production including life cycle emissions and indirect land use impact is not an indicator to determining whether the standard is robust or not, as GHG emissions issue is covered in the Mitigation Component of these Bioenergy Criteria as described above.

19 voluntary standards have been evaluated including RSB, RTRS, FSC, ISCC+, ISCC EU, RSPO, 2BSvs, RBSA, Greenergy, Ensus, Red Tractor, SQC, Red Cert, NTA 8080, GGL, PEFC, Proterra and SBP. The TWG has both evaluated the principles and criteria of each voluntary standard against the indicators above, and for cross-checking, also reviewed other literature which similarly assesses the robustness of these voluntary standards[86]:

IUCN, based on the comparison prepared by Proforest, concluded that: *"RSB covers more sustainability criteria, with greater detail, and with more breadth in terms of level of assurance than any of the other VSS. NTA8080, Bonsucro, RTRS and RSPO also meet a good level of quality in all comparisons made. ISCC, Proterra*[87] *and Greenergy can be considered to be of overall medium quality. REDcert and 2BSvs fall in the low quality segment, with 2BSvs having the overall lowest quality"*[88]*.*

In case of solid biomass (wood chips, wood pellets mainly) the standard landscape looks differently. The proliferation of standards has been less of a problem, even though various stakeholders have set up a number of standard setting processes. Additionally, compared with liquid biofuels, the standards that are relevant for solid biomass have not been analysed to the extent that the liquid biofuel standards have been by comparative studies. Some of the standards used to certify solid biomass have been created prior to the developments in the bioenergy sector to cover forest products in

[86] This includes: 1. Jinke van Dam Consultancy (2015). Inventory trends sustainability biomass for various end-uses. 2. S2Biom (2015). Benchmark and gap analysis of criteria and indicators (C&I) for legislation, regulations and voluntary schemes at international level and in selected EU Member States. 3. WWF (2013). Searching for Sustainability Comparative Analysis of Certification Schemes for Biomass used for the Production of Biofuels. 4. IUCN (2013). Betting on Best Quality. A Comparison of Quality and Level of Assurance of Sustainability Standards for Biomass, Soy and Palm oil.

[87] Certification according to the ProTerra Standard is available worldwide, for `all agricultural commodities. More information: www.proterrafoundation.org

[88] Page 5, http://cmsdata.iucn.org/downloads/betting_on_best_quality.pdf

general, among which FSC[89] and PEFC[90] are the two largest. Others such as Green Gold Label (GGL)[91], NTA8080[92] or the SBP[93] have been specifically created for the bioenergy sector. There are other ongoing initiatives, but at the moment the standards listed above are probably the most important ones. These standards are building on the forest certification schemes.

FSC sufficiently covers most environmental and governance issues in indicators, though chemical use, pest management and nutrient management are only partially covered. While the international PEFC standard closely follows the FSC standard on environmental requirements, implementation of the standard at national, regional level remains fragmented. There are significant qualitative differences between various PEFC labels. For example, a number of EU countries continue to not accept MTCS (Malaysia Timber Certification Scheme) certified timber, one of the national standards endorsed by PEFC due to concern about certified operations being involved in forest conversion.

RSB sufficiently covers almost all aspects in indicators.[94] Only chemical use and sustainable resource extraction are partially covered: the most hazardous chemicals are not explicitly banned[95] and sustainable resource extraction is only covered implicitly by the requirement of "Conservation Agriculture practice".

RTRS also performs well against most indicators, with partial coverage of chemical use and nutrient management: the most hazardous chemicals are not explicitly banned[96]; nutrient management is implicitly covered by "Principle 5 Good Agriculture Practice". It seems there is no training opportunities provided for users of the standard.

ISCC Plus covers the majority of the environmental issues, though pest management and sustainable resource extraction: they are "minor must" requirements, i.e. the applicant not necessarily need to meet these requirements as they are only required to meet 60% of all "minor must" requirements. The governance of IPCC Plus is slightly weaker than other FSC, RSB and RTRS in terms of transparency and multi-stakeholder engagement.[97] And there are different certification bodies who can give accreditation, making it difficult to harmonise the implementation of the standard.[98]

GGL was originally set up by the Dutch utility Essent and continues to have relatively low support from various stakeholders. It is likely that with the launch of the Sustainable Biomass Partnership (SBP) its role will decrease and as a result it is unlikely that it will be suitable to include under the Climate Bond Standard.

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89 http://ic.fsc.org
90 http://pefc.org
91 http://www.greengoldcertified.org
92 http://www.sustainable-biomass.org
93 http://www.sustainablebiomasspartnership.org
8 http://www.biograce.net
94 Jinke van Dam Consultancy (2015). *Inventory trends sustainability biomass for various end-uses;* WWF (2013). *Searching for Sustainability Comparative Analysis of Certification Schemes for Biomass used for the Production of Biofuels;* IUCN (2013). *Betting on Best Quality. A Comparison of Quality and Level of Assurance of Sustainability Standards for Biomass, Soy and Palm oil.*
95 WWF (2013). *Searching for Sustainability Comparative Analysis of Certification Schemes for Biomass used for the Production of Biofuels*
96 Ibid.
97 Ibid.
98 Ibid.

