

Methodology | May 2024

Method Description

Impact Report

NRW Sustainability Bond #10

Indicators, Data & Methods

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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1 Scope of the Report

The Wuppertal Institute analysed the NRW Sustainability Bond #10 (2023) on behalf of the State Government of North Rhine-Westphalia (NRW). The report at hand provides a description of the data and methods 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 Bond #9 (Teubler et al., 2023), which is, in most cases, applying the same rationale, methods and types of data sources also shown in the report at hand. Projects, or project categories, which have been part of NRW Sustainability Bond #9, but are no longer part of NRW Sustainability Bond #10, are no longer part of this methodology report.

Projects in the Sustainability Bond #10 were classified by the issuer in the 2023 framework into 14 different categories from A to N (Ministry of Finance of the State of North-Rhine Westphalia, 2023). Of these categories, the categories A to F are more closely related to desired social effects and G to N 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. It particular describes how indicators are qualified, how robustness of values is evaluated, how effects are attributed and how effects can be accumulated.

Section 3 describes social effects in categories A to F. Only projects with at least one quantified indicator (above the input level) are discussed here.

Section 4 describes environmental effects in categories G to N. Again, only projects where at least one indicator was quantified are discussed.

Section 5 describes methods and data for the estimation of GHG savings in the following systems: low-carbon public transport, cycling infrastructure as well as construction and modernisation of buildings.

Section 6 lists all literature sources.

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

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 the simplified Theory-of-Change approach introduced in Bond #8 (see Teubler & Schuster, 2022) and further discussed in Teubler, (2024)), indicators are classified according to their location in a linear cause-effect chain:

- 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 or monitoring reports. 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 randomized 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 (State of North Rhine-Westphalia, 2021) 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.

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 (such as cost factors in regulations) or simple models in order to estimate the effects in reference to the funding in the bond. 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 (Teubler & Brauneis, 2022). Robustness can be directly applied to the quality of the indicator (A-D) with the help of indices.

D₂ 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)	the number of returned researchers in the <i>return programme for highly qualified young researchers from abroad</i>
2	directly estimated from primary data	States' share (estimate) for women shelters places (monitored) in NRW compared to funding from all sources (State and EU funding)
3	calculated with the help of secondary sources or auxiliary variables	the number of social school worker jobs based on annual lump costs per person awarded by the associated regulation
4	estimated on the basis of models with a simplified universal mechanism	conservative estimate for number of created jobs for persons with disabilities based on maximum funding per job available
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)

Attribution of effects to the issuer

The impact reports for bond issues #2 to #7 focused on indicators that could clearly be attributed¹ 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 allow 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.*

All other values are considered to be a partial contribution, where it is not possible to attribute the actual contribution of the State or NRW and its institutions in a robust manner.

Accumulation of effects within and with other bonds by the issuer

The summation of reported values requires a process of normalization. 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 normalization 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
[ha] of sustainable land-use	funding to enable, expand or sustain sustainable land-use	re-afforestation of damaged forests

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
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

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

source: own compilation

Outlook on methodology

The next step is to focus on a potential alignment of methods and depiction of results across impact reporting for State bonds in Germany. In particular, it has to be investigated, and discussed, whether the current differences in reporting for the Green Bond Baden-Württemberg (Ministerium für Finanzen Baden-Württemberg, 2023) and the NRW Sustainability Bond (both of which are assessed by Wuppertal Institut) should be aligned more closely as well as if and how the new European Green Bond Standard (European Parliament, 2023) affects the reporting of indicators or their calculation and depiction.

The second future update relates to the explication of causal pathways for desired changes, as discussed and suggested in “Logic Model for Environmental, Social, and Governance (ESG) Impact Pathways and Assessments” (Teubler, 2024). Although it will not be possible to draw-out all causal relationships between all projects in the Bond and their corresponding SDGs, some generic relationships might be applicable and of interest to investors. For example, the generic ESG Logic Model for Climate Change Mitigation according to the EU-Taxonomy in Teubler, (2024) might be used to depict and assess likely causal mechanisms for a contribution to overarching goals.

3 Social Effects

A: Affordable basic infrastructure

In total, EUR 351.8m of the budget result are allocated to projects in this category, of which 100% could be quantified regarding their impacts.

Broadband expansion/Digitalization

The budget result in this category (EUR 172.8m) is allocated to broadband expansion for households, industries as well as schools, universities, and hospitals. Since this measure is part of the NRW Sustainability Bond (#4 to now #10), considerable progress has been made in this regard. According to reports by the Federal Ministry for Digital and Transport (BMVI, 2022), the access of households in NRW to bandwidths of 50 Mbit/s and more increased between 2017 and 2021 from 83.3% to now 96.5% (difference of 13.2 percentage point). For commercial locations, it increased even more from 80.0% in 2017 to 95.4% in 2021 (increase of 15.4 percentage point). The state funding in Sustainability Bond #8 contributes to these achievements in relation to both private investments and federal funding. According to PwC (2021), about 390,000 households were promoted as a result of both federal funding (EUR 948m) and state funding since 2015. If typical promotional shares are assumed (50% from federal, 40% from co-funding by NRW), the budgeted funding for NHA NRW #10 (EUR 172.7m for co-financing as budget result in 2023) therefore attributes to circa 58,100 households that will benefit from better bandwidth in the future.

