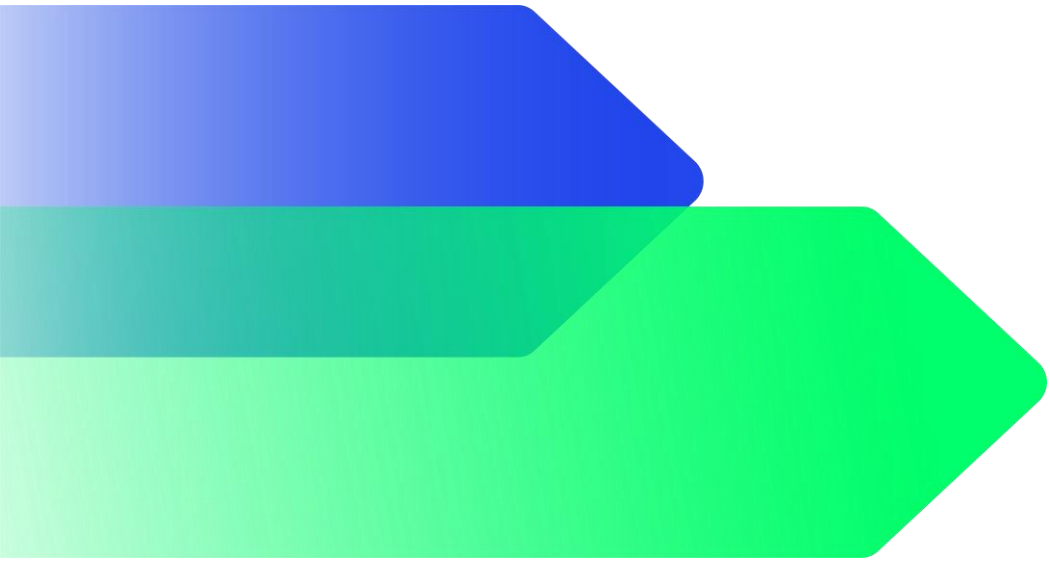
CARBON TRUST

REPORT

AIB Renewable Energy Impact Assessment Methodology

For eligible Renewable Energy projects.

November 2023



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Abbreviations and glossary

Avoided carbon emissions	The avoided carbon emissions of the underlying properties when comparing them against a baseline of the average property (by sector and geography), on an annual basis. The avoided emissions are a result of these properties being more efficient and less carbon intensive than the average property (by sector and geography)
Baseline	The average energy and carbon intensity of properties by sector and geography, informed by the SEAI and EPC datasets
Eligible Green Project Portfolio	Eligible green bond use of proceeds as outlined in the Framework
Framework	AIB's green bond framework outlines its green bond processes and procedures for (1) Use of Proceeds, (2) Process for Project Evaluation and Selection, (3) Management of Proceeds, and (4) Reporting
Solar PV	Solar Photovoltaics
CSP	Concentrated Solar Power
OM	Operating Margin
EF	Emissions Factor
CM	Combined Margin
HVDC	High Voltage Direct Current
GHG	Greenhouse gases
GWP	Greenhouse Warming Potential
SF6	Sulfur Hexaflouride, a commonly used insulation gas that is a powerful GHG

Introduction

Who We Are

Our mission is to accelerate the move to a decarbonised future. We have been climate pioneers for more than 20 years, partnering with leading businesses, governments and financial institutions globally. From strategic planning and target setting to activation and communication - we are your expert guide to turn your climate ambition into impact.

We are one global network of 400 experts with offices in the UK, the Netherlands, South Africa, China, Singapore and Mexico. To date, we have helped set 200+ science-based targets and guided 3,000+ organisations in 70 countries on their route to Net Zero.

AIB Overview

Aligned with its sustainability strategy, Allied Irish Banks ("**AIB**") intends to issue green bonds to finance and / or refinance loans that meet the requirements as described in the AIB Green Bond Framework ("**Framework**")[1]. The objective of the Framework, and subsequent green bonds issued from it, is to fund projects or assets that mitigate climate change by reducing emissions, protect ecosystems, or otherwise have a positive environmental impact. The Framework has been aligned with the ICMA Green Bond Principles and has received a Second Party Opinion from Sustainalytics.

