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Impact Assessment Methodology for NRW.BANK Green Bonds

Framework and Rationale for #2022-2

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on behalf of

NRW.BANK

Wuppertal Institut

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The current method paper represents version 2.0 and is most closely aligned to the NRW.BANK Green Bond Impact Analysis #2-2022 (ISIN: DE000NWB0AR8). It is expected that a further update of this methodology will be made available within the next 12 months.

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The paper at hand presents the principles and methods applied for the impact assessment of the NRW.BANK Green Bonds (currently #2-2022) in the area of Climate Change Mitigation.

For further information see the full impact report #2-2022, which will be published after the results have been incorporated in the sustainability reporting by the issuer.

1 Rationale for Methodology

NRW.BANK aims to report on the contribution of their Green Bonds for the target of climate change mitigation. The main goal is to assess and quantify avoided greenhouse gas (GHG) emissions. The selection process for eligible projects is solely the responsibility of the issuer and described in a Green Bond Framework (NRW.BANK, 2020). The eligibility of this process is corroborated by a second-party opinion provider (ISS ESG, 2022).

Each of the included project categories represents a low-carbon technology with lower GHG emissions than the status quo in the State of North-Rhine Westphalia (NRW). This status quo is represented by so-called reference systems, and it is reasoned that each of the implemented measures and projects or purchased products saves GHG emissions by comparison with these reference systems. The issuer provides some or all of the initial financing and is therefore a necessary stakeholder for their implementation. Because other stakeholders are involved (e.g., the owners of the assets), all reported effects are considered potentials that are financially induced until the maturity of the bond. Neither the impact report or the method paper at hand investigates if these effects are realized after the fact to the estimated degree (ex-post) or if these effects would also have happened without the issuer's financing in the first place (see section 4 on the question of additionality).

This rationale is in line with current market practices as suggested by the ICMA Green Bond Principles as well as Harmonized Framework for Impact Reporting (ICMA, 2021, 2022).

2 Methodology

We use the ICMA recommendations, and the decisions made in the issuer's framework for the distinction and classification of different types of projects in the Green Bond. The following types of projects are distinguished with each of these categories requiring its own model (although some models are very similar or build upon each other).

- Renewable Electricity Production (REP)
- Renewable Heat Production (RHP)
- Energy Efficiency (EE)
- Green Buildings (GB)
- Clean Transportation (CT)

The main indicator for all projects is greenhouse gas (GHG) emissions avoided (ex-ante, potentials, induced by financing) in form global warming potential savings. The global warming potential refers to 100 years (GWP 100a) and is calculated with the help of characterization factors for Kyoto-Gases by the IPCC (AR5).

Additional indicators can include nominal power, energy produced, energy capacity for storage, remaining GHG emissions, normalized GHG emissions (per monetary unit of financing) and pollutants from vehicles. They are either part of the GHG calculation process, directly derived results or drawn from literature.

Finally, all effects are reported for both the full effect (from the point of view of the actor implementing the project) and the financed effect (proportion of costs that can be attributed to the financing institution). This is discussed in the last sub-section of the framework.

Other areas of green finance have been assessed in the past but the method paper at hand is limited to projects described in the current Green Bond #2-2022. If additional project types are included in the future, this method paper will be updated accordingly.

2.1 Renewable electricity production (REP)

Renewable electricity production is assumed to displace electricity from coal, oil, gas and nuclear energy in the conventional electricity mix (gross energy mix as referenced in the data section). Avoided emissions are calculated by multiplying the generated renewable electricity with a corresponding GHG intensity (g CO_2-equivalents per kWh) for both systems (the renewable energy systems as well as the conventional electricity mix) and reporting on the annual difference in GHG emissions. In order to ensure comparability, the combined margin suggested and published by the IFI is used as emission factor for the reference system (IFI, 2022). Because this is a novelty in our methodological approach, the calculation is repeated with emission factors for the German electricity mix, which were used in previous reports.

