Climate Bonds INITIATIVE

Electrical Utilities Background Paper

Development of Eligibility Criteria under the Climate Bonds Standard & Certification Scheme

Final for Issuance

Climate Bond Certified

Acknowledgements

Climate Bonds gratefully acknowledges the Technical and Industry Working Group members who supported the development of these Criteria. Members are listed in ***Appendix A***. Special thanks are given to *Ana Díaz,* the technical lead specialist and *Francisco Moreno* for coordinating the development of the Criteria through the Technical Working Group.

The Industry Working Group provided critical and useability focused consultation and feedback on the Criteria, but this does not automatically reflect endorsement of the criteria by all members.

Revision	Date	Summary of Changes
Rev 0.1	05 December 2023	Draft for public review

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1 Introduction

1.1 Overview

This document serves as a reference to the Criteria Document for Electrical Utilities. The purpose is to provide an overview of the key considerations and issues that were raised during development of the Electrical Utilities Criteria and provide the rationale for why requirements were chosen and set.

The Criteria were developed through a consultative process with the technical working group (TWG) and the industrial working group (IWG), and through public consultation. The TWG comprised academic and research institutions, civil society organizations, multilateral banks and specialist consultancies whereas IWGs are represented by industry experts as well as potential bond issuers, verifiers and investors. A 60-day period of public consultation offers the opportunity to any member of the public to comment on the Criteria. This document aims to capture these various dialogues and inputs and substantiate the reasoning behind the Electrical Utilities Criteria.

Supplementary information will be made available in addition to this document, including:

Information to support issuers and verifiers is available at Electrical Utilities Criteria | Climate Bonds Initiative as follows:

- Electrical Utilities Criteria document: the complete Criteria requirements.
- Electrical Utilities Frequently Asked Questions.
- Electrical Utilities public consultation feedback and responses summary.
- Climate Bonds Standard: contains the requirements of the overarching CBS.
- The Climate Bonds Standard & Certification Scheme Brochure: provides an overview of the Climate Bonds Standard & Certification Scheme, of which these Criteria are a part.

For more information on Climate Bonds and the Climate Bonds Standard and Certification Scheme, see www.climatebonds.net.

1.2 Funding the goals of the Paris Agreement

The current trajectory of climate change, expected to lead to a global warming of 2.6-2.9-degree by 2100[1], poses an enormous threat to the future of the world's nations and economies. The aim of the Paris Agreement is to limit warming to a global average of no more than 2°C higher than pre-industrial levels by the end of the century, and ideally no more than 1.5°C. The effects of climate change and the risks associated even with a 2°C rise is significant: rising sea levels, increased frequency and severity of hurricanes, droughts, wildfires and typhoons, and changes in agricultural patterns and yields. Meeting the 2°C goal requires a dramatic reduction in global greenhouse gas (GHG) emissions.

At the same time, the world is entering an age of unprecedented urbanisation and related infrastructure development. Global infrastructure investment is expected to amount to USD 90 trillion by 2030, more than the entire current infrastructure stock[2].

To ensure sustainable development and avoid dangerous climate change, this infrastructure needs to be low-carbon and resilient to physical climate impacts, without compromising the economic growth needed to improve the livelihoods and wellbeing of the world's poorer citizens. Ensuring that the infrastructure built is low-carbon raises the annual investment needs by 3-4%. Climate adaptation needs to add another significant amount of investment, estimated at USD 280-500 billion per annum by 2050 for a 2°C scenario.

[1] According to Climate Tracker, under current policies we could expect 2.6 – 2.9°C: http://climateactiontracker.org/global.html

[2] The Global Commission on the Economy and Climate (2018), 'Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times': https://newclimateeconomy.report/2018

1.3 The role of bonds

Traditional sources of capital for infrastructure investment (governments and commercial banks) are insufficient to meet these capital needs; 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 refinancing instruments. 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 can 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, and commercial and development banks to finance or re-finance assets or activities with environmental benefits. Green Bonds are regular bonds with one distinguishing feature: proceeds are earmarked for projects with environmental benefits. Green Bonds are in high demand and can help issuers attract new types of investors.

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.

Currently Green Bonds only account for less than 5% of a global bond market of USD133 trillion[3]. The potential for scaling up is tremendous. The market now needs to grow much bigger, and quickly.

1.4 Introduction to the CBS

Activating the mainstream debt capital markets to finance and refinance climate friendly 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 intended to address climate change is fundamental to the credibility of the role that green bonds play in a low carbon and climate resilient economy. Trust in the green label and transparency to the underlying assets are essential for this market to reach scale but investor capacity to assess green credentials is limited. Therefore, Climate Bonds created the Climate Bonds Standard & Certification Scheme, which aims to provide the green bond market with the trust and assurance to achieve the required scale.

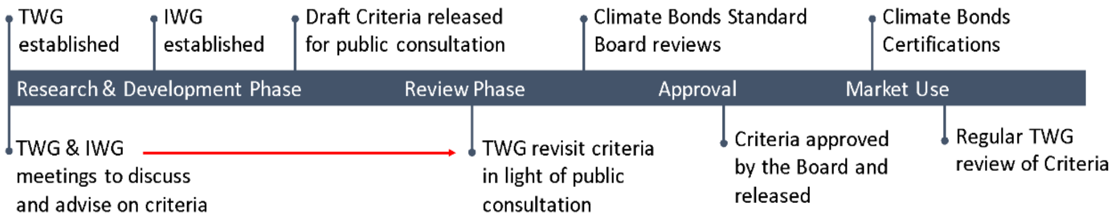
The Climate Bonds Standard & Certification Scheme is an easy-to-use tool for investors and issuers to assist them in prioritising investments that truly contribute to addressing climate change, both from a resilience and a mitigation point of view. It is made up of the overarching Climate Bonds Standards (CBS) detailing management and reporting processes, and a set of Sector Criteria detailing the requirements assets must meet to be eligible for certification. The Sector Criteria covers a range of sectors including solar energy, wind energy, marine renewable energy, geothermal power, low carbon buildings, low carbon transport, and water. The Certification Scheme requires issuers to obtain independent verification, pre- and post-issuance, to ensure the bond meets the requirements of the CBS.

Existing Sector Criteria cover solar energy, wind energy, marine renewable energy, geothermal power, buildings, transport (land and sea), bioenergy, forestry, agriculture, waste management and water infrastructure, hydropower, electricity grids and storage. In addition to Steel, additional industry transition Criteria currently available include Cement, Basic Chemicals and Hydrogen Production.

[3] www.icmagroup.org/regulatory-policy-and-market-practice/secondary-markets/bond-market-size

1.5 Process for Sector Criteria Development

The CBS has been developed based on public consultation, road testing, and review by the Assurance Roundtable (a group of verifiers) and expert support from experienced green bond market participants.



Source: Climate Bonds Initiative.

Figure 1. Criteria development process.

The Standard is revisited and amended on an annual basis in response to the growing climate aligned finance market. Sector specific Criteria are developed by TWG made up of scientists, engineers, and technical specialists. Draft Criteria are presented to IWG before being released for public comment. Finally, Criteria are presented to the Climate Bonds Standards Board (CBSB) for approval (see diagram above).

1.6 Structure of this document

This document supports the Electrical Utilities Criteria. It captures the issues raised and discussed by the TWG, as well as the arguments and evidence in support of the Criteria. It is structured as follows:

- Section 2: provides a brief overview of the sector: its status, trends and role in mitigating and adapting to climate change.
- Section 3: outlines the objectives, principles, boundaries, and overarching considerations for setting the criteria and provides an overview of the criteria.
- Section 4: describes the rationale behind the mitigation requirements.
- Section 5: describes the rationale behind the adaptation and resilience requirements.

2 Sector Overview

2.1 What is Electricity?

Electricity is the second source of energy final consumption in the world, counting in 2019 for 82,3 EJ (19,7% share)[4]. It's role in modern societies is central and is expected to increase dramatically (in the future, to more than 50% by 2050, as it adopts its new important role in deeply decarbonizing the entire energy systems by reducing emissions in other sectors through direct electrification and indirect electrification through electricity-derived fuels) as electrification is a key part of the decarbonisation of the energy system. Electric vehicles in transport and heat pumps in buildings as well as shifting some fossil fuels assets to electricity in industry, are calling to lead the transition to a low-carbon economy.

The electricity sector is today the largest source of global greenhouse gases (GHG) emissions. According to the International Energy Agency (IEA), the electricity sector accounted for approximately 42% of global energy-related CO_2 emissions in 2020[5]. Thus, electricity utilities will play a critical role in decarbonizing the global energy system, as countries and companies adopt net-zero targets.

The Electricity Utilities value changes includes generation, transmission, distribution, and customer. Figure 2.

Source: Development Bank of Singapore

Figure 2 Electricity value chain.

Electricity can be produced using many different technologies each of ones have their own global warming potential (GWP), fossil energy consumption and electricity cost. **Table 1** shows the electricity generation technologies, including mature technologies as well as emerging or future technologies, that will be needed to meet future demand while meeting climate restrictions.

[4] IEA KWES 2021
[5] International Energy Agency, 2023, https://www.iea.org/energy-system/electricity

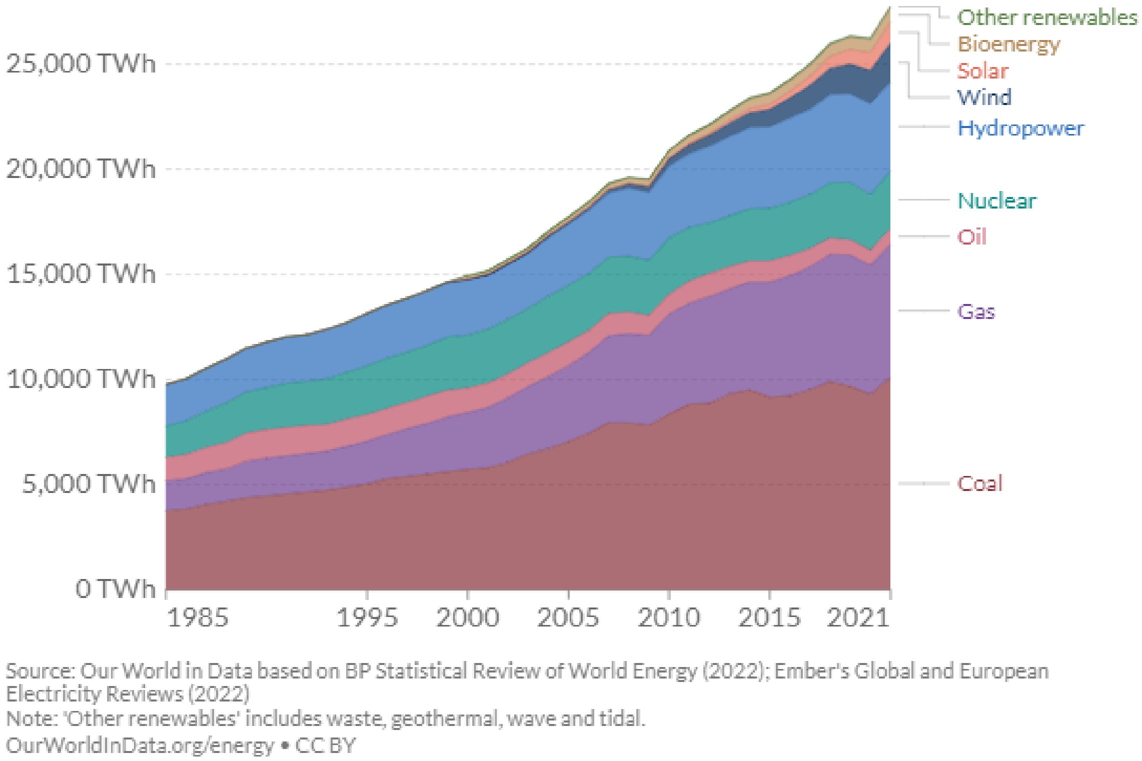
Table 1: Electricity generation technologies.

Fuel/resource	Power generation Technologies	Subcategories
Coal	Pulverized solid fuel-based subcritical combustion	High quality Coal
		Lignite
	Advanced (Supercritical/Ultra-supercritical)	High quality Coal
	Integrated gasification combined cycle	IGCC coal
Gas	Gas-fired steam turbine	
	Gas fired gas turbine open cycle	
	Nature gas combined cycle	
Oil	Oil-fired steam turbine	
	Oil-fired combined cycle	
Carbon based fuel with Carbon capture	CCS Post combustion for sub/ultra/super-critical	CCS High quality Coal
		CCS Lignite retrofit
	CCS Nature gas combined cycle	CCS NGCC retrofit
		CCS NGCC
	CCS Pre-combustion	CCS Coal IGCC Retrofit
		CCS Coal IGCC
		CCS Biomass IGCC Retrofit
		CCS Biomass IGCC
	Oxy-fuel combustion	CCS Coal advanced retrofit
		CCS Coal advanced
Nuclear	Nuclear	
	New generation Nuclear	
Renewable	Hydroelectric	Hydroelectric lake
		Hydroelectric Run-of-river
		Hydroelectric Small
	Wind	Wind onshore
		Wind 0ff-shore
	Concentrated Solar Power plant	Concentrated Solar
	Photovoltaics	Distributed Photovoltaics
		Centralized Photovoltaic
	Geothermal Power plant	Geothermal
	Biomass Power plant	Sub-critical
		IGCC
	Ocean power plant	Tidal
		Wave
Hydrogen	Fuel Cell Power plant	Distributed Hydrogen Fuel cell
	Gas-fired steam turbine	20-100% co-firing
	Gas fired gas turbine open cycle	20-100% co-firing
	Gas-fired steam turbine	20-100% co-firing
Ammonia	Gas fired gas turbine open cycle	20-100% co-firing
	Gas-fired steam turbine	20-100% co-firing

Source: Own elaboration

Each of these technologies differs not only in terms of the feedstock used to generate electricity, but also in terms of investment, CAPEX, O&M costs, associated GHG emissions, environmental impact, efficiency, flexibility, reliability, scalability etc. The use of each technology depends on factors such as location, availability of resources, access to capital, climate, and regional regulations among others.

To date, the global electricity sector is dominated by fossil fuels. About 60% of global electricity generation in 2021 came from coal and gas-fired power plants, see **Figure 3**. Hydropower (16%) was the largest source of renewable electricity, followed by nuclear power (10%), Wind turbines and solar photovoltaic (PV) have expanded strongly in recent years, increasing their share of global electricity generation from almost zero in 2000 to 6% and 4% respectively in 2021, respectively. This expansion has been driven by a significant existence of supportive policies, (Oxford University, 2022). reduction in the technology costs and the financing landscape for solar PV and wind power plants.



Source: Our World in data

Figure 3 Global electricity generation mix by source.

2.2 Future of Electricity. It's role in a low-carbon economy.

The transformation of the electricity system over the coming decades plays a crucial role in the decarbonisation of the global economy. In addition to reducing direct GHG emissions, low-carbon electricity is essential for decarbonising transport, industrial and buildings sectors via end-use electrification.

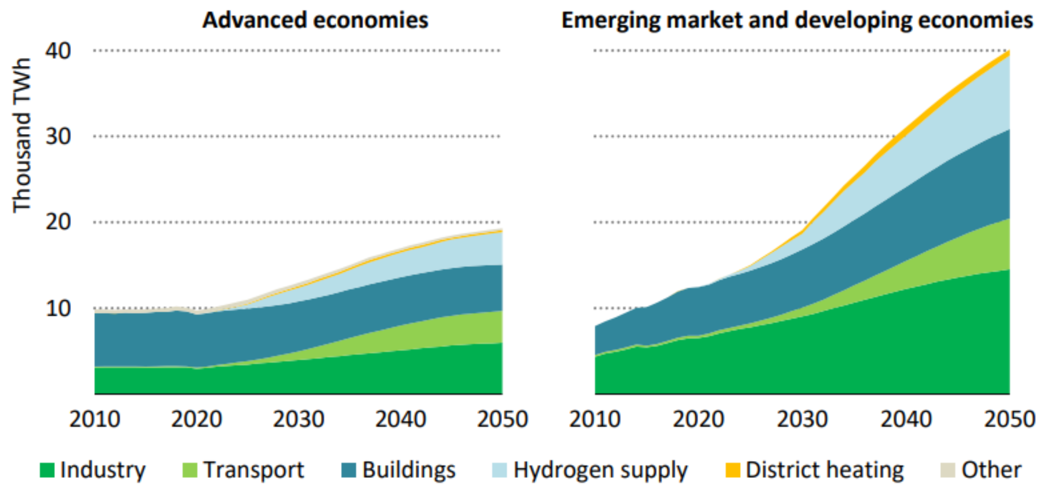
The electricity generation mix shift drastically from a carbon-based system to renewables in science-based scenarios aligned with 1,5-degrees increase of temperature above the preindustrial levels. Wind turbines and solar photovoltaic (PV) have expanded strongly in recent years, and these trends must increase to achieve almost 90% of the electricity generation in the world in 2050 (IEA, 2021a).

The future of electricity will face three mayor aspects: **increasing demand, decarbonisation, and end-use electrification**.

2.2.1 Electricity Demand

Studies agreed that achieving net zero emissions in 2050 will require a significant increase in electricity demand over the next 30 years. This is the result of increased economic activity, rapid electrification of end-uses, the expansion of hydrogen production through electrolysis and synthetic fuels derived from electricity, which will lead to a radical change in the way electricity is consumed. Global electricity demand was 23 230 TWh in 2020 with an average growth rate of 2.3% per year over the last decade. It will rise to 60 000 TWh in 2050 in the net zero emissions scenario (NZE), an average increase of 3.2% per year (IEA, 2021a).

Regional grouping is considered in the net zero scenario (IEA) to echo the differences about the actual situation, the population trends, technological development, etc. See **Figure 4**



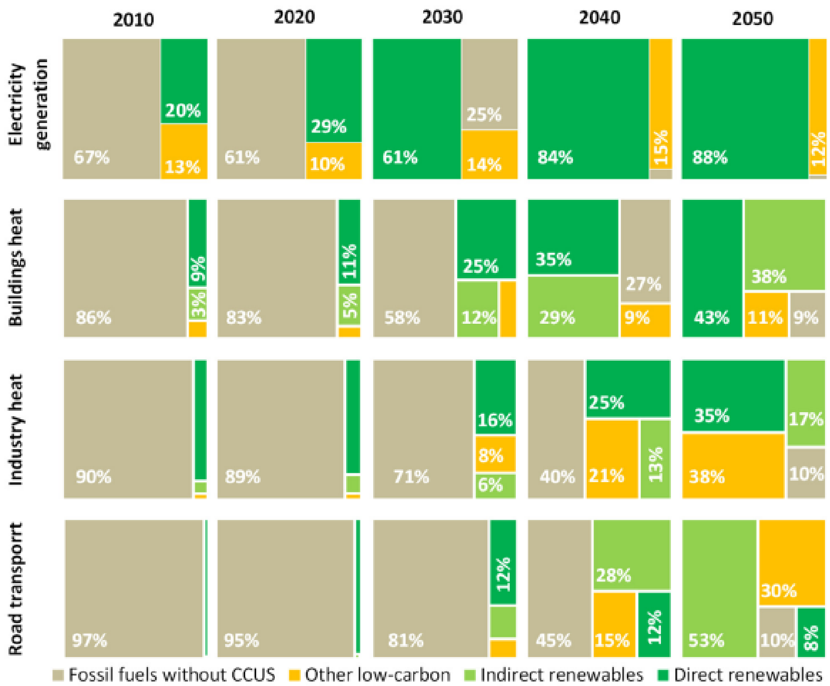
Source: Net Zero by 2050. A roadmap for the global energy sector. IEA 2021. (IEA, 2021a)

Figure 4. Electricity demand by sector and regional grouping.

2.2.2 Decarbonisation.

Decarbonisation of the electricity generation is the key to reduce emissions in the whole energy sector. It is achieved by increasing the share of low-carbon energy sources, especially renewables, and correspondingly reducing the use of fossil fuels. The share of renewables in global electricity generation reached 28.7% in 2021, after modest growth of 0.4 percentage points (IEA, 2022d).

Renewable energy sources such as wind, solar, hydro, and geothermal have zero or very low GHG emissions during operation. For a life-cycle emissions analysis please see ***section 4.2*** The global renewable energy potential is expected to continue to grow rapidly and could provide more than 88% of global electricity supply by 2050, according to the IEA net-zero emissions scenario (IEA, 2021a), Figure 5

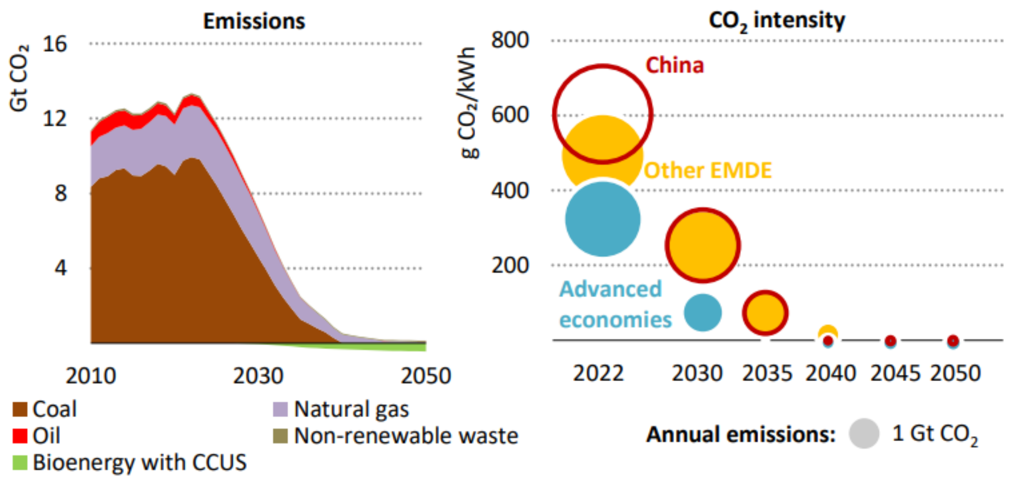


Source: Net Zero by 2050. A roadmap for the global energy sector. IEA 2021. (IEA, 2021a)

Figure 5: Fuel share in electricity generation in the NZE scenario compared to the other sectors.

