Solar Energy and the Climate Bond Standard

Background Paper to eligibility criteria

Solar Technical Working Group

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Contents

Introduction

This paper provides context to the work of the Solar Technical Working Group (TWG) under the Climate Bonds Standard and Certification Scheme. The Solar TWG has explored the issues around developing low-carbon eligibility criteria for bonds linked to solar energy. This paper present these issues considered by the TWG in arriving at the proposed eligibility criteria, and describes the next stages in developing further criteria on other solar sector assets

These issues include:

- Criteria for different types of solar assets e.g. solar PV plants, concentrated solar power (CSP) and manufacturing
- Considering environmental impact of solar assets

Accompanying this background paper is a first stage of proposed eligibility criteria solar energy assets linked to certified Climate Bonds. This criteria allows solar assets where a minimum of 85% of the electricity generated is from solar energy. It follows that fossil fuels may provide back-up or hybrid electricity generation to a limit of 15% of the total annual electricity generated.

Criteria for manufacturing assets will be developed in later stages in Autumn 2013.

Solar bond market and potential for growth

Solar energy is a priority because of its pivotal importance in achieving a low carbon economy. The International Energy Agency conservatively predicts that solar power (photovoltaic and concentrated solar power) can contribute 22% of global electricity supply by 2050. In the near term this would require annual investments of US$65 billion out to 2020.[1]

In the longer term, it has been estimated that solar energy could provide up to 67% of global primary energy consumption by 2100 in a world aiming to limit temperature increase to 2°C.[2]

How many bonds exist already?

Research conducted by the Climate Bonds Initiative and HSBC has identified up to US$8.9bn of bonds outstanding clearly aligned with solar energy.[3]

62% of this figure are corporate bonds from pureplay solar industry players such as PV manufacturers. 38% derives from project bonds such as the US$850m Topaz solar bond issue in the US. These project bonds are attractive to institutional investors as they attain investment grade ratings of BBB or above due to government guarantees or strong counterparty credentials. Municipal bonds from the US market make up the rest of the 1% of bonds identified for solar power deployment, again with strong credit ratings.

How can bond certification help grow the market?

The scheme will not only allow solar bond issuers to be part of a broader investment-grade climate bond portfolio including transport, property and water investments. It will also facilitate the issuance of bonds from issuers who would otherwise find it difficult to gain recognition for their low carbon investments.

Investment-grade electricity utilities could link their 'A' or 'BBB'-rated corporate bonds to their solar power generation portfolio. Financial institutions such as commercial banks could link their corporate bonds to their solar loanbook. And large conglomerates in the upstream segment of the solar supply chain, such as

[1] IEA Energy Technology Perspectives 2012

[2] WBGU 2004 World in Transition: Towards Sustainable Energy Systems

[3] http://climatebonds.net/resources/our-publications/bonds-climate-change-2013/

polysilicon production, glass and chemicals, could link the their solar product divisions to a corporate bond issuance.

This would grow the market of investment-grade bonds that are clearly identifiable as solar bonds and allow investors to easily incorporate them into low carbon investment strategies. It will also support the development of a securitisation market for solar assets through gradual investor education on asset performance and familiarity.

Table 1 provides an overview of these potential bond-types, issuers, and revenue streams of bonds that could be eligible for certification due to financing solar energy deployment.

Table 1: Map of potential Solar-linked Climate Bonds

Bond-types	Issuers	Revenue Streams	Purposes	Potential Examples
Public Sector Bonds	Sovereign	Treasury revenues	Solar FiT support or subsidy policies	Potential NAMA bonds
	Public Agencies Municipal authorities	Treasury revenues	Roll-out of solar power generation on public lands/buildings	US muni bonds
Financial Institution Bonds	Development Banks and Commercial Banks	Treasury revenues Solar project loans	Solar power generation, Solar manufacturing facility Solar grid connection	World Bank green bonds
Portfolio Bonds	Aggregator: Asset-backed Securities (ABS)	Power purchase agreements on power plants (PPAs), rooftops	Solar power generation	E.g. Solarcity
		Solar project loans Solar infrastructure fees	Solar power generation, Solar grid connections	E.g. Aggregated fund
Project Bonds	Project SPV	PPAs	Solar power generation Solar grid connections;	Topaz Solar Farm
Corporate Bonds	Utilities	Feed-in tariffs	Solar power generation	E.g. any electrical utility
	Solar manufacturers	Treasury revenues	Solar manufacturing facility	Sunpower Corp
	Solar supply chain te1chnology providers	Treasury revenues Lease Finance contracts	Polysilicon; solar glass production etc.	E.g. Applied Materials
	Solar Deployment Property Owners	Treasury revenues	Commercial building rooftop roll-out	E.g. Tesco

