

Final Report | March 2019

Impact Report

NRW Sustainability Bond #4

Analysis of the Sustainability Bond #4
issued in 2018 by the German State of
North Rhine-Westphalia (NRW)

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.

Project Duration: June 2018 - February 2019

Authors:

Jens Teubler, Prof. Dr. Oscar Reutter, Katrin Bienge, Lena Hennes

Project Coordination:

Jens Teubler

Wuppertal Institut Klima, Umwelt, Energie gGmbH

Department Sustainable Production and Consumption

Döppersberg 19, 42103 Wuppertal

jens.teubler@wupperinst.org

Scientific Advisor:

Prof. Dr. Oscar Reutter

Cited as:

Teubler, J.; Reutter, O.; Bienge, K.; Hennes, L. (2019). Impact Report NRW Sustainability Bond #4. Analysis of the Sustainability Bond #4 issued in 2018 by the German State of North Rhine-Westphalia (NRW). Final report on behalf of the Ministerium der Finanzen Nordrhein-Westfalen. Wuppertal Institut Klima, Umwelt, Energie gGmbH. Wuppertal, 2019.

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Summary | February 2019

Impact Report

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Analysis of the Sustainability Bond #4 issued in 2018
by the German State of North Rhine-Westphalia (NRW)

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.

Project Duration: August 2018 - February 2019

Authors:

Jens Teubler, Lena Hennes and Katrin Bienge

Scientific Advisor:

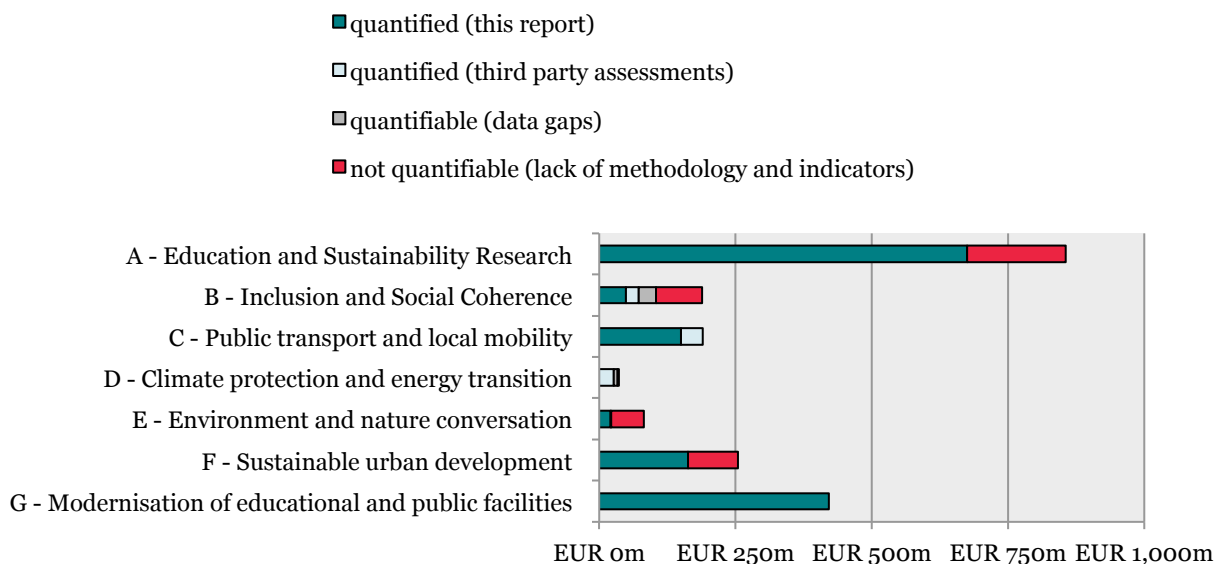
Prof. Dr. Oscar Reutter

General Overview

The Wuppertal Institute conducted an impact analysis of the NRW Sustainability Bond #4 of 2018 on behalf of the State Government of North Rhine-Westphalia (NRW). The most recent bond has a volume of EUR 2.025bn, a term of 10 years and consists of 52 eligible projects from the State's 2017 general budget (sustainable value-added was confirmed in a second party opinion by oekom research¹). This report analyses the contribution of the bond to climate mitigation, sustainable land use and social impacts. It also includes information on the impacts of the previous three bonds (NRW Sustainability Bond #1 to #3).

Figure A shows the project categories in the bond and quantifies the shares that could be directly associated with either environmental or social impacts. 73.0% or EUR 1,479m of the overall investments of EUR 2,027m could be directly quantified in the paper at hand. Additional EUR 90m (4.4%) has been assessed by third parties and is also reported in this briefing. The remaining EUR 458m could either not be quantified due to lack of data (EUR 40m or 2.0%) or are not quantifiable at all within existing scientific frameworks (EUR 418m or 20.6%).

Figure A: Share of quantified investments in the Sustainability Bond #4



source: own calculation

Co-Benefits of projects in the bond

Some projects induce positive environmental and social impacts alike. The refurbishment and construction of university clinical buildings for example is quantified as part of the measures that reduce GHG emissions. The intended purpose however is to prevent health hazards, improve research capabilities and patient care. The same is true for over EUR 130m invested into public transportation for pupils and students (of which only EUR 20.0m were directly allocated to tickets for students and their climate mitigation effect), as additionally financed improvements into public traffic systems are beneficial to all citizens. These types of co-impacts are often not quantifiable in all their dimensions.

¹ see https://www.nachhaltigkeit.nrw.de/fileadmin/download/New_oekomSPO_LandNRW_2018.pdf

Further Information: NRW Sustainability Strategy

The NRW Sustainability Bond #4 is part of the *Sustainability Strategy NRW*, which aims to improve the sustainable development of the whole State of NRW. It comprises almost 70 indicators, which relate to the 19 fields of action in the strategy and to the 17 Sustainable Development Goals by the United Nations (SDGs). The first indicator report of this strategy was published in 2016. Regular updates of the results are also presented on a dedicated website (<http://www.nachhaltigkeitsindikatoren.nrw.de/sdgs>).

The Sustainability Strategy NRW (including the indicator report) is going to be updated in 2019, aligning the methodology more closely with the federal Sustainability Strategy of 2017.

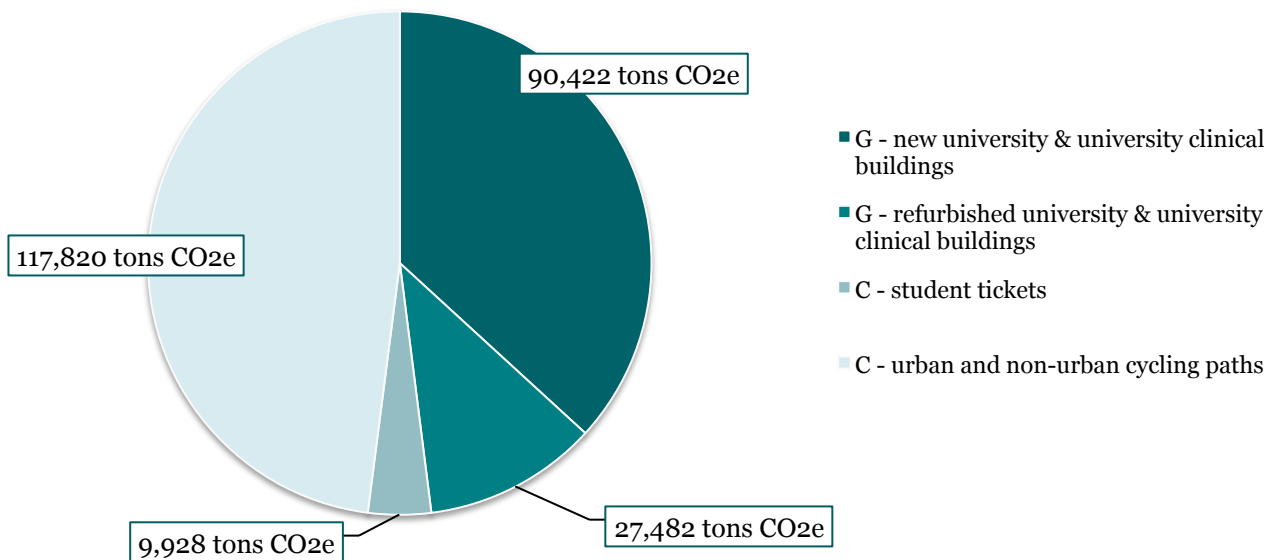
Environmental Impacts

Quantified GHG Savings in NRW Sustainability Bond #4

Climate protection is affected by 7 different measures within the bond and EUR 421m of investments. 82.7% or EUR 348m of these investments help to avoid GHG emissions. The measures are part of investments in category C (student tickets, urban cycle paths and non-urban fast cycle paths) and G (new and refurbished university and university clinical buildings).

As a result, EUR 421m help to induce savings of 246,000 tons of CO₂ equivalents (CO₂e) over the lifetime of the measures (see Figure B).

Figure B: Summary of assessed and quantified GHG savings in the NRW Sustainability Bond #4 (over average lifetime of measures)



source: own calculation

Results for each measure range from 65 tons CO₂e per year to 9,928 tons per year (see Table A). All of these measures, with exception of student tickets, are likely to save emissions beyond the 10-year term of the Sustainability Bond.

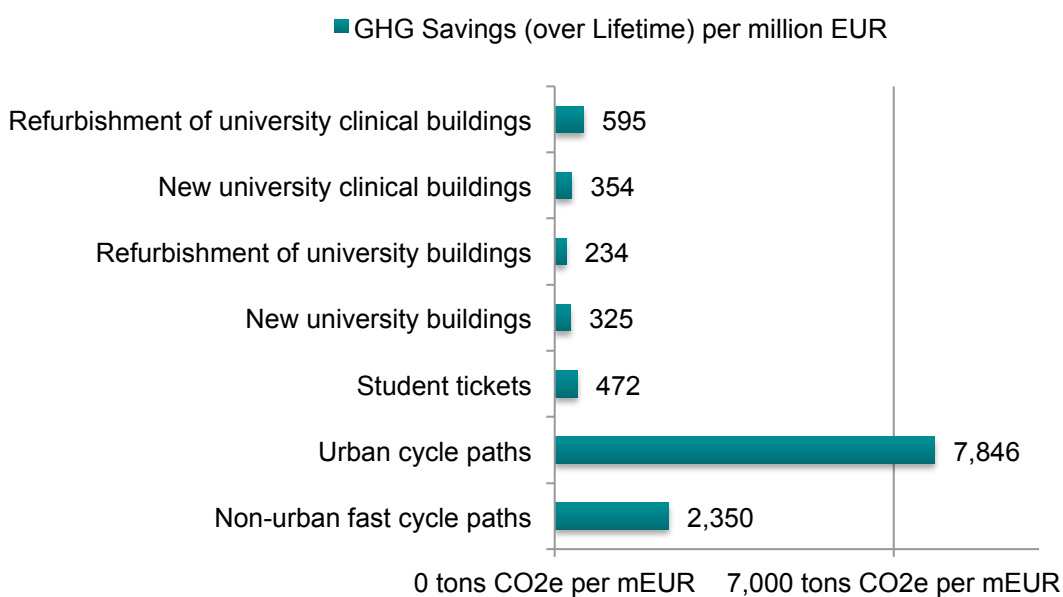
Table A: GHG savings of measures in categories C (Public Transport and Mobility) and G (Modernisation of Educational and Public Health Facilities)

Measure	GHG savings per year	GHG savings over Lifetime	average Lifetime (assumption)
	<i>tons CO₂e per year</i>	<i>tons CO₂e in total</i>	<i>years</i>
Non-urban fast cycle paths	580	17,387	30
Urban cycle paths	3,348	100,433	30
Student tickets	9,928	9,928	1
New university buildings	129	6,473	50
University buildings (refurbishment)	65	1,290	20
New university clinical buildings	1,272	83,949	66
University clinical buildings (refurbishment)	1,310	26,192	20

source: own calculation based on methods and data depicted in the full report

Figure C also depicts the normalised efficiency of the different measures for climate protection (GHG savings over life time per EUR 1m). The highest efficiency measured can be attributed to the construction of cycle paths, in particular to cycle paths in urban areas.

Figure C: Efficiency of climate protection measures for quantified investments



source: own calculation

Overview on GHG savings (NRW Sustainability Bond #4)

Table B summarizes the results for potential GHG savings from the bond.

**Table B: Results on GHG savings according to IFC framework 2015
(Green Bonds -- Working Towards a Harmonized Framework for Impact Reporting)**

Energy Efficiency (EE)	Signed Amount	Share (of investment)	Eligibility for green bonds	EE Component	Annual energy savings		Annual GHG emissions avoided	
Project name	million EURO	%	% of signed amount	% of signed amount	GWh/a		in 1,000 tonnes of CO ₂ -equivalents	
					100%	financed	100%	financed
New university buildings	45.6	100	100	43.6	0.6	0.6	0.13	0.13
University buildings (refurbishment)	21.4	100	100	25.8	0.3	0.3	0.07	0.07
New university clinical buildings	262.8	100	100	90.3	5.7	5.7	1.27	1.27
University clinical buildings (refurbishment)	91.0	100	100	48.4	5.9	5.9	1.31	1.31
Low Carbon Transport (LCT)	Signed Amount	Share (of investment)	Eligibility for green bonds	LCT Component	Annual savings of car km		Annual GHG emissions avoided	
Project name	million EURO	%	% of signed amount	% of signed amount	million passenger km/a		in 1,000 tonnes of CO ₂ -equivalents	
					100%	financed	100%	financed
Student tickets	21.0	9.1	100	100	765	70	108.7	9.93
Urban cycle paths	12.8	100	100	100	23.6	23.6	3.35	3.35
Non-urban fast cycle paths	7.4	100	100	100	4.1	4.1	0.58	0.58

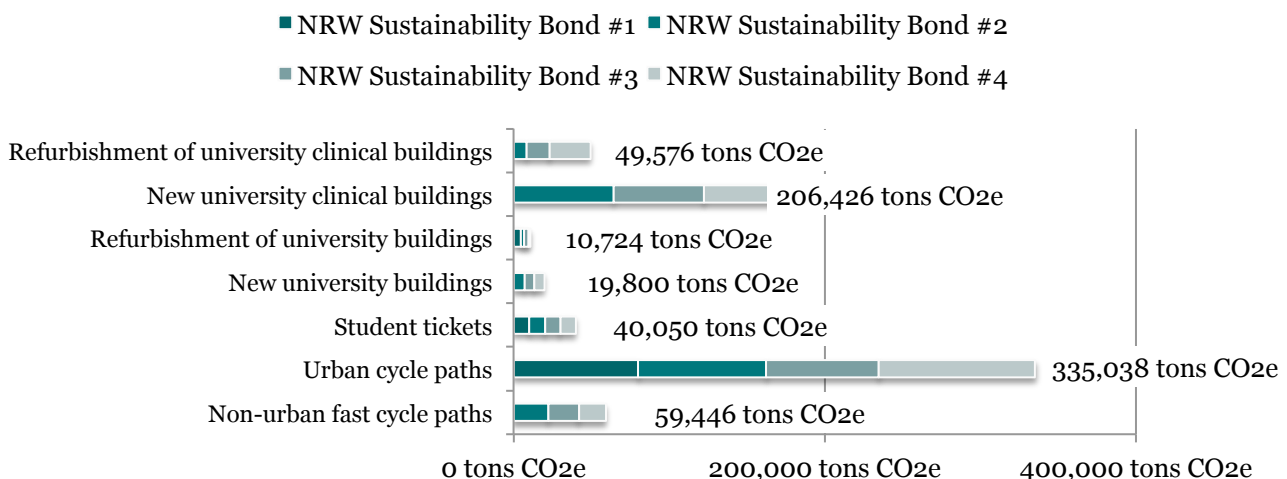
source: own calculation based on methods and data depicted in the full report

Quantified GHG Savings for NRW Sustainability Bonds #1 to #4

All of the quantified categories for climate protection in the Sustainability Bond #4 were already part of the Sustainability Bonds #3 (2017), #2 (2016) and #1 (2015). They can therefore be aggregated to a four-year portfolio (see Figure D). This was not possible for singular measures like solar thermal energy generation (Bond #3) or co-generation of heat and power (Bond #2).

In total, EUR 926m were invested over four years (2014 - 2017) that help to induce GHG savings of over 721,000 tons CO₂e over the assumed lifetime of measures.

Figure D: GHG savings over lifetime of projects from 2014 to 2017 in the portfolio for NRW Sustainability Bonds



source: own calculation

Additional environmental impacts for NRW Sustainability Bonds #1 to #4 (third party assessments)

The NRW Sustainability Bonds also include EUR 150m investments into other projects that improve ecological developments over the course of four years (2014-2017). These projects not only help to mitigate GHG emissions by e.g. additional capacities for renewable energies or by improving energy efficiency. They also contain measures to increase resource efficiency or waste avoidance in companies. The State's funding within the Sustainability Bond facilitates investments from other actors, thus creating leverage for joint efforts to reduce environmental impacts in these areas.

The „Effizienz Agentur NRW“ (efa+) and „Ökoprofit“ provide consulting services for companies that want to reduce their energy consumption, resource throughput and GHG emissions.

ERFD is a European fund for regional development. One of the main goals of ERDF-sponsored projects is to facilitate efforts to reduce GHG emissions. Its priority axis 3 uses 25% of the overall funding of EUR 2.42bn (including EU funds) almost exclusively to this purpose².

While the projects themselves are beyond the scope of this analysis, some of their results are reported here in form of third party assessments. Table C shows the State's investments into such projects from the bond category D (Climate Protection and Energy Transition), in addition to investments from private, municipal, federal and European funds.

Table C: Third party assessments and quantified effects in category D

Type	State funding (NRW Bond #1 to #4)	Investments outside the Sustainability Bond (budget years 2014-2017)	Environmental Savings (2014 to 2017)*
Effizienz Agentur NRW efa+ (as part of resource efficient economy)	circa EUR 14m	EUR 46.6m in the scope of resource efficiency (validated)	<ul style="list-style-type: none"> ■ 60,157 tons of CO₂e ■ 9,807 tons of material resources ■ 401,795 m³ of water
		EUR 372.1m in the scope of financing (validated)	<ul style="list-style-type: none"> ■ 120,211 tons of CO₂e ■ 13,048 tons of material resources ■ 200,763 m³ of water
Ökoprofit NRW (as part of resource efficient economy)	circa EUR 1m	EUR 59.7m for 2,922 measures	<ul style="list-style-type: none"> ■ 84,231 tons of CO₂e ■ 5,979 tons of waste ■ 495,995 m³ of water
ERDF (2014-2020) (priority axis 3 on CO ₂ reduction)	EUR 76.5m	circa EUR 530m	<ul style="list-style-type: none"> ■ 454,424 tons of CO₂e
<p><i>*Different methods were used to calculate the ecological impacts of the projects. The results are not summable. These numbers refer to the most recent reporting in the projects (including retrospective adjustment of data).</i></p>			

source: correspondence with related agencies for Effizienz Agentur NRW efa+ and Ökoprofit NRW; current (2018) implementation report for ERDF results in NRW

² see also <https://www.efre.nrw.de/efre-programm/what-is-efre/op-erdf-nrw/>

Sustainable Land Use

EUR 81.4m of the NRW Sustainability Bond #4 can be attributed to the protection of natural resources. Measures in this project category E aim at nature conservation, flood protection, animal welfare or sustainable farming and land use. The latter could be directly associated with investments in the bond. EUR 20.9m or 26% of the investments in this category promote an area for sustainable land use of 295,425 ha (see Table D).

Some of the other subcategories also partly promote sustainable land use such as areas for biotopes within nature conservation or flood protection areas. For these subcategories, however, it was not possible to directly allocate investments to individual measures with a corresponding land reference.

Table D: Results of the quantification of the subsidised sustainable land use

Subcategory	Investment volume (2017)	Area supported per year (2017)
Agro-environmental measures	EUR 4.9m	39,018 ha
NRW Rural Area Programme - state share	EUR 16.0m	256,407 ha
in TOTAL	EUR 20.9m	295,425 ha

source: own calculation

Social Impacts

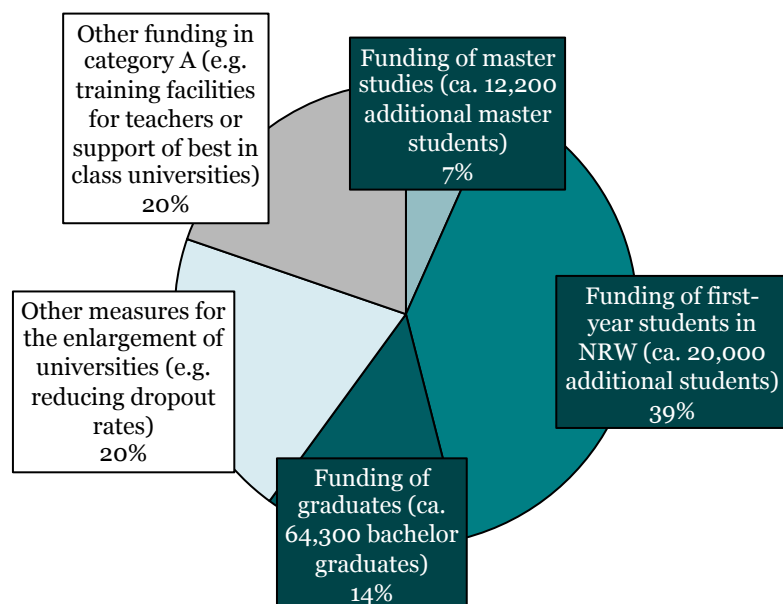
A large portion of the social impacts from investments in the bond cannot be directly quantified due to lack of data or appropriate methodologies. Numerous projects benefiting education, inclusion, social cohesion as well as co-benefits of projects in other areas are therefore not part of the impact assessment. Social tickets (part of category C) for example enabled the social integration and increased mobility of approximately 300,000 people in 2015³. The funding of student tickets on the other hand was quantified for this report in terms of GHG savings, while in fact also improving the universal access to education for roughly 600,000 students.

Enlargement of Universities

The enlargement of universities is part of the State's funding into education and sustainability research (bond category A as part of e.g. the Bund-Länder-Covenant for the expansion of universities). Out of EUR 856.3m, 79% or EUR 675.2m were invested to finance additional student capacities, reward universities for graduates or to reduce the number of dropouts. Based on current State grants for universities, these investments supported 20,000 additional first-year students, 12,200 additional master students and the graduation of 64,300 bachelor students in 2017 (see also figure E).

³ see <https://www.landtag.nrw.de/Dokumentenservice/portal/WWW/dokumentenarchiv/Dokument/MMD17-717.pdf>

Figure E: Allocation of funding in category A (total of EUR 856.3m)



source: own calculations

Job Creation, Funding and Qualification

The NRW Sustainability Bond #4 investments dedicated to *Inclusion and Social Coherence* total EUR 188.3m. Some of this funding in category B was used to create new jobs for people with disabilities and social workers in schools. These social workers support the State's efforts to school success and cultural participation for disadvantaged children. By relating the available funding for these two projects, it can be quantified that the Sustainability Bond NRW #4 provides at least 125 new jobs for people with disabilities (newly created jobs) and 725 jobs for social workers in NRW (costs for material and salary per year). Both projects also show how investments into social development can also lead to an improvement of economic indicators (job creation).

