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 Working Group (TWG) and Industry Working Group (IWG) 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 1.0	March 2024	Issued for Certification
Rev 0.1	December 2023	Issued for Public Consultation

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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 IWG is represented by industry experts as well as potential bond issuers, verifiers and investors. A 45-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 Criteria Brochure;
- Electrical Utilities Frequently Asked Questions;
- 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 2.5-2.9-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-degree higher than pre-industrial levels by the end of the century, and ideally no more than 1.5-degree. The effects of climate change and the risks associated even with a 2-degree 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-degree 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-degree scenario.

[1] According to Climate Tracker, under current policies we could expect 2.5 - 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.

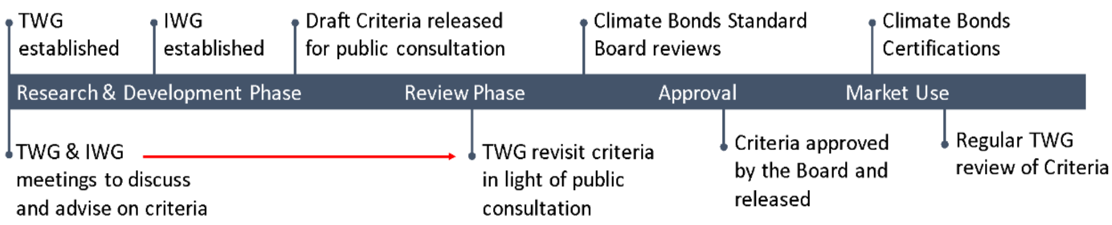
Sustainable debt issuance as of end of year 2023 was on the order of USD5.5 tn (with 4.4 tn aligned) and continues on an upward trajectory with ongoing diversification in the types of debt issued. To support this growth, standards, assurance, and certification are essential to demonstrate credibility, which improves confidence and transparency.

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 (land and sea), bioenergy, forestry, agriculture, waste management and water infrastructure, hydropower, electricity grids and storage. In In addition to steel, additional industry transition criteria currently available include cement, basic chemicals and hydrogen production and delivery.

The Certification Scheme requires issuers to obtain independent verification, pre- and post-issuance, to ensure the bond meets the requirements of the CBS. 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, Figure 1).

1.5 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.

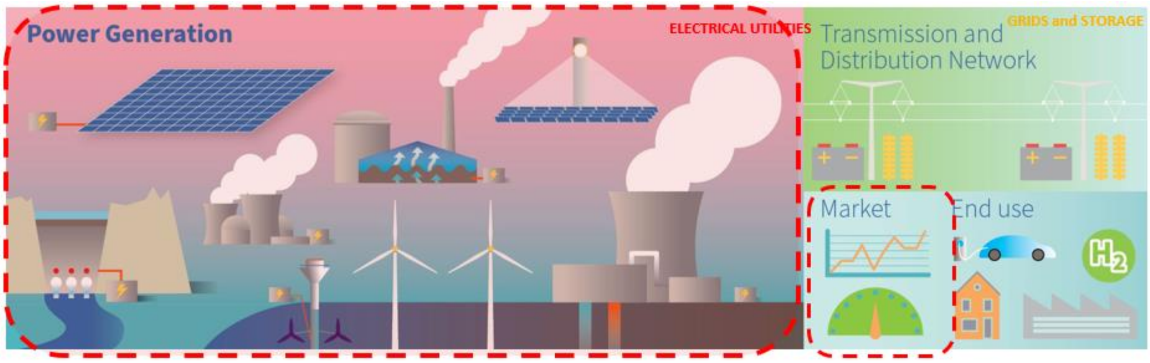
2 Sector Overview

2.1 What is Electricity?

Electricity is the second secondary source of energy final consumption in the world, counting in 2023 for 82,3 EJ 20% share.[3] 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 also 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.[4] Thus, electricity utilities will play a critical role in decarbonizing the global energy system, as countries and companies adopt net-zero targets.

The electricity value chain includes generation, transmission, distribution, and final supply (see Figure 2).



Source: Climate Bonds Initiative

Figure 2 Electricity value chain.

These Criteria are focused on the generation segment where 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 different electricity generation technologies, including mature as well as emerging or future technologies, that will be needed to meet future demand while meeting climate restrictions.

The Electrical Utilities Criteria is focused on the generation segment of the value chain including to the electricity produced by an entity, the electricity purchased in the grid for distribution or trading in the market.

[3] International Energy Agency. Executive Summary. Electricity 2024. Analysis. IEA Electricity 2024
[4] International Energy Agency, 2023, https://www.iea.org/energy-system/electricity

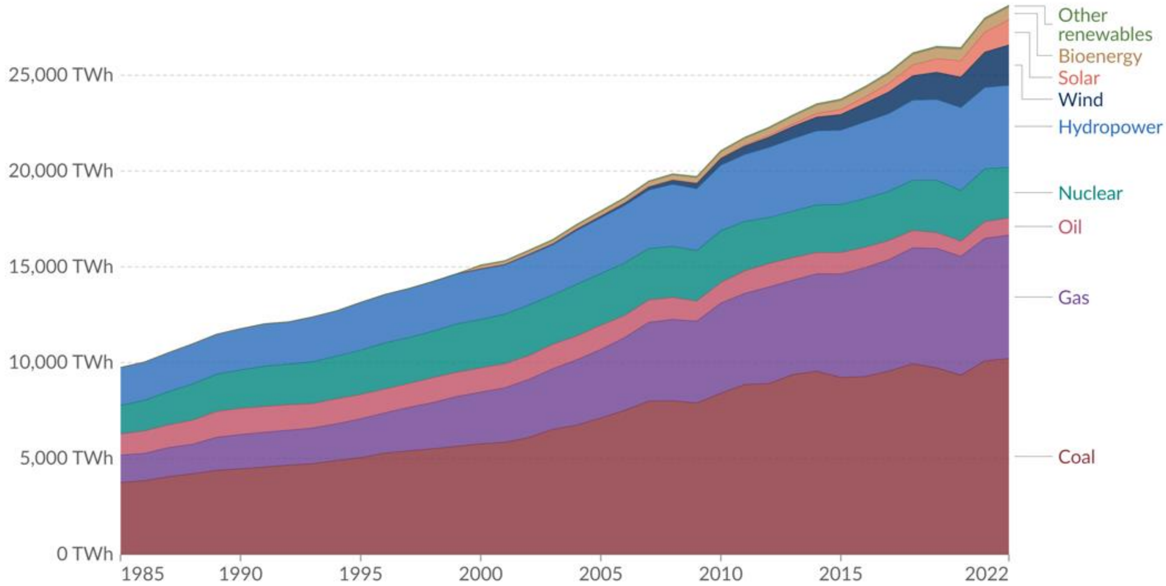
Table 1: Electricity generation technologies.

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: Climate Bonds Initiative

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 2022 came from coal and gas-fired power plants, see Figure 3. Hydropower (15%) was the largest source of renewable electricity, followed by nuclear power (9%). 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 7% and 4,5% respectively in 2022, respectively. This expansion has been driven by a significant existence of supportive policies,[5]. 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 and solar energy have experienced a strong development in recent years, and these trends must increase to achieve almost 90% of the electricity generation in the world in 2050.[6]

The future of electricity will pass through three major features: **decarbonisation, end-use electrification** and consequently **increasing demand of electricity.**

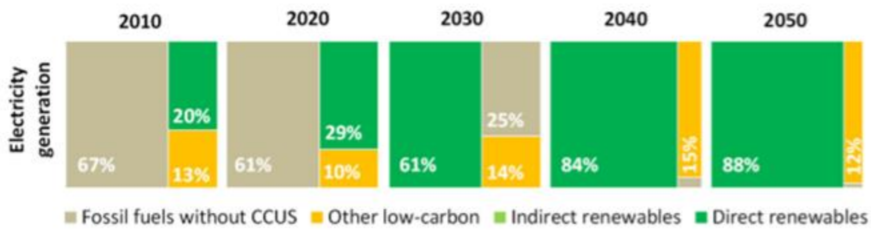
2.2.1 Decarbonisation

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.[7]

2.2.1.1 Increase of renewable energy.

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 see section 4.2) The global renewable energy potential is expected to continue growing rapidly and could provide more than 88% of global electricity supply by 2050.[8] (See Figure 4)

[5] Our World In Data (Oxford University, 2022)
[6] Net zero by 2050. A roadmap for the global energy sector. (IEA, 2021a)
[7] Renewable electricity tracking report. (IEA, 2022d)
[8] Net zero by 2050. A roadmap for the global energy sector. (IEA, 2021a)



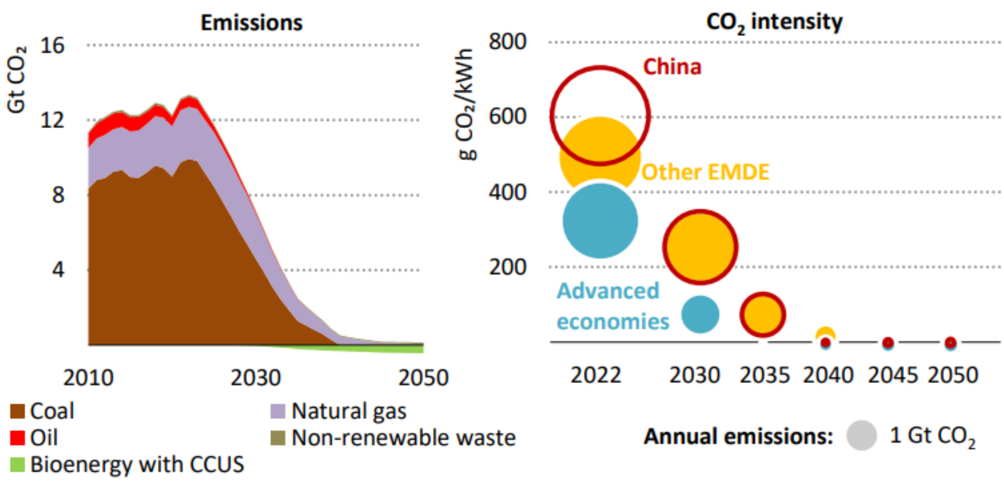
Source: Net Zero by 2050. A roadmap for the global energy sector. IEA, 2021.

Figure 4: 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.

2.2.1.2 Phase-out of fossil fuel power plants

The IEA has stated that the power sector should achieve net zero emissions by 2040,[9] requiring the elimination of the largest contributors to power generation today, fossil fuels, such as coal and gas within 30 years, Figure 5. 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 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

Figure 5. Global electricity sector emissions and CO_2 intensity of electricity generation in the NZE scenario.

2.2.1.3 Mitigation technologies: CCS/U and co-firing.

There are also other abatement technologies that can significantly contribute to decarbonize the electricity sector. However, these 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 leakages and geological-storage capacity limitations.

On the other hand, they can support the transition of existing fossil assets, providing a way to address emissions from some of the most challenging hard to abate economic activities.

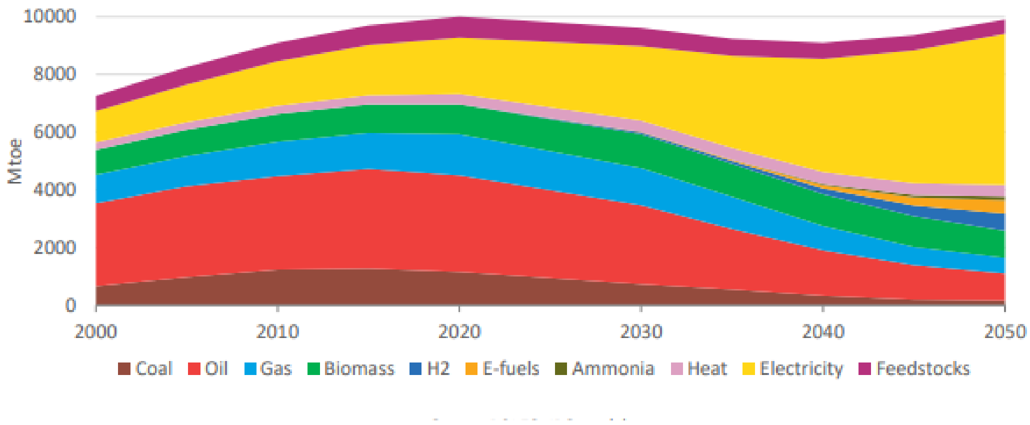
On the cofiring technology, transportation of low-carbon fuels to cofire with coal or fossil gas, is also a challenge to make these technologies as low-emitting as renewable energy. Producing the low-carbon fuel near the place where it will be used reveal as the best practice to significantly reduce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

[9] Net zero roadmap. A global pathway to keep the 1.5-degree goal in reach. (IEA, 2023)

2.2.2 Electrification of the energy system

Electrification process will become the second key to decarbonise the whole energy system. The electrification of final demand sectors is a long-term trend driven primarily by the potential for electricity to decarbonise 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. The share of electricity in final energy consumption grows steadily between 2020 and 2050.[10]

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,[11] there seems to be a global consensus on the following points.[12] First, it is likely that achieving ambitious long-term stabilisation climate goals will require, on average, an accelerated penetration of electricity use in the economy over the next three decades, Figure 6. 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,[13] the trend in renewable electricity capacity additions is not on track.