NTA8080 is another Dutch initiative, created following the adoption of the Cramer Criteria. Is generally well regarded by stakeholders, but has low market share. While the environmental and social requirements are relatively ambitious, implementation including auditing, transparency and accreditation does not provide adequate confidence.

SBP is probably the most important initiative in Europe if we consider possible market share. The SBP is a partnership of large European utilities that represent over 70% of the EU wood pellets market. However the process was mainly industry driven, so the governance structure is not strong. Note that the SBP is currently undergoing a transformation into a multi-stakeholder organisation where the new arrangement is expected to be implemented in early 2019.[99] In due course the Bioenergy TWG will re-assess the governance of the SBP to decide whether it should be included as one of the approved standards. Other deficiencies of the SBP include lack of concrete, performance-oriented thresholds and protections and thus little assurance regarding environmental or social protections in source forests; little requirement on field verification of source forestry management; insufficient requirements on biodiversity, high conservation value forests, high carbon stock forests, water quality, harvest sustainability, biomass removals to protect soils and habitats, conversion to plantations and non-forest.[100]

Another aspect the Bioenergy TWG recommends considering when selecting the different standards to be leveraged by the Climate Bond Standard is the market share of various certification schemes. The Climate Bond Standard aims to address the mainstream market, but it wants to do so by ensuring robust implementation of the sustainability criteria. Market share of FSC, RSB, RTRS and ISCC Plus are fairly high compared to other standards. More details can be found in Appendix 4.

The reports reviewed for this paper also found that there are significant differences between the voluntary standards created specifically as a response to EU RED implementation and the multi-stakeholder processes developing sustainability standards independently from the legislative requirements. The multi-stakeholder standards are, generally speaking, more ambitious when it comes to the environmental and social criteria but also perform better on the process requirements.

Figure 5 below shows result of robustness analysis on pre-approved voluntary standards. Appendix 5 provides a summary of reasons to exclude other voluntary standards.

It should be noted that as discussed above, the Bioenergy Criteria are designed to be feedstock agnostic. One implication of this is that they do not automatically exclude the use of palm oil as a feedstock. As the WWF pointed out, in order to achieve a more sustainable palm oil sector, real efforts are needed to transform the entire industry toward sustainability, not just a niche group of sustainable suppliers serving Western markets. Taking this approach, these Criteria should ensure that where palm oil feedstock is used, palm oil production practices are sustainable – as evidenced by certification under best practice standards including RSB, RTRS, FSC and ISCC Plus.

Proposal for approved best practice standards

Based on the discussion above, the TWG found that the RSB, RTRS, FSC and ISCC+ are sufficiently covering the majority of the environmental issues and governance issues well. Therefore, the TWG

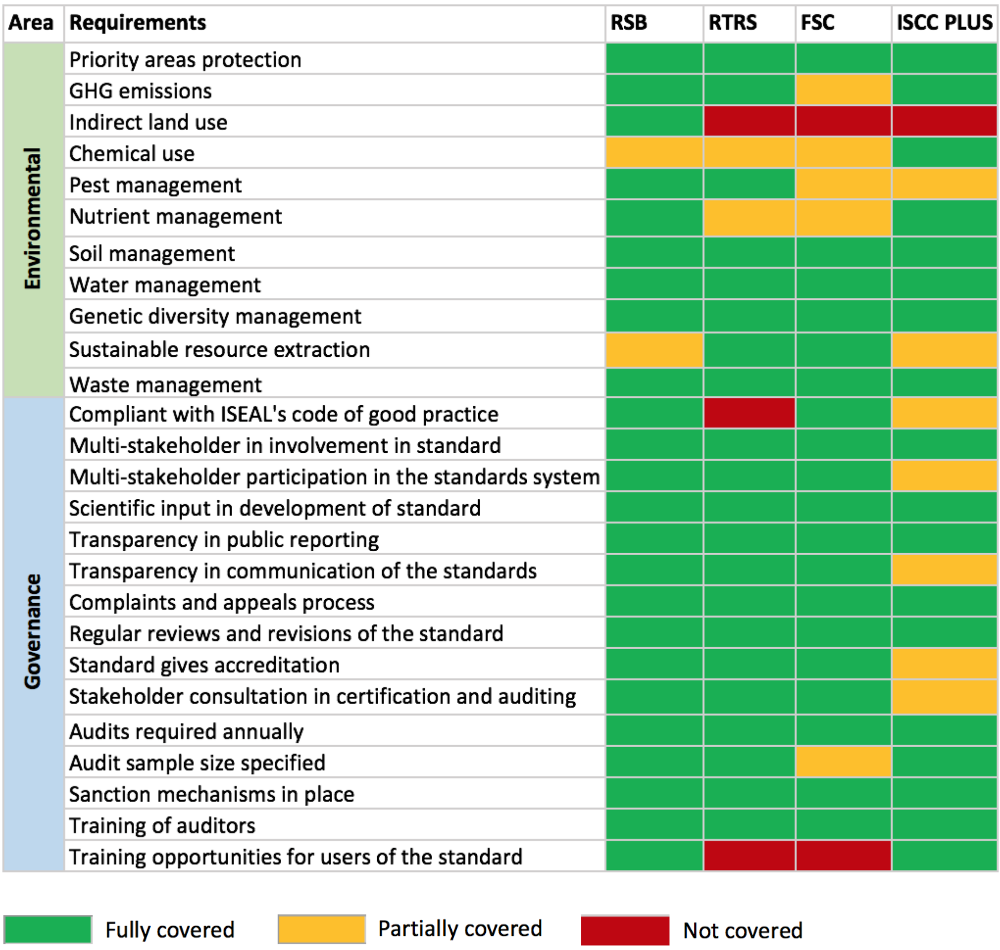
[99] https://sbp-cert.org/news/sbp-governance-transition-process-consultation-launched