The ICMA Green Bond Principles are a set of voluntary guidelines that recommend transparency and disclosure and promote integrity in the development of the green bond market by clarifying the approach to issuing a green bond. The Framework, therefore, has four key components:

1. Use of Proceeds
2. Process for Project Evaluation and Selection
3. Management of Proceeds
4. Reporting

For each green bond issued, AIB asserts that it will adopt (1) Use of Proceeds, (2) Process for Project Evaluation and Selection, (3) Management of Proceeds, and (4) Reporting, as set out in the Framework.

AIB, at its discretion but in accordance with the Green Bond Principles, will allocate the net proceeds of the Green Bonds to an eligible loan portfolio of new and existing green loans ("**Eligible Green Project Portfolio**"). The Eligible Green Project Portfolio is to be financed and/or refinanced in whole or in part by an allocation of the bond proceeds.

[1] AIB Green Bond Framework (2023)

Renewable Energy assets

- Loans to finance or refinance equipment, development, manufacturing, construction, operation, distribution and maintenance of renewable energy generation. Eligible renewable energy sources include:
    - **Solar Energy**: Photovoltaics (PV), Concentrated Solar Power (CSP) and Solar Thermal facilities.
    - **Wind Energy**: Onshore and offshore wind energy generation facilities and other emerging technologies
    - **Geothermal Energy**: Geothermal power plants with life cycle emissions lower than 100g CO_2e/kWh
    - **Power Storage Facilities**: Compressed air, flywheels, synchronous condensers and batteries
    - **Energy Transmission Infrastructure**:
        i. Interconnectors between transmission systems provided that the systems meet one of the following criteria[2]:
            1. The system is the interconnected European system, i.e., the interconnected control areas of Member States, Norway, Switzerland and the United Kingdom, and its subordinated systems.
            2. More than 67% of newly enabled generation capacity in the system is below the generation threshold value of 100gCO_2e/kWh measured on a life cycle basis in accordance with electricity generation criteria, over a rolling five-year period.
            3. The average system grid emission factor, calculated as the total annual emissions from power generation connected to the system, divided by the total annual net electricity production in that system, is below the threshold value of 100gCO2e/kWh measured on a life cycle basis in accordance with electricity generation criteria, over a rolling five-year period.

For this assessment, the above categories are split between energy generation (Solar Energy, Wind Energy, and Geothermal Energy), Power Storage Facilities ("**PSF**") and Energy Transmission Infrastructure.

[2] AIB does not to intend to finance and/or refinance any interconnector dedicated to creating a direct connection or expanding an existing direct connection between a substation or network and a power production plant that is more greenhouse gas intensive than 100gCO2e/kWh measured on a life cycle basis.

Methodology

Reporting Principles

Reporting of the environmental impacts of green bonds is evolving and is a relatively new concept. However, AIB is committed to reporting on the method used to calculate the avoided GHG emissions for its Green Bond Framework based on:

- *PCAF's The Global GHG Accounting and Reporting Standard Part A: Financed Emissions (2022)[3],*
- *IFI GHG Accounting for Grid Connected Renewable Energy Projects (April 2022)[4];*
- *Green Bond Principles, Voluntary Process Guidelines for Issuing Green Bonds (2021; June 2022 Appendix 1)[5];*
- *Climate Bonds Standard V3.0[6],*
- *Green Loan Principles (Feb 2021),*
- *ICMA Harmonised Framework for Impact Reporting (2023)[7], and,*
- *WBCSD Guidance on Avoided Emissions[8]*

AIB follows the key recommendations outlined in the Green Bond Principles, with external reviewers present across their reporting process. In addition, AIB is committed to reporting greenhouse gas emissions in accordance with the five principles contained within the Greenhouse Gas Protocol, namely relevance, completeness consistency, transparency, and accuracy.