Additional third party assessments allowed estimating that the Bond helped 2,000 people suffering from social and economic disparities (the majority under 25 years old) to improve their long-term job qualification and integration. These funds are part of the European Social Fund and therefore co-funded by the EU, the Federal Government and private investors. Table E shows the allocated investments of the Bond and their effects in this category.

Table E: Impacts for Integration and Social Cohesion

Inclusion and Social Cohesion	Sustainability Bond NRW #4 funding	Type of quantification	Social Impact
Employment opportunities for persons with disabilities	EUR 2.5m*	direct	job creation: 125 to 250 new jobs
Social School Work	EUR 47.0m	direct	job funding: 725 jobs
European Social Fund	EUR 23.0m	3 rd party	job qualification and integration: 2,000 participants

* The EUR 2.5m are only part of the EUR 6.6m that is used to provide employment opportunities.

source: own calculation

Broadband Expansion

A majority of the investments for urban development (63% of category F) is used to sponsor the telecommunication infrastructure in NRW in form of broadband connections with 50 Mbits/s and more, in particular for areas that lack a market-based expansion. The programme aims to improve social and economic access by households and businesses alike, while also providing opportunities for a green economy (e.g. reducing work-related traffic with help of home-office solution or even enabling the settlement of companies in rural areas in the first place).

Quantifying the effect of funding for broadband connections is rather difficult though, as the costs of an access point increase exponentially with higher penetrations rates. Using data on NRW broadband expansion in the past (from an interactive website by the Federal Ministry of Transport and Digital Infrastructure⁴), it could be estimated that the funds of EUR 162.5m enable 81,000 broadband connections for households, institutions and industry.

Social impact indicators for the Sustainability Bond NRW #4

Table F summarizes the scalable social impact indicators for the Sustainability Bond NRW #4, which are mainly based on fix lump sums in the different State programmes (e.g. such as refundable costs for social workers).

It is recommended to integrate appropriate literature and evaluation data when using these indicators in another context or further impact assessments of bonds.

Table F: Social Impact Indicators for Sustainability Bond NRW #4

Impact indicator	Scaling Factor	Metric
First-year students	EUR 18,000 per student	lump sum
Graduates	EUR 4,000 per graduate	lump sum
Master student place	EUR 10,000 per place over 2 years	lump sum
Jobs for persons with disabilities	EUR 20,000 per job created	maximum funding in programme
Jobs for social school workers	EUR 65,000 per job	lump sum
Broadband connections	EUR 2,000 per access point	factor based on cost sample for NRW

source: own calculation

⁴ see <https://www.bmvi.de/Foerdergebiete/karte.html>

Methods and Data

GHG factors (without upstream) are drawn from the research centre for energy economics (FfE 2010), the balance of energy for German federal states (LAK 2017) as well as data by the Federal Environmental Agency (UBA) (UBA and TREMOD 5.63 2014).

The energy efficiency potentials for new buildings refer to the heat demand (electricity is not considered due to lack of data) of public buildings in the building stock of Germany from different years of construction (Deilmann et al. 2013). On average, 117 kWh per m² and year could be saved compared to average buildings in these sectors. It is also assumed that 52% of the State's funding is used for initial furniture and does not contribute to higher energy efficiencies. Costs for construction of university buildings and university clinical buildings are based on press releases on current and past construction projects by universities in NRW. The allocation of funding (new and refurbished buildings) was conducted with help of the State's budget plan (which includes individual plans for each university clinic).

The quantification of GHG savings for refurbished buildings required additional data on the share of construction measures for purposes of energy efficiency, the costs thereof and the reduced energy demand after refurbishment. They are based on two reference refurbishment measures at the university hospital of Munster and the university of Bochum. As a result, final heat savings of 3,156 kWh per bed (clinics) and 88 kWh per m² (gross area of usage for university buildings) were calculated.

GHG savings from Low Carbon Transport are based on avoided trips with cars. For bicycle paths, data from a feasibility study for the fast bicycle track RS1 was used: 177,719 km by car can be avoided for 22,439 ways per day in a conservative case (Regionalverband Ruhr 2014). While the costs of fast bicycle tracks were drawn from press releases, costs of urban cycle paths are based on statistics by the Ministry of Transport of the State of NRW. It is also assumed that urban cycle paths only avoid car emissions for ways up to 5 km.

Avoided car emissions for student tickets are based on an empirical study from 2011 by the Wuppertal Institute (Müller 2011): 1,242 car km per year and student could be avoided in Bielefeld. The allocation of the number of tickets in use, the costs of student tickets and their co-funding by the State of NRW are based on data provided by the Ministry of Finance of the State of NRW and a report on public transport in NRW (KCM NRW 2018).

In the case of sustainable land use and social impacts, data was provided by the relevant Ministry for Environment, Agriculture, Conservation and Consumer Protection and the Ministry of Culture and Science of the State of NRW. Additional data was drawn from publicly available data on funding (e.g. re-fundable lump sums in applications) within the related projects as well as evaluation reports (e.g. intermediate reports of the European Social Fund).

2 Background, Goal and Approach

The federal state of North Rhine-Westphalia (NRW) (Germany) has issued annual Sustainability Bonds since 2015, which relate to projects in the budget enhancing sustainable development in the State (*NRW Sustainability Bonds #1 to #4*).

The Bonds focus on projects that ensure social and ecological sustainability and are part of the "strategy for sustainability" in North Rhine-Westphalia (Landesregierung NRW 2016). The 4th Bond was issued in 2018 with a volume of EUR 2.025bn, referring to 52 eligible projects from the States' 2017 budget.

While oekom research provides a second party opinion on the eligibility of the selected projects for a sustainability bond (oekom research AG and Leue 2018), the Wuppertal Institute has been asked to analyse the impacts in regard to a sustainable development for the third year in a row (see Greiff et al. 2018; Wiesen et al. 2017 for the full German reports).

The 4th Sustainability Bond is split into seven different project categories and can be associated with the Sustainable Development Goals (SDGs) by the United Nations (Nino 2016), as shown in Table 2-1.

Table 2-1: Project categories in the Sustainability Bond #4 NRW

Project category	SDGs'
A Education and Sustainability Research (EUR 856.3m)	SDG 4 – Ensure inclusive and quality education for all and promote lifelong learning SDG 9 – Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
B Inclusion and Social Coherence (EUR 188.3m)	SDG 1 – End poverty in all its forms everywhere SDG 10 – Reduce income inequality within and among countries
C Public transport and local mobility (EUR 190.2m)	SDG 9 – Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation SDG 11 – Make cities and human settlements inclusive, safe, resilient and sustainable
D Climate protection and energy transition (EUR 35.7m)	SDG 7 – Ensure access to affordable, reliable, sustainable and modern energy for all SDG 13 – Take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy
E Environment and nature conservation (EUR 81.4m)	SDG 2 – End hunger, achieve food security and improved nutrition and promote sustainable agriculture SDG 15 – Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
F Sustainable urban development (EUR 254.1m)	SDG 9 – Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation SDG 11 – Make cities and human settlements inclusive, safe, resilient and sustainable
G Modernisation of educational and public facilities (EUR 420.8m)	SDG 3 – Ensure healthy lives and promote well-being for all at all ages SDG 13 – Take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy

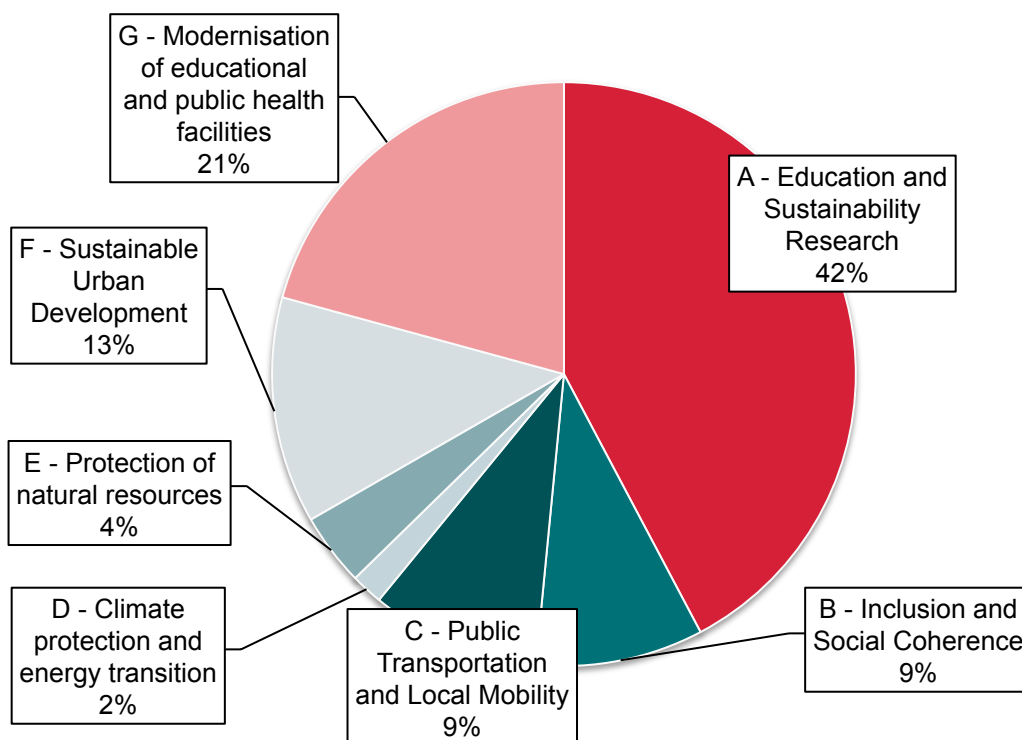
source: own compilation based on State of North Rhine-Westphalia (NRW) 2018

The goal of the project is to evaluate positive sustainability effects for the Sustainability Bond #4 NRW. The report covers not only the mitigation effects on climate change (avoided greenhouse gas emissions), but also further environmental and social impacts.

The net proceeds of Sustainability Bond #4 NRW (issued in 2018) are distributed among the seven project categories shown in Figure 2-1. The categories "Education and sustainability research" (A, 42 %) and "Modernisation of university and public health buildings" (G, 21 %) account for the largest share of funding. The categories "Inclusion and social cohesion" and "Local public transport and local mobility" each have a share of 9%. The other three project categories together account for only 19% of the volume.

The project categories cannot be clearly classified according to their ecological, economic and social impact. For example, the construction of a new, energy-efficient university building will also create new study places, so that this measure will have positive ecological, social and economic effects at the same time.

Figure 2-1: Proportion of funding from the 4th Sustainability Bond NRW (issued in 2018).



source: own compilation based on State of North Rhine-Westphalia (NRW) 2018

The impact analysis is based on the "Harmonized Framework for Impact Reporting" (The World Bank et al. 2015), which also provides a uniform presentation of the results of an impact analysis. Going into the third year of the assessment and fourth year of the bond, the Wuppertal Institute has continuously advanced the scope of the impact assessment of the Sustainability Bond NRW. Recently, a group of experts appointed by the EU Commission also recommended developing EU-wide standards for green bonds (Valero 2018). Finance experts call, among other things, for the "creation of an official EU sustainability standard for green bonds". The first reports by this "Technical Expert Group on Sustainable Finance" (TEG) are expected in 2019.

3 Methodology for Greenhouse Gas Emissions (GHG)

This chapter describes how the calculation of avoided greenhouse gas emissions (GHG reduction) is carried out.

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 (Intergovernmental Panel on Climate Change 2014; Qin 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, CO₂e or CO₂e) (Bernstein et al. 2008).

In the presented impact analysis, 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).

3.1 Conventions and Variables

Even if certain standards have been established in the Harmonized Framework, they do not specify a tangible 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 section 3.2).

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 realization 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 effects (e.g. 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 has to 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: Whenever sufficient data was not available to assign the amounts spent 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 on the basis of the refurbishment costs of real and comparable buildings.

3.2 Double-Counting and Additionality

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 the investors, these are all actors in the funded projects themselves. Since each ton of GHG can only be saved once, double counting must be avoided, regardless of the fact that financing and re-financing might be considered to add sustainable value.

Universities for example own their properties and invest in the conversion and new construction of their buildings. However, the heating energy consumption of a building is mainly caused by its users: 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 realized without financial subsidies or loans. In the process of estimating Carbon Footprints for companies, this is usually achieved by 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*.

3.3 Limitations

A number of assumptions are necessary to calculate the financed GHG savings for the project categories C (Public Transportation and Local Mobility) and G (Modernisation of Educational and Public Health Facilities). These assumptions relate to costs on the one hand (e.g. construction costs of a building) and to the physical changes of the system on the other hand (e.g. the actual difference in energy demand after a refurbishment). These assumptions were usually made from a conservative point of view, presumably underestimating (*underestimation*) 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 are further in use, then the overall energy demand of an university increases, thus also emitting more GHG emissions (*overestimation*). Table 3-1 lists the assumptions made for calculations and estimates their effect on the avoidance of GHG emissions.

Table 3-1: Estimation of the effects of assumptions on the potential for avoided GHG emissions

Bond Category	Assumptions	Impact on GHG emissions	Estimation
Category C Public Transportation and Local Mobility	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 taken into account.	underestimation
	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.	no estimation possible
	Assumptions of 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.	no estimation possible
Category G Modernisation of Educational and Public Health Facilities	Assumptions for the replacement of new 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.	overestimation
	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 increases or is converted by the investments, and thus the GHG reduction potentials cannot be reliably determined.	no estimation possible
	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 financing initial equipment (52%).	underestimation
	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.	no estimation possible
	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 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 reference buildings. The allocation of these specific GHG reduction potentials to all implemented measures is therefore subject to high uncertainties.	underestimation

source: own presentation

4 Estimation of Impacts for Sustainability Bond #4

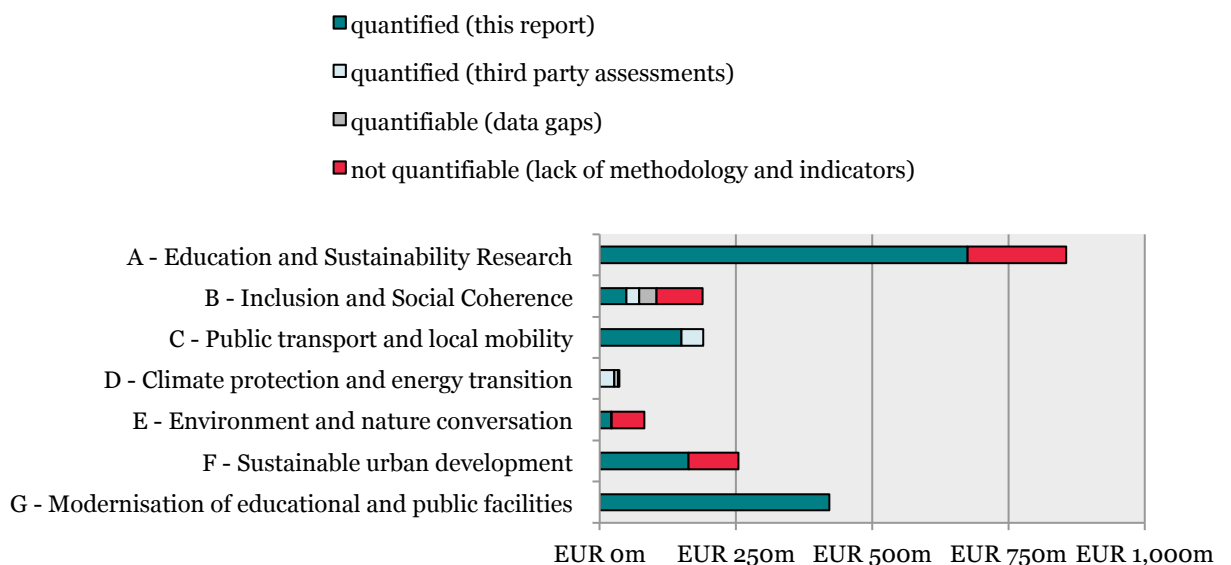
The NRW Sustainability Bond #4 provides environmental (green) and social benefits. The environmental impacts are mostly GHG reduction potentials achieved through energy efficiency measures and investments into means of transport with lower GHG emissions. Previous bonds also included quantifiable investments into renewables (e.g. solar thermal panels) and the co-generation of heat and power. Additional environmental impacts can be achieved by sustainable land use (quantified in this report) as well as resource-efficiency in companies (reported by other parties).

Social impacts in form of indicators could be quantified for students in universities (first-year students, bachelor graduates and capacities for master students) as well as jobs in the social sector (social workers in schools) and for people with disabilities. Further social impacts include job qualification as part of the European Social Fund, but also access to broadband internet.

The report at hand includes quantifications for 73% of the projects from the bond, totaling EUR 1,479m. These quantifications cover 6 of 7 project categories. A further 4.4% or EUR 90m could be reported on the basis of other assessments, including funding for the European Social Fund (ESF in category B) and the European Fund for Regional Development (ERDF in category D). The remaining investments are either not quantifiable for lack of data (EUR 40m or 2.0%) or lack of methodologies and indicators (EUR 418m or 20.6%). While these shares might decrease with future impact assessments, there are several projects that might never be fully quantifiable.

All results depicted in this report are based on model calculations, available data and assumptions described in the following sections. They are, for the most part, *estimations* (and should be cited as such).

Figure 4-1: Breakdown of the quantified, quantifiable and non-quantified shares of the 2017 Sustainable Bond



Source: own compilation

4.1 Co-Impacts

The Sustainable Development Goals of the United Nations feature 17 different goals and (currently) 232 indicators for measurement. This diversity attests to the fact that sustainable development covers several interconnected ecological and social areas at once. Improving education for example (SDG 4) is very likely to reduce poverty (SDG 1) as well as overall inequalities in a society (SDG 10).

The same is true for many of the projects in a sustainability bond, as quantified impacts are not always the only impacts and not even the most important impact of projects financed through the State's budget. The focus on GHG savings by modern buildings for example neglects the fact that university buildings are built and refurbished for other reasons than climate protection. The improvement of clinical buildings improves patient care, and a new laboratory in a university provides additional research capacities. Beneficiaries are not only employees and students, but society as a whole.

To account for all these benefits would require appropriate indicators for each impact and an additional methodology for the combination of these impacts. This type of multiple-impact or multiple-benefit assessment usually relies on the monetisation of impacts and already exists for some areas. However, it is still not far advanced even for well-researched areas such as energy-efficiency measures⁵ and thus not feasible for the impact assessment of sustainable financing.

The report at hand only quantifies single impacts in one particular areas of environment or society.

However, it also includes a first analysis of the State's overall budget and interactions between the State's expenditures and different areas of sustainable development (interaction analysis). This approach has proved to be a viable starting point for multiple-impact reporting in the future.

⁵ see e.g. <https://combi-project.eu/> for an example of such a methodology

4.2 A: Education and Sustainability Research

Category A funds projects that enlarge education capacities for teachers, trainees and students. It also promotes research for sustainable development and innovation.

4.2.1 Volume in category A

The overall funds amount to EUR 856.3m. EUR 769.8m are invested into the expansion of universities (EUR 675.2m), training facilities for teachers and special education training (EUR 34.4m) and professional training for geriatric nurses (EUR 60.3m). An additional EUR 23.5m are in supporting "best in class" universities.

Funds for sustainability research amount to EUR 47.7m and funds for consumer education to EUR 15.5m.

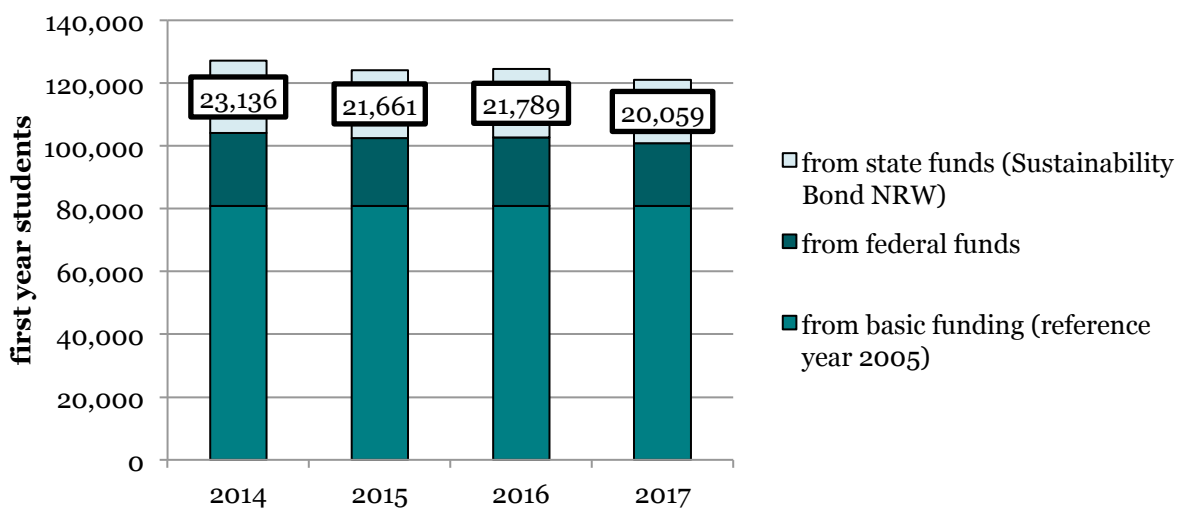
The report at hand quantifies the funds for the expansion of universities as part of the Federal and State government pact for the expansion of universities (State's share of the so-called "Hochschulpakt") as well as the funding for additional master students. However, the funding is also used for other measures such as reducing the amount of university dropouts.

4.2.2 Data and Results

One impact of the "Hochschulpakt" is the expansion of university capacities in terms of first-year students. Using a baseline of 80,903 first-year students in NRW in 2005, it can be shown that additional capacities could be provided for 40,000 to 46,000 students each year between 2014 and 2017. Half of these students can be allocated to projects from the Sustainability Bond.

Figure 4-2 shows the results of this allocation in relation to the reference year 2005 for funding in the "Hochschulpakt".