Public transportation for low-income citizens

The State of NRW supports financially price discounts of its municipalities for social tickets. There are different public transport systems and different tariff landscapes in the State. It is therefore not possible to attribute the support of the State to an actual number of beneficiaries or any desired societal outcomes beyond these discounts. However, a typical social ticket price can be used to estimate the overall effect. Assuming a monthly rate of approximately EUR 41.20 per ticket (VRR, 2023) the State funding of EUR 39.8m alone, is sufficient to fund 80,500 tickets in 2023.

Public transportation for pupils and students

In line with the methodology of previous impact reports (from #2 onward), it can be estimated how much GHG is potentially saved by usage of pupil and student tickets compared to car travel (see section Co-Benefits for Climate Change Mitigation). Based on a funding of EUR 139.4m and in reference to the current GHG intensities of transport systems in Germany, Bond #10 can be attributed to 8.3% of the total costs of the tickets. As a result, circa 101,900 tickets and 10,250 tonnes of potentially saved GHG emissions per year can be attributed to the bond.

B: Access to essential services

In total, EUR 1,293m of the budget result are allocated to projects in this category. Of this sum, EUR 769m or 59.4% could be assessed in the report at hand.

Vaccination against SARS-CoV-2

The funds are intended for purposes of (1) purchasing vaccine supplies (0.6% of total state and federal funding), (2) procurement and logistics (3.3%), (3) reconstitution and separation of vaccines (2.4%), (4) scientific support (0.1%), (5) provision of unscheduleable expenses (1.1%), (6) vaccination costs of doctors (49.3%) and (7) costs for vaccination centres (43.2%) (Ministerium der Finanzen NRW, 2021). The last item is assumed with costs of EUR 0.5m to EUR 1.0m per month and centre (the budget plan estimates EUR 0.75m on average). We estimate that the expenditures in Bond #10 of EUR 13m can be allocated to a direct of funding of EUR 2.8m (43.2% for centres as well as 50% co-financing) and that these funds are sufficient to finance 0.3 facilities (full contribution).

Professional education of geriatric nurses

The State of NRW supports the education of geriatric nurses with EUR 1m in 2023, which is equivalent to the promotion of 200 students per year (at EUR 380 school cost lump sum per student according to §5 of AltPflG NRW).

Return programme for highly qualified young researchers from abroad

In 2023, EUR 7.6m were used to facilitate the return of 70 researchers and their research groups (primary data).

PlusKita and language courses at childcare facilities

The budget results in 2023 amount to expenditures of EUR 103m for these measures. According to the lump sum calculation from previous impact reporting (Teubler & Hennes, 2021), this funding can be attributed to circa 2,600 full-time positions for pedagogical educators with additional qualification in language support (at an assumed yearly salary of EUR 40,365, according to oeffentlicher-dienst.info (2022)).

Measures at day care centres in response to the coronavirus pandemic

This funding is aimed at the provision of day-to-day helpers for day-care centres during the pandemic as well as funding for Covid-19 related schooling and equipment. In previous budgets (State of North Rhine-Westphalia, 2020) the ratio between expenditures for day-to-day helpers compared to other Covid-19 related measures was at 90%. By applying the same ratio to the current expenditures for 2023 (EUR 6m), EUR 5.4m can be attributed to funding these jobs. At an annual salary of EUR 14,700 (part-time according to the State of North Rhine-Westphalia (2021b)) this contributes to the promotion of circa 400 jobs.

Social work at schools

The State promotes social workers at schools with EUR 57.4m, which corresponds to the promotion of 900 social workers (at annual costs of EUR 64,815 per position in line with the previous lump cost factor in Teubler & Hennes (2021)).

Bund-Länder-Covenant for the expansion of universities (State's share)

The third Bund-Länder-Covenant is financed by both federal and State budgets (with expenditures of EUR 113.7m in 2023). It is intended to recruit additional staff, increase the proportion of women in professorships, enable high-quality studies, increase success of studies, increase the proportion of first-year students and increase the number of vocationally qualified students at universities (see GWK (2021) for a detailed monitoring of 2019). Although the base year for comparison (and financing) is 2005, the third (current) covenant covers the period of 2016 to 2020 (financed until 2023).

The current funding period focuses mainly on additional first-year students. Additional first-year students are funded with EUR 26,000 for four years, which is co-financed 50/50. The estimated additional 22,900 first-year students in NRW (based on reporting for the previous period in 2022) can therefore be attributed to funds of EUR 74.6m.

Exemption to contribution for parents for the last two years of day care

The last two years of day-care are exempt from costs for parents in NRW (Ministerium des Innern NRW, 2024), which is promoted in Bond #10 with expenditures of EUR 444.6m. This is equivalent to 300,000 children (partial contribution) above the age of 3 in 2022/2023 (Ministerium der Finanzen NRW, 2023, p. 75).