In accordance with the principles of reporting described above, AIB commits to transparent disclosure of any assumptions and estimations used in the calculation of its reporting framework.

Scope of Calculations and Reporting

AIB intends to report the expected or actual quantitative environmental impact of RE assets it finances or co-finances through its green bond issuances. The reporting includes the estimated reduction or avoidance of greenhouse gases ("**GHGs**") estimated to have occurred from its RE holdings. AIB also evaluates other indicators that are appropriate to report for environmental impact and performance, such as energy generation figures by type. At this stage, social and other economic indicators are not within the scope of the green bonds in question. Governance indicators are also not in scope.

AIB undertakes to report the environmental impact of projects it finances or co-finances through its green bonds based, where possible, on the actual environmental performance of the asset. Where this is

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[3] PCAF (2022). The Global GHG Accounting and Reporting Standard for the Financial Industry. second edition

[4] AHSA-001 - IFI Approach to GHG Accounting for Renewable Energy Projects

[5] ICMA (2021 (with June 2022 Appendix I)), Green Bond Principles, Voluntary Process Guidelines for Issuing Green Bonds

[6] Climate Bonds Standard V3.0 | Climate Bonds Initiative

[7] Handbook Harmonised framework for impact reporting (June 2023)

[8] WBCSD Guidance on Avoided Emissions (Mar 2023)

not possible, expected performance is used. The reporting includes both green indicators and resulting emissions reductions or avoidance, both of which require assumptions and calculations. The reporting is based on the net-benefit resulting from the asset in a given period of operation, rather than the gross emissions change before or after the life of the asset or project.

Calculations include project-by-project impacts, as well as aggregated results across the portfolio of assets financed or co-financed with the proceeds of AIB's green bonds. Environmental indicators are attributed to AIB on a project-by-project basis, based on the current percentage share financed (where applicable) and disbursed by the bank. The reporting is undertaken on an annual basis, covering the previous 12-month period and considers any dynamic changes in the assets financed or co-financed that occur from one reporting period to another.

In accordance with the principles of reporting described above, AIB has, and continues to commit to transparent disclosure of any assumptions and estimations used in the calculation of its reporting framework.

Scope of Energy Generation Impact Assessment

Renewable energy generation is a low GHG emission energy source and has an environmental benefit in replacing energy generated from fossil fuel-based power generation. Energy generated from renewable sources reduces the demand for fossil fuel sources and therefore reduces emissions of greenhouse gases into the atmosphere. In an electricity grid, renewable generation will displace fossil fuel sources and reduce the emissions intensity of the electricity grid. This is known as avoided emissions and AIB has calculated the avoided GHG emissions associated with its RE assets, namely geothermal, solar and wind assets.

For wind and solar PV assets, the actual (or estimated) energy generation is multiplied by a consolidated country-specific electricity emission factor ("**EF**") for the relevant country grid electricity mix. In line with PCAF recommendations, the Operating Margin ("**OM**") was used as the emission factor. The OM represents the marginal generating capacity in the existing dispatch hierarchy that will most likely be displaced by the project. The full dataset for the OM emission factors is published by IFI AHG-001[9]. This approach was undertaken instead of the IFI combined margin ("**CM**") as the OM provided the best outlook on which operations would most be affected, and ultimately which technologies were most likely to have been reduced over the period of a year. The results are reported in tonnes of Carbon Dioxide (tCO_2).

Scope of Power Storage Facilities Impact Assessment

The impact of Power Storage Facilities ("**PSF**") financing varies depending on the strategy deployed by the facility, these strategies are typically:

- load shifting,
- firm frequency response and/or
- inertia provision

[9] IFI TWG - List of harmonized GHG accounting standards/approaches and guidelines developed

Estimating the avoided emissions arising from the deployment of power storage facilities varies. Avoided emissions refer to the incremental difference in the PSF net export emissions compared with the carbon emissions associated with either the grid emission factor or the grid firm emission factor, depending on the strategy carried out by the PSF. In other words, the estimated annual emissions avoided due to the application of the PSF compared to if the facility would not have been operational.