Two consecutive steps are necessary to calculate GHG savings. First, the annual amount of produced electricity is calculated (see REP_1), and second, the potentially avoided GHG emissions are calculated and summed up for all power plants of one technology (see REP_2):

$E_{RE,i} \;=\; P_{nom,i}\; x\; flh_i \; [kWh/a]$ (REP$_1$)

$GHG_{avoid,REP} \;= \sum_{i=1}^{n} E_{RE,i}\; x\; ghg_{IFI} \quad [kg\; CO_2 - equ./\,a]$ (REP$_2$)

with
$E_{RE,i}$: annual electricity production of selected renewable power plant in [kWh/a]
$P_{nom,i}$: nominal power of selected renewable power plant in [kW]
flh_i: full-load hours of selected renewable power plant in [h/a]
$GHG_{avoid,\,REP}$: potentially avoided GHG emissions technology [g CO2e/a]
ghg_{IFI}: GHG intensity of combined margin grid emission in country or region [g CO2e/kWh]

All other values reported in this category are derived from the results of these two formulars (e.g., GHG emissions over duration of the Green Bond).

2.2 Renewable Heat Production (RHP)

Renewable heat production is assumed to displace heat production by fossil fuels. Avoided emissions are calculated by multiplying the generated renewable heat with a corresponding GHG intensity (g CO_2-equivalents per kWh) for both systems (the renewable heat systems as well as the conventional heat system) and reporting on the annual difference in GHG emissions.

The annual amount of produced heat is based on operator data. The potentially avoided GHG emissions are calculated as shown in formula RHP$_1$:

$GHG_{avoid,RHP} \;= (H_{RHP,i}\; x\; ghg_{ref} \;-\; H_{RHP,i}\; x\; ghg_i) \;\; [kg\; CO_2 - equ./\,a]$ (RHP$_2$)

with
$GHG_{avoid,\,RHP}$: potentially avoided GHG emissions technology [g CO2e/a]
$H_{RHP,i}$: annual heat production of selected renewable source [kWh/a]
ghg_{ref}: GHG intensity of reference heat production [g CO2e/kWh]
ghg_i: GHG intensity of selected renewable heat plant [g CO2e/kWh]

All other values reported in this category are derived from the results of this formular (e.g., GHG emissions over duration of the Green Bond).

2.3 Energie Efficiency (EE)

The rationale for GHG savings from buildings relates to the construction or renovation of both private and public buildings. Energy-efficient buildings require less final energy for heating than buildings in stock in Germany. With the latter representing the reference system, each new or renovated building saves GHG emissions compared to the Status Quo. This effect is expressed on an annual basis and an ex-ante estimate which value remains unchanged for the duration of the Green Bond.

In reality, these effects will decline over time as the buildings in stock become more and more energy-efficient and climate-friendly as well. On the other hand, GHG savings will still occur after that, as most buildings have an expected lifetime of 50 years and more. In some cases, not all investments by a loan directly relate to a more energy-efficient building. This is why a portion is attributed to other purposes in building renovation or construction (e.g., to accommodate people with disabilities). This results in a smaller portion of GHG savings depending on the share of area contributing to energy efficiency (EE$_2$). The following formulas can be applied to both private and public buildings:

$dE_{heat,EE} = (e_{stock} - e_{new}) \; x \; A_{new} \; x \; a_{ee}$ (EE1)

$GHG_{avoid,EE} = dE_{heat,EE} \; x \; ghg_{heat,mix}$ (EE2)

with

$GHG_{avoid,EE}$: avoided GHG emissions from energy-efficient buildings [g CO2e/a]
$dE_{heat,EE}$: annual final energy saving of refurbishments compared to building stock [kWh/a]
$ghg_{heat,mix}$: GHG intensity of heating mix for German buildings [g CO2e/kWh]
e_{stock}: average annual energy demand per area for buildings in German building stock [kWh/(m^2*a)]
e_{new}: average annual energy demand per area for refurbished buildings in Germany [kWh/(m^2*a)]
A_{new}: refurbished area [m^2]
a_{ee}: share of refurbished area that contributes to energy-efficiency [%]

2.4 Green Buildings (GB)

The rationale for GHG savings from Green Buildings relates to the construction of both private and public buildings. Each building that is newly erected in Germany has to meet a certain Energy Efficiency standard. Therefore, a real improvement to the Status Quo is only accomplished, when the energy efficiency of the new building is more ambitious than the national standard.