The mitigation potential of these low carbon technologies for the power system depends on several factors, including the availability of resources, the cost and performance of the technologies, the policy and regulatory framework, and the level of public acceptance.

In addition, the IEA has stated that the power sector should achieve net zero emissions by 2040 (IEA, 2023), requiring the elimination of the largest contributors to power generation today, fossil fuels, such as coal and gas within 30 years, **Figure 6.** Moving away from 61% of the electricity generation system, is a colossal transition that has never been prosecuted on a global scale in such a short time. If achieved, it would require not only the decarbonization of the power system but also a radical efficiency measures and behavioural changes affecting the global economy system.



Source: Net Zero Roadmap. A global pathway to keep the 1,5oC goal in reach. IEA, 2023 (IEA, update 2023)

Figure 6. Global electricity sector emissions and CO_2 intensity of electricity generation in the NZE scenario (IEA, 2023).

There are also mitigations measures as abatement technologies that can significantly contribute to decarbonize the electricity sector. Abatement technologies for thermal power plants such as carbon capture and storage (CCS) and low-carbon co-firing, are still high-cost technologies that risk not being fully deployed as quickly as needed, with other associated problems such as the CO_2 transport leakage and geological-storage capacity limitations. On the other hand, carbon capture technologies can support the transition to NZE by addressing emissions from existing fossil assets. Providing a way to address emissions from some of the most challenging hard to abate economic activities.

Transport of low-carbon fuels to cofire in coal or fossil gas power plants is also a challenge to make these technologies as low-emitting as renewable energy. Producing the low-carbon fuel near the place where it will be used reveal as the best practice to significantly reduce the emissions of cofiring assets.

2.2.3 Electrification of the energy system

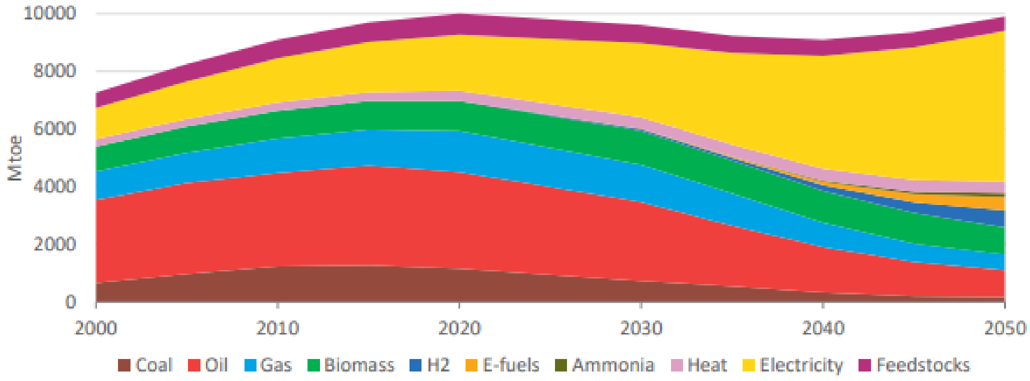
Electrification process will become the third key to decarbonise the whole energy system. The share of electricity in final energy consumption grows steadily between 2020 and 2050 (IPCC, 2018).The electrification of final demand sectors is a long-term trend driven primarily by the potential for electricity to decarbonize much faster than alternative energy sources, and the advantages of electricity as an end-use energy carrier in the building sector, as well as in many industrial applications.

To get on track with the net zero scenario the speed of the electricity increasing will need to almost double to reach the 2030 milestone. Based on the existing literature on long-term energy scenarios[6] (Huppmann, 2019), there seems to be a global consensus on the following points (Keramidas, 2019). First, it is likely that achieving ambitious long-term stabilization climate goals will require,

[6] The IAMC 1.5°C Scenario Explorer and Data hosted by IIASA (Huppmann, et al., 2019) is a multi-model long-term energy scenarios dataset, gathered from multiple collaborative projects. From this dataset, the "2.0°C" and "1.5°C" scenarios categories were identified as follows:

- 2°C scenarios have a higher than 66% chance of stabilizing global mean temperature increase below 2°C, based on MAGICC6 diagnosis.
- 1.5°C scenarios have a higher than 50% chance of stabilizing global mean temperature increase below 1.5°C, based on MAGICC6 diagnosis

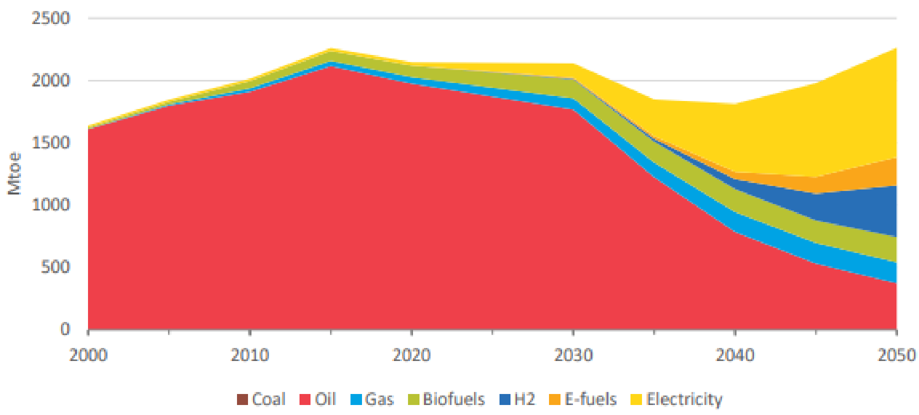
on average, an accelerated penetration of electricity use in the economy over the next three decades, **Figure 7**. This would contribute to the decarbonization of end uses; the trend is likely to be more pronounced for more stringent (1.5-degrees) climate targets. However, as some scenarios and pathways show, the rapid growth in electricity demand could outweigh the emission reductions from different technologies. A massive electrification strategy would only be sustainable if power generation itself is decarbonized, and this strongly depends on how fast this decarbonisation takes place, compared to the rate of electrification. Today, according to the IEA Net Zero by 2050 Scenario (IEA, 2022a), the trend in renewable electricity capacity additions is not on track.



Source: GECO 2019 (Keramidas, 2019)

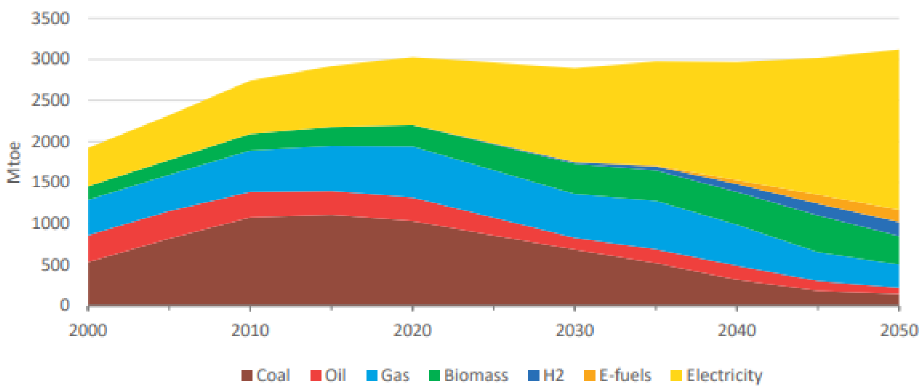
Figure 7: Global final energy consumption by fuel. Electrification process 1.5oC scenario.

Following **Figure 8, Figure 9** and **Figure 10** show the electrification process at the 1.5-degree scenario for three main sectors. Much of the demand can be met by switching to electric transport and installation of heat pumps. In industry the highest potential for electrification is in low-temperature heat processes.



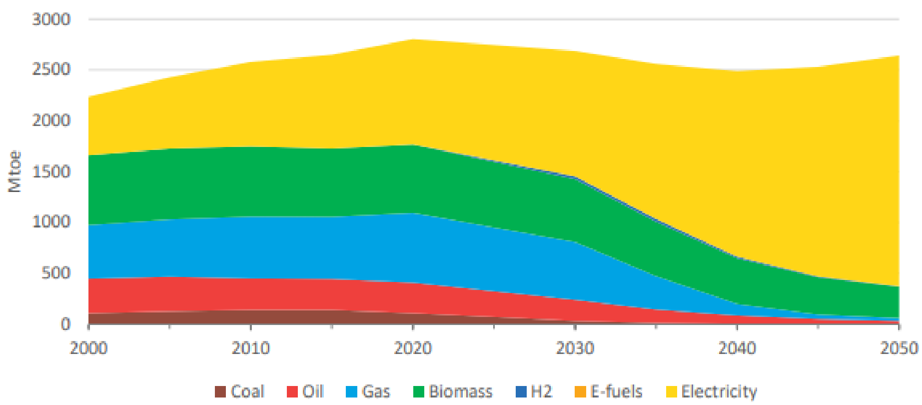
Source: GECO 2019 (Keramidas, 2019)

Figure 8: Global transport sector energy demand by fuels, 1.5-degree scenario.



Source: GECO 2019 (Keramidas, 2019)

Figure 9: Global industrial sector energy demand by fuels, 1.5-degree scenario.



Source GECO 2019 (Keramidas, 2019)

Figure 10: Global buildings sector energy demand by fuels, 1.5-degree scenario.

2.3 Climate change and main decarbonization challenges for electricity

Because electricity demand is growing, the biggest challenges to mitigate GHG emissions from the electricity sector is how quickly the unabated fossil fuel capacity can be replaced by low-carbon capacity, especially in growing scenario demand.

Key challenges for GHG emissions mitigation remain:

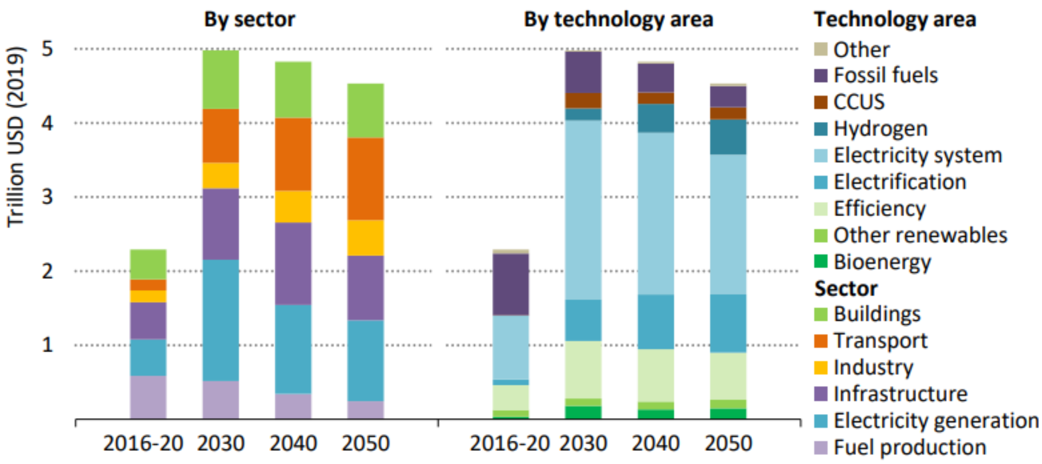
1. **Additionality**, demand for low-carbon electricity-derived synfuels, such as hydrogen, can cannibalise renewable electricity capacity. Without requiring additional renewable capacity, the 2030 hydrogen targets will cannibalise renewable electricity used to displace coal and gas-fired electricity.
2. **Coal** is both the largest emitter of energy-related global carbon dioxide (CO_2) – 15 gigatonnes (Gt) in 2021 – and the largest source of electricity generation, accounting for 36% in 2021. If no action is taken, emissions from existing coal thermal power plants alone would tip the world across the 1.5-degree limit (IEA, 2022c).
3. **Thermal electricity generation** can be covered by renewable generation, but the capacity and system services required other technologies, such as energy storage and smart grids.
4. **Grid Infrastructure**: The existing grid infrastructure in many countries is not designed to support the large-scale deployment of renewable energy sources. Building new transmission and distribution infrastructure can be expensive and time-consuming and may face resistance from local communities.
5. **Policy and Regulatory Frameworks** The policy and regulatory framework in many countries is not designed to encourage the deployment of low-carbon technologies. For example, many countries still provide subsidies or tax breaks to the fossil fuel-based technologies, while renewable energy sources face higher taxes and regulatory barriers.
6. **Public acceptance**: Some low-carbon technologies, such as nuclear power and carbon capture, face public opposition due to safety concerns and perceived risks.
7. **System integration**: Integrating large amounts of renewable energy into the electricity grid can be challenging, as it requires a flexible and robust grid infrastructure to balance supply and demand. This challenge can be addressed using smart grid technologies, energy storage, and demand-side management.
8. **Geopolitics**: The availability of resources for low-carbon technologies, such as rare earth metals for wind turbines and electric vehicles, can be subject to geopolitical tensions and supply chain disruptions.
9. **Opportunity cost**: When evaluating mitigation options, it is also interesting to consider the cost of an alternative that must be forgone to pursue a certain action or decision. In the electricity sector, decisions taken today will determine the system for the next decade, resulting in stranded assets, or irreversible paths. Investment in one technology will lead to a lack of investment in other technologies, resources are limited. An example would be the decision of prioritizing the use of hydrogen for the power sector, over the chemical industry.

In principle, different power system configurations can meet the emission reduction targets of the 1.5-degree pathway. One possible 1.5-degree scenario could be based on a predominant deployment of CCS/CCUS technologies, another on hydrogen, and yet another plausible one on renewables. The question, however, is whether there is a better feasible cost-effective pathway that can put the economy on the desired 1.5-degree pathway. Better in this case means, cheaper, faster, more feasible, more resilient, with lower social or environmental costs, depending on available resources, technological readiness, regulation, and market conditions.

2.4 Investment need

Robust investment in the power sector is critical to meet the expected growth in electricity demand, reduce GHG emissions, and accelerate the transition to a low-carbon economy. Investment in low-emission technologies in the power sector is picking up, underlining the central role of clean power in a sustainable energy future.

The IEA scenario expands annual investments to USD 4,5 trillion by 2050 for the energy sector with relevant share to the power generation. See **Figure 11¡Error! No se encuentra el origen de la referencia.**.



Source: Net Zero by 2050 A road map to the Global energy sector IEA, 2021

Figure 11. Annual average capital investment in the net zero scenario.

Investments related to the electricity take the lead by sector (electricity generation) as well as by technology (electrification and electricity system). Capital investments in energy sector rises form 2.5% of GDP in recent years to 4.5% by 2030; the majority in spent on electricity generation, networks, and electric end-user equipment[7].

Despite numerous issues affecting the sector, including inflationary pressures, tighter financing conditions and supply chain bottlenecks, there is a solid pipeline of projects driven by more ambitious climate targets and robust policy support: renewable capacity is forecast to account for almost 95% of global power capacity growth to 2026.

2.5 Deals already seen in the sector.

Governments, businesses, and consumers are pushing for greater electrification of the economy and an accelerated transition to clean energy. Investment in 2021, led by renewables, power grids and battery storage, have accounted for more than 80% of total power sector investment since 2019. Governments alone, as part of their clean recovery packages, have committed USD 75 billion in spending as of 31 March 2022 on low-carbon electricity generation, transmission and distribution through tax credits, auctions, consumer subsidies and direct financing of manufacturing facilities. This could leverage an additional USD 475 billion from the private sector by 2023. Renewables will remain the largest category in the power sector (IEA, 2022e) as they are set to keep the number one power sector category for investment in 2022, following a record year in 2021 when more than USD 440 billion was spent for the first time ever.

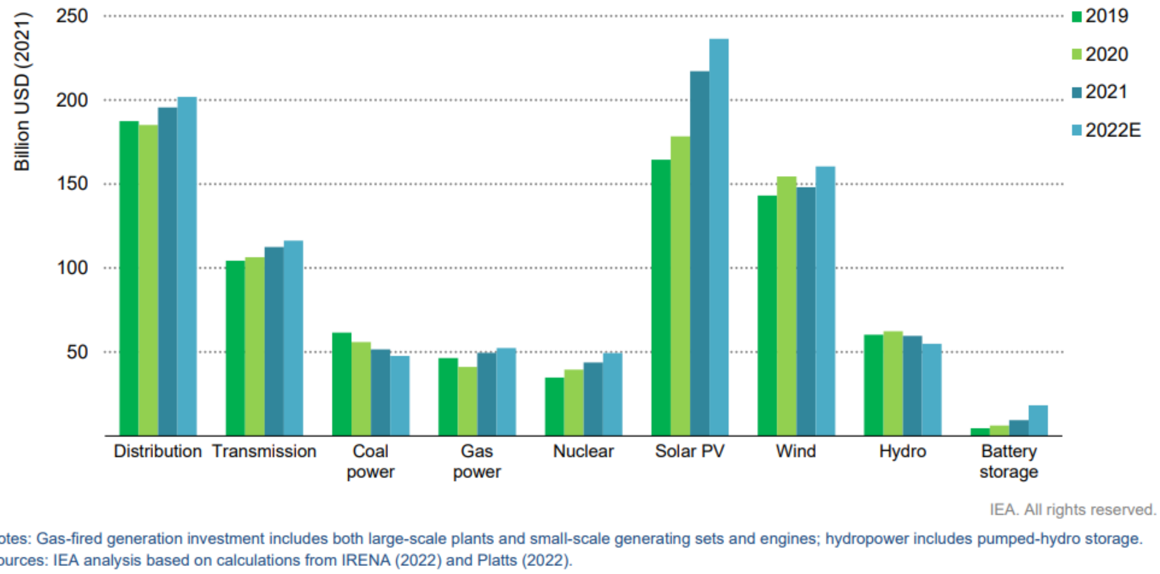
Solar PV have lead power sector investment in 2021, accounting for almost half of the renewables investment. Spending is almost evenly split between utility-scale projects and distributed solar PV systems, with each sub-category set to break the USD 100 billion mark in 2022. For wind, while 2020 was a record year for onshore deployment, 2021 was a record year for offshore deployment, with more than 20 GW commissioned and around USD 40 billion of expenditure. As with the onshore peak in 2020, developers pushed to commit offshore wind projects in 2021 before the expiry of subsidy regimes in China.

[7] Net Zero by 2050. A roadmap for the global energy sector. IEA

Investment in fossil fuel power generation is expected to be flat in 2022, consolidating the rebound experienced in 2021, with higher spending on natural gas offsetting the decline in spending on coal-fired power generation. Combine investment in these technologies remains over USD 100 billion, despite governments and corporate announcements of a continued shift away from unabated fossil fuels and the current uncertainties affecting fuel prices.

Investment in clean dispatchable generation has been stable at around USD 100 billion per year for the past four years, with a steady increase in nuclear spending outweighing a decline in hydropower. Nuclear investment is accelerating with the construction of new nuclear reactors in China, Europe and Pakistan, and the refurbishment, modernisation, and life extension of existing reactors in France, the United States and Russia.

Figure 12 and ¡Error! No se encuentra el origen de la referencia. show the global annual investments in the power sector by technology. As detailed above solar PV is leading with positive signs for transmission and distribution networks and an acceleration in battery energy storage.



Source: World energy investment 2022 IEA (IEA, 2022e)

Figure 12: Global annual investment in the power sector by technology 2019-2022E.

Investment in the power sector requires a supportive policy and regulatory framework to encourage private investment, provide long-term stability, and reduce investment risk. Public-private partnerships, innovative financing mechanisms, and multilateral development banks can also play a critical role in mobilizing investment in the power sector.

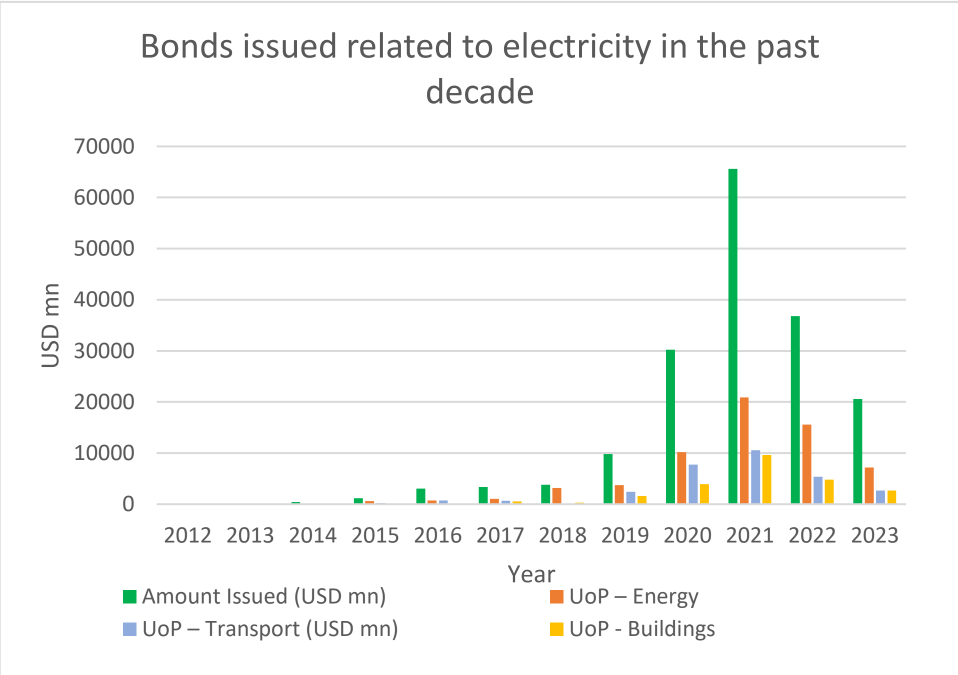
Labelled bonds can help the acceleration needed in the investments for the energy and electricity sector. A market survey of Use of Proceeds (UoP) allocation, provide a view of the green bond issuance towards electricity related projects. **Table 2** and **Figure 13** shows the yearly overview of our green bond issuance related to electricity and highlights the top three Use of Proceeds allocations within these bonds.