[100] NRDC (2017). *The Sustainable Biomass Program: Smokescreen for Forest Destruction and Corporate Non-Accounting Ability.*

has chosen RSB, RTRS, FSC and ISCC+ as approved best practice standards under the Bioenergy Criteria.

There are ongoing efforts to improve the compatibility of various standards, driven either by developments related to the implementation of the EU RED or by efforts of various standards, enjoying broad stakeholder support, under the umbrella of ISEAL.[101] Therefore, the TWG will also check every two years whether there are other standards or schemes that should be included in the preferred voluntary standards in the Bioenergy Criteria.

Figure 5 Analysis on the robustness of approved best practice standards



Reference: 1. Jinke van Dam Consultancy (2015). *Inventory trends sustainability biomass for various end-uses*. 2. S2Biom (2015). *Benchmark and gap analysis of criteria and indicators (C&I) for legislation, regulations and voluntary schemes at international level and in selected EU Member States*. 3. WWF (2013). *Searching for Sustainability Comparative Analysis of Certification Schemes for Biomass used for the Production of Biofuels.* 4. IUCN (2013). *Betting on Best Quality. A Comparison of Quality and Level of Assurance of Sustainability Standards for Biomass, Soy and Palm oil.*

[101] ISEAL is a non-governmental organization whose mission is to strengthen sustainability standards systems for the benefit of people and the environment.

Option B – feedstock certified under a standard or a similar scheme where issuer can prove the standard has sufficient requirements and thus is robust.

In cases where certification under one of the approved best practice standards is not a viable option, issuers will be able to demonstrate to the verifiers their compliance with the Criteria using other standards/certification schemes.

Issuer needs to provide: evidence that the proposed standard/scheme has sufficient requirement about environmental impacts and governance, as shown in Table 13 and Appendix 3. That is, the issuer needs to check the proposed standard against Table 13 and Appendix 3 and demonstrate the proposed standard sufficiently covers the requirements in Table 13 and Appendix 3. A table similar to Figure 5 can be submitted.

The TWG will review the evidence provided and decide whether the standards or scheme used by the issuer is robust and sufficient to cover environmental and governance issues, and make a decision on whether to approve the standard proposed by the issuer as one of the approved best practice standards. Once approved, the issuer will be able to use the certification against the proposed standard to demonstrate the compliance of their feedstock with the adaptation and resilience requirements under the Bioenergy Criteria.

4.4.4 Requirement 3: Addressing food security risks

Bioenergy generation can create potential competition between feedstock for bioenergy and food. Unless the feedstocks for bioenergy are grown on abandoned land or use residues that previously had no economic value, liquid biofuel production places additional pressure on natural resources such as land and water, which are needed for production of food and agriculture products as well.[102] It is estimated that an increase of 70% of global food production by 2050 is required to meet food demand of the world's growing population.[103] As the increase in arable land between 2005 and 2050 will only be about 5%,[104] using land for increased production of feedstock for bioenergy may pose risks to food security.

In order to reduce risks to food security, the TWG has decided to adopt the risk-based approach under the *RSB Food Security Assessment Guidelines*.[105] Under the RSB, operators are required to assess risks to food security in the region and locality and to mitigate any negative impacts that result from their operations. And in food insecure regions, the operator is required to enhance the local food security of the directly affected stakeholders.[106]

Therefore, under the Bioenergy Criteria, issuers are required to first evaluate food security at national level by checking latest International Food Policy and Research Institute's Global Hunger Index (GHI)[107] to see whether their sourcing feedstock are produced in food insecure nations. If the feedstock production is located in a country with low or moderate ranking on the GHI, there is no further requirement.