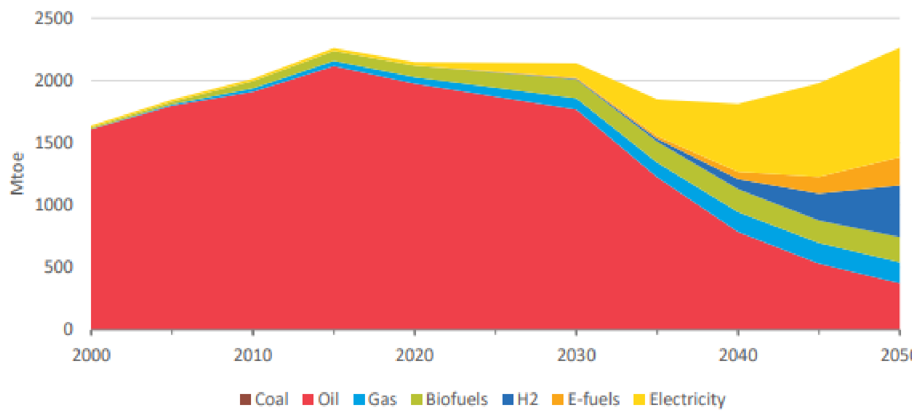


Source: GECO, 2019

Figure 6: Global final energy consumption by fuel. Electrification process 1.5-degree scenario.

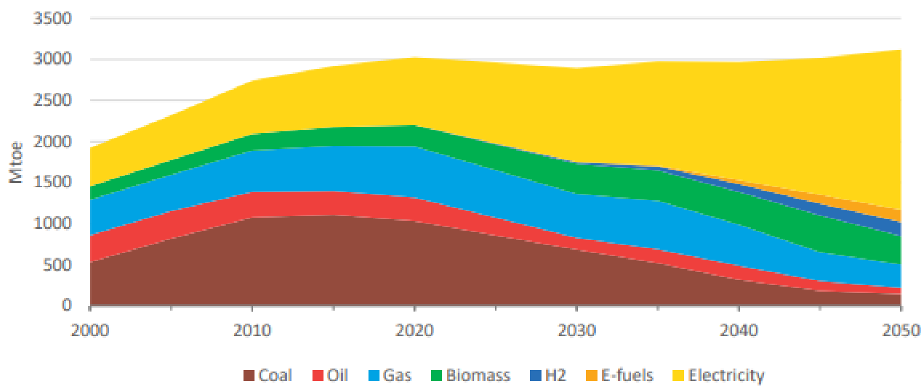
Following Figure 7, Figure 8 and Figure 9 show the electrification process at the 1.5-degree scenario for three main sectors. Much of the demand can be met by switching to electric transport and installation of heat pumps. In industry the highest potential for electrification is in low-temperature heat processes.

[10] Mitigation pathways compatible with 1.5-degree in the context of sustainable development. (IPCC, 2018)
[11] 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
[12] Global energy and Climate outlook 2019: Electrification for the low-carbon transition. (Keramidas, 2019)
[13] Electricity sector tracking progress. (IEA, 2022a)



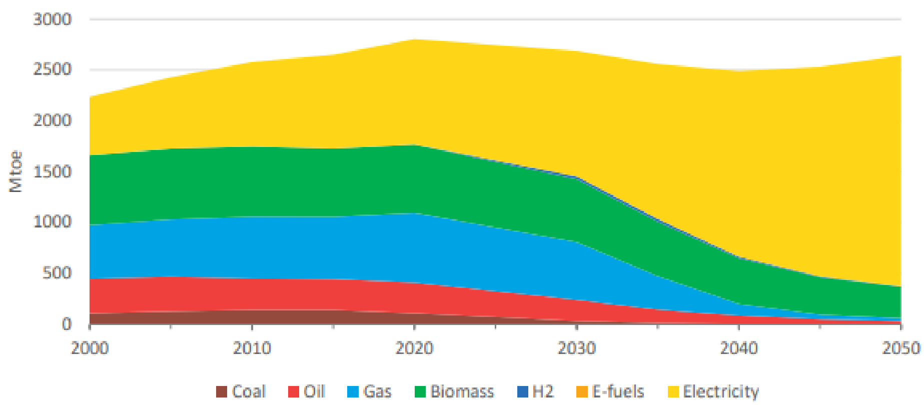
Source: GECO, 2019

Figure 7: Global transport sector energy demand by fuels, 1.5-degree scenario.



Source: GECO, 2019

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



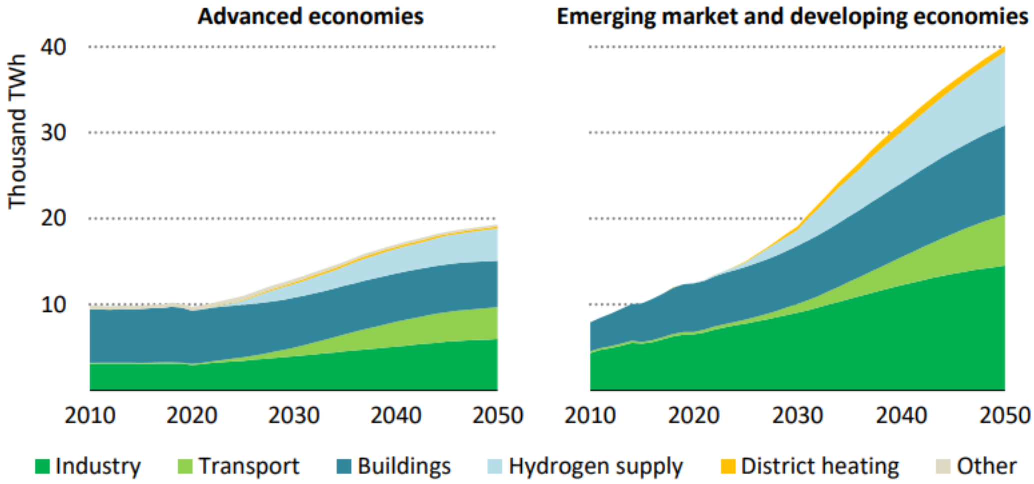
Source: GECO, 2019

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

2.2.3 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 logical 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 IEA net zero emissions scenario (NZE), an average increase of 3.2% per year.[14]

Regional grouping is considered in some net zero scenarios, as the one from the International Energy Agency (IEA) to echo the differences regarding the actual situation, the population trends, technological development, etc. See Figure 10.



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

Figure 10. Electricity demand by sector and regional grouping.

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 in the power sector 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.[15]
3. **Thermal electricity generation** can be covered by renewable generation, but the capacity and system services requires other technologies, such as energy storage and smart grids.

[14] Ner zero by 2050. A roadmap for the global energy sector. (IEA, 2021a)
[15] Coal in Net Zero. (IEA, 2022c)

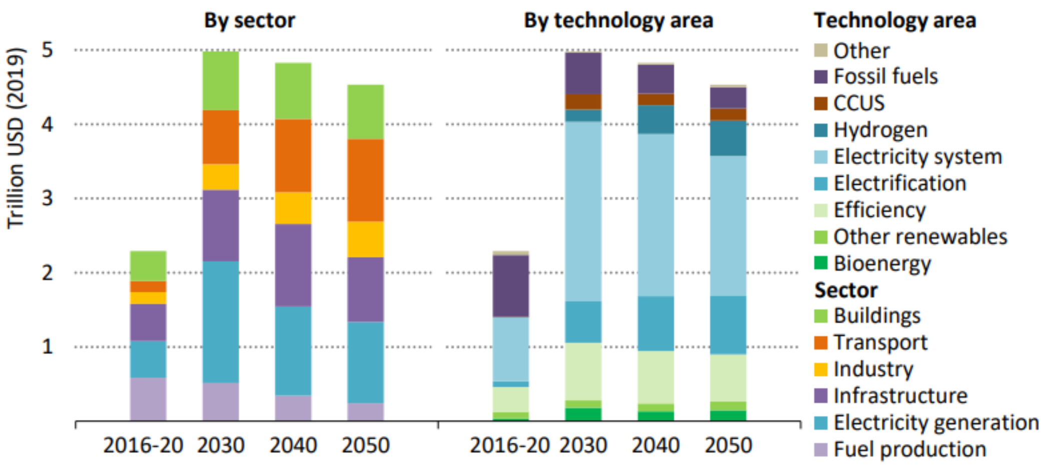
4. **Grid Infrastructure**: The existing grid infrastructure in many countries is not designed to support the large-scale deployment of renewable energy sources. Building new transmission and distribution infrastructure can be expensive and time-consuming and may face resistance from local communities.
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. These investments require 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.

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.



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.[16]

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[17] 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.

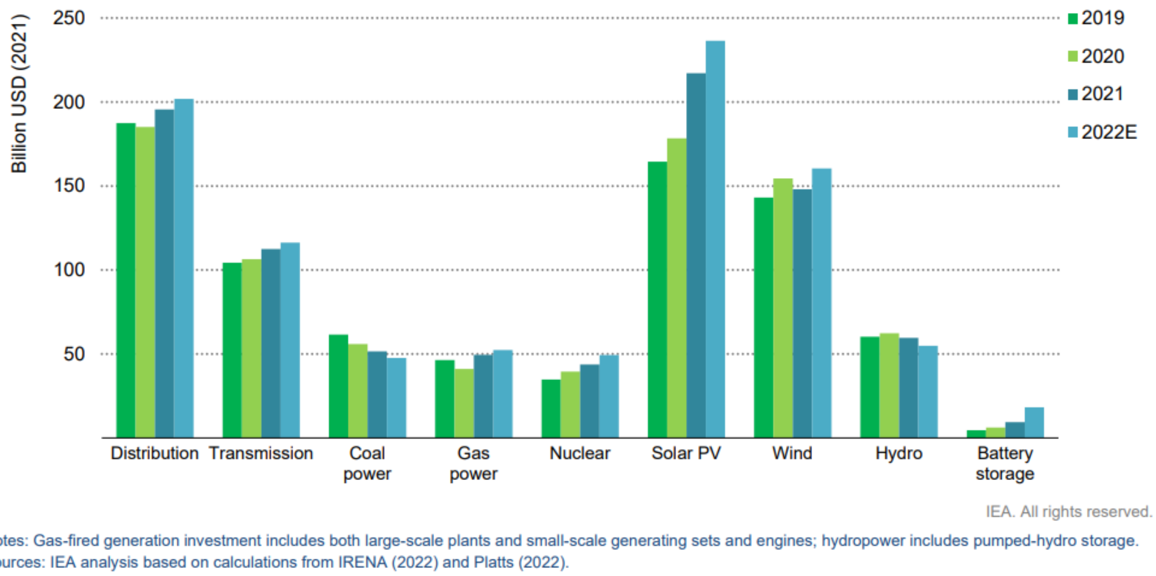
Solar PV have lead power sector investment in 2021, accounting for almost half of the renewables investment. Spending is almost evenly split between utility-scale projects and distributed solar PV systems, with each sub-category set to break the USD 100 billion mark in 2022. For wind, while 2020 was 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.

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.

