Final Report | August 2020

Impact Report
NRW Sustainability Bond #6

Analysis of the Sustainability Bond #6 issued in 2019 by the German State of North Rhine-Westphalia (NRW)

Wuppertal Institut

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

Project Duration: February 2020 - April 2020

Authors: Jens Teubler, Lena Hennes, Andrea Esken, Prof. Dr. Oscar Reutter, Jakob Lohmann

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.; Hennes, L.; Esken, A.; Reutter, O.; Lohmann, J. (2020). Impact Report NRW Sustainability Bond #6. Analysis of the Sustainability Bond #6 issued in 2019 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, 2020.

Content

Tables

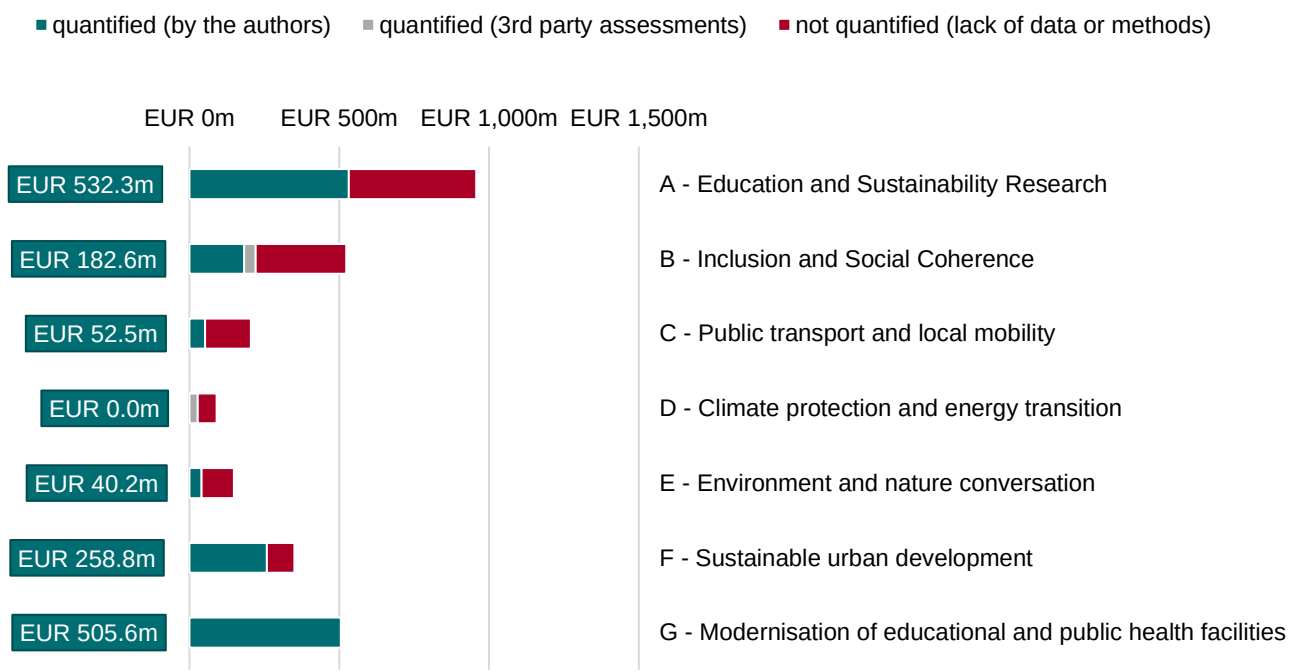
Figures

1 Summary

The Wuppertal Institute conducted an impact analysis of the NRW Sustainability Bond #6 (2019) on behalf of the State Government of North Rhine-Westphalia (NRW). The most recent bond has a volume of EUR 2.5 bn (EUR 2.8 bn were allocated), terms of 10 or 20 years and consists of 62 eligible projects from the State's 2019 general budget (sustainable value-added was confirmed in a second party opinion by ISS ESG[1]). This report analyses the contribution of the bond to climate mitigation, ecological and social impacts. It also includes information on the impacts of the previous five bonds (NRW Sustainability Bond #1 to #5). The impact report at hand is based on data that was collected until April 2020 and is published in advance of the full report. Any changes in data will be documented later in the full report.

Figure 1-1 shows the project categories in the bond and quantifies the shares that could be directly associated with either environmental or social impacts. 56% or EUR 1.56 bn of the overall investments (EUR 2.79 bn) could be directly quantified in the paper at hand. Additional EUR 66m (2%) has been assessed by third parties and is also reported in this briefing. The remaining EUR 1.14 bn (41%) could either not be quantified due to lack of data or are not quantifiable at all within existing scientific frameworks.

Figure 1-1: Share of quantified investments in the Sustainability Bond #6



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

Table 1-10 lists all projects in the bond according to the final volume in the State's budget and the volume in the bond.

[1] see **https://www.nachhaltigkeit.nrw.de/fileadmin/download/Nachhaltigkeitsanleihe/191031_LandNRW_SPO_final.pdf**

Co-Benefits of projects in the bond

Many projects in the bond help to mitigate both green and social issues. While the refurbishment of a university clinic is intended to reduce its energy demand, it will in many cases also improve the health care standard provided by the hospital. The same is true for investments in public infrastructures (e.g. enabling broadband connections or social tickets), where measures lead to improvements in more than one area. These types of effects are called co-impact and are often difficult to quantify. The Wuppertal Institute plans to look deeper into this kind of effects in the future and for up-coming NRW Sustainability Bonds.

Further Information: NRW Sustainability Strategy

The NRW Sustainability Bond #6 is part of the *Sustainability Strategy NRW*, which aims to improve the sustainable development of the whole State of NRW.

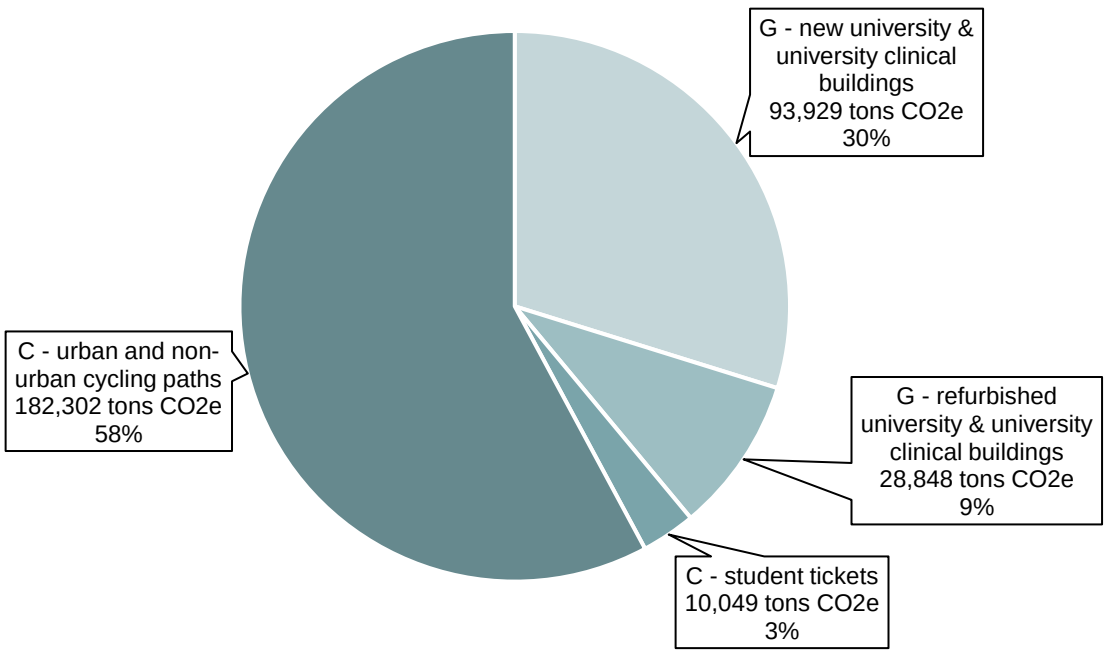
Regular updates of the results are also presented on a dedicated website (http://www.nachhaltigkeitsindikatoren.nrw.de/sdgs). The Sustainability Strategy NRW (including the indicator report) is going to be updated in the future, aligning the methodology more closely with the federal Sustainability Strategy of 2017.