The emissions accounted for within this assessment originate from the use phase of the PSF and do not include upstream or downstream emissions. Details around the calculations and justifications for all emission scopes are explained below.

Scope of Energy Transmission Infrastructure Impact Assessment

The emissions impact of energy transmission infrastructure is assessed by calculating net avoided emissions arising from the operation of electricity interconnectors between two countries. It is important to note that electricity is expected to travel both ways along the interconnector, motivated by price. While there is a general correlation between the amount of variable low carbon electricity generation (wind and solar) supply and electricity price, such that when it is windy and/or sunny, the price tends to be low, there is a risk that this correlation does not hold all the time. In this case, electricity with a high carbon intensity might be transported across the transmission infrastructure to the lower carbon jurisdiction which would, under the current methodology, result in a positive carbon emissions net. An example is that France has very low average carbon intensity due to a large volume of nuclear generation in the mix, but when demand exceeds the available low carbon generation in France, this leads to higher prices which drive imports from higher average emission countries. Nevertheless, in line with EU targets, a climate neutral Europe, running firmly on intermittent renewable power sources, will require more interconnected energy systems.

Net avoided emissions refer to the incremental difference in emissions calculated as the:

Scope 1: Direct emissions

- Possible fugitive GHG emissions from high voltage switchgear (sulphur hexafluoride, SF_6).

Scope 2 (Indirect Emissions from the generation of energy):

- Emissions from energy losses incurred from transmitting electricity between countries are calculated on the average of the carbon intensities of the two countries at the time of transport (ideally half hourly granularity).
- Net emissions change due to the transmission of electricity between countries. This is counted as the transported volumes times the difference in carbon intensity between the two countries at the time of transport (ideally half hourly granularity).
- Emissions avoided by the electricity transmission asset providing grid stabilisation / ancillary services relative to the fossil fuelled counterfactual (normally natural gas fuelled power, though will depend on the energy mix of the connected countries).

In other words, the assessment quantifies the estimated change in annual GHG emissions due to the operation of a funded electricity transmission asset. Both Direct and Indirect emissions originate from the use phase of the asset and do not currently include upstream (embedded construction emissions) or downstream (e.g., end of life treatment) emissions (Scope 3). Details around the calculations and justifications for all emission scopes are explained below.

Impact Calculation

Energy Generation Impact Calculation

Energy Generation Emissions Calculation

In line with PCAF, and unless otherwise stated, wind and solar PV are assumed to have no operational carbon, for geothermal however, this is not the case, and as such a project specific emission factor will be used to determine the emissions associated with the asset, for comparison with a usual grid scenario. If the actual project specific emission factor was not available, then a separate relevant alternative would be used from Carbon Trust studies.

RE assets are broken down by project and include Geothermal, Solar PV and Wind assets. The emissions associated with RE are calculated based on the actual energy generation/export from the facility, multiplied by the emission factor for geothermal energy generation.

To account for data availability challenges when estimating the avoided emissions associated with a energy generation assets, three options have been made available, all of which provide a sufficient understanding of the emissions associated with the property to assess the impact. Option 1 is the recommended option, with the highest level of granularity and quality, and option 3 is the least granular but still suitable to sufficiently estimate the impact.