[16] Net Zero by 2050. A roadmap for the global energy sector. IEA (IEA, 2021a)
[17] World Energy Investment. (IEA, 2022e)

Figure 12 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. IEA, 2022

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

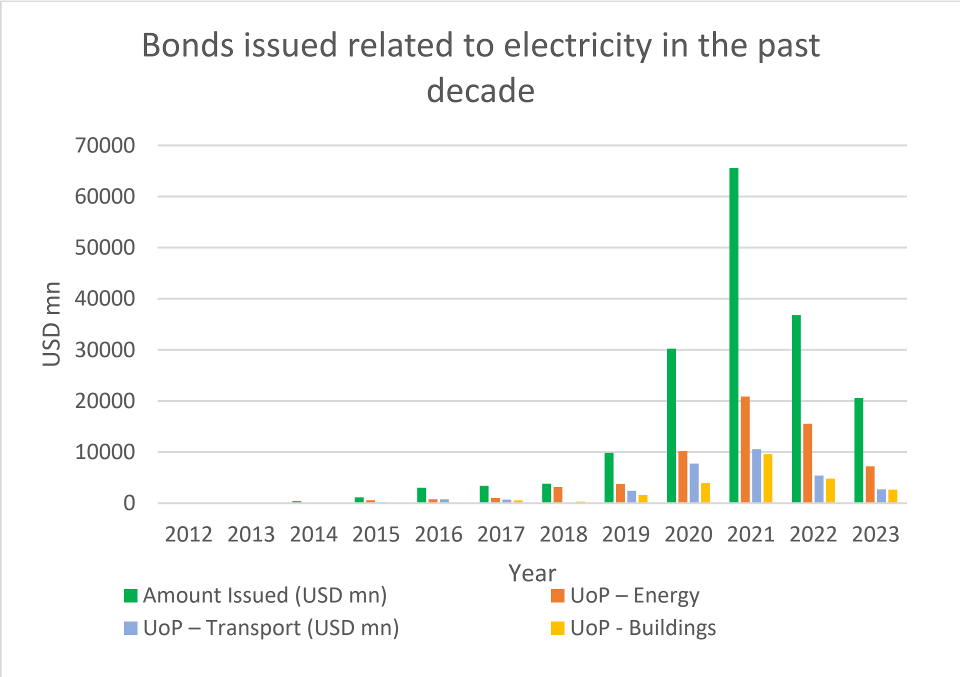
Labelled bonds can help the acceleration needed in the investments for the energy and electricity sector. A market survey of use of proceeds (UoP) allocation, provide a view of the green bond issuance towards electricity related projects. Table 2 and Figure 13 shows the yearly overview of our green bond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

Table 2. Bonds issued in the energy sector from 2012 to 2023.

Bonds related to electricity from 2012 to 2023.				
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: Climate Bonds Initiative

The data above are showed in the following chart.



Source: Climate Bonds Initiative

Figure 13. Bonds issued in the energy sector from 2012 to 2023.

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 emission intensity transition pathway and other non-combustion and indirect 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, the following can be certified under these criteria and the update of the Overarching Climate Bonds Standard:

- 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 3.1.2)

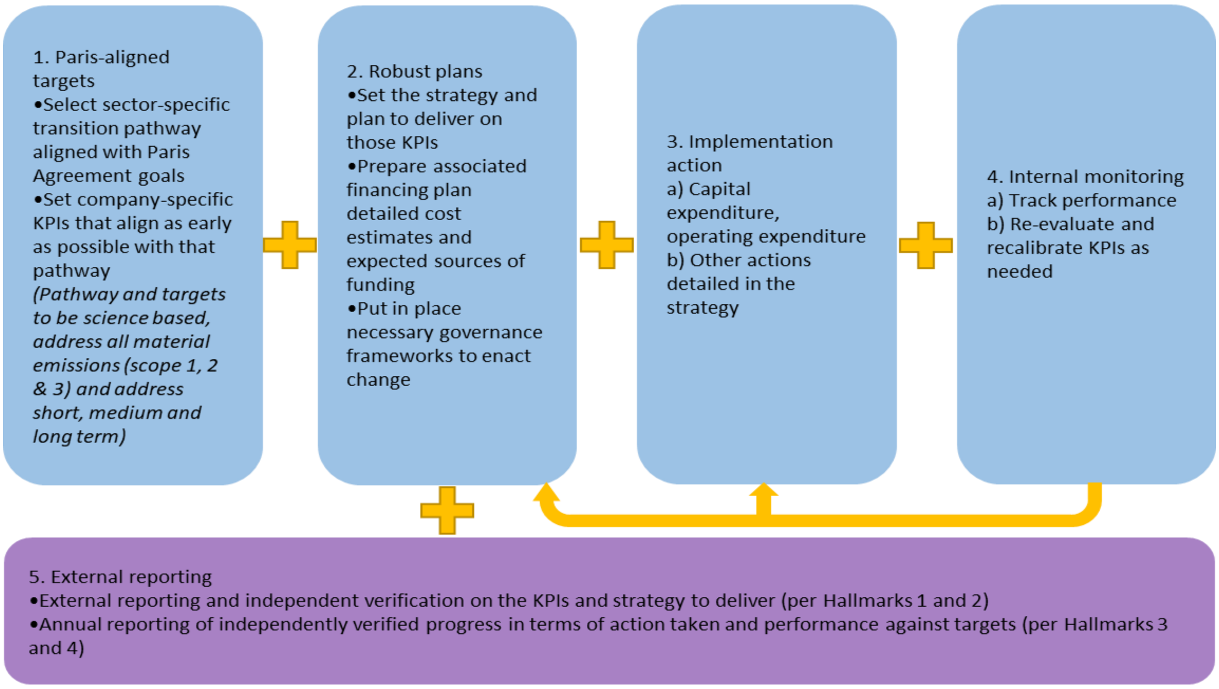
3.1.1 Guiding principles - General Corporate Purpose bonds

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 key performance indicators (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 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 4 of the criteria document for details.
2) Climate Change Adaptation and Resilience Component - addressing whether the facility/ies 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.

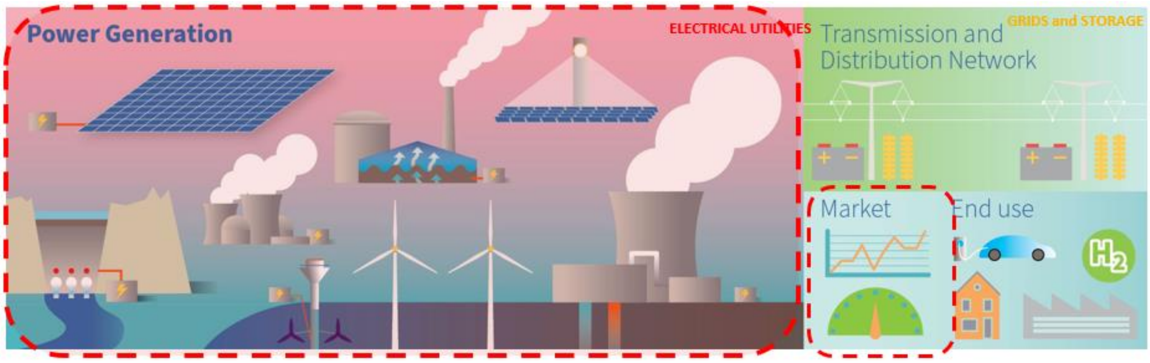
Table 3. Key principles for the design of Climate Bond Standard sector Criteria.

Principle	Requirement for the Criteria
Ambitious	Compatible with meeting the objective of limiting global average warming to a 1.5-degree 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 and 3 emissions should be addressed directly.
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 they 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.

Source: Climate Bonds Initiative

3.2 Entities and activities covered by the Electrical Utilities Criteria

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

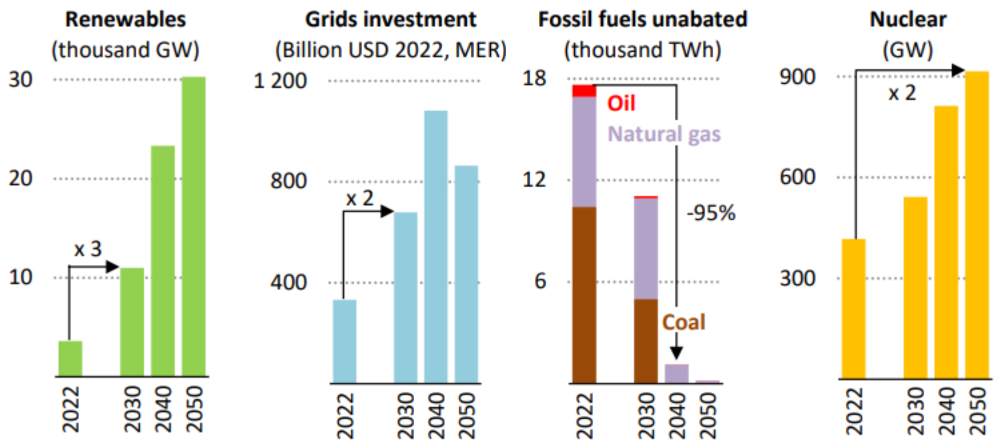


Source: Climate Bonds Initiative

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 in the IEA NZE scenario 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

Figure 16. Key milestones for the electricity sector.

These Criteria cover only the generation segment of the overall electricity supply chain framed in red in Figure 15, including the entity's electricity purchased from the grid for distribution or trading in the 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 or the electricity generation part of 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.

Assessment at the entity level would include all the material emissions related to the electricity generation and those related to the electricity purchased from the grid for distribution and/or trading in the market.

Emissions from heat or other fossil fuel business not related to electricity 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, and refining of fossil fuels.

Also, a commitment by the parent company of behalf of the parent group to phase-out the trading in fossil fuels by 2040 at the latest is required. See section 2.1, table 1 of the Criteria Document.

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.

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 fossil fuel emissions Scope 1 non-combustion 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 market	Scope 3 for electricity purchased from the grid for distribution or trading in the market
Fossil fuel activities other than electricity production	Commitment to no expansion of exploration, extraction, transport, or refining of fossil fuels Commitment of phasing-out trading of fossil fuels.	Scopes 1, 2, and 3

Source: Climate Bonds Initiative

3.2.2 Assets

Electrical Utilities Criteria is 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 already 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

Source: Climate Bonds Initiative

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 (coal, oil or fossil 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 or investments	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 or investments	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 or investments	No extension of fossil fuels is considered in ClimateBonds principles to align with 1.5-degree scenarios. It is not certifiable under these criteria

Source: Climate Bonds Initiative

3.2.3 Activities

The Electrical Utilities Criteria also include some UoP Certification for decarbonisation measures, setting out requirements for potential investments in specific mitigation projects within fossil fuel facilities.

These measures (see Table 7) 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 and/or fossil gas power plants. Even if these entities could not be eligible for an entity Certification, they can have access to Climate UoP bonds to reduce their GHG emissions.

Table 7. Activities eligible for certification.

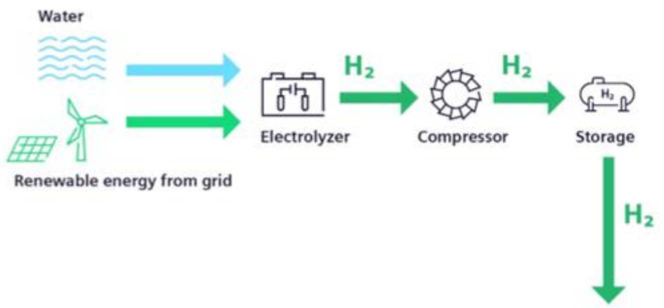
Power plants	Eligible Mitigation measures	Thresholds
Coal and Gas	CCS for CO_2 capture, transport, and storage CCUS for CO_2 capture, transport, and utilisation	Capture rate 90% Cross-cutting Criteria for CO_2 leakages and storage Utilisation Criteria
Coal and Gas	Cofiring with low-carbon synthetic fuels 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

Source: Climate Bonds Initiative

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.[18] To accomplish its mission, hydrogen must be green, 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)

[18] Net zero by 2050. A roadmap for the global energy sector. (IEA, 2021a)

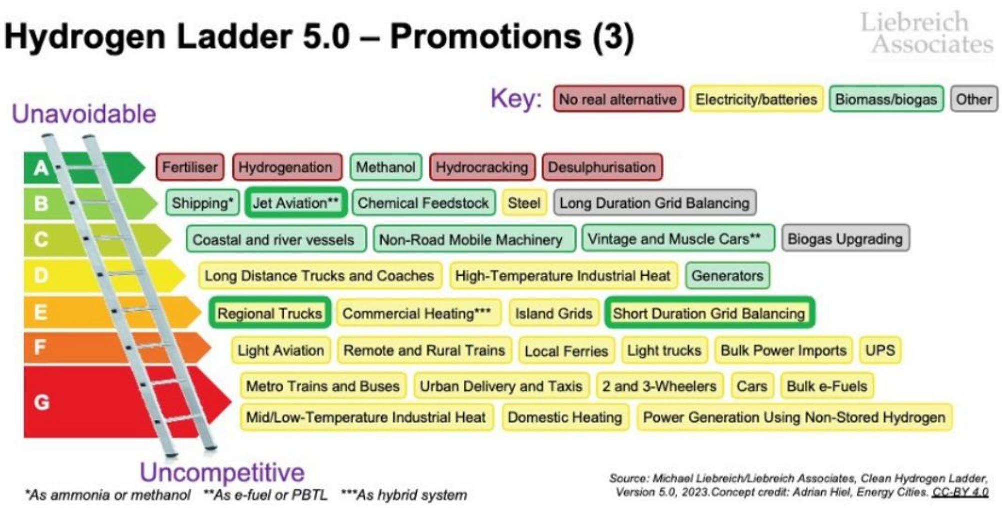


Source: Hyflexpower Project

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

Although there are investments and projects to demonstrate that renewable energy can serve as flexible means of storing energy which can be used to generate electricity, these processes commit substantial loses of energy and means cannibalize green electricity that can be used to electrify other high emitting activities.