Figure 4-2: Allocation of funds for first-year students to the sustainability bond



source: Bund und Länder 2013; IT NRW 2018

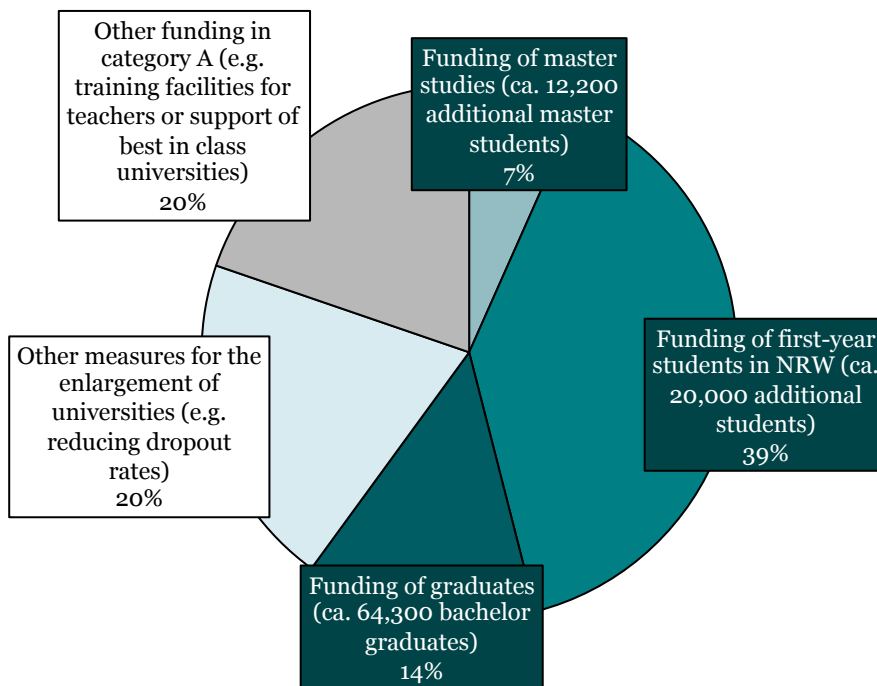
The overall investments through the Sustainability Bond in this area (EUR 675.2m in 2017) also helped to increase the overall amount of graduates and increased the capacities for master students.

The current "Hochschulpakt" (Stage III) finances each additional first-year student with EUR 18,000 and each additional graduate with EUR 4,000. Additionally, universities are encouraged to increase their capacity for master students with a grant of EUR 10,000 per student (of which EUR 5,000 are funded in the first and another EUR 5,000 are funded in the following year). This programme aims at 65,000 additional master students between 2014 and 2020 (16,250 students on average per year).

The official statistic for universities in NRW reports 40,118 additional first-year students, which represents (IT NRW 2018) – net of federal co-funding – EUR 361.0m or 53% of investments in the Sustainability Bond #4. Funds attributable to bachelor graduates (64,324) amount to EUR 128.6m or 19% of the investments in the bond.

The remaining EUR 185.5m could therefore be used to enlarge the capacities for master students (potentially sufficient funding for 18,550 students over 2 years). Summing up the goal for additional master students of each university for 2017/2018 (see Table 4-1), ca. 33% of this funding (or EUR 61.5m) is already sufficient to provide capacities for the required 12,206 students in their first year (EUR 5,000 per student). The remaining EUR 124.2m could therefore be used to finance other measures or to provide further financing for these students (see Figure 4-3).

Figure 4-3: Overview of social impacts in category A



source: own calculation

Table 4-1: Individual plans for additional master students in NRW between 2014 and 2020

Universities in NRW	Plan for additional master students from 2014-2020	Plan for additional master students in 2017/2018 (2017)
RTWH Aachen	7,146	1,334
FH Aachen	1,830	353
Uni Bielefeld	3,282	567
FH Bielefeld	760	135
Uni Bochum	5,981	1,205
FH Bochum	618	122
Uni Bonn	4,609	903
Uni Rhein-Sieg	830	148
Uni Dortmund	4,430	680
FH Dortmund	1,016	200
Uni Duisburg-Essen	4,570	623
Uni Düsseldorf	1,731	339
FH Düsseldorf	873	155
Uni Gelsenkirchen	1,045	238
Uni Aachen	1,616	523
FH Hamm-Lipstadt	210	0
Uni Köln	5,712	827
Sporthochschule Köln	404	67
FH Köln	2,156	408
Uni Münster	5,482	912
FH Münster	1,800	357
Uni Niederrhein	1,194	234
Uni Ostwestfalen-Lippe	560	104
Uni Paderborn	3,546	464
FH Rhein-Waal	577	132
FH Ruhr-West	494	93
Uni Siegen	3,413	493
FH Südwestfalen	792	155
Uni Wuppertal	3,389	435
in TOTAL	70,066	12,206

source: own compilation based on the individual agreements between universities in NRW and the Ministerium für Kultur und Wissenschaft des Landes Nordrhein-Westfalen⁶

⁶ The website of the Ministerium für Kultur und Wissenschaft NRW provides all general agreements on this matter as well as individual agreements with each university in NRW (<https://www.mkw.nrw/hochschule/hochschulen-in-nrw/hochschulvertraege-und-landeshochschulentwicklungsplan/>)

4.3 B: Inclusion and Social Coherence

Project category B (Inclusion and Social Cohesion) funds projects that recognize diversity and provide equal opportunities for people with disabilities, migrant background and/or otherwise disadvantaged people (e.g. poor people). It includes measures for employment and education as well as integration.

4.3.1 Volume in category B

The total volume of category B amounts to EUR 188.4m. The largest share (44% or EUR 83.3m) is attributed to "Inclusion, integration and qualification". This includes numerous projects and programmes regarding the qualification of the poor or unemployed, the social inclusion of people with disabilities as well as the integration of immigrants. The rest of the investments in category B are used for „Language skills in early child-hood education, support and advice for families“ (EUR 58.1m or 31%) and "Social school work" (EUR 47.0m or 25%).

About 26% of this volume could be quantified in the report at hand (see 4.3.3), 12% is reported elsewhere and ca. 17% of this volume could very likely be quantified in the future if data is provided (potentially allowing to generate a scalable social impact indicator). However, for about 45% of the funds there is either no method to do so or the funding is allocated in a way that quantifiable impacts cannot be generated at all (e.g. by indirectly funding institutions with a social agenda).

Among the potentially quantifiable funds there are 3 project groups that require data in order to generate scalable indicators. EUR 2.5m of the EUR 25.5m for the European Social Fund provide in fact funds for language courses for refugees and should be relatable to the number of participants or even success rates (e.g. in relation to achieved language competence). The programme currently funds language teachers as well as travel expenses for participants⁷ and aims at a language competence level of A1 (EU et al. 2017). Also quantifiable should be EUR 4.4m that are invested into fighting longterm unemployment (e.g. by counting the number of successfully integrated people).

EUR 25m for "language courses at child care facilities", on the other hand, will be quantified in the future. This programme is currently under evaluation, including an analysis of the amounts spent and their effects. The duration of this study (SEIKA-NRW) is from 2015 to 2020⁸.

Table 4-2 and Figure 4-4 show the break-down in funds that were quantified in this report, funds that were quantified based on other reports, potentially quantifiable segments and funds without a potential for quantification.

⁷ The programme funds 80% of the costs of 300 lessons (45 minutes each based on lump sums for teachers) as well as travel expenses of participants (EUR 15 per person).

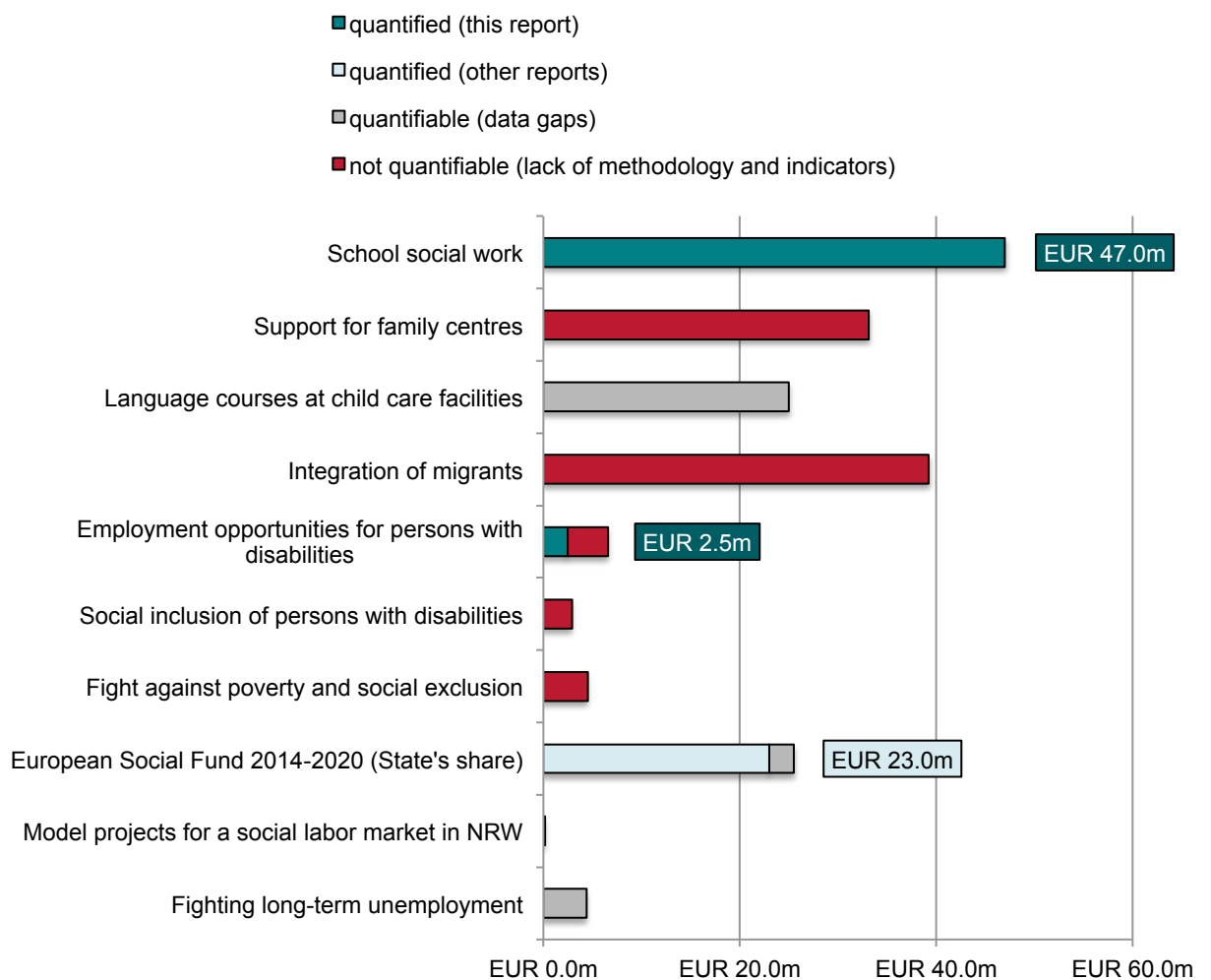
⁸ <https://www.dji.de/ueber-uns/projekte/projekte/sprachbildung-und-entwicklung-im-kita-alltag-seika-nrw.html>

Table 4-2: Quantified and quantifiable volume in category B

Sub-Categories	Investment volume	quantified (this report)	quantified (other reports)	quantifiable (lack of data)	not quantifiable
Inclusion, integration and qualification	EUR 83.3m	EUR 2.5m	EUR 23.0m	EUR 6.9m	EUR 50.9m
Language skills in early childhood education, support and advice for families	EUR 58.1m	-	-	EUR 25.0m	EUR 33.1m
Social school work	EUR 47.0m	EUR 47.0m	-	-	-
in Total	EUR 188.4m (100%)	EUR 49.5m (26%)	EUR 23.0m (12%)	EUR 31.9 (17%)	EUR 84.0 (45%)

source: own compilation

Figure 4-4: Quantifiability of different project groups in category B (including categories beneath sub-categories)



source: own compilation

4.3.2 Third-Party assessments in category B

The State's co-funding for the European Social Fund (ESF) in category B (see Table 4-3) relates to the priority axis B in this European Fund ("promoting social inclusion and combating poverty and all forms of discrimination"). The German implementation report (Bundesministerium für Arbeit und Soziales 2018) reports that 42,000 participants were supported in 2017 alone. From the total number of 150,000 participants until the end of 2017, 39.0% were women, 72.5% lived in households suffering from unemployment and 59.5% were longterm unemployed.

For NRW (Ministerium für Arbeit, Gesundheit und Soziales des Landes Nordrhein-Westfalen 2018), it is reported that 5,402 participated in projects and programmes that aim at the longterm integration into the labour market (4,834 of these participants were under 25 years old). The Sustainability Bond contains a funding for ESF priority axis B of EUR 23.0m⁹, while the overall funds (European funds, federal funds, private funds and State funds combined) in this category amount to EUR 387.8m from 2014 to 2020. The State of NRW provides EUR 150m of state funds for priority B. It can therefore be estimated that 38.6% of the participants (ca. 2,000) directly benefit from investments in the bond.

An explicit example of this funding is the programme "Kooperative Ausbildung an Kohlestandorten", aimed at apprenticeships for young people in regions with current or former coal sites. In 2017, the State of NRW provided EUR 0.73m out of a larger co-financed fund of ca. EUR 3.3m (Ehlert 2019). Since apprenticeships in the programme are funded with EUR 900 per month and apprentice, the investments in the bond alone could provide support for 67 apprenticeships per year.

Table 4-3: Third party assessments for category B on social inclusion and cohesion

Sub-Categories of B	Investments in Bond	Reported Funding	Reported Effects (estimates for NRW)
European Social Fund 2014-2020	EUR 25.5m	EUR 23.0m	2,000 participants in programmes for education and longterm integration into the labour market (e.g. 67 apprenticeships in regions with coal-sites)

source: Ministerium für Arbeit, Gesundheit und Soziales des Landes Nordrhein-Westfalen 2018

4.3.3 Jobs for persons with disabilities (quantified social impact in category B)

EUR 2.5m of the total investments can be quantified indirectly as part of the EUR 6.6m funding for "Employment opportunities for persons with disabilities". The programme aims at the creation of 250 new jobs for people with disabilities in inclusion companies. With a maximum funding of EUR 20,000 for each newly created job, this relates to at least 125 new jobs (Gesellschaft für innovative Beschäftigungsförderung mbH 2018).

⁹ EUR 2.5m of the EUR 25.5 are allocated to language courses for refugees.

4.3.4 Social school work (quantified social impact in category B)

About 25% of the overall investments in category B is used to promote education and participation of disadvantaged children. By doing so, the State of NRW continues financing social school work that had temporarily discontinued. Initially planned for 3 years (until 2017), funding is now secured until 2021 (Bildungsportal des Landes NRW 2019).

The State programme provides ca. EUR 47.0m per year for 53 cities and municipalities in order to provide targeted assistance for youth work and to reduce social disadvantages in this area. The funding is focused on promoting jobs for social workers, that help to

- reduce absenteeism in schools,
- improve school success,
- reduce school drop-out numbers,
- and increase the participation of students in sports and cultural activities.

A first evaluation of the programme in 2017 (Gabler et al. 2017) concludes that while there is still an information gap (e.g. only half of the parents entitled to apply for benefits under the programme know about them), children from poor households are overrepresented when it comes to benefiting from services such as additional school excursion or joint lunch. It is also estimated that the programme itself has financed 1,700 skilled social workers so far.

The impact of this category of the bond can therefore be directly related to the financing of these jobs. The State of NRW promotes jobs in this area based on generalized costs of ca. EUR 50,000 of annual gross salary and direct material expenses of ca. EUR 15,000, summing up to refundable costs of EUR 64,815 per year.

Thus, EUR 47m in the bond amount to potential 725 jobs for school social workers, which is about 27% of the financed social workers so far or 14 social worker per municipality.

4.4 C: Public Transportation and Local Mobility

Category C projects are investments for reduced ticket fares for certain groups (e.g. students) and the development of infrastructures for low-carbon mobility (e.g. roads for biking).

4.4.1 Volume in category C

The volume in category C totals EUR 190m, of which EUR 130m are invested into public transportation for students and pupils, EUR 20.2m into transportation infrastructure (cycle paths) and EUR 40m into public transportation for low-income citizens.

The latter refers to the so-called "social tickets", which mainly aims at social impacts such as participation, integration or mobility. It has been reported (third-party assessments) for 2015 that circa 300,000 people benefit from these tickets (Landtag NRW 2017). It is questionable whether the social ticket will actually lead to a GHG reduction though, since a considerable proportion (67%) of ticket recipients cannot fall back on a car in any case (KCM 2015).

Overall, investments of EUR 150m or 78.9% of this category were directly allocated with quantifiable effects on the climate (quantified effects).

4.4.2 Allocation of investments for category C

The funding for students and pupils in category C supports the public transportation system in NRW by financing the reduced tariffs for pupils, students and trainees, while also promoting the improvement of services and quality (Finanzministerium Nordrhein-Westfalen 2016). The Public Transport Act of North Rhine-Westphalia stipulates in Section §11a (1) that EUR 130 million per year is to be invested for this purpose. Of this amount, EUR 113.75m is used to offset the cost of tickets for all beneficiaries and, approximately EUR 21m is used for student tickets only (according to the NRW Ministry of Finance). The remaining 12.5% can be used for other financing measures, such as further development of the system or quality improvements.

EUR 92.75m are used for funding tickets for trainees and pupils. Although these tickets are also expected to lead to a GHG reduction, there is no reliable data source available to estimate the effects. Similar to social tickets, it is also questionable whether many pupils and trainees have access to a car or some may lack a driving license to begin with.

The investments into urban and non-urban cycle paths on the other hand (EUR 20.2m) are fully taken into account for quantification as they fully relate to the costs of construction.

4.4.3 Data basis and calculation of the CHG reduction of semester tickets

The GHG reduction of the student or semester tickets was measured by the car-km avoided per ticket. A extensive 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 simply be generalised. The figure of 1,242 pkm per student (or 621 pkm per ticket) is nonetheless the best available basis for the calculation and a good proxy for estimating the effects in this category. In contrast to the other project groups, only the reduction for one year is taken into account, since the semester ticket is only financed for two semesters (one year).

In order to determine the total costs for the semester ticket and the share of the bond in the total costs, the number of tickets sold for each year (2014, 2015, 2016, 2017) is offset against the ticket price as well as the costs for the regional expansion (EUR 120) and added to the investments from the bond.

Table 4-4 shows the necessary steps to calculate the share of the Bond for the funding of semester tickets (number and price of sold tickets in relation to revenues and costs). This share also corresponds to the share of the expected reductions for greenhouse gases in the bond. 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 2018](#) for the most recent data).

Table 4-4: Calculation of the share of expenses for semester tickets from the bond in the total costs for semester tickets

Reference budget year	2014 (#1)	2015 (#2)	2016 (#3)	2017 (#4)
Sold tickets with NRW extension (98% of all semester tickets)	1.11 m pcs.	1.16 m pcs.	1,19 m pcs.	1,21 m pcs.
Price of the semester ticket with NRW extension	EUR 46.00	EUR 48.10	EUR 49.50	EUR 50.90
Income from semester tickets with NRW extension	EUR 50.83m	EUR 55.60m	EUR 58.88m	EUR 61.46m
State financing share (NHA NRW; constant over four years)	EUR 21.04m	EUR 21.04m	EUR 21.04m	EUR 21.04m
Costs for regional tickets (EUR 120 per ticket)	EUR 135.31m	EUR 141.55m	EUR 145.65m	EUR 147.86m
Total costs semester ticket	EUR 207.18m	EUR 218.20m	EUR 225.57m	EUR 230.36m
Share of bond in total costs	10.2%	9.6%	9.3%	9.1%

source: own calculations based on tariff data and data provided by the Ministry of Finance NRW

Based on data from the Federal Environment Agency, 142 g CO₂e per car-km are assumed to be GHG reductions through avoided car-km (Umweltbundesamt (UBA) 2016). In total (see Table 4-5), between 99,500 and 109,000 tonnes of CO₂e per year can thus be avoided, of which 9,900 to 10,100 tonnes of CO₂e per year are attributable to investments in the bond.

Table 4-5: GHG reduction potential for the promotion of semester tickets in the NHA NRW

Bond Number	NRW Bond #1	NRW Bond #2	NRW Bond #3	NRW Bond #4
Total GHG reduction potentials for semester tickets in NRW	99,450 t CO ₂ e/a	104,040 t CO ₂ e/a	107,050 t CO ₂ e/a	108,676 t CO ₂ e/a
GHG reduction potentials for the NHA NRW (Share in %)	10,100 t CO ₂ e/a (10.2%)	10,030 t CO ₂ e/a (9.6%)	9,990 t CO ₂ e/a (9.3%)	9,927 t CO ₂ e/a (9.1%)

Source: own calculation

4.4.4 Data basis and calculation of GHG reduction of 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 (RS1) between Duisburg and Hamm (Regionalverband Ruhr 2014). Based on statistics of purposes and number of routes in NRW, an estimation of the passenger car-km avoided is carried out there. In the "zero case" scenario, a conservative design, 1,760 car-km per km of cycle distance and day are avoided by high-speed cycle paths.

In the area of municipal cycle paths, no data are available on the avoidance of car km. In a first approximation, the assumptions about the fast cycle paths are adopted. However, it is assumed that municipal cycle paths only have a substituting effect on car use for paths up to 5 km in length (60% of paths or 1,060 car-km per km cycle path per day).

The cost factors to be determined make it possible to identify the added cycle routes with the help of the investments made by the State of NRW within the bond. For municipal cycle paths, they are based on data from the Ministry of Transport of the State of NRW. The 5-year average of the added cycle paths in municipal construction load is EUR 209,000 per km.

No sufficient data was available for non-urban cycle paths. Instead, the average construction costs per km of cycle path were calculated from existing projects (see Table 4-6). Accordingly, the average construction costs are EUR 1.16m per km cycle path built.

Table 4-6: Considered construction costs and length of the fast cycle paths

Cycle path	Length	Cost	Source
RS1 Duisburg - Hamm	101 km	EUR 184m	feasibility study RS1
RSW Mittleres Ruhrgebiet Gladbeck - Bottrop -Essen	17 km	EUR 39m	feasibility study RS MR
Regio Velo Isselburg-Bocholt - Velen	61 km	EUR 39m	AGSF ¹⁰ Data & Facts
RSW OWL Minden-Herford	50 km	EUR 26m	final report on RS3
RSW Aachen-Herzogenrath-Kerkrade	30 km	EUR 21m	website
RSW Köln-Frechen	8 km	EUR 6m	AGSF Data & Facts
RSW Neuss-Düsseldorf-Langfeld/Monheim	31 km	EUR 32m	project report (website)
Average cost per km	1 km	EUR 1.16m	

Source: own calculation based on web publications

For the GHG reduction through avoided car km 142 g CO₂e per car-km are assumed (Umweltbundesamt (UBA) 2016). Table 4-7 shows the results of the analysis for GHG reduction by cycle path construction within the bond.

The service life of a cycle path is 30 years for a bituminous pavement.