Environmental Impacts

Quantified GHG Savings in NRW Sustainability Bond #6

The estimated avoided GHG emissions in the bond can be traced back to investments of EUR 344m for 7 different measures. 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, the measures are expected to save ca. 315,028 tons of CO_2 equivalents (CO_2e) over their lifetime (see Figure 1-2).

Figure 1-2: GHG Savings (over lifetime) in the NRW Sustainability Bond #6



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

Results for each measure range from 72 tons CO2e per year to 10,049 tons per year (see Table 1-1). All these measures, with exception of student tickets, are likely to save emissions beyond the term of the Sustainability Bond.

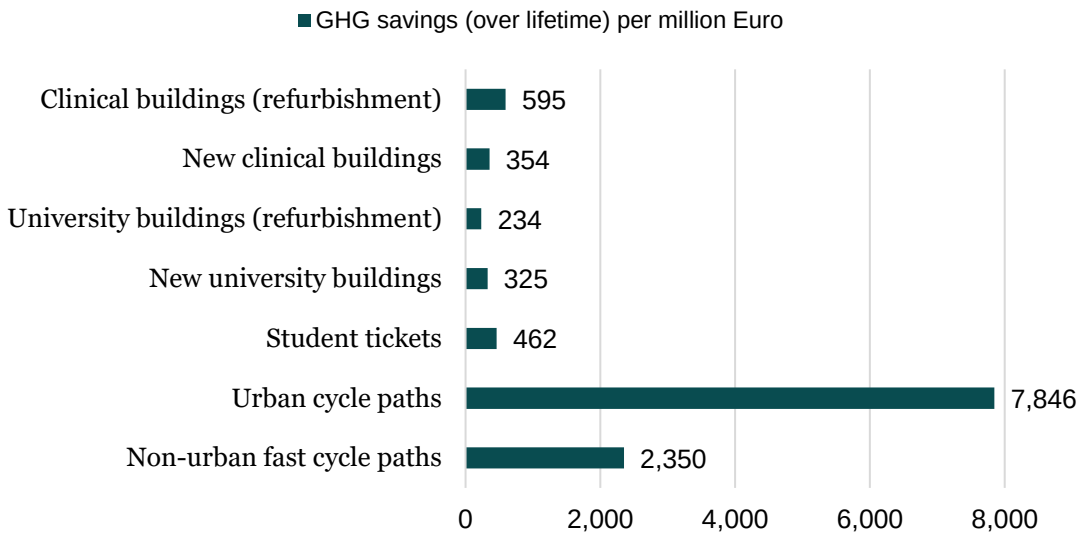
Table 1-1: GHG savings of measures in categories C and G

Measure	GHG savings per year	GHG savings over Lifetime	average Lifetime (assumption)
	tons CO2e per year	*tons CO2e in total*	*years*
Non-urban fast cycle paths	846	25,376	30
Urban cycle paths	5,231	156,926	30
Student tickets	10,049	10,049	1
New university buildings	403	20,147	50
University buildings (refurbishment)	72	1,435	20
New university clinical buildings	1,118	73,782	66
University clinical buildings (refurbishment)	1,371	27,413	20

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

Figure 1-3 also depicts the normalised efficiency of the different measures for climate protection:

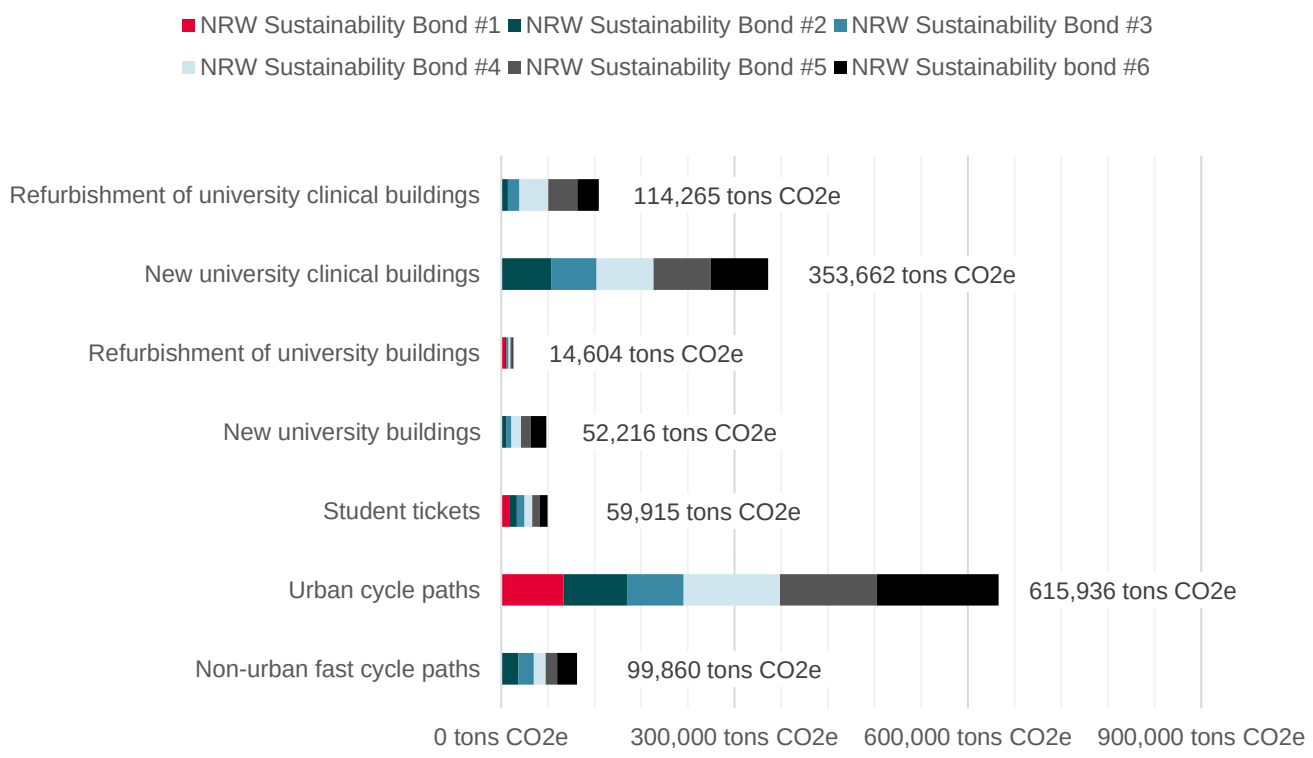
Figure 1-3: Efficiency of climate protection measures for quantified investments



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

All the quantified categories for climate protection in the Sustainability Bond #6 were already part of the Sustainability Bonds #5 (2019), #4 (2018), #3 (2017), #2 (2016) and #1 (2015). They can therefore be aggregated to a six-year portfolio (see Figure 1-4). This was not possible for solar thermal energy generation (Bond #3) and co-generation of heat and power (Bond #2). In total, EUR 1,287m were invested over six years (2014-2019) that help to induce GHG savings of over 1,310,457 tons CO2e over the assumed lifetime of measures.