Table 2. Bonds issued in the energy sector form 2012 to date.

Bonds related to electricity from 2012 to date.				
Year	Amount Issued (USD mn)	UoP – Energy (USD mn)	UoP – Transport (USD mn)	UoP - Buildings (USD mn)
2012	38	38	0	0
2013	79	20	20	0
2014	407	71	71	71
2015	1150	596	209	20
2016	3029	757	757	0
2017	3387	1033	704	561
2018	3796	3191	38	314
2019	9844	3761	2421	1611
2020	30242	10209	7757	3947
2021	65576	20879	10576	9602
2022	36812	15555	5394	4809
2023	20594	7211	2702	2646

Source: Own elaboration

The data above are showed in the following chart.



Source: Own elaboration

Figure 13. Bonds issued in the energy sector form 2012 to date.

3 Principles and Boundaries of the Criteria

3.1 Guiding Principles

The objective of ClimateBonds developing the Electrical Utilities Criteria is to maximise viable bond issuances with verifiable environmental and social outcomes. This means the Criteria need to balance the following objectives:

- They form a set of scientifically robust, verifiable targets and metrics; and
- They are usable by the market, which means they must be understandable for non-scientific audiences, implementable at scale, and affordable in terms of assessment burden.

The Criteria should:

- Define the system and emissions boundaries of the electricity generation process to assess the emissions of an Electrical Utility for inclusion in a Certified Climate Label or Bond.
- Set a combustion emissions intensity transition pathway and other non-combustion emissions criteria for the generation portfolio mix of an Electrical Utility to be included in an Entity Climate Certification.
- Set the conditions for the Sustainability-Linked Bonds issued by a certified entity.
- Enable the identification of eligible assets and projects (or use of proceeds) related to Electricity Generation investments that can potentially be included in a Certified Climate Bond.
- Deploy appropriate eligibility Criteria under which the assets and projects can be assessed for their suitability for inclusion in a Certified Climate Bond; and
- Identify associated metrics, methodologies, and tools to enable the effective measurement and monitoring of compliance with the eligibility Criteria.

Subject to meeting the eligibility criteria in the following sectors, the following can be certified under these criteria and the update of the Overarching Climate Bonds Standard to v4.0:

- Entities (Electrical Utilities) and Sustainability-Linked Debt (SLD) issued by those entities –
- Use-of-Proceed (UoP) bonds financing mitigation measures (e.g., Carbon capture, co-firing)

Each subset of criteria may share common requirements, pathways or metrics but require different demonstrations of compliance. The following sections will make distinction between the hallmarks for transition for entities and companies (described in ***section 3.1.13.1.2***) and the guiding principles for certifying assets and activities. (***Section 3.1.23.1.1***)

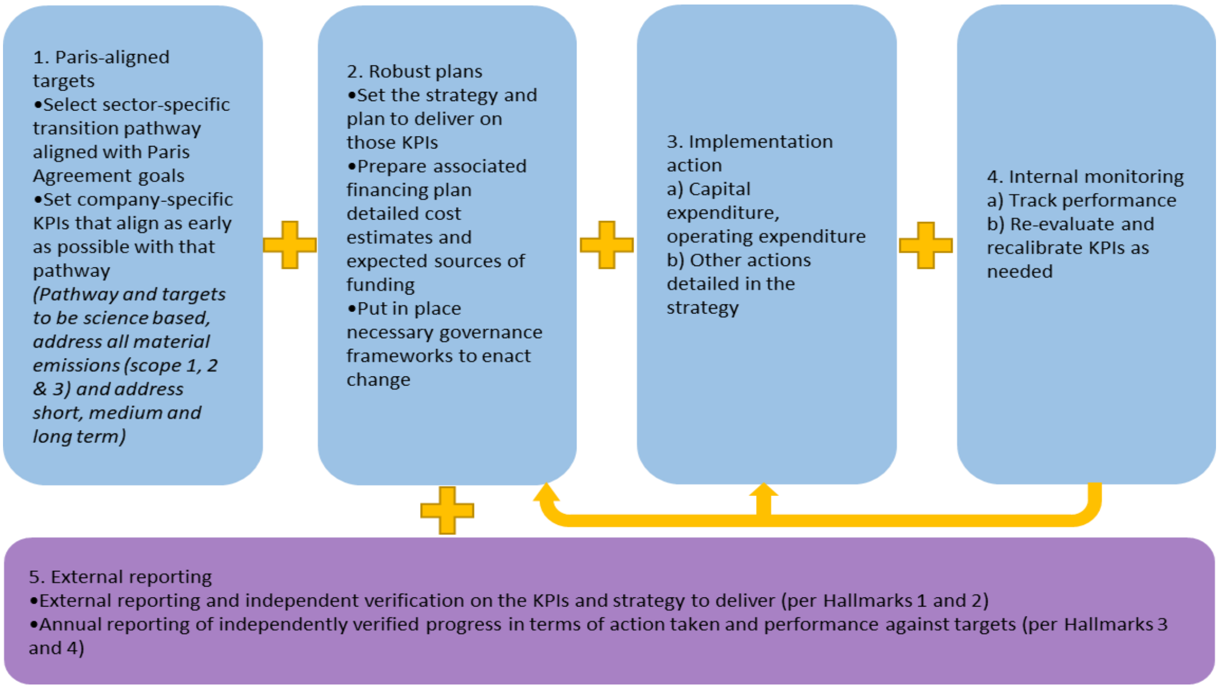
3.1.1 Guiding principles - General Corporate Purpose bonds

Climate Bonds' focus to date has been UoP bonds but it is our intention to certify instruments beyond UoP, including corporate SLBs and similar (e.g. Sustainability Linked Loans - SLLs). This will allow us to provide guidance to issuers and assurance to investors around the credibility of those instruments, which can at present prove difficult to evaluate due to lack of consistency in approaches and metrics used by each issuer. This will require assessment of both the company's transition KPIs, and their ability to deliver on their targets. Such certification would follow the requirements set, namely a standardised, common rule set, binary assessment, simplicity, transparency, and science-based criteria.

Nonetheless, the two subsets of criteria share many of the same guiding principles. The Climate Bonds Initiative sets out the following as key principles for setting entity level criteria:

- Science based.
- Testable.
- Relatively simple.
- Not reinvent the wheel.
- Consistent over time and companies.

Rather than the two components for green (mitigation and adaptation & resilience), the Climate Bonds Initiative has proposed five hallmarks for transition that are relevant to entities, these are summarized in *¡Error! No se encuentra el origen de la referencia.***Figure 14**.



Source: Climate Bonds Initiative

Figure 14. The Hallmarks of a credibly transitioning company.

3.1.2 Guiding principles - Use-of-Proceeds bonds

For UoP bonds, the guiding principles for the design of the Electrical Utilities Criteria, which is a standard approach for all Climate Bonds criteria are summarised in Table 3.

The Electrical Utilities Criteria are made up of two components, both of which need to be satisfied for assets to be eligible for inclusion in a Certified Climate Bond. These are as follows:

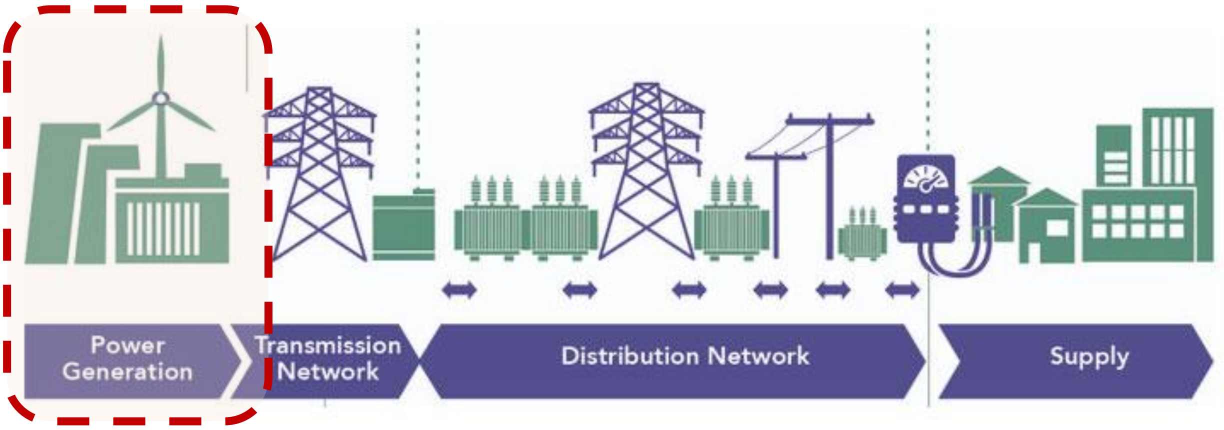
1) Climate Change Mitigation Component - addressing whether the entity or asset/project is sufficiently 'low GHG' to be compliant with rapid decarbonisation needs across the sector - see ***section 3 and 4*** of the criteria document for details.
2) Climate Change Adaptation and Resilience Component - addressing whether the facility/ies included in the entity's portfolio or associated to the bond is/are itself/themselves resilient to climate change and furthermore not adversely impacting the resilience of the surrounding system. This encompasses a broad set of environmental and social topics - see ***section 6*** of the criteria document for details.

Table 3. Key principles for the design of Climate Bond Standard Sector Criteria.

Principle	Requirement for the Criteria
Ambitious	Compatible with meeting the objective of limiting global average warming to a 1.5°C temperature rise above pre-industrial levels set by the Paris Agreement.
Material	Criteria should address all material sources of emissions over the lifecycle. Scope 1 & 2 emissions should be addressed directly and scope 3 considered.
No offsets	Offsets should not be counted towards emissions reduction performance.
Resilient	To ensure that the activities being financed are adapted to physical climate change and do not harm the resilience of the system them are in.
Scientifically Robust	Based on science not industry objectives.
Granular	Criteria should be sufficiently granular for the assessment of a specific project, asset or activity. Every asset or project to be financed must comply.
Globally consistent	Criteria should be globally applicable. National legislation or NDC's are not sufficient.
Aligned	Leverage existing robust tools, methodologies, standards.
Technology neutral	Criteria should describe the result to be achieved.
Avoid lock-in	Avoid supporting development that may result in long term commitments to high emission activities.

3.2 Entities and activities covered by the Electrical Utilities criteria.

The electricity value chain covers generation, transmission, distribution, and customer. **Figure 15.**

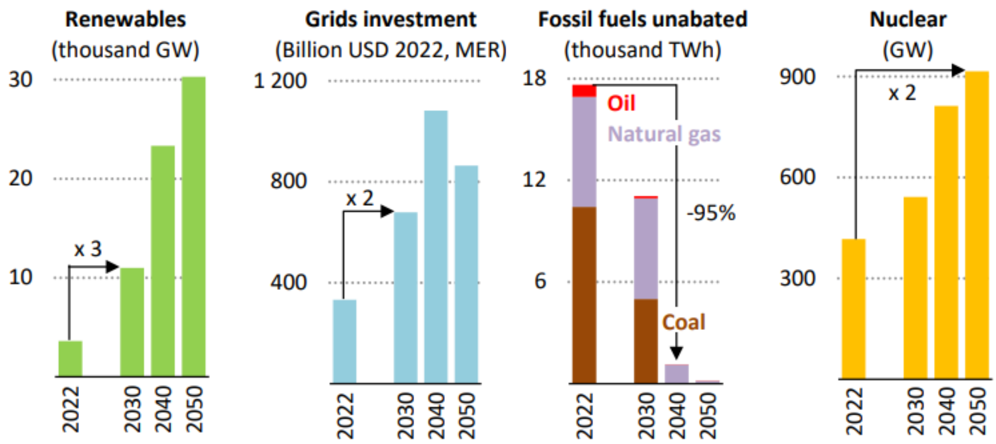


Source: Development Bank of Singapore

Figure 15. Simplified representation of the power system value chain that covers generation, distribution, and end-users.

The electrification of the energy system relies on a low-carbon electricity generation and a transmission line/grid that provide secure electricity integrating renewables with dispatchable low-carbon electricity. Key milestones for the electricity sector include (**Figure 16**):

- High share of renewables in the electricity generation.
- Increasing grid investments.
- Phasing out of unabated fossil fuel.
- Increasing of nuclear energy to make the electricity grid reliable and efficient.



Source: Net Zero Roadmap. A global pathway to keep the 1,5oC goal in reach. IEA, 2023 (IEA, update 2023)

Figure 16. Key milestones for the electricity sector.

These Criteria covers the generation segment of the overall electricity supply chain framed in red in **Figure 15**, and the entity's electricity purchased from the grid for distribution or trading in the retail market. The rest of the power sector supply chain is partially or wholly covered by other sector criteria, e.g. ClimateBonds Grid and Storage Criteria**.**

3.2.1 Entities

The criteria mainly apply to eligible electricity generation entities with transition plans.

The way these criteria have been set out is to focus on investments addressed to shift the carbon-based electricity system to low-carbon generation. This include phasing-out of fossil fuel plants (mitigate their emissions when phase-out is not possible) and boosting renewables and other low-carbon technologies at an entity level.

Emissions from heat or other fossil fuel business not related to electrical generation, are not considered in the criteria but, to be certified, the entity must pledge, since 1 January 2023, a commitment by the parent Company on behalf of the parent group to zero future expansion of fossil fuel activities, which covers the exploration, extraction, transport, refining and trading of fossil fuels[8], detailed in Clause D.4.1.1 of the Climate bons Standard V4.0.[9].

Pureplay heat companies are not eligible for certification as the criteria is focused on emissions from the generation of electricity.

Table 4 summarises the entities in scope of the Electrical Utilities Criteria

[8] Statement by the Parent Company on behalf of the Parent Group that no entity within the Parent Group has expanded any of the activities detailed in Clause D.4.1.1 since 1 January 2023. Climate Bonds Standard version 4.0 https://www.climatebonds.net/files/files/CBI_Standard_V4.pdf.

[9] Climate Bonds Standards Version 4.0. *Globally Recognised, Paris-aligned certification of debt Instruments, Entities and Assets using robust, science-based methodologies*. Updated version 2023. Please assure that this is the latest version on https://www.climatebonds.net/files/files/CBI_Standard_V4.pdf

Table 4. Electricity supply chain in scope.

Business segment of the Electricity Supply chain	Eligible entities or section of the entity	Emissions Scope considered
Electricity generation	• The electricity generation portfolio.	• Scope 1 direct combustion emission of fossil fuels. • Scope 1 Non-combustions emissions for hydropower and geothermal electricity generation. • Scope 3 for biomass electricity generation.
Electricity purchased	• the electricity purchased from the grid for distribution or trading in the retail market.	• Scope 3 for electricity purchased from the grid for distribution or trading in the retail market.
Fossil Fuel Activities other than electricity production	• Commitment of no expansion of exploration, extraction, transport, refining of fossil fuels	• Scope 1,2,3

3.2.2 Assets.

Electrical Utilities criteria is mainly focused on entities with an electricity portfolio including a mix of facilities generating electricity. Individual facilities are not included in the Electrical Utilities Criteria. Climate Bonds Initiative has developed criteria for renewable electricity generation Applicants for renewable energy facilities can follow Climate Bonds Criteria collected in **Table 5**

Table 5. Climate Bonds renewable energy criteria for individual electrical generation facilities.

Renewable energy criteria already developed by Climate Bonds Initiative.	
Assets	Solar power plants. See Climate Bonds Sector Criteria.
	Wind power plants. See Climate Bonds Sector Criteria.
	Geothermal power plants. See Climate Bonds Sector Criteria.
	Hydropower plants. See Climate Bonds Sector Criteria.
	Marine Renewable. See Climate Bonds Sector Criteria

Following the main climate institutions and scenarios, to reduce emissions it is crucial to decarbonize the energy system, namely the electricity sector. Related to this objective, the TWG discussions agreed that investment in new fossil fuel power plants (carbon, oil or gas) are out of scope and cannot be certified as an asset neither a whole entity. So, there is no criteria at all in Climate Bonds Standards for fossil fuel power generation.

Table 6. Electrical facilities excluded from the Climate Bonds principles.

Excluded Assets/ Activities	Comment
New carbon power plants	No extension of fossil fuels is considered in ClimateBonds principles to align with 1.5-degree scenarios. It is not certifiable under these criteria.
New oil power plants	No extension of fossil fuels is considered in ClimateBonds principles to align with 1.5-degree scenarios. It is not certifiable under these criteria.
New Fossil Gas power plants	No extension of fossil fuels is considered in ClimateBonds principles to align with 1.5-degree scenarios. It is not certifiable under these criteria

3.2.3 Activities.

The Electrical Utilities Criteria also include some UoP certification for decarbonization measures setting out requirements to certify potential investments in specific mitigation projects within fossil fuel facilities.

These measures cover the retrofitting of coal and/or fossil gas plants with CCS/CCUS or cofiring with low-carbon fuels. These investments could play an important role in the CO_2 emissions reduction due to the importance of fossil fuel in the mix of some entities operating in countries whose electricity mix is based on carbon power plants. Even if these entities could not be certified, they can access to Climate UoP bonds to reduce their emissions.

Table 7 shows these measures.

Table 7. Activities eligible for certification.

Power plants	Eligible Mitigation measures	Thresholds
Coal and Gas	• CCS for CO_2 capture, transport, and storage. • CCUS for CO_2 capture, transport, and utilisation.	• Capture rate 90% • Cross-cutting criteria for CO_2 leakages and storage • Utilisation Criteria
	• Cofiring with low-carbon synthetic fuels comprising liquid and gaseous biofuels, hydrogen and hydrogen-derived fuels. • Cofiring with solid biomass	• Cofiring rate 100% • Cross-cutting criteria for cofiring low-carbon fuels • Cross cutting criteria for cofiring with biomass.

3.2.4 The use of hydrogen in electricity generation.

Hydrogen is counted to be an important factor in the transition of the energy system and its role in almost every decarbonized scenario is enormous due to Its potential to substitute fossil fuels in many situations. In the IEA NZE by 2050 scenario, the consumption of hydrogen and hydrogen-based fuels is about 6% in world total final energy consumption (IEA, 2021a).

To accomplish its mission, hydrogen must be green hydrogen, what means that must be produced from electrolysers fed with low-carbon electricity. Thus, to be green, hydrogen needs the consumption of electricity produced from renewable energy. (**Figure 17**) According to the few discussions on the subject, held with members of the TWG, utilisation of hydrogen to produce electricity cofired or not with fossil gas, means cannibalize green electricity that can be used to electrify other high emitting activities.

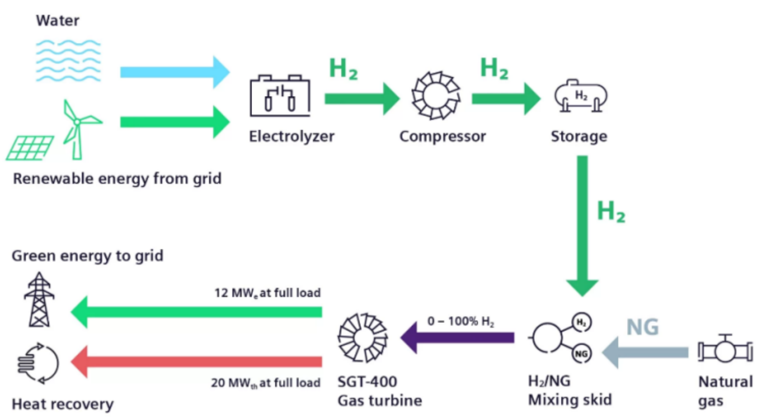
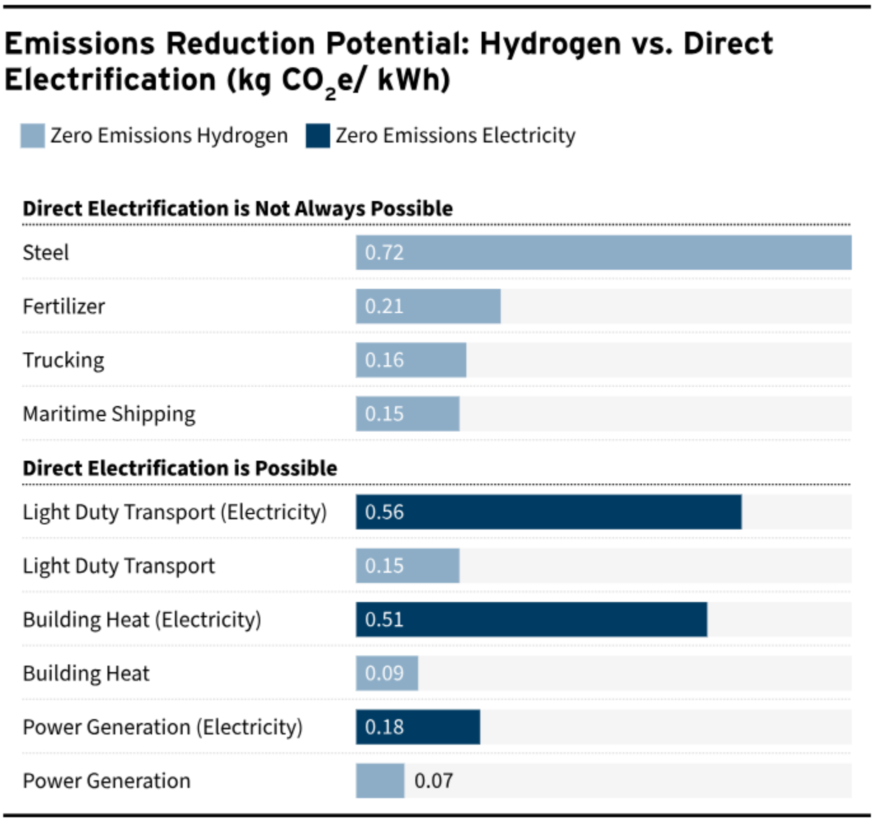


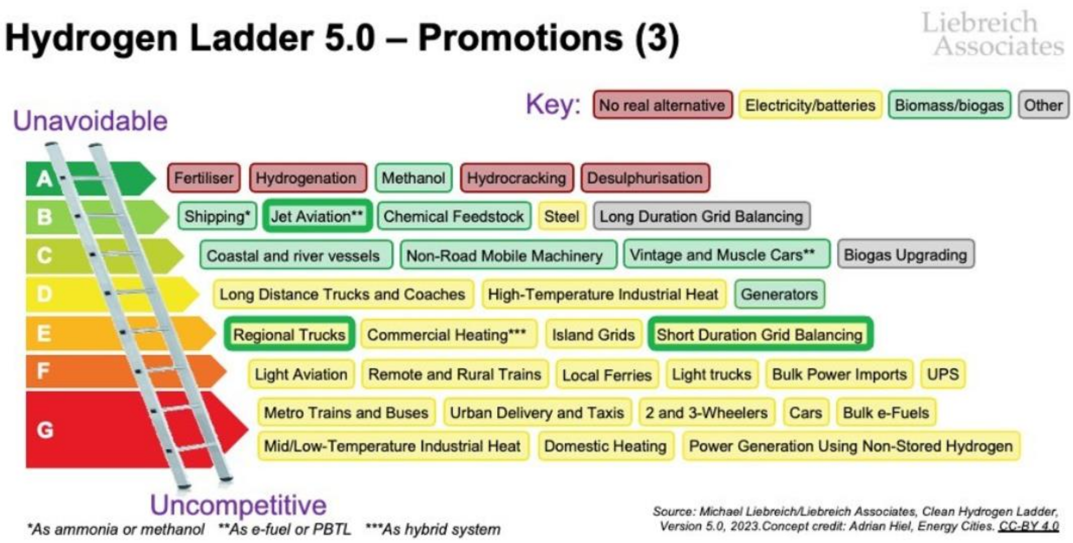
Figure 17. Scheme for hydrogen production, storage, and consumption to generate electricity.