Support for family centres

In 2023, EUR 72.5m were attributed to family centres in socially deprived areas in NRW. Based on a lump promotion of EUR 20,000 per centre and year (see Teubler & Hennes, 2021) this funding can be attributed to 3,600 family centres (partial contribution).

C: Affordable housing

In total, EUR 90.9m of the budget result are allocated to programmes in this category. Of this sum, EUR 57.5m or 63% could be assessed in the report at hand.

Urban development programmes

Several urban development programmes are addressed here, of which the following could be assessed using the same metric: "Urban Reconstruction in the West", "Growth and Sustainable Renewal" and "Social Cohesion". The current report on the NRW urban development programme 2023 (MHKBG, 2023) lists projects for a total funding of EUR 368.2m. From this reporting alone, it is not possible to distinguish what projects are related to which parts of the programme. However, it can be estimated how many projects would be promoted from the NRW Sustainability Bond alone (activity-indicator) when accounting for the State's share. From the overall funding, EUR 202.9m and therefore 52.5% are allocated to state funding. The funding under consideration of the State's share can then be used to estimate the number of projects. Budget results of EUR 41.5m for "Urban Reconstruction in the West" and "Growth and Sustainable Renewal" represent full funding of 13 projects (project equivalents with full contribution) and EUR 16.0m for "Social Cohesion" represents 5 projects.

D Employment generation

In total, EUR 5.1m of the budget result are allocated to projects in this category. Of this sum, EUR 2.6m or 52% could be assessed in the report at hand.

Occupational integration of people with disabilities

The State of NRW promotes directly the creation of jobs for persons with disabilities. Up to EUR 20,000 are provided for each job created (MAGS, 2022). Attributed to the 2023 budget expenditures of EUR 2.6m, at least 132 new jobs were created in this manner as an intermediate outcome of the programme (or even more, but at a lower contribution by the State).

E Food Security and sustainable food systems

In total, EUR 3.4m of the budget result are allocated to one programme in Bond #10. Of this sum, EUR 2.3m or 69% could be assessed in the report at hand.

EU school programme

The EU school programme provides fruit and vegetables as well as dairy products to pupils in its member countries. In addition to the overall EU funding for Germany between 2017 and 2023 (EUR 32.21m for fruits and vegetables, EUR 14.53m for dairy), federal funds are provided as well (Federal State of NRW, 2022). The State of NRW funded the programme in 2023 and monitors the overall success of the programme. Regarding fruit, vegetables and milk, 262,000 pupils benefited in 2021/2022 (Bundesministerium für Ernährung und Landwirtschaft, 2022).

These outcomes can be considered a contribution to beneficiaries in relation to funding for fruit and vegetables compared to dairy (68.9%). Thus, on average, EUR 2.4m of the funding in this category led to these benefits children (partial contribution).

F Socioeconomic advancement and empowerment

In total, EUR 111.9m of the budget result are allocated to projects in this category. Of this sum, EUR 72.1m or 64.4% could be assessed in the report at hand.

Fight against poverty and social exclusion

Out of EUR 6.8m (budget result 2023), circa EUR 6.5m are used to prevent homelessness or help homeless persons to find a home ("Endlich ein Zuhause") (MAGS, 2022). In 2023, 22 communities received funding for that purpose. Based on the success of previous years, it can be estimated that (on average) EUR 2,071 are needed to help one person (Teubler & Hennes, 2021). This translates into a potential of 3,100 persons that benefited from the programme in 2023 (output-indicator).

European Social Fund 2014-2020 (State's share)/Programmes "No dead-end qualification"/"No dead-end qualification (compact)"

Out of EUR 29.2m (budget expenditures in 2023), EUR 15.4m are used to facilitate the career-entry for pupils in NRW. Based on the overall number of participants over the entire project period, total funds of EUR 21.4m (2014-2020) can be attributed to 5,842 participants of the programme (activity-indicator) (MAGS, 2021). This translates into a potential of 4,200 persons that benefited from the programme in 2023 (each participant is supported for 18 months).

Equality and potential development in work and society

This programme is budgeted with EUR 4.9m in 2023. Most of the funds are used for 16 competence centres for women and jobs (activity-based indicator with partial contribution)

(Ministerium der Finanzen NRW, 2023c)². In some regions of NRW, this also includes the support of female entrepreneurs, woman's organizations and networking projects.

Protection from violence

The funds in this category are intended to support women's shelters and their staff (85% of budget plan), women's counselling centres as well as specialized counselling centres for the protection from forced marriage (6.5% of budget plan) and funds for the implementation of the state action plan to combat violence against women and girls (Ministerium der Finanzen NRW, 2023c).

The overall success of these projects is monitored and funds have been expanded over the recent years. Regarding the budget result of EUR 33.4m for 2023, a budget of EUR 28m can be partially attributed to 673 places in women's shelters (monitored output-indicator), and a budget of EUR 2.29m to 62 specialized consulting centres (monitored activity-indicator). These effects were calculated based on the budget results and allocated according to the most current reporting in (MHKBG, 2020).