Figure 1-4: GHG savings over lifetime of projects from 2014 to 2019 in the portfolio



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

Additional environmental impacts for NRW Sustainability Bonds #1 to #6 (3rd party assessments)

The NRW Sustainability Bonds also include ca. EUR 66m investments into other projects that improve ecological developments over the course of six years (2014-2019). These projects not only help to mitigate GHG emissions by e.g. 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 European Regional Development Fund (ERDF) aims to correct imbalances between the regions of the European Union, but it also channels resources towards a low-carbon economy in its priority axis 3. The agencies reporting in this category are the “Effizienz Agentur NRW” (efa+) and “Ökoprofit”, which both provide consulting services for companies.

Although a direct attribution of the effects to the investments in the bond is not possible, they are reported here in form of third-party assessments. The State’s investments as well as investments by other actors are shown in Table 1-2. They contribute to savings of energy, material and GHG emissions over the course of several years. Because the 2019 results for ERDF were not available at the time of the impact report, its investments and effects still refer to the timeframe from 2014 until 2018.

Table 1-2: Third party assessments and quantified effects in category D

Type	Funding in NRW Sustainability Bond	Investments outside the Sustainability Bond	Environmental Savings*
	#1 to #6	for budget years 2014-2019	
Effizienz Agentur NRW efa+ (as part of resource efficient economy)	circa EUR 30m	EUR 63.5m in the scope of resource efficiency (validated)	79,853 tons of CO2e
			17,891 tons of material resources
			560,266 m^3 of water
		EUR 578.2m in the scope of financing (validated)	183,210 tons of CO2e
			33,169 tons of material resources
			217,329 m^3 of water
Ökoprofit NRW (as part of resource efficient economy)	circa EUR 1.5m	EUR 72.2m	102,901 tons of CO2e
			10,791 tons of waste
			511,630 m^3 of water
ERDF (2014-2020) (priority axis 3 on CO2 reduction)	circa EUR 34.9m** (ca. 24% of overall funding)	only for budget years 2014-2018 (no report for 2019 as of yet)	
		circa EUR 114m	675,720 tons of CO2e (estimates until 2018)

**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).*

*** previous reports showed the sum of all ERDF funding in the context of NRW Sustainability Bonds; this value refers to the estimated share for priority axis 3 only*

source: correspondence with related agencies, and the ERDF implementation report for NRW (MWIDE NRW (Ministry of Economy, Innovation, Digitalisation and Energy), 2019)

In regard to the GHG savings from funding in the ERDF, it can be estimated that savings of approximately 13,000 tons of CO_2-equivalents can be attributed to the NRW Sustainability Bond #6 (EUR 5.9m out of EUR 24.5m). This estimate is based on the fact that circa 675,700 tons of CO_2-equivalents are anticipated until 2018 with an overall funding of EUR 309m so far (including EU funds).

Ecological Impacts

While methods for GHG emission accounting are well established, only few ecological impacts can be monitored and quantified in a manner that is consistent with effects on climate mitigation. Nonetheless, the following impact-indicators could be derived that can be directly associated with investments in the State's budget.

The current findings and methodology for ecological impacts are described in the full report.

Sustainable Land Use

Of the total volume of EUR 148.3m in category E, EUR 28.3m (of which EUR 21.6m are part of the European agricultural fund for rural development or EAFRD) can be attributed to sustainable land use such as promoting diverse cultures in agriculture, development of protective stripes, nature conservation of grasslands, organic farming or compensating farmers when faced with environmental restrictions (e.g. in mountain areas).

Table 1-3 shows the results for the indicator Sustainable Land Use. As the method for calculations has been more closely aligned with funding allocation and monitored results, promoted areas per EUR 1m are lower compared to previous reports.

Table 1-3: Indicator „Sustainable Land Use" in NRW Sustainability Bond #6

Subcategory	Investment volume (2019)	Area supported per year (2019) (estimated)
Responsible Agriculture	EUR 6.7m	13,015 ha
EAFRD	EUR 21.6m	41,983 ha
in TOTAL	**EUR 28.3m**	**54,998 ha**

source: own calculation based on MULNV NRW (Ministry for Environment, Agriculture, Nature and Consumer Protection) (2019b)

Animal-friendly Husbandry

In addition to previous reports, EAFRD funding can now also be attributed to animal-friendly husbandry. Table 1-4 shows the results in this category, referring to attributed effects in the EAFRD for animals in summer grazing and rearing on straw.

Table 1-4: Indicator „Animals in animal-friendly husbandry" in NRW Sustainability Bond #6

Subcategory	Investment volume (2019)	Number of Animals (2019) (estimated)
EAFRD	**EUR 4.4m**	**60,300**

source: own calculation based on MULNV NRW (Ministry for Environment, Agriculture, Nature and Consumer Protection) (2019b)

Biological Stations

The tasks of Biological Stations include the protection and care of the flora, fauna, and landscape as well as nature conservation education and the associated public relations work. Out of a total investment volume of EUR 32.2m in the bond category "protection of nature", EUR 9.3m can be allocated to these stations (Ministry for Environment, Agriculture, Nature and Consumer Protection of North Rhine-Westphalia, 2019). This funding is mainly required to maintain 39 such stations throughout NRW (https://www.biostationen-nrw.com, 2020).

Table 1-5: Indicator „Number of Biological Stations" in NRW Sustainability Bond #6

Subcategory	Investment volume (2019)	Number of Biological Stations
Protection of Nature	**EUR 9.3m**	**39**

source: own attribution based on MULNV NRW (Ministry for Environment, Agriculture, Nature and Consumer Protection) (2019a)

Social Impacts

Only few social projects in the bond can be directly associated with quantifiable effects because required data is not reported or there is a lack of appropriate methods. Many projects are therefore not part of the current impact assessment, in particular projects in education, inclusion and social cohesion. Social tickets for example clearly help poor people in their daily mobility, but the number of beneficiaries has not been collected since 2015 (about 300,000 people back then[2]). Other examples for indirect social impacts from funding in the bond are the support of 54 municipal integration centres or the exemption from parental contributions for the last year of day-care for children. The Wuppertal Institut is continuously expanding the range of social impacts reported in its impact reports. The current findings as well as the first consistent methodology for social impact reporting are integrated into the full report.