Literature and experts also advise that green hydrogen must be used to replace fossil fuels in process that can be difficult or impossible to electrify such as high temperature industrial processes or fabrication of fertilisers. Therefore, the role of hydrogen in reducing emissions will be important in long-distance transport, chemicals, and heavy industry due to additionality and thermodynamical reasons. (Figure 18 and Figure 19)



Source: Rocky Mountain Institute (RMI)

Figure 18. Hydrogen emissions reduction potential vs direct electrification.



Source: Michael Lierbrich

Figure 19. Hydrogen Ladder.

Hydrogen is thus recommended when direct electrification is not possible. However, TWG decided to accept it in electricity generation setting up high benchmarks for the cofiring rate due to the potential of substituting and moreover reducing fossil fuel use in the electricity sector. The hydrogen used for cofiring must also meet requirements regarding the emissions in its production and delivery.

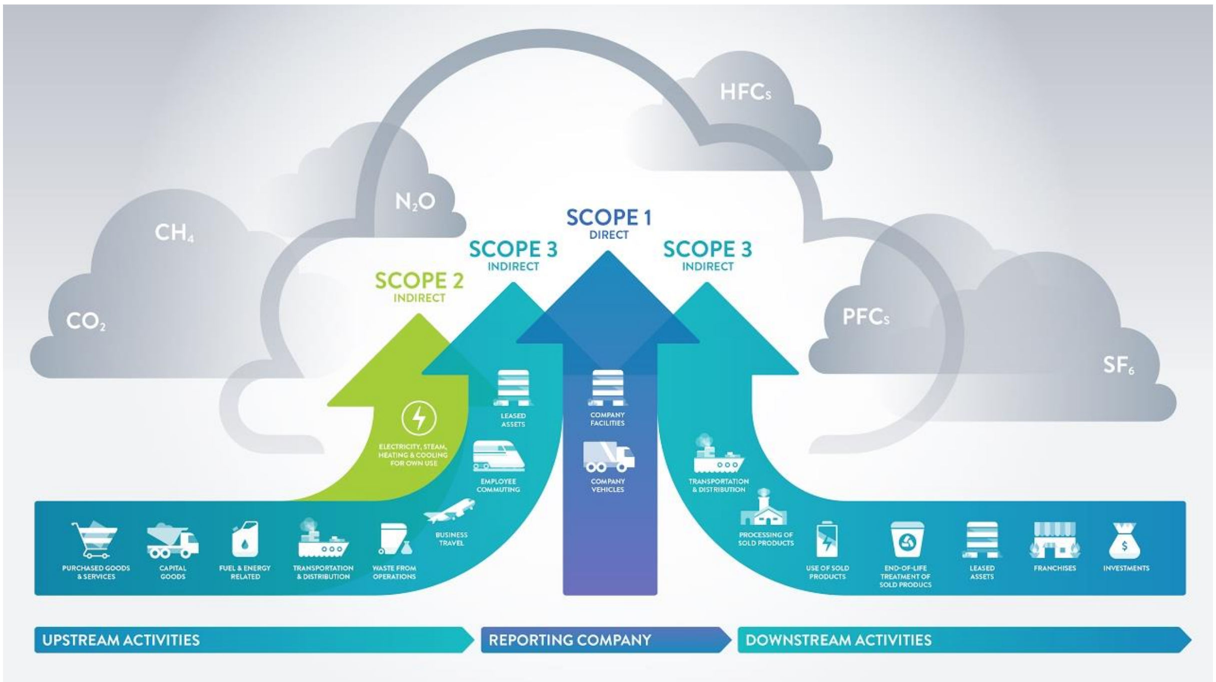
3.3 Scope of emissions. Overarching considerations

In setting the criteria, the emissions to be included were discussed, along with the scope of emissions and what criteria would test that the sector is decarbonising and give assurance to investors that financial instruments issued by companies are of satisfactory quality. The key considerations are summarised in this section.

3.3.1 Scope of emissions. Assessing all the emissions of the electrical utility

Previous section reflects that the electricity value chain includes generation, transmission, distribution, and customers. The electrical utility criteria only cover the emissions of the generation part of this process and the emissions related to the electricity purchased from the grid for distribution or trading in the retail market.

These criteria adopt the approach of the GHG Protocol. According to it, scope 1 emissions are direct emissions, scope 2 are indirect emissions from purchased electricity, heat, and power; and scope 3 emissions are indirect emissions from extraction and manufacture of raw materials and fuels that are not included in scope 2. It also includes waste disposal, products end use, among others (WRI/WBCSD, GHG Protocol, 2004). See **Figure 20.**



Source: The Greenhouse Gas Protocol

Figure 20. Scheme of the scopes related to Greenhouse Gases emissions.

Emissions from electricity generation are mainly scope 1 emission as Scope 2 is near zero in electrical consumption. Scope 2 emissions are usually auto produced and it's relevant in renewable energy with high temporal generation process. Scope 3 is important for entities that purchased and/or commercialise electricity or those that also have gas commerce besides electricity. Electrical Utilities Criteria will consider emissions from direct combustion, emissions related to the electricity purchased from the grid for distribution or trading in the retail market, non-combustion emissions from hydropower and geothermal and indirect emissions from manufacturing and transporting biomass and/or hydrogen-based fuels. Indirect emissions from solar and wind will be included in further actualizations of these criteria.

Table 8 shows the emissions assessed in the criteria and its inclusions in the entities' emissions intensity.

Table 8. Reported emissions from the generation technologies of an electrical utility.

Reported emissions in the criteria from the generation technologies.		
Technology	Reported emissions	Included in the entity's emissions intensity
Coal	Scope 1 direct combustion emissions	YES
Fossil Gas	Scope 1 direct combustion emissions	YES
Geothermal	Scope 1 direct non-combustion emissions	NO
Hydropower	Scope 1 direct non-combustion emissions	NO
Nuclear		NO
Solar CSP	Recommended Scope 3 emissions	NO
Solar PV	Recommended Scope 3 emissions	NO
Wind onshore	Recommended Scope 3 emissions	NO
Wind offshore	Recommended Scope 3 emissions	NO
Biomass	Scope 3 emissions	NO
BECCS	Negative emissions from CO_2 captured	YES

At the entity level a comprehensive approach of company's GHG emissions are assessed to certify the entity. Applicants of certification must comply with the sector specific criteria transition pathway Total CO_2 emissions must include the direct combustion emission of the **electricity generation portfolio,** and the emission resulting from activities such as the **electricity purchased for distribution or trading in the retail market**.

The entity's certification includes:

- An emissions intensity transition pathway against with the entity's average direct combustion emissions intensity (including Scope 1 emissions and 3 from the electricity purchased from the grid for distribution or trading in the retail market) will be compared. Section **3.3.2**
- Compatible emissions intensity thresholds for non-combustion emissions. The threshold will be differentiated for any plant operating at the tie of certification (existing capacity) and for any plant operating after the time of certification (new capacity). Section **3.2.3**
- Cross cutting criteria when using CCS/CCUS; hydrogen or biomass to cofire and for methane leakages in fossil gas plants.

3.3.2 Scope 1 and 3 for the generation portfolio. Entities' emissions intensity.

Models and scenarios with net zero CO2 emissions aligned to a temperature increase of 1.5-degrees above preindustrial levels, assume Scope 1 for the electrical generation as they usually are global models that allocate emissions (Scope 1 emissions) for each sector of the energy system. These criteria are based on the net zero emissions scenario by the IEA (IEA, 2021a) and its emissions allocation.

As global models, the electrical value chain upstream emissions are covered by mining or sourcing process. And downstream emissions are contained in transmissions, distribution, and end-use emissions. In the Climate Bonds Standards presents (Climate Bonds Electrical Grids and Storage) and future criteria will tend to cover all the emissions scope.

Thus, the criteria first establish a compatible CO_2 emissions[10] intensity transition pathway for the direct combustion emissions of an electrical utility, allowing the transition to net zero emissions by 2040, aligned to the goal to limiting global warming to 1.5-degrees Celsius (IEA, update 2023).

3.3.3 Scope 1 and 3 for indirect emissions and/or non-combustion emissions – Scope 3 for solar, wind and bioelectricity and other Scope 1 for hydropower, geothermal.

In addition to meet the emissions intensity transition pathway, the entity must meet other emissions intensity thresholds which cover other non-combustion emissions.

The electrical utility portfolio could include fossil fuels, nuclear energy along with renewables: solar, wind, hydropower, geothermal or bioenergy. The latter are considered as low-carbon electricity generation technologies and their direct combustion emissions compute as 0 gr CO_2/kWh in the entity direct emissions. Nonetheless, literature warn about the high risk of other non-combustion emissions of these technologies that sometimes, when not well designed, could be higher than fossil fuel power plants. (Schlömer, Technology-specific costs and performance parameters, 2014)

Values for GHG emissions from different technologies are shown in **Table 9.**

Table 9. GHG direct and indirect emissions by fuel.

GHG emissions (gCO_2e/kWh)[11]						
Option	Direct emissions			LCA		
	Min	Med	Max	Min	Med	Max
Coal	670	760	870	740	820	910
Fossil Gas	350	370	490	410	490	650
Geothermal	0	0	0	6	38	7
Hydropower	0	0	0	1	24	2200
Nuclear	0	0	0	3,7	12	110
Solar CSP	0	0	0	8,8	27	63
Solar PV	0	0	0	18	48	180
Wind onshore	0	0	0	7	11	56
Wind offshore	0	0	0	8	12	35
Biomass	0	0	0	130	230	420

As remarqued, non-combustion emissions could be not negligible in hydropower and bioenergy and careful assessment are required in the Electrical Utilities Criteria. For other renewables technologies Scope 3 emissions are recommended to be evaluated as the will remain as important emissions as the electricity system is electrified. Following section explain the discussions around these emissions for each generation technology.

3.3.3.1 Solar and Wind

Wind and solar electricity generation contribute as low-carbon technologies with 0 gCO_2e/kwh added to the entity's generation portfolio. However, Scope 3 emissions could be important as the electricity system will be decarbonised. At that moment, only remaining Scope 3 emissions will be the main emissions from the electricity sector.

[10] Carbon dioxide accounts for the majority of greenhouse gas emissions from most stationary combustion units. When weighted by their Global Warming Potentials (GWPs) CO2 typically represent over 99 percent of the greenhouse gas emissions from the stationary combustion of fossil fuels. (Potential exceptions include CH4 from open burning processes and N_2O from some engines with catalytic NOx emissions controls)

[11] IPCC AR5 Annex III

IPPC LCA values for solar and wind generation establish a median figure for solar energy of 48 gCO_2e/kWh and about 12 gCO_2e/kWh for wind. These are the lowest CO_2 emitting technologies with values far away from those of fossil fuels (490 and 920 gCO_2e/kWh for fossil gas and coal respectively). See **Table 10**

Table 10. Literature LCA emissions values for solar and wind.

Lifecycle emissions (gCO_2e/kWh)						
Option	IPCC AR5 (2020)[12]			IAM models (2050)[13]		
	Min	Med	Max	Min	Med	Ma
Solar PV	14	48	180	2,9	5,1	20,7
Solar CSP				9,1	12,2	24,6
Wind onshore	7	11	56	3,3	4,5	6,3
Wind offshore	8	12	35			

Most net zero emissions scenarios in line with 1,5ºC rely on a high share of renewable energy in the electricity generation, mainly solar and wind. In the IEA NZE by 2050 scenario, the rate from solar and wind raise up from 11% in 2022 to 72% in 2050 (IEA, update 2023).

3.3.3.2 Hydropower.

Hydropower is essential to address climate change and reduce global carbon emissions. Its flexibility and storage capacity are integral to tackle climate change and can help variable renewables when they are unavailable[14]. Emissions form hydropower procced from the reservoir (in storage projects). Physic and biological process can release important amounts of CO_2 and CH_4 to the atmosphere[15]. Materiality of other indirect emissions makes them irrelevant.

These emissions are considered as Scope 1 emissions for the hydropower asset but not included in the entity's average emissions intensity when integrates hydropower generation in its portfolio. For this reason, emissions from hydropower generation must be assessed separately. The criteria will set up thresholds to these hydropower emissions to certify an entity including this technology in its portfolio.

According to literature, non-combustions emissions range from 10,9 to 2210 gCO_2e/kWh in 2050[16], while from 1 to 2200 gCO_2e/kWh in 2050 at actual data. Regarding these figures, studies, and assessments of GHG emissions in hydropower plants are essential to be compliant with climate goals of Paris Agreement.

Table 11. LCA today and future values for hydropower.

Lifecycle emissions (gCO_2e/kWh)						
Option	IPCC AR5 (2020)[17]			IAM models (2050)[18]		
	Min	Med	Max	Min	Med	Ma
Hydropower	1	24	2200	10,9	33,9	2210

[12] IPCC AR5 Annex III
13 Nature Energy, Articles. Understanding future emissions from low carbon power systems.
[14] International Hydropower Association (IHA)
[15] https://www.hydropower.org/blog/carbon-emissions-from-hydropower-reservoirs-facts-and-myths
[16] ClimateBonds Hydropower Criteria
[17] IPCC AR5 Annex III
[18] Nature Energy, Articles. Understanding future emissions from low carbon power systems.

3.3.3.3 Geothermal

Geothermal power plants emit CO_2 because of occurring non-condensable gases from the geothermal fluid[19]. IPCC AR5 report range geothermal LCA emissions from 6 gCO_2e/kWh to 79 gCO_2e/kWh, while others can extend geothermal direct emissions up to 1300 gCO_2e/kWh.

Table 12. LCA today and future values for geothermal.

Lifecycle emissions (gCO_2e/kWh)			
Option	IPCC AR5 (2020)[20]		
	Min	Med	Max
Geothermal	6	3	79

3.3.3.4 Bioenergy.

Bioenergy net-emissions can procced from many sources from feedstock harvesting, processing, and transporting to land use change or combustion emissions. LCA must be considered to include these emissions that can vary from 130 to 420 gCO_2e/kWh according to the IPCC AR5 or from 66 to 1360 gCO_2e/kWh in 2050 based on ARM scenarios (Michaja Pehl, 2017).

Thus, emissions from bioenergy could be important and exhaust assessment is required for those entities including it in the generation portfolio.

3.3.3.5 BECCS

Biomass combustion including CCS (BECCS) play an important role in in decarbonising sectors such as heavy industry, aviation, and trucking in the Net Zero Emissions by 2050 Scenario because BECCS is the only carbon dioxide removal technique that can also provide energy. In the electricity generation also participate as a negative source of CO_2 emissions. As a sink, BECCS can help the electricity sector to achieve net zero emissions globally by 2040 as required in many 1.5-degree increased temperature in line scenarios.

As detailed above bioenergy reports 0 gCO_2e to the global entity's emissions intensity and further assessment is required to assess other non-combustion emissions. However, when using BECCS, all the amount of CO_2 captured will be reported as negative in the entity's emissions intensity.

Table 13 resume the bioenergy emissions allocation in the entity emissions assessment.

Table 13. Allocation of bioenergy GHG emissions.

GHG emissions for bioenergy		
Option	Included in Entities' Scope 1	Separately assessed using LCA and Biograce methodology. Scope 3
Bioenergy	NO	YES
BECCS	Only negative emissions form CO_2 captured.	Yes. Excluding emissions savings from CO_2 capture.

3.4 Plants operating at the time of certification (existing capacity) and after the certification (new capacity).

As the certification consider not only the actual emissions but also futures climate targets, TWG estimated that a difference between facilities operating at the time of certification (existing capacity) and investments related to these facilities, and plants planned to

[19] ClimateBonds Geothermal Criteria
[20] IPCC AR5 Annex III

operate before the certification (new capacity) and investments related to them. Also due to the mix of technologies that compose an electrical utility portfolio some differences and requirements are established for each single generation technology, differencing between fossil fuel power plants and low-carbon generation technologies.

3.4.1 Investments in existing facilities

When looking at existing carbon and gas power plants, we aim at avoiding investments that would lock-in heavy emitting technologies, without overlooking those producers that will make credible efforts to reduce their current emissions. In some countries and regions, the power generation system is carbon-based with many young carbon plants that still face several years of operation.

For those fossil existing power plants, the aim is to phase out as much as possible and guide the investments to low emitting technologies already available and suitable depending on regional environments and circumstances. TWG also recognize and is conscious of many investments developing mitigation technologies for fossil fuel young power plants. Median age of coal plants, in Asia is 10—15 years for coal[21].

In these countries development projects are taking place to cofire fossil fuel with low-carbon gaseous fuels based on hydrogen or with biofuels/biomass. Net zero scenarios also rely on CCS and CCUS to achieve the targets for the power sector.

Thus, investments in existing fossil fuel power plants are included in the criteria for certified entities. But also, for those companies that couldn't meet the entity's transition pathway, UoP bonds can be applicable in these mitigation measures aiming to reduce CO2 emissions, just in high emitting power systems.

Criteria establish benchmarks for CCS capture rate and for the blended share of low-carbon fuels in cofiring **(including transport leakages**), to ensure than the investments are well allocated with the Paris Agreement goals and the emissions reductions targets. The principle behind is that renewable plants and mature low carbon technologies must be boosted and not rely on uncertain and expensive solutions. These must be thought as a valid option when no other better situation is possible.

3.4.2 Investments in new capacity

Considering the lifetime of most of power plants, it is important to avoid the lock-in of certain technologies that do not deliver the sufficient emissions reductions, keeping in mind that most new plants built today will still be online in 2050. Renewable electrical plants have seen in the last years amazing development so low carbon generation technologies are already available and affordable. And it is expected that more will become commercially ready before and beyond 2030.

Since the electrical sector will be the enabler to decarbonize the whole energy system by reaching net zero emissions globally by 2040, TWG discussions conclude that new power capacity should avoid the use of fossil fuels. **No new fossil fuel power plants could be certified under these criteria.**

Renewables and low-carbon facilities must follow criteria to be the best in class at the time of implementation and avoid emissions that are not contemplated in the entity's emissions intensity, e.g. scope 1 emissions from hydropower or geothermal and scope 3 from solar, wind or bioenergy.

3.5 GHG emissions methodology.

3.5.1 Entity's emissions intensity. Scope 1 and 3 emissions.

To account and report the entity's emissions intensity for the electricity generation portfolio the GHG Protocol is required[22]. This document aims to provide guidance on the estimation of direct greenhouse gas emissions from stationary combustion processes with guidance on the selection and implementation of emissions estimation methodologies, data collection, documentation, and quality management. Emissions from electricity the electricity purchased from the grid for distribution or trading in the retail market should be added to the entity's emissions intensity. To calculate these emissions the "location-based method" of the GHG Protocol Scope 2 Guidance[23].

[21] Average age of existing cola power plants in selected regions in 2020. IEA, 2021
[22] Calculation Tool for Direct Emissions from Stationary Combustion. WRI/WBCSD
[23] GHG Protocol Scope 2 Guidance. WRI.

Emissions from CHP power plants will be allocated to electricity following the efficiency method of the GHG Protocol methodology[24],

3.5.2 Non-combustion emissions. LCA analysis for each individual technology.

However, from an assets point of view, emissions from construction, manufacturing and dismantling, decommissioning, or recycling are out of the entity's emissions intensity Scope 1 and 3 emissions. To consider these emissions, life cycle assessments (LCA) must be contemplated following different methodologies depending on the generation technology. Electrical Utilities criteria include these emissions as individual requirements for each generation technology.

3.5.2.1 Solar and wind.

LCA should follow the methodology disclosure in ISO 14040 and 14044.

