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Method Update for Impact Report of NRW Sustainability Bond #13

Indicators, Data, Methods

Jens Teubler

Benedikt Teuber

Wuppertal Institut

This report is based on the results of a study conducted on behalf of the State Government of North Rhine-Westphalia. The authors are responsible for the content.

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Döppersberg 19
42103 Wuppertal, Germany

www.wupperinst.org

Authors:

Dr. Jens Teubler; Benedikt Teuber
jens.teubler@wupperinst.org

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List of Abbreviations

ERDF	European Regional Development Fund
FTTB/H	Fibre to the Building/Home
GEG	Gebäudeenergiegesetz
GHG	Greenhouse Gas Emissions as [CO2e] or [CO_2 equivalents]
NRW	North Rhine-Westphalia (State in Germany)
SDG	Sustainable Development Goals
VRR	Verkehrsverbund Rhein-Ruhr

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1 Scope of the Report

The Wuppertal Institute analysed NRW Sustainability Bond #13 (based on the budget results for 2025) on behalf of the State Government of North Rhine-Westphalia (NRW). The report at hand provides an updated methodology and the description of the data used to derive indicators reported in the main report (investor briefing).

It is based on the further development of methods and data already described in previous publications. The most recent method paper referred to NRW Sustainability Bonds #11 & #12 (Teubler & Dietz, 2025). The paper at hand applies the same rationale, methods and types of data sources in most cases. It is referenced in cases in which no principal changes to the method or underlying rationale were deemed necessary or possible by the authors. In cases in which only input variables were updated, only the changes of these values are captured in the report at hand. Projects, or project categories, which have been part of NRW Sustainability Bonds #11 & #12, but are no longer part of NRW Sustainability Bond #13, are no longer part of this methodology report.

Projects in Sustainability Bond #13 are classified by the issuer into 13 different categories from A to M. Of these categories, the categories A to F are more closely related to desired social effects and G to M to desired ecological effects. However, numerous projects also relate to other sustainability dimensions, which is represented by their association with more than one sustainable development goal (SDG) in many cases. For climate change mitigation purposes in particular, additional greenhouse gas (GHG) savings can be attributed to several social programmes such as promoting low-carbon public transport services. The report at hand therefore differentiates between social and environmental effects, but considers potential GHG savings as an additional category of co-benefits.

Section 2 of the report describes the current methodology for indicator identification and qualification. In particular, it describes how indicators are qualified, how the robustness of values is evaluated, how effects are attributed and how effects can be accumulated. These principles remain unchanged.

Section 3 lists all projects and their indicators that are part of Sustainability Bond #13 but have already been described in the previous method paper. This list only indicates the reference to the unchanged methodology and updates of primary as well as auxiliary variables.

Section 4 covers all projects and indicators for which methodologies were developed or adapted, including all relevant primary and auxiliary information.

Section 5 discusses the limitations of Carbon Accounting in the current NRW Sustainability Bond Impact Report and an outlook for future impact reporting.

Section 6 lists all literature and data sources.

The annex contains a table with a full list of all quantified indicators, their quality as well as their robustness.

2 Methodology

Reported values are qualified according to the following characteristics:

- **Qualification**: What is the context of the measured effect?
- **Robustness**: How was the value determined?
- **Attributability**: Is the State of NRW the sole promoter of the effect?
- **Accumulability**: Which values can be summed up over a period of time?

The following sections explain each criterion and the solution in the report at hand.

2.1 Qualification of reported values

The quality of an indicator should convey to the reader if the reported value is just describing the intervention or if it also provides information on the desired outcomes of an intervention or programme. Using a simplified version of ESG Logic Model methodology developed and discussed in Teubler (2024), indicators are classified according to their location in a linear cause-effect chain:

- Input-indicators are classified as E (minimum requirement) and measure "resources", such as capital, personnel, or physical assets, deployed in service of activities.
- Activity-indicators are classified as D (standard reporting practice) and measure the materialization (promoted activities) of State funding on the level of projects and entities.
- Output-indicators are classified as C (best-practice) and report the tangible results of state funding on the level of projects and entities.
- Intermediate outcome-indicators are classified as B (best-in-class) and report desired effects on the societal level in a close temporal and regional context.
- Long-term outcome-indicators are classified as A (best-needed) and report on desired persistent changes on the societal level in a region.