Table 4-7: Built-up cycle paths and GHG reduction potential through cycle path construction in the bond

Bond Number	Effect	NRW Bond #1	NRW Bond #2	NRW Bond #3	NRW Bond #4
Non-urban fast cycle paths	Annual GHG reduction	0 t CO ₂ e/a	744 t CO ₂ e/a	658 t CO ₂ e/a	580 t CO ₂ e/a
	GHG reduction over lifetime (30 years)	0 t CO ₂ e	22,322 t CO ₂ e	19,737 t CO ₂ e	17,387 t CO ₂ e
	Kilometres built up	0.0 km	8.2 km	7.2 km	6.4 km
Urban cycle paths	Annual GHG reduction	2,668 t CO ₂ e/a	2,746 t CO ₂ e/a	2,406 t CO ₂ e/a	2,350 t CO ₂ e
	GHG reduction over lifetime (30 years)	80,032 t CO ₂ e	82,386 t CO ₂ e	72,186 t CO ₂ e	100,433 t CO ₂ e
	Kilometres built up	48.8 km	50.2 km	44.0 km	61.2 km

source: own calculation

¹⁰ AGSF: Arbeitsgemeinschaft fußgänger- und fahrradfreundlicher Städte, Gemeinden und Kreise in Nordrhein-Westfalen e.V.

4.5 D: Climate Protection and Energy Transition

The investment volume in category D amounts to EUR 35.7m. 65% or EUR 23.5 of this sum are the State's co-financing of projects within the framework of the European Fund for Regional Development (ERDF). The effects of these funds are reported in the current implementation report for NRW (Ministerium für Wirtschaft, Innovation, Digitalisierung und Energie des Landes Nordrhein-Westfalen 2018).

EUR 7.0m (or 20% of the investments) are used for the State's other efforts towards climate protection, energy transition, renewable energies and energy efficiency. These funds are potentially quantifiable, but could not be quantified due to lack of data.

The last category refers to resource efficiency with EUR 5.2m or 15% of the investments. EUR 3.3m of these funds are used for the consultation of companies in order to reduce their energy use, GHG emissions, waste and water use. They are part of the public funding for Effizienzagentur NRW efa+ and Ökoprofit NRW.

Table 4-8 and Figure 4-5 list all investments in category D and their breakdown into quantifiable assets as well as assets which effects were reported elsewhere (see next section).

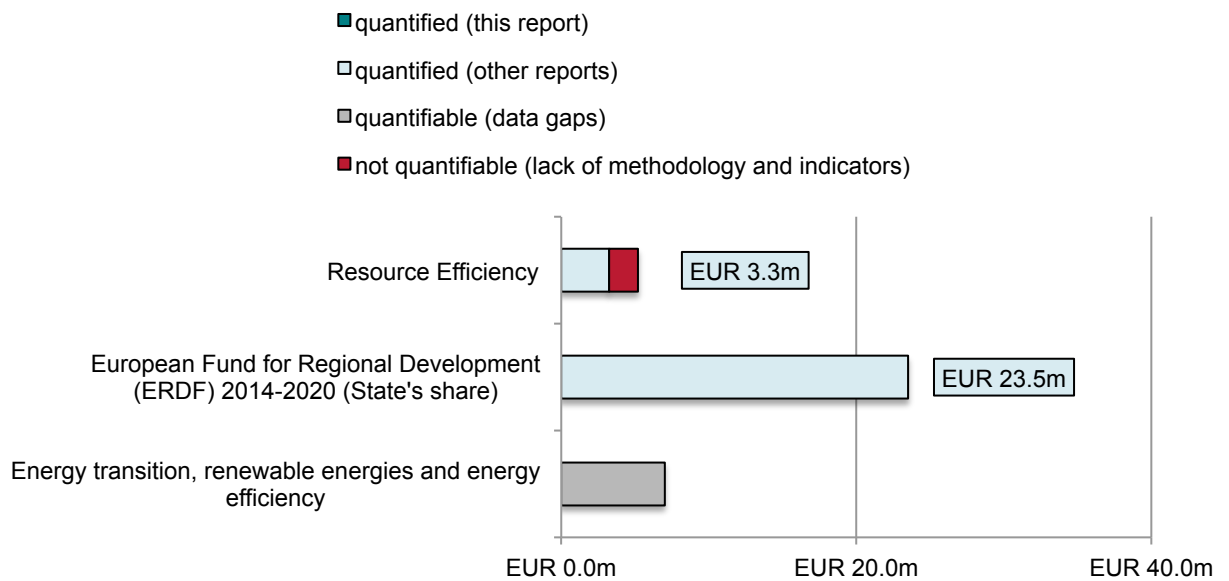
Unfortunately, none of the investments in this category could be quantified directly in the report at hand (lack of data on financed projects).

Table 4-8: Quantified and quantifiable volume in category D

Sub-Categories	Investment volume	quantified (this report)	quantified (other reports)	quantifiable (lack of data)	not quantifiable
Energy transition, renewable energies and energy efficiency	EUR 7.0m	-	-	EUR 7.0m	-
European Fund for Regional Development (ERDF) 2014-2020 (State's share)	EUR 23.5m	-	EUR 23.5m	-	-
Resource Efficiency	EUR 5.2m	-	EUR 3.3m	-	EUR 2.0m
in Total	EUR 35.7m	-	EUR 26.8m	EUR 7.0m	EUR 2.0m

source: own compilation

Figure 4-5: Quantifiability of different project groups in category D



source: own compilation

4.5.1 Third-Party assessments in category D

Category D covers a number of measures which lead to GHG reduction but which could not be quantified in this analysis due to insufficient data. These include the expansion of renewable energies and measures to increase resource and energy efficiency. Between 2014 and 2017, EUR 91.5m were invested. The resulting ecological effects, however, were partly estimated by the participating institutions themselves.

Table 4-8 shows the results of supporting companies within the framework of the "NRW Efficiency Agency" (efa+), Ökoprofit and the use of ERDF funds. The Efficiency Agency and Ökoprofit provide consultancy services that support companies and business networks in reducing their consumption of energy and resources. ERDF is a European fund for the promotion of regional development that draws on EU, federal and state funds. This fund is divided into various priorities or thematic areas. Priority axis 3 focuses on the reduction of greenhouse gas emissions.

Table 4-9: Overview of quantified effects in category D from other reports

Type	Sustainability Bond NRW funding (budget years 2014-2017)	Investments outside the Sustainability Bond (budget years 2014-2017)	Ecological savings (per annum between 2014 and 2017)*
Effizienz Agentur NRW efa+ (as part of resource efficient economy)	ca. EUR 14m	EUR 46.6m in the scope of resource efficiency (validated)	<ul style="list-style-type: none"> ■ 60,157 tons of CO₂e ■ 9,807 tons of material resources ■ 401,795 m³ of water
		EUR 372.1m in the scope of financing (validated)	<ul style="list-style-type: none"> ■ 120,211 tons of CO₂e ■ 13,048 tons of material resources ■ 200,763 m³ of water
Ökoprofit NRW (as part of resource efficient economy)	ca. EUR 1m	EUR 59.7m for 2,922 measures	<ul style="list-style-type: none"> ■ 84,231 tons of CO₂e ■ 5,979 tons of waste ■ 495,995 m³ of water
ERDF (2014-2020) (priority axis 3)	EUR 76.5m	not assignable	<ul style="list-style-type: none"> ■ 454,424 tons of CO₂e

**Different methods were used to calculate the ecological impacts of the projects. The results are not summable. These numbers refer to the most recent reporting in the projects (including retrospective adjustment of data).*

source: Ministerium für Wirtschaft, Innovation, Digitalisierung und Energie des Landes Nordrhein-Westfalen 2018 and personal correspondence with Effizienz Agentur NRW efa+ and Ökoprofit NRW

4.6 E: Environmental Protection and Nature Conversation

Within project category E, a total of EUR 81.5 million from the fourth Sustainability Bond was spent for projects that contribute to the conservation of biological diversity in the State of NRW. This category refers to SDG14 and 15 (Ministry of Finance of the State of North Rhine-Westphalia 2017). The following subcategories are included in this category:

- Risk Assessment and Remediation, Land Recycling
- Nature Conservation and Landscape Management
- Flood Protection and near-natural River Engineering
- Promotion of environmentally friendly and animal-friendly Agriculture
- NRW Rural Area Programme (ELER), State's share

The subcategory "nature conservation and landscape management" has the highest investment share of EUR 31.7 million.

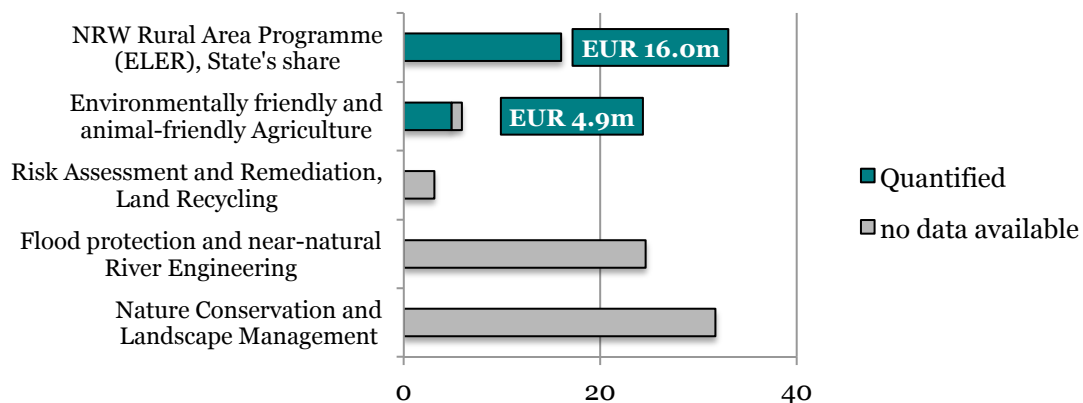
4.6.1 Investment volume taken into account

Of the total volume of EUR 81.5 million, EUR 20.9 million can be allocated to quantifiable sustainable land use. These are the "Promotion of environmentally friendly and animal-friendly Agriculture" and the NRW programme "Rural Areas" (ELER). Investments in animal-friendly agriculture (EUR 1 million) could not be taken into account in these categories as it was not possible to establish an area reference.

The other subcategories also partly lead to sustainable land use, e.g. areas for the biotope network that are promoted within the subcategory "Nature Conservation and Landscape Management" or also areas for flood protection and near-natural water-course construction. For these subcategories, however, it was not possible to directly allocate investments to individual measures with a corresponding land reference.

Figure 4-6 shows the investments, divided into the corresponding subcategories, as well as the investment volumes that could be certified with quantifiable data.

Figure 4-6: Overview of the investment shares within project group E for which sustainable land use could be quantified.



source: own calculations based on data provided by the Ministerium für Umwelt, Landwirtschaft, Naturschutz und Verbraucherschutz des Landes Nordrhein-Westfalen

4.6.2 Data basis and calculation of land use

Data from the Ministry for the Environment, Agriculture, Nature Conservation and Consumer Protection of the State of North Rhine-Westphalia (MULNV) as well as Data from the "Gemeinschaftsaufgabe zur Verbesserung der Agrarstruktur und des Küstenschutzes" (GAK) (Bundesministerium für Ernährung und Landwirtschaft 2016) were used to evaluate sustainable land use. The investments for the NRW programme "Ländlicher Raum" (ELER) were estimated on the basis of the ELER Annual Report 2015 and 2016 (written notification by MULNV).

The amounts of funding in these report do not match exactly to investments in the bond. Similar to other categories in this impact report, cost-factors were generated to estimate the effects.

A total of 20.9% of the investment volume in project category E was quantified for areas with sustainable use. Table 4-10 shows the quantified areas and their allocation to the corresponding subcategories. A total of 293,948 ha of subsidised land was identified.

According to the State Office for Nature, Environment and Consumer Protection North Rhine-Westphalia (LANUV 2017), a total of 16.2% of NRW's land area is under protection. The report of the sustainability indicators of NRW shows a steady increase of nature conservation areas (Federal Government NRW 2016). These data allow the conclusion to be drawn with certainty that the measures financed by the Sustainability Bond #4 have led to an overall increase in sustainable land use, even if this increase is not clearly quantifiable in this order of magnitude.

Table 4-10: Results of the quantification of the subsidised sustainable land use within the framework of environmentally friendly and animal-friendly agriculture

Subcategory	Investment volume (2017)	Area supported per year (2017)
Promotion of environmentally friendly and animal-friendly Agriculture (via GAK)	4,9 EUR	37.841 ha
NRW Rural Area Programme (ELER), State's share	16,0 EUR	256.407 ha

Source: own calculation

4.7 F: Sustainable Urban Development

4.7.1 Broadband Expansion

The state of NRW invests EUR 162.5m for the expansion of broadband connections (50 Mbit/s and more) for households, companies and public institutions. These investments are provided as co-funding and are targeted in particular for communities where such infrastructure projects are currently not feasible from an economic point of view. This expansion is co-financed by up to 50% from federal funds. It is the goal of the Federal as well as State's government to achieve a nearly universal broadband coverage in Germany in the foreseeable future.

Although broadband expansion is not necessarily directly economically feasible (in turns of direct revenues for communities), it is often assumed that it prevents external costs in the future, while also providing additional benefits even in the most rural areas. Possible positive effects range from economic growth, efficiency and productivity gains to additional employment. As such, broadband expansion can contribute to an economically sustainable development, but also to a better quality of life in schools and households (Wernick and Bender 2016). However, there is currently not enough sufficient scientific literature to support any of these claims.

While these impacts cannot be measured in direct relation to the investments of the Sustainability Bond, the number of additional access points can be estimated. A study from 2013 on behalf of the German Federal Ministry for Economic Affairs and Energy (TÜVRheinland et al. 2013) estimated cost factors per access between EUR 810 (for penetrations rates between 75% and 95%) and EUR 3,850 (for penetration rates between 95% and 100%). This large range can be explained by the availability of different technological options, different aims for bandwidth, but most importantly by the different length of cables and necessary excavations in different rural and non-rural regions.

In order to calculate a rough estimate, the authors use data from the German Federal Ministry of Transport and Digital Infrastructure. 13 different regions and cities in NRW, which already expanded their broadband accessibility, were selected to calculate a ratio between funding for broadband expansion and resulting access points for households, companies and institutions (see Table 4-11). This covers more than 50,000 access points with an overall funding of EUR 100m.

Related to the EUR 162.5m in the Sustainability Bond NRW #4 (from the State's 2017 budget), it can thus be estimated that these investments help to provide more than 81,000 broadband connections in North Rhine-Westphalia. By comparison, literature data from the 2013 study (TÜVRheinland et al. 2013) results in a range between 42,000 and 200,000 connections per year (with decreasing annual values as lower populated areas are more likely to be connected last).

Table 4-11: Funding for broadband connections in selected regions in NRW

Region	Federal Funds	Other Funds (including state funds)	Overall Funding	households	companies	institutions	overall access	Funds per access
<i>unit</i>	<i>EUR</i>	<i>EUR</i>	<i>EUR</i>	<i>number</i>	<i>number</i>	<i>number</i>	<i>number</i>	<i>EUR</i>
Rheinisch-Bergischer Kreis	5,147,788	84,311	5,232,099	5,476	752	26	6,254	837
Gemeinde Nümbrecht	8,696,934	0	8,696,934	7,561	125	31	7,717	1,127
StädteRegion Aachen - A 85	3,604,911	0	3,604,911	3,004	67	10	3,081	1,170
Rhein-Sieg-Kreis	9,896,621	1,979,325	11,875,946	7,893	244	185	8,322	1,427
Stadt Duisburg	8,958,584	0	8,958,584	4,168	1,502	98	5,768	1,553
Stadt Mönchengladbach	4,515,513	0	4,515,513	2,279	161	7	2,447	1,845
Kreis Recklinghausen	14,998,498	0	14,998,498	5,969	627	7	6,603	2,271
Gemeinde Neuenkirchen	10,897,849	1,755,256	12,653,105	3,268	386	13	3,667	3,451
Stadt Bielefeld	7,893,418	0	7,893,418	1,861	379	7	2,247	3,513
Stadt Bonn	1,326,326	0	1,326,326	128	80	54	262	5,062
Gemeinde Westerkappeln	4,427,340	885,469	5,312,809	956	70	8	1,034	5,138
Kreis Düren	14,045,903	1,134,044	15,179,947	2,526	208	112	2,846	5,334
Stadt Ahaus	198,503	39,700	238,203		35		35	6,806
All selected projects	EUR 94.61m	EUR 5.88m	EUR 100.49m	45,089	4,636	558	50,283	0

source: selected regions from Digitalacker, a interactive map on broadband expansions in Germany (Bundesministerium für Verkehr und digitale Infrastruktur 2018)

4.8 G: Modernisation of Educational and Public Health Facilities

Category G covers funding for construction of universities and university clinics (new buildings and refurbishment). Increasing the energy efficiency of these buildings (in particular for the end-use of heat) is one of its major goals. Table 4-12 shows the investments by the State as well as their listing in the State's budget.

Table 4-12: Investments in project category G

Topic	Title	Budget items	Investments (EUR 420.8m)
Modernisation of university buildings	<i>Modernisation of university buildings</i>	# 06 100 891 20, 06 110 685 20, 894 20	EUR 67.0m
Modernisation of university clinical buildings	<i>Conservation and remediation of existing facilities</i>	# 06 102 TG 63, 06 103-108 891 20	EUR 148.1m
	<i>Enlargement and other investments</i>	# 06 103-108 891 30	EUR 205.7m
in total			EUR 420.8m

source: own compilation based on Ministerium für Finanzen des Landes Nordrhein-Westfalen (2017)

4.8.1 Volume for GHG reductions

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 pay rent.

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

The investments in the bond correspond to actual investments in the State's budget from 2017, but do not allow to differentiate into these four segments with GHG relevance. Therefore, additional information on the State's investments are drawn from the budget, which allow to assign the amounts spent in greater detail.

4.8.2 Investments for GHG relevant measures in category G

The assignment of funds to general university buildings is based on the funding for the *Hochschulbaukonsolidierungsprogramm* (HKoP; programme for the construction of university buildings) and for the *Hochschulmodernisierungsprogramm* (HMoP; programme for the modernisation of university buildings).

The State's budget for 2017 lists EUR 50m for HKoP (assumed to be mainly used for new buildings and building extensions) and EUR 30.8m for HMoP (assumed to be mainly used for refurbishment). Of EUR 67.0m investments, presumably 61 % are used for new buildings and 39 % are used for refurbishment measures.

Both investments are assumed to use 52 % of funds available for equipment (according to the Ministry for Finances). In addition, only 45 % of investments into refurbishment measures lead to higher energy efficiency in buildings. The latter value describes the energy refurbishment ratio and is based on a study on the refurbishment of public buildings in Germany (Hebel et al. 2011).

As a result, EUR 19.9m are direct investments into new general university buildings and EUR 5.5m are investments into energy refurbishment in the same segment.

Investments into clinical university buildings are listed individually in the State's budget and can therefore be used to generate a more specific allocation of funds. Based on the 2017 listings for all university clinics in NRW (Aachen, Bonn, Cologne, Düsseldorf, Essen, Münster), 67.1 % of the funds are used for new buildings and 23.3 % for refurbishment measures. Considering also a reference energy refurbishment ratio of 53.6 % (based on the "Bettenturm Münster"), the following allocation is assumed: EUR 237.3m are used for new buildings, EUR 44.0m for energy refurbishment and EUR 34.4m for other purposes such as equipment.

Table 4-13 shows the resulting investments in category G into measures with direct GHG mitigation potential and other measures.

Table 4-13: Allocation of funds with GHG relevance in category G for the Sustainability Bond 2018

Topic	Measures for GHG mitigation/avoidance	Investments into measures for GHG emission reduction	Investments into other measures (e.g. equipment)
General university buildings	New and Extensions	EUR 19.9m	EUR 41.6m
	Energy Refurbishment	EUR 5.5m	
Clinical university buildings	New and Extensions	EUR 237.3m	EUR 34.4m
	Energy Refurbishment	EUR 44.0m	

source: own allocations based on information provided by the Finanzministerium des Landes Nordrhein-Westfalen and the 2017 budget of the State of North Rhine-Westphalia

4.8.3 Specific GHG emission factors for general and clinical university buildings

Table 4-14 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 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 4-14: Emission factors for the heat demand in university and university clinical buildings

Energy source	Emission factor (without upstream)	Data source	Spatiality	Share in buildings
Gas*	202 g CO ₂ e/kWh	FfE (2010)	Deutschland	55.8 %
Oil, light*	266 g CO ₂ e/kWh	FfE (2010)	Deutschland	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 universities & clinics	222 g CO₂e/kWh			100 %

* 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.

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

4.8.4 Heat demand in new 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.

The heat demand of buildings in the class "Universities and Research" is estimated in a 2013 study by the Federal Ministry of Transportation and Construction (Bundesministerium für Verkehr, Bau und Stadtentwicklung) (Deilmann et al. 2013). This study contains data on the share for energy carriers as well as the average heat demand in regard to the age of the buildings before and after an energy-related refurbishment. Table 4-15 shows the results sorted by the year of construction as well as their share of the overall existing buildings. These potential savings are used for all new university buildings funded by the Sustainability Bond (see the next section for energy savings after refurbishment).

Table 4-15: Heat energy savings in university buildings (Germany)

Year of construction	Heat demand in existing buildings	Heat demand after refurbishment (base-case for new buildings)	Share of existing buildings
until 1976	236.3 kWh/(m ² a)	108.5 kWh/(m ² a)	80 %
1977 - 1983	209.9 kWh/(m ² a)	107.4 kWh/(m ² a)	6 %
1984 - 1995	167.9 kWh/(m ² a)	104.9 kWh/(m ² a)	6 %
from 1995 onward	129.6 kWh/(m ² a)	104.9 kWh/(m ² a)	8 %
Heat energy savings		117,2 kWh/(m²a)	100 %

Quelle: own calculations based on Deilmann et al. (2013)

Linking the data in Table 4-15 and Table 4-14 results in GHG emission savings of 26 kg CO₂e per m² for new university buildings when compared to the building stock (222 g CO₂e per kWh at a difference of 117.2 kWh/(m²a)).

4.8.5 Calculation of GHG emission savings in new university buildings

The available data on State funding does not include the area of newly constructed buildings. Instead, data on recently constructed university buildings was used to generate a cost factor on the amount of useful area that can be constructed per EUR. This results in an average of the sample of 250 m² per million euro. Table 4-16 shows the data used for the estimation of the cost factor, based on several large projects in NRW.