The boundaries for these LCA analysis are:

E1: Upstream feedstock related emissions (including sourcing[25], processing, transport and storage)

E2: Upstream energy related emissions (including sourcing, processing, transport and storage)

E3: Process and transport emissions[26]

3.5.2.2 Hydropower.

Based on Climate Bonds Hydropower, **Table 14¡Error! No se encuentra el origen de la referencia.** propose methods to estimate direct measures.

Table 14. Methodologies required for GHG assessment of hydropower assets.

GHG Assesment		
Generation Technology	Scope of emissions assessed	GHG Assessment
Hydropower	1	G-Res Tool
		Specific site assessment following the guides laid-out by the IEA Hydro Framework

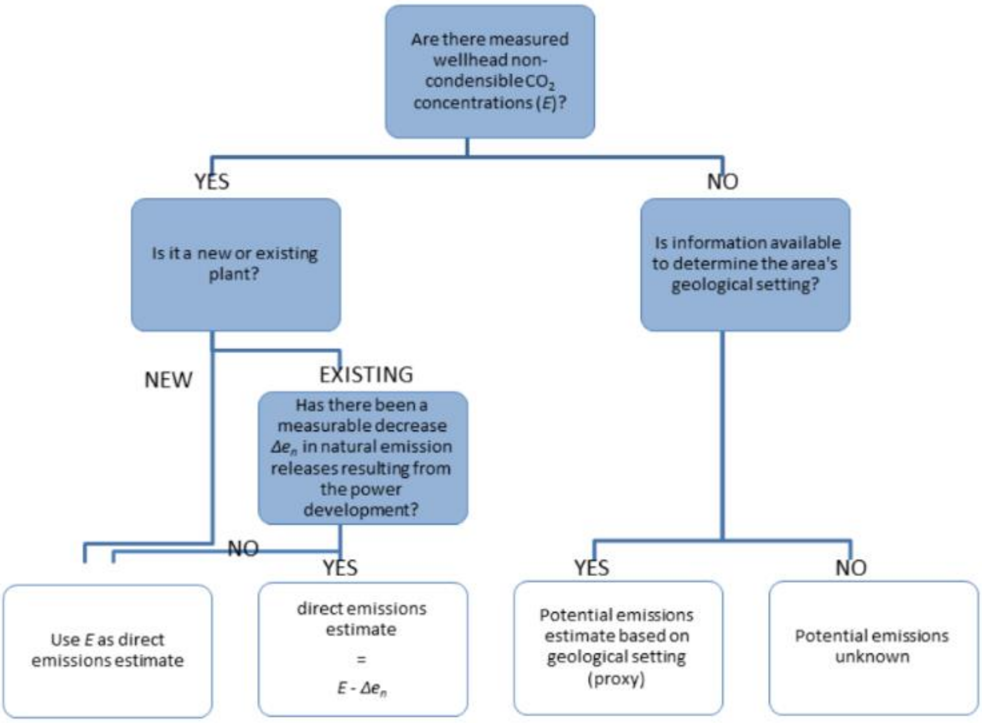
3.5.2.3 Geothermal

Measure direct emissions from biological process are not always easily feasible. Based on ClimateBonds Geothermal Criteria, **Figure 21** propose methods to estimate direct measures geothermal electricity generation.

[24] Allocation of GHG emissions from a combined heat and power (CHP) plant. WRI/WBCSD. September 2006

[25] Depending on the feedstock, it can be extraction, cultivation, or collection.

[26] Due to the materiality decommissioning emissions are not included in the assessment.



Source: ClimateBonds Geothermal Criteria

Figure 21. Methodologies required for GHG assessment of geothermal assets.

3.5.2.4 Bioenergy

Based on Climate Bonds Bioenergy criteria **Table 15** propose methods to account the emissions embedded in the production and delivery of biomass to be used as a fuel in electricity generation,

Table 15. Emissions addressed in bioenergy.

GHG emissions accounting methodology for bioenergy.	
Methodology	Emissions included
Biograce II	• Feedstock Production. • Feedstock processing. • Biofuel/bioenergy production. • Biofuel storage and blending • Intermediate and final transport steps.

3.5.3 Addressing mitigation measures emissions cross-cutting criteria.

For those mitigation measures included in the criteria, CCS/CCUS and/or cofiring, Scope 1 emissions leave behind an important amount of possible WGP sources (producing and transporting the blended fuel for cofiring and/or CO_2 leakages in CCS and CCUS). According to it, additional limitations are set off in this part of the criteria (section 6). For CCS and CCUS transport, storage and utilization, where CO_2 leakages can occur with important GHG effects, EU Taxonomy criteria has been adopted.

In cofiring solution, conditions to the energy source, namely hydrogen-based fuels, and bioenergy, will avoid GHG loses when accounting the emissions for the power generation process, taking into account the whole life cycle process following the sector criteria already developed by ClimateBonds.

Finally, in fossil gas power plants, methane leakages can make them as pollutant as coal power plants, even more. So, some requirements are requested on order to measure and avoid methane leakages in these fossil plants, following the EU Taxonomy.

4 Criteria Overview

The mitigation requirements are based on a strategy to be part of an economy that is net zero by 2050. The electricity sector can get very close to net-zero emissions with technology that it is currently available by 2040 enabling the whole energy sector to be net-zero emissions align with the Paris Agreement goals.

4.1 Setting the emissions pathway for electricity generation.

The electricity sector needs to decarbonise fast to align with the requirements of the Paris Agreement and to enable energy sector to reach zero emissions by 2050. How fast and by when, can be portrayed as an emissions intensity transition pathway. Electrical utilities that align their activities with such a transition pathway with a clear plan could potentially achieve Climate Bonds certification. In line with the principles that govern how criteria are developed, transition pathways can be adopted from other initiatives where it is consistent in approach and developed through a high degree of scrutiny from academia and industry experts such as that developed by the Transition Pathway Initiative (TPI) or the Science Based Targets Initiative (SBTi).

Evaluating existing material for adoption as criteria requires that the chosen pathway and underlying methodology meets certain principles. Where possible it should:

- Be based on a robust methodology and stakeholder engagement.
- Be aligned with an ambition level of limiting global warming to 1.5-degrees.
- Be globally applicable, not based on regional data or standards.
- Represent a level playing field for all stakeholders and geographies.
- Be based on a carbon intensity of production metric.
- Be specific to the electricity sector and focus on power generation as the scope of emissions.
- Provide a pathway out to 2050 at least, with intermediate points.

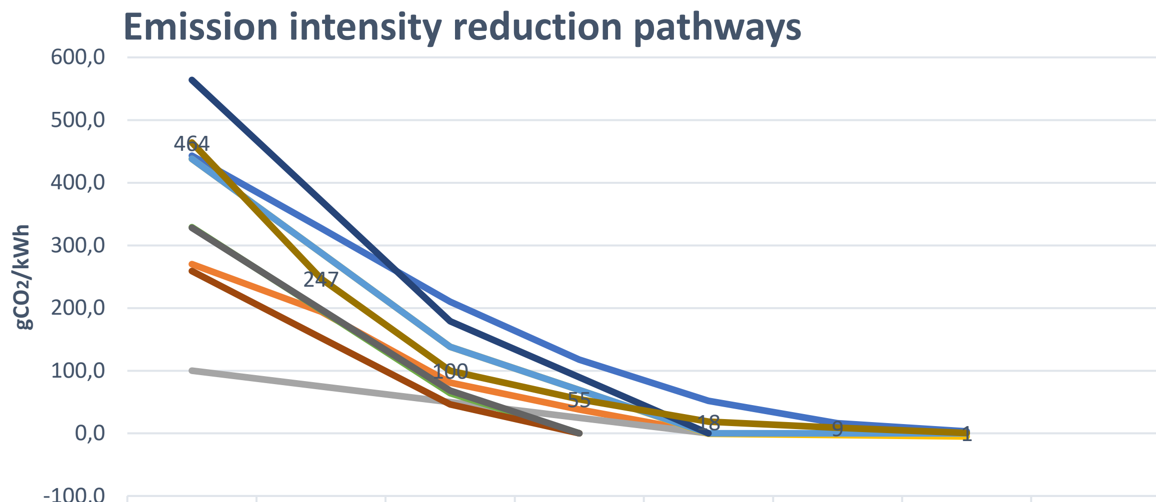
The options listed below were brought up for the consideration of the TWG for adoption in this Electrical Utilities criteria:

- International Energy Agency (IEA) Net Zero by 2050 scenario
- Transition Pathway Initiative (TPI) because of their geographical distinction (based on IEA data).

Other pathways were used as reference and are part of the research work behind the criteria but were already discarded for its usage as targets in the criteria document, these include those developed by World EU Poles Model and the Science Based Targets Initiative (SBTI).

Apart from considering the points listed above, the pathways evaluated as main options were, at the moment of having this discussion, the most relevant ones being developed by initiatives with purposes aligned with those of these criteria. Ultimately, the main reasons to pick this set of options for the TWG to evaluate were to keep consistency with other initiatives without sacrificing ambition and to ensure that the practicality and usability of the chosen approach was being vetted by a wide group of stakeholders. Finally discussing the details of each pathway, the TWG agreed on adopting the IEA NZE by 2050 updated trajectory approach.

The main considerations included in the TWG discussions when choosing the pathway were: the starting point, the geographical differentiation and the shape of the curve were the main issues in consideration. Figure 22 shows the pathways studied.



	2020	2025	2030	2035	2040	2045	2050
WORLD EU POLES model	443,1	327,2	210,2	117,5	51,7	15,8	3,1
EU taxonomy (DNSH)	270	194	81	38	0		
EU taxonomy (Renewable)	100	75	50	25	0		
IEA NZ2050 world	438	288	138	69	-1	-3	-5
TPI World	438	288	138	69	0	0	0
TPI OECD	329	196,5	64	0			
TPI Non-OECD	564	371,5	179	89,5	0		
TPI EU	259	152,5	46	0			
TPI north America	328	198	68	0			
SBTi 1.5	464	247	100	55	18	9	1

Source: Own elaboration

Figure 22. Pathways studied during the TWG discussions.

4.1.1 Starting Point

The starting point of the transition pathway is important. The rationale for considering it regards the inclusion of as many entities as possible in the Climate Bonds certification, provided that always compatible with CBIs principle of keeping alignment with 1.5-degree. TPI non-OECD countries, the higher pathway in **Figure 23** starts in 564 gCO_2/kWh, down to 179 gCO_2/kWh in 2030 and reach zero in 2040.

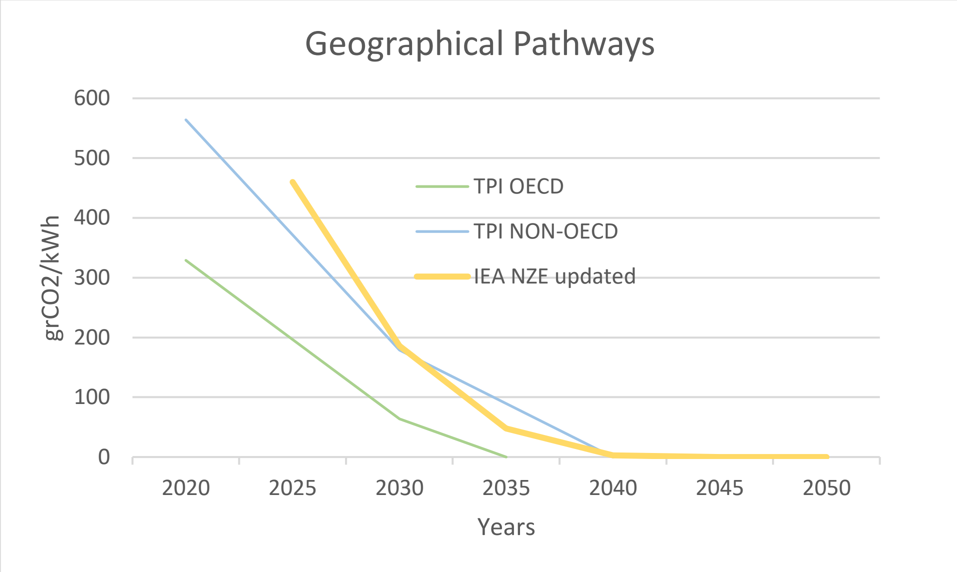
Many non-OECD countries carbon intensity of electricity are over 600 gCO_2/kWh in 2022[27] and they are the most concerned in reducing their emissions. They can adopt transition plans to be aligned by 2030 and be certified in the criteria. For this reason, TWG decided to adopt the TPI non-OECD country approach based on IEA WEO 2020, 2021 data and the IEA NZE by 2050 emissions intensity pathway with some assumptions. Furthermore, the criteria are focused on entities and not in countries. Some entities can operate in different countries, concerning different economic regions. The generous approach would include the most as possible aligned with the Paris Agreement.

The IEA Net Zero Roadmap 2023 updated.

When developing the criteria, the IEA updated its Net Zero Roadmap and the figures for the grid intensity. **Figure 23**.

The actualization gives more floor in the recent years (2025-2030) and joined the TPI-non-OECD curve by 2030 (is even a little higher). Thus, the TWG decided to finally adopt the IEA 2023 update transition pathway. That avoid the assumptions and estimation made to develop the TPI Non-OECD countries pathway.

[27] https://ourworldindata.org/grapher/carbon-intensity-electricity?tab=table



Source: Own elaboration based on IEA and TPI data

Figure 23. Different sector pathways considering a geographical approach.

Table 16. Values for the different transition pathways considering a geographical approach.

Emissions Intensity trajectory			
Year	TPI OECD (gCO_2/kWh)	TPI NON-OECD (gCO_2/kWh)	IEA NZE 2023 Update (gCO_2/kWh)
2020	329	564	
2025	196,5*	371,5*	460
2030	64	179	186
2035	0	89,5*	48
2040	0	0	3
2045	0	0	0
2050	0	0	-4

* These figures don't appear in the pathway and have been interpolate

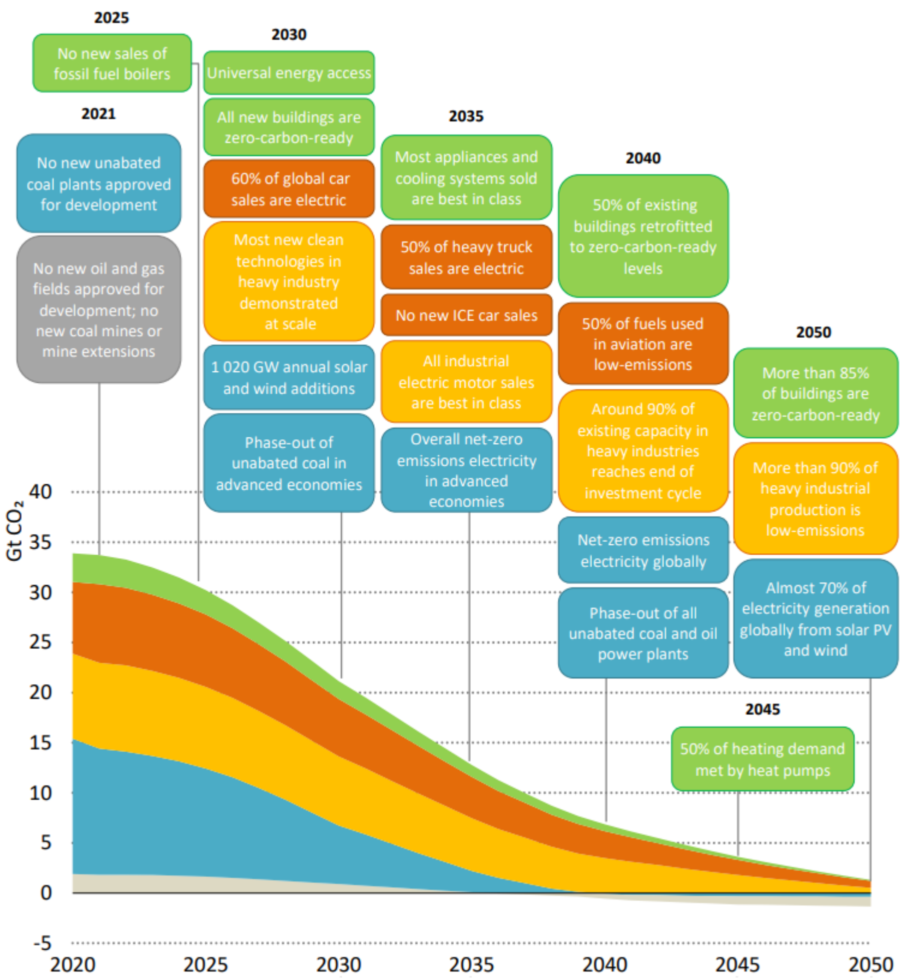
4.1.2 Ending point

Some of the scenarios studied set negative emissions for the whole electricity sector. TWG estimates that these negative emissions should not be asked to one electrical utility. Thus, the electrical utilities criteria will set up 0 gCO_2/kWh when the adopted scenario could have negative figures for the emissions intensity as the IEA scenario belongs to the whole power sector, not for an entity approach.

4.1.3 Geographical approach in the Electrical Utilities criteria

Although IEA report offers only a global pathway for electricity generation, they underscore in its document a difference between advance and emerging economies. The report underpins that net zero by 2050 globally doesn't mean net zero by 2050 for every country. In the IEA scenario and pathway, advanced economies reach net zero sooner to allow emerging and developing economies more time[28]. **Figure 24.**

[28] https://www.iea.org/reports/net-zero-roadmap-a-global-pathway-to-keep-the-15-0c-goal-in-reach



Source: Net Zero by 2050. A roadmap for the global Energy Sector, 2021 (IEA, 2021a)

Figure 24. IEA key milestones in the pathway to net zero.

The criteria established the higher global pathway for entity' emissions intensity but will set up regional separated benchmarks for fossil fuel power generation (dates for phasing-out fossil fuels power plant, or dates for achieving rates for cofiring or CCS) as disclosure in the IEA report.

In conclusion, the TWG adopts the higher global pathway because of the entity's approach of the criteria trying to involve the maximum number of companies and established separated geographical benchmarks in the development of the criteria for the different technologies that compose the portfolio.

4.1.4 The final emissions intensity transition pathway of the Electrical Utilities Criteria

Finally, to assess the net-zero emissions alignment of entities and SLD instruments the approach from the IEA NZE has been adopted.

The International Energy Agency is an autonomous intergovernmental organization composed by 31 member countries and 13 association countries that represent 75% of global energy demand. IEA publish annually its World Energy Outlook providing analysis and insights about the energy system across the world[29]. In May 2021 IEA published the Net Zero Roadmap (IEA, 2021a) setting out what would need to happen in the global energy sector in the years and decades ahead to limit global warming to 1.5-degree.

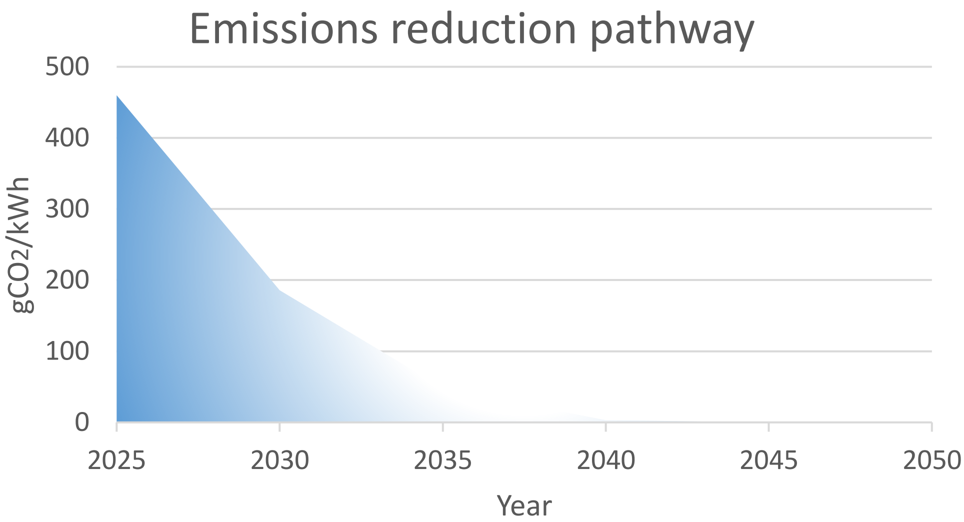
IEA NZE 2023 update drawing on the latest data and the implications in the energy sector of the world's situation (economic recovery from Covid crisis or the Russian's invasions of Ukraine) provide new benchmarks to keep the 1.5-degree goal in reach.

[29] https://www.iea.org/reports/world-energy-outlook-2022

The Net Zero Emissions by 2050 Scenario (IEA) for the whole energy sector, meets key energy-related United Nations Sustainable Development Goals (SDG's) and it is consistent with limiting the global temperature rise to 1.5-degree with no or limited temperature overshoot (with a 50% probability), in line with reductions assessed in the IPPC in its Sixth Assessment Report (IEA, 2021a)

IEA NZE emissions intensity benchmarks for electricity generation are detailed in the 2023 actualization of the IEA NZE by 2050 report (IEA, update 2023). The values of the thresholds are stablished to achieve near-zero emissions in the electricity sector in 2040. With this goal other areas of the whole energy sector could be decarbonised directly by the electrification of energy end-use and indirectly using electricity derived fuels by 2050, requirements to keep the temperature 1.5-degree below the preindustrial levels.

The applicant's average entity's emissions intensity shall be compared against these values. The NZE benchmarks for the years 2025, 2030, 2035, 2040 and 2050. Internal figures (2045) have been estimated. As explained before, ClimateBonds do not consider negative emissions for the electrical utilities to be certified. Thus, the emissions intensity pathway set up 0 emissions where the IEA pathway established negative figures. This results in a decarbonization pathway illustrated in **Figure 25**¡Error! No se encuentra el origen de la referencia. and emission intensity thresholds given in **Table 17**



Source: Own elaboration based on IEA

Figure 25. CO_2 intensity of CliamteBonds electrical utilities criteria based on the IEA net zero emissions by 2050 scenario.