Since May 2020, the state government has also been funding apartments for men affected by violence at four locations. Currently, 16 such places (monitored output-indicator) are promoted in NRW with a budget result of EUR 0.86m (MHKBG, 2022).

Promoting integration of migrants living together in diversity

The State supports various projects at a municipal level in order to integrate migrants into society (Ministerium der Finanzen NRW, 2023b), with a portion of the budget directly allocated to personnel expenses in the 54 municipal integration centres in NRW. These centres mainly work with migrants who have been in North Rhine-Westphalia for a long time and provide possibilities to support integration and self-organization of the participants. Due to a significant reduction in funding in 2023 compared to 2022, calculations based on last year's report are not applicable. To assess the impact, a metric of promoted jobs per million euros of invested budget is calculated and then applied to this year's budget. This results in a total of 74 jobs being created or sustained with a full contribution (output-indicator). Last year's calculations are based on the annual funding for these persons in two similar programmes (Bezirksregierung Arnsberg 2022h, 2022a).

4 Environmental Effects

G Renewable energy

In total, EUR 190m of the budget result are allocated to projects in this category. Of this sum, EUR 126.5m or 67% could be assessed in the report at hand.

Energy and heat transition investment programme

This project, funded by the state through the *progres.nrw – Klimaschutztechnik* programme, advances climate mitigation technologies by supporting measures such as installing photovoltaic systems, thermal solar systems and training for heat pump installers. By reviewing the monthly report of all approved measures (without record of actual completed measures) (Ministerium für Wirtschaft, Industrie, Klimaschutz und Energie, 2023) two output-indicators were evaluated. With state funding of EUR 0.17m, 156 heat pump expert

² The number of promoted centres has not changed between 2021 and 2022.

trainings were promoted. Additionally, the state supported over 980 photovoltaic roof systems, capable of producing a total of 75,800 MWh of renewable energy. This calculation was based on the estimated cost of a 1 kWp PV rooftop system in Germany and the total funded kWp. The location of Düsseldorf was chosen to estimate the average annual production per kWp.

H Energy efficiency

In total, EUR 121.4m of the budget result are allocated to projects in this category. Of this sum, EUR 31.7m or 26.1% could be assessed in the report at hand.

Low emission mobility

Similar to the previous project in category G, this project is partially funded by the State through the progres.nrw – Emissionsarme Mobilität programme, which aims to achieve low emission mobility. Two output-indicators and one activity-indicator were assessed in this report. Within the programme, which is funded with a total of EUR 90m, 13,100 charging stations were approved in 2023, of which 1,900 are public (Ministerium für Wirtschaft, Industrie, Klimaschutz und Energie, 2024). These are funded with a total of EUR 14m, with the assumption of a maximum funding of EUR 1,500 and EUR 1,000 per public and private charging station respectively. Furthermore, the procurement of 1,400 vehicles with zero tailpipe emissions (funding EUR 14m, assuming maximum funding per vehicle at EUR 10,000) and 2,100 electric cargo bikes (funding of EUR 3.7m, assuming maximum funding at EUR 2,000 per bike for communal use, and EUR 1,000 per bike for commercial use) were approved and promoted (Ministerium für Wirtschaft, Industrie, Klimaschutz und Energie, 2024).

I Pollution prevention and control

In total, EUR 32.8m of the budget result are allocated to projects in this category. Of this sum, EUR 8.3m or 25.1% could be assessed in the report at hand.

Innovation for the climate-neutral energy and economic system of the future

This project, which is funded through the state's progres.nrw – Innovation programme, supports various scientific projects revolving around innovation towards clean energy and a circular economy. 8 projects were supported in 2023 with a total funding of EUR 8.3m.

J Environmentally sustainable management of living natural resources and land use

In total, EUR 42.5m of the budget result are allocated to projects in this category. Of this sum, 100% could be assessed in the report at hand.

European Agricultural Fund for Rural Development – EAFRD (State's share)

Through the State's share of the EAFRD, a network of 40 biological stations is supported (full contribution) (Dachverband der biologischen Stationen in Nordrhein-Westfalen, 2023). They serve as an important link between private and public efforts in order to implement conservation work on site. The areas are protected from intensive economic exploitation and can therefore develop in a more environment-friendly way. The budget result of EUR 42.5m created/sustained 400 full-time work positions (output indicator calculated with the help of auxiliary variables). The calculations are based on funding for project hours

(EUR 60.95/hour) and hours per year of full-time (1,706 hours/a) in North Rhine-Westphalia (Ministerium des Innern des Landes Nordrhein-Westfalen, 2005)³.

K Clean transportation

In total, EUR 76.6m of the budget result are allocated to one project in Bond #10, of which EUR 33.7m or 44% could be assessed in the report at hand.