Option 1 – Actual Energy Generation and Project Specific Emissions Factor

$$\boldsymbol{Projet\ Emissions}\ (\boldsymbol{tCO_2e/MWh}) = \sum (Actual\ Energy\ Generation\ (MWh/year) \times Project\ Specific\ Emissions\ Factor\ (tCO_2e/MWh)$$

Option 2 – Actual Energy Generation and RE Technology Type Emissions Factor

$$\boldsymbol{Project\ Emissions}\ (\boldsymbol{tCO_2e/MWh}) = \sum (Actual\ Energy\ Generation\ (MWh/year) \times Renewable\ Energy\ Technology\ Type\ Emissions\ Factor\ (tCO_2e/MWh)$$

Option 3 – Estimated Energy Generation

$$\boldsymbol{Estimated\ Energy\ Generation}\ (\boldsymbol{MWh}) = Capacity\ of\ the\ asset\ (MW) \times (Regionally\ and\ Technology\ Sepcific\ Load\ Factor \times Number\ of\ Hours\ Active\ per\ Year)$$

$$\boldsymbol{Project\ Emissions}\ (\boldsymbol{tCO_2e/MWh}) = \sum (Estimated\ Energy\ Generation\ (MWh/year) \times Renewable\ Energy\ Specific\ Emissions\ Factor\ (tCO_2e/MWh)$$

Energy Generation Avoided Emissions Calculation

To calculate the baseline emissions or the emissions from power generation had the RE project not taken place, the energy generation data is multiplied by a consolidated country-specific electricity emission factor, or grid average carbon intensity, for the relevant country grid electricity mix. To calculate the avoided emissions, the emissions associated with RE are subtracted from the baseline emissions.

To account for data availability challenges when estimating the emissions from RE, two options have been provided (where "i" is half hours from 1 – 17,520 for the year and j is monthly data (1 – 12).

Option 1 – Half Hourly Data

$$\boldsymbol{Avoided\ emissions}\ (\boldsymbol{tCO_2e}) = \sum_{i=1}^{n} (Generation\ (MWh)_i \times Grid\ Operating\ Margin\ Carbon\ Intensity\ (tCO_2e/MWh)) - Project\ Specfic\ Energy\ Generation\ Emissions\ (tCO_2e)$$

Option 2 – Monthly/Annually Data

$$\boldsymbol{Avoided\ emissions}\ (\boldsymbol{tCO_2e}) = \sum_{j=1}^{n} (Generation\ (MWh)_i \times Grid\ Operating\ Margin\ Carbon\ Intensity\ (tCO_2e/MWh)) - Project\ Specfic\ Energy\ Generation\ Emissions\ (tCO_2e)$$

All qualifying assets began operation in years dating before 2023 and therefore were operating and generating energy in the reporting period. Assets that are not yet operational are reported separately within the assessment. For each asset, AIB recorded the energy generation in the given year through actual production figures on a half-hourly, monthly or annual basis. Where actual data is unavailable, P50 estimates are to be used. P50 estimates are a reasonable estimate in statistical modelling of energy generation and are commonly used in the evaluation of renewable energy assets.

Power Storage Facilities Impact Calculation

Power Storage Facilities Emissions Calculations

To account for data availability challenges when estimating the avoided emissions associated with a PSF, three options have been made available, all of which provide a sufficient understanding of the emissions associated with the PSF to assess the impact. Option 1 is the recommended option, with the highest level of granularity and quality, and option 3 is the least granular but still suitable to sufficiently estimate the impact of the PSF.

The emissions associated with PSF are calculated based on the net import minus net export stored within the facility, multiplied by the emission factor of the connected electricity system, average carbon intensity for imports and operating margin for exports. Please note this methodology is simplified and may, depending on how the electricity storage asset is utilised, indicate a higher carbon saving than is

the case. To minimise this risk, data for electricity storage projects should ideally be as granular as possible.

Option 1 – Half Hourly Data

1a – Half hourly PSF import and export data against half hourly regional carbon intensity:

$$\boldsymbol{Project\ Emissions}\ (\boldsymbol{tCO_2e}) = \sum_{i=1}^{n}\left(Half\ Hourly\ Imports \times\ Half\ Hourly\ Regional\ Average\ Carbon\ Intensity_i\right) - \left(Half\ Hourly\ Export \times\ Half\ Hourly\ Regional\ Average\ Carbon\ Intensity_i\right)$$