Education and Sustainability Research (Category A)

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 957.2m, 90% or EUR 858.9m were invested to finance additional student capacities (e.g. 36,000 first-year students), reward universities for graduates or to reduce the number of dropouts. Other investments in this bond category facilitate training of geriatric nurses or teachers for special education.

Also included in the bond are funds to finance 14 research-groups in NRW as part of the "return programme for highly qualified researchers from abroad". Within the "EU School programme", fruits, vegetables and milk was provided to a minimum of 10,700 primary school pupils. Table 1-6 lists the results in all sub-categories and shows the share of funding attributed to the NRW Sustainability Bond.

Table 1-6: Allocation of funding in category A and quantification of effects

Category	Share	volume (2019)	Effect
Other funding in category A (e.g. for best-in-class universities)	36%	EUR 347.6m	*no quantification*
Funding of graduates	26%	EUR 248.0m	62,000 graduates
Funding of first-year students in NRW	12%	EUR 117.7m	36,000 students
Funding of the professional education of geriatric nurses	9%	EUR 86.6m	21,500 nurses
Other measures for the enlargement of universities	8%	EUR 77.3m	*no quantification*
Funding of master studies	6%	EUR 52.9m	10,600 students
Training facilities for the education of special education teachers	2%	EUR 21.2m	2,300 study places
Funding of the return for highly qualified young researchers	1%	EUR 3.6m	14 research groups
EU School program	*<1%*	EUR 2.3m	10,700 pupils
in TOTAL	**100%**	**EUR 957.2m**	**-**

source: own calculations based on methods and data depicted in this report
(number of bachelor graduates based on 2018 as new statistics were not available at the time of publication)

[2] see https://www.landtag.nrw.de/Dokumentenservice/portal/WWW/dokumentenarchiv/Dokument/MMD17-717.pdf

Inclusion and Social Coherence (Category B)

The NRW Sustainability Bond #6 investments dedicated to *Inclusion and Social Coherence* total EUR 528.6m. Some of this funding in category B was used to create new jobs for people with disabilities, funding day-care centres, qualification of young people with individual needs (esp. young refugees) or additional social workers in schools.

By relating the available funding for these four measures, it can be quantified that the Sustainability Bond NRW #6 provides at least 245 new jobs for people with disabilities (newly created jobs), helps to qualify 13,700 refugees and creates 730 jobs for social workers in NRW (costs for material and salary per year). In addition, 1,700 plusKITAS are funded with EUR 45.0m to improve educational opportunities for children from low-income families, with a migration background or from a relatively uneducated social environment. All four projects also show how investments into social development can also lead to an improvement of economic indicators (job creation and qualification). Table 1-7 shows the allocated investments of the Bond and their estimated effects in this category.

Table 1-7: Social Impacts for Integration and Social Cohesion

Inclusion & Social Cohesion	Sustainability Bond NRW #6	Type of quantification	Social Impact
Occupational integration of people with disabilities	EUR 4.9m	costs	**job creation:** ca. 245 new jobs
plusKITA	EUR 45.0m	reported effects	**Day care centre funding:** 1,700 day care centres
Start in education and work	EUR 50.0m	anticipated effects	**qualification:** 13,700 young people
Social School Work	EUR 47.3m	costs	**job funding:** ca. 730 jobs

source: own calculation based on reported data and calculated lump sums for scaling

Broadband Expansion

Broadband connections (download rates of 50 Mbits/s and more) improve social and economic access by households, institutions, and businesses. They also facilitate opportunities for a greener economy by reducing work-related traffic with the help of home-office solutions or the settlement of companies in more rural areas. 74% of the investments in the bond's category of urban development or EUR 258.8m are attributed to this purpose.

Quantifying the effect of funding for broadband connections is rather difficult, as the costs of an access point increase exponentially with higher penetrations rates. Based on NRW broadband expansions in the past (from an interactive website by the Federal Ministry of Transport and Digital Infrastructure[3]), about EUR 2,000 can be estimated as costs per access point on average. The investment in that bond category therefore represent about 129,400 new broadband connections in NRW.

[3] see https://www.bmvi.de/SharedDocs/DE/Artikel/DG/breitbandatlas/breitbandatlas.html

Social impact indicators for the Sustainability Bond NRW #6

Table 1-8 summarizes the scalable social impact indicators for the Sustainability Bond NRW #6, which are mainly based on fix lump sums in the different State programmes (e.g. such as re-fundable costs for social workers

Table 1-8: Social Impact Indicators for Sustainability Bond NRW #6

Impact indicator	Scaling Factor [EUR]	Metric	Project
First-year students	18,000 per student	lump sum	Expansion of universities
Graduates	4,000 per graduate	lump sum	Expansion of universities
Master student place	10,000 per place	lump sum	Expansion of universities
Geriatric nurses	2,870 per student	lump sum	Education of geriatric nurses
Jobs for disabled people	20,000 per job created	max. funding	Integration of people with disabilities
Jobs for school workers	65,000 per job	lump sum	School social work
Broadband connections	2,000 per access point	sample	Broadband expansion
Day-care centres	26,000 per centre	lump sum	plusKITA
Support of young people	3,800 per participant	lump sum	Start in education and work

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

Additional social impacts for NRW Sustainability Bonds (3rd party assessments)

The European Social Fund (ESF) promotes education and employment opportunities also aiming at social inclusion and reduction of poverty in NRW. The most recent report refers to monitored effects from 2014 to 2018 (MAGS NRW (Ministry of Labour, Health and Social Affairs), 2019). Within the current use of proceeds of the NRW Sustainability Bond #6, EUR 38.5m are attributed to further co-finance these measures.

Table 1-9: 3rd party assessment for ESF (common output indicators from 2014-2018)

Sub-Categories of B	Share	Reported Effects for 2014-2018 in NRW
Priority A (promoting employment and supporting labour mobility)	56%	847 participants still looking for work 4,343 participants in school-based or professional education 1,565 participants achieving professional training 4,864 participants in jobs after participating
Priority B (promoting social inclusion and combating poverty and all forms of discrimination)	21%	890 participants still looking for work 2,111 participants in school-based or professional education 5,322 participants achieving professional training 7,951 participants in jobs after participating
Priority C (investment in education, skills, and lifelong learning)	19%	323 participants still looking for work 1,729 participants in school-based or professional education 2,991 participants achieving professional training 1,663 participants in jobs after participating
Priority D (technical help)	4%	116 new employees 92,337 ESF projects supported 193 publications

source: MAGS

Final Financial Allocation by Ministerium der Finanzen NRW

Table 1-10: Budget plan and budget result for projects in NRW Sustainability Bond #6