As a rule of thumb, activity-indicators are the easiest values to measure and can often directly be based on evaluation, monitoring reports or even press releases. Long-term outcomes on the other hand require a lot more evidence and usually cannot be attributed to one cause alone without applying a simplified and "mechanistic" view on how policies and interventions develop in society. As a consequence, the need for data (and evidence) increases from D to A.

In this scheme or "outcome-pathway", two types of indicators are not explicated in the report at hand. First, it is assumed, that the final impacts of the State's projects – direct contribution to Sustainable Development Goals – cannot be measured within the framework of a Sustainability Bond. Such indicators would require a more complex theory of change (with non-linear interactions between actors and alternative causal strands), a more robust data basis and in most cases, empirical research and a study design that incorporates randomised events. This is also the reason why indicators with quality A (as pre-conditions for achieving overarching goals) are very rare (in fact, the report at hand does not report one such indicator). The second type of indicators not accounted for are input-indicators (classified as E in the scheme). It is assumed that inputs to the cause-effect chain can be mainly attributed to the funding for a specific purpose. As such, the issuer's own report on eligible assets already provides a rationale and data basis for these interventions. As a result, each budget expenditure dedicated to a specific project described in the issuer's list of eligible assets is considered to be an indicator with quality E.

2.2 Robustness of reported values

Information on the robustness of a reported value conveys to the reader how an indicator was determined. Ideally, all reported values stem directly from official sources (or commissioned studies) and were gathered under high scrutiny (e.g., by state agencies such as IT.NRW). Although such values are not validated by the authors of the report at hand, it is assumed that they are primary data and robust.

However, even in this case, there might not be a clear indication to what extent different actors contributed to that effect. It is therefore not surprising, that most reported values in the report at hand make use of auxiliary variables or simple models in order to estimate the effects in reference to the funding in the bond. A common example for such auxiliary variables are maximum grant sums for investments (e.g. a maximum grant per charging station for electric vehicles). Since the actual spending and effects are often unknown, using the maximum grant (usually regulated in laws and directives) introduces uncertainty to the results. However, the resulting estimate from dividing expenditures by maximum grants will constitute the lower bound of the effect and is thus considered a under- rather than an over-estimate. In addition, there are also values reported by sources, that can be considered results from third parties or personal communication. These results are not directly gathered by government agencies or published in studies and are therefore deemed not to be verifiable.

Robustness is qualified in five different levels (as shown in Table 1) with 1 attributed to the highest and 5 attributed to the lowest robustness according to the developed methodology by the authors in Teubler & Brauneis (2022). Robustness can be directly applied to the quality of the indicator (A-D) with the help of indices.

D_2 for example translates into: the value reported describes an activity (D) on project level funded by the State of NRW and has been directly estimated on the basis of primary data (2).

Table 1: robustness criteria for data collection and quantification

Robustness	Criteria	Example
1	primary data (directly monitored or evaluated)	number of returned researchers in the *return programme for highly qualified young researchers from abroad*
2	directly estimated from primary data or relevant statistical reporting	number of projects for nature and sustainable development based on the average funding per projects over circa 2,000 projects so far
3	calculated with the help of secondary sources or auxiliary variables	number of promoted medical practitioners based on the maximum funding per doctor's office
4	estimated on the basis of models with a simplified universal mechanism	financial attribution of geothermal installations is based on a typical drilling depth of 100 m per system and maximum grants per metre
5	results from 3rd party reporting without the possibility for validation	GHG savings from projects in ERDF Funding

source: own compilation based on Teubler & Brauneis (2022)

2.3 Attribution of effects to the issuer

The impact reports for Sustainability Bond issues #2 to #7 focused on indicators that could clearly be attributed[1] to the issuer alone (the State of NRW and its institutions) or could be related to the State's share of total funding (all other programmes were either not assessed at all or indirectly reported as data from 3rd parties). This is a dubious undertaking for many of the eligible assets for two reasons. First, even a 100 % public funding by the State does not necessarily exclude additional interventions of private actors. And secondly, only few programmes and projects are evaluated in a way that allows for the robust allocation of means to different or (if possible) distinct purposes. However, there is reliable information on many of the desired effects of State programmes that could be reported, but cannot be attributed to the issuer due to a lack of data on the stakeholders. The authors therefore decided to introduce two distinct categories of reported effects in the previous method paper: full contribution and partial contribution. A full contribution in this regard is defined as follows:

*The **full contribution** of the issuer to a reported value is achieved if there is either a high confidence that the State is the sole contributor of a monitored effect or if the funds by the State can be directly attributed to an estimate made by the analysts.*

The latter (estimate by the analysts) is usually depicted in the impact report by (i) declaring 'full attribution' and (ii) by the use of the term 'equivalent' as part of the indicator description. All other values are considered to be a partial contribution, where it is not possible to attribute the actual contribution of the State of NRW and its institutions in a robust manner.