[102] IPCC (2011). *Special Report on Renewable Energy Sources and Climate Change Mitigation.*
[103] Bruinsma, J. (2009). *The resource outlook to 2050: by how much do land, water and crop yields need to increase by 2050?*
[104] FAO (2008). *The role of agricultural biotechnologies for production of bioenergy in developing countries.*
[105] http://rsb.org/the-rsb-standard/rsb-standard-tools-guidance/impact-assessment-guide/
[106] RSB (2012). *RSB Food Security Guidelines.*
[107] http://ghi.ifpri.org

Otherwise, the issuer needs to assess whether the production of the sourcing feedstock is likely to have impacts on food security, and to establish corresponding mitigation and enhancement measures if the impacts are significant. Issuers can follow guidelines such as RSB Food Security Assessment Guidelines and FAO's Bioenergy and Food Security Assessment[108], or any other robust and publicly available guidance.

Note that there is no need for issuers whose feedstock already obtained certification from RSB (which covers food security issues), to meet this requirement. In this case, verifiers only need to verify that the issuer's feedstock is all certified under RSB.

4.5 Reporting Requirement

4.5.1 Reporting to demonstrate compliance with the Criteria

In accordance with the Climate Bonds Standard, it is the issuers responsibility to provide to the approved verifier the information necessary to demonstrate compliance with each requirement of the Criteria. Per the requirements outlined above, it is therefore necessary for the issuer to provide the approved verifier with:

- Life cycle assessment (LCA) of GHG emissions of biofuel/biomass produced/used, including scope, tool(s), GHG emissions allocation methodology, and the result of GHG emissions (not applicable for facilities producing electricity from biofuel/biomass).
- LCA of GHG emissions of electricity produced, including scope, tool(s), GHG emissions allocation methodology, and the results of GHG emissions in terms of gCO2e/kWh (only applicable for facilities producing electricity from biofuel/biomass).
- Energy efficiency of facilities (only applicable for heating/cooling, and co-generation facilities using biofuel/biomass).
- Certification against the RSB iLUC module or evidence and documentation required under the RSB iLUC optional module to demonstrate the compliance with the module.
- Assessment against the Adaptation & Resilience Checklist.
- Certification of the feedstock against one of the approved best practice standards; or assessment of the proposed standard/scheme against Table 13 and Appendix 3, and certification of the feedstock against the proposed standard/scheme.
- Information about the GHI ranking of the country where the feedstock production is, and if applicable, assessment of impacts on food security and the corresponding mitigation plan (not applicable to operators already obtained certification from RSB).

Note that when the bond portfolio includes several separately identifiable projects or groups of assets, these conditions must be met for each separately identified project or asset grouping. Bond issuers should determine these project boundaries, which may be based on geographical and/ or supply chain linkages.

4.5.2 Additional reporting encouraged, but not mandatory for certification

In the interests of transparency and disclosure, issuers of Certified Climate Bonds are encouraged to publically disclose the following in respect of the assets and use of proceeds incorporated in that issuance. This is for transparency purpose only. There is no need for verifier to check this information.

[108] http://www.fao.org/energy/bioenergy/bioenergy-and-food-security/assessment/en/

- Project location and size, including description of ecosystem in proximity to planned installations;
- Projected lifespan of the asset/project;
- Key stakeholders involved, including other users of the area and surrounding area (sea, land or air depending on what is applicable) of the facility(ies);
- Description of project activities including details on installation, operation and decommissioning activities;
- Expected/current facility capacity and generation during and after the life of the bond;
- Details of where the energy generated is being fed into, and estimated impact on grid mix;
- The planning standards, environmental regulations and other regulations that the project has been required to comply with.

4.6 Updating the Criteria

The Bioenergy TWG will revisit these requirements and make adjustments to the requirements if necessary. Where amendments are made, they will not be applied retrospectively to any bonds already certified under prior versions of the Criteria.

5. Appendix

Appendix 1 Bioenergy Working Group Member

Bioenergy Technical Working Group (TWG) Members
Round 2 development
Dr. Ausilio Bauen, *Director, E4Tech.*
Barbara Bramble, *Vice President, International Conservation and Corporate Strategies, National Wildlife Federation.*
Aziz Elbehri, *Senior Economist, Trade and Markets Division, Food & Agriculture Organisation (FAO).*
Dr Birka Wicke, *Assistant Professor, Copernicus Institute of Sustainable Development - Energy & Resource, Utrecht University.*
Jack (John) N Saddler, *Professor, Department of Wood Science, The University of British Columbia.*
Uwe R. Fritsche, *Scientific Director, International Institute for Sustainability Analysis and Strategy.*
Luc Pelkmans, *Project Manager Bioenergy & Biomass, VITO.*
Dr Thomas Buchholz, *Forest and Agriculture, Spatial Informatics Group (SIG).*
Round 1 development
László Máthé*, Accreditation Program Manager and Lead Author, Accreditation Services International.*
Molly Jahn, *Professor, University of Wisconsin-Madison.*
Uwe R. Fritsche, *Scientific Director, International Institute for Sustainability Analysis and Strategy.*
Luc Pelkmans, *Project Manager Bioenergy & Biomass, VITO.*
Dr Thomas Buchholz, *Forest and Agriculture, Spatial Informatics Group (SIG).*
Shay Reza*, Co-Founder, Arise International.*