main SDGs | *second. SDGs*	**Project** (** indicates changes in the budget plan compared to prior publications)* **Type**: social (S) | green (G)		**Budget Plan**	**Budget Result**
			[million EUR]	[million EUR]
	A - Education & Sustainability Research		**968.4**	**957.2**
4/9 | *5*	Bund-Länder-Covenant for the expansion of universities	S	495.9	495.9
	Training facilities for the education of special education teachers	S	21.2	21.2
	Measures to improve the quality of teaching and study at universities	S	249.0	249.0
	Return programme for highly qualified young researchers from abroad	S	4.3	3.6
	Promotion of equality at universities	S	4.3	2.6
	Professional education of geriatric nurses	S	85.5	86.6
	Excellence Strategy	S	32.0	31.0
	Promotion of innovation	S	16.3	12.9
	Johannes-Rau-Forschungsgemeinschaft	S	14.9	13.9
	Energy research	S	6.9	5.1
	Research and innovation in the fields of sustainable development	S	11.1	10.7
	Sustainable development	S	1.5	1.2
	Foundation for Nature and Sustainable Development	S	2.0	2.0
	Facilities for environmental education	S	1.9	1.8
	EU School programme	S	2.9	2.3
	Consumer protection	S	18.8	17.4
	B - Inclusion & Social Coherence		**556.9**	**528.6**
1/10 | *4/8/16*	Model projects for a social labour market in NRW	S	20.0	5.0
	Start in education and work	S	50.0	50.0
	European Social Fund 2014-2020 (State's share)	S	39.0	38.5
	Fight against poverty and social exclusion	S	9.3	7.8
	Social inclusion of persons with disabilities	S	3.7	3.4
	Occupational integration of people with disabilities	S	7.7	4.9
	Promoting integration of migrants living together in diversity	S	55.1	50.3
	Language courses at childcare facilities	S	25.0	25.0
	Support for family centres	S	42.1	40.3
	Assignments to municipalities for childcare in special cases	S	18.2	20.8
	plusKITA	S	45.0	45.0
	Exemption to contribution for parents for the last year of day care	S	194.1	190.5
	School social work	S	47.7	47.3

	C - Public Transportation & Local Mobility		**214.2**	**205.2**
9/11 | *10/12/13*	Public transportation for low-income citizens	S	40.0	40.0
	Public transportation for pupils and students	G	135.0	134.5
	Local mobility	G	26.8	20.0
	Improvement and expansion of bicycle lanes	G	12.4	10.8
	D - Climate Protection & Energy Transition		**96.1**	**91.2**
7/13 | *8*	Energy systems of the future	G	59.0	62.4
	Environmental economy, sustainable economy	G	1.9	0.6
	Funding programme for pumped storage power plants	G	4.0	0.0
	European Regional Development Fund (ERDF) 2014-2020	G	24.5	23.2
	Climate Action / Regional Climate Adaptation Measures (LIFE)	G	0.8	0.3
	Resource efficiency	G	5.9	4.7
	E - Protection of Natural Resources		**153.4**	**148.3**
2/15 | *6/11/12/13*	Soil protection	G	4.7	3.4
	Protection of nature	G	35.9	32.2
	Flood protection and river restoration	G	66.7	66.7
	Responsible agriculture	G	6.8	6.7
	European Agricultural Fund for Rural Development – EAFRD	G	39.3	39.3
	F - Sustainable Urban Development		**430.4**	**349.9**
9/11 | *10/12*	Urban Reconstruction in the West	S&G	50.1	45.7
	Social City	S&G	55.2	38.1
	Development plan geriatric care	S&G	16.3	7.3
	Broadband expansion / Digitalization	S&G	308.9	258.8
	G – Modernisation of Educational & Public Health Facilities		**508.1**	**505.6**
3/13 | *4/7/11/12*	Modernisation of university buildings	G	164.2	157.4
	Conservation and remediation of existing university clinics	G	131.5	150.0
	Enlargement and other investments for university clinics	G	212.4*	198.2
	in TOTAL		**2,927.5**	**2,786.1**

Overview on GHG savings (NRW Sustainability Bond #6)

Table 1-11: Results on GHG savings according to ICMA framework 2019

Energy Efficiency (EE)	Signed Amount	Share (of investment)	Eligibility for green bonds	EE Component	Annual energy savings		Annual GHG emissions avoided		Absolute GHG emissions	
Project name	million EURO	%	%	%	GWh/a		kilotons of CO2-equivalents		kilotons of CO2-equivalents	
					100%	financed	100%	financed	100%	financed
New university buildings	61.9	100	100	46	1.8	1.8	0.40	0.40	360.7	360.7
University buildings (refurbishment)	6.1	100	100	28	0.3	0.3	0.07	0.07	66.4	66.4
New university clinical buildings	208.5	100	100	85	5.0	5.0	1.12	1.12	634.8	634.8
University clinical buildings (refurbishment)	46.1	100	100	45	6.2	6.2	1.37	1.37	527.8	527.8
Low Carbon Transport (LCT)	**Signed Amount**	**Share (of investment)**	**Eligibility for green bonds**	**LCT Component**	**Annual savings of car km**		**Annual GHG emissions avoided**		**Absolute GHG emissions**	
Project name	million EURO	%	%	%	million passenger km/a		kilotons of CO2-equivalents		kilotons of CO2-equivalents	
					100%	financed	100%	financed	100%	financed
Student tickets	21.7	9.2	100	100	768.8	70.8	109.2	10.0	51.5	4.7
Urban cycle paths*	20.0	100	100	100	36.8	36.8	5.23	5.23	0	0
Non-urban fast cycle paths*	10.8	100	100	100	5.9	5.9	0.85	0.85	0	0

**production of bicycles not included*

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

2 Background and Scope

Since 2015, the federal state of North Rhine-Westphalia (NRW) (Germany) emits a periodic Sustainability Bond that consists of projects in the State's budget linked to sustainable development (NRW Sustainability Bonds #1 to #6). The Bond focuses on projects that ensure social and ecological sustainability and is part of the Sustainability Strategy in North Rhine-Westphalia (Landesregierung NRW (State Government of NRW), 2016b). The 6th Bond was issued in 2019 with a volume of EUR 2.5bn, referring to 62 eligible projects from the States' 2019 budget. While ISS ESG (former ISS-oekom) provided a second party opinion on the eligibility of the selected projects for a sustainability bond (ISS ESG (former ISS-oekom), 2019), the Wuppertal Institute has been asked to analyse the impacts in regard to a sustainable development for the fifth year in a row[4]. The 6th Sustainability Bond (NHA NRW #6) is clustered in 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.

The goal of this report is to evaluate positive sustainability effects for the NRW Sustainability Bond #6. It covers not only the mitigation effects on climate change (avoided greenhouse gas emissions), but also further environmental and social impacts.

The volume of the Sustainability Bond #6 NRW (issued in 2019) is distributed among the seven project categories shown in Figure 2-1. The categories "Education and sustainability research" (A, 34 %) and "Inclusion and social coherence" (B, 19 %) and "Modernisation of educational and public facilities" (G, 18%) account for about two thirds of the funding. The categories "Sustainable urban development" and "Public transport and local mobility" have a combined share of 21%. The other two project categories "Environment and nature conversation" and "Climate protection and energy transition" account for only 8% 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.