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. (See Figure 18)



Source: Michael Lierbrich

Figure 18. Hydrogen Ladder.

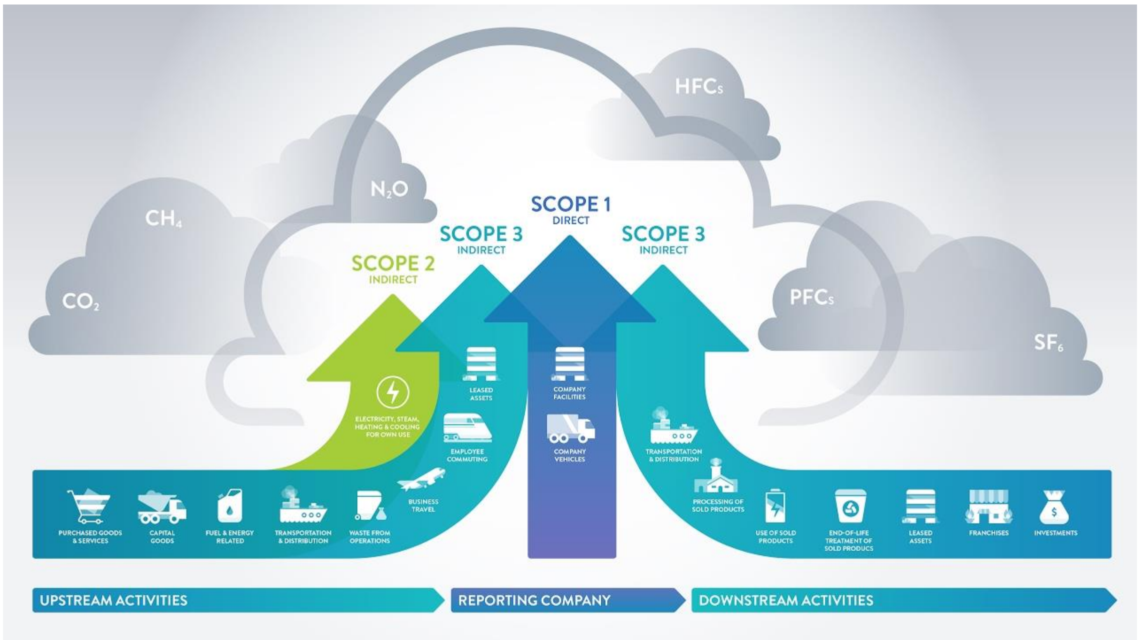
Hydrogen is thus recommended when direct electrification is not possible. However, TWG decided to accept it in electricity generation setting up high benchmarks for the cofiring rate due to the potential of substituting and moreover reducing fossil fuel use in the electricity sector. The hydrogen used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

Previous section reflects that the electricity value chain includes generation, transmission, distribution, and supply, Figure 2. 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 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 and/or heat, 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.[19] See Figure 19.



Source: The Greenhouse Gas Protocol

Figure 19. Scheme of the scopes related to Greenhouse Gases emissions.

Emissions from electricity generation are mainly scope 1 emission. Scope 2 emissions comes from electricity, steam, heating and/or cooling for own-use that is usually auto produced and fall under Scope 1 emission. Materiality thus of Scope 2 makes it irrelevant, although could be important in renewable energy with high temporal generation process or in a decarbonised entity. Scope 3 is important for entities that purchased and/or commercialise electricity and/or for those that also have gas trade 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 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 technologies will be included in further actualizations of these criteria. All these emissions fall over different scopes as appear in Table 8.

[19] GHG Protocol. (WRI/WBCSD, GHG Protocol, 2004)

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

Reported emissions in the criteria from the generation technologies.		
Technology	Reported emissions and its scope	Included in the entity's emission 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

Source: Climate Bonds Initiative

At the entity level a comprehensive approach of company's GHG emissions are assessed to certify the entity. To address all the emissions and other important environmental impacts, the entity's Certification includes:

- An emission intensity transition pathway against with the entity's average direct combustion emission intensity (including Scope 1 direct combustion emissions of the electricity generation portfolio and 3 from the electricity purchased from the grid for distribution or trading in the market) will be compared. Section 3.3.1.
- Compatible emission intensity thresholds for non-combustion emissions. The threshold will be differentiated for any plant operating at the time of certification (existing capacity) and for any plant operating after the time of certification (new capacity). Section 3.3.2
- Cross cutting criteria when using CCS/CCUS; hydrogen or biomass to cofire and for methane leakages in fossil gas plants.

Following sections detail the emissions included in the different assessment of the Criteria.

3.3.1 Scope 1 and 3 for the generation portfolio. Entity's emission intensity

Models and scenarios with net zero CO_2 emissions aligned with a temperature increase of 1.5-degree above preindustrial levels, assign Scope 1 to the electricity generation as they are usually global models that allocate emissions (Scope 1 emissions) to each sector of the energy system. These Criteria are based on the net zero emissions scenario by the IEA[20] and its emissions allocation.

As global models Scope 3 of certain sectors will be Scope 1 of other sectors. In the electricity value chain upstream emissions are covered by mining or sourcing process, and downstream emissions are contained in transmissions, distribution, and end-use sectors. Climate Bonds Standards present (Climate Bonds Electrical Grids and Storage) and future criteria, will tend to cover all the emissions scope.

[20] Net zero by 2050. A roadmap for the global energy sector. (IEA, 2021a)

Thus, the Electrical Utilities Criteria establish first a compatible CO_2[21] emission intensity transition pathway allowing the transition to net zero emissions by 2040, aligned to the goal of limiting global warming to 1.5-degree.[22]

The average entity's direct emission intensity must include direct combustion emissions and emissions related to the electricity purchased by the entity to be compared against this scope 1 transition pathway.

3.3.2 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 emission intensity transition pathway, the entity must meet further emission intensity thresholds which cover other non-combustion emissions of the generation technologies included in the portfolio.

This could include fossil fuels, nuclear energy along with renewables: solar, wind, hydropower, geothermal or bioenergy. The latter are considered as low-carbon electricity and their direct combustion emissions compute as 0 gr CO_2/kWh in the entity's direct emissions. Nonetheless, literature warns about the high risk of other non-combustion emissions of these technologies that sometimes, when not well designed, could be higher than fossil fuel combustions GHG emissions.[23]. See Table 9.

Table 9. GHG direct and indirect emissions by fuel.

GHG emissions (gCO_2e/kWh)[24]						
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

Source: IPCC AR5 Annex III

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 they will remain important emissions as the electricity system is decarbonised. At that moment, only remaining Scope 3 emissions will be the main emissions from the electricity sector.

Following sections explain the discussions around these emissions for each generation technology.

[21] 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). (WRI/WBCSD, Calcultation tool for direct emissions from stationary combustion , 2005)
[22] Net zero roadmap. A global pathway to keep 1.5-degree goal in reach. (IEA, 2023)
[23] IPCC AR5 Annex III. (Schlömer, IPPC AR5 Annex III: Technology-specific cost and performance parameters, 2014)
[24] IPCC AR5 Annex III. (Schlömer, IPPC AR5 Annex III: Technology-specific cost and performance parameters, 2014)

3.3.2.1 Solar and Wind

Wind and solar electricity generation contribute with 0 gCO_2e/kwh to the entity's generation portfolio. However, Scope 3 emissions could be important in a green power system.

IPPC LCA values for solar and wind generation, including emissions from equipment manufacturing and decommissioning, 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)[25]			IAM models (2050)[26]		
	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			

Source: IPCC and Nature Energy

Most net zero emissions scenarios 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.[27]

Actual version of the Criteria does not require assessment for Scope 3 emissions in solar and wind, waiting for future actualisations as the power sector is decarbonised.

3.3.2.2 Hydropower

Hydropower is essential to address climate change and reduce global carbon emissions. Its flexibility and storage capacity are fundamental to tackle climate change and can help variable other renewables when they are unavailable.[28] Emissions from hydropower derive from the reservoir (in storage projects). Physic and biological process can release important amounts of CO_2 and CH_4 to the atmosphere.[29] Materiality of other indirect emissions makes them irrelevant.

These emissions are considered Scope 1 emissions for the hydropower asset but not included in the entity's average emission intensity when the utility integrates hydropower generation in its portfolio. For this reason, emissions from hydropower generation must be assessed separately.

According to literature, non-combustions emissions range from 10,9 to 2210 gCO_2e/kWh in 2050.[30] Other studies vary these figures from 1 to 2200 gCO_2e/kWh in 2050 at actual data. Regarding this, assessments of GHG emissions in hydropower plants are essential to be compliant with climate goals of Paris Agreement (See Table 11)

[25] IPCC AR5 Annex III, (Schlömer, IPPC AR5 Annex III: Technology-specific cost and performance parameters, 2014)
[26] Nature Energy, Articles. Understanding future emissions from low carbon power systems. (Michaja Pehl, 2017)
[27] Net zero roadmap. A global pathway to keep 1.5-degree goal in reach. (IEA, 2023)
[28] International Hydropower Association (IHA)
[29] https://www.hydropower.org/blog/carbon-emissions-from-hydropower-reservoirs-facts-and-myths
[30] ClimateBonds Hydropower Criteria

Table 11. LCA today and future values for hydropower.

Lifecycle emissions (gCO_2e/kWh)						
Option	IPCC AR5 (2020)[31]			IAM models (2050)[32]		
	Min	Med	Max	Min	Med	Ma
Hydropower	1	24	2200	10,9	33,9	2210

Source: IPCC and Nature Energy

The criteria will set up thresholds to these hydropower emissions. See sections 4.2.2 and 4.2.3

3.3.2.3 Geothermal

Geothermal power plants emit CO_2 because of occurring non-condensable gases from the geothermal fluid.[33] 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 (See Table 12).

Table 12. LCA values for geothermal.

Lifecycle emissions (gCO_2e/kWh)			
Option	IPCC AR5 (2020)[34]		
	Min	Med	Max
Geothermal	6	3	79

Source: IPCC AR5 Annex III

The Criteria also establish thresholds for geothermal direct emissions. See sections 4.2.2 and 4.2.3

3.3.2.4 Bioenergy

Bioenergy net-emissions can be originated in different 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[35].

Table 13. LCA today and future values for bioenergy.

Lifecycle emissions (gCO_2e/kWh)						
Option	IPCC AR5 (2020)[36]			IAM models (2050)[37]		
	Min	Med	Max	Min	Med	Ma
Bioenegyr	130	230	420	66	248	1360

Source: IPCC and Nature Energy

Thus, emissions from bioenergy could be important and exhaust assessment is required for those entities including it in their portfolio. Sections 4.2.2 and 4.2.3 limits the bioenergy emissions and set the conditions for the assessments.

[31] IPCC AR5 Annex III. (Schlömer, IPPC AR5 Annex III: Technology-specific cost and performance parameters, 2014)
[32] Nature Energy, Articles. Understanding future emissions from low carbon power systems. (Michaja Pehl, 2017)
[33] ClimateBonds Geothermal Criteria
[34] IPCC AR5 Annex III. (Schlömer, IPPC AR5 Annex III: Technology-specific cost and performance parameters, 2014)
[35] Nature Energy, Articles. Understanding future emissions from low carbon power systems. (Michaja Pehl, 2017)
[36] IPCC AR5 Annex III. (Schlömer, IPPC AR5 Annex III: Technology-specific cost and performance parameters, 2014)
[37] Nature Energy, Articles. Understanding future emissions from low carbon power systems. (Michaja Pehl, 2017)

3.3.2.5 BECCS

Biomass combustion including CCS (BECCS) play an important role 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 power sector also participates with negative 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 scenarios.

Previous section detailed that bioenergy reports 0 gCO_2e to the global entity's emission 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 included negatively into the entity's emission intensity.

Table 14 resume the allocation of bioenergy emissions in the entity's emissions assessment.

Table 14. 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 from CO_2 captured.	Yes. Excluding emissions savings from CO_2 capture.