Table 17. Transition pathway of the Electrical Utilities Criteria values.

Transition pathway of the sector specific criteria						
Year	2025	2030	2035	2040	2045	2050
Emissions Intensity (gCO_2/kWh)	460	186	48	3	0	0

4.2 Criteria to certify entities and SLD's.

The following sections lay out the rationale for the mitigation requirements set out in the Electrical Utilities Criteria to certify entities (in this case, a business segment or part of the company producing, purchased and trading electricity) and SLD issued by them dedicated to produce, purchase, and trade electricity.

These criteria are set at the entity level, this means for certifying electrical utilities producing electricity. The requirements that have been set up in section 3 of the criteria document are made up of:

- Meting an emissions intensity pathway. To test if electrical utilities currently meet the emissions intensity pathway described in ***section 4.1*** the average entity's direct emissions intensity must be compared with the pathway. This average emissions intensity includes combustion emissions and the emissions related to the electricity purchased by the entity, accounted and reported following GHG Protocol methodology.
- For any plant operating at the time of certification (existing facilities), meet criteria: plan to phase out unabated fossil fuels and/or abate them and emissions intensity thresholds for low-carbon capacity.
- For any plant operating at any the time after the certification (New facilities), meet criteria in new renewable power plants (as no new investments are allowed for fossil fuel electricity generation).
- When the entity implements or use CCS/CCUS, hydrogen-based fuels, biomass to produce electricity or retrofitting fossil gas plants, meet cross-cutting criteria for hydrogen-based fuels, biomass and CCS/CCUS transport, storage and utilization, and methane leakages in fossil gas plants. The background information for this last component is explained in ***section 4.5***

4.2.1 Meet the sector-specific pathway

To be certified the average entity's emissions intensity must meet the sector-specific pathway described in ***section 4.1*** The entity's emissions intensity include:

- All direct combustion emissions from the generation facilities included in the portfolio.
- The emissions related to the electricity purchased by the entity to be.

The GHG methodologies are required to account and reported these emissions:

- Calculation Tool for Direct emissions from stationary combustion. (WRI/WBCSD, Calcultation tool for direct emissions from stationary combustion , 2005)
- The location-based method of the Scope 2 guidance from the GHG Protocol. (WRI, 2015)

4.2.2 Criteria for any plant operating at the time of certification (existing capacity)

As described in ***section 3.4*** the emissions intensity transition pathway of the Electrical Utilities Criteria and the entity's average emissions intensity that shall be compared with, only applies for direct combustion emissions, Scope 1 (including the direct emissions related to the electricity purchased by the gris, Scope 3).

But to be consistent with a real net zero emissions scenario, TWG would incorporate some indirect (Scope 3) and direct non-combustion (Scope 1) emissions in the criteria, depending on the technology. They can be also important for some generation facilities and are not included in the average entity's emissions intensity. **Table 18** shows some of these non-combustion emissions values from recent literature (Michaja Pehl, 2017).

Table 18: Low-carbon technologies GHG non-combustion emissions.

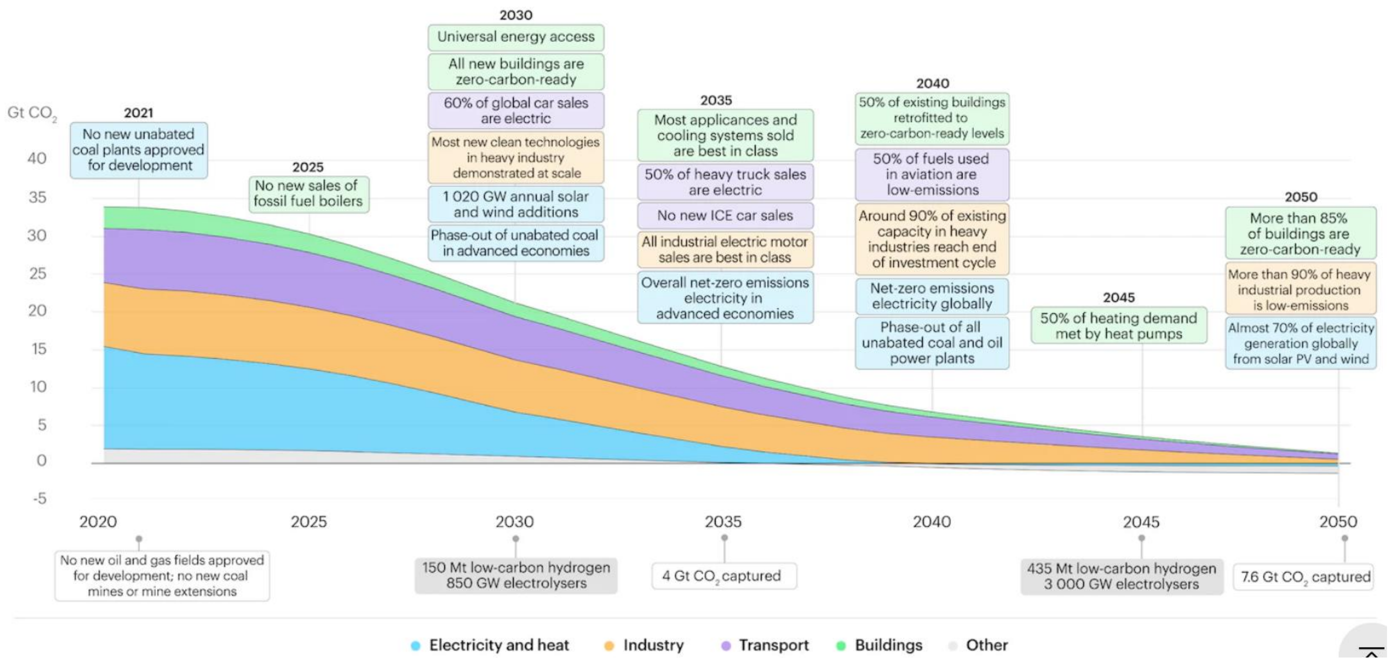
GHG emissions (gCO2e/kWh)[30]			
Option	LCA		
	Min	Med	Max
Geothermal	6	38	7
Hydropower	1	24	2200
Nuclear	3,7	12	110
Solar CSP	8,8	27	63
Solar PV	18	48	180
Wind onshore	7	11	56
Wind offshore	8	12	35
Biomass	130	230	420

The TWG establish some requirements to address these non-combustion emissions. These additional requirements focus on the challenges posed by each of these technologies. Being able to overcome these challenges will depend on factors related to the geographical location of the plant. Consequently, the criteria tackle these questions providing enough flexibility to producers to use the technology that will provide the most emissions mitigation based on the conditions and context of the plant location.

4.2.2.1 Fossil Fuels based power generation.

One of the main goals of the criteria is to phase out fossil fuel power plants as soon as possible to reach the targets established by science-based perspective aiming to achieve net zero emissions by 2050 and keep the global temperature 1.5-degree above the pre-industrial levels.

Thus lead the TWG to exclude any measures that could lock-in emissions from fossil fuel and set up threshold to phase out these plants following the trends of the IEA Roadmap to net zero emissions (IEA, 2021a).



Source: Net Zero Roadmap. A global pathway to keep the 1,5oC goal in reach. IEA, 2023 (IEA, update 2023)

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[30] IPCC AR5 Annex III

Figure 26. Near term milestones and long-term milestones to the energy sector in the IEA NZE by 2050.

But as discussed in ***section 3.4***, TWG note down that many entities, operating if some areas of the world geography based their generation portfolio in young coal or fossil gas plants and criteria should include some requirements to these technologies to assure the full decarbonisation of the entity by 2050 and preventing again carbon lock-in.

Table 19. Milestones and benchmarks for phased-out or retrofitting fossil fuel plants. (IEA, update 2023).

Milestones	2022	2030	2035	2050
Total electricity generation from unabated fossil fuels (TWh)	**17 636**	**11 066**	**4 241**	**158**
Coal	10 427	4 988	1 379	0
Natural gas	6 500	5 943	2 834	158
Share of unabated fossil fuels in total generation	**61%**	**29%**	**9%**	**0.2%**
Coal	36%	13%	3%	0%
Natural gas	22%	16%	6%	0.2%
Retrofits and blending				
Coal and gas plants equipped with CCUS (GW)	0.12	50	141	241
Average ammonia blending in global coal-fired generation (without CCUS)	0%	1%	11%	100%
Average hydrogen blending in global gas-fired generation (without CCUS)	0%	5%	16%	79%
Average biomethane blending in global gas-fired generation (without CCUS)	0.1%	1%	1%	7%
Average annual capacity retirements (GW)	**2017-22**	**2023-30**	**2031-35**	**2036-50**
Coal	27	110	81	43
Natural gas	8	39	43	46

Source: Net Zero Roadmap. A global pathway to keep the 1,5oC goal in reach. IEA, 2023 (IEA, update 2023)

Final decisions of the criteria include benchmarks to phase out all the unabated fossil plants and conditions for abated plants leading to be net zero emissions in 2050.

As described in ***section 4.1*** the emissions intensity pathway is only one global pathway, the geographic differentiation, included in the IEA NZE by 2050, has been considered in this section with separately criteria for emerging and advance economies[31]

Emerging economies

Phase-out benchmarks.

- Phase-out coal power plants: 2040.
- Phase out fossil gas power plants: 2040.
- Phase out oil power plants: 2040.

Retrofitting thresholds and benchmarks:

- Install CCS technologies with a carbon capture rate > 90% and storage by the end of 2040 (CO_2 transport, storage and utilization must follow EU Taxonomy)
- Co-firing with 100% low-carbon fuels by the end of 2040

Advanced economies

Phase-out benchmarks.

- Phase-out coal power plants: 2030.
- Phase out fossil gas power plants: 2040.
- Phase-out oil power plant: 2030

[31] Climate Bonds Criteria follow the IEA definition of emerging and advance economies. (IEA, 2021a)

Retrofitting thresholds and benchmarks:

- Install CCS technologies with a carbon capture rate > 90% and storage by the end of 2035 (CO_2 transport, storage and utilization must follow EU Taxonomy)
- Co-firing with 100% low-carbon fuels by the end of 2040

In some countries it exists a regulation on electrical utilities to assure the supply of electricity to the population. This grid security is mainly covered by fossil gas plants as renewables generation depend on climate conditions and are not always available when electricity is needed. Waiting for the development of the power storage systems and the development of the smart grids, the Electrical Utilities Criteria allows the switching of coal power plants to coal power plants with some restrictions that the applicant must comply with. Box 1 resume the conditions for this permission.

Box 1. Switching coal to gas only in the case.

- where security of electricity supply is at risk,
- The fossil gas capacity must replace an existing coal generation plant.
- The fossil gas plant cannot exceed **the replaced facility's capacity by more than 15%**
- Direct average emissions intensity of the entity remains below the emission intensity pathway of these sectoral criteria.
- the entity has a **coal and gas phaseout** plan in place.

Safeguards:

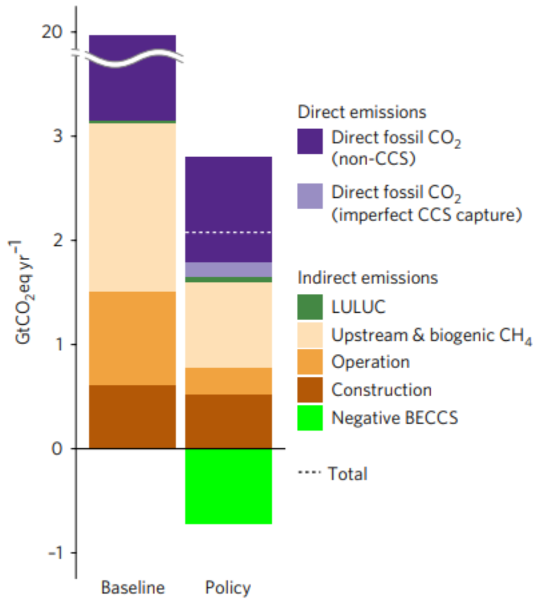
- Critical grid security - needs to be demonstrated, and agreed to on an ad hoc, basis.

Fully system-wide proof that renewable energy systems not suitable

4.2.2.2 Low-carbon generation technologies.

Alongside with the phasing-out of the fossil fuel generation, renewables must grow huge and rapidly. The criteria aim at increasing the proportion of renewable energy in the electricity generation mix because of the high potential of these technologies to reduce the GHG emissions of the electricity sector. However, emissions of some of these low carbon technologies can be as important, more and more as the power sector becomes near zero direct emissions.

Figure 27 shows how the share of indirect emissions will be as important as direct emissions in future energy scenarios.



Source: (Michaja Pehl, 2017)

Figure 27. Total global 2050 emissions in baseline (with no climate policy) and the policy (2-degree-compatible) scenario.

The GHG emissions thresholds established by the TWG in the criteria try to consider all the

Solar and Wind.

- No direct emissions and relatively low indirect emissions. Existing solar and wind power plants will be automatically eligible.

Hydropower and geothermal.

- Direct emissions could be important[32]. A GHG thresholds of **100 gCO$_2$e/kWh** is required in consistency with the ClimateBonds Hydropower and Geothermal Criteria.
- Materiality of both generation technologies makes them irrelevant and are not considered in the criteria.

Bioenergy

The emissions balance from bioenergy is as detailed in following equation:

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} + e_{ccs} + e_{ccr}$$

Where:

e = total emissions from the use of the biofuel or bioliquid

e_{ec} = emissions from the extraction and cultivation of raw materials;

e_l = annualized emissions from carbon stock changes caused by land use;

e_p = emissions from processing;

e_{td} = emissions from transport and distribution;

e_u = emission from the fuel in use;

e_{sca} = emission saving from soil carbon accumulation via improved agricultural management;

[32] ClimateBonds Hydropower Criteria and Geothermal Criteria (Sections 3.2 and 5.2, respectively)

e_{ccs} = emissions savings from CO_2 capture and geological storage;

e_{ccr} = emissions savings from CO_2 capture and replacement.

These emissions can range from negative values (if implemented with CCS/CCUS) to 420 gCO_2e/kWh (Schlömer, IPPC AR5 Annex III: Technology-specific cost and performance parameters, 2014) or even 1490 gCO_2e/kWh (Michaja Pehl, 2017).

Direct combustion emissions should be seen in connection with CO_2 absorbed by growing plants. That's why bioenergy in not included in the average entity's emissions intensity and is assessed separately. Indirect Scope 3 emissions can be important in biomass and because of materiality reason, mainly come from:

- e_p = emissions from processing.
- e_{td} = emissions from transport and distribution.
- e_l =annualized emissions from carbon stock changes caused by land use.

The TWG decided to set a threshold for the emissions embedded in the processing and transport of biomass. In consistency with the ClimateBonds Bioenergy criteria, this value is **100 gCO_2e/kWh** and the Biograce II method is required to carry on the LCA analysis including:

Table 20. Emissions addressed in bioenergy.

GHG emissions accounting methodology for bioenergy	
Methodology	Emissions included
BioGrace II	• Feedstock Production. • Feedstock processing. • Biofuel/bioenergy production. • Biofuel storage and blending • Intermediate and final transport steps.

Emissions related to the land use change are more difficult to measure and converted in a value of emissions intensity. To assess these emissions, these criteria ask to undergo adaptation and resilience criteria from the ClimateBonds Bioenergy Criteria guaranteeing that the feedstock source is certified under best-practise standards. See section …

4.2.3 Criteria for any plant operating after the time of certification (new capacity).

For plants operating after the time of certification these additional requirements for non-combustion emissions consider the specific characteristics of each technology and also aim to encourage the use of the best-in-class available technology and the right choice of the low-carbon technology based on the conditions and context of the entity's location. Opportunity cost concept is part of the rationale behind the low-carbon criteria.

4.2.3.1 Fossil Fuels based power generation.

According to the Climate Bonds Principles and all the science-based recommendations, the economy system must shift the energy source from fossil-based energy to low-carbon energy via:

1. Zero emissions electricity generation.
2. Electrification of energy end-use
3. Use of low-carbon fuels in high industry when electrification is not possible.

Thus, TWG accord that **no new investment in new fossil fuel capacity is certifiable under these criteria**.

4.2.3.2 Low-carbon generation technologies.

As described above, the criteria aim to boost the share of renewable generation in the electricity generation mix as required in net zero scenarios. **Table 21**

Table 21. Low emissions sources of electricity in the IEA NZE scenario.

Milestones	2022	2030	2035	2050
Total electricity generation from low-emissions sources (TWh)	**11 281**	**27 061**	**43 117**	**76 603**
Solar PV and wind	3 416	15 247	27 362	54 679
Other renewables	5 183	7 284	9 377	13 752
Nuclear	2 682	3 936	4 952	6 015
Share of low-emissions sources in total generation	**39%**	**71%**	**91%**	**100%**
Share of solar PV and wind in total generation	12%	40%	58%	71%
Share of renewables in total generation	30%	59%	77%	89%
Annual capacity additions of low-emissions sources (GW)	**344**	**1 301**	**1 382**	**1 268**
Solar PV	220	823	878	815
Wind	75	318	350	352
Nuclear	8	35	37	21
Average annual investment (USD billion 2022, MER)	**2017-22**	**2023-30**	**2031-35**	**2036-50**
Low-emissions	507	1 202	1 321	973
Renewables	466	1 080	1 185	875
Nuclear	41	114	121	93

Source: (IEA, update 2023)

Solar and Wind.

For solar and Wind, the TWG, based on literature and established a transition pathway from actual values (Schlömer, IPPC AR5 Annex III: Technology-specific cost and performance parameters, 2014) and 2050 values (Michaja Pehl, 2017). The trajectory is shown in Table 22

Table 22. Scope 3 indirect emissions threshold for solar and wind.

Scope 3 LCA Declining thresholds		
Year	Emissions Intensity (gCO_2e/kWh) Solar	Emissions Intensity (gCO_2e/kWh) Wind
2020	48	11
2025	40,85	9,92
2030	33,7	8,83
2035	26,55	7,75
2040	19,4	6,67
2045	12,25	5,58
2050	5,1	4,5

As solar and wind assets cannot improve their emissions intensity over the lifetime of operation, what is required in the criteria is that the GHG Scope 3 emissions of the plants installed must be below figures in **Table 22 at the time of implementation.**

However, in the first version of the criteria, solar and wind new capacity is automatically eligible with a requirement of implement the best-in-class technology available at the moment Future actualizations will incorporate these declining thresholds for these renewable facilities.

Hydropower

Non-combustion emissions from hydropower procced from reservoir and biological decomposition. Materiality of other indirect emissions makes them irrelevant. According to literature, non-combustions emissions range from 10,9 to 2210 gCO_2e/kWh in 205012, while from 1 to 2200 gCO_2e/kWh in 2050 at actual data. Regarding these figures, studies, and assessments of GHG emissions in new hydropower plants are essential to be compliant with climate goals of Paris Agreement.

The GHG limit for new hydropower plants is **50 gCO_2e/kWh** that is consistent with ClimateBonds Hydropower Criteria.

Hydropower also involves high environmental risk and need to be assessed. For that reason, for any hydropower plant operating at the time of certification the applicant must have undergo an assessment under the **ESG Gap Analysis Tool** carried out by an **Accredited Assessor**.

Geothermal

Geothermal power plants emit CO_2 because occurring non-condensable gases from the geothermal fluid[33]. Range of geothermal LCA emissions can vary from 6 gCO_2e/kWh to 79 gCO_2e/kWh (Schlömer, Technology-specific costs and performance parameters, 2014), while other references can extend geothermal direct emissions up to 1300 gCO_{2e}/kWh.

The electrical utilities criteria, considering that historically, up of ne third of existing geothermal plants shows an emissions intensity lower than 50 gCO_2e/kWh[34], this value **of 50 gCO_2e/kWh** is settled to new geothermal facilities, making also consistent with the hydropower scope 1 threshold.

This limit can ensure that low-emitting renewables are not displaced when possible.

Bioenergy

The GHG threshold for new bioenergy facilities is 50 gCO_2e/kWh, taking in consideration the emissions from processing and transport of the biomass and/or biofuels used to generate electricity as detailed in ***section 4.2.2.2***.

The rationale behind this GHG limit can be followed in the section 4.3.4 of the Climate Bonds Bioenergy Background Paper. In this section is explained that IEA analysis suggest average emissions intensity of new-build electricity capacity should be ~ 50 gCO_2e/kWh over the period 2020-2040. The TWG however decided to adopt a lower threshold of 29 gCO_2e/kWh for plants commissioned after 2021.

The Electrical Utilities Criteria, in consistency with the other non-combustion threshold for hydropower and bioenergy, limit the GHG emissions for biomass used to generate electricity in **50 gCO_2e/kWh.**

Notice that this limit is compatible with another threshold of **5.5 gCO_2e/MJ** biomass produced and transported to be used a as fuel in a generation plant with a 40% of electricity efficiency.

The biomass used to generate electricity must meet the cross-cutting criteria to address all the emissions and some environmental important risk related to the production of biomass, carbon stock changes caused by land use and other indirect impacts from land use change.