2.4 Accumulation of effects within and with other Sustainability Bonds by the issuer

The summation of reported values requires a process of normalisation. Units of reported values have to be selected in a manner that clusters similar effects or similar target groups. As a convention in line with the criterion of attributability, only effects that have the same unit and the same level of attribution can be added up. The following Table 2 shows all units of comparison for this and previous reports.

Table 2: clustering and normalisation of reported values in the report at hand (as well as previous reports)

Unit of comparison*	Description	Example for an indicator
beneficiaries [1]	funding desired outputs or outcomes for target groups of a programme	equivalent of paid student tickets
jobs created/sustained [1]	funding of salaries or job creation for desired tasks and/or among target groups	returned researchers
projects [1]	funding of public or private projects facilitating desired project results	equivalent of paid urban development projects
entities [1]	funding of public or private entities facilitating certain desired tasks	competence centres women and profession

[1] The question of attribution is distinct from the question on whether the Sustainability Bond itself is either a necessary or sufficient condition for contribution. This is usually discussed under the umbrella term 'Additionality' in both the scholarly and practitioner's literature. Such 'additional' financing is often understood to be consequential for effects that would have otherwise not occurred or not occurred to the same extent. For further reading, Teubler (2024) discusses the different concepts of 'Additionality' in the literature as well as methods of operationalisation for impact assessments in green and social financing.

Unit of comparison*	Description	Example for an indicator
[ha] of sustainable land-use	funding to enable, expand or sustain sustainable land-use	re-afforestation of damaged forests
vehicles [1]	funding the purchase of low-carbon vehicles	equivalent of promoted low-carbon vehicles
[MWh] of RE production/storage	funding of the installation of renewable energy systems	equivalent of promoted solar battery capacity
[m²] of new buildings	funding of construction efforts of energy-efficient buildings	expansion university clinic buildings
[m²] of building area renovated	funding of modernisation efforts to decrease the energy-use of buildings	modernisation of university clinic buildings
animals benefiting [1]	funding of efforts for animal-friendly agriculture	equivalent of animals in animal-friendly husbandry
[km] of bicycle lanes	funding for new bicycle lanes	additional lanes for bicycles
[million m³] water retention	funding for flood prevention measures other than dykes	future additional retention volume (flood retention, Rhine area)
[ha] natural retention area	funding for new dykes or dyke relocation as a flood prevention measure	future additional retention area
** All reported values refer to annual funding in a given year. However, there might be a temporal distortion between reported values and funding in the State's budget (e.g., if remaining funds are allocated after a programme ends or if evaluated effects from previous years are attributed to estimates for the current reporting period).*		

source: own compilation

2.5 Overview of indicator characterization

The following Table 3 summarizes the characteristics of quantified values in this impact report.

Table 3: overview of characteristics of reported values for NRW Sustainability Bonds

Qualification	Robustness	Attribution	Accumulation
A: long-term outcome (best-needed) **B**: intermediate outcome (best-in-class) **C**: output (best-practice) **D**: activity (standard practice)	**1**: reported primary data **2**: calculated based on primary data/statistics **3**: calculated with the help of auxiliary variables **4**: estimated on the basis of models **5**: third party reporting (non-validated)	**full contribution**: State of NRW is sole contributor or effects can be directly attributed based on allocated funding **partial contribution**: other actors are clearly or likely contributing to the effect	beneficiaries [1] jobs created/sustained [1] projects [1] entities [1] [ha] of sustainable land-use [MWh] of RE production/storage [m2] of new buildings [m2] of building area renovated [km] bicycle lanes [million m³] water retention [ha] natural retention area

source: own compilation

3 Indicators with reference to established methodology

The following list in Table 4 comprises all indicators that have already been operationalized in the previous method paper:

https://nachhaltigkeit.nrw.de/fileadmin/Dokumente/12_Nachhaltigkeitsanleihe/Method_Description_for_Impact_Report_on_Sustainability_Bond_11_12.pdf

This list references the page number as well as changes to primary and auxiliary variables. The first refers to main datapoints directly related to the indicators (e.g. from reporting by state agencies), whereas the latter refers to parameters required to estimate these effects (usually on the basis of linear relationships such as lump costs).