Bioenergy Industry Working Group (IWG) Members
Artur Yabe Milanez, *Director of Biofuels, BNDES*
Brad C. Friedman, *Ramirez & Co., Inc.*
Bryan Sherbacow, *CEO, AltAir Fuels*
Christian Carraretto, *EBRD*
Cindy Thyfault, *Founder & CEO, Wester Trade Resources*
David Fairchild, *Principal Consultant, Assurance and Sustainability Services, Bureau Veritas UK*
David Kemp, *Director, Project & Infrastructure Finance Fixed Income, M&G Investment*
Dimitri Koufos, *EBRD*
Elena Schmidt, *Standards Director, RSB*
Gerard J.Ostheimer, PhD. *Senior Advisor, Below50*
Mark Robinson, *Manager, Sustainability Services, DNV GL Business Assurance*
Matthew Brander, *University of Edinburgh*
Melanie Eddis, *Partner, ERM Certification and Verification Services*
Michael Brown, *Technology Advisor, Ryze Capital Partners, LLC*
Michael Burns, *Head of Biorefining Business Development, Novozymes North America Inc.*
Mike Cao, *Managing director, Shanghai Mu Yi Investment Advisors Ltd.*
Monica Reid, *Kestrel Consulting*
Nikos Ntavos, *Manager, Cluster of Bioenergy & Environment of Western Macedonia*
Noim Uddin, *Senior Consultant, CPMA International*
Paul Curtis-Hayward, *Guy Butler Limited*

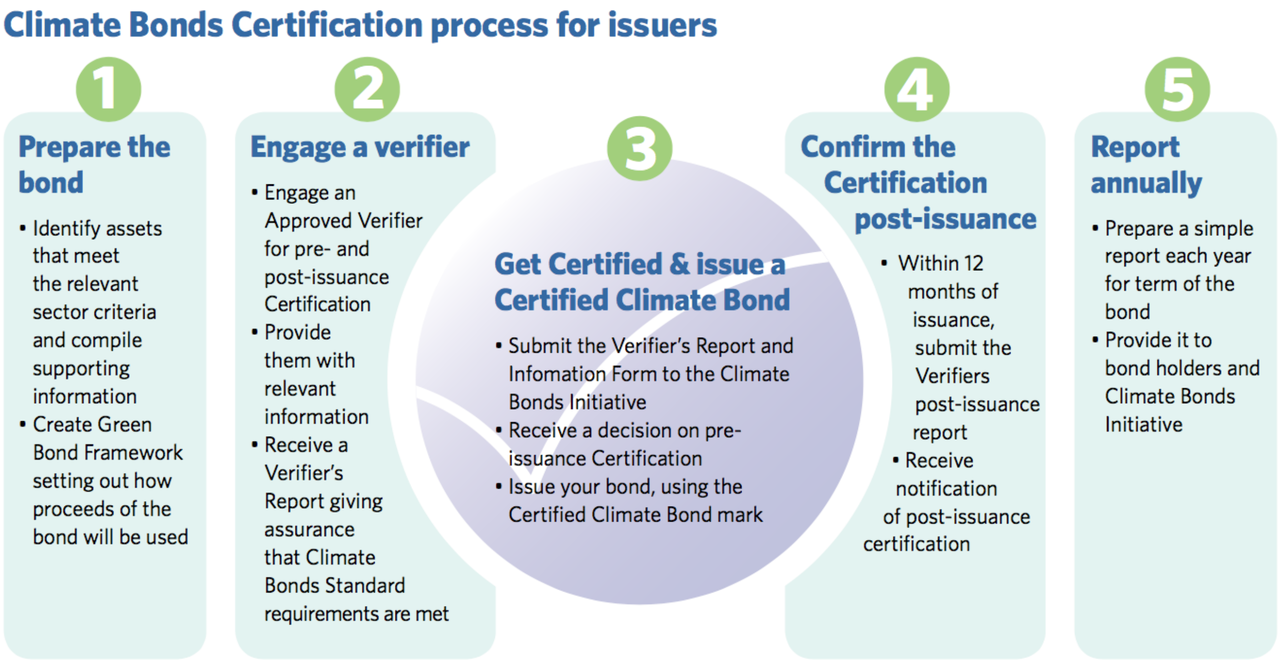
Steve Csonka, *Executive Director, CAAFI*
Terri Smalinsky, *Managing Director, Ziegler Investment Banking*
Wenqin Lu, *China Energy Conservation and Environmental Protection (CECEP) Consulting*