Construction and maintenance of bicycle paths along country roads

The new Bicycle Path Programme 2023 (Ministerium für Umwelt, Naturschutz und Verkehr, 2023), funded entirely by the state with a total budget of EUR 33.7m, approved the construction of 108km of new bicycle paths along country roads, at a cost of EUR 21.15m. Additionally, the programme funded the maintenance of 83km of existing bicycle paths along country roads, with a budget of EUR 12.5m. The measures also include the pilot project “Bürgeradwege” and other initiatives.

L Sustainable Water and wastewater management

In total, EUR 76.1m of the budget result are allocated to projects in this category, of which 64.9m or 85.0% are assessed for this report.

Flood protection

According to the State’s budget plan , EUR 64.9m out of EUR 76.1m are solely dedicated to flood protection. As of now, there is no data on recent activities that could be attributed to the Sustainability Bond. However, the German federal agency for hydrology (BfG) has modelled the physical outcomes of flood protection measures in Germany from 2022 onward (Hatz et al., 2021). This includes both dyke re-locations and flood retention measures for Rhine areas in NRW from 2022 onward. According to this study, the State of NRW contributes (partially) to an additional future retention area of 922 ha and a future additional retention volume of 73.8 million m³.

M Climate change adaption

In total, EUR 39.6m of the budget result are allocated projects in this category. Of this sum, 100% could be assessed in the report at hand.

Climate Action/Regional Climate Adaptation Measures (LIFE)/Adaptation to climate change

In order to achieve the State’s climate goals and to develop the protection of nature, the EU programme LIFE supports environmental and conservation projects (activity indicator) (Ministerium für Umwelt, Naturschutz und Verkehr, 2024). In 2023, 12 projects were promoted (partial contribution- directly monitored) with budget expenditures of EUR 15.4m.

Forests reforestation

In order to cope with damaged spruce wood due to storm, droughts and bark beetles, the State supports the re-afforestation of damaged forests (Landesregierung NRW (State Government of NRW), 2019; Ministerium für Landwirtschaft und Verbraucherschutz, 2023). In 2023, EUR 24.2m were funded. This represents a full contribution to 35,625 ha of sustainable land-use (full contribution- monitored intermediate outcome indicator).

³ as of 2023

N Green buildings

In total, EUR 434.8m of the budget result are allocated to projects in this category. Of this sum, EUR 278.6m or 64.1% could be assessed in the report at hand.

The project in this category contributes to two distinct indicators: (i) university clinic expansion and (ii) university clinic modernisation. The allocation of funds to each category, as well as of shares for actual construction and modernisation activities is based on primary data from State budgets for previous measures at the different locations in NRW.

Expansion of university clinics

Based on previous reporting on shares of expenditures for the different programmes as well as different types of measures (including such measures that do not add floor space), it could be estimated that expenditures of EUR 238.7m are associated with new clinic buildings. It can also be estimated, in line with previous cost estimates (see section "Modernisation of educational and public health facilities"), that 49,100 m² of floor space were added in 2023 from this funding (full contribution).

Modernisation of university clinics

For modernising, Bond expenditures of EUR 2.0m can be associated with university clinics in line with previous expenditures. It is estimated (see Modernisation of educational and public health facilities) that this translates into a full contribution to 97,750 m² of renovated floor space in 2023.

5 Co-Benefits for Climate Change Mitigation

This chapter describes how the calculation of avoided greenhouse gas emissions (GHG reduction) is carried out (sometimes also referred to as scope 4 emissions)⁴. The underlying methodology has been established in previous reports, and has remained unchanged since then.

The GHG reduction potentials are estimated with the help of the indicator "Carbon Footprint". This indicator corresponds to the internationally recognised methodology of the Intergovernmental Panel on Climate Change on the classification and characterisation of greenhouse gases (Qin, Manning, Chen, et al., 2007; Qin, Manning, Marquis, et al., 2007). The Carbon Footprint records the greenhouse gases emitted by products and services over their entire life cycle. It expresses the greenhouse gas potential, i.e., the influence on anthropogenic warming of the global climate. The emissions of various greenhouse gases are measured with the respective global warming potential for 100 years in the unit CO₂ equivalents (CO₂ equivalent or CO₂e) (Bernstein et al., 2008).

In the presented method description, published GHG factors of the Research Centre for Energy Economics e.V., the German Federal Environment Agency and the energy balances of the federal states are used. These GHG factors (e.g., CO₂e for 1 kWh of electricity) usually refer to the use phase only (e.g., the combustion of fuel) and therefore do not include upstream and downstream processes (utilities, infrastructures, and end-of-life).

Conventions and Variables

Even if certain standards have been established in the Harmonized Framework, they do not specify a specific procedure for determining the Carbon Footprint or the avoidance of GHG emissions (also called GHG savings in this report). Therefore, the following conventions and variables had to be defined for each project group (the issue of double-counting and additionality is further discussed in the following section).

Reference system: In order to calculate the GHG reductions, an initial or reference system must be defined against which the savings are measured. This is the previous system or business-as-usual and its emissions. An investment measure can either replace the original system with a system with lower emissions (e.g., increasing the heating efficiency of buildings) or provide alternative services with lower GHG emissions (e.g., using a public transport system instead of a car). The difference between the emissions of the subsidised system and those of the initial system results in the potentials for GHG reduction.