Table 4: list of projects and indicators with no changes or only updates to values

Project	**Indicator**	**Reference** (Teubler & Dietz, 2025)	**Change in Values** (most recent available data)
A: Public transportation for pupils and students	equivalent of paid student tickets	p.11	updated price values (EUR 67.50) according to KCM NRW (2025)
A: Digitalization	equivalent of households with accessibility to glassfibre connections	p.13	updated value for increase in FTTB/H accessibility (from 31.56% in 2023 to 38.96% in 2024 according to Bundesnetzagentur (BNETZ, 2026)) and the number of private households (8,717,000 in 2023 according to (IT.NRW, 2025))
B: Measures to ensure medical care	equivalent of promoted general practitioners in rural regions	p.14	no changes
B: Conservation, remediation and enlargement of university clinics as well as other investments	measures to modernize and equip university clinics	p.14	no changes (number of measures based on the most recent budget plan in 2025)
B: Childcare in special cases	equivalent of supported children from vulnerable backgrounds	p.14	no changes
B: Excellence Strategy	promoted excellence universities and clusters	p.14	no changes (primary data)
B: Return programme for highly qualified young researchers from abroad	returned researchers	p.11	no changes (primary data)
B: Social work at schools	equivalent of paid social school workers	p.11	no changes
B: Support for family centres/promotion of cooperation of family formation and counselling centres with family centres	equivalent of promoted family centres	p.11	no changes
B: Exemption to contribution for parents for the last two years of day care	supported children benefiting from day-care exemptions for parents	p.11	no changes; value directly reported in budget plan 2025 (296.680 in group form III)
C: Urban Development Programmes	equivalent of paid urban development projects	p.12	value and allocation of state funding to the programmes; new subprogramme on “Project Social Cohesion”
D: Occupational integration of people with disabilities	equivalent of jobs promoted for persons with disabilities	p.12	no other than value in state expenditures

Project	**Indicator**	**Reference** (Teubler & Dietz, 2025)	**Change in Values** (most recent available data)
D: Environmental economy, sustainable economy	regional projects (ongoing) for strengthening the green economy	p.14	no changes; primary data directly reported in a database
E: EU school programme	equivalent of children/students supported with healthy meals	p.12	change in state expenditures and integration of most recent reported values for 2023/2024
F: Measures to combat poverty and for social cohesion	promoted programmes fighting poverty	p.14	no changes; number of programmes directly reported in budget plan for 2025
F: European Social Fund 2021-2027 (State's share)/Programmes "No dead-end qualification"/"No dead-end qualification (compact)"	promoted pupils with handicap supported for career-entry promoted (other) pupils supported for career-entry (Berufseinstiegsbegleitung)	p.15	no changes; number of beneficiaries belong to the same cohort
F: Promotion of equality and universities	promoted female professorships	p.15	no changes
F: Equality and potential development in work and society	competence centres women and profession (each entity represents one region)	p.12	no change to method (direct reporting), but change in reporting source (MKJFGFI (2026) instead of direct reporting in budget plan)
F: Protection from violence	promoted women shelter places	p.12	no other than value in state expenditures and thus estimated effect
	promoted women counselling centres	p.12	no changes (primary data)
	promoted men shelter places	p.12	no changes
F: Promoting integration of migrants living together in diversity	equivalent of paid personnel for integration centres	p.15	no changes
F: Measures for children from refugee families and for young refugees	equivalent of number of supported underage & unaccompanied refugee children	p.15	no changes
F: Measures against homelessness	equivalent of vulnerable persons (at risk of homelessness) receiving help	p.15	no changes to methodology; estimate still relying on 2024 data (no new data available)
F: Measures to prevent child and youth poverty	equivalent of promoted children & youth for poverty prevention	p.15	no change to methodology; update of the number of children in SGB II according to (MKJFGFI, 2025)
G: Energy storage	promoted thermal storage capacity	p.16	no change to methodology; effect estimated based on total costs of EUR 30m
H: Enhancement of resource efficiency	promoted experts for resource efficiency and carbon accounting	p.16	no changes
I: Hydrogen-energy carrier of the future (State's share)	promotion of innovation projects	p.16	no changes (number of projects directly reported in budget plan)
J: Protection of nature	equivalent of paid full-time project work for biological stations	p.12	no other than value in State expenditures