Appendix 2 Climate Bonds Standard & Certification Scheme

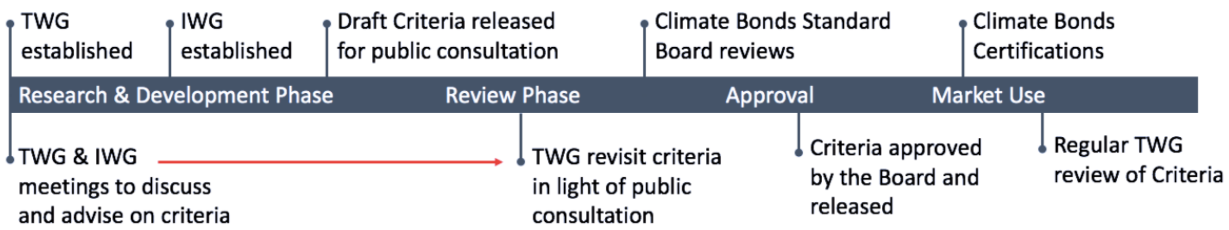
The Climate Bonds Standard and Certification Scheme is a Fair Trade-like labelling scheme for bonds. It is designed as an easy-to-use tool for investors and issuers to assist them in prioritising investments that truly contribute to addressing climate change. The Standard is a public good resource for the market.

The Climate Bonds Standard is made up of two parts; (i) the parent standard detailing management and reporting processes (see Climate Bonds Standard V2.1) and (ii) a suite of sector Criteria detailing the requirements assets must meet to be eligible for certification.

The Certification Scheme requires issuers to obtain independent verification, pre- and post-issuance, to ensure the bond meets the requirements of the Climate Bonds Standard (see diagram below).



The Climate Bonds Standard has been developed based on public consultation, road testing, review by the assurance roundtable and expert support from experienced green bond market actors. The Standard is revisited and amended on an annual basis in response to the growing green bond market. Sector specific Criteria, or definitions of green, are developed by Technical Working Groups (TWGs), made up of scientists, engineers and technical specialists. Draft Criteria are presented to Industry Working Groups before being released for public comment. Finally, Criteria are presented to the Climate Bonds Standard Board for approval.



To date, Sector Criteria for wind, solar, geothermal, road transport, water, buildings and forestry are available for certification. Sector Criteria for hydropower, marine, waste management, agriculture, and shipping are under development. Work groups for energy distribution & management, ICT, and industrial energy efficiency will be launched soon.

As of December 2017, USD31.2bn green bonds have been successfully certified against the Climate Bonds Standard and issued in the market, including those from issuers ANZ, New York MTA, SNCF and San Francisco Public Utilities Commission. In 2017, 14% of green bonds issued globally were Certified Climate Bonds.

Appendix 3 Areas to be considered for determining the robustness of best practice standards

Environmental	Priority areas protection The area of land to be utilized does not contain, and is not suspected of containing, primary forest or High Conservation Value (HCV) areas. The land area is not being converted from native ecosystems, such as forests to a plantation or other land use.
	GHG emissions Efforts are made on the farm to reduce fossil fuel emissions and increase carbon sequestration. Techniques can include soil carbon management, restoration of native vegetation, and eliminating in-field burning practices.
	Indirect land use Possible unintended consequences of indirect land use change have been assessed and show that the crop generates low indirect land use change risks (e.g., produced from agricultural waste/byproducts, produced on degraded lands, or production is integrated with food production).
	Chemical use Agrochemicals are properly used on site, judiciously and in a targeted fashion using available expertise. There is no use of hazardous agrochemicals listed as Classification I or II in the World Health Organization's Recommended Classification of Pesticides by Hazard. Agrochemicals are prepared and applied by trained personnel with appropriate protective gear and in accordance with the law and producer guidelines - and not by children or pregnant women. Potential impacts on local communities of chemical run-off and spraying are assessed and managed.
	Pest management An Integrated Pest Management (IPM) plan is developed and implemented, ideally incorporating biological controls. An Integrated Weed Management plan is developed and implemented, ideally including cultural and biological controls, appropriate rates of pre- and post-emergent applications, and appropriate altering of active ingredients.
	Nutrient management A Nutrient Management Plan focused on optimal uptake and minimal loss of nutrients has been developed and is implemented. The plan can include: soil and foliage testing (regularly and especially prior to fertilizer applications), use of variable rate technologies for fertilizer application, crop rotation, and use of cover crops and filter strips.
	Soil management A Soil Management Plan is developed and implemented with a focus on soil productivity, including retention of soil biomass levels, soil structure, salinity, pH, and carbon sequestration. The plan can outline crop and geographically appropriate practices such as no-till, only planting on suitable slopes, use of cover crops, crop rotation, tree hedges, and contour planting, etc. The plan should also include adequate protection of riparian areas.