Lifetime and Continuity: As the reduction of greenhouse gases occurs only after the realisation of the funded projects, the calculation of the GHG reduction potential is based on forecasts (ex-ante analyses). For this reason, the useful life (lifetime) must be estimated for each implemented measure. During this time, the funded projects help to reduce GHG savings every year. It is also assumed that the surrounding systems undergo no changes during the same time frame (continuity).

In reality, some of the projects will not provide their full services for the entire lifetime assumed and changes in the surrounding systems are likely to decrease GHG mitigation

⁴ This section of the report has not been changed compared to the previous reports (Teubler et al., 2019)

effects (e.g., if an energy system becomes more climate-friendly with the shutdown of coal plants).

Attribution: In determining the GHG reduction, the share of the State's budget spending in the overall financing of the project must be taken into account. If, for example, a project is State funded for only 50% of its costs, only half of its GHG savings can be attributed to the bond.

Proportion of GHG reduction financed: There are also measures towards climate protection, which only partially lead to GHG reductions. This applies in particular to the construction and renovation of buildings, where further legal requirements such as accessibility, fire protection or occupational safety play a role.

Auxiliary variables: Wherever sufficient data was not available to assign the funding sums to physical systems; auxiliary variables were derived from the literature. These "proxies" estimate the influence of the investment on the physical changes of a system and are cost-factors for the most part. The refurbished net floor area per euro invested for example, is determined based on the refurbishment costs of real and comparable buildings.

Double-Counting

A fundamental problem in the quantitative evaluation of avoided emissions (GHG reduction potentials) arises in the attribution of impacts to different actors of a system. In addition to the issuers and investors of the bond, these are all actors in the funded projects themselves. Since each tonne of GHG can only be saved once, double counting must be avoided, although financing and re-financing might be considered to be added sustainable value.

Universities, for example, own their properties and invest in the conversion and new construction of their buildings. However, its users mainly cause the heating energy consumption of a building: university staff, students, and visitors.

The actual effect occurs through the implementation of the measure and should be attributed to the operator. On the other hand, many of the measures described here could not be realised without financial subsidies or loans.

In the process of estimating Carbon Footprints for e.g., companies, this is usually achieved using so-called attribution rules. For avoided emissions in the context of bonds, the authors use the terms ***financed*** or ***induced GHG reduction potentials*** or ***savings***.

Limitations

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 of this rule are assumptions regarding the replacement of buildings. If new energy-efficient buildings are constructed, but old buildings are further in use, then the overall energy demand of a university increases, thus also emitting more GHG emissions.

The following table 4 lists the assumptions made for calculations and estimates their effect on the avoidance of GHG emissions.

table 4: 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
Student 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 semester tickets	The robustness of the empirical survey cannot be validated. However, it can be assumed that the effects are higher in some universities and lower in others.	o (no final estimate)
	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)
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)
	Assumptions on the use of funds	Only clear budget titles were allocated as part of the investment allocation. The resulting GHG reduction potentials are therefore underestimated with a high degree of certainty, especially since a relatively high proportion was assumed for the initial installation (52%).	+ (underestimated)
	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)

Bond Category	Assumptions	Impact on GHG emissions	Over- and under-estimation
	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 EnEV 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)
Rooftop PV systems	Assumption on the cost of PV systems in Germany	The costs of PV systems (panels plus installation) are based on average costs for Germany. They do not account for differences in technology or economies-of-scale from large installations. We expect that these costs are overestimated and thus the effects on GHG savings underestimated.	+ (underestimated)
	Assumption on annual production of electricity in the State of NRW	The annual production is based on a location in Duesseldorf, NRW, Germany. Thus, it does not represent an annual average for the entire territory of the State. However, variance between locations in NRW is low, which is why we think that this effect is neglectable.	o (no final estimate)

source: own presentation

Public transportation for pupils and students

The funding for students and pupils supports the public transportation system in NRW by financing the reduced tariffs for pupils, students and trainees, while also promoting the improvement of services. The Public Transport Act of North Rhine-Westphalia stipulates in Section §11a (1) that EUR 139.4m per year is to be invested for this purpose. Of this amount, at least 87.5% is used to offset the cost of tickets. Of this, approximately 18.5 % is used for semester tickets (according to the Ministry of Finance in NRW). The remaining 12.5% can be used for other financing measures, such as further development of the system or quality improvements.

In order to determine the total costs for the semester ticket and the respective share of the bond in the total costs, the quantity of tickets sold for each year is offset against the ticket price as well as the costs for the regional expansion of public transportation and added to the investments from the bond. The shares of the total costs calculated in this way also correspond to the share of the bond in the expected reductions for greenhouse gases. The data were collected both on the basis of data from the Ministry of Finance in NRW and on the basis of tariff data (see KCM NRW, 2021; VRS, 2023).