For accounting GHG savings, this means that the national standard serves as a reference system against which the energy efficiency of new buildings is compared. This aligns with the accounting methodology of the Nordic Public Sector Issuers[1] (NPSI, 2020) and constitutes a change of method compared to previous impact reports for NRW.BANK Green Bonds (which compared new buildings to the average energy demand in the building stock).

The following formulas can be applied to both, public and private buildings.

$dE_{heat,GB} = (e_{standard} - e_{new}) \; x \; A_{new}$ (GB1)

$GHG_{avoid,GB} = dE_{heat,GB} \; x \; ghg_{heat,mix}$ (GB2)

with

$GHG_{avoid,GB}$: avoided GHG emissions from newly built Green Buildings [g CO2e/a]
$dE_{heat,GB}$: annual final energy saving of building compared to the national standard [kWh/a]
$ghg_{heat,mix}$: GHG intensity of heating mix [g CO2e/kWh]
$e_{standard}$: annual energy demand per area for a reference building (German standard) [kWh/(m^2*a)]
e_{new}: annual energy demand per area for newly erected buildings [kWh/(m^2*a)]
A_{new}: area of newly erected building [m^2]

2.5 Clean Transportation (CT)

In the transport sector several mechanisms for saving GHG exist. We follow the categorization of these mechanisms proposed by the ICMA (ICMA, 2022): i) **reduce**, ii) **shift** and iii) **improve**.

2.5.1 Reduce

This effect enhances the system's efficiency and includes "any operation that avoids the need to travel or reduces the length of travel, including through integrated land-

[1] We consider the NPSI methodology the best standard for impact reporting of Green Bonds currently available.

use planning, and transport demand management." The following formular describes the related estimation of avoided GHG emissions.

$$GHG_{avoid,CT,reduce} = passdist_{reduce}\ x\ ghg_{reduce,ref} \quad (CT_1)$$

with
$GHG_{avoid,\ CT,\ reduce}$: avoided GHG emissions by reducing travel [g CO2e/a]
$passdist_{reduce}$: passenger distance of reduced travel [pkm/a]
$ghg_{reduce,\ ref}$: GHG intensity of Status Quo transport mode of the analyzed route(s) [g CO2e/pkm]

2.5.2 Shift

This effect enhances the trip's efficiency and includes "any operation that moves people or freight to a more sustainable and less polluting means of transportation, such as cycling, walking, buses, ferries, trains and trams." The following formular describes the related estimation of avoided GHG emissions.

$$passdist_{shift} = passengers_{shift}\ \ x\ distance_{shift}\ x\ S \quad (CT_2)$$

$$GHG_{avoid,CT,shift} = passdist_{shift}\ x\ (ghg_{shift,ref} - ghg_{shift,new}) \quad (CT_3)$$

with
$GHG_{avoid,\ CT,\ shift}$: avoided GHG emissions by shifting from one transport mode to another [g CO2e/a]
dist: passenger distance where a modal shift could be induced [pkm/a]
$ghg_{shift,\ ref}$: GHG intensity of Status Quo transport mode of the analyzed route [g CO2e/pkm]
$ghg_{shift,\ new}$: GHG intensity of new transport mode of the analyzed route [g CO2e/pkm]
$passdist_{shift}$: passenger distance where a modal shift is induced [pkm/a]
$passengers_{shift}$: number of passengers that travel the analyzed route [pers./a]
$distance_{shift}$: distance of the analyzed route [km]
S: factor accounting for the share of people who change the mode of transport on the analyzed route

2.5.3 Improve

This effect enhances the trip's efficiency and includes "any operation that reduces the emissions (both GHG and local pollutants) of vehicles or the transport system." The following formular describes the related estimation of avoided GHG emissions.

$$GHG_{avoid,CT,improve} = passdist_{improve}\ x\ (ghg_{improve,ref} - ghg_{improve,new}) \quad (CT_4)$$

with
$GHG_{avoid,\ CT,\ improve}$: avoided GHG emissions by reducing GHG emissions of vehicles [g CO2e/a]
passdist: passenger distance covered by the vehicle(s) [pkm/a]
$ghg_{improve,\ ref}$: GHG intensity of reference vehicle(s) [g CO2e/pkm]
$ghg_{improve,\ new}$: GHG intensity of new vehicle(s) [g CO2e/pkm]