	Water management A complete assessment of water resource requirements and discharge impacts should be conducted, taking into consideration crop needs, soil water holding capacity, hydrological conditions, downstream human and environmental needs and uses, and impacts that the water use and discharge will have on the watershed, community health, and regional ecology. This is especially important in water stressed areas. A Water Management Plan is in place that addresses relevant risks and includes concrete measures to protect ground water or local water bodies.
	Genetic diversity management Species selection e.g. no introduction of invasive alien species that disrupt native genetic diversity, or that are not suitable for current or projected future ecological conditions
	Sustainable resource extraction Resources are managed to prevent overexploitation
	Waste management Minimising waste from spoilage, utilisation of by products, maximisation of waste to energy opportunities
Governance	Compliant with ISEAL's code of good practice
	Multi-stakeholder in involvement in standard development process
	Multi-stakeholder participation in the standards system
	Scientific input in development of standard
	Transparency in public reporting
	Transparency in communication of the standards documents and processes
	Complaints and appeals process
	Regular reviews and revisions of the standard
	Standard gives accreditation
	Stakeholder consultation in certification and auditing process
	Audits required annually
	Audit sample size specified
	Sanction mechanisms in place
	Training of auditors
	Training opportunities for users of the standard

Appendix 4 Market Share of Various Voluntary Standards

Standards – liquid biofuels	Market share
RSPO	Over 1000 certificates, representing approx. 15% of the global market and covering over 1,7 million hectares of plantations (RSPO n.d.).
RTRS	Over 480 thousand hectares producing around 873 thousand tonnes of certified soy (RTRS n.d.).
RSB	15 valid certificates, slowly growing market share (RSB n.d.).
Bonsucro	38 production certificates, representing 3,6% of global sugarcane surface, over 2,6 million m3 of certified ethanol (Bonsucro n.d.).
ISCC	Over 2600 certificates, no further details on area or volumes (ISCC n.d.).
NTA8080	31 certificates (including biofuels, solid biomass, biogas) no further details with regards to volumes or certified area (NTA8080 n.d.).
Greenergy	No publicly available information.
Red Tractor	There are over 78,000 UK farmers (the majority of these is for food production) certified, but no information with regards to biofuel share, area or volumes (RED Tractor n.d.).
SQC	No publicly available information.
2BSvs	635 certificates, no further information with regards to area or volumes (2BSvs n.d.)
REDcert	Approximately 2000 certificates, but no further information about area or volumes (REDcert n.d.).
RBSA	No publicly available information.

Standards – solid biomass	Market share
FSC	Over 180 million hectares of certified forests, in 80 countries and nearly 1300 certificates (FSC n.d.).
PEFC	220 million hectares of certified forests (PEFC n.d.)
NTA8080	See above.
RSB	See above.
SBP	Over 100 certificate holders.

Appendix 5 Reasons for exclusion of other voluntary standards

Scheme	Reason for exclusion	
	TWG view	Literature review
ISCC EU	Medium quality.	Only partially covers criteria on environmental and social management system, pest management, soil management, water; no criteria on GHG emissions; poor requirement on biodiversity and conservation (IUCN, WWF).
RSPO	The governance due to overweighting of local industry; Land use and deforestation issues are not covered.	
2BSvs	Low quality.	Partially covers soil and water on voluntary basis, not cover legality, land tenure and labour rights (Jinke van Dam Consultancy); Does not cover soil and agrochemical issues, water quality and management issues; no criteria on highly biodiverse grassland; no/poor criteria on biodiversity; not adequately address any of the labour related criteria (IUCN); The majority of the environmental and social issues are not covered; a few partially covered. Not perform good in terms of governance (WWF)
RBSA	Market share N/A.	The majority of the environmental and social issues are not covered; a few partially covered. Not perform good in terms of governance (WWF)
Greenergy	Medium quality; market share N/A.	No requirement on GHG emissions; partially covers soil, pest and water management, biodiversity (habitat protection and conservation) issues; poor requirements on social and governance issues (S2Biom, IUCN, WWF).
Ensus		Poor/no requirements on all environmental, social and governance issues (WWF).
Red Tractor	There are over 78,000 UK farmers (the majority of these is for food production) certified, but no information with regards to biofuel share, area or volumes.	Poor requirements on governance and social issues, water, biodiversity and conservation, soil and waste issues (IUCN, WWF).
NTA 8080	Low market share, implementation including	Poor requirements on soil management, pest management, water, and