Table 4-16: Construction of useable area based on investments for university buildings in NRW

(* refers to costs according to cost estimations)

Building	Construction costs	Net area	Promoted share by State of NRW	Cost factors (calculated)
FH Aachen, replacement construction	EUR 12.5m	3,900 m ²	100 %	312 m ² per EUR 1m
RWTH Aachen, auditorium centre	EUR 45.0m	14,000 m ²	100 %	311 m ² per EUR 1m
Univ. Dortmund, Replacement New Building Chemistry/Physics (EE)	EUR 82.3m	14,661 m ²	100 %	178 m ² per EUR 1m
FH Niederrhein, Replacement new multi-building	EUR 20.0m	6,900 m ²	75 %	259 m ² per EUR 1m
FH Bielefeld, Replacement new construction, network expansion	EUR 279.3m	60,400 m ²	100 %	216 m ² per EUR 1m
FH Düsseldorf, ENB 1. BA*	EUR 170.0m	54,000 m ²	100 %	318 m ² per EUR 1m
in Total	EUR 609m	153.861 m²	average (weighted)	250 m² per EUR 1m

Source: own calculation; Information on construction costs and constructed area are based on press releases

Taking into account the assumed savings in heating energy, the associated factor for GHG reduction and a life of 50 years (Stibbe and Stratmann 2014), the EUR 19.9m bond investment will potentially build 5,000 m² of building space, which could lead to annual savings of 129 t CO₂e. GHG emissions are reduced by up to 6,470 t CO₂e compared with existing buildings and over the life of the building.

4.8.6 Data basis and calculation of the GHG reduction of new buildings in university clinics

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 4-17; also based on a selection of large projects). The information on the construction costs determined or estimated is taken from the State's 2016 budget¹¹ for Title Groups 06 103 to 06 108 (for each of those, budget item # 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.

¹¹ the calculation of cost-factors for buildings is based on the previous impact report for the NRW Sustainability Bond #3

Table 4-17: Net additional floor space for investments in new buildings in university clinics

Intentions	Building costs	Net floor area	Specific cost factor
Cologne: CIO Centre (outpatient)	EUR 77.9m	13,500 m ²	173 m ² per EUR 1m
Aachen: extension building for intensive surgical care	EUR 41.2m	8,643 m ²	210 m ² per EUR 1m
Düsseldorf: Medical Research Centre I	EUR 79.9m	19,650 m ²	246 m ² per EUR 1m
Düsseldorf: Medical Research Centre II	EUR 26.2m	7,970 m ²	304 m ² per EUR 1m
Bonn: building parent-child centre	EUR 71.9m	11,787 m ²	164 m ² per EUR 1m
Bonn: neurology, psychiatry and palliative medicine (NPP)	EUR 64.6m	12,842 m ²	199 m ² per EUR 1m
Sum	EUR 361.6m	74,392 m²	206 m² per EUR 1m

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

Taking into account the assumed savings of heating energy, the associated factor for GHG reduction and a life of 66 years (Hebel et al. 2011), the investments of EUR 237.3m through the bond will potentially create 48,800 m² of building space (see Table 4-17), which could lead to annual savings of 1,272 t CO₂e.

GHG emissions are reduced by up to 84,000 t CO₂e compared with existing buildings and over the life of the building.

4.8.7 Data basis and calculation of the GHG reduction of renovated buildings in general universities

The determination of the cost factor and the reduction of the heating energy requirement of renovated buildings in general universities is based on data from a facade renovation at the Ruhr University Bochum (Krewald 2017). Construction costs of EUR 87.9m were incurred to renovate a 52,300 m² site. Thus, investments of EUR 11.4 m lead to the redevelopment of 6,800 m² (at costs of EUR 1,680 per m²). The share of the energy-related renovation quota is already considered in the allocation of investments.

On the basis of general heating energy demand in universities (see chapter 4.8.4) and a reduction in heating energy demand of probably 88 kWh/m² (NF 1-6 buildings), potential GHG reductions of 19.6 kg CO₂e per m² are achieved.

A total of 133 t CO₂e per year are saved by this. GHG emissions could be reduced by up to 2,700 t CO₂e over a service life of 20 years (EnEV stipulates financial amortisation).

4.8.8 Data basis and calculation of the GHG reduction of renovated buildings in university clinics

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

- The construction costs for facade works (energetic refurbishment) amount to EUR 20.6m.
- The total construction costs amount to EUR 38.5m with a subsidy amount of EUR 45.9m.
- 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 taking into account 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 4-18 can be determined.

Table 4-18: 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 taken into account 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

With investments of EUR 25.0 million for energy-related refurbishment, an estimated 1,060 beds will be refurbished, which would lead to annual GHG savings of 744 t CO₂e. If a service life of 20 years is also assumed here, GHG emissions can be reduced by a total of 14,880 tonnes of CO₂e.

4.8.9 Summary of results for category G

Table 4-19 summarises the results in category G for the NRW Sustainability Bond #4.

Table 4-19: Results of the impact assessment in category G

Measure	Investments for GHG reduction	Annual GHG reduction	GHG reduction potential over service life
Construction of new University Buildings	EUR 19.9m	129 tons CO ₂ e / a	6,473 tons CO ₂ e
Refurbishment of University Buildings	EUR 5.5.m	65 tons CO ₂ e / a	1,290 tons CO ₂ e
Construction of new University Clinical Buildings	EUR 237.3m	1,272 tons CO ₂ e / a	83,949 tons CO ₂ e
Refurbishment of University Clinical Buildings	EUR 44.0m	1,310 tons CO ₂ e / a	26,192 tons CO ₂ e

source: own calculation

5 Longterm Development of GHG Savings

The following sections summarises key figures of climate change mitigation in the Sustainability Bond NRW #4 as well as in the previous bonds. It compares the GHG saving effects to the investments and over time.

5.1 Efficiency of GHG savings in Sustainability Bond NRW #4

The investments in the bond are the main input for the calculation of greenhouse gas savings. They are related to costs of financed projects as well as their effects.

Each investment is usually provided with a technical lifetime. While annual expenditures for e.g. student tickets relate to a lifetime of 1 year, buildings save energy and greenhouse gas emissions every year until they are dismantled or refurbished again (with expected lifetimes of 20 years and more).

Table 5-1 lists the annual GHG savings for 7 different measures in the bond categories C (Public Transportation and Local Mobility) and G (Modernisation of Educational and Public Health Facilities). While the annual effects for student tickets are the largest by far, they relate to annual spending in the budget.

Urban cycle paths on the other hand show a comparatively smaller effect for the budget year 2017, but are expected to reduce the demand for car travel for 30 years and more, leading to overall savings of more than 100,000 tons of GHG.

Table 5-1: GHG savings of measures in the project categories C and G

Financed Projects in NRW Sustainability Bond #4	GHG savings per year	GHG savings over Lifetime	average Lifetime (assumption)
	<i>tons CO_{2e} per year</i>	<i>tons CO_{2e} in total</i>	<i>years</i>
Non-urban Cycle Paths	580	17,387	30
Urban Cycle Paths	3,348	100,433	30
Student Tickets	9,928	9,928	1
New University Buildings	129	6,473	50
University Buildings (refurbishment)	65	1,290	20
New Clinical Buildings	1,272	83,949	66
Clinical Buildings (refurbishment)	1,310	26,192	20

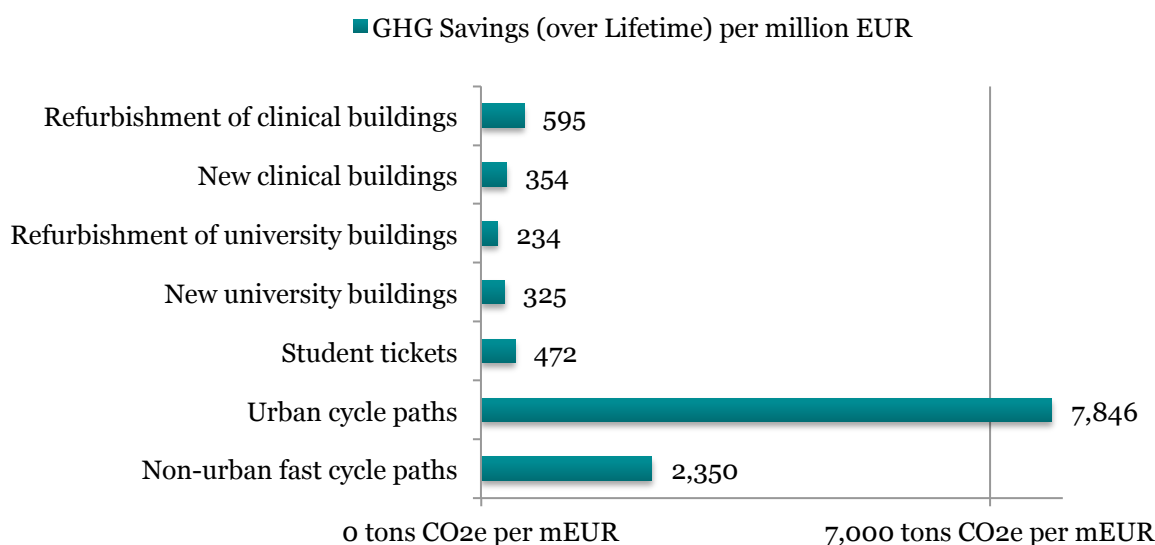
source: own calculation based on methods and data depicted in this report (deviations stem from round ups)

By relating the GHG savings over lifetime to the money invested through the bond, it can be shown which measures are most efficient. The highest efficiency in terms of GHG savings per million euros invested (see Figure 5-1) can be attributed to the construction of cycle paths. Even at a much lower assumption for the technical lifetime, these two areas would show a very high efficiency (e.g. non-urban cycle paths would still have a normalised efficiency of ca. 780 tons per EURm based on the assumption of a lifetime of only 10 years). This high efficiency cannot be attributed to large climate protection effects of cycling alone (or the underlying empirical data used to calculate the effects). Partly responsible for this effect are also the costs of different measures, in particular high costs for building construction and refurbishment.

However, focusing on comparing these efficiencies can be misleading. Buildings, in particular the building types financed through Sustainability Bonds, provide co-benefits that affect numerous areas of sustainable development. Clinical and non-clinical university buildings prevent health hazards, improve research capabilities and patient care. The same is true for over EUR 130m invested into public transportation for pupils and students (of which only EUR 21.0m were directly assigned to tickets for students and their climate mitigation effect), as additionally financed improvements of supply and quality in public traffic are beneficial to all citizens.

Finally, not every climate protection measure provides additional GHG savings in the end. The calculation scheme at hand for example assumes newly constructed buildings replace old buildings. If this is not the case or if energy savings for heat are partly compensated or overcompensated by additional demand for electricity, the resulting net effect can be negative for the climate as the overall GHG emissions increase instead.

Figure 5-1: Normalised¹² efficiency of climate protection measures for quantified investments



source: own calculation based on methods and data depicted in this report

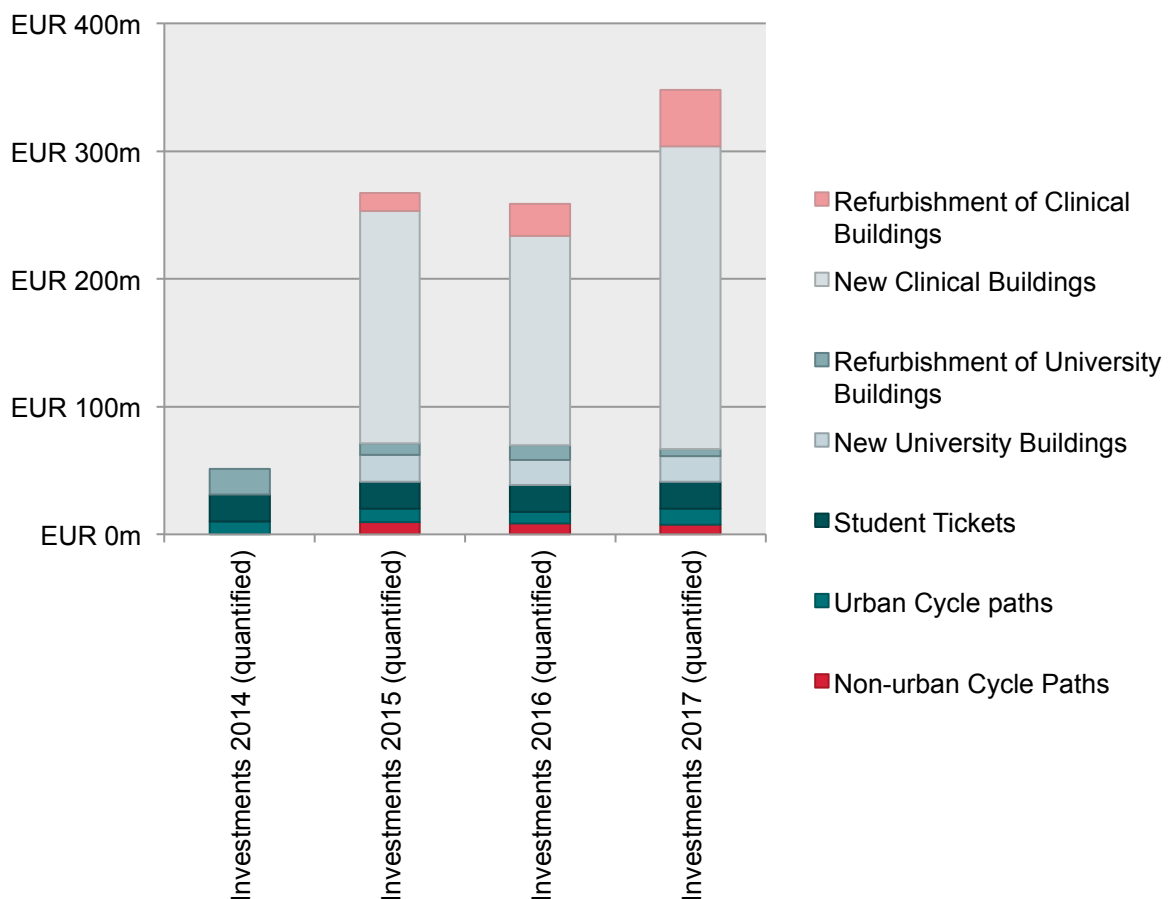
¹² The efficiency factors refer to the assessed investments only and the GHG savings over the assumed average lifetime of measures.

5.2 GHG Savings from 2014 to 2017

A number of project categories have been part of the NRW Sustainability Bonds for several years now. They also relate to the same or extended programmes, allowing to compare the effects from the budgetary years 2014 to 2017. With the exception of solar thermal energy (Bond #3) and co-generation of heat and power (Bond #2), they can therefore be aggregated to a four-year portfolio.

The evaluated projects related to the NRW bond have increased continuously over these 4 years from EUR 50m in 2014 to EUR 350m in 2017 (see Figure 5-2). The largest increase in investments can be allocated to new and refurbished clinical buildings: quantifiable investments increased from EUR 196m in 2015 to EUR 281m in 2017. Over the same time (and partly due to shifts in the State's financing structure for investments into universities) the quantifiable investments for other university buildings decreased from ca. EUR 30m to EUR 25m.

Figure 5-2: Quantifiable investments for climate protection projects from 2014 to 2017 in the portfolio of NRW Sustainability Bonds

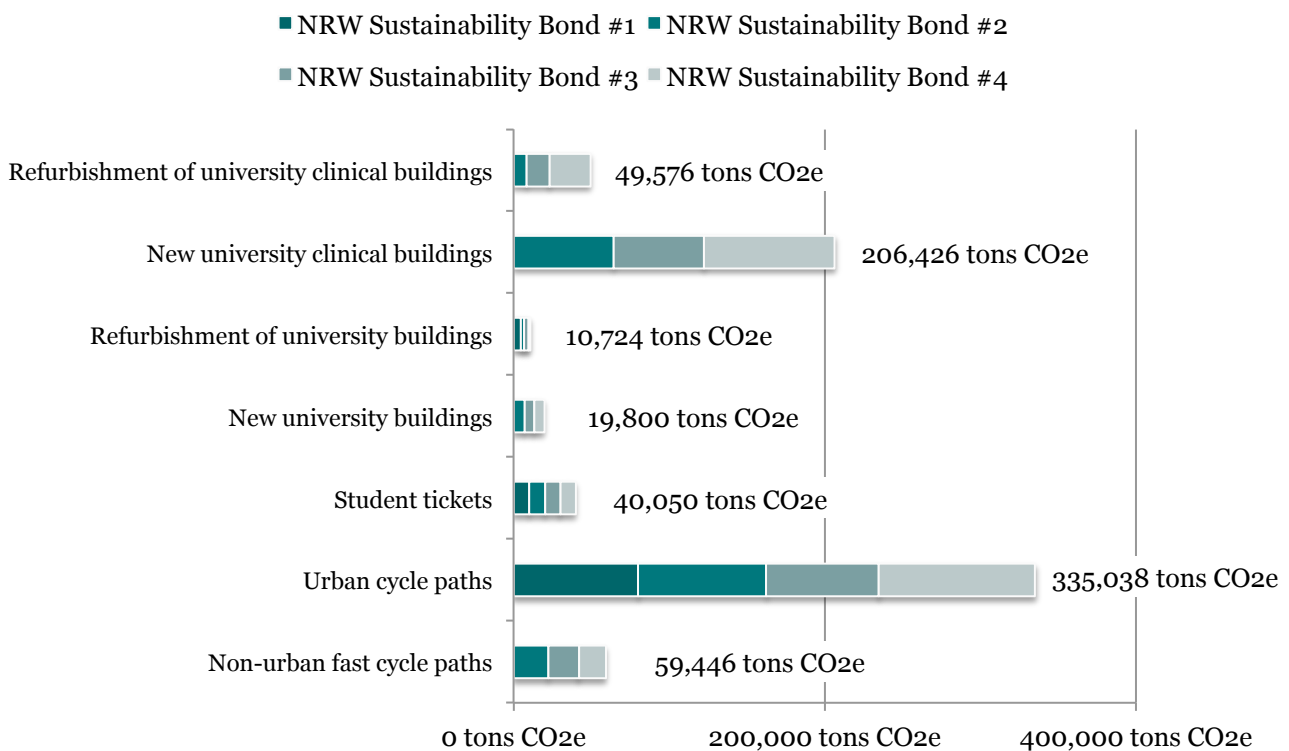


source: own compilation based on assessments in this and earlier reports (projects for solar thermal energy and co-generation heat/power are not included in the figure)

Over the course of four years (2014 – 2017) EUR 926m were invested, inducing potential GHG savings of 721,000 tons CO₂e over the assumed lifetime of the measures (see Figure 5-3). About 55 % of these savings could be attributed to the construction of cycle paths in NRW alone, while the construction of new clinical buildings contribute another 29% of the overall financed savings.

In terms of annual contribution or contribution per Bond, the NRW Sustainability Bond #4 induces 34% of the avoided GHG emissions.

Figure 5-3: GHG savings over lifetime of projects from 2014 to 2017 in the portfolio for NRW Sustainability Bonds



source: own calculation based on methods and data depicted in the full report (as well as previous reports)

6 Analysis of the State's budgetary expenditures in 2017

The Sustainability Bond #4 refers to projects in the State's budget of 2017 (the net proceeds from the State Treasury Notes are used to cover expenditures of the fiscal year of 2017). These projects were selected in accordance with the criteria and categories in the "Sustainability Bond Framework", based on the ICMA Green/Social Bond Principles (GBP, SBP) and Sustainability Bond Guidelines (SBG) (see also <https://www.icmagroup.org/green-social-and-sustainability-bonds/> for an overview of documents). Other funding (e.g. on EU level) or the State's personnel costs as well as projects prescribed by federal law are excluded.

The aim of this work package is to look more closely into those parts of the State's budget that are not eligible for sustainability bond reporting under the named framework but still likely to have either a positive or negative impact on the sustainable development of the State NRW. The analysis at hand provides a first overview on the issue in form of an exploratory study. It describes a possible approach for differentiating budgetary expenditures by their potential to affect the sustainable development of the State as well as a method for identifying trade-offs between the funding of measures and different goals of sustainable development. The short study reflects the evaluation of the authors, not the State Government, and is divided into the following sections (see also Figure 6-2 on the general approach):

- 6.1 The Sustainability Bond #4 within the State's Budget
- 6.2 Method of Analysis
- 6.3 1st order assessment: Matching with Principal Groups of Budget Items
- 6.4 2nd order assessment: Matching with Main Groups of Budget Items
- 6.5 3rd order assessment: Capital Expenditures
- 6.6 Interaction Analysis

6.1 The Sustainability Bond #4 within the State's Budget

The 2017 budget amounts to EUR 73.9bn of expenditures (see Table 6-1) with the largest shares assigned to the Ministry of Education and Training (budget section 5 with a share of 24.0%), the General Financial Management (budget section 20 with share of 20.6%), the Ministry of Culture and Science (budget section 6 with 11.9%) and the Ministry of Children, Family, Refugees and Integration (budget section 7 with 9.8%).

Table 6-1: Sections in the State's 2017 budget

Section	Section of expenditures	Expenditures	Share	Share (cumulative)
05	Ministry of Education and Training	EUR 17,776m	24.0%	24.0%
20	General financial management	EUR 15,202m	20.6%	44.6%
06	Ministry of Culture and Science	EUR 8,767m	11.9%	56.5%
07	Ministry of Children, Family, Refugees and Integration	EUR 7,265m	9.8%	66.3%
11	Ministry of Labour, Integration and Social Affairs	EUR 6,007m	8.1%	74.4%
03	Ministry of the Interior	EUR 5,379m	7.3%	81.7%
04	Ministry of Justice	EUR 4,151m	5.6%	87.3%
12	Ministry of Finance	EUR 3,159m	4.3%	91.6%
09	Ministry of Transport	EUR 2,488m	3.4%	94.9%
08	Ministry of Home Affairs, Municipalities, Construction and Equal Opportunities	EUR 1,210m	1.6%	96.6%
14	Ministry of Economy, Innovation, Digitisation and Energy	EUR 1,121m	1.5%	98.1%
10	Ministry of the Environment, Agriculture, Nature and Consumer Protection	EUR 1,037m	1.4%	99.5%
02	Prime Minister	EUR 188m	0.3%	99.8%
01	State Parliament	EUR 135m	0.2%	99.9%
13	State Audit Office	EUR 45m	0.1%	100.0%
16	Constitutional Court	EUR 0m*	0.0%*	
	TOTAL	EUR 73.9bn	100%	

* Less than EUR 80,000 are allocated to the constitutional court in NRW.