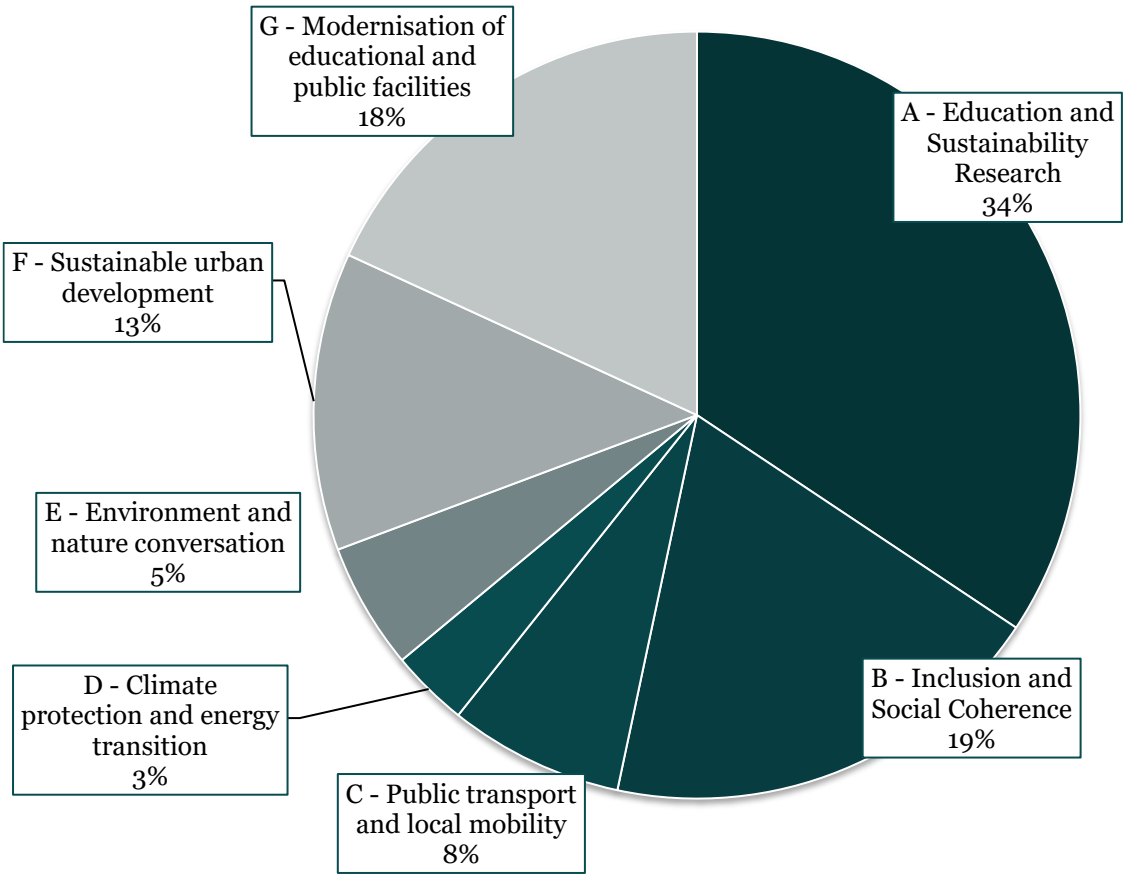
[4] see https://www.nachhaltigkeit.nrw.de/fileadmin/download/Nachhaltigkeitsanleihe/NHA-NRW_V_Long_Report_FINAL_30-OKT-2019.pdf for the full report

Table 2-1: Project categories in the Sustainability Bond #6 NRW (P: Budget Plan | R: Budget Results)

Project category	Primary SDGs'	Secondary SDGs'
A Education and Sustainability Research (P: EUR 968.4m | R: 957.2m)	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	SDG 5 – Achieve gender equality and empower all women and girls
B Inclusion and Social Coherence (P: EUR 556.9m | R: 528.6m)	SDG 1 – End poverty in all its forms everywhere SDG 10 – Reduce income inequality within and among countries	SDG 4 – Ensure inclusive and quality education for all and promote lifelong learning SDG 8 – Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all SDG 16 – Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
C Public Transportation and Local Mobility (P: EUR 214.2m | R: 205.2m)	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	SDG 10 – Reduce income inequality within and among countries SDG 12 – Ensure sustainable consumption and production patterns SDG 13 – Take urgent action to combat climate change and its impacts
D Climate Protection and Energy Transition (P: EUR 96.1m | R: 91.2m)	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	SDG 8 – Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
E Protection of Natural Resources (P: EUR 153.4m | R: 148.3m)	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	SDG 6 – Ensure access to water and sanitation for all SDG 11 – Make cities and human settlements inclusive, safe, resilient and sustainable SDG 12 – Ensure sustainable consumption and production patterns SDG 13 – Take urgent action to combat climate change and its impacts
F Sustainable Urban Development (P: EUR 430.4m | R: 349.9m)	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	SDG 3 – Ensure healthy lives and promote well-being for all at all ages SDG 10 – Reduce income inequality within and among countries SDG 12 – Ensure sustainable consumption and production patterns
G Modernisation of Educational and Public Health Facilities (P: EUR 508.1m | R: 505.6m)	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	SDG 4 – Ensure inclusive and quality education for all and promote lifelong learning SDG 7 – Ensure access to affordable, reliable, sustainable and modern energy SDG 11 – Make cities and human settlements inclusive, safe, resilient and sustainable SDG 12 – Ensure sustainable consumption and production patterns

source: own compilation based on final financial allocation (see Table 1-10 in the summary)

Figure 2-1: Proportion of funding from the 6th Sustainability Bond NRW (issued in 2019).



source: own compilation based on use of proceeds for NRW Sustainability Bond #6

2.1 Overview of Report

The impact analysis is based on the "Harmonized Framework for Impact Reporting" by the International Capital Market Association (ICMA) and the World Bank (ICMA, 2019; The World Bank et al., 2015), which suggests a uniform presentation of the results of an impact analysis. Going into the fifth year, the Wuppertal Institute has continuously advanced the scope of the impact assessment of the Sustainability Bond NRW.

This holds true for the dimension of social impacts, which has been expanded over the last couple of years. However, there are also ongoing discussions on identifying additional indicators that reflect the ecological dimension in terms of biodiversity, animal welfare or organic farming. In addition to regular reporting within the scope of the NRW Sustainability Bond (the so-called Impact Reporting), the Wuppertal Institute continuously advances the corresponding methodology with the aims of

- improving the robustness of results,
- ensure transparency,
- verify and validate methods of calculation,
- and to enlarge the set of indicators reported.

A number of additional studies have already been carried out for the operationalization of reporting, such as impact assessment of the state budget as a whole or guidelines for recording co-impacts. The areas of social as well as ecological impact assessment are discussed in their own chapters for the first time.

As standardization for social and sustainability bonds increase, many issuers as well as analysts refer to the sustainable development goals or SDGs as a point of reference for impacts. Identifying the impacts of projects or government programs and mapping them to these international goals is difficult though, since there is currently no commonly agreed method for doing so. The final chapter of this report therefore presents promising approaches and provides a first tool. The goal of the tool is to facilitate the mapping processes itself while also increasing the robustness of the results.

The report at hand is sorted into the following chapters:

- Chapter 3 provides an overview of the methods to calculate reduction potentials for greenhouse gas emissions or GHG.
- Chapter 4 discusses the integration of further ecological effects into the impact reporting of the bond.
- Chapter 5 provides an overview on how social effects are handled in this impact report.
- Chapter 6 provides the results of the impact report based on the before mentioned methods. It also provides background data from literature and assumptions by the authors.
- Chapter 7 describes the long-term development of GHG effects over the recent couple of years (NHA NRW #2 to NHA NRW #6).
- Chapter 8 presents a literature review on SDG mapping methods and presents a tool to map projects to sustainable development goals.
- And the final chapter 9 discusses the results of the report while also providing an outlook into the future.