Notes: Some bonds may be a combination of two approaches e.g. asset-backed securities backed by government agencies or local authorities; or covered bonds with FI and portfolio bond characteristics.
Treasury – denotes balance sheet finance of issuer
PACE – Property Assessed Clean Energy Bonds

Key issues in developing criteria

Our starting point

The approach for developing criteria is defined in the introduction to the Climate Bond Standard.[4] To the maximum degree possible, it aims to adopt a positive technology or fixed asset approach by specifically including, "*projects or assets that directly contribute to*

- *developing low carbon industries, technologies and practices that achieve resource efficiency consistent with avoiding dangerous climate change*
- *essential adaptation to the consequences of climate change"*

After wind energy criteria, solar energy is the clearest low carbon solution for eligibility in the scheme. However, there remain three key issues that the technical working group consider in order to develop and finalise the criteria:

- Potential environmental impacts of solar assets
- How to treat hybrid plants or plants with fossil fuel back-up
- Identifying solar specific assets from potential issuers in the supply chain

Environmental Impacts of solar assets

Solar plants have been subject to numerous environmental impact concerns in recent years. These can include inter alia:

- Land use rights and land access: where land is subject to native title or cultural heritage conditions restricting use or where projects cross borders.
- Water requirements: depending on geographical location PV modules and CSP plants require periodic rinsing to remove dust. Solar thermal plants also often require substantial water resources to operate
- Environmental sensitivities: Costly habitat relocation or remediation and additional permitting can be required if sites are located on environmentally sensitive land.
- Downstream land impacts: Ensuring the facility does not have an adverse effect on downstream stakeholders during flooding events
- Visual impacts: PV modules absorb as much light as possible yet reflectance remains. This can have an impact on the ability of birdlife to navigate and can potentially impact pilots when located near airports

Any bond applying for Climate Bond certification is required to show that the relevant low carbon assets operate in accordance with relevant national environmental laws and regulations (clause 4 of the Climate Bond Standard).

Environmental Impact Assessments (EIAs) are common requirements in most jurisdictions for solar power plant developments, which might include studies of threatened species; land disturbance; historical and archaeological studies and visual impact etc.

In this section, we outline the key evidence base in consideration of environmental impacts of solar assets.

Carbon footprint

The lifecycle emissions of solar plants are low enough to allow solar energy to be designated as a low carbon solution. Lifecycle emissions include all emissions related to the construction, operation (including upstream and downstream fuel emissions) and decommissioning of the power plants. Table 2 provides a comparison across different fuel sources. The emissions are quoted in terms of CO_2-eq (or carbon dioxide

[4] http://standards.climatebonds.net/wp-content/uploads/2011/11/ClimateBondStandard_Text_24Nov11.pdf

equivalent), which normalises the greenhouse effect of other gases released in the process (e.g. methane) to that of CO_2.

Table 2: Comparison of normalised lifecycle emissions (g CO_2-eq / kWh_e) for power plants using various fuel sources. [5]

Fuel Source	Lifecycle Emissions Intensity (g CO_2-eq / kWh_e)
Coal	850-1300
Natural Gas	400-650
Nuclear	10-40
Solar PV	35-100
Solar Thermal	10-35
Solar Thermal / Gas Hybrid	234-345
Wind	10-20
Hydro	7.5-20
Biomass	65-350
Marine	15-25

The Solar TWG notes that the high end of the solar PV estimate relates to a typical residential PV installation in the UK and that the carbon footprint of solar PV in general has decreased approximately 50% in the last 10 years due to performance improvements, raw material savings and manufacturing process improvements.[6] The group also note that the lifecycle emissions of solar thermal plants remain relatively low to fossil fuel alternatives, even when the emissions of the fossil fuel hybrid element are factored in, provided the extent of fossil fuel use in the hybrid plant is controlled.