The GHG reduction of the semester tickets was measured by the car-km avoided per ticket. A study by the Wuppertal Institute on the use of the semester ticket shows that 1,242 person-kilometres (pkm) per year are not covered by car due to the semester ticket per student (Müller, 2011). The study is based on an empirical survey of the mobility behaviour of students at Bielefeld University. The results are not representative for other universities in NRW and therefore cannot be generalised. Due to a lack of alternative data, the figure of 1,242 pkm per student (or 621 pkm per ticket) is nevertheless chosen as a basis for the calculation. In contrast to the other project groups, only the reduction for one year is considered, since the semester ticket is only financed for two semesters (one year). Based on

data from the Federal Environment Agency, 162 g CO_{2e} per car-km are assumed for the GHG reduction through avoided car-km .

Non-urban fast cycle paths

The initial system for the construction of cycle paths is the car traffic that occurs if there were no cycle paths (GHG reductions from avoided car km). Although further effects in the area of public transports could occur, it is unclear whether this modal shift (people switching from a public transport system towards cycling) would affect the GHG emissions of these systems in any way. Conversely, it is also not assumed that the climate impact of public transports will be negatively affected.

Data on the influence of the construction of cycle paths on the modal split can be found in the feasibility study of the cycle fast track (RS RM) between Gladbeck, Bottrop and Essen (Regionalverband Ruhr, 2014). Based on statistics of purposes and number of routes in NRW, an estimation of the passenger car km saved is carried out. With a primary settlement region, a conservative assumption, on average 1,131 car-km per km of cycle distance and day, are avoided by high-speed cycle paths.

Data on the average costs of 1 km of non-urban cycle path is scarce. Instead, the average construction costs per km of cycle path were calculated from existing projects (see table 5). Accordingly, the average construction costs are EUR 1.23m per kilometre built.

table 5: Construction costs for different cycle path projects

Project	Length	Costs
RS1 Duisburg - Hamm	101 km	EUR 184m
RSW Mittleres Ruhrgebiet Gladbeck - Bottrop -Essen	17 km	EUR 39m
Regio Velo Isselburg-Bocholt - Velen	61 km	EUR 39m
RSW OWL Minden-Herford	50 km	EUR 26m
RSW Aachen-Herzogenrath-Kerkrade	30 km	EUR 21m
RSW Köln-Frechen	8 km	EUR 6m
RSW Neuss-Düsseldorf-Langefeld/Monheim	31 km	EUR 32m
RM	17 km	EUR 39m
in TOTAL	315 km	EUR 385m

source: own calculation based on web publications

Based on data from the Federal Environment Agency, 152 g CO_{2e} per car-km are assumed for the GHG reduction through avoided car-km (Umweltbundesamt, 2022).

Modernisation of educational and public health facilities

The Sustainability Bond covers funding for buildings of university clinics (new buildings and refurbishment). Increasing the energy efficiency in these buildings (in particular for the end-use of heat) is one of its major goals. Only parts of the investments are used to reduce the energy demand of buildings or to develop buildings with a low energy standard. Some investments are also used to provide equipment or rents. Refurbishments are also not restricted to energy-efficiency measures alone but cover for example requirements for safety

or health measures. It is therefore necessary to estimate the shares for actual GHG mitigation potentials from

- the construction of new clinical university buildings with lower heat demand compared to existing buildings,
- higher heat efficiency after refurbishment in clinical university buildings.

The investments in the bond correspond to actual investments in the State's budget, but do not allow differentiating into these two segments with GHG relevance. Therefore, additional information on the State's investments is drawn from the budget, that allows allocating the funding in higher detail.

Investments into clinical university buildings are listed individually in the State's budget and these investments from past budget plans was used to estimate generic shares of funding for each category (see table 6).

The following tables shows these shares of allocation for the project, and each category (there were no changes to these shares between NRW Sustainability Bond #10 and #9).

table 6: Allocation of funds for green buildings in category N

Project	Expenditures in #10	Category	Share of funding for category
Conservation, remediation and enlargement of university clinics as well as other investments	EUR 391.7m	Expansion of buildings	59.0%
		Modernisation of buildings	18.4%
		other purposes (e.g. equipment)	22.6%

source: own compilation based on previous data and assumptions

Specific GHG emission factors for educational and public health facilities

The following table 7 shows the GHG emission factors for heat demand and heat sources in public buildings. The electricity demand of university buildings and its GHG emissions is not included in the quantification due to a lack of data. While electricity use in public buildings can have a large effect on the actual GHG emissions, it could not be allocated to the investments in the bond. However, this effect is not necessarily positive, as for example the installation of new medical equipment can also increase the electricity demand in a building.

table 7: Emission factors for the heat demand in public buildings

Energy source	Emission factor (without upstream)	Data source	Spatiality	Share in buildings
Gas*	202 g CO ₂ e/kWh	FfE (2010)	Germany	55.8 %
Oil, light*	266 g CO ₂ e/kWh	FfE (2010)	Germany	23.1 %
District heating	229 g CO ₂ e/kWh	(Agentur für Erneuerbare Energien e.V. 2014)	NRW	21.1 %
Electricity	820 g CO ₂ e/kWh	LAK (2015)	NRW	0.0 %
Emission Factor	222 g CO₂e/kWh			100 %
<i>* Roughly 79 % of heat is provided in form of gas and oil. According to the Agency for Renewable Energies in Germany (AGEB, 2013) 70.7 % of heat by these energy carriers is provided in form of gas.</i>				

source: own calculations based on statistics for heat demand in public buildings

Efficiency gains are calculated by comparing the average heat demand of existing public buildings to the average heat demand of new public buildings. This simplification is required, because the actual efficiency gains in the university buildings funded by the bond are unknown. This also leads to a conservative estimation of the GHG effects in most cases; as older buildings are usually refurbished first, and new buildings often exceed the legal requirements for energy efficiency.