3 Data and Assumptions

3.1 Data and Assumptions for REP

Data and assumptions for renewable electricity production (REP) are summarized in the following table.

table 1: data and assumptions REP

Data	Sources	Additional assumptions
power plants nominal power	wind, onshore: partly provided by issuer, partly derived from plant type biomass, solid: DHE dinslaker holz-energiezentrum (2021)	-
power plants type	wind, onshore: provided by issuer biomass, solid: DHE dinslaker holz-energiezentrum (2021)	-
power plants electricity production	wind, onshore: Statista (2021) biomass, solid: DHE dinslaker holz-energiezentrum (2021)	REP 1) average full-load hours for a given year and technology in Germany represent the electricity production of each plant
reference systems electricity mix	gross electricity mix, Germany (old method): Destasis (2022)	REP 2) gross electricity production by renewables replaces fully gross production in electricity mix
GHG intensity electricity mix	combined margin grid emission, Germany: IFI (2022)	-
GHG intensity power plants	upstream & use-phase, Germany: Lauf et al. (2022)	-

3.2 Data and Assumptions for RHP

Data and assumptions for renewable heat production (RHP) are summarized in the following table.

table 2: data and assumptions for RHP

Data	Sources	Additional assumptions
power plants nominal power	DHE dinslaker holz-energiezentrum (2021)	-
power plants type	provided by issuer	-
power plants heat production	DHE dinslaker holz-energiezentrum (2021)	-
reference systems conventional heat production	heat production, Germany: Agentur für Erneuerbare Energien (2022)	RHP 1) final energy use as placeholder for heat production

Data	Sources	Additional assumptions
		RHP 2) gross heat production by renewables replaces gross production in heat mix
GHG intensity heat mix	upstream & use-phase, Germany: Lauf et al. (2022)	-
GHG intensity power plants	upstream & use-phase, Germany: Lauf et al. (2022)	-

3.3 Data and Assumptions for EE & GB

Data and assumptions for refurbished energy efficient buildings (EE) as well as newly constructed green buildings (GB) are summarized in the following table.

table 3: data and assumptions for EE and GB

Data	Sources	Additional assumptions
GHG emissions heating in private buildings	energy-mix, Germany: Agentur für Erneuerbare Energien (2022) ghg intensity, energy sources: Lauf et al. (2022)	EE & GB 1) energy carrier mix for heat provision in residential buildings (proportional to number of buildings) represents the reference system for energy savings by energy-efficient buildings
proportion of investments into energy-efficiency in private buildings	-	EE & GB 2) because no information is given, it is assumed that investments are used to increase heating energy-efficiency
modernization energy efficiency in residential buildings	energy demand, residential, Germany: *Tabula WebTool* (2017) construction year(s), residential, Germany: Destasis (2020) building stock, residential, Germany: Statistische Ämter des Bundes und der Länder (2011)	EE & GB 3) mean calculated with age and type of the building stock in Germany as weights
modernization energy efficiency in non-residential buildings	energy demand & building stock, non-residential, Germany: BMVBS (2013)	EE & GB 4) mean calculated with age and type of the building stock in Germany as weights
proportion of investments into energy-efficiency in residential buildings	-	EE & GB 5) because no information is given, it is assumed that investments are used to increase heating energy-efficiency

3.4 Data and Assumptions for CT

Data and assumptions for clean transportation (CT) is summarized in the following table.

table 4: data and assumptions for CT

Data	Sources	Additional assumptions
electricity demand	*see REP*	*see REP*
vehicles & infrastructures type	provided by issuers or on the basis of desk research	CT 1) generic types are assumed if no specific information is available
GHG savings mechanism	desk research by authors on financed activities (transportation grid expansion / vehicle replacement)	CT 2) If new vehicles are replacing old ones, “improve” is assumed. If the transportation grid is expanded, “shift” is assumed
vehicles & infrastructures GHG intensity	electro bus: EMCEL (2020) cars: International Council on Clean Transportation ICCT (2021) other or generic vehicles: Umweltbundesamt (2021)	CT 3) project-specific data preferred to type-specific data which in turn is preferred to generic data
passenger distance travelled	specific project data: Start (2023) Bogestra (2019) WUPSI (2022) electrive.net (2022) generic occupancy: Umweltbundesamt (2021)	CT 4) estimates on the basis of distance and average occupancy rate if not specifically available