Source: Climate Bonds Initiative

3.4 Plants operating at the time of Certification (existing capacity) and post Certification (new capacity)

As the Certification focus on credible transition plans, considering not only the actual emissions but also futures climate targets, TWG estimated a difference between facilities operating at the time of Certification (existing capacity) and investments related to these facilities, and plants planned to operate post Certification (new capacity) and investments related to them. Also due to the differences of technologies that compose an electrical utility portfolio, separated requirements are established for each single generation technology, mainly differencing between fossil fuel power plants and low-carbon electricity.

3.4.1 Investments in existing capacity

When looking at existing carbon and gas power plants, the Criteria 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 young carbon plants still facing several years of operation.

For those existing fossil 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 recognise and is conscious of investments developing mitigation technologies for fossil fuel young power plants. Median age of coal plants, in Asia is around 10—15 years according to recent literature[38].

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, the Criteria include investments in existing fossil fuel power plants to retrofit them but establishing benchmarks for carbon capture rate in CCS/CCUS systems, and for the blended share of low-carbon fuels in cofiring **(including transport leakages),** to assure their alignment with the Paris agreement goals.

[38] Average age of existing coal power plants in selected regions in 2020. IEA, 2021

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 decarbonise 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 investments in 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 emission intensity, e.g. scope 1 emissions from hydropower or geothermal and scope 3 from solar, wind or bioenergy as explained in Section 3.3

3.4.2.1 Grid security

The power sector not only must decarbonise fast to arrive to a green economy but also assure the electricity supply in an electrified future. Decarbonisation rely on renewable energy but these technologies depend on several circumstances and are not always available when the electricity is needed. For that reason, dispatchable energy could be present in the utility's portfolio, sometimes, obliged by national regulations.

The Criteria want to recognise the problem of grid security and face the challenge of provide electricity in a decarbonised scenario. Although there is no inclusion on investments in new fossil fuel capacity, criteria allow the shifting of coal capacity by fossil gas complying with several conditions detailed in section 3.1.2 of the criteria document, box 5. (See also section 4.2.2.1 of this paper)

3.5 Accounting greenhouse gas emissions. Methodological notes

There are several methods for accounting for GHG emissions. Having a defined methodology is essential to lead to consistent assessments and improve the climate reporting. The Electrical Utilities Criteria follow usually the GHG Protocol methodologies including other specific methods for certain technologies (biomass or hydropower) due to the feasibility in measuring and reporting their emissions.

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

To account and report the entity's emission intensity for the electricity generation portfolio, the GHG Protocol is required.[39] 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.

As explained above in this paper, emissions from the electricity purchased from the grid for distribution or trading in the market should be added to the entity's emission intensity. For accounting these emissions, the criteria require the "location-based method" of the GHG Protocol Scope 2 Guidance.[40]. These emissions are in the Scope 3 of an electrical utility although the GHG Protocol document's name is Scope 2 Guidance. The reason is that these Scope 3 emissions of an electrical utility are usually scope 2 emissions for other entities.

Finally, if the portfolio includes CHP power plants, emissions will be allocated to electricity following the efficiency method of the GHG Protocol methodology.[41]

[39] (WRI/WBCSD, Calcultation tool for direct emissions from stationary combustion , 2005)
[40] GHG Protocol Scope 2 Guidance. WRI. (WRI, 2015)
[41] Allocation of GHG emissions from a combined heat and power (CHP) plant. WRI/WBCSD. September 2006

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 emission intensity Scope 1 and 3 emissions. To consider these emissions, Life Cycle Assessment (LCA) must be contemplated with 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 explained in ISO 14040 and 14044.

The boundaries for these LCA analysis are:

E1: Upstream feedstock related emissions (including sourcing[42], processing, transport and storage)

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

E3: Process and transport emissions[43]

3.5.2.2 Hydropower

Based on Climate Bonds Hydropower these Criteria propose methods to estimate direct emissions (Table 15).

Table 15. Methodologies required for GHG assessment of hydropower assets.

GHG Assessment		
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

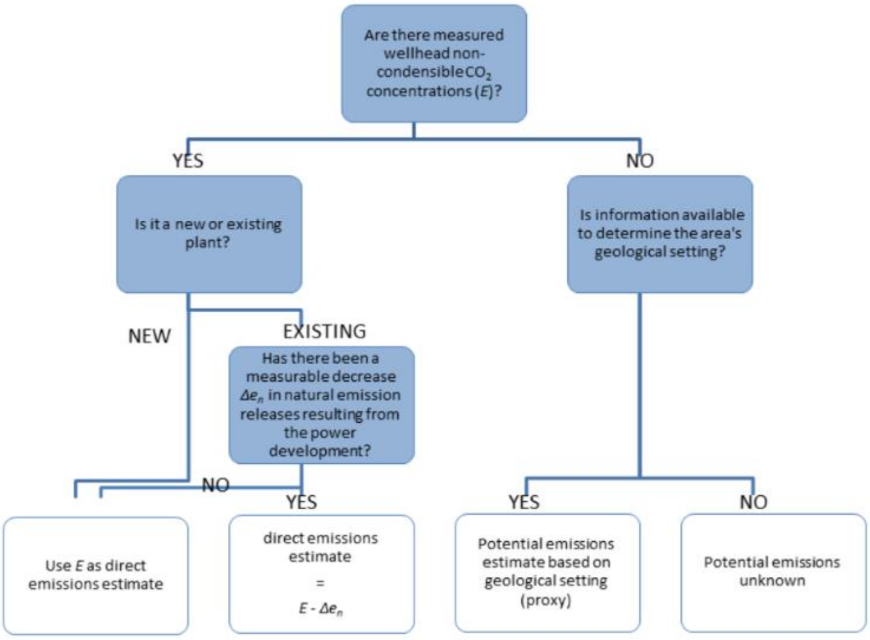
Source: Climate Bonds Initiative

3.5.2.3 Geothermal

Measure direct emissions from biological process are not always easily feasible. Based on ClimateBonds Geothermal Criteria, methods to estimate direct measures emissions are shown in Figure 20.

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

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



Source: ClimateBonds Geothermal Criteria

Figure 20. Methodologies required for GHG assessment of geothermal assets.

This process acknowledges the following practical considerations in determining direct emissions:

- Wellhead non-condensable gas estimates may not be available, and a proxy measure based on potential emissions determined from geological setting may be the only viable option.
- The release of direct CO_2 emissions due to the operation of the power station may result in lower natural release. This should be taken into account when these can be estimated. This canon l be achieved once the power station is in operation. It is proposed that this could be used in the case of retrofit of existing stations, or for re-applications for certification of facilities thar were initially rejected.

3.5.2.4 Bioenergy

Table 16 collects methods to account the emissions embedded in the production and delivery of biomass to be used as a fuel in electricity generation,

Table 16. 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.

Source: Climate Bonds Initiative

3.5.3 Addressing emissions from carbon-capture systems or cofiring (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 (production and transporting of the blended fuel for cofiring, CO_2 leakages in CCS and CCUS and/or methane leakages in fossil gas plants). According to it, additional limitations are set up in the criteria (See section 6 of the Criteria document).

- For transport, storage and/or utilization of CO_2 captured in CCS/CCUS systems, 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, taking into account the whole life cycle process. The criteria follow the relevant sector Criteria already developed by Climate Bonds Initiative (Hydrogen Production and Delivery) and establish conditions for bioenergy.
- 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 leading to a net-zero energy system. The electricity sector can get very close to net-zero emissions with technology that is currently available, by 2040.

4.1 Setting the emission intensity 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 emission intensity transition pathway. 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 International Energy Agency (IEA).

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-degree;
- 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.

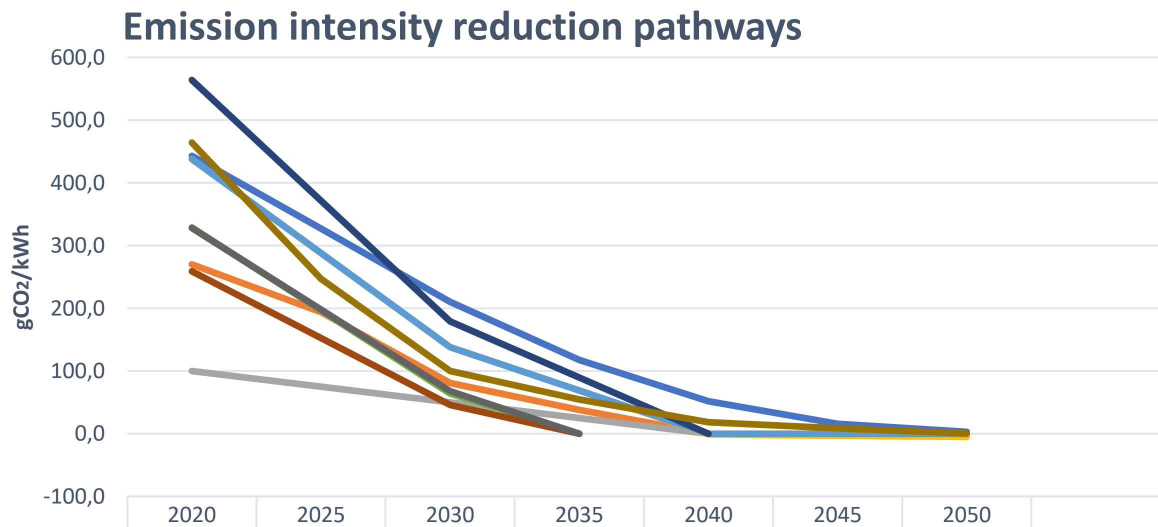
The options listed below were brought up for the consideration of the TWG for adoption in this Electrical Utilities Criteria:

- International Energy Agency (IEA) Net Zero by 2050 scenario;
- Transition Pathway Initiative (TPI) because of their geographical approach (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.

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. Figure 21 shows all 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: Climate Bonds Initiative

Figure 21. 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 eventual Climate Bonds Certification, provided that always compatible with ClimateBonds principle of keeping alignment with 1.5-degree. TPI non-OECD countries, the higher pathway in Figure 22 starts in 564 gCO_2/kWh, down to 179 gCO_2/kWh in 2030 and reach zero in 2040.

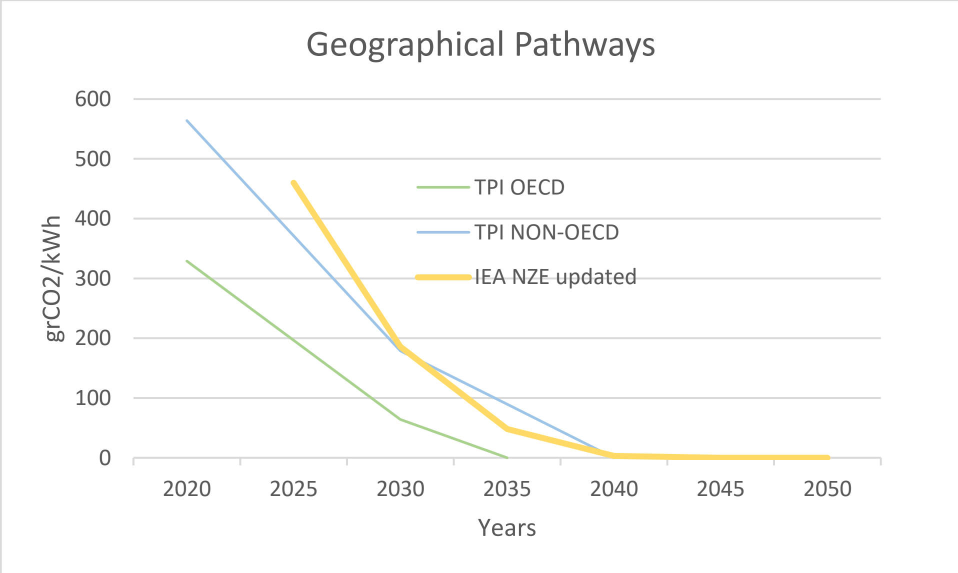
Many non-OECD countries grid's carbon intensities are over 600 gCO_2/kWh in 2022[44] and they are the most concerned in reducing their emissions. They can adopt transition plans to be aligned by 2030 and be included in an entity's Certification. For this reason, TWG decided to adopt the TPI non-OECD country approach based on IEA WEO 2020, 2021 data and the IEA NZE by 2050 emission 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 as much as possible, keeping alignment with the Paris Agreement.

The IEA Net Zero Roadmap 2023 updated.

When developing the criteria, the IEA updated its Net Zero Roadmap[45] and the figures for the grid's intensity. Figure 22.

[44] https://ourworldindata.org/grapher/carbon-intensity-electricity?tab=table
[45] Net zero roadap. A global pathway to keep 1.5-degree goal in reach. (IEA, update 2023)

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 avoiding also the estimations made to develop the TPI Non-OECD countries pathway.