Energy payback

Energy payback periods are also improving. For solar PV systems, the energy payback period including balance-of-system components, measured in 2004 was between 3-4 years depending on the type of base material used.[7] A more recent study estimated the period at between 6 months and 1.4 years.[8] For CSP plants, it is estimated that the energy payback period ranges from 5 months to 1 year.[9] Both systems have life times of approximately 30 years.

Water requirements

The withdrawal of water of in the lifecycle of solar PV systems, that is water diverted or withdrawn from groundwater or surface water sources, is relatively lower than in other forms of electricity generation. Assuming strong sun locations, water withdrawal use ranges from 0.8 l/kWh to 1.9 l/kWh. Other forms of high carbon energy range from 1.2 l/kWh to 230 l/kWh.

In terms of water consumption, that is water permanently withdrawn from sources and no longer available, solar PV consumes 0.1 l/kWh. This compares to ranges of 0.75 l/kWh to 75 l/kWh for high carbon electricity generation.[10]

[5] Weisser, D. (2006). *A guide to life-cycle greenhouse gas (GHG) emissions from electric supply technologies.* Vienna: PESS / IAEA.; Parliamentary Office of Science & Technology (UK). (2011). *Carbon Footprint of Electricity Generation.* London: Houses of Parliament (UK).; Jacobson, M. Z. (2009). Review of solutions to global warming, air pollution and energy security. *Energy & Environmental Science* (2), 148-173.; Lechón, Y., de la Rúa, C., & Sáez, R. (2008). *Life Cycle Environmental Impacts of Electricity Production by Solar Thermal Power Plants in Spain.* Madrid: CIEMAT.

[6] E.A. Alsema, E. Nieuwlaar, Energy viability of photovoltaic systems, Energy Policy 28 (2000) 999-1010

[7] NREL (2004) PV FAQs available at: http://www.nrel.gov/docs/fy05osti/37322.pdf

[8] EPIA (2011) The Energy Pay Back Time, available at www.epia.org

[9] Geyer et al (2005) Concentrated Solar Power Now, SolarPACES, ESTIA, Greenpeace International; Burkhardt et al (2011) Life Cycle Assessment of a Parabolic Trough Concentrating Solar Power Plant and the Impacts of Key Design Alternatives, NREL.

[10] V. Fthenakis and al., (2010) Life-cycle uses of water in U.S. electricity generation, Renewable and Sustainable Energy Reviews 14 2039–2048; E. Lebre La Rovere and al., (2010) Sustainable expansion of electricity sector: Sustainability indicators as an instrument to support decision making, Renewable and Sustainable Energy Reviews 14 422–429; N. Onat, (2010) "The sustainability indicators of power production systems," Renewable and Sustainable Energy Reviews 14, no. 9 3108-311; R Saidur and al., Environmental impact of wind energy, Centre of Research UMPEDAC, Level 5,

For CSP however, there is a broader range of different technologies with differing water withdrawal and consumption requirements. According to NREL, dish-type Stirling CSP plants have extremely low water consumption factors of 5 gal/MWh, while CSP technologies using a cooling tower at the upper range at 1000 gal/MWh.[11]

Land use impacts

Ground-based solar plants require land at approximately 2.5 to 3.5 hectares per MW depending on technology and location.[12] Life-cycle analysis over 30 year periods shows this can still be less than land than the average power plant using surface-mined coal.[13]

Siting in environmental sensitive areas of wildlife, conservation, and cultural heritage can be another factor in solar assets. Regulatory frameworks around environmental impact assessments are improving in key solar markets, particularly in South and Southwest US as well as Europe and Australia. The Solar TWG therefore notes the proliferation of projects and alliances in this area in local markets. For example, in the US the US Bureau of Land Management conducts Solar Energy Study Areas, the California Renewable Energy Transmission Initiative and the EPA RE-powering America's Land project.[14]

Recycling

In Europe, solar PV systems are covered under the Waste from Electrical and Electronic Equipment (WEEE) Directive since July 2012. Associations such as PV Cycle, covering 90% of the module manufacturing industry allow for easy compliance across member-states of this requirement. In the US, leading manufacturers such as First Solar are implementing company-specific recycling and collection programmes.