1b – Half hourly PSF import and export data against half hourly national carbon intensity:

$$\boldsymbol{Project\ Emissions}\ (\boldsymbol{tCO_2e}) = \sum_{i=1}^{n}\left(Half\ Hourly\ Imports \times\ Half\ Hourly\ Naitonal\ Average\ Carbon\ Intensity_i\right) - \left(Half\ Hourly\ Export \times\ Half\ Hourly\ National\ Average\ Carbon\ Intensity_i\right)$$

Option 2 – Monthly/Annual Data

2 – Actual monthly/annual PSF import and export data against monthly/annual regional or national grid carbon intensity:

$$\boldsymbol{Project\ Emissions}\ (\boldsymbol{tCO_2e}) = \sum_{j=1}^{n}\left(Monthly/Annual\ Net\ Export\ (MWh)_i \times Monthly/Annual\ Average\ Carbon\ Intensity_i\right)$$

Option 3 – High level estimate

3 – Estimated import and export based on PSF capacity against national grid carbon intensity:

$$\boldsymbol{Project\ Emissions}\ (\boldsymbol{tCO_2e}) = \sum_{j=1}^{n}\left(Estimated\ Monthly/Annual\ Net\ Export\ (MWh)_i \times Monthly/Annual\ Average\ Carbon\ Intensity_i\right)$$

Power Storage Facilities Avoided Emissions Calculations

A baseline was calculated to estimate the avoided emissions. The baseline can be considered as a hypothetical scenario in which the PSF financed by AIB was not present within the grid. In other words, the baseline refers to what would have happened if AIB had not, in recent years, increased the avoidance

of carbon intensive electricity generation sources and increased the resilience of the electricity grid, it calculates the emissions that would have occurred if the grid had continued to operate as usual, using either the typical grid emission factor or the average operating margin emission factor.

The baseline for CO_2 emissions will vary depending on the strategy deployed by the PSF. For times when the PSF is not directly co-located with a renewable energy plant, the baseline will be the average grid emission factor (either half hourly, monthly or annually). It should also be noted that the approach taken is a conservative estimation of the avoided baseline emissions.

If the primary operating mode is to provide grid support services such as balancing, dynamic containment, firm frequency response or inertia response, the counterfactual baseline is assumed to be the operating margin. If PSFs provide both turn-up (charge) and turn-down (discharge) services, the PSF will need to maintain "headroom" in the battery at all times. For simplicity, the assumption made by CT is that when the PSF provides grid support services, the state-of-charge of the battery is 50% (half-full).

The impact of this assumption is that when compared to the counterfactual average operating margin plant, only half of the nominal battery capacity is used (the turn-up service part) multiplied against the number of hours the PSF has been operational. This is then multiplied against the average operational margin grid carbon intensity of the host country.

Grid stability services counterfactual baseline

$$\boldsymbol{Grid\ Stability\ Baseline\ Emissions}\ (\boldsymbol{tCO_2e}) = Half\ the\ capacity\ of\ the\ PSF \times number\ of\ hours\ PSF\ is\ operational \times Country\ grid\ operational\ margin\ (tCO_2e/MWh)$$

$$\boldsymbol{Avoided\ Emissions}\ (\boldsymbol{tCO_2e}) = \sum (Project\ Emissions - Grid\ Stability\ Baseline\ Emissions)$$

Energy Transmission Infrastructure Impact Calculation

Energy Transmission Infrastructure Emissions Calculation

Energy Transmission Infrastructure emissions are broken down between scope 1 and scope 2 emissions. Scope 3 emissions are not currently included in this assessment but, depending on data availability, the inclusion of Scope 3 emissions may be revisited in future impact reports. The final calculation is the addition of all the equations below together.

Direct emissions are the GHG emissions from the operation of electricity transmission assets. Some electricity transmission assets use sulphur hexafluoride (SF_6), (a very powerful GHG with a Greenhouse Warming Potential (GWP) 22,800 times that of CO_2) as a high efficiency, non-toxic, non-flammable

insulator in high voltage switchgear. The EU is looking to phase out the use of SF_6 in favour of alternatives[10,11].