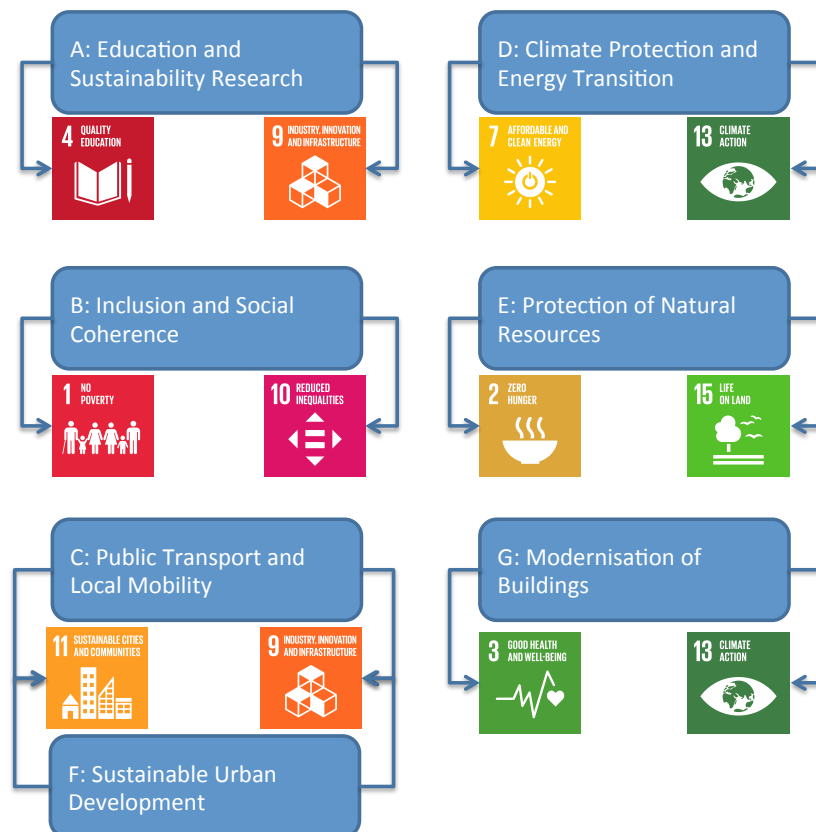
source: Ministerium der Finanzen des Landes Nordrhein-Westfalen 2019

The Sustainability Bond #4 relates to sections of the budgets ("Einzelpläne") worth 56% of overall expenditures for

- (1) Ministry of Innovation, Science and Research (Section 6),
- (2) Ministry of Family, Children, Youth, Culture and Sport (Section 7),
- (3) Ministry of Building, Housing, Urban Development and Transport (Section 9),
- (4) Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection (Section 10),
- (5) Ministry of Labour, Integration and Social Affairs (Section 11),
- (6) Ministry of Economy, Energy, Industry, Small and Medium-Sized Businesses and Crafts (Section 14),
- (7) Ministry of Health, Emancipation, Care and Ageing (Section 15).

The projects of EUR 2,027m in total amount to around 3% of the overall State's budget (EUR 73,932m), which equals 5% of the spending in the 7 sections affected. At the same time, the projects address 10 out of the 17 Sustainable Development Goals (SDGs), as Figure 6-1 shows.

Figure 6-1: Relevance of Sustainability Bond #4 NRW for the Sustainable Development Goals (SDGs)



source: own compilation based on NRW Sustainability Bond #4 (Ministry of Finance of the State of North Rhine-Westphalia 2018)

If ordered by principal groups of budget items ("Hauptgruppen", see Table 6-2), expenditures on personnel costs (excluded from the bond) together with interest expenditures (also excluded) are alone responsible for EUR 33.8bn or 45.8% of the State's budget.

Table 6-2: Budget expenditures in regard to the principal groups of budget items

Principal groups of budget items	Expenditures	Share
06 - Grants and subsidies (other than for capital expenditures)	EUR 33,985m	46.0%
04 - Personnel	EUR 26,145m	35.4%
05 - Operating expenditures and interest	EUR 7,706m	10.4%
08 - Capital expenditures and grants for capital expenditures (other than construction)	EUR 6,634m	9.0%
07 - Construction	EUR 311m	0.4%
09 - Special items	-EUR 849m*	-1.1%*
in TOTAL	EUR 73.9bn	100%
* Negative amounts for special items indicate net revenue		

source: Ministerium der Finanzen des Landes Nordrhein-Westfalen 2019

6.2 Method of Analysis

Both the Green Bond Principles (GBP) and the Social Bond Principles (SBP) include a non-exhaustive list of eligible assets for green financing¹³. In addition, the State of NRW has already published a Sustainable Development Strategy in 2016. This strategy (SDS NRW) identifies 19 fields of action and covers most of the Sustainable Development Goals¹⁴. These fields of action are the basis for the analysis of the State's budget, as they are already assigned to the Sustainable Development Goals (shown in Table 6-3). Since some of these actions already imply a positive development (e.g. sustainable development), but this analysis only shows affected areas of the budget, we use neutral action labels instead.

Field of action #8 (sustainable financial policy) plays a crucial role in this analysis, since it aims at structurally balanced state budgets from 2020 onward. Because all budget items affect this goal, field of action #8 is excluded from 2nd order assessments and further analysis.

¹³ <https://www.icmagroup.org/green-social-and-sustainability-bonds/>

¹⁴ <https://www.nachhaltigkeit.nrw.de/themen/nachhaltigkeitsstrategie-fuer-nordrhein-westfalen-en/>

Table 6-3: Fields of actions in the Sustainable Development Strategy NRW, neutral labels for analysis and their relation to the SDGs (assigned by strategy)

	Sustainable Development Strategy NRW (SDS NRW)	Neutral Label (of the assessment)	SDGs
1	Climate protection and energy transition	<i>Climate & Energy</i>	13 + 7
2	Sustainable business	<i>Business</i>	8 + 9 + 12
3	Protection of natural resources	<i>Natural Resources</i>	6 + 15
4	Demographic change	<i>Demographics</i>	3 + 11 + 16
5	Social cohesion and societal participation	<i>Social Cohesion</i>	1 + 10 + 16
6	Decent work – fair work	<i>Work</i>	8
7	Integration	<i>Integration</i>	16
8	Sustainable financial policy	<i>Financial Policy</i>	8
9	Sustainable development of urban areas and neighbourhoods	<i>Urban Areas</i>	9 + 11
10	Sustainable mobility	<i>Mobility</i>	9
11	Sustainable consumption/sustainable lifestyles	<i>Consumption/Lifestyles</i>	12
12	Land cultivation	<i>Land Cultivation</i>	2
13	Health	<i>Health</i>	3
14	One-world policy/European and international dimension	<i>Policy</i>	4 + 17
15	Gender equality	<i>Gender Equality</i>	5
16	Accessibility/inclusion	<i>Inclusion</i>	16
17	Sustainability in the municipal communities	<i>Municipal Communities</i>	11
18	Civic commitment/ participation	<i>Civic Commitment</i>	16
19	Education and science	<i>Education and Science</i>	4 + 9

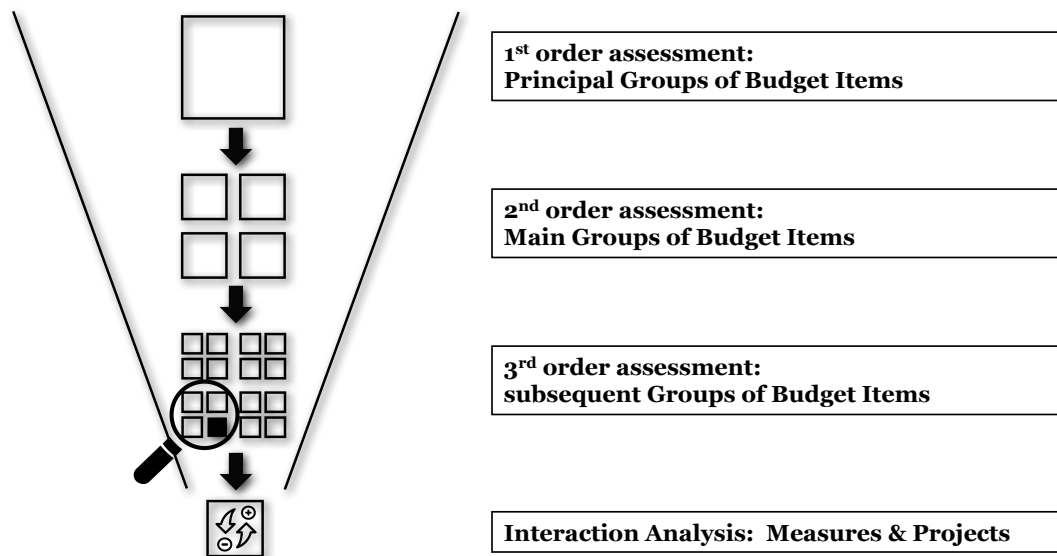
source: Landesregierung NRW 2016

The analysis is conducted in 4 consecutive steps (see also Figure 6-2):

- (1) Matching of the SDS NRW fields of action with the 5 principal groups of budget items (1st order assessment)¹⁵,
- (2) Matching of the SDS NRW fields of actions with main groups of budget items (2nd order assessment),
- (3) Matching of the SDS NRW fields of action with subsequent groups of budget items (3rd order assessment),
- (4) Exemplary analysis of interactions between budget expenditures and effects on sustainable development.

¹⁵ The principal group 9 of budget items ("special items") refers to budgetary items (see above), which are of a more technical nature. On balance, these items can be net revenues or net expenditures. Since these items typically do not have a measurable effect on sustainable development, they are excluded from the further analysis.

Figure 6-2: Approach to Budget Analysis



source: own compilation

Step (1) and step (2) describe the share of the budget that *potentially* helps to achieve the Sustainable development goals. Step (3) is dedicated to an in-depth analysis of one of the 5 principal groups of the State's budget (as an example). Steps 1 to 3 result in a description of areas of the budget that affect the sustainable development in the State of NRW either positively or negatively. Step (4) concludes the assessment with the description of a analysis of interdependencies between financed projects and their effect on the sustainable development goals. By using a case-study, it allows to differentiate not only between positive and negative effects on different SDGs, but also on the scale of these effects.

6.3 1st order assessment: Matching with Principal Groups of Budget Items

The NRW budget can be classified into groups with 3-digit-numbers assigned to them (XXX), as shown in Table 6-4. The groups are clustered into main groups ("Obergruppen") with 2-digit-numbers (XX). The main groups are clustered into principal groups ("Hauptgruppen") with 1-digit-numbers (X). Therefore, every budget item can be assigned to a group, a main group and a principal group. The principal groups for expenditures range from #4 to #9, revenues and income are classified by principal groups #0 to #3. Principal group 9 covers special items of a more technical nature, which can be revenues or expenditures.

This classification can be used to relate State expenditures to potential areas of sustainability. On the level of principal groups of budget items, only operating and interest expenditures (principal group #5) cannot directly be associated with one or more of the Sustainable Development Goals (SDGs).

Principal group 4 (personnel expenses) not only covers payments and pensions for State employees (the lion's share of spending within this group), but also obligations regarding their health and well-being. It relates strongly to the State's goal of decent and fair employment that focuses on employment rates as well as staff safety and health. It can be safely assumed that some of the expenditures improve the working conditions of State employees and are therefore sustainable in terms of decent work and economic growth (SDG 8).

Principal group 5 (operating expenditures and interest) comprises of administrative expenditures. Some of these are used to fulfil legal or financial obligations and discharge administrative duties. Due to the wide variety of expenditures covered, it cannot be ascertained without a more detailed analysis whether these expenditures are generally sustainable in nature.

Principal group 6 (grants and subsidies other than for capital expenditures) covers a large portion of expenditures on public social services and early childhood education in particular. It relates strongly to the national goal of social cohesion and participation in society. While the information provided in the budget does not allow to assess whether the amounts spent are sufficient, the funds are likely to enhance the sustainable development goal of quality education (SDG 4).

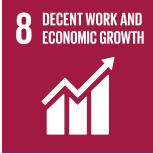



A majority of expenditures for construction within **principal group 7** is used for public roads (including the investments into cycle paths in the Sustainability Bond). It partly relates to the State's goal of improving the efficiency of traffic and goods transportation systems (sustainable mobility), although it is unclear whether the amounts spent are sufficient to provide sustainable and eco-friendly mobility. If a positive effect could be ascertained, it would in all likelihood be associated with the sustainable development goal on improving industry, innovation and infrastructure (SDG 9).

The expenditures in **principal group 8** (capital expenditures and grants for capital expenditures, other than construction) are mainly used for investments in communities, but also for public institutions and private companies. The strongest link can be associated with urban development and the State's goal of sustainable development of urban areas and neighbourhoods. While the information provided in the budget does not allow to assess whether the amounts spent are sufficient to achieve those goals, it can be assumed that these investments strengthen sustainable development, in particular enabling sustainable cities and communities (SDG 11).

All expenditures in all principal groups relate to responsibilities of federal States in Germany: public services provided by the States such as education, law enforcement, general administration and social welfare, financial support for municipalities and certain private sector entities as well as investments into public infrastructure.

Principal groups #4 and #6 in particular clearly also relate to additional social development goals such as SDG 2 (Zero Hunger) or SDG 3 (Good Health and Well-Being). On the other hand, typical issues of ecological sustainability (e.g. measures to mitigate climate change or adapt to climate change) did not surface in this 1st order assessment that focused on the largest shares in the State's budget.

Table 6-4: State's budget (expenditures) by principal groups of budget items (1st order assessment)

Budget Function	Budget share	Mainly dedicated to	Strongest link to SDS NRW actions	Strongest link to SDGs
expert guess on sustainable/non-sustainable development				
Principal Group 4 Personnel expenses	35.0%	<ul style="list-style-type: none"> Payments, allowances and pensions of civil servants and judges 	6 Work	
Principal Group 5 Operating expenditures and interest	10.3%	<ul style="list-style-type: none"> interest payments related to debt outstanding administrative payments (e.g. rents, leases, allowances) 	8 Financial Policy	no strong link
Principal Group 6 Grants and subsidies (other than for capital expenditures)	45.4%	<ul style="list-style-type: none"> public social services (e.g. early childhood education) operation of public and social facilities (e.g. universities) general purpose grants for municipalities 	5 Social Cohesion	
Principal Group 7 Construction	0.4%	<ul style="list-style-type: none"> construction and maintenance of State roads small construction measures in public buildings 	10 Mobility	
Principal Group 8 Capital expenditures and grants for capital expenditures (other than construction)	8.9%	<ul style="list-style-type: none"> investments for communities investments for public companies and institutions (e.g. universities) 	9 Urban Areas	

source: own compilation (results of 1st order assessment)

6.4 2nd order assessment: Matching with Main Groups of Budget Items

The 2nd order assessment looks deeper into the State's budget. Its aim is to identify more budget items that potentially affect the sustainable development strategy in the State of North-Rhine Westphalia (SDS NRW). Each of the 5 principal groups affected by the Sustainability Bonds are analysed in terms of

- their direct link to SDS NRW fields of action,
- their related SDGs (based on the framework of the SDS NRW report),
- and the share of the respective budget item affecting areas of sustainable development (attribution).

The **attribution** roughly estimates whether budget items affect sustainable development:

- **high** (more than 80% of expenditures relate to SDS NRW fields of action),
- **medium** (20% to 80% of the expenditures have such relations),
- **low** (5% to 20%),
- or **no attribution** (less than 5% of expenditures affected).

These estimates are based on an expert guess by the authors of the study, matching the description of a budget item with potentially affected areas of sustainable development.

6.4.1 Principal Budget Group 6 (45% share): Grants and subsidies other than for capital expenditures

Principal group 6 covers expenditures for social welfare (e.g. childhood education or reduction of poverty via housing benefits), including expenditures for refugees. It also relates to land cultivation (via expenses for the chamber of agriculture), education (e.g. regular operating expenditures of universities, or qualification measures for workers from the coal industries) and health (e.g. assistance in the event of illness).

About 70 % of the expenditures in this group relate to SDS NRW fields of action and therefore potentially affect the sustainable development in the State. All budget items that relate to these fields of action (and also indirectly to the SDGs) are relevant in terms of the budgetary allowances (high attribution). Group 6 plays a crucial role in the social dimension of sustainability, benefiting poor people, children and immigrants (if financed to a sufficient extent). These expenditures are also necessary to provide public education in schools and universities. The impacts on the ecological development of NRW, on the other hand, are comparatively small (and could be negative in some areas such as housing).

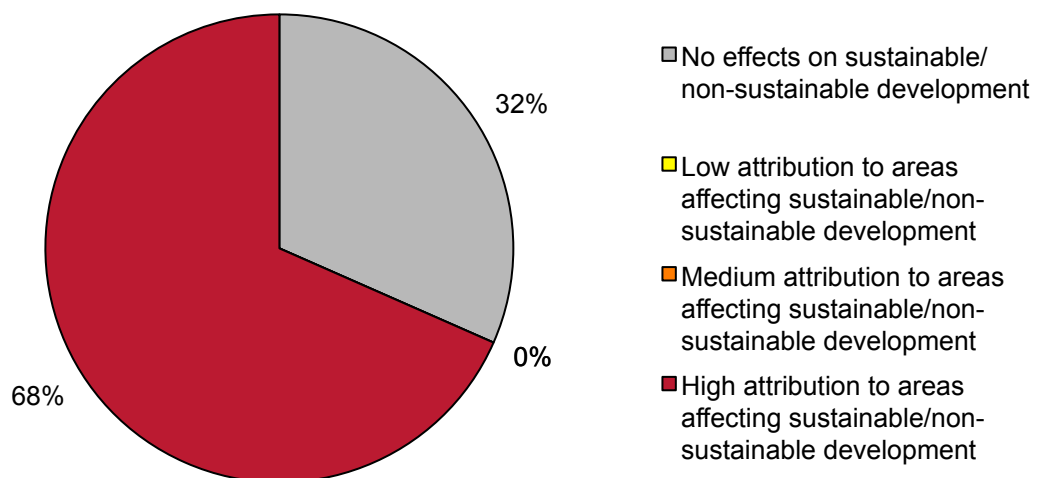
Table 6-5 and Figure 6-3 summarize and illustrate the results of the 2nd order assessment of principal group 6 on grants and subsidies other than investments.

Table 6-5: Expenditures in Principal Group 6 and related SDS NRW fields of action (qualitative assessment)

Principal Group 6: Grants and subsidies other than for capital expenditures	Budget (EUR 33.9bn)	Strong link(s) to SDS NRW fields of action	Affected SDGs	Attribution
expert guess				
Other (earmarked) allocations to the public sector (main group 63X)	EUR 11,998m	5 (Social Cohesion); 4 (Demographics); 7 (Integration)	1; 3; 10; 11; 16	high
Other current grants to other sectors (main group 68X)	EUR 10,979m	5 (Social Cohesion); 4 (Demographics); 7 (Integration); 19 (Education and Science)	1; 3; 4; 9; 10; 11; 16	high
General (non-targeted) allocations to the public sector (main group 61X)	EUR 10,656m	none (mainly financial allocations)	none	none
Refunds to other areas (main group 67X)	EUR 197m	12 (Land Cultivation); 13 (Health)	2; 3	high
Debt service assistance to the public sector (main group 62X)	EUR 82m	none (sustainable financial policy excluded)	none	none
Capital transfers, other than for investments (main group 69X)	EUR 48m	6 (Work)	8	high
Debt servicing assistance to other sectors (main group 66X)	EUR 25m	9 (Urban Areas)	9;11	high

source: own compilation

Figure 6-3: Attribution of principal group 6 (Grants and Subsidies) to areas of sustainable/non-sustainable development



source: own compilation

6.4.2 Principal Group 4 (35% share): Personnel expenses

About 70% of the expenditures in principal group 4 are used to pay wages of state employees including honorary employees in e.g. courts. This relates directly to SDS field of action of decent work / fair work and thus the SDG on decent work and economic growth (SDG 8). At least for civil servants it can be assumed that this mostly entails long-term contracts (or even lifelong occupation) and fair wages.

28% of personnel expenses are used for pensions including benefits for bereaved relatives in case of death. These expenditures reduce poverty risks, relating to SDS NRW field of action "demographic change". While it can be assumed that these expenditures are positive drivers in terms of sustainable development (good health & well-being, sustainable cities & communities as well as peace, justice and strong institutions), it cannot be ascertained which portion of these employees would be confronted with poverty risks if not employed by the State of NRW in the first place.

A considerable portion of the expenditures (8%) is also used to provide aid to state employees in case of illness, death or pregnancy. This direct link to health can only be partly associated with the SDS NRW fields of action, as the latter focuses on the prevention of health issues rather than aid in case of e.g. illness. The same holds true for the related SDG goal on health & well-being (SDG 3), which focuses on lower mortality (including child mortality) in developing countries. Nonetheless, the sub-targets on improvements of reproductive health-care as well as financial risk protection in health coverage can be positively associated with the expenditures in this category.

All expenses in this group are highly attributable to SDS NRW fields of action, meaning that 80% and more can be associated with them (see Table 6-6).

Table 6-6: Expenditures in Principal Group 4 and related SDS NRW fields of action (qualitative assessment)

Principal Group 4: Personnel expenses	Budget (EUR 26.1bn)	Strong link(s) to SDS NRW fields of action	Affected SDGs	Attribu- tion
expert guess				
Remuneration and fringe benefits (budget group 42X)	EUR 16,371m	6 (Work)	9	high
Pensions and the like (budget group 43X)	EUR 7,417m	4 (Demographics)	3; 11; 16	high
Aid, grants and the like (budget group 44X)	EUR 2,133m	13 (Health)	3	high
Global increases and decreases in personnel expenditure (budget group 46X)	EUR 88m	6 (Work)	9	high
Expenses for members of parlia- ment and volunteers (budget group 41X)	EUR 70m	6 (Work)	9	high
Other staff-related expenditure (budget group 45X)	EUR 66m	6 (Work)	9	high

source: own compilation

6.4.3 Principal Group 5 (10% share): Operating and interest expenditures

Principal group 5 covers administrative expenditures of a general nature (e.g., rents paid for office space or vehicles leased, office equipment and material) as well as interest payments for debt outstanding. A third of principal group 5 can be assigned to SDS NRW fields of actions whereby the relevance of payments (attribution) can be classified as low to medium. Group 5 also focuses on the social dimension of sustainability as integration of refugees is supported by several items of administrative expenditures in the budget. This relates directly to the SDS NRW field of action on the integration of refugees and immigrants. Further expenses cover e.g. payments for caretakers that ensure legal representation for minors, sick or otherwise handicapped people. Although the latter does not directly relate to an indicator in the State's strategy, it clearly contributes to SDG 16 (Peace, Justice and Strong Institutions) and its sub-goal of providing equal access to justice for all.

A small portion of the budget is also dedicated to the training of state employees, thus relating to the SDS NRW field of action on education and science as well as potentially contributing to the SDG on quality education (SDG 4).

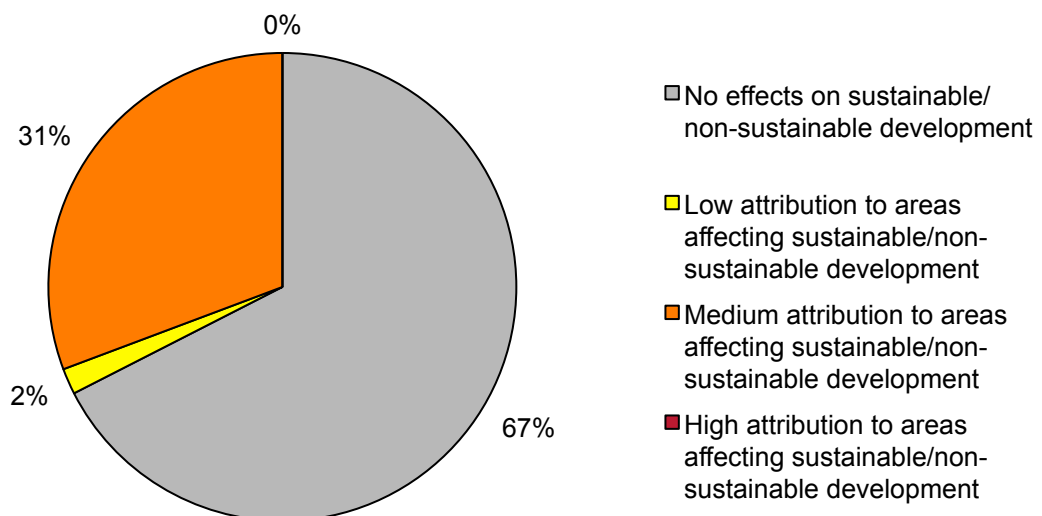
Table 6-7 and Figure 6-4 summarize and illustrate the results of the 2nd order assessment of budget group 5.