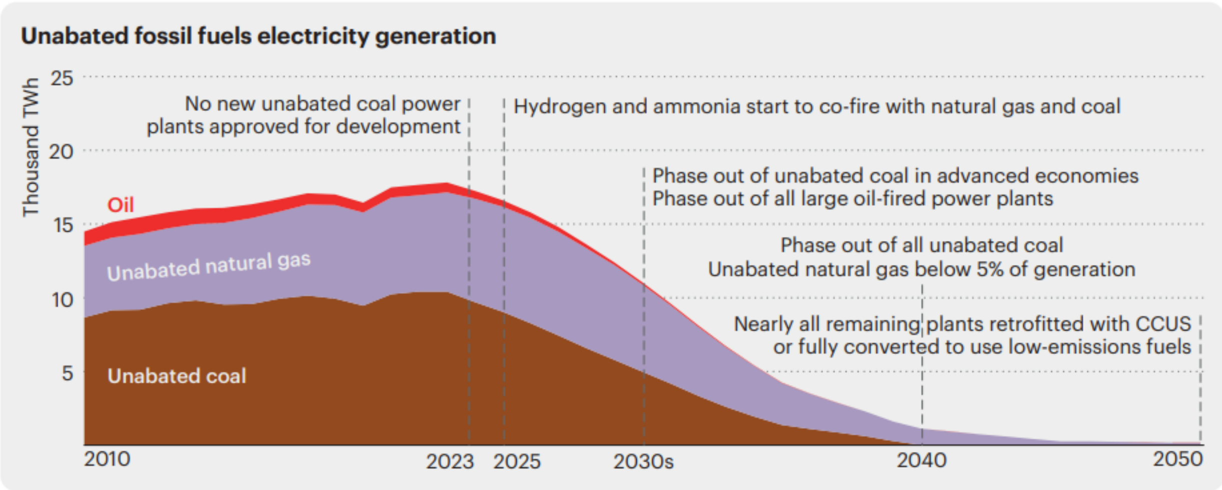
4.3 Setting criteria for decarbonization measures within fossil fuel facilities

The criteria for capital investments (decarbonisation measures) differs from an investment that would finance the whole facility in that it involves investments that are focused on the measures or specific areas of improvement within the asset (thus certification is granted to the measure itself and not the facility).

Investments in decarbonisation measures only affects fossil fuel power plants as renewables do not have direct GHG emissions.

First thought of the TWG agreed to avoid the use of fossil fuels in electricity generation as required in most science-based scenarios to be aligned with an increase of 1.5-degree of global warming[35]. Thus, the first criteria adopted the decisions of only establishing threshold for phasing-out data of coal and fossil gas power plants. (Figure 28).

[33] ClimateBonds Geothermal Criteria
[34] ClimateBonds Geothermal Criteria
[35]

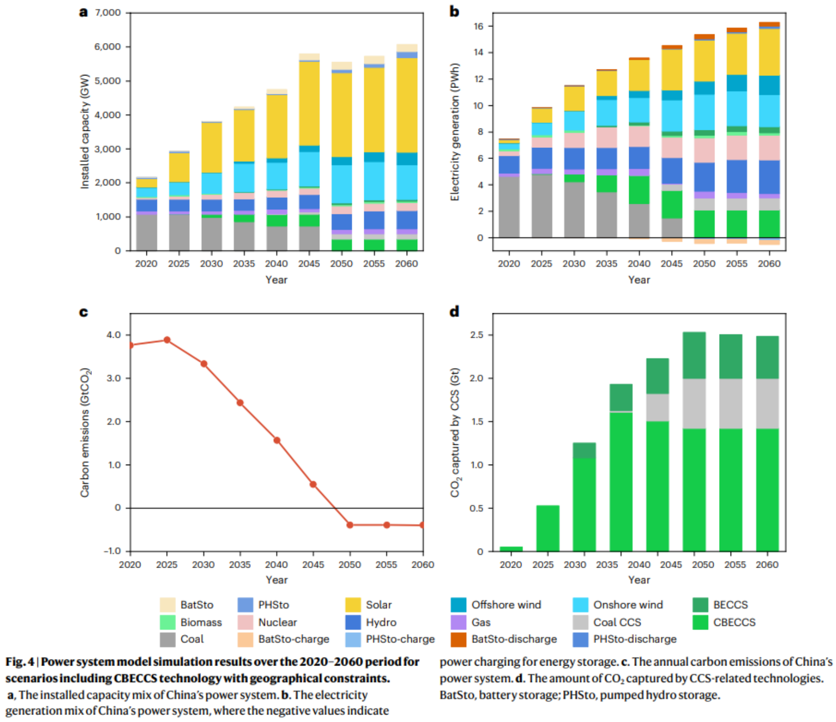


Source: Net Zero roadmap. A global pathway to keep the 1,5oC goal in reach. IEA, 2023. (IEA, update 2023)

Figure 28. Unabated fossil fuels trajectory in the IEA net zero by 2050 emissions scenario.

However, some mitigation technologies as cofiring with low-carbon fuels or installation of CCUS systems are now in development in some countries whose generation mix is dominated by young coal o fossil gas plants. TWG didn't want to consider them because of some technical and thermodynamical reasons: no mature technology and reduce generation efficiencies, leaking problems, and energy intensive for CCUS.

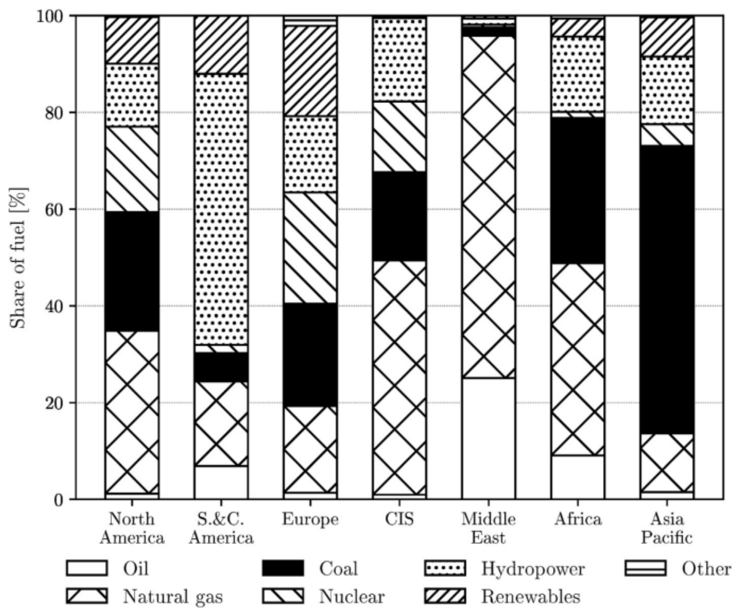
Nevertheless, many of science-based scenarios include CCUS, BECCS and cofiring in their assumptions to achieve the goals of Paris Agreement. Figure 29.



Source: Cofiring plants with retrofitted CCS for power sector emissions mitigation. Nature Energy, 2023

Figure 29. Power system model situation result over the 2020-206 period.

Also, important countries, mostly placed in Assia base their electricity systems in young coal or fossil gas power plants and need to look for some mitigation technologies to reduce their emissions. **Figure 30.**



Source: Challenges in the decarbonization of the energy sector. Elsevier Energy, 2020

Figure 30. Share of fuel in electricity generation of each region in 2018.

Countries as China or Japan are making great efforts to develop cofiring technologies with hydrogen-based fuels or with biomass and CCUS systems (BECCS) to reduce emissions associated with electricity generation. Japan government is supporting four critical ammonia projects to demonstrate 50% ammonia-coal co-firing by 2030[36] and a gas turbine with 100% H_2 has been achieved recently[37].

Table 23. Projects in cofiring aiming to achieve 100% of low-carbon fuels in 2040.

TECHNOLOGY	MATURITY	CHALLENGES
Ammonia-carbon cofiring: Coal power cofired with ammonia.	Demonstration since 2021 of 20% ammonia cofiring	The goal is to achieve single fuel firing up to 100% by 2030. If coal fuelled power ca be zero-emissions, it would make a huge contribution to the world's Climate change issues.
Hydrogen cofiring: 100% Hydrogen in industrial gas turbine	Achieved in 2023	A industrial gas turbine has been fed with 100% hydrogen produced from renewable energy n France. The turbine's capacity is 12 MW.

Source: Own elaboration

With these considerations, TWG accepted to include these technologies as mitigation measures with benchmarks in cofiring ratios and CO_2 percentage in CCUS systems as well as conditions in the transport, storage and utilization of CO_2 captured and in GHG emissions intensity of co-firing fuels related to processing and transporting.

The limits have been set up to achieve the 2030 reduction targets that will allow the sector to contribute to keeping global warming at 1.5-degree. Furthermore, as the facility's emissions intensity only include combustion emissions, cross-cutting criteria for low-carbon fuels must be accomplished. Processing or transporting can enlarge the emissions of these fuels with zero emissions in the combustion process.

As a result, in order to not promote the lock-in of technologies that may impede keeping the global warming limit, measures implemented in fossil plants for electricity generation need to be aimed at significantly lowering the emissions intensity of the plant, in line with the criteria set up for certifying whole electrical utilities, which rationale is explained in ***Section 4.2***

Benchmarks identified by the TWG for the fossil power facilities aligned with the goals of Paris Agreement are:

Fossil-fuel co-firing with low carbon fuels:

- The aim is to achieve a cofiring rate of 100%
- Cross-cutting criteria set up limits on GHG emissions for processing and transport of low-carbon fuels.

Fossil fuel facilities with CCS/CCUS equipment:

- The aim is to achieve a carbon capture rate of 90%
- Cross-cutting criteria set up conditions for transport, storage, and utilization of CO_2.

As the proceeds are financing the retrofitting of the equipment but the ratio of co-firing and/or carbon capture can vary within the retrofitted equipment, the Electrical Utilities Criteria will require the applicant to provide a plan with evidence of the decarbonization measures that will be implemented and have a contract with a certified energy auditor demonstrating the assets thresholds shall be improved over the term of the bond. Annual reporting is required to demonstrate that the performance of the assets is achieved from day one of operation to the term of the bond.

[36] https://www.ammoniaenergy.org/articles/jera-targets-50-ammonia-coal-co-firing-by-2030/#:~:text=JERA%20targets%2050%25%20ammonia-coal%20co-firing%20by%202030%201,Exporting%20Japanese%20ammonia%20energy%20solutions%20to%20Asia%20
[37] https://www.hydrogeninsight.com/power/world-first-as-siemens-energy-burns-100-hydrogen-in-industrial-gas-turbine/2-1-1535850

4.4 Setting criteria for new electricity generation facilities

Previously to these entity's approach, Climate Bonds had developed criteria for power generation low-carbon assets. The actual criteria available for certification in Climate Bonds are:

- The Climate Bonds Solar Criteria.
- The Climate Bonds Wind Criteria.
- The Climate Bonds Hydropower Criteria.
- The Climate Bonds Geothermal Criteria.
- The Climate Bonds Marine Renewable Energy Criteria.

Finance instruments (bonds and loans) linked to these eligible assets will be aligned with Paris Agreement. If an electrical utility wants to access to investments for one of these plants separately from an entity's certification, it can apply to the criteria to be certifies having access to UoP bonds to finance the electricity generation plant within the entity, without certification at the entity level.

4.5 Setting cross-cutting criteria

Behind the emissions assessed in the electricity generation there are other important environmental impacts related to electricity generation assets that the Electrical Utilities Criteria by the Climate Bonds Standards would like to address. Also, some emissions related to measures proposed in these criteria fall over the scope and these cross-cutting requirements will include them in the assessment needed, as for entity's certification as for UoP bonds.

These cross-cutting criteria cover:

- Criteria for GHG emissions related to processing and transport of low-carbon fuels: hydrogen-based fuels and fuels derived from bioenergy. ***Section 4.5.1*** and ***section 4.5.2***
- Assessment of potential environmental risk posed by bioenergy concerning the source feedstock, land use or carbon stock. ***Section 4.5.2***
- Requirements for the transport, storage and utilization of CO_2 when using carbon capture systems. ***Section 4.5.3***
- Measures to monitoring and reduce methane emissions in fossil gas power plants. ***Section 4.5.4***

4.5.1 Additional criteria when using hydrogen as a fuel.

Section 3.2.4 explained the rationale for the use of hydrogen to facilitate the transition to a low-carbon economy. To include all the emissions in electricity generation from hydrogen-based fuels, an assessment of GHG emissions from processing and transport of hydrogen is needed. Climate Bonds Standards has already developed criteria for these emissions, so the Electrical Utilities Criteria will call at these criteria for certification.

Coal or fossil gas plants cofiring with hydrogen or hydrogen-based fuels, need to meet the Climate Bonds Hydrogen Production and delivery Criteria[38]. Further background information for the development of the hydrogen criteria is available in the Criteria for Hydrogen Production and delivery Background paper.

As a resume the GHG thresholds for hydrogen Production and Delivery can be seen in table…

Table 24. Hydrogen carbon intensity thresholds[39].

Asset Type	Criteria			
	2023[28]	2030	2040	2050
Production and delivery of hydrogen	3.0 $kgCO_2e/kgH_2$	1.5 $kgCO_2e/kgH_2$	0.7 $kgCO_2e/kgH_2$	0 $kgCO_2e/kgH_2$

To demonstrate compliance with these thresholds, applicant is required to carry out an LCA withing the following emissions boundaries (more information about it in the Climate Bonds Hydrogen Production and Delivery Criteria):

$$Etotal = E1 + E2 + E3 + E4 + E5 - E6 + E7 + E8$$

E total: Total emissions

E1: Upstream feedstock related emissions (including sourcing[40], processing, transport, and storage)

E2: Upstream energy related emissions (including sourcing, processing, transport, and storage)

E3: Fugitive emissions (Including hydrogen emissions)

E4: Process emissions

E5: CCS/CCUS emissions related to energy consumption and leakages.

E6: Carbon emissions captured.

[38] www.climatebonds.net/standard/hydrogen-production

[39] Hydrogen Production and Delivery Criteria under the Climate Bonds Standards. Climate Bonds Initiative. December 2023.

[40] Depending on the feedstock, it can be extraction, cultivation, or collection.

E7: Compression and purification emission (Energy required to compress and purify hydrogen)

E8: Transportation emissions to the site where hydrogen will be used (energy and electricity related emissions, and fugitive emissions during transportation)[41]

4.5.2 Additional criteria when using biomass as a fuel.

The substitution of coal or fossil gas for biomass is only partial at that moment and scalability of the technology is constrained by the availability of sustainable biomass and the many environmental trade-offs related to its use, thus specific criteria apply for use of biomass to generate electricity.

The Climate Bonds Initiative has criteria for Bioenergy that establish conditions for both mitigation and adaptation and resilience when using biomass to generate heat and electricity. Challenges posed by this technology, focus mainly on the biomass feedstock, the land use change and the production and delivery of biomass.

Mitigation criteria include:

- GHG emissions thresholds: although the Climate Bonds Bioenergy Criteria don't include the use of bioenergy to produce electricity only, the discussion described in the ClimateBonds Bioenergy Background Document, lead the TWG to establish a Scope 3 threshold for the bioenergy feedstock of 5,5 gCO_2e/MJ biomass. **Table 25** shows the emissions boundaries for GHG assessment and the methodology required.

Table 25. Emissions addressed in bioenergy.

GHG emissions accounting methodology for bioenergy	
Methodology	Emissions included
BioGrace II	• Feedstock Production. • Feedstock processing. • Biofuel/bioenergy production. • Biofuel storage and blending • Intermediate and final transport steps.

Notice that 5,5 gCO_2e/MJ corresponds to a net GHG emissions of 49,5 gCO_2e/kWh with an assumed efficiency of the electricity generation of 40%.

Qualitative assessment about other indirect impacts of biomass were also issued by the TWG and IWG members and have been contemplated in:

- Biomass sources allowed. Section 2 at the Climate Bonds Bioenergy Criteria.
- Reducing the risk of Indirect Land Use Impact (iLUC). *Section 3.2.2* of the Climate Bonds Bioenergy Criteria.

Adaptation and Resilience address:

- That the source feedstock is compliant with established and approved best practice standards. Section 3.3.2 of the Climate Bonds Bioenergy Criteria.
- Identity food risk and have plan to address them. Section 3.3.3 of the Climate Bonds Bioenergy Criteria.
- That a climate risk assessment is conduced. Section 3.3.1 of the Climate Bonds Bioenergy Criteria.

[41] Transportation infrastructure emissions are not included

4.5.3 Additional criteria for CCS and CCUS

CCS is the process of capturing (concentrating from diluted sources), transporting and storing CO_2 in order to prevent its release into the atmosphere. Carbon storage can be in open, closed or cycling systems[42]. Open systems include natural systems such as in biomass growth and soil. Closed systems include the geological storage in lithosphere or deep oceans and mineral formations. Cyclic systems include the conversion of CO_2 into fuels or chemicals, this form is also known as carbon capture and utilisation (CCU). For the purposes of this criteria document, CCS refers specifically to closed systems as in geological storage since this is the one with the largest storage life span[43].

The technologies required for carbon capture are in early stages of development, but it is expected to make progress towards commercialisation. In addition, care should be taken in regard to the end use of the product generated from CO_2. This is mainly because if the CO_2 is immediately released into the atmosphere during end product use, the mitigation is ephemeral. This means, additional restrictions are included for the end product, which should be a long-lasting or recyclable product so as to keep CO_2 in a loop.

The EU taxonomy has set up criteria for CO_2 transport and storage which has been adopted for the purposes of this Electrical Utilities criteria with the inclusion of utilization requirements.

Table 26. Criteria for CO_2 transport, storage, and utilisation.

Component	Requirements
Transport[44]	1. The CO_2 transported from the installation where it is captured to the injection point does not lead to CO_2 leakages above 0.5 % of the mass of CO_2 transported. 2. Appropriate leakage detection systems are applied, and a monitoring plan is in place, with the report verified by an independent third party.
Storage[45]	1. Characterisation and assessment of the potential storage complex and surrounding area, or exploration[46] is carried out in order to establish whether the geological formation is suitable for use as a CO_2 storage site. 2. For operation of underground geological CO_2 storage sites, including closure and post-closure obligations: a. appropriate leakage detection systems are implemented to prevent release during operation; b. a monitoring plan of the injection facilities, the storage complex, and, where appropriate, the surrounding environment is in place, with the regular reports checked by the competent national authority. 3. For the exploration and operation of storage sites, the activity complies with ISO 27914:2017225[47] for geological storage of CO_2.
Utilisation	4. Utilisation of direct CO_2 emissions from electricity generation is only eligible when the CO_2 is used for the manufacture of durable products (e.g., construction materials stored in buildings, or recyclable products e.g., PET). CO_2 should not be used for products that release the CO_2 immediately when these are used (such as in urea, carbonated beverages, or fuels), nor for enhanced oil recovery, and the production of other forms of fossil energy sources.

[42] Hepburn, C, Adlen, E, Beddington, J et al. (2019) The technological and economic prospects for CO_2 utilisation and removal. Nature, 575 (7781). pp. 87-97. ISSN 0028-0836

[43] According to the IPCC, well-selected, well-designed and well-managed geological storage sites can maintain CO2 trapped for millions of years, retaining over 99 per cent of the injected CO_2 over 1000 years. IPCC Special Report on Carbon Dioxide Capture and Storage, www.ipcc.ch/site/assets/uploads/2018/03/srccs_wholereport-1.pdf

[44] From the technical screening criteria for qualifying as contributing substantially to climate change mitigation for "Transport of CO_2" in Annex 1 of the Commission Delegated Regulation (EU) 2021/2139 (EU taxonomy)

[45] From the technical screening criteria for qualifying as contributing substantially to climate change mitigation for "Underground permanent geological storage of CO_2" in Annex 1 of the Commission Delegated Regulation (EU) 2021/2139

[46] "Exploration' means the assessment of potential storage complexes for the purposes of geologically storing CO_2 by means of activities intruding into the subsurface such as drilling to obtain geological information about strata in the potential storage complex and, as appropriate, carrying out injection tests in order to characterise the storage site

[47] ISO Standard 27914:2017, Carbon dioxide capture, transportation and geological storage - Geological storage: www.iso.org/standard/64148.html)

Source: Criteria based on EU taxonomy[48]

4.5.4 Additional criteria for methane leakages in fossil gas power plants.

Methane is a GHG with a high GWP: 28, following fifth assessment report by the IPPC (Change, 2015). Although fossil gas has lower combustion emissions than carbon plants, recent studies[49] have shown that, due to methane leakages in transportation of fossil gas, it can be as high emitting as coal. For that reason, actions are required to limit methane leakages.

These include the detection and reparation of methane leakages at operation, physical measurement of emissions is reported, and leak is eliminated, or a leak detection and repair programme is introduced, following EU Taxonomy regulation[50].

[48] https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en

[49] https://gas-vs-coal-calculator.rmi.org/

[50] Electricity generation from fossil gaseous fuels

5 An overview of the criteria for adaptation & resilience

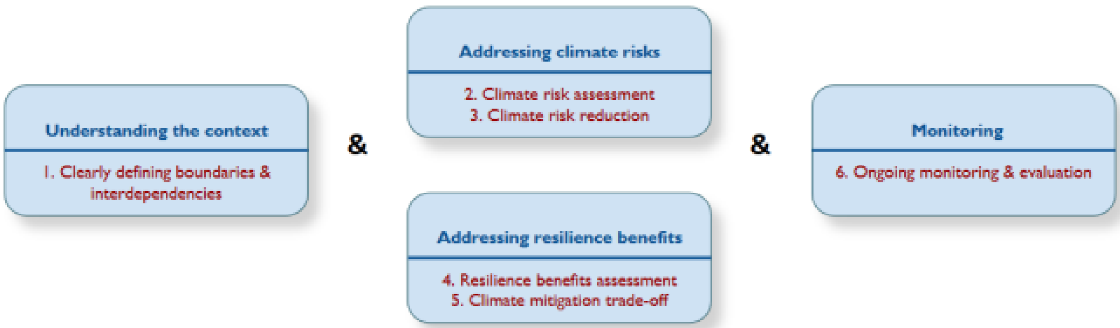
The IPCC defines adaptation as: "The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects." [51].

The IPCC defines resilience as: "The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation." Capacity for adaptation and for resilience will depend on available assets and their distribution within a population as well as institutional infrastructure.

The Climate Resilience Principles further offers the below definition to inspire investors and issuer engagement: Climate resilience investments improve the ability of assets and systems to persist, adapt and/or transform in a timely, efficient, and fair manner that reduces risk, avoids maladaptation, unlocks development and creates benefits, including for the public good, against the increasing prevalence and severity of climate-related stresses and shocks.