3 Greenhouse Gas Accounting

This chapter describes how the calculation of avoided greenhouse gas emissions (GHG reduction) is carried out (sometimes also referred to as scope 4 emissions)[5].

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 CO_2 equivalents (CO_2 equivalent or CO_2e) (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. CO_2e 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 specific procedure for determining the Carbon Footprint or the avoidance of GHG emissions (also called GHG savings in this report). Therefore, the following conventions and variables had to be defined for each project group (the issue of double-counting and additionality is further discussed in 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. if an energy system becomes more climate-friendly with the shutdown of coal plants).

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

Proportion of GHG reduction financed: There are also measures towards climate protection which only partially lead to GHG reductions. This applies in particular to the construction and renovation of

[5] This section of the report has not been changed compared to the previous report (Jens Teubler et al., 2019)

buildings, where further legal requirements such as accessibility, fire protection or occupational safety play a role.

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

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 investors of the bond, these are all actors in the funded projects themselves. Since each tonne of GHG can only be saved once, double counting must be avoided, although financing and re-financing might be considered to be added sustainable value.

Universities for example, own their properties and invest in the conversion and new construction of their buildings. However, 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 e.g. companies, this is usually achieved using so-called attribution rules. For avoided emissions in the context of bonds, the authors use the terms ***financed*** or ***induced*** **GHG reduction** ***potentials*** *or* ***savings***.

3.3 Limitations

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

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
(underestimated: conservative results; overestimation: optimistic results)

Bond Category	Assumptions	Impact on GHG emissions	Over- and under-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.	+ (underestimated)
	Modal shift assumptions in the area of semester tickets	The robustness of the empirical survey cannot be validated. However, it can be assumed that the effects are higher in some universities and lower in others.	o (no final estimate)
	Assumptions on the cost of cycle paths	The cost factor for the construction of municipal cycle paths is based on a 5-year average and can be considered robust. The cost factor for high-speed cycle paths is based on published construction costs. Since many of the cycle paths concerned are still under construction at the time of the analysis, the real costs could be higher. This would lead to an overestimation of the GHG reduction potentials for fast cycle paths in the analysis.	o (no final estimate)
Category G Modernisation of educational and public health facilities	New buildings replace old buildings	The GHG reduction potentials are rather overestimated due to this assumption, because the total heating energy requirement of a university facility increases if existing buildings continue to be used.	- (overestimated)
	Assumptions on construction costs	The data used cannot be used to calculate robust average values for the construction costs of new buildings and those to be renovated. The actual usable area increased or converted by the investments, and thus the GHG reduction potentials, cannot be reliably determined.	o (no final estimate)
	Assumptions on the use of funds	Only clear budget titles were allocated as part of the investment allocation. The resulting GHG reduction potentials are therefore underestimated with a high degree of certainty, especially since a relatively high proportion was assumed for the initial installation (52%).	+ (underestimated)
	Non-consideration of the electricity consumption	Additional GHG reduction potentials could be realised through savings in electricity consumption. However, this is not the case for all building types and uses.	o (no final estimate)
	Assumptions for saving heating energy in buildings	For the new and replacement construction of buildings, data from the existing stock of public buildings were used, which lead to energy and GHG savings compared to the EnEV standard and with regard to the usable area. It can be assumed that in reality greater savings will be achieved. However, the development measures were only mapped on the basis of a reference building. The allocation of these specific GHG reduction potentials to all implemented measures is therefore subject to high uncertainties.	+ (underestimated)

source: own presentation

4 Ecological Impact Indicators

The following chapter focuses on the area of ecological impacts, in particular for bond category E on “Environment and Nature Conservation”. Below, suggestions and recommendations for improvement made by the TEAM Sustainability (Team Nachhaltigkeit) are taken up which appear suitable for supplementing the ecological indicator set of the NRW Sustainability Strategy and are thus suitable for application to refinanced measures within the framework of the bond.

Since 2014, the TEAM Sustainability has accompanied and advised the Wuppertal Institute as Stakeholder Advisory Board in the projects "Sustainability Strategy NRW. Conceptual Analyses and Considerations on the Design of a Sustainability Strategy NRW from a Scientific Perspective" (2013-2017) and "Implementation Experiences with State Sustainability Strategies - Case Study Sustainability Strategy NRW" (2016-2020). TEAM Sustainability is thus involved in the development and implementation of the NRW sustainability strategy from the stakeholder perspective[6].

Three fields of action were identified that currently lack indicators on the State level and could therefore also be of interest for impact reporting of the NRW sustainability bond. For each of the three areas, suggestions by TEAM Sustainability are described and matched with a first table of potential new indicators.

The areas of protection are

- Natural Resources,
- Land Management,
- Nature Conservation and Biodiversity.

4.1 Natural Resources

As an addition to the measures in the field of action "Protection of natural resources - Safeguarding and securing sustainable and ecological water management" and the existing indicator "Ecological condition of surface waters", the TEAM Sustainability proposes the renaturation of water catchment basins and river floodplains and the reduction of open sewers in order to link them more closely to the NRW Biodiversity Strategy[7].

The proposed renaturation of water catchment basins (green-blue infrastructure) could serve not only as flood prevention but also as an extension of the indicator "endangered species", since renaturalised water catchment basins can act as stepping stone biotopes[8] for the biotope network (BDLA, 2020; Connor et al., 2018; Jedicke, 2017). The indicator could reflect the number of renatured water catchment basins.

The renaturation of river floodplains would also fit into the current project portfolio of the Sustainability Bond NRW as a complementary measure of preventive ecological flood protection. The spatial extent of renaturalised river floodplains for example could serve as an indicator if the area of renaturalised floodplains is captured (based on the indicators of the Biodiversity Strategy NRW "Qualitative improvement of habitats - water bodies and floodplains" as discussed by the Ministry for Environment,

[6] see https://www.nachhaltigkeit.nrw.de/dialog/partizipation-zur-nachhaltigkeitsstrategie/team-nachhaltigkeit/ for a link to TEAM Sustainability (Website in German)

[7] See: https://www.nachhaltigkeit.nrw.de/themen/schwerpunktfelder/biodiversitaetsstrategie/

[8] Stepping stone biotopes are more or less regularly distributed biotope islands whose site conditions allow numerous animal and plant species to stay temporarily and to spread and migrate. In nature conservation, such stepping stone biotopes are often created artificially to replace the connecting structures between the actual core habitats that have been lost in the cultural landscape as a result of the clearing out (biotope network system). Stepping stone biotopes can be, for example groups of trees or shrubs, small bodies of water, flower strips on fields, etc. See at: https://www.spektrum.de/lexikon/geowissenschaften/trittsteinbiotop/16966

Agriculture, Nature and consumer protection of North Rhine-Westphalia (MULNV NRW (Ministry for Environment, Agriculture, Nature and Consumer Protection), 2015a).

A further suggestion of the TEAM Sustainability is to measure residues in the water other than nitrate, such as antibiotics and hormone preparations, pesticides, plastics or microplastics and drugs. In this context, the TEAM Sustainability suggests examining to what extent and by when all water bodies in NRW will achieve a good chemical status in accordance with the EU Water Framework Directive.