Project	**Indicator**	**Reference** (Teubler & Dietz, 2025)	**Change in Values** (most recent available data)
K: Clean Transportation - Infrastructure for cyclists and pedestrians (main benefit)	additional bicycle lanes	p.12	none other than value in State expenditures
	maintained bicycle lanes	p.12	
K: Infrastructure for cyclists and pedestrians (co-benefit)	potential GHG savings per year and over lifetime	p.12	none other than value in State expenditures
K: Ticket for regional public transportation in Germany	equivalent of beneficiaries for Deutschland-Ticket (public transport)	p.16	none other than the value in state expenditures and the price of the tickets (EUR 58 for 2025)
	potential GHG savings per year		
L: Flood protection	future additional retention volume (flood retention, Rhine area)	p.12	no changes as these indicators refer to the future total of measures
	future additional retention area (dyke relocation, Rhine area)	p.12	
M: Forests reforestation	re-afforestation of damaged forests	p.13	update based on primary data by the Ministerium für Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen (15,000 ha according to (MLV NRW, 2025))

source: current Impact Report (#13) and Method Paper 2025 (Teubler & Dietz, 2025)

4 Indicators with new or adapted methodology

B: PlusKita and language courses at childcare facilities

The project indicator used in previous impact reports was obtained by a direct report on the amount of PlusKitas in NRW and is extended for the current report. The methodology for the indicator on “equivalent of funded PlusKita childcare places” (activity C_3) is based on (i) the reported budget item and (ii) data on public childcare expenses in Germany 2025 from IW Köln (Geis-Thöne, 2025). To obtain an estimate of the indicator, we used the average public expenses in 2025 of the federal states in Germany. PlusKita childcare places indicate a greater need for language support and are therefore more expensive than regular childcare places in Germany. Under the assumption that the expenses for a PlusKita childcare place exceed the regular costs by 20% of the German-average, we estimated that in 2025 NRW has funded 7,765 PlusKita places.

B: Combating the dangers of addiction

The indicator „equivalent of persons benefitting from support of addiction centres“ (activity C_4) is based on different statistical information: (i) NRW’s current population (18,034,454 according to IT.NRW (2024)), (ii) estimated share of population suffering from addiction (20 to 25% according to eligible asset report for NRW Sustainability Bond #13) and (iii) the project data base of „Suchtkooperation NRW“ on yearly provided support in addiction centres (7 such projects according to Suchtkooperation NRW (2026)). Using that information, we calculated the average number of annual provided support (2016-2022) obtaining that on average 87,564 persons had the opportunity to receive support in one of NRW’s addiction centres.

B: Foundation for Nature and Sustainable Development

The foundation for nature and sustainable development (Stiftung Umwelt und Entwicklung Nordrhein-Westfalen) promotes projects in the context of development, interculture, organisational development, fundraising, and environment. The previous impact report accessed the project data base to allocate the funding by the state in a given year to the number of promoted projects (with a certain amount of uncertainty due to the funding durations of these projects). With the publication of its most recent report, the foundation now depicts the funding over all projects since 2001 (Stiftung Umwelt und Entwicklung Nordrhein-Westfalen, 2025). Thus, the indicator remains the same as "promoted projects towards sustainable development" (D_2) but it is now calculated on the basis of the overall funding of EUR 100.345m for 1,978 projects (lump 'cost' factor of EUR 50,731 per project).

H: Climate protection technologies and low-emission mobility

Several previous impact reports estimated investments into low-emission mobility in form of e.g. the number of electric vehicles. The new indicator on “equivalent of beneficiaries of support for low-carbon mobility investments” (output C_3) now accumulates the effects of various different programmes. We used information on the maximum funding amounts for recipients derived from the funding guidelines (MWIKE, 2026b) as well as the overall expenditures for both climate protection and low-emission mobility as the basis for our calculations. Furthermore, NRW’s Ministry of Economic Affairs reported the average annual shares of the overall budget that have been allocated towards different funding purposes in the past (MWIKE, 2026a). Under the assumptions that (i) the shares were similar in 2025 to

the averages over the project-period if not reported otherwise and (ii) every beneficiary has been granted with the maximum funding amount possible; we estimated that 7,919 beneficiaries profited from the project. This estimation already includes directly reported beneficiaries in 2025 for some funding categories and is combined with our calculations.