Calculation of GHG emission savings in educational and public health facilities

In order to calculate the GHG reduction potential of buildings in university hospitals, the costs per m² of usable space are required, analogous to new buildings in general universities (see table 8). The information on the construction costs determined or estimated is taken from the budget for Title Groups 06 103 to 06 108 (each Title 891 30). The corresponding floor areas are taken from the websites of the individual clinics. All construction measures are assumed to have a 100 % share of funding, which means that the simple average of total investment and total net floor area can be used to determine the cost factor. No changes have been made to these cost factors between NRW Sustainability Bond #10 and #9.

table 8: Net additional floor space for investments in new buildings in university clinics

Institutions	Building costs	Net floor area	Specific cost factor
Cologne: CIO Centre (ambulatory)	EUR 77.9m	13,500 m ²	312.0E-6 m ² /€
Aachen: Extension building for intensive surgical care	EUR 41.2m	8,643 m ²	311.1E-6 m ² /€
Düsseldorf: Medical Research Centre I	EUR 79.9m	19,650 m ²	178.1E-6 m ² /€
Düsseldorf: Medical Research Centre II	EUR 26.2m	7,970 m ²	258.8E-6 m ² /€
Bonn: New building parent-child centre	EUR 71.9m	11,787 m ²	216.3E-6 m ² /€
Bonn: Neurology, psychiatry and palliative medicine (NPP)	EUR 64.6m	12,842 m ²	317.6E-6 m ² /€
in Total	EUR 361.6m	74,392 m²	206 m² per million euro

source: own calculations on the basis of the NRW budget (medium-term financial planning 2016-2018) and publications of the clinics examined.

A lifetime of 66 years for new university clinics is assumed (Hebel et al., 2011).

Calculation of GHG emission savings in refurbished educational and public health facilities

The “Bettenturm” in Münster serves as a reference for the renovation of buildings in university clinics, for which a number of data is available:

- The construction costs for facade works (energetic refurbishment) amount to EUR 20.6 million.
- The total construction costs amount to EUR 38.5 million with a subsidy amount of EUR 45.9 million.
- The estimated transmission heat loss before completion of works is 2.23 W/(m²K) and 0.62 W/(m²K) after refurbishment.
- 875 beds are in the renovated building.

Based on these data and considering the heating degree-days in Germany in 2016 (3005 HDD according to Eurostat) and the energy expenditure figure for a condensing boiler (1.03), the reference values for hospital renovations shown in table 9 can be determined.

A service life of 20 years is also assumed.

table 9: Reference value for GHG reduction potentials for the renovation of hospital buildings

Reference level	Reference value
Share of construction costs in funding amount	84.0 %
Share of energy-efficient refurbishment in construction costs (already considered when allocating investments)	53.6 %
Difference in transmission heat requirement per bed	3,156 kWh/bed
Number of refurbished beds	42.4 bed per EUR m
GHG factor for the provision of heating energy	0.222 kg CO ₂ e/kWh
GHG reduction potential per bed	702 kg CO₂e per bed and year

source: own calculation

Rooftop photovoltaic systems

Through state funding for photovoltaic roof systems and the calculation of total annual renewable electricity production, it is possible to estimate the greenhouse gas (GHG) emissions replaced in North Rhine-Westphalia (NRW) by the energy produced. The process begins by calculating the total annual renewable electricity production. This involves multiplying the maximum average cost of a 1 kWp PV rooftop system in Germany in 2022 by the total funding amount of EUR 126 million, which covers both photovoltaic roof systems with battery storage on communal buildings and photovoltaic roof systems outside of EEG funding. This calculation yields the total kWp funded, based on a cost factor of EUR 1,650 (Fraunhofer ISE, 2024).

With a reference location in Düsseldorf and utilizing crystalline silicone technology (European Commission, 2024), it is established that a 1 kWp system produces 990 kWh per year (equivalent to 990 full-load hours). By multiplying this annual production figure by the total funded kWp, the total annual renewable electricity production is obtained.

To quantify the GHG emissions replaced in NRW, the combined margin grid emission factor for Germany is applied. This factor, which includes considerations for intermittent energy sources such as solar (UNFCCC, 2021), is multiplied by the total annual renewable electricity production. Thus, we estimate that 39,634 tons of CO₂ equivalent per year (t CO₂e/a) could be replaced by the energy generated from these state-funded photovoltaic systems.

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