	auditing, transparency and accreditation does not provide adequate confidence.	agrochemicals and fertilisers, and social issues (health and risks).
GGL	Relatively low support from various stakeholders. It is likely that with the launch of the Sustainable Biomass Partnership (SBP) its role will decrease and as a result it is unlikely that it will be suitable to include under the Climate Bond Standard.	Partially covers legality and waste issues; poor requirement on social issues (Jinke van Dam Consultancy, S2Biom).
PEFC	Implementation of the standard at national, regional level remains fragmented. There are significant qualitative differences between various PEFC labels.	No requirement on GHG issues; only partially covers water issues (Jinke van Dam Consultancy, S2Biom).
Proterra	Medium quality	Partially covers water and soil, GHG, biodiversity and conservation issues; poor requirements on social issues (IUCN).
Bonscucro	Application is small, and it is driven by large commodity chain for food sector, so its ambition level is comparatively low.	The majority of the environmental and social issues are only partially covered or not covered (WWF, S2Biom).
SBP	The governance is not strong; the requirements on environmental issues are not sufficient. Note that the SBP is currently undergoing a transformation into a multi-stakeholder organisation where the new arrangement is expected to be implemented in early 2019.[109] In due course the Bioenergy TWG will re-assess the governance of the SBP to decide whether it should be included as one of the approved standards.	The process was mainly industry driven, so the governance structure is not strong. Other deficiencies include lack of concrete, performance-oriented thresholds and protections and thus little assurance regarding environmental or social protections in source forests; little requirement on field verification of source forestry management; insufficient requirements on biodiversity, high conservation value forests, high carbon stock forests, water quality, harvest sustainability, biomass removals to protect soils and habitats, conversion to plantations and non-forest.

Reference: 1. Jinke van Dam Consultancy (2015). Inventory trends sustainability biomass for various end-uses. 2. S2Biom (2015). Benchmark and gap analysis of criteria and indicators (C&I) for legislation, regulations and voluntary schemes at international level and in selected EU Member States. 3. WWF (2013). Searching for Sustainability Comparative Analysis of Certification Schemes for Biomass used for the Production of Biofuels. 4. IUCN (2013). Betting on Best Quality. A

109 https://sbp-cert.org/news/sbp-governance-transition-process-consultation-launched

Comparison of Quality and Level of Assurance of Sustainability Standards for Biomass, Soy and Palmoil. 5. NRDC (2017). *The Sustainable Biomass Program: Smokescreen for Forest Destruction and Corporate Non-Accounting Ability.*

Appendix 6 Summary of Public Consultation Responses

Feedback	Response
The use of a **'feedstock neutral approach'** is problematic as burning trees for biomass energy is not carbon neutral.	Regarding the facilities which use wood as a feedstock, we have additional requirements in place to ensure that carbon stock is maintained or enhanced within the decade.
Endorsed **GHG calculation tools** BIOGRACE II and UK Solid and Gaseous Biomass Carbon Calculator methodologies both ignore the emissions of combustion of biomass.	As above

On **emissions associated with the forest sources of feedstock**, the models mandate accounting for land use change emissions. This is seriously lacking as forest conversion to tree plantations and clearcutting of forests that remain in a logging cycle do not qualify as LUC.	The carbon stock of the forests is managed with a separate requirement, the forest management plan that requires carbon stocks to be maintained or enhanced within a decade
The established **GHG emissions threshold for electricity** generators is significantly lower than the agreed value in EU RED II.	The Bioenergy TWG has agreed to go further than the existing regulations such as EU RED to ensure that bioenergy is consistent with the need to make the power sector as a whole net zero carbon by 2050, as required to stay within the 2D global warming target.
What would be considered **"equivalent documentation"** to a forest management plan?	Issuers need to decide what information they would disclose in the documentation, and verifiers need to decide whether the documentation is sufficient for them to evaluate the compliance of the issuer.
The requirement to collect a **forest management plan** for each source forest may be an onerous requirement to implement.	The TWG has decided to use Forest Management Plan as this approach is more practical than including carbon stock changes in LCA or a Carbon Payback Period; and more robust and consistent compared to having no additional requirements as covered by the best practice standards. It is a conservative approach but necessary to address concerns over carbon debts.
If some indicators are only partially covered, why is **FSC** still considered compliant?	The TWG chose the RSB, RTRS, FSC and ISCC+ as they are sufficiently covering most of the environmental issues and governance issues. The FSC scores at the highest level in all aspects except three (excluding GHG emissions as that is covered separately in these criteria), and even for those three there is particial coverage. Therefore, overall, it is deemed sufficiently robust.
Many **feedstock certification schemes** do not have sufficient coverage to be used in all regions where bioenergy is used.	The TWG reviewed many schemes with the intention to give as broad a reach to these Criteria as possible. However, only these five schemes were deemed sufficiently robust. Still, the TWG has left open the option for an issuer to present a case for an alternative scheme to the TWG for approval, with the intention of adding as many schemes as possible so long as they are sufficiently robust. The TWG will also check every two years whether there are other standards or schemes that should be included.

Addressing **food security** is not a requirement but a voluntary assessment.	The TWG have now decided to require bioenergy assets and projects to identify food security risk, if any; and have a plan to address it when the risk is significant.
There are no **timeframes** specified when calculating the carbon debt	This has now been amended. In the forest management plan, the TWG has decided to use a ten-year timeframe period for calculating carbon stocks with continuous forestry inventory. This time period is based on the European Academics Science Advisory Council endorsement. Some fluctuations within those 10 years due to harvest and other events are acceptable but on average, it should not decline.