Source: Climate Bonds Initiative

Figure 22. Different sector pathways studied.

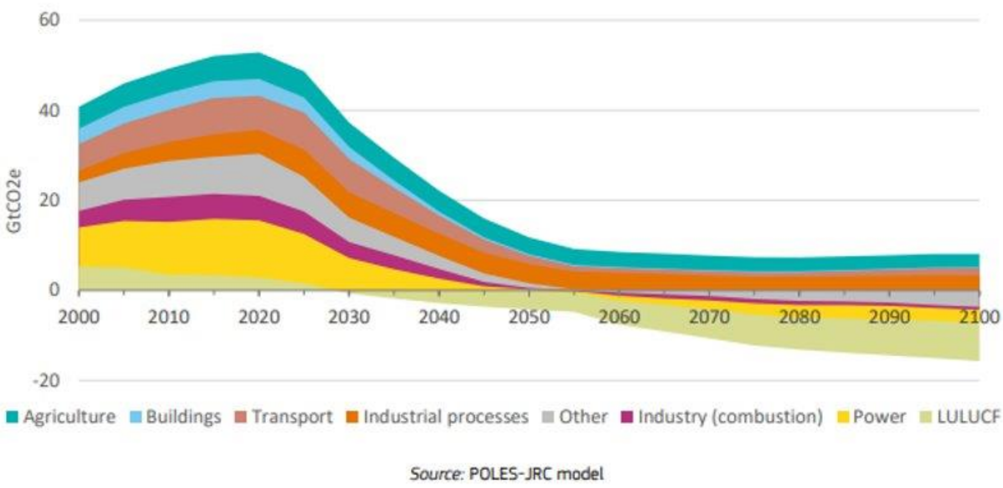
Table 17. Values for the different transition pathways studied.

Emission 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.
Source: Climate Bonds Initiative

4.1.2 Ending point

To keep the temperature 1.5-degree above the preindustrial levels, the global economy emissions must reach net zero in 2100, by 2050 for the energy sector. (see Figure 23). Net zero means that some sectors can contribute with negative emissions and compensate other hard to abate sectors. In Figure 23, the power and/or LULUCF sectors can equilibrate the emissions from transport or industry.



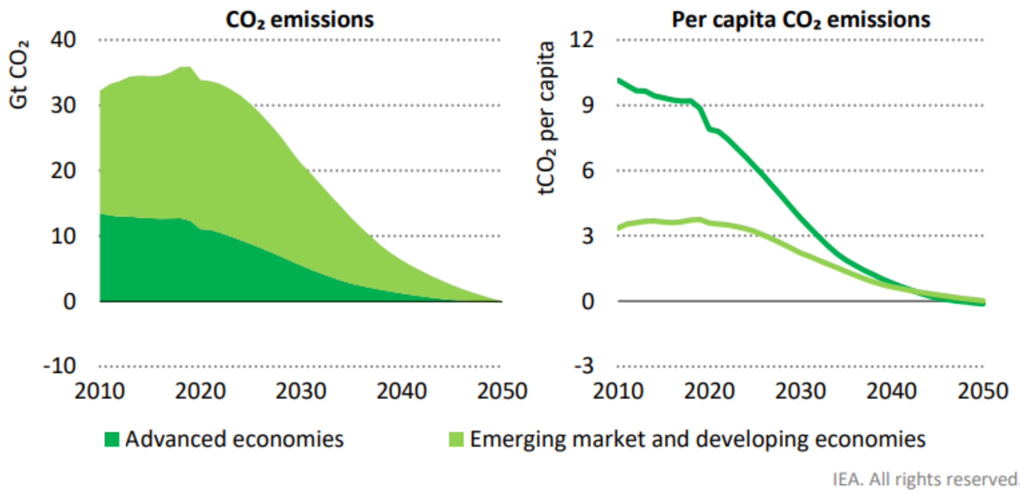
Source: POLES-JRC model

Figure 23. Global emissions in 1.5-degree scenario.

Due to the feasibility of reaching negative emissions in the power sector (with BECCS), some of the pathways studied set negative emissions for the whole electricity sector. TWG estimates that these negative emissions should not be asked to one electrical utility as these scenarios belong to the whole power sector, not to entities. Thus, the Electrical Utilities Criteria will set up 0 gCO_2/kWh when the adopted scenario could have negative figures for the emission intensity.

4.1.3 Geographical approach in the Electrical Utilities criteria

Although the IEA report offers only a global pathway for electricity generation, they underscore in its document a difference between advanced and emerging economies. The report underpins that net zero by 2050 globally doesn't mean net zero by 2050 for every country at the same time. In the IEA scenario and pathway, advanced economies reach net zero sooner to allow emerging and developing economies more time.[46] (See Figure 24)

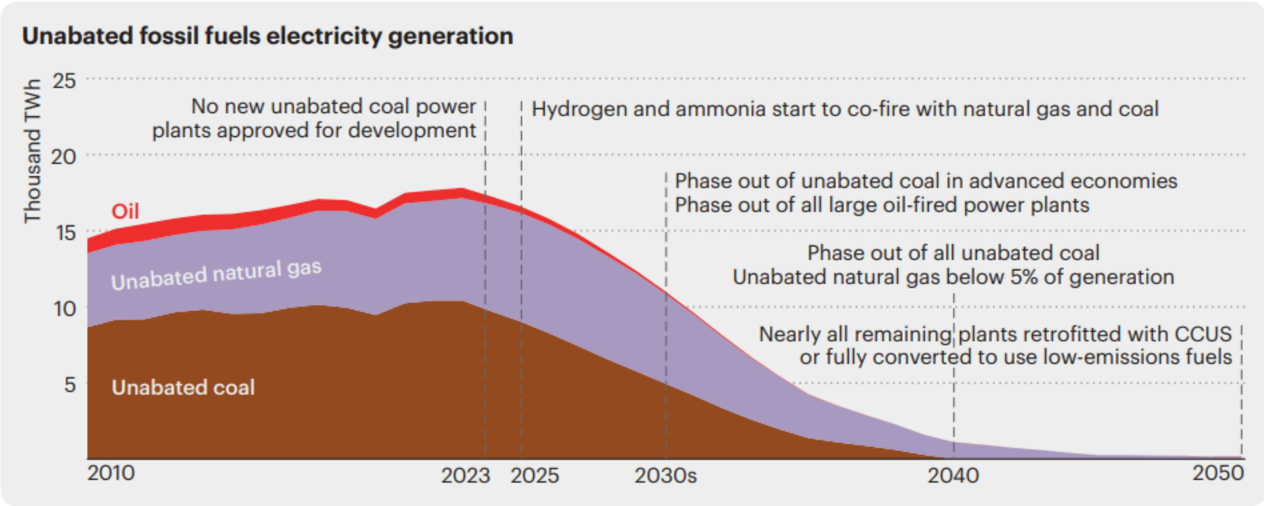


Source: Net Zero by 2050. A roadmap for the global Energy Sector. IEA, 2021

Figure 24. Global net-zero emissions in the NZE.

Advanced economies must phase out all unabated coal in 2030 while 2040 is the benchmark for all unabated coal. (Figure 25)

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



Source: Net Zero roadmap. A global Pathway to Keep the 1.5-degree Goal in Reach. IEA, 2023

Figure 25. IEA fossil fuel key milestones in the pathway to net zero.

The Criteria adopted the higher global pathway for emission intensity but will keep the geographical approach by setting 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.

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

In conclusion, TWG adopted IEA NZE approach, the higher global pathway, because of the entity's approach of the Criteria and trying to involve the maximum number of companies. But established afterwards separated geographical benchmarks for the fossil fuel capacity included in the portfolio.

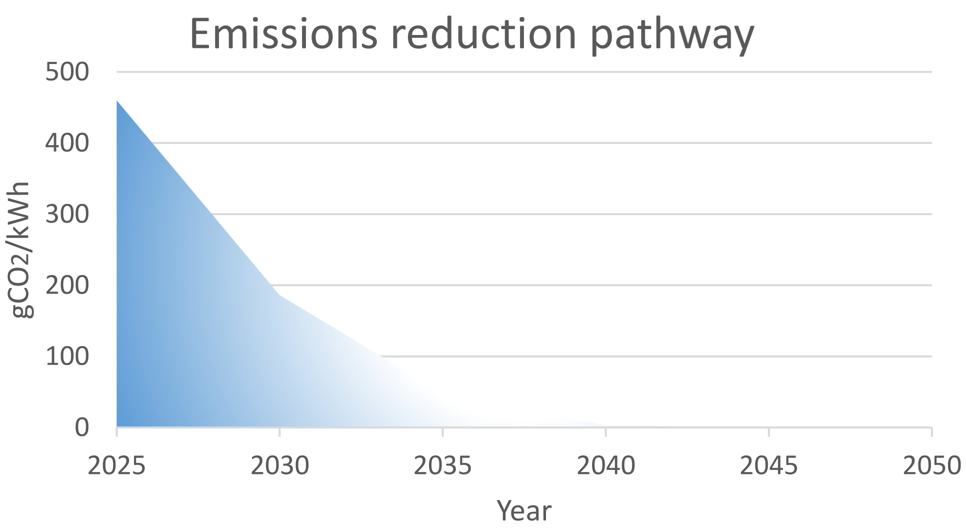
The International Energy Agency is an autonomous intergovernmental organization composed by 31 member countries and 13 association countries that represent 75% of global energy demand. IEA publishes annually its World Energy Outlook providing analysis and insights about the energy system across the world.[47] In May 2021 IEA published the Net Zero Roadmap[48] 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.

The IEA Net Zero Emissions by 2050 Scenario 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.[49]

IEA NZE emission intensity benchmarks for electricity generation are specified for years 2025, 2030, 2035, 2040 and 2050. Internal figures (2045) have been estimated. The applicant's average entity's emission intensity shall be compared against these values. As explained before, ClimateBonds do not consider negative emissions for the electrical utilities to be certified. Thus, the emission intensity pathway set up 0 emissions where the IEA pathway established negative figures (2050). This results in a decarbonization pathway illustrated in Figure 26¡Error! No se encuentra el origen de la referencia. and emission intensity thresholds given in Table 18.

[47] https://www.iea.org/reports/world-energy-outlook-2022
[48] Net zero by 2050. A roadmap for the global energy sector. (IEA, 2021a)
[49] Net zero by 2050. A roadmap for the global energy sector. (IEA, 2021a)



Source: Climate Bonds Initiative

Figure 26. CO_2 intensity of ClimateBonds electrical utilities criteria based on the IEA net zero emissions by 2050 scenario.

Table 18. Transition pathway of the Electrical Utilities Criteria values.

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

Source: Climate Bonds Initiative

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:

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

4.2.1 Meeting the sector-specific pathway

To be certified the average entity's emission intensity must meet the sector-specific pathway described in section 4.1 The entity's emission 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.[50]
- The location-based method of the Scope 2 guidance from the GHG Protocol.[51]

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

As described in section 0 the emission intensity transition pathway of the Electrical Utilities Criteria and the entity's average emission 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 emission intensity. Table 19 shows some of these non-combustion emissions values from recent literature.[52]

[50] (WRI/WBCSD, Calcultation tool for direct emissions from stationary combustion , 2005)
[51] GHG Protocol. Scope 2 Guidance. (WRI, 2015)
[52] Understanding future emissions for low-carbon power systems by integration of life-cycle assessment and integrated energy modelling. (Michaja Pehl, 2017)

Table 19: Low-carbon technologies GHG non-combustion emissions.

GHG emissions (gCO_2e/kWh)[53]			
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

Source: IPCC AR5 Annex III

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.