Environmental Impacts Conclusion:

The Solar TWG notes the existing requirement in accordance with clause 4 of the Climate Bond Standard on adherence to environmental and social laws and regulations. Given the focus of the Solar TWG on establishing *low-carbon* eligibility criteria for solar assets, combined with the safeguards in clause 4 of the Standard, as well as existing industry initiatives in environmental impact areas, the Solar TWG does not consider it necessary to adopt specific criteria in relation to environmental impacts for solar assets.

Treatment of solar energy assets with fossil fuel back or hybrid plants

According to the IEA, virtually all concentrated solar power plants (CSP), with or without energy storage, are equipped with fossil fuel-powered backup systems that help to regulate production and guarantee capacity – especially in peak and mid-peak periods.[15] In addition, solar power systems such as PV may be hybridized with existing or purpose-built fossil fuel generators.

For the purposes of this working group, it was important to identify the suitable role that back-up or hybridised power may play in supporting more solar power generation.

Firstly, the group considered whether the bond certification should apply solely to the solar-specific investment in a plant with fossil fuel back-up or hybridisation, or to the entire investment linked to the

Engineering Tower, Faculty of Engineering, University of Malaya ; Macknick et al, (2011) "A Review of Operational Water Consumption and Withdrawal Factors for Electricity Generating Technologies", NREL

[11] Macknick et al (2011) "A Review of Operational Water Consumption and Withdrawal Factors for Electricity Generating Technologies", NREL

[12] Turney et.al., (2011), Environmental impacts from the installation and operation of large-scale solar power plants, Renewable and Sustainable Energy Reviews 15 3261-3270

[13] Fthenakis, V.M. and Kim, H.C. (2009), Land use and Electricity Generation: A life cycle analysis, Renewable and Sustainable Energy Review, 13, 1465-1474

[14] DOE (2012) Sunshot Vision Study, Washington D.C.

[15] IEA (2010) Technology Roadmap – CSP, Paris 2010

bond. It was considered that to provide practical implementation of the certification against project investments, it was important to provide criteria that would incorporate the entire investment cost.

Secondly, it was important to consider in the case of fossil fuel back-up or hybridisation under the bond, to what threshold should this be allowed in total electricity generation and the appropriate metric used.

The group referred to the feed-in tariff legislation developed in Spain where several CSP plants with fossil back up have been established. Decree 436/2004[16] applies a 12-15% threshold on back-up fuel, stating:

> *Subgroup b.1.2 Installations that use solar radiation as primary energy for electricity generation. These installations may use equipment that use a fuel to maintain the temperature of the heat transmission fluid in order to offset the lack of solar irradiation that might affect the forecast delivery of energy.*
>
> *Electricity generation using that fuel must be less than 12% as an annual calculation of the total production of electricity if the plant sells its energy in accordance with option a) of article 22.1. That percentage may be as high as 15% if the plant sells its energy in line with option b) of article 22.1. (Article 22.1 relating to whether the offtake price is set at a flat rate through the grid company (option a) or whether the operator sells electricity in the pool market where prices change daily (option b).*

The group also discussed the emissions-intensive nature of the fuel, noting the potential greater proliferation of shale gas has in increasing emissions compared to conventional gas production.

Role of fossil fuel back-up and hybridisation Conclusion:

Given the precedent set down the by the law, it was considered most appropriate to adopt a flat threshold rate of 15% for annual electricity generated by the plant to be allowed from the fossil fuel. Working group experts developed a 4-step guideline to clarify how the 15% rule is applied to plant operators:

- Calculate annual net electricity production output of the plant in MWh,
- Calculate the 15% share of this output
- Apply conversion efficiency of the plant in question to derive thermal energy delivered in MWh
- Apply lower heat value ratio and heat conversion factor of the fuel to estimate allowable annual consumption in the plant.

In addition, the group agreed that a review on the role of shale gas would be conducted by the group no more than 2 years after the publication of the criteria. However, no retrospective changes would apply to existing certified bonds.

Linking solar-specific assets in the manufacturing supply chain to bonds

A background note and specific eligibility criteria on this area will be published in due course.

[16] http://www.futurepolicy.org/fileadmin/user_upload/PACT/Laws/Spain_436_2004_english.pdf

Proposed eligibility criteria (subject to updates)

The Solar Technical Working Group is proposing a first version of low-carbon eligibility criteria for solar assets, for a 30-day public consultation period.

The following criteria is added to Part B – Low Carbon Criteria, under clauses 8 [Eligible projects and physical assets] and clause 9 [Technical criteria] of the Climate Bond Standard version 1.0.