4 Discussion and Outlook

4.1 Carbon Accounting Methodology

All models described here provide plausible estimates for the effects based on the data available. Differences in data quality as well as assumptions shown here strongly influence the robustness of the results. Two strategies were used to improve the overall robustness from the perspective of the investor. Firstly, all models were tested for changes in the variables to investigate the influence of assumptions and model simplifications on the results (sensitivity analysis). Secondly and subsequently, conservative approaches were used whenever possible. However, some auxiliary variables are highly uncertain, such as any data related to the actual costs of materialization. It is therefore not recommended to use the models and data described here and apply them to another context without a thorough review of the cause-effect links implied and the data used.

Some data points used for quantification also not necessarily represent the current State of Art. This is a consequence of the objectives of the assessment since the investor briefings are intended to be comparable to each other and ex-post updates of the results would lead to inconsistency in the reporting. Any changes to crucial data points as well as methodology are thus introduced gradually and accompanied by estimates and discussion of the effects caused by these changes.

4.2 Additionality of Investments

The report itself and the method paper at hand should not be used to imply or evaluate the financial or development additionality of the bond. Green securities, framed by Migliorelli (2021) as "labelled sustainable finance", do not provide the same sustainability benefits as impact investing strategies or taxonomies, nor do they intend to do so.

According to the OECD (OECD (2016) in Andersen et al. (2021)), (direct) financial additionality can be defined as: “*[...] [A]n official transaction [...] is financially additional if it is extended to an entity that cannot obtain finance from local or international private capital markets with similar terms or quantities without official support, or if it mobilises investment from the private sector that would not have been invested otherwise*".

Although many loans by NRW.BANK do in fact provide favorable financing conditions (in compliance with the first criterium), Green Bonds are not a direct contributor in this counter-factual manner. Rather, they can be considered a second-order effect of sustainable finance that itself can be more broadly defined as: *"finance to support sectors or activities that contribute to the achievement of, or the improvement in, at least one of the relevant sustainability dimensions"* (Migliorelli, 2021, p. 2).

The issuer itself is providing that contribution or promising to do so. It can be and is in fact argued that the green bond investor lowers the costs of debt and the costs of equity for that issuer as he is willing to accept lower returns (Pastor et al., 2022).

Thus, the investor is making further and future sustainable finance interactions possible in the first place[2].

However, this indirect cause-effect link is difficult to evaluate and not part of the impact report by the authors. On the other hand, two of the potential down-sides of green bonds can indeed be mitigated with the tools at hand (see (Migliorelli (2021) and Krahnen et al. (2021) for a more detailed discussion of these issues).

The first risk of "no real impacts", is dealt with the help of robust impact reporting (which the authors hope to provide) as well as the second-party opinion for the eligibility of the selected projects. The second risk of "diluting sustainable policy actions" (especially from greenwashing or the use of unreliable ESG scores) can be mitigated by a closer look at the corporate entities involved in the actual materializations. Additional sustainability information by these companies ensures that activities contribute to sustainability goals. Apart from non-financial disclosures according to e.g., the European Corporate Sustainability Reporting Directive (CSRD), the reporting obligations of the EU taxonomy regulation seem like a suitable tool for that.

The authors therefore intend to include considerations on the taxonomy-eligibility and taxonomy-alignment in future reports and updates of the methodology (if not otherwise already corroborated by updates of the issuers' Green Bond Framework).

4.3 Future Publications

Updates to this method paper will be published if new project categories are introduced (or re-introduced from older NRW.BANK Green Bonds) or if relevant changes to the current project categories require an update of the methodology as well. It is also planned to publish the entire calculation procedure (R-script) in a public data repository to enable others to check or emulate our calculations.

[2] Krahnen et al. (2021) argue that this is not necessarily the case, especially in the case of green government bonds. The authors point out that despite the investors' expectations to do so, the issuer has no obligation to use these extra funds for additional green projects.

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