5.1 Key aspects to be assessed

Climate adaptation and resilience mitigation criteria are designed to ensure that a project itself is resilient to climate change and that it does not affect the resilience of other sectors. The development of the requirements for the A&R component was based on CBI's "Climate resilience principles" document[52]. Figure 31 gives an overview of the six principles for resilience.



Source: Climate Bonds Initiative

Figure 31: The CBI's principles for Resilience.

Although the principles provide a framework and serve as guidance for general aspects to consider, it is also recognised the challenges and limitations to assess the adaptation and resilience aspects in general. Such limitations include the lack of awareness of climate resilience benefits and a common language, robust data on climate risks and common methodologies for climate risk assessment, lack of capacity and interdependencies with other assets or actors in the supply chains. It is also acknowledged that A&R has inherent complexities which makes it harder to quantify and it can be very context specific, depending not only on location but also on the type of asset, the type of risk looked at, the level of severity and frequency of the risk, and so on. The frequency and magnitude of the impacts are commonly underestimated by companies.

Location: Appropriate geographic or other spatial boundaries for climate risk and benefits assessments for assets and activities in the sector was discussed as well as consideration of the broader system affected by those assets and activities. There are expected

[51] Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability.Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field CB et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32. www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf

[52] CBI (2019). Climate Resilience Principles. A framework for assessing climate resilience investments. www.climatebonds.net/climate-resilience-principles

internal and external interdependencies between assets or activities in a given sector and between sectors (which become evident when a climate event results in a potential failure of value chains) but there can also be opportunities to maximise resilience benefit.

When developing criteria for setting the boundaries for assessment, it was proposed to separate the analysis as follows:

- Capital assets.
- Production
- Logistics and supply (including raw materials, utilities and their distribution),
- Labour

Key infrastructure dependencies were identified with special relevance for the sector including water, gas, and other key factors necessary to run the electricity generation and keep the adaptation and resilience equipment and infrastructure operating during any outage arising from climate change events. All these infrastructure dependencies are to be included in the production element.

- **Timeframes**: Appropriate time horizons for climate resilience assessments need to be set for the assets and activities in scope. The criteria to base the time horizon for the assessments are set based on the typical lifetimes of assets in the sector which is 50 years on average.
- **Disclosure**: As part of the monitoring and evaluation principle, there are requirements for reporting and disclosing risks assessments. Currently there are a number of issues seen:
    - a lack of alignment or harmonisation as reporting is often undertaken on a voluntary basis.
    - the level of completeness can be low which leads to accusations of greenwashing.
    - the frequency for reporting and updating the assessment varies (recognising that the time horizons for revisiting the assessments will likely depend on the level of risk of a facility: low risk facilities can have long time horizons, and high-risk facilities short time horizons). Depending on the severity of the risk the time horizon can be set.

Other aspects to consider when setting the A&R requirements are listed as follows:

- **Identification of the key climate risks** - including hazards, exposures and vulnerabilities - likely to be experienced by assets and activities in that sector. Some insurance companies, such as FM global, can provide a useful source of data for risk assessments.
- **Models, methodologies and data sets** that would be most appropriate for determining likely physical climate risks to be faced in context for activities and assets in the sector.
- **Climate change risk measures and metrics** for assets and activities in the sector - e.g. how should assets and activities deal with these risks? How this could be evaluated?

Based on the discussions presented above, the assessment methodology includes a verification list that the verifier should complete when assessing an asset or project included in the entity's portfolio. It is recognised that this may not be complete, but is presented as the most robust available, given the complexities and several angles of the topic, and the lack of robust and more quantitative methodologies and tools.

Wider environmental and social risks are complex and interconnected and should be assessed under these Criteria, however the following points are noted:

- The Climate Bonds Standard is focused on climate impacts - including low GHG-compatibility (mitigation) and also climate adaptation and resilience. Defining resilience can be challenging. However, it is clear that many topics which have been a part of environmental and social assessments for a number of years overlap significantly with the resilience of affected populations and ecosystems and their ability to adapt to climate change.
- The most obvious example is the potential impact of climate change on hydrological conditions, and consequently water supply and local livelihoods. Another is climate change exacerbating ecological problems such as impaired species migration and algal blooms. Environmental and social impacts such as these, already complex and interconnected, become more so when climate change impacts and risks are taken into account, and there is a logic to addressing all key environmental factors, rather than trying to separate them out.

The Climate Bonds Standard does not usually address primarily social impact issues, these were discussed but not considered within scope.

5.2 Practical requirements for this Component

Leverage existing tools

The knowledge and literature on adaptation and resilience impacts of electricity generation facilities is limited as this area is in its infancy. The A&R Component will require consideration of a highly complex and varied set of issues across the environmental and social spectrum for which data, methodologies and metrics may not be available. Qualitative methods based on verification lists or questionnaires have been proposed which can however be leveraged. It is not appropriate for Climate Bonds to commit resources to address these issues, and the guiding principle of simplicity shall be applied at this time. More robust criteria can be developed over time as more information is generated and integrated in the subsequent revisions of the Criteria.

However, it should be noted that existing methods do not always fully or explicitly cover the additional, often interrelated impacts connected to climate adaptation and resilience. Many of the risk assessments and management processes specified by existing guidelines will be a prerequisite for identifying A&R risks, but more may be needed to fully address them given that this is an emerging topic.

Minimise the assessment burden

In addition, there needs to be a balance between rigour and practicality. Any Criteria with a prohibitively expensive assessment burden will discourage certification. Any methodology adopted therefore need to avoid this.

A binary 'pass'/'fail' outcome rather than scores or grades

Certification decisions under the Climate Bonds Standard are binary - applicants are either certified or not. Therefore, the A&R Component needs to be framed in terms of pass/fail thresholds. Where an assessment tool provides scores or grades for a facility, consideration has been given to what threshold 'score' or result should represent a pass for the purposes of Climate Bonds Certification. It is important to note that applicants may put 'n/a' as 'not applicable' with suitable justification. Where an aspect of the requirements is not relevant to an applicant's asset or measure, it is not expected the applicant should provide evidence of meeting this.

Retrospective application

Finance raised in this sector may be for new, greenfield facilities, for retrofits or upgrades to existing facilities, or they may be a straight refinancing of an existing facility. Therefore, any proposal and associated approved assessment tool under this Component needs to be usable for both new and existing facilities.

This is not a straightforward issue; as in the case of refinancing, the facility may have been operating for a number of years. It may have been compliant with best practices in place at the time of its implementation but may not meet current best practice requirements. The selected methodology and tool will therefore need to be able to address and resolve any 'legacy issues' that may be identified.

Distinct requirements for measures and entire facilities

When the focus of certification is on a decarbonisation measure or bundle of measures, as compared to an entire production facility, adaptation risks and resilience impacts change. It is not considered proportionate to require a single measure being financed to also have to demonstrate A&R criteria are satisfied for the whole facility it is found in. As such, there are two separate A&R checklists: one for measures, the other for plants.

5.3 Existing tools and guidelines considered

A range of existing tools and guidelines with the most potential to be leveraged for the Electrical Utilities Criteria are listed below, with a brief indication of whether they were taken forward for further consideration or not.

Risk Assessment and Climate Scenarios

- The ISO 14091:2021 Adaptation to climate change - Guidelines on vulnerability, impacts and risk assessment standard offers guidelines for assessing the risks related to the potential impacts of climate change.53
- Risks can be characterised by the associated annual probability of failure or annual costs of loss or damage
- For risk assessment, the TCFD The Use of Scenario Analysis in Disclosure of Climate Related Risks and Opportunities is recommended.
- A broad range of models can be used to generate climate scenarios. Users should apply climate scenarios based on representative concentration pathway (RCP) 4.5 and 8.5 or similar / equivalent to ensure consideration for the worst case scenario. (The IPCC 'Shared Socioeconomic Pathways' to develop potential temperature scenarios. SSP5-8.5 is the highest warming pathway, SSP3-7.0 the second highest and so on).
- The IPCC Sixth Assessment report also provides an indication as to how different temperatures impact the likelihood and severity of different climate impacts
- A framework for risk management for climate security. www.c2es.org/document/degrees-of-risk-defining-a-risk-management-framework-for-climate-security/
- Climate Change Risk Assessment Guidelines. www.ctc-n.org/system/files/dossier/3b/D4.2%20Climate%20change%20risk%20assessment%20guidelines.pdf

[53] www.iso.org/standard/68508.html

Definitions

Adaptation and Resilience Criteria: Rules or principles for evaluating and preventing the physical climate risk and asses the vulnerability of an asset or entities aiming to reduce of this vulnerability to the effects of climate change. These rules also tend to guarantee that the activities don't do any significative harm to other assets within their system boundaries which covers the area affected by the activity.

Advanced economies: OECD regional grouping and Bulgaria, Croatia, Cyprus, Malta and Romania

Applicant: The term or name for any potential bond issuer, or non-financial corporate entity that might seek certification under the Electrical Utilities Criteria.

Base load: It is the minimum level of electricity demand required over a period of 24 hours. It must be guaranteed by the electricity system.

Carbon Capture and Storage (CCS): describes a suite of technologies that capture waste CO_2, usually from large point sources, transport it to a storage site, and deposit it where it will not enter the atmosphere. Stored CO_2 is injected into an underground geological formation; this could be a depleted oil and gas reservoir or other suitable geological formation.

Carbon Capture, Utilisation, and storage (CCUS): describes a suite of technologies that capture waste CO_2, usually from large point sources, to then use it in other processes, or to make products.

Certified Entity: The entity or part thereof which is being certified under the Climate Bonds Standard. Currently, Entity Certification is limited to non-financial Entities or segregated segments thereof, for which the Climate Bonds Initiative has Climate Bonds Standard Sector Criteria for Entity Certification.

Climate Bond Certification: allows the applicant to use the Climate Bond Certification Mark in relation to that bond. Climate Bond Certification is provided once the independent CBSB is satisfied the bond conforms with the CBS.

Climate Bonds Initiative (Climate Bonds): An investor focused not-for-profit organisation, promoting large-scale investments that will deliver a global low carbon and climate resilient economy. Climate Bonds 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.

Climate Bonds Standard (CBS): A screening tool for investors and governments that allows them to identify green bonds the proceeds of which are being used to deliver climate change solutions. This may be through climate mitigation impact and/or climate adaptation or resilience. The CBS is made up of two parts: the parent standard (CBS v4.0) 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 Criteria detail specific requirements for assets identified as falling under that specific sector. The latest version of the CBS is published on the Climate Bonds website.

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 CBS, including the adoption of additional sector Criteria, (ii) Approved verifiers, and (iii) Applications for Certification of a bond under the CBS. The CBSB is constituted, appointed, and supported in line with the governance arrangements and processes as published on the Climate Bonds website.

Climate Change: A change in global or regional climate patterns attributed to the increased levels of CO_2 in the atmosphere, produced mainly by the combustion of fossil fuels.

Climate Goals: Objectives that aim to reduce GHG emissions to limit the global temperature increase to 2.0°C or even 1.5-degrees above pre-industrial levels.

Climate Mitigation Performance Targets: The performance targets that define the measurable climate mitigation performance to be achieved.

Climate resilience and adaptation: Measures or assessments related to protecting communities or ecosystems from the effects of climate change. Adaptation refers to the protection and resilience is the ability to adapt and recover from the impacts of climate change.

Climate Targets: Limits that scientist and policymakers set in plans to combat climate change.

CO_2 equivalent: A unit to measure the effect of all greenhouse gases according to their global warming potential that express the warming effect of each greenhouse gas over a set period of time (usually 100 years) in comparison to CO_2. Thus, an amount of a GHG can be expressed by the amount of CO_2 that will have the equivalent warming effect over 100 years.

CO_2 geological storage: It is the process of keeping the CO_2 in underground geologic formation, usually pressurizing the carbon dioxide until it becomes a liquid.

CO_2 transport leakages: Undesired CO_2 losses to the atmosphere during the transportation from where sequestered to where storage.

Critical interdependencies: The asset or activity's boundaries and interdependencies with surrounding infrastructure systems. Interdependencies are specific to local context but are often connected to wider systems through complex relationships that depend on factors 'outside the asset fence' that could cause cascading failures or contribute to collateral system benefits.

Decarbonisation pathways: Transformation process, strategies, or indications to be implemented in energy sector aiming to reduce emissions and the use of fossil fuels. They involve measures as shifting the energy mix, increasing energy efficiency, utilizing circular economy, or managing demand for energy.

Decarbonize: Moving away from energy systems that produce carbon dioxide and other greenhouse gas emissions and remove the amount of carbon gaseous compounds in the atmosphere.

Distribution: It is the final stage of the electricity value chain. Electricity is carried from the transmission system to individual consumers.

Electricity generation portfolio: The strategic collection of investments and assets in electricity generation technologies and projects by energy source.

Electrification: The process of using electricity to provide services that were previously met by other energy sources, usually fossil fuels. If the electricity come from renewable sources, it can help to the decarbonization of the economic system.

Emerging economies: All other countries not included in the advanced economies regional grouping.

Emissions intensity: Volume of emissions per unit of a representative factor in the assessed sector. In the electricity utilities sector this factor is kWh generated, so, the emissions intensity is the grams of CO_2 eq per kWh generated: gCO_2/kWh.

Emissions target: Limits that scientist set focused on the quantity of emissions that needs to be aligned with the Paris Climate Agreement.

Energy Utilities: A Company that provides energy, mainly electricity and fossil gas but also heat.

Fossil Gas: It is a hydrocarbon fuel mostly composed by methane produced from the decay of organic material over millions of years.

Green Bond: A green bond is a bond of which the proceeds are allocated to environmental projects or expenditures. The term generally refers to bonds that have been marketed as green. In theory, green bonds proceeds could be used for a wide variety of environmental projects or expenditures, but in practice they have mostly been earmarked for climate change projects.

Industry Working Group (IWG): A group of key organisations that are potential applicants, verifiers and investors convened by Climate Bonds. The IWG provides feedback on the draft sector Criteria developed by the TWG before they are released for public consultation.

Investment Period: The interval between the bond's issuance and its maturity date. Otherwise known as the bond tenor.

Life-cycle emissions analysis: It is a methodology for assessing or accounting environmental emissions associated with all the stage of the life cycle of a product or process. IT covers emissions from the initial design phase to the moment it's thrown away or recycled.

Low-carbon fuels: They are materials, that, when burned, provide thermal energy with fewer emissions than fossil fuels. This thermal energy can be used to generate electricity.

Low-carbon technologies: Technologies referred to as innovative technical solutions that are characterized by a low-emission intensity, compared to state-of-the-art alternatives. They can be seen as best-in-class technologies with a focus on environmental impact. For electricity utilities low-carbon technologies could be solar, wind, marine, bioenergy, hydropower, geothermal and nuclear.

Mitigation Criteria: Rules and principles containing thresholds, benchmarks and milestones for sector activities whose objective is the reduction of the harmful effects of greenhouse gases emissions.

Mitigation Technologies: Actions within technological process implemented to reduce and curb greenhouse gas emissions.

Natural Gas: A naturally occurring mixing of gaseous hydrocarbon consists primarily of methane in addition to other alkanes.

Negative emissions: It refers to processes in which more CO_2 is taken off and stored from the atmosphere than added into it, so the final GHG emissions balance is negative. It can be achieved by natural processes or a variety of technological solutions. Negative emissions are necessary to meet the Paris Agreement.

Net Zero Emissions Scenario (NZE): A science-based scenario designed to show what is needed across the main sector by various actor, and by when, for the world to achieve net-zero energy-related and industrial process CO_2 emissions by 2050. It also aims to minimize methane emissions for the energy sector.

Net zero emissions: It is a situation where global greenhouse gases emissions from human activity are in balance with emissions reductions. To achieve this situation human-caused emissions should be reduced as close to zero as possible.

Net-zero targets: Global policy instruments of international GHG reductions to achieve net zero emissions.

Non-fossil renewable gaseous and liquid fuels: Fuels produced using energy from other renewable energy sources.

Offsetting: A climate action that enables organizations to compensate for the emissions they put into the atmosphere, by supporting worthy projects that reduce emissions in separated regions of the world.

Parent Company/Group: A company is considered a parent company of another entity (a subsidiary) if it exercises control over the subsidiary. The terms "control" and "subsidiary" have the meaning assigned to them under International Financial Reporting Standard 10 (IFRS 10). A Parent Group consists of the Parent Company and all the companies that the Parent Company exercises control over. Where the Applicant does not belong to a group of companies, the term Parent Company applies to the Applicant.

Paris Agreement: A legally binding international treaty on climate change. It was adopted 196 Parties. Its overarching goal is to hold the increase in the global average temperature to well below 2-degrees above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5-degrees above pre-industrial levels.

Pathways: Science-based trajectories for different sectors indicating the way to achieve targets related to relevant indicators. In the electricity sector, these trajectories are referred usually to the emissions intensity.

Scenarios: Science-based plausible descriptions of how the future my unfold based on several assumptions (economic, social, behavioural, technological) Usually they are one of a ser of alternative pathways. Most common scenarios are the IEA Net Zero Emissions Scenario, the NDC's Scenario…

Scope of emissions: The boundaries within the emissions will be taken into account. Usually for business, companies, or organizations, the GHG Protocol has divided all the companies' emissions into 3 categories. Scope 1, 2 and 3.

Standards Criteria: Principles settled to evaluate processes, assets, or entities referred to benchmarks, targets, or goals aimed to achieve.

Sustainability-Linked Debt (SLD): Any debt instrument for which the financial and structural characteristics can vary depending on whether the issuer achieves predefined Sustainability/ ESG objectives. Such objectives are measured through predefined KPIs and assessed against predefined performance targets. Proceeds of SLD are intended to be used for general purposes.

Synthetic Fuels: Liquid or gaseous fuels produced artificially that can come from renewable raw materials or electricity generated using renewable energy sources. They tend to have the same properties as fossil fuels and can replace them.

Technical Working Group (TWG): A group of key experts from academia, international agencies, industry and NGOs convened by Climate Bonds. The TWG develops the 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 (see below) and through public consultation. Final approval of Sector Criteria is given by the CBSB.

Transition targets: Thresholds, benchmarks, and milestones based on key assumptions and dependencies used by scientist and policymakers to develop a plan to achieve climate targets.

Unabated fossil fuel: Fossil Fuels without any intervention that substantially reduce the amount of greenhouse gas emitted throughout their life cycle.

List of acronyms

BECCS	Bioenergy equipped with CCUS
CAPEX	Capital expenditures
CBS	Climate Bonds Standard
CBSB	Climate Bonds Standard Board
CCGT	Combined circle gas turbine
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CCUS	Carbon capture, utilisation, and storage
CEM	Continuing emissions monitoring
CHP	Combined Heat and Power
CO_2	Carbon dioxide
CSP	Concentrating solar power
EU	European Union
FSC	Forest Stewardship Council
GHG	Greenhouse gases
IAMC	Integrated alarm, monitoring and control systems
IEA	International Energy Agency
IGCC	Integrated gasification combined cycle
IPPC	Intergovernmental Panel on Climate Change
ISCC	International Sustainability & Carbon Certification
IWG	Industrial working group
LCA	Life cycle analysis
NGCC	Natural gas combined cycle
NZE	Net zero emissions by 2050 scenario
O&M	Operation and maintenance
PV	Photovoltaic
RSB	Roundtable on Sustainable Biomaterials Association
RTRS	Round Table of Responsible Soy
SBTi	Science Based Targets initiative
SLB	Sustainability-linked bond
SLD	Sustainability-linked debt
T&D	Transmission and distribution
TPI	Transition Pathway Initiative
TWG	Technical working group
UoP	Use of process
WRI	World Resource Institute
WBCSD	World Business Council for Sustainable Development

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Appendix A: TWG and IWG members

Climate Bonds Coordinator:			
Francisco Moreno Castro	Energy Analyst Climate Bonds Initiative		
Technical Lead Advisor:			
Ana Díaz Vázquez	Energy Transition Lead Climate Bonds Initiative		
TWG Members			
Andy Ross	Senior Manager Assessing Low-Carbon Transition, SBTi	**Shuilng Rao**	Senior Researcher, The Institute of Finance and Sustainability
Catgalin Dragostin	Director Energy Serv, Vice-President Excorom	**Steve Pye**	Associate Professor of Energy Systems, UCL
Cristobal Budnevich Portales	Policy Officer and Data Analyst, TPI	**Tetsuo Saito**	Senior Research Fellow, Renewable Energy Institute
Kae Takase	Renewable Energy Institute	**Tom Luff**	Energy Strategy and Policy Expert, Energy System Catapult
Ruhn Zhang	Agora Energiewende	**Wu Di**	Senior Power Sector Analyst, Institute of Energy, Peking Universi
Ryan Foelsk	Manager on Utility Transition Finance Team, RMI		

Members of the following organizations have participated in IWG meetings and provided critical and useability focused consultation and feedback on the Criteria, but this does not automatically reflect endorsement of the criteria by all members.

IWG Members			
Adrian Ghita	Romanian Energy Efficiency Fund	**Lazeena Rahman**	ADB (Asia Development Bank)
Alison Chan	NAB (National Australian Bank)	**Margaret Onije**	BGI Resources Limited
April Strid	Kestrel	**Mitra Apurba**	KPMG
Atsuko Kajiwaraüj	Japan Credit Rating Agency, Ltd	**Monica Reid**	Kestrel
Bia Bu	Ingreen Bank	**Nishtha Aggarwal**	Climate Energy Finance
Christian Carraretto	EBRD (European Bank for Reconstruction and Development)	**Pradeep Tharakan**	ADB (Asia Development Bank)
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Haruna Goto	Individual capacity	**Randolph Brazier**	HSBC Holdings PLC
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Jimi Ogbonbine	Agusto Consulting	**Tim Buchholz**	DZ Bank AG
Jin Boyang	Refinitiv China	**William Battye**	EBRD (European Bank for Reconstruction and Development)
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