Table 6-7: Expenditures in Group 5 and related SDS NRW actions (qualitative assessment)

Principal Group 5: Operating and interest expenditures	Budget (EUR 7.7bn)	Strong link(s) to SDS NRW fields of action	Affected SDGs	Attribution
educated guess				
Interest paid in the credit market (main group 57X)	EUR 2.653m	none	none	none
Administrative expenditure in kind (main group 54X)	EUR 2.367m	7 (Integration)	16	medium
Administrative expenditure in kind (main group 51X)	EUR 1.568m	none	none	none
Administrative expenditure in kind (main group 53X)	EUR 818m	none	none	none
Debt repayment (public sector creditors) (main group 58X)	EUR 161m	none	none	none
Administrative expenditure in kind (main group 52X)	EUR 138m	9 (Education and Science)	4;9	low
Redemption expenditure to local authorities, special funds and local authority mergers (main group 59X)	EUR 0m	none	none	none

source: own compilation

Figure 6-4: Attribution of principal group 5 (Operating Expenditures) to areas of sustainable/non-sustainable development



source: own compilation

6.4.4 Principal Group 8 (9% share): Capital expenditures and grants for capital expenditures

Principal group 8 is the part of the budget that focuses on capital expenditures which do not directly relate to construction. The largest group (grants for capital expenditure in other areas) has a share of 44% in this group and consists of grants for public companies (e.g. hospitals or social housing sponsored through NRW bank), public institutions (e.g. universities) and private companies (e.g. research facilities). These investments are directly attributed to a purpose and affect SDS NRW fields of action for business, urban areas, health, education and science. Again, it cannot be ascertained whether these investments are sufficiently large to enhance sustainable development significantly, but it is very unlikely that these budget allocations have a negative impact on these particular areas.

The second largest group has a share of 44% as well and is directly associated with the public sector in NRW. A majority of these funds is used for investments in municipalities, thus affecting the SDS NRW field of action on urban areas and municipal communities in particular and more general on social cohesion (e.g. child care), education and science (e.g. lump sum for education according to section 17 of the State law concerning financial grants for municipalities in the year 2017 ("Gemeindefinanzierungsgesetz 2017"¹⁶), mobility (e.g. for public transportation and road construction) and demographics (e.g. investments in the areas of old-age help and care). As there are also many funds that could not directly be assigned to a sustainable purpose, it is assumed that less than 80%, but more than 20% of capital expenditures are attributed to these areas (medium attribution). Whether these investments are sufficient to ensure sustainable development also depends on the needs of these municipalities (e.g. providing funds for additional programmes).

The third group (acquisition of movable property) with a share of only 6% of the expenditures in principal group 8 includes expenditures on vehicles for public institutions (e.g. police cars). These investments (around 30% of expenditures) therefore directly affect the State's strategy on mobility as well as SDG 13 on climate protection most likely in a negative way (although a "sustainable acquisition strategy" might reduce the effects).

Another, rather small, portion in this principal group (around 4%) affect education and science as well, but with a very high attribution. The budget group "loans to other divisions" is almost exclusively earmarked for the support of students and trainees (within the frame of the Federal Training Assistance Act – "Bundesausbildungsförderungsgesetz", BAFÖG¹⁷). While it can be assumed that many young people from poor families benefit from this funding (thus enabling sustainable development related to SDG 4 on quality education), it cannot be ascertained in the analysis at hand whether this funding is sufficient to provide funds for all students in need.

¹⁶ These funds from the "Gemeindefinanzierungsgesetz" (GFG) can be used for new buildings or building conversions in schools, school building rents and loans or school equipment. It therefore also affects the SDS NRW field of action on climate and energy.

¹⁷ The Federal Training Assistance Act (BAFÖG) provides trainees with the financial means necessary to cover living expenses and tuition. The actual support depends on the income of the trainees and their parents.

The smallest group in principal group 8 has a share of less than 1% and consists of acquisitions of fixed assets. It funds construction costs as well as the acquisition of land, affecting SDS NRW fields of action for natural resources, urban areas and mobility (re-financing of rural roads). Almost all of the investments can be attributed to these purposes, resulting in a high attribution. However, it cannot be concluded whether these investments have a positive or negative effect on the related SDGs.

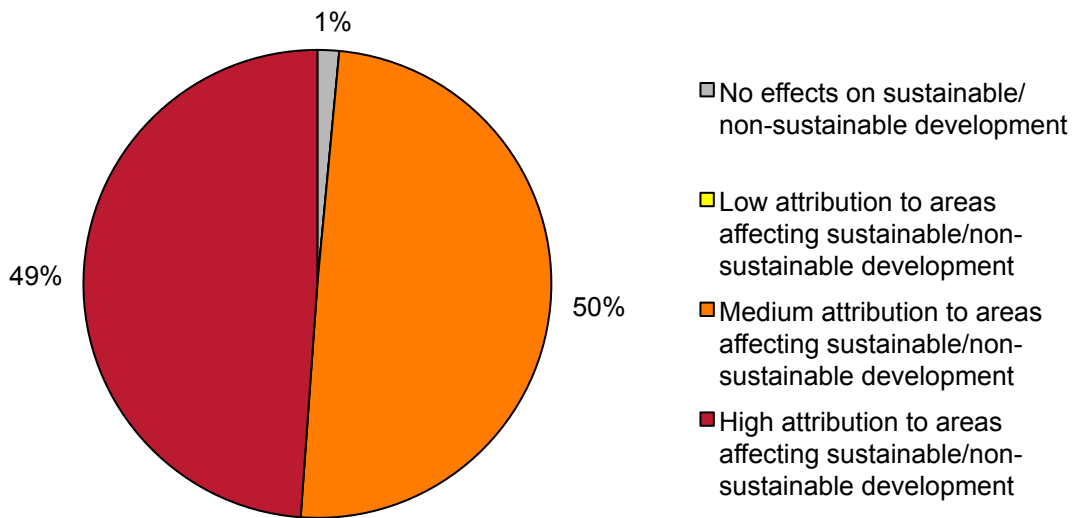
Table 6-8 lists all main groups in the 2nd order assessment of principal group 8. For three of these main groups the SDS NRW fields actions are not affected at all and the majority of affected actions relate to social aspects of sustainable development (see also Figure 6-5). However, the high diversity in links to the State's sustainable development strategy suggests that this perspective is highly aggregated and a more in-depth analysis might help differentiate the results (see below).

Table 6-8: Expenditures in Principal Group 8 and related SDS NRW fields of action (qualitative assessment)

Principal Group 8: Capital expenditures and grants for capital expenditures	Budget (EUR 7.7bn)	Strong link(s) to SDS NRW actions	Affected SDGs	Attribution
expert guess				
Grants for investments in other areas (main group 89X)	EUR 2,924.3m	2 (Business); 9 (Urban Areas); 13 (Health); 19 (Education)	3; 4; 8; 9; 11; 12	high
Allocations for public sector investments (main group 88X)	EUR 2,918.0m	5 (Social Cohesion); 9 (Urban Areas); 17 (Municipal Communities); 10 (Mobility); 19 (Education and Science)	1; 4; 9; 10; 11; 16	medium
Acquisition of movable property (main group 81X)	EUR 375.0m	1 (Climate and energy)	13; 7	medium
Loans to other divisions (main group 86X)	EUR 290.5m	19 (Education and Science)	4; 9	high
Warranty claims (main group 87X)	EUR 99.2m	none	none	none
Acquisition of immovable property (main group 82X)	EUR 26.5m	3 (Natural Resources); 9 (Urban Areas); 10 (Mobility)	6; 9; 11; 15	high
Acquisition of participations and the like (main group 83X)	EUR 0.0m*	none	none	none
Loans to the public sector (main group 85X)	EUR 0.0m**	none	none	none
* less than EUR 100,000				
** EUR 0				

source: own compilation

Figure 6-5: Attribution of principal group 8 (Capital Expenditures) to areas of sustainable/non-sustainable development



source: own compilation

6.4.5 Principal Group 7 (0.5% share): Construction

Principal group 7 covers all construction projects carried out by the State itself which are not otherwise part of capital expenditures for other entities (such as the enlargement of universities). Since construction measure for buildings are relevant in terms of greenhouse gas emissions, about 40% of the expenditures in this budget group affect the SDS NRW goal of climate protection, in particular the aim of achieving climate-neutrality of all buildings by 2050. Any new building or building renovation that helps to reduce the energy demand is therefore also an indication for progress towards the SDG on Climate Action (SDG 13). The State's own policies (e.g. Climate Protection Plan from 2015) strongly suggest that this is the case in an increasing number of cases.

This budget group is therefore one of the most relevant groups in terms of ecological sustainability, although not in terms of overall State budget. It has to be kept in mind, though, that most real estate projects, including retrofitting the existing stock of buildings, are carried out through a dedicated agency owned by the State of NRW ("Bau- und Liegenschaftsbetrieb", BLB NRW). BLB NRW leases office space to the State, its investments are refinanced through appropriate rents paid by the State (among other sources of funding). Most of the costs of construction projects thus do not show in principal group 8, but principal group 5 of the State budgets (rents for office space, see above). That's why the figures in principal group 8 appear comparatively low in the context of the overall size of the budget.

The rest of the expenditures is mainly used for construction and maintenance of roads and cycle paths in NRW, affecting the SDS NRW fields of action on mobility. While cycle paths can clearly be considered to also have a positive effect on climate (SDG 13), budget information alone does not allow to ascertain whether the majority of spending in this group exhibits an overall positive net effect.

Additional links to the SDS NRW fields of action can be attributed to the goal of integration, since some expenditures are used to the conversion and extension of buildings that relate to accommodation and support for refugees.

Despite the rather low overall share in the budget (EUR 0.3bn), it can be attested that this budget group is highly relevant for the sustainable development of NRW, because all budget items relate to the State's strategy on sustainable development (see Table 6-9).

Table 6-9: Expenditures in Principal Group 7 and related SDS NRW fields of action (qualitative assessment)

Principal Group 7: Construction	Budget (EUR 311m)	Strong link(s) to SDS NRW actions	Affected SDGs	Attribution
expert guess				
Large new buildings, conversions and extensions (main group 77X)	EUR 181m	10 (Mobility)	9	high
Construction measures (main group 71X)	EUR 73m	1 (Climate and Energy); 7 (Integration)	7;13;16	high
Large new buildings, conversions and extensions (main group 79X)	EUR 30m	1 (Climate and Energy); 3 (Natural Resources)	6;15	high
Large new buildings, conversions and extensions (main group 72X)	EUR 21m	1 (Climate and Energy); 7 (Integration)	7;13;16	high
Large new buildings, conversions and extensions (main group 75X)	EUR 6m	19 (Education and Science)	4;9	high

source: own compilation

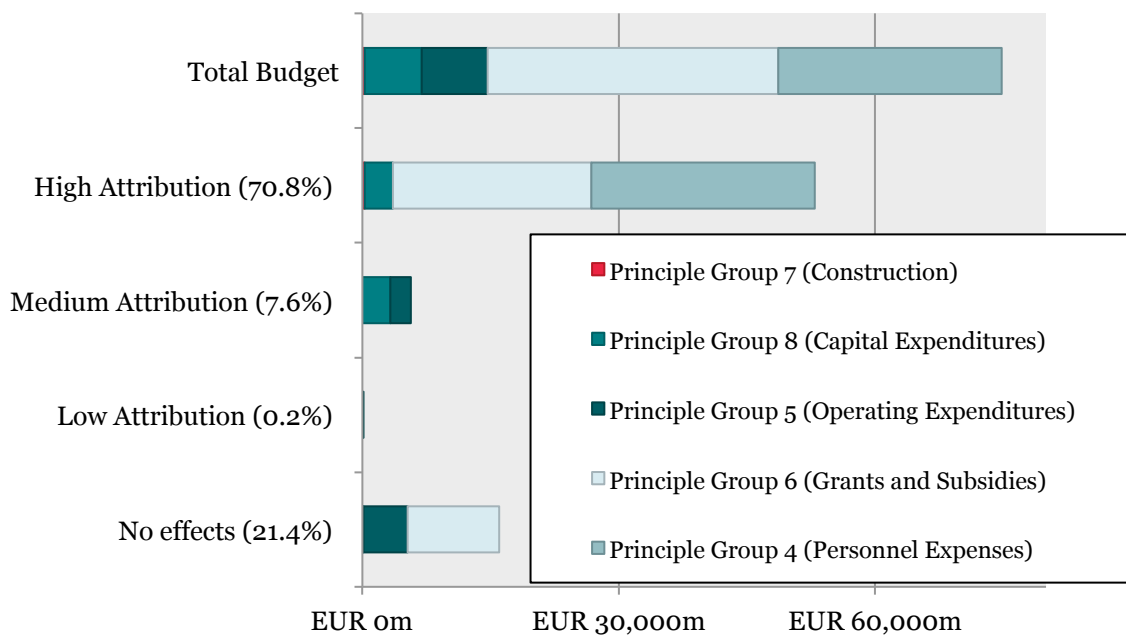
6.4.6 2nd order analysis: Synthesis

Figure 6-6 and Figure 6-7 summarize the results of the 2nd order analysis of the five distinct principal groups in the State's 2017 budget.

About 21% of the budget (EUR 16.4bn) could not be allocated at all. These expenditures show no link to the State's sustainable development strategy (SDS NRW). It is therefore unlikely that this funding contributes either negatively or positively to the sustainable development in NRW (with exception of the State's aim of having a "structurally balanced State budget from 2020 onward"). By comparison with the 1st order analysis, some budget groups can now be linked to sustainable/non-sustainable development in the State of NRW (e.g. administrative expenditures).

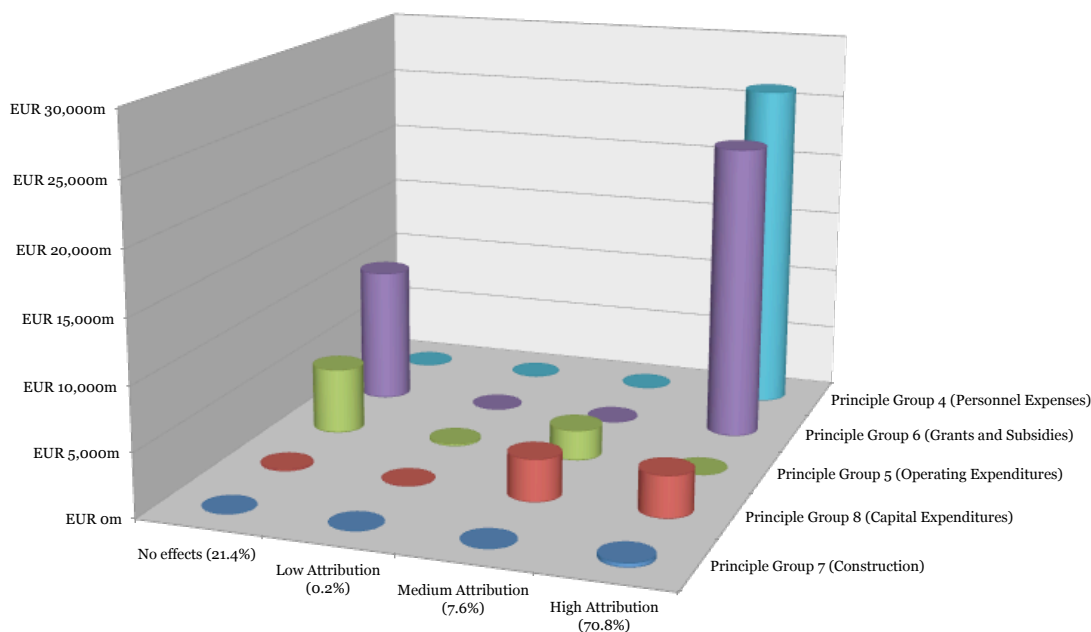
On the other hand, about 71% of the budget (EUR 52.9bn) either relates to positive or negative development. It was found that at least 80% of these funds (criteria to attest high attribution) can be connected to different areas of the SDS NRW. It could not be ascertained whether these budget items improve sustainable development or not. Although some items show a direct cause-effect relationship (meaning any funding leads to improvements), the potential positive effect often depends on whether the amount of funding is sufficient to improve the status quo.

Figure 6-6: Summary of 2nd order analysis (expert guess; 2nd order assessment)



source: own compilation based on the assessment in the report at hand

Figure 6-7: Contribution of principal groups of budget items (expert guess; 2nd order assessment)



source: own compilation based on the assessment in the report at hand

Contribution of different budget items to overall evaluation

Figure 6-7 shows the results of the synthesis in more detail. The largest column for high attribution to sustainable/non-sustainable development is assigned to about EUR 26bn in Principal Group 4 (Personnel Expenses). More than 99% of expenditures in this category relate to employees of the State of NRW as well as their relatives (salaries, pensions and other benefits). It is therefore a large leverage for potential sustainable development under the SDG 8 on "Decent Work and Economic Growth".

The second largest column with high attribution is dedicated to about EUR 23bn for "Grants and Subsidies" in Principal Group 6. It comprises numerous State expenditures for children, poor people or people with poverty risks as well as immigrants or refugees. It symbolises in many ways the social responsibility of the State of NRW, directly affecting the SDGs 1 (No Poverty), 4 (Quality Education) and 10 (Reduced Inequalities) as well as other social development goals (although to a smaller extent).

Both columns combined already make up about 69% of the overall expenditures.

As expected, the main areas affected are part of the social dimension of sustainability. In particular *social cohesion and participation, work, education and science* as well as *integration and demographic development* are affected by the expenditures in the State's budget. Ecological areas, in particular budget funds affecting *climate change and energy use or mobility and natural resources* are affected less by the budget and often as part of construction measures for other purposes (e.g. enlargement of educational buildings).

A number of SDS NRW fields of action could also not be connected to the budget at all. Examples are *sustainable consumption, gender equality or civic commitment*. The reason for that might very well be that the overall funding for these fields is small by comparison (not showing up in an aggregated analysis) or that they are subordinated aims of larger programmes.

The principal budget group with the highest diversity in terms of number of areas affected is group 8, consisting of capital expenditures and grants for capital expenditures (other than construction). As this area also shows a high consistency with projects financed in the Sustainability Bond NRW #4, it is selected for an in-depth analysis (see 3rd order analysis in the next section).

The main outputs of the 2nd order analysis are:

- 3 quarters of the budget affect sustainable/non-sustainable development in NRW one way or another.
- The closer scrutiny in the 2nd analysis revealed effects in areas that showed no effect in the 1st order analysis.
- Areas affected relate mainly to the social dimension of sustainability with funding for ecological development usually being a part of funding for other purposes.
- Some areas of the State's sustainable development strategy are not affected at all on this high level of aggregation.

6.5 3rd order assessment: Capital Expenditures

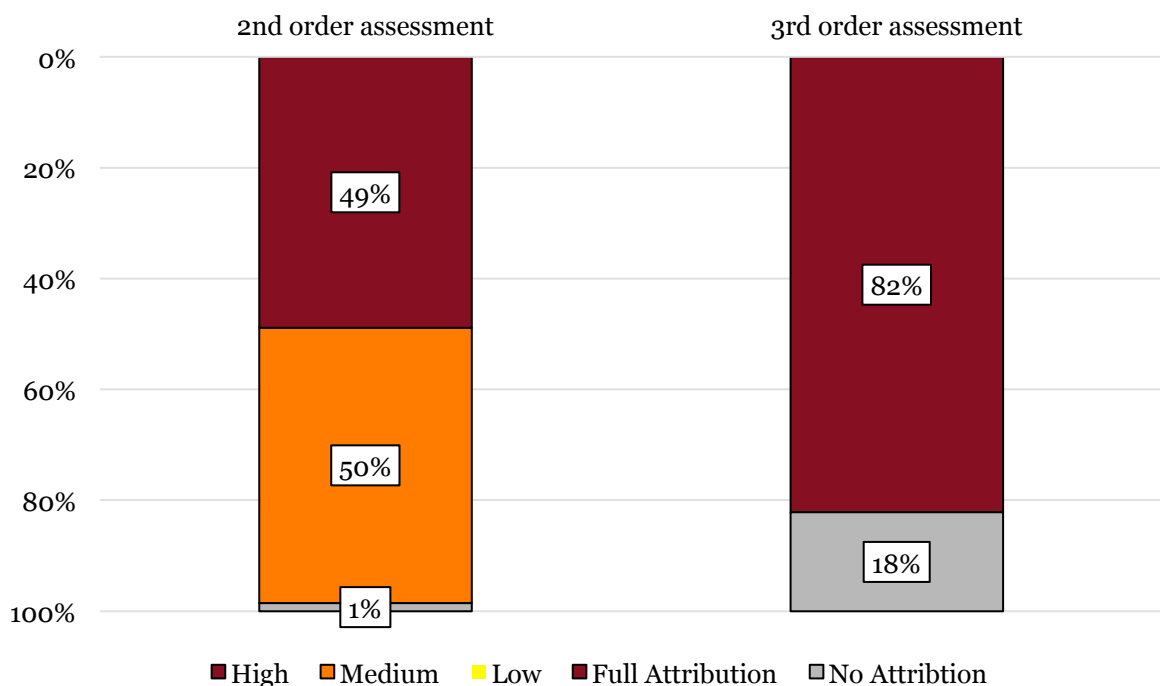
This section aims to further analyse the budget group on capital expenditures (principal group 8 of budget items).

Because it shows a much higher level of detail, it is possible to allocate funding better, in particular funding that shows no or only weak links to the SDS NRW. Data basis for assessment are often comments in the State's budget itself, which allow in many cases a determination of the purpose of a single budget item.

The information displayed here is based on an unequivocal assignment (m:m matrix), meaning that only 1 SDS field of action affected was selected for each budget item. The action selected is the one that showed the best match with its description and, if available, comment in the budget plan. This means that some areas are underrepresented, in particular ecological effects related to buildings and vehicles. Investments related to university buildings for example affect education and science, but not climate and energy. On the other hand, the construction of buildings without links to the SDS are assumed to affect climate and energy only.