If funded electricity transmission assets use SF_6, in their high voltage switchgear, and if the asset operator provides reporting on annual fugitive emissions, these will be included in the quantification of emissions. If SF_6 is not used and/or the reporting is not available, this will be noted in the reporting methodology.

$$\boldsymbol{Direct\ Emissions\ (tCO_2e)} = kgSF6\ emitted\ per\ year\ * 22{,}800^{1}$$

Indirect emissions from electricity transmission assets are the net CO_2 emissions from generating electricity in the sending country less the emissions avoided in the receiving country.

When transmitting electricity from one country to another, some of the electricity is lost due to resistance in wires and transformers. The magnitude of interconnector losses depends on several factors, including distance, operating voltage and converter station design choices. Current UK interconnectors losses range from 2.34% – 3.40% while the two current Irish interconnectors range from 2.36% (Moyle, 63.5km long) to 4.68% (East-West Interconnector, 262km)[12].

The allocation of these losses is typically done on a "mid-point" basis, i.e., half of the losses are assumed incurred by the sending country/entity and half by the receiving country/entity. This means that for assessment purposes losses can be calculated as the average of the carbon intensities of the two countries' electricity grid at the time of transmission multiplied by the volumes of electricity transmitted.

$$\boldsymbol{Electricity\ loss\ Emissions\ (tCO_2e)} = \sum_{i=1} \frac{(Emission\ Intensity\ Export\ Country_i + Emission\ Intensity\ Import\ Country_i)}{2} \times MWh_i \times Electricity\ Loss\ Factor$$

With losses separated above, the emissions from interconnector operations are simplified into the difference in emissions intensities of the connected countries' grids at the point of transmission.

$$\boldsymbol{Transmission\ Emissions\ Loss\ (tCO_2e)} = \sum_{i=1} (Emission\ Intensity\ Export\ Country_i - Emission\ Intensity\ Import\ Country_i) \times Transmission\ Volume\ MWh_i$$

[10] c_2020_6635_en.pdf (europa.eu)

[11] Fluorinated greenhouse gases – review of EU rules (2015-20)

[12] Carbon Trust Desktop research

$$\boldsymbol{Project\ Emissions}\ (\boldsymbol{tCO_2e}) = Direct\ Emissions + Electricity\ loss\ Emissions + Transmission\ Emissions\ Loss$$

Energy Transmission Infrastructure Avoided Emissions Calculation

Emissions are avoided from the electricity transmission asset by providing grid stabilisation services in either the exporting or importing country relative to a fossil fuel counterfactual. Depending on data availability, the avoided emissions from the provision of grid stabilisation services, if present, are assessed relative to a fossil fuelled counterfactual (normally natural gas fuelled, though will depend on the energy mix of the connected countries).

$$\boldsymbol{Avoided\ emissions}\ (\boldsymbol{tCO_2e}) = \sum Ancillary\ Services\ Provision_i \times (Country\ Emissions\ Intensity_i - Counterfactual\ Carbon\ Intensity)$$

Attribution

As per the guidance of the Partnership for Carbon Accounting Financials (PCAF), and in line with the ICMA Reporting Metric and Databases Harmonised Framework, it is recommended that AIB also report their attribution. The area of impact assessment related to green bonds and more widely the accounting of financed carbon emissions is developing rapidly. We aim to represent current best practices and where possible move that forward. To this end we have considered current market practice, recognised impact reporting standards including ICMA's Harmonised Framework for Impact Reporting, and from the related area of emissions reporting, the PCAF methodologies, specifically around attribution.

In some cases, AIB does not finance the entire project. As a result, the avoided emissions are adjusted by the share of financing attributable to AIB. This share is calculated by taking the amount outstanding on the deal and dividing by the project value.

$$\boldsymbol{Attribution\ Factor} = \frac{AIB\ Outstanding\ Amount\ (EUR)}{Total\ Project\ Value\ (EUR)}$$

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