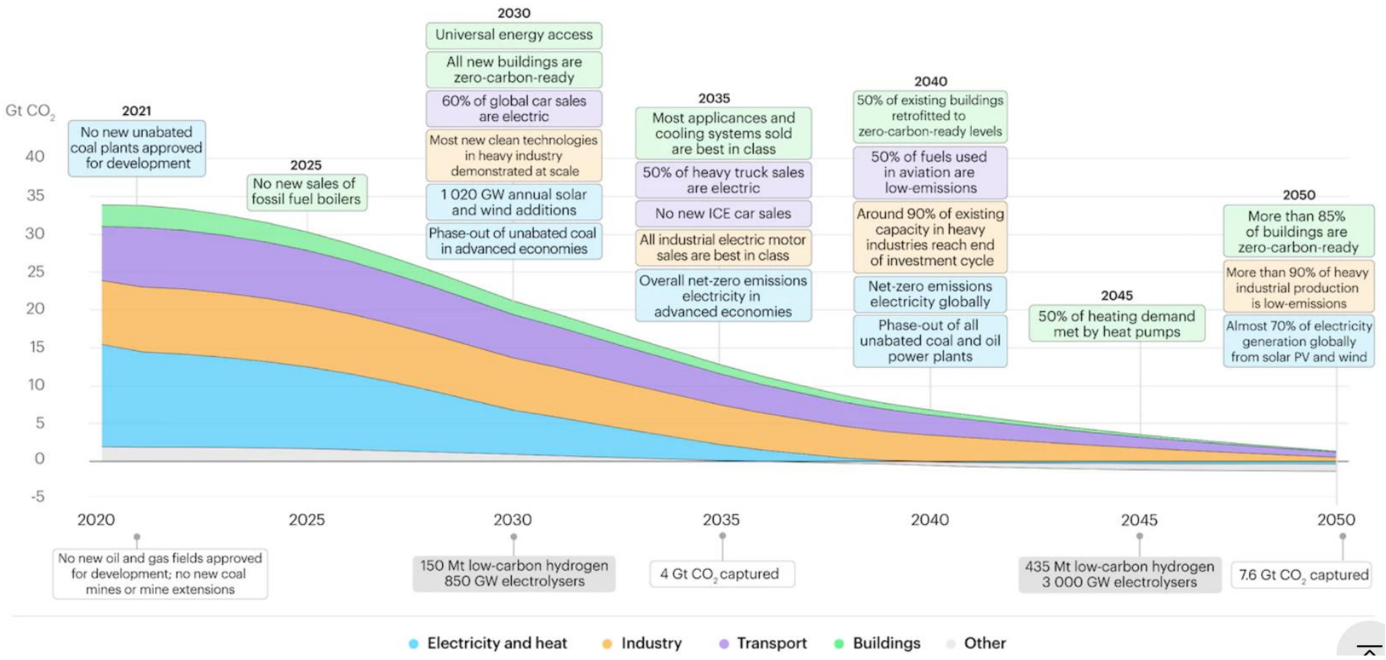
The criteria though, established benchmarks and thresholds for fossil fuel existing power plants in the portfolio as well as for low-carbon existing electricity generation.

4.2.2.1 Fossil Fuels based power generation.

One of the main goals of the criteria is to facilitate the phase-out of 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 benchmarks to phase out these plants following the trends of the IEA Roadmap to net zero emissions.[54] Figure 27.

[53] IPCC AR5 Annex III. (Schlömer, IPPC AR5 Annex III: Technology-specific cost and performance parameters, 2014)
[54] Net zero roadmap. A global pathway to keep 1.5-degree goal in reach. (IEA, update 2023)



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

Figure 27. Near term milestones and long-term milestones to the energy sector in the IEA NZE by 2050.

But as discussed in section 0, 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. Retrofits and blending are included in the and criteria but include some requirements to assure the full decarbonisation of the entity by 2050 and preventing again carbon lock-in. IEA scenario also considers this situation with some GW equipped with CCUS or cofiring with ammonia, hydrogen or biomethane. Table 20.

Table 20. Milestones and benchmarks for phased-out or retrofitting fossil fuel plants.[55]

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

As described in section 4.1 the emission intensity pathway is only one global pathway. The geographic differentiation, included in the IEA NZE by 2050, has been considered in this section with differencing the benchmarks for emerging and advance economies.[56]

[55] Net zero roadmap. A global pathway to keep 1.5-degree goal in reach. (IEA, update 2023)
[56] Climate Bonds Criteria follow the IEA definition of emerging and advance economies. (IEA, 2021a)

TWG decided next phase-out and retrofitting benchmarks depending on regions and fossil fuel to achieve net-zero emissions by 2050.

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

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 to 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.**
- Direct average emission 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.

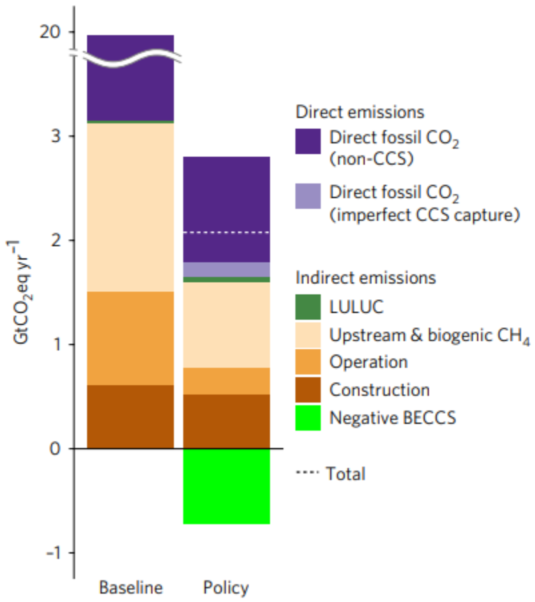
Safeguards:

- 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 hugely 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 GHG emissions of the electricity sector. However, emissions of some of these low carbon technologies can be important, overall, as the power sector becomes near zero direct emissions.

Figure 28 shows the share of indirect emissions in future energy scenarios. Whereas today indirect emissions are about 15% of total emissions, in the future they can count for more than 50%.



Source: Nature Energy, 2017.

Figure 28. 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 relevant emissions of an electrical utility.

Solar and Wind.

- No direct emissions and relatively low indirect emissions. No thresholds for these indirect emissions in the present version of the criteria, looking for future actualisations.

Hydropower and geothermal.

- Direct emissions could be important.[57] A GHG thresholds of **100 gCO_2e/kWh** is required in consistency with ClimateBonds Hydropower and Geothermal Criteria.
- Materiality of scope 3 emissions from 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;

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

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

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.[58]

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 emission intensity and is assessed separately. Indirect Scope 3 emissions can be important in biomass. For materiality reason, emissions 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. This value is **100 gCO_2e/kWh** and the Biograce II method is required to carry on the LCA analysis including:

Table 21. 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.

Source: Climate Bonds Initiative

Emissions related to the land use change are more difficult to measure and convert in a value of emission 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 4.5.2.

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 science-based recommendations, the economy system must shift the energy feedstock 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**.

[58] Understanding future emissions for low-carbon power systems by integration of life-cycle assessment and integrated energy modelling. (Michaja Pehl, 2017)

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 with 89% of renewables in electricity generation and 100% share of low-emissions sources in total generation. Table 22

Table 22. 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: Net zero road map. A global pathway to keep the 1.5-degree goal in reach. IEA, 2023

Solar and Wind.

For solar and Wind, the TWG, based on literature, established a transition pathway from actual values[59] to 2050 values.[60] The trajectory is shown in Table 23.

Table 23. Scope 3 indirect emissions threshold for solar and wind.

Scope 3 LCA Declining thresholds		
Year	Emission Intensity (gCO_2e/kWh) Solar	Emission 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

Source: IPCC and Nature Energy

As solar and wind assets cannot improve their emission 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 23 at the time of implementation.

[59] IPPC AR5. Annex III. (Schlömer, IPPC AR5 Annex III: Technology-specific cost and performance parameters, 2014)
[60] Understanding future emissions for low-carbon power systems by integration of life-cycle assessment and integrated energy modelling. (Michaja Pehl, 2017)

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.

Hydropower.

Non-combustion emissions from hydropower derive from reservoir and biological decomposition. Materiality of other indirect emissions makes them irrelevant but 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**, consistent with ClimateBonds Hydropower Criteria.

Hydropower also involves high environmental risk that need to be assessed. For any hydropower plant operating post certification the applicant must have undergo an assessment under the **ESG Gap Analysis Tool** developed by the International Hydropower Association (IHA) carried out by an **Accredited Assessor** and follow the requirements detailed in the ClimateBonds Hydropower Criteria.

Geothermal

Geothermal power plants emit CO_2 because occurring non-condensable gases from the geothermal fluid.[61]

The electrical utilities criteria, considering that historically, up of one third of existing geothermal plants shows an emission intensity lower than 50 gCO_2e/kWh[62], settled this threshold **of 50 gCO_2e/kWh** to new geothermal facilities, also in consistency with the hydropower scope 1 threshold.

This limit tries to ensure that other low-emitting renewables are not displaced when possible.

Geothermal power plants also have important environmental impacts including:

- Air emissions, e.g. ammonia and hydrogen sulphure;
- Some degree of surface water extraction which may be returned to water bodies with increased heat content;
- Potential to contaminate groundwater by the presence of hazardous chemicals, e.g. arsenic, in geothermal fluid;
- Reinjection or disposal of condensate which is more chemically concentrated than the original fluid;
- Contaminants from drilling activities.

All of these impacts are generally considered manageable with proper procedures and regulation. In addition, Enhanced Geothermal Systems (EGS) raises concerns regarding contamination of surface waters or soil; and noticeable earthquakes which, very occasionally, damage property (induced seismicity). Experts believe that earthquake damage can be avoided with proper monitoring. There are also concerns that EGS has high water requirements and may be unsuitable in water-stressed areas.

All projects associated with Climate Bonds must comply with the environmental regulations of the host country. In addition to this requirement, we propose additional criteria to enhance EHS and social performance for all projects, and specifically for EGS projects. The IFC[63] has detailed guidelines for managing effluents, air emissions, solid wastes, and water extraction which projects would be required to follow. This would provide extra assurances where national regulation is lacking or insufficient.

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.

IEA analysis suggest average emission intensity of new-build electricity capacity should be ~ 50 gCO_2e/kWh over the period 2020-2040. The Electrical Utilities Criteria, in consistency also with the other non-combustion threshold for hydropower or geothermal, accept this limit for GHG emissions for biomass used to generate electricity of **50 gCO_2e/kWh.**

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[61] ClimateBonds Geothermal Criteria
[62] ClimateBonds Geothermal Criteria
[63] As set out in IFC environmental, health and safety guidelines for geothermal power generation available on the IFC website. https://www.ifc.org/en/insights-reports/2000/general-environmental-health-and-safety-guidelines.

Notice that this limit is compatible with a 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 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

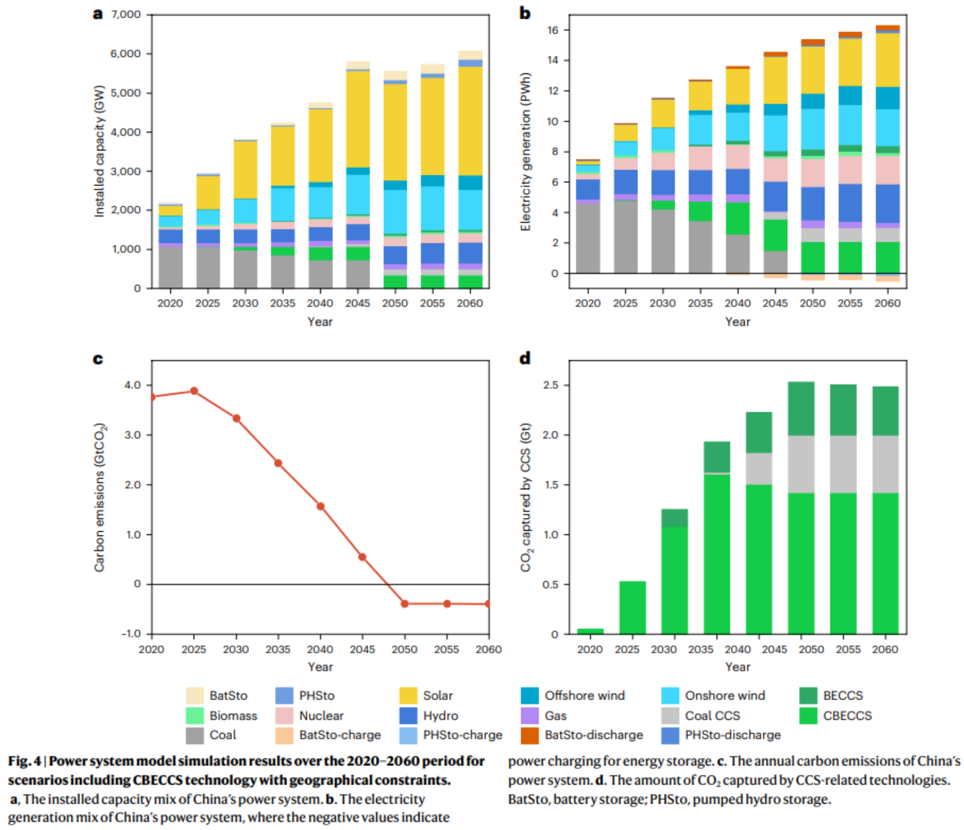
Capital investments in decarbonisation measures differs from an investment that would finance the whole facility in that it involves investments that are focused on the measures or specific areas of improvement within the asset. Thus, when criteria are fulfilled, certification is granted to the measure itself and not the facility. Criteria for investments in decarbonisation measures only cover fossil fuel power plants as renewables do not have direct GHG emissions.