In the area of climate protection (budget results in 2025 refer to both climate protection and low-emission mobility), the number of "promoted geothermal systems for households" (output C_4) is reported (3,400) with primary data according to MWIKE (2026c). However, there is no information on the actual expenditures for these geothermal systems, which is why we estimate the financial attribution on the basis of two auxiliary values: the maximum funding of EUR 30 per metre of drilling to access the geothermal heat and the assumption that a typical drilling depth reaches 100 metres. This amounts to a financial attribution of EUR 10.2m.

M: Climate Action/Adaptation to climate change

The indicator "promotion of climate change adaptation measures" (D_3) refers to a portion of the overall programme. EUR 1.4m of the budget result in 2025 (out of EUR 2.8m) is dedicated to such measures. According to the funding announcement (MUNV, 2025), projects are separated by a threshold of EUR 200,000. Projects below this value are considered to be easy to implement and awarded via a first-come first-served basis, whereas projects above this value are considered to be more comprehensive adaptation measures by e.g. communities which require a two-step application to access the funds. Due to lack of information on the actual shares between these two project types (or any other available ex-ante primary data), we use this threshold to estimate that at least seven measures were funded (EUR 1.4m divided by EUR 200k).

5 Discussion

5.1 Limitations of Carbon Accounting in NRW Sustainability Bond #13

The principles of Carbon Accounting, that is, the estimation of potential annual and lifetime savings of Greenhouse Gas Emissions for NRW Sustainability Bond impact reports, are established in the previous methodology (Teubler & Flynn, 2024). These remain unchanged. This section focuses instead on the particular limitations in each project category for which such effects were estimated.

Several assumptions are necessary to calculate the financed GHG savings for the project categories. These assumptions relate to costs on the one hand (e.g., construction costs of a building) and to the physical changes on the system on the other hand (e.g., the actual difference in energy demand after an energetic refurbishment). These assumptions were usually made from a conservative point of view, rather underestimating the positive effects for the environment. Exceptions to this rule are assumptions regarding the replacement of buildings. If new energy-efficient buildings are constructed, but old buildings continue to be used, then the overall energy demand of a university increases, thus also emitting more GHG emissions.

The following Table 5 lists the assumptions made for calculations and estimates their effect on the avoidance of GHG emissions.

Table 5: estimation of the effects of assumptions on the potential for avoided GHG emissions (underestimated: conservative results; overestimation: optimistic results)

Bond Category	Assumptions	Impact on GHG emissions	Over- and under-estimation
Public Transport Tickets & Cycle Paths	Modal shift assumptions in the area of bike paths	The GHG reduction potentials are probably lower in the analysis than in reality, because data from conservative scenarios were used and public transport systems are not considered.	+ (underestimated)
	Modal shift assumptions in the area of public transport tickets	The robustness of the empirical survey cannot be validated. However, it can be assumed that the empirical effects for Germany are close to the estimate effects for the State of NRW. Since we used the lower boundary of avoided car travel, we assume that the results are slightly underestimated.	+ (underestimated)
	Assumptions on the cost of cycle paths	The cost factor for the construction of municipal cycle paths is based on a 5-year average and can be considered robust. The cost factor for high-speed cycle paths is based on published construction costs. Since many of the cycle paths concerned are still under construction at the time of the analysis, the real costs could be higher. This would lead to an overestimation of the GHG reduction potentials for fast cycle paths in the analysis.	o (no final estimate)