For a bond to be certified as a Climate Bond, the funds raised under it must be used to finance or re-finance:

Solar Energy Generation – that is, activities to generate electricity directly from solar resources, specifically:

- The development, construction and operation of solar electricity generation facilities, where a minimum of 85% of electricity generated from the facility is derived from solar energy resources.*
- Wholly dedicated transmission infrastructure for solar electricity generation facilities.

*Refer to Climate Bond Solar criteria guidelines to calculate allowed non-solar fuel use under the 85% rule.

During the prototype phase, bonds may be certified using the proposed eligibility criteria.

The criteria will be reviewed by the technical working group in Q2 2015.

No retrospective changes will apply to bonds certified through the current criteria.

Guidelines on calculating allowable non-solar energy use under Climate Bond Standard and Certification Scheme:

Step-by-step guideline	**Example implementation for solar plant with gas back-up**
1. Calculate the annual net electricity production output of the plant	E.g. 150,000 MWh
2. Calculate 15% of this net output	E.g. 150,000 MWh*0.15 = 22500 MWh
3. Apply total plant conversion efficiency to the 15% net output to derive thermal energy delivered	E.g. Plant energy conversion efficiency is 40%. 22500/0.40 = 56250 MWh
4. Apply applicable lower heat value ratio and heat rate conversion factor of fossil fuel to estimate the allowable fossil fuel annual consumption.	E.g. lower heat value of natural gas = 0.9 Thermal energy equivalent of natural gas use in plant is: 56250/0.9=62500 MWh Heat rate conversion factor of gas to electricity is 3.413 MMBtu/MWh. Allowable annual natural gas consumption limit of 62500*3.413 = 213312.5 MMBtu/yr.

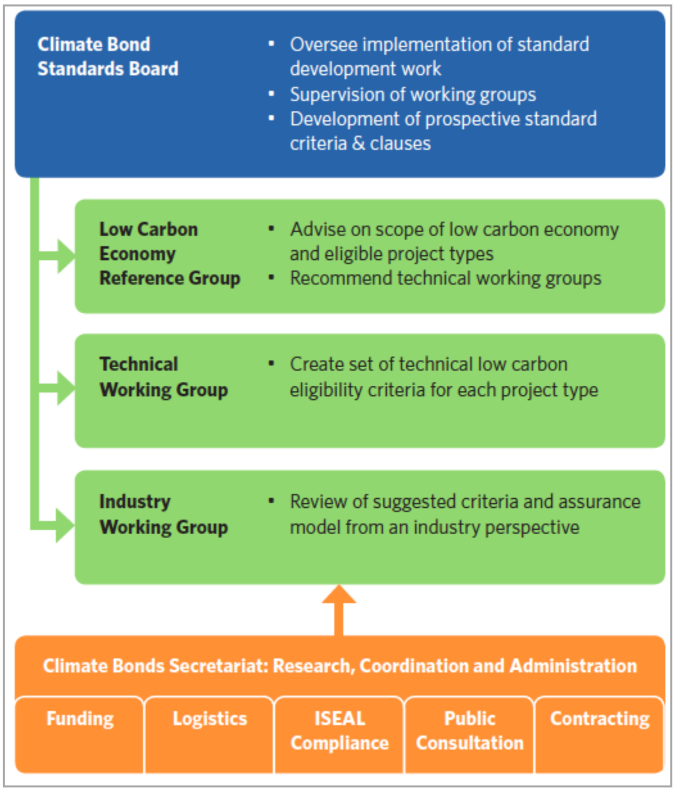
APPENDIX

About the Climate Bond Standard and Certification Scheme

The Climate Bond Standard and Certification Scheme ('the Scheme') is a project of the Climate Bonds Initiative with the cooperation of major investor groups, environmental NGOs and corporations from the financial sector.

Its aim is to assure investors that their funds are being used to deliver a low-carbon, climate resilient economy. This is achieved through:

- Supporting the credibility of the Scheme through the organizations publicly supporting and endorsing the project.
- Transparent and stakeholder-focused governance
- Ensuring the technical low carbon credibility of the Scheme across different sectors through evidence-based deliberation.
- Ensuring the practicality and accessibility of the Scheme through easy-to-use, low-cost product offering.