First thought of the TWG agreed to avoid any 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. Thus, the first criteria adopted the decisions of only establishing threshold for phasing-out data of coal and fossil gas power plants.

However, some mitigation technologies as cofiring with low-carbon fuels or installation of CCUS systems are now in development and so, included in the future performance of the power system.

Some countries whose generation mix is dominated by young coal o fossil gas plants trust in these technologies to decarbonise their power system. TWG didn't want to consider them because of some technical and thermodynamical reasons: no mature technologies, reduction of generation efficiencies, leaking problems and energy intensive for CCUS.

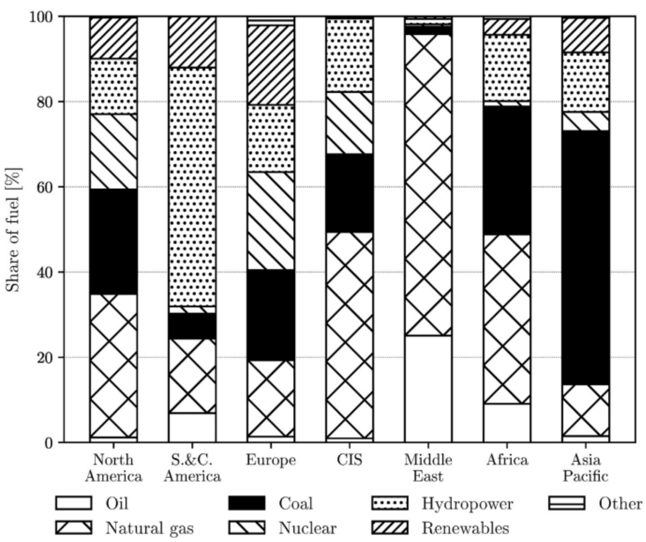
Nevertheless, for these countries, many of science-based scenarios include CCUS, BECCS and cofiring in their assumptions to achieve the goals of Paris Agreement. An example of a Chinese model can be seen in Figure 29.



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

Figure 29. China's power system model situation results over the 2020-2060 period.

All these countries basing their electricity systems in young coal or fossil gas power plants need to look for some mitigation technologies to reduce their emissions. Figure 30 shows a regional distribution of fuel sources in power generation.



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). Japan government is supporting four critical ammonia projects to demonstrate 50% ammonia-coal cofiring by 2030[64] and a gas turbine with 100% H_2 has been achieved recently.[65]Even Europe in investing in H_2 turbines but in these case for energy storage solutions.

Table 24. Projects in cofiring aiming to achieve 100% of low-carbon fuels in 2040.

TECHNOLOGY	MATURITY	CHALLENGES
Ammonia-carbon cofiring: Coal power cofired with ammonia. (JAPAN)	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: First fully integrated power-to-hydrogen-to-power industrial scale power plant.	Achieved in 2023	An industrial gas turbine has been fed with 100% hydrogen produced from renewable energy in France. The turbine's capacity is 12 MW.

Source: Climate Bonds Initiative

All these considerations made TWG accept mitigation measures in fossil fuel plants with benchmarks in cofire blending ratios and CO_2 capture rate in CCS/CCUS systems as well as conditions in the transport, storage and utilization of CO_2 captured. Furthermore, as the facility's emission 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.

The limits have been set up to achieve the 2040 reduction targets that will allow the sector to contribute to keeping global warming at 1.5-degree.

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 emission 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:

- Achieve a cofiring rate of 100%;
- Cross-cutting criteria setting up limits on GHG emissions for processing and transport of low-carbon fuels.

Fossil fuel facilities with CCS/CCUS equipment:

- Achieve a carbon capture rate of 90%;
- Cross-cutting criteria setting 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.

[64] 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
[65] 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 this 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 certified 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 power assets that the Electrical Utilities Criteria would like to address. Also, some emissions related to measures proposed in these criteria fall out the scope of direct emission and these cross-cutting requirements will include them in the assessment needed, as for entity's certification and SLD's as for assets and UoP.

These cross-cutting criteria cover:

- Criteria for GHG emissions related to processing and transportation 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 transportation 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.[66] Further background information for the development of the hydrogen criteria is available in the Criteria for Hydrogen Production and delivery Background paper.

The GHG thresholds for hydrogen Production and Delivery can be seen in Table 25.

Table 25. Hydrogen carbon intensity thresholds.[67]

Asset Type	Criteria			
	2023	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 $kgCO_2e/kgH_2$

Source: Climate Bonds Initiative

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[68], 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;

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

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

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

E6: Carbon emissions captured;

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).[69]

4.5.2 Additional criteria when using biomass as a fuel.

The substitution of coal or fossil gas by 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.

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: discussions lead the TWG to establish a Scope 3 threshold for the bioenergy feedstock of **5.5 gCO_2e/MJ biomass**. Table 26 shows the emissions boundaries for GHG assessment and the methodology required.

Table 26. 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.

Source: Climate Bonds Initiative

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 5.3 and Appendix B at the ClimateBonds Electrical Utilities Criteria Document;
- Reducing the risk of Indirect Land Use Impact (iLUC). Section 5.3 and Appendix B at the ClimateBonds Electrical Utilities Criteria Document.

Adaptation and Resilience address that:

- The source feedstock is compliant with established and approved best practice standards. Section 5.3 at the ClimateBonds Electrical Utilities Criteria Document;
- The applicant identity food risk and have plan to address them. Section 5.3 at the ClimateBonds Electrical Utilities Criteria Document;
- A climate risk assessment is conduced. Section 5.3 at the ClimateBonds Electrical Utilities Criteria Document.

[69] 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.[70] 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 mainly to closed systems as in geological storage since this is the one with the largest storage life span.[71]

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 utilisation requirements.

[70] 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

[71] According to the IPCC, well-selected, well-designed and well-managed geological storage sites can maintain CO_2 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

Table 27. Criteria for CO_2 transport, storage, and utilisation.

Component	Requirements
Transport[72]	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[73]	1. Characterisation and assessment of the potential storage complex and surrounding area, or exploration[74] 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[75] 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.

Source: Criteria based on EU taxonomy[76]

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

Methane is a GHG with a high GWP of 28, following fifth assessment report by the IPPC.[77] Although fossil gas has lower combustion emissions than carbon plants, recent studies[78] 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.[79]

[72] 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)

[73] 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

[74] "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

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

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

[77] Climate Change 2014. Synthesis Report. (Change, 2015)

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

[79] Electricity generation from fossil gaseous fuels

5 An overview of the criteria for adaptation & resilience

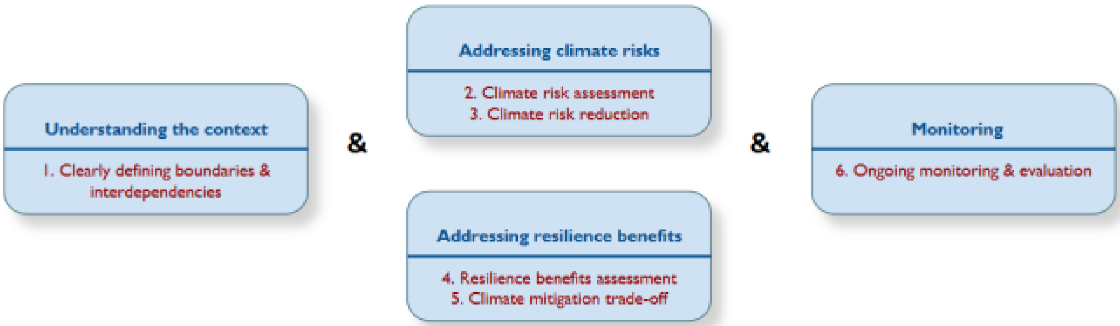
The IPCC defines adaptation as: "The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects".[80]

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 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.[81] Figure 31 gives an overview of the six principles for resilience. From the perspective of an entity, the Climate Adaptation and Resilience Criteria aim to assure that the entity will be able to provide its commodity taking into account the hazard risks associated with climate change without harming the resilience of other sectors or subsectors eventually connected within the boundaries of the entity.



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.

[80] 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

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

In the case of an entity owning and operating several assets, spread geographically an Adaptation and Resilience assessment of each asset may involve additional difficulties to assess the Criteria for each plant and for the whole entity as the addition of all the individual assets.

Adaptation and Resilience Criteria for entity's certification will ask the entity to hold and assessment considering the climate hazards to which will be exposed and vulnerable over its operating life including the measures identified and the plan to implement them to manage and mitigate the risks identified. The Criteria also requires ongoing monitoring and evaluation of the relevance of the risks and resilience measures and related projects adjustments as needed.

5.2 Practical considerations for this Component

Leverage existing tools

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.

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.

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 30 years on average.[82]

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.

Wider environmental and social risks

[82] Energy sources and power plants lifetime by type | Statista

They 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.

5.3 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.[83]
- 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

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

Definitions

Adaptation and Resilience Criteria: Rules or principles for evaluating and preventing physical climate risk and assessing the vulnerability of an asset or entities to the effects of climate changes, which aim to reduce of this vulnerability. These rules generally guarantee that the activities don't do any significant 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, which 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, which 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 complies 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-degree 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 protection, while resilience is the ability to adapt and recover from the impacts of climate change.

Climate targets: Limits established by scientists and policymakers 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 expresses 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: The process of keeping CO_2 in underground geologic formations, usually pressurising the carbon dioxide until it becomes a liquid.

CO_2 transport leakages: Undesired CO_2 losses to the atmosphere during the transportation from where it was sequestered to where stored.

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 processes, strategies, or indications to be implemented in the energy sector aiming to reduce emissions and the use of fossil fuels. They involve measures such as shifting the energy mix, increasing energy efficiency, utilising the circular economy, or managing demand for energy.

Decarbonise: Move 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: The final stage of the electricity value chain, where 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 originates from renewable sources, it can help to decarbonise the economic system.

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

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

Emissions target: Limits that scientists set for the quantity of emissions to be aligned with the Paris Climate Agreement.

Energy utility: 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 bond where 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 generally 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 Technical Working Group (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: A methodology for assessing or accounting for environmental emissions associated with all the stages of the life cycle of a product or process, from the initial design phase to disposal or recycling.

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

Low-carbon technologies: Technologies referred to as innovative technical solutions that are characterised by a low-emission intensity, compared to state-of-the-art alternatives. Considered best-in-class technologies with a focus on environmental impact, examples of electricity utility low-carbon technologies would 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 processes implemented to reduce and curb greenhouse gas emissions.

Natural gas: A naturally occurring mix of gaseous hydrocarbon consisting primarily of methane in addition to other alkanes.

Negative emissions: Processes in which more CO_2 is removed and stored from the atmosphere than added to 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 sectors by various actors, and by when, for the world to achieve net-zero energy-related and industrial process CO_2 emissions by 2050. It also aims to minimise methane emissions for the energy sector.

Net-zero emissions: A situation where global greenhouse gas 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 for 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 other 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 adopted by 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 generally refer to the emission intensity.

Scenarios: Science-based plausible descriptions of how the future may unfold based on several assumptions (economic, social, behavioural, technological), which generally form part of a set of alternative pathways. Examples are the IEA net zero emissions scenario and the NDC Scenario.

Scope of emissions: Scope 1, 2 and 3 are terms devised by the GHG Protocol to categorise the different sources of carbon emissions an organisation creates in its own operations, and in its wider value chain.

Standards Criteria: Established principles to evaluate processes, assets, or entities aiming to achieve benchmarks, targets, or goals.

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 key performance indicators (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 originate 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 recognised experts from academia, international agencies, industry, and NGOs convened by Climate Bonds. The TWG develops the Sector Criteria, which are 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 scientists and policymakers to develop a plan to achieve climate targets.

Unabated fossil fuel: Fossil fuels, the use of which continues without any intervention to 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	Global Energy Transition Lead Climate Bonds Initiative		
TWG Members			
Andy Ross	Head of Content Excellence & Quality Assurance CDP	**Shuling Rao**	Senior Researcher, The Institute of Finance and Sustainability
Catalin 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 University
Ryan Foelske	Manager on Utility Transition Finance Team, RMI		

Participation in IWG meetings does not necessarily reflect endorsement of the Criteria and serves to provide critical feedback on the usability-focused consultation process.

IWG Members			
Adrian Ghita	Executive Director Romanian Energy Efficiency Fund	**Lazeena Rahman**	Senior Energy Finance Specialist – Energy Transition Mechanism ADB (Asia Development Bank)
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