The higher level of disaggregation also leads to differences in the share of the budget that can be attributed. As a result, large portions of the areas of the budget that were deemed to have a "medium" attribution to the SDS NRW (at least 20%, but not more than 80% of the budget) could be re-attributed to areas with full attribution or no attribution at all (red area on high attribution increases from 49% to 82% and grey area from 1% to 18%). Figure 6-8 shows the differences between the two levels of resolution; based on ca. 20 groups for the 2nd order compared to ca. 340 groups for the 3rd order of analysis.

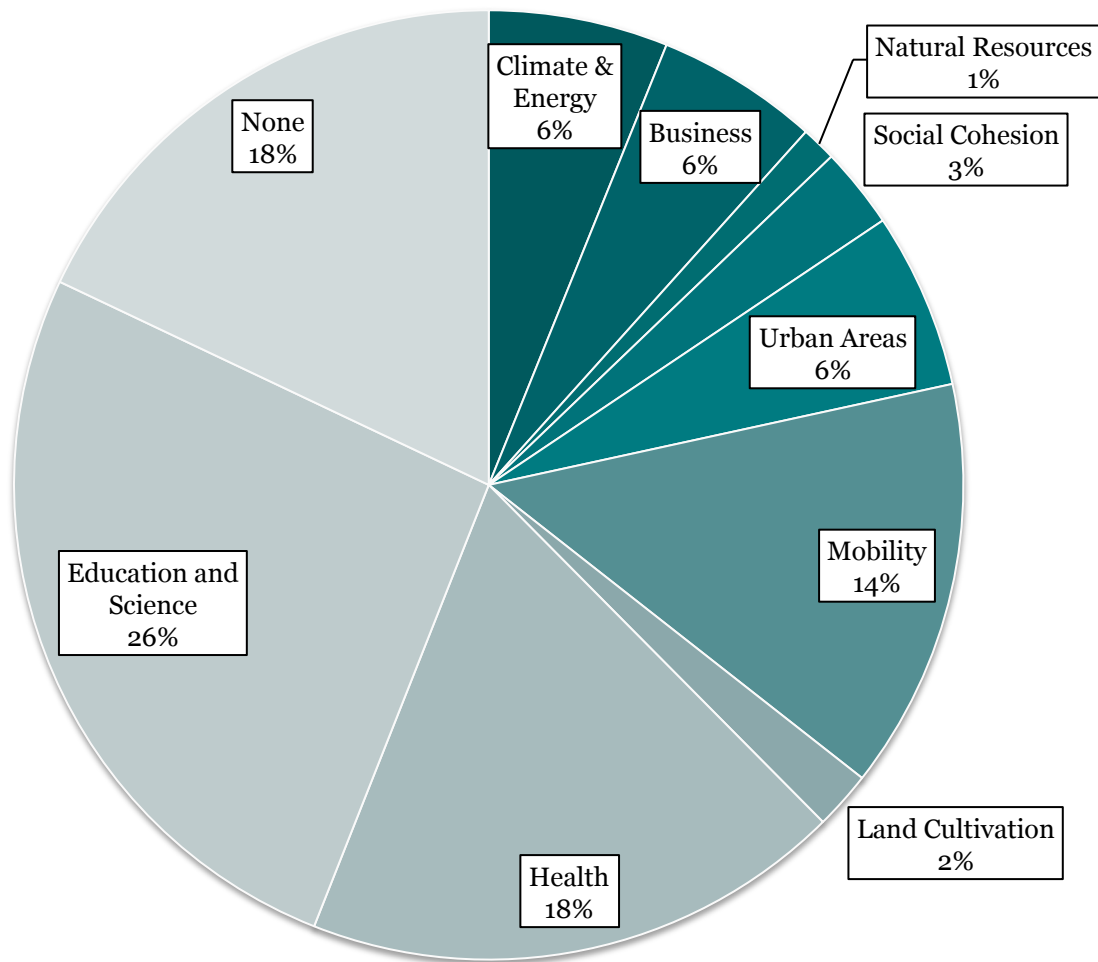
Figure 6-8: Comparison of budget attribution of 2nd and 3rd order assessment (Principal Group 8 on Capital Expenditures)



source: own compilation based on the results of the budget analysis

Figure 6-9 shows the in-depth results of the 3rd order analysis. In opposition to the 2nd order analysis, it could now be ascertained that for about 18% of the budget in principal group 8 there is no potential positive or negative effect on the sustainable development of the State. Of the remaining 82%, a large share can be contributed to education and science (26%) as well as health (18%). Ecological effects (mobility, climate and energy, natural resources, land cultivation) relate to about 23% of the budget in this group, although grants for municipalities and regions will also have effects on the environment in many cases and vice versa. Clearly distinguishable in most cases are expenditures targeting social cohesion and participation (3%) and private business (6%).

Figure 6-9: Results of 3rd order analysis of principal group 8 (expenditures on investments)



source: own compilation based on 3rd order assessment on Capital Expenditures (Principal Group 8)

6.6 Interaction Analysis

The budget analysis provided first insights into the shares of the budget that potentially affect sustainable/non-sustainable development in the State of NRW. This information alone does not allow to determine whether the spending is sufficient to achieve positive or negative effects. Moreover, it does not allow to identify positive synergies (State expenditures contributing to more than one sustainable development goal) or conflicting goals (positive effects in one area being partly or fully compensated by negative effects in other areas).

The construction of a building for example usually requires an assigned building site as well as energy and material resources (affecting ecosystems), thus partly compensating the positive environmental effects from reduced energy demands in energy-efficient buildings. It is often difficult to provide a final sustainability evaluation, in particular if also other dimensions of sustainability are taken into account (e.g. the social benefits of accommodation for refugees or of the education of students).

An analysis of interactions can be an intermediate step towards this goal. It requires profound expertise in the area of analysis (and additional information), but allows to estimate the size of effects along different areas of interest.

The following section shows, with help of a case-study, such an analysis with regard to the funding of student tickets in the Sustainability Bond #4 NRW and the State's budget.

6.6.1 Method for a simplified interaction analysis

The interaction analysis is conducted in 4 steps:

- (1) Definition of case-study
- (2) Identification of affected SDG Goals
- (3) Assignment of strong (++/--) and weak (+/-) effects
- (4) Visualization

Steps (1) and (2) are a selection process defining the scope of the study and can also depend on the purpose of the analysis (e.g. evaluation of a certain area of public policy). The study at hand includes all 17 SDGs and refers to the State's co-funding of student tickets (see also section 4.4). Here it is based on an expert-guess in the study at hand, but would normally entail the involvement of different stakeholders or even different groups of stakeholders for robust assessment.

The same is true for step (3), which is also based on the expertise of the researchers instead of stakeholders from different areas (the so-called expert guess further described in the gray box below). Step (3) is the actual analysis, applying a semi-quantitative assessment on neutral, positive and negative effects as well as their comparable size (smaller, equal, or larger). Step (4) is then only used to interpret and to visualize the results.

Expert Guess in the study at hand - Peer Review in 3 stages

The expert guess was conducted in 3 stages. Each step involved the expertise of the researchers as well as research into scientific background and literature.

Stage 1:

The researchers (Oscar Reutter and Jens Teubler) conducted the assessment independently of each other.

Stage 2:

The researchers met to compare and to discuss the results. They assigned final evaluations on all items they could agree upon. During this process a re-evaluation of the scope became necessary.

Stage 3:

A third researchers was asked to contribute to the discussion on items where the other two researcher could not come to a clear judgement.

An *example* for this process is the evaluation of the effects of funding for student tickets on SDG 13 for Climate Action. Researcher 1 assigned a strong positive and a weak negative impact, because he assumed this type of funding contributes to the construction of additional public transport systems. Researcher 2 argued, based on literature, that this type of funding does not enlarge public transport systems (which made it necessary to re-evaluate the scope of the case-study). Instead, funding increases the load factor of these systems, while maintaining the system as a whole (meaning that without this funding some transport systems might even be closed).

Both researchers therefore agreed upon a strong positive, but no negative impact for this SDG.

6.6.2 Scope of the case-study on student tickets

The investigated case-study is the State's funding for student tickets, also included in the NRW Sustainability Bond. It is assumed that these funds do not cause additional construction measure for larger public transport systems, but rather improve the efficiency of these systems by enabling more people to use them. It is also assumed that without this type of funding, public transportation systems lack basic funding as a whole.

This limitation also directly affects the following example, as larger public transport system would affect SDGs in a different way (e.g. the SDG on Life on Land is affected by land use change).

6.6.3 SDG goals directly affected by student tickets

The first step of the analysis is to match the State's funding for student tickets with the sustainable development goals in order to identify affected goals. During this stage, SDGs can either be affected (option "1"), not be affected at all or affected to a lower degree compared with similiar SDGs (option "0") .

Table 6-10 lists all 17 SDGs and their connection to this area of State expenditures, with 7 goals being affected by the State's funding of public transportation for students.

Table 6-10: Matching of State funding for student tickets with Sustainable Development Goals

SDG	directly affected?	Assessment (expert guess)
1 - No Poverty	1	funds mobility for <u>all</u> students
2 - Zero Hunger	0	no direct connection
3 - Good Health and Well-Being	1	public transport systems and motorized individual transport affect health differently
4 - Quality Education	1	funds mobility for <u>all</u> <u>students</u>
5 - Gender Equality	0	no direct connection (evaluation after 3 rd stage of review process)
6 - Clean Water and Sanitation	0	no direct connection
7 - Affordable and Clean Energy	0	no direct connection (energy systems only indirectly affected)
8 - Decent Work and Economic Growth	0	no direct connection (connection only between education and work)
9 - Industry, Innovation and Infrastructure	1	affects investments into infrastructure
10 - Reduced Inequalities	1	funds mobility for all students
11 - Sustainable Cities and Communities	1	affects investments into infrastructure
12 - Responsible Consumption and Production	0	no direct connection (only affected via the issue of GHG emissions of mobility options)
13 - Climate Action	1	affects GHG emissions of mobility options
14 - Life below Water	0	no direct connection
15 - Life on Land	0	public transportation requires land, but no additional construction measures induced (see scope)
16 - Peace, Justice and Strong Institutions	0	no direct connection
17 - Partnership for the Goals	0	no direct connection

source: own compilation based on expert guess by authors

6.6.4 Interactions between SDGs and case-study

The next step involves decision-making on the type and strength of the effects for each affected SDGs. Effects can either be strong (++ or --), slight (+ or -) or neutral (o), resulting in one of up to 7 different options for each SDG (with completely neutral effects being excluded in the previous step).

Table 6-11 shows the result of the expert guess of the authors of the study (peer-review in 3 stages), relying on their previous experience with the evaluation of public funding for transport systems in general and funding of student tickets in Germany in particular (e.g. Müller 2011).

Estimating the actual strength of an effect is (in almost every case) more difficult than deciding whether there are positive or negative effects at all. It is therefore useful for interpretation to cluster the results into two types of impacts: unambiguous and reliable effects on the one hand or ambiguous effects and trade-offs on the other hand.

The first group of impacts (reliable effects) only apply if there is no indication for an interaction (only strong positive or negative effects can be identified), while the second group (trade-offs) applies to all the rest.

This means that results for each SDG can fall into one of four categories:

- **reliable positive effects:**
- **reliable negative effects**
- **positive trade-offs**
- **negative trade-offs**

Reliable effects are therefore impacts that show a higher certainty compared to trade-offs which are more subjective and also rely more heavily on the available information provided by research.

For State expenditures into the funding of student tickets (case-study) only positive relations could be identified (see Table 6-11). **Reliable positive effects** were allocated to **SDG 4** (Quality Education), **SDG 9** (Industry, Innovation, Infrastructure), **SDG 10** (Reduced Inequalities), **SDG 11** (Sustainable Cities and Communities) and **SDG 13** (Climate Action).

Less certain impacts in terms of **positive trade-offs** were allocated to **SDG 1** (No Poverty) and **SDG 3** (Good Health and Well-Being).

The less robust assignment of student ticket funding in relation to SDG 1 is based on the higher uncertainty of the system-wide effects. A more thorough literature review could facilitate decision-making here, in particular if studies are found that deal with the issue specifically. The impacts on SDG 3 on the other hand are deemed less robust, because it is unclear how other mobility options for students (e.g. cycling) are affected by this funding.

Table 6-11: Interactions between student tickets, their funding and the SDGs

SDGs	Positive Effects	Negative Effects	Comment	Impact
1 - No Poverty	+	0	Funding facilitates mobility for students, while there is likely no lack of funds for similar purposes.	positive trade-off
3 - Good Health and Well-Being	+	0	Public transportation systems help do decrease harmful emissions. However, student health would benefit even more from funding of zero-emission mobility options (e.g. cycle paths)	positive trade-off
4 - Quality Education	++	0	Student tickets in NRW are usually tickets for the whole area of the State of NRW. They therefore additionally enable students to enroll in universities in other cities.	reliable positive effect
9 - Industry, Innovation, Infrastructure	++	0	Expenditures into student tickets indirectly fund maintenance and improvement of public transportation systems.	reliable positive effect
10 - Reduced Inequalities	++	0	Students with handicaps benefit from good transportation systems and cheaper tickets. Although not all students paying for the system also depend on it, it could be that this has no negative impact on inequality.	reliable positive effect
11 - Sustainable Cities and Communities	++	0	Funding for student tickets is beneficial for public transportation systems, which in turn is deemed to be a crucial part of sustainable cities.	reliable positive effect
13 - Climate Action	++	0	Public transportation systems provide a sustainable alternative for students that would have otherwise used a car. Public funding is also necessary to maintain the systems.	reliable positive effect

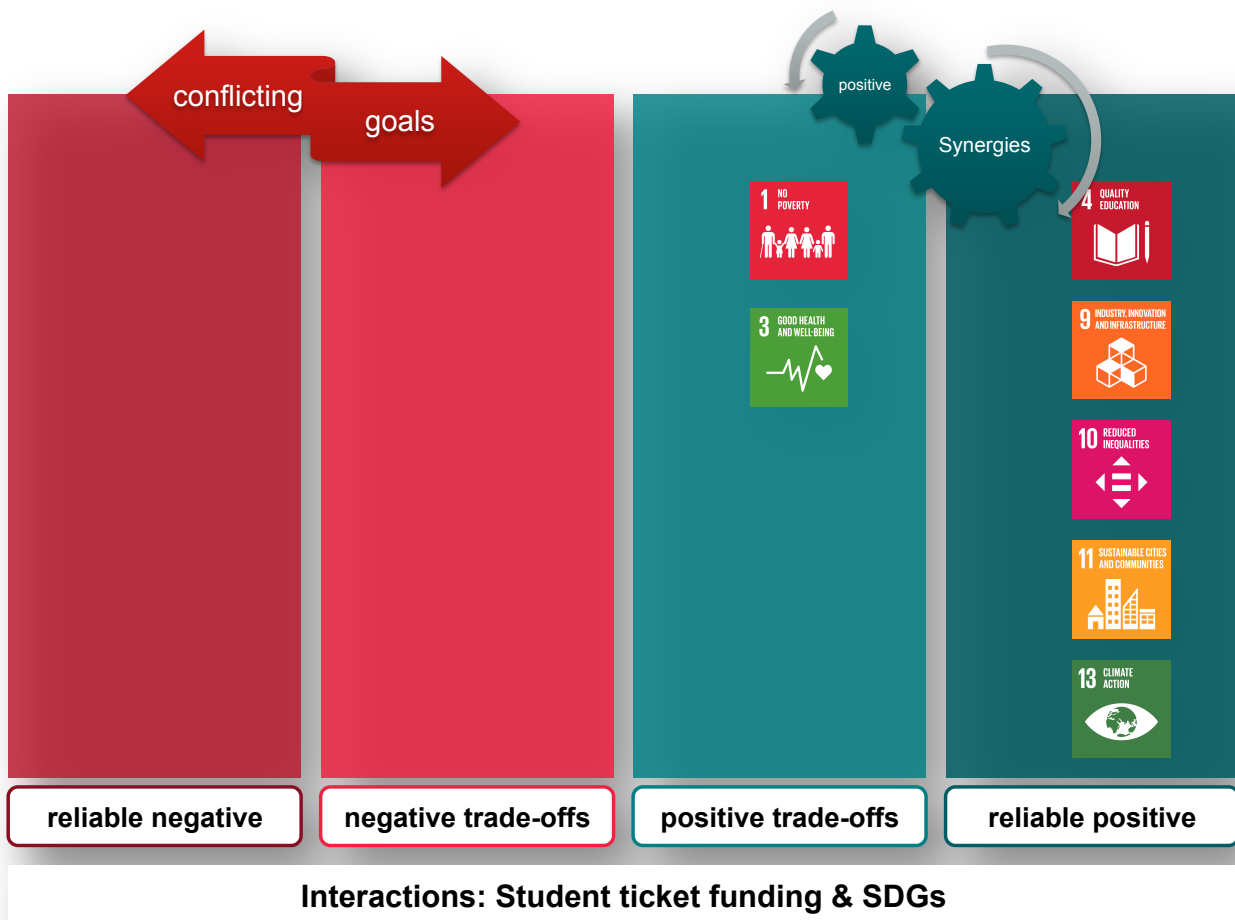
source: own compilation based on expert-guess by the authors

6.6.5 Visualisation

The results of step (3) can also be interpreted in a way that not only show the evaluated impacts of the assessments, but also potential synergy effects and conflicting goals.

Figure 6-10 shows an example for such a visualisation, assigning the identified SDGs to the 4 types of impacts and their potential synergies.

Figure 6-10: Interpretation and Visualisation of interation assessment



source: own compilation

6.7 Limitations of the Budget Analysis

It could be shown that the approach itself is a viable option to analyse the budget of a federal State. However, the methods described rely heavily on the assessment of experts (expert guess in peer-review process), who assign expenditures to areas of State development and estimate the strength or direction of effects. This type of assessment is normally conducted with multiple stakeholders from different areas, such as science, politics or NGOs. While the number of people involved is no direct indication for the robustness of results alone, the method would clearly benefit from integrating different point of views and expertise from different fields of interest.

7 Discussion

The final three sections discuss the results of the impact and budget analysis and make first recommendations for future studies (Recommendations and Outlook).

7.1 Discussion of the Results of the Impact Report

This impact report is the third in a row, including investments in the NRW Sustainability Bonds #4, #3, and #2, but also covering selected projects from NRW Sustainability Bond #1 (budget year 2014). Although Bond #4 only affects about 3% of the State's budgetary expenditures, it covers projects that are highly relevant for the sustainable development of NRW.

During this time, not only the bond size has increased by a large margin from EUR 750m to EUR 2,025m, but also investments in the bond that could be associated with impacts (EUR 260m in #1 compared to EUR 1,500m in #4). The report at hand already quantifies 74% of the investments, while also stating that circa 20% of the bond are currently not quantifiable due to lack of data or methodologies.

In terms of environmental impacts, direct quantifications are still mainly restricted to potentials to avoid GHG emissions (GHG reductions or savings). Other environmental effects are either attributed to a small share of the bond (circa EUR 21m reported to provide sustainable land use), or stem from third party assessments where investments from other stakeholders also play an important role (less than EUR 6m that help companies to also reduce waste, water and material use).

The directly quantified GHG savings from investments in the bond have increased over the four Sustainability Bonds, with the largest increase from investments for educational buildings and the highest effect attributed to urban cycle paths (over 330,000 tons of CO₂ equivalents in four years). Since most of the funded projects have a larger lifetime, these effects potentially also take place after the bond term of 10 years runs out.

Quantifiable social impacts in the Sustainability Bond #3 were restricted to investments into public universities in NRW, where funding for additional 23,000 first-year students could be associated with the bond.

The current NRW Sustainability Bond #4 could not only be associated with 20,000 additional first year students, but also with

- 12,200 additional master student places,
- 64,300 bachelor graduates,
- 125 to 250 new jobs for persons with disabilities,
- 725 social workers,
- 81,000 new broadband connections.

In total, circa EUR 910m were invested from the State budget in 2017 for these quantified impacts, matching 45% of the NRW Sustainability Bond #4.

7.2 Discussion of the Budget Analysis

This report also includes a separate analysis of the State's budget and its association with the State's own strategy for sustainable development. Using a novel approach, it could be shown that about 71% of the State's budget are affecting either sustainable or non-sustainable development in the State to a high degree (high attribution), while about 21% will neither have a positive nor negative effect on this strategy.

Due to the high aggregation of budget groups in the so-called 2nd order assessment, further studies are required to ascertain these results with a higher certainty. It could be shown in a in-depth analysis for the principal budget group 8 (Capital Expenditures) that higher shares of the State budget can be related to sustainable/non-sustainable development, if all of the budget items are considered and if the State's budget plan is consulted as well. In the example in the report at hand, shares deemed to have no attribution at all increased from 1% to 18%, while the remaining 82% could now be associated with sustainable/non-sustainable development with a lot higher certainty (full attribution).

Another limitation of the approach described in this impact report is its design. While the authors of this study conducted the analysis on their own, the method developed provides more robust results if several stakeholders are involved. This enhancement of the method can be achieved by integrating different point of views (e.g. persons from different research fields and State agencies) and also integrating additional methods (e.g. by using the DELPHI¹⁸ adaption for face-to-face meetings).

This further development of the approach is also needed for the last step of the assessment: interaction analysis. An interaction analysis allows a group of experts to ascertain whether a specific measure affects more than one sustainable development goal (SDG) and to which degree positive effects outweigh negative effects. It provides a array of affected SDGs as well as a judgment on the size of positive and negative impacts on sustainable development (no, smaller or larger impacts). It is a viable approach to identify positive synergies as well as conflicting goals in a time-efficient manner, assuming that the panel of experts is familiar with the measure or project investigated.

¹⁸ DELPHI, also known as Estimate-Talk-Estimate, is a method to structure and guide expert panels. It usually involves questionnaires over several rounds and requires the participants to state the reasons for their judgments. It is a common and well-proven method in social sciences.

7.3 Recommendations and Outlook

The analysis of the 4th Sustainability Bond clearly improved methods and data availability. It also increased the share of quantifiable social impacts, which are a unique characteristic of sustainability bonds compared to the more common green bonds. The additional budget analysis in the report at hand also catered to the fact that the NRW Sustainability Bond is issued by a public and not private player on the market.

However, while many issues could be solved compared to previous studies, future assessments should focus on the following recommendations:

- The GHG savings currently only scale with the size of the investments, but do not account for the fact that new and more efficient technologies can be used or are already in use. It is therefore recommended to include "best-in-class" projects in future assessments, where higher efficiencies could be realized in terms of GHG savings per measure.
- Many projects in the bond can be associated with impacts in different areas of sustainable development. It is recommended to develop and introduce a first set of methods to quantify some of these so-called co-impacts.
- The current assessment of social impacts relies on their scalability. It was often difficult to differentiate between impacts that were just reported and impacts that can be directly associated with investments in the bond. It is therefore recommended to introduce a more wholesome and precise definition of what constitutes and defines a quantifiable social impact in future studies.
- For budget analysis, the authors of this study conducted the assessment by means of an educated guess or expert guess. Since this approach only reflects one point of view, it is recommended to include a multi-stakeholder approach in future studies.

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