Climate Bond Standard and Certification Scheme – organisational structure

Deploying climate change solutions requires some $1 trillion of investment in energy, transport, industry and building sectors each year, above business as usual[17].

Bonds are particularly suited for providing the capital for infrastructure required to build the climate economy, notably in buildings, energy, transport, waste and water. Bonds can provide the long-term, low-cost capital needed for deployment of proven technologies and also free up corporate balance sheets for new developments.

In order for this market to grow, new tools need to be at hand to:

- assist bond issuers in meeting investor demand for climate-themed bonds;
- assist investors in recognising such bonds; and
- assist governments to easily support investments in such bonds.

Certified Climate Bonds against an easy-to-use Climate Bond Standard will provide integrity and reduce reputational risks for all those involved in participating in a new asset class.

Progress to date

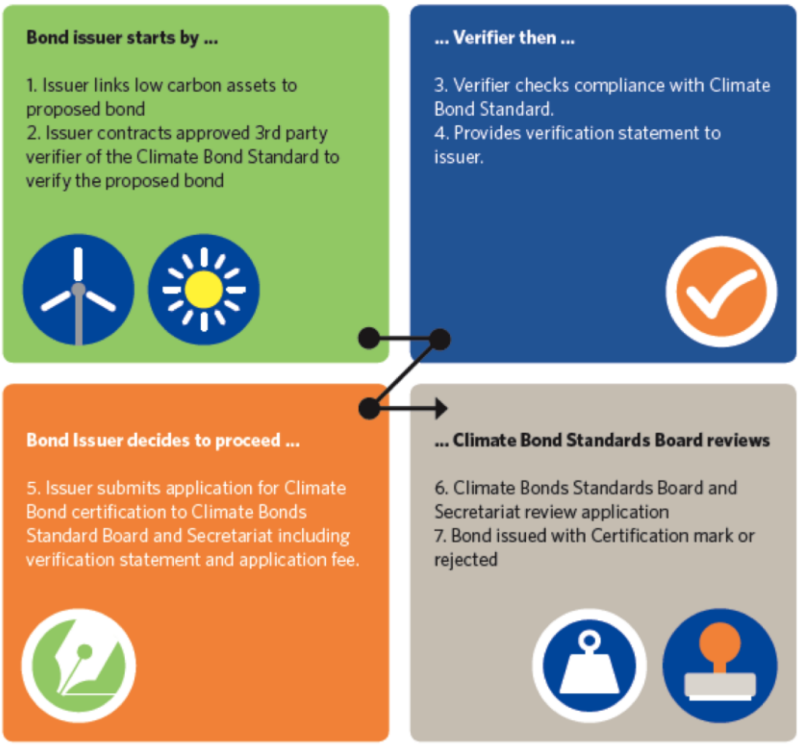
The Climate Bond Standard prototype version was officially launched in November 2011. Over the course of the 2012, numerous milestones on the way to building a credible standard and certification scheme were achieved including:

[17] World Energy Outlook 2011. www.iea.org

- Building a broad-based coalition of supporters for the Scheme.
- Establishing a Climate Bond Standards Board of six not-for-profit organisations balanced between large institutional investors and reputable environmental NGOs.
- Establishing an Industry Working Group of rating agencies, banks, fund managers, assurance providers and consultants.
- Launching the final approved prototype text including supplementary materials of a report on a 60-day public consultation and a brochure highlighting the benefits of the Scheme.
- Registering the Climate Bonds Certified mark for copyright use by the CBI.
- Finalising the certification of a first 'test' bond linked to wind assets including the development of a contractual agreement between the CBI and the issuer.

How bond certification works

In the prototype phase of the Scheme, we have proposed a straightforward 7-step process for bond certification as illustrated in the chart right.



Issuers must firstly link the bond to low carbon project assets or activities. These activities are listed in Part B of the Climate Bond Standard.

A prospective issuer of a Climate Bond would be required to secure a verification statement from a 3rd Party Verifier that the bond is in compliance with the Climate Bond Standard. The issuer then submits both an application for certification and the verification statement to the Climate Bond Standards Board and Secretariat for review.

Beyond the prototype phase, the certification and assurance model of the Scheme will be finalised by a dedicated Assurance working group that will consider accreditation for verifiers; complaint resolution mechanisms; and the role of verifiers vis-à-vis the Standard Board.

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