Bond Category	Assumptions	Impact on GHG emissions	Over- and under-estimation
University clinical Buildings	New buildings replace old buildings	The GHG reduction potentials are rather overestimated due to this assumption, because the total heating energy requirement of a university facility increases if existing buildings continue to be used.	- (overestimated)
	Assumptions on construction costs	The data used cannot be used to calculate robust average values for the construction costs of new buildings and those to be renovated. The actual usable area increased or converted by the investments, and thus the GHG reduction potentials, cannot be reliably determined.	o (no final estimate)
	Non-consideration of the electricity consumption	Additional GHG reduction potentials could be realised through savings in electricity consumption. However, this is not the case for all building types and uses.	o (no final estimate)
	Assumptions for saving heating energy in buildings	For the new and replacement construction of buildings, data from the existing stock of public buildings were used, which lead to energy and GHG savings compared to the GEG standard and with regard to the usable area. It can be assumed that in reality greater savings will be achieved. However, the development measures were only mapped on the basis of a reference building. The allocation of these specific GHG reduction potentials to all implemented measures is therefore subject to high uncertainties.	+ (underestimated)

source: own presentation

5.2 Outlook

NRW Sustainability Bond #13 refers to the results of the state budget of the previous year[2]. This means that, in many cases, there is yet no or little information from state sources regarding reported direct effects or suitable auxiliary values. The authors intend to address this time delay challenge by integrating additional considerations regarding the indicator robustness.

Moreover, reporting on GHG effects has decreased over the years as new types of projects replace other projects that were easier to associate with potentials for GHG reductions. The authors aim to investigate new areas to model such co-benefits in future reports (e.g. on the installation of charging stations).

Such changes, as well as any other changes to the current methodology, will be published as a further update of the report at hand.

[2] Statistics report data with delays of at least one or two years and press releases on the success of measures usually look back at previous implementations. This means that for most projects in 2025, data from 2024 can be considered to be the best-case for data availability.

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The following page depicts the set of indicators for NRW Sustainability Bond #13 that were derived from the methods discussed in this method paper.

Category (quantified share in %)	budget results 2025	Indicators	Quality 2025	Share 2025	Indicator Value*	
A: Affordable Basic Infrastructure (25% assessed here)	EUR 156.2m	equivalent of households with accessibility to glasfibre connections (a)	C_3	10.5%	115,600	beneficiaries (full contribution)
		equivalent of paid student tickets (b)	C_3	14.5%	29,600	beneficiaries (full contribution)
B: Access to Essential Services (67% assessed here)	EUR 1,599.1m	equivalent of persons benefitting from support of addiction centres	C_4	0.8%	87,600	beneficiaries (partial contribution)
		equivalent of promoted general practitioners in rural regions (c)	C_3	0.2%	50	jobs created/sustained (partial contribution)
		measures to modernize and equip university clinics	D_1	13.9%	32	projects (full contribution)
		equivalent of funded PlusKita childcare places (c)	C_3	7.5%	7,765	beneficiaries (full contribution)
		returned researchers	C_1	0.3%	29	jobs created/sustained (full contribution)
		equivalent of paid social school workers (c)	C_3	3.6%	800	jobs created/sustained (full contribution)
		equivalent of promoted family centres (c)	C_3	5.3%	4,200	entities (partial contribution)
		equivalent of supported children from vulnerable backgrounds (c)	C_4	1.1%	1,900	beneficiaries (partial contribution)
		supported children benefiting from day-care exemptions for parents	C_1	32.9%	296,700	beneficiaries (partial contribution)
		promoted excellence universities and clusters	D_1	1.5%	16	entities (full contribution)
		promoted projects towards sustainable development	D_2	0.2%	69	projects (full contribution)
C: Affordable Housing (100% assessed here)	EUR 104.5m	equivalent of paid urban development projects (c) | (d)	D_3	100.0%	61	projects (full contribution)
D: Employment Generation (100% assessed here)	EUR 3.6m	equivalent of jobs promoted for persons with disabilities (c) | (e)	B_3	40.2%	73	jobs created/sustained (partial contribution)
		regional projects (ongoing) for strengthening the green economy	D_1	59.8%	13	projects (partial contribution)
E: Food Security and sustainable food systems (100% assessed here)	EUR 4.0m	equivalent of children/students supported with healthy meals	C_2	100.0%	253,600	beneficiaries (partial contribution)
F: Socioeconomic advancement and empowerment (73% assessed here)	EUR 114.9m	promoted programmes fighting poverty	D_1	2.6%	3	projects (full contribution)
		promoted students with handicap supported for career-entry (f)	B_2	4.3%	6,200	beneficiaries (full contribution)
		promoted (other) students supported for career-entry (Berufseinstiegsbegleitung)	B_1	2.9%	5,000	beneficiaries (full contribution)
		promoted female professorships	C_2	2.5%	18	jobs created/sustained (partial contribution)
		competence centres women and profession (each entity represents one region)	D_1	5.7%	16	entities (partial contribution)
		promoted women shelter places	C_1	20.8%	708	beneficiaries (partial contribution)
		promoted women counselling centres	D_1	2.2%	62	entities (partial contribution)
		promoted men shelter places	C_1	0.9%	20	beneficiaries (partial contribution)
		equivalent of paid personnel for integration centres (c)	C_3	6.6%	151	jobs created/sustained (full contribution)
		equivalent of number of supported underage & unaccompanied refugee children	B_3	10.1%	7,300	beneficiaries (partial contribution)
		equivalent of vulnerable persons (at risk of homelessness) receiving help (g)	B_3	3.8%	2,108	beneficiaries (full contribution)
		equivalent of promoted children & youth for poverty prevention	B_2	10.5%	400	beneficiaries (partial contribution)
G: Renewable Energy (100% assessed here)	EUR 5.0m	promoted thermal storage capacity	C_2	100.0%	173	[MWh] of re production/storage (full contribution)
H: Energy Efficiency (63% assessed here)	EUR 48.6m	promoted experts for resource efficiency and carbon accounting	C_1	14.1%	35	jobs created/sustained (partial contribution)
		equivalent of beneficiaries of support for low-carbon mobility investments	C_3	28.4%	7,900	beneficiaries (partial contribution)
		promoted geothermal systems for households (i)	C_4	21.0%	3,400	projects (partial contribution)
I: Pollution Prevention & Control (99% assessed here)	EUR 112.1m	promotion of innovation projects	D_1	98.8%	45	projects (partial contribution)
J: Environmentally sustainable management [...] (100% assessed here)	EUR 48.3m	equivalent of paid full-time project work for biological stations (c)	C_3	100.0%	500	jobs created/sustained (full contribution)
K: Clean transportation (97% assessed here)	EUR 447.3m	additional bicycle lanes	C_1	0.9%	89	[km] of bicycle lanes (partial contribution)
		maintained bicycle lanes	C_1	3.6%	19	[km] of bicycle lanes (partial contribution)
		equivalent of beneficiaries for Deutschland-Ticket (public transport)	C_3	92.1%	893,700	beneficiaries (full contribution)
L Sustainable water and wastewater management (87% assessed here)	EUR 40.1m	future additional retention volume (flood retention, Rhine area) (j)	C_1	n.a.	74	[million m3] water retention (partial contribution)
		future additional retention area (dyke relocation, Rhine area (j)	C_1	n.a.	922	[ha] natural retention area (partial contribution)
M: Climate change adaptation (77% assessed here)	EUR 6.0m	promotion of climate change adaptation measures	D_3	23.6%	7	projects (partial contribution)
		re-afforestation of damaged forests	B_1	53.2%	15,000	[ha] of sustainable land-use (full contribution)

* rounded in most cases to avoid the appearance of accuracy where it is not warranted

(a) increase in capacity as basis for estimating ex-ante effects

(b) potential number based on funding and ticket prices alone (without other promotions)

(c) based on lump cost factors (e.g. maximum funding per unit, or salary of hired persons)

(d) based on lump promotion and states' share for urban development programs in NRW (including other programs)

(e) the initial promotion relates to job creation and is therefore considered a intermediate-outcome rather than project output

(f) Diminished funding while retaining the effect is the result of a discontinued project. We changed the robustness to 5 as a result (remaining pay-out for beneficiaries).

(g) Initial indicator for budget year 2024 derived from absolute values over longer periods of time. Indicator for 2025 based on this effect with the help of a lump sum factor.

(h) This refers to grants as part of the state programme for "Emissionsarme Mobility" (low-emission mobility) for the acquisition of public or private charging stations, zero-emission vehicles, bicycles and low-emission service vehicles.

(i) The indicator is directly reported but is part of a larger set of measures and projects. We used the funding factor of 30 EUR per metre (drilling depth, primary data), the number of promoted systems (3,400, primary data) and an estimate of 100 metre per system to attribute funding to this effect.

(j) These estimates relate to planned measures in the NRW part of the river Rhine area from 2022 onward. The direct funding for these measures in 2024 (compared to the total funding) could not be ascertained.

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