Overall, the current focus should be shifted from technological repair measures to the provision of clean water. In Lower Saxony, a study on the contamination of near-surface groundwater with antibiotics was carried out with the indicator "Distribution and concentration of antibiotic agents in regions with high livestock numbers" (Karfusehr et al., 2018). By fertilization with the manure of animals treated with antibiotics, the antibiotics are diffused onto agricultural land and seep into the groundwater as well as surface waters. In this context, the existing indicator "Ecological status of surface waters" (according to the EU Water Framework Directive) could be supplemented with a similar indicator for groundwater. The indicator „Chemical status of groundwater – Pollution by pesticides" could be measured according to the EU-Groundwater Framework Directive EU-RL 2006/118/EG. The Data required is currently processed in irregular intervals by the Federal Government/Federal states Working Group on Water (LAWA) together with the Federal Environment Agency[9] (1997, 2004, 2011, 2015, 2019[10]).

4.2 Land Management and Animal Welfare

In the field of land management, the TEAM Sustainability proposes to differentiate the indicator "organic farming" (share of agricultural land in %). New indicators should separately address the categories ecological farming (taking into account the interrelationships between living beings and the environment), biological farming (avoiding environmental pollution and taking into account crop rotations) and sustainable farming (use of resources taking into account the natural regeneration capacity of ecosystems and living beings and the holistic approach to farm management with equal attention to ecological, social and economic aspects). First quantified and scheduled objectives for the individual categories are discussed in Schostock (2018, p. 13).

The online search for additional suitable ecological indicators led to the indicator "Increase in agricultural areas of high nature value" in the subject area of biodiversity and habitats in the form of "High Nature Value (HNV) farmland", which is applied in the State of Rhineland-Palatinate. This indicator is intended to record changes in the ecological condition of agricultural land (MWVLW RP (Ministry of Economics, Transport, Agriculture and Viticulture Rhineland-Palatinate), 2018). Agricultural areas with high nature value include the following areas: extensively used, species-rich arable land and grassland, orchards and vineyards, and fallow land. In addition, landscape-structuring elements such as hedges, unploughed strips, field shrubs and small bodies of water are surveyed, provided they belong to the cultural landscape used for agriculture. These areas are divided into three quality levels: extremely high (HNV 1), very high (HNV 2) and moderately high nature value (HNV 3). In Rhineland-Palatinate these data are determined by the land surveying authorities. Similarly, in NRW these data are available from the District Government of Cologne in the Department 7 Geobasis NRW. Within the framework of the evaluation of the development programs for rural areas (EAFRD), there is a reporting obligation for this indicator vis-à-vis the European Union, both by the federal and state governments. It is also one of 19 indicators of the "National Strategy on Biological Diversity" (NBS) of

[9] See: https://www.umweltbundesamt.de/themen/wasser/grundwasser/zustand-des-grundwassers/chemischer-zustand-des-grundwassers#textpart-3

[10] See: https://www.lawa.de/documents/lawa-bericht-zur-gw-beschaffenheit--psm_2_1558355266.pdf

2014.[11] Measures to increase the quota of HNV-Farmland are e.g. avoiding further grassland conversion and extensification of suitable grassland areas as well as the establishment of buffer strips around landscape features and arable land (e.g. in the form of flowering strips).

For the field of action of land management and the related area of animal-friendly agriculture, indicators on animal welfare are still in the development process, i.e. there is not yet a generally accepted set of indicators for measuring and evaluating animal welfare (and therefore currently no suggestion for new indicators in impact reporting). However, there are already several indicator systems that have been designed for different user groups and purposes:

- for policy-making and scientific policy advice,
- for farm planning or self-monitoring of farmers or
- for the product labelling (animal welfare-label) of trading- and marketing companies.

The measurement of the different aspects of animal welfare is usually captured by different types of indicators[12]:

- Resource-related indicators: they provide information on, for example, husbandry practices and space allowances.
- Management-related indicators: They record practices such as the dehorning of cattle or the castration of fattening pigs, but also the feeding and handling of animals.
- Animal-related indicators: They are measured directly on the animal, for example bunion inflammation in poultry for fattening, lameness in dairy cows, but also behavioral disorders such as stick biting of swine.

Within the framework of the interdisciplinary project “National Animal Welfare Monitoring”, which is funded by the Federal Ministry of Food and Agriculture, the Thuenen Institute and other external partners are currently developing the basis for regular, indicator-based monitoring and reporting on the status quo and development of animal welfare in livestock farming in Germany.[13]

In terms of impact reporting, the current reports introduces a first indicator on “the number of animals in animal-friendly husbandry”. This relates to European Funding that promotes summer grazing and rearing with straw (see section 6.6).

[11] The NBS target definition for the increase in the proportion of agricultural land of high nature value is: "...establishing an increase of at least 10 percentage points between 2005 and 2015" "As the survey was first carried out in 2009, the starting value was taken as the level of 2009. If the share of HNV farmland is to be increased by at least 10 percentage points over a period of 10 years starting in 2009 and assuming a linear development until 2019, the target value is an increase of at least 6 percentage points to a share of at least 19% of the agricultural area by 2015.“ See: https://biologischevielfalt.bfn.de/nationale-strategie/indikatoren-und-berichterstattung/indikatorenbericht-2014/indikatoren/landwirtschaftsflaechen-mit-hohem-naturwert.html

[12] See: https://www.thuenen.de/de/thema/nutztiershyhaltung-und-aquakultur/wie-tiergerecht-ist-die-nutztierhaltung/wie-sich-tiergerechtheit-messen-laesst/ also https://www.thuenen.de/de/institutsuebergreifende-projekte/5-laender-evaluierung-tierschutzwirkungen/ and https://www.thuenen.de/de/institutsuebergreifende-projekte/tiergerechte-milchviehhaltung-das-ergebnis-messen-und-honorieren/

[13] See: https://www.thuenen.de/de/institutsuebergreifende-projekte/nationales-tierwohl-monitoring/

4.3 Biodiversity

For the area biodiversity, the particularly important work of the so-called **Biological Stations** is emphasized here:

> "*With these diverse tasks and functions, they make a central contribution to the conservation of biological diversity and support and supplement the lower landscape authorities of the state to a considerable extent in their tasks. In the future, the Biological Stations should provide technical support for the nature conservation areas and NATURA 2000 areas in all districts as far as possible. For this purpose it is necessary to ensure the long-term financing of the biological stations." (translated from* MULNV NRW (Ministry for Environment, Agriculture, Nature and Consumer Protection) (2015, p. 145)"

The Biological Stations NRW originally emerged from voluntary nature conservation and today represent an elementary link between voluntary and official nature conservation, which is unique in this form in Germany. There are now Biological Stations in almost all administrative districts, which are financed by the NRW Ministry for Environment and the respective district. Their tasks include protecting and caring for the flora and fauna as well as nature conservation education and public relations. In addition to their scientific expertise and sound knowledge of the area, they are in close contact with land users and the rest of the population. Biological stations, in coordination with the landscape authorities, now look after more than half of all nature conservation areas in NRW by recording changes in flora and fauna but also planning, coordinating and in some cases measures to improve the protected areas. Suitable indicators for extending the measures and work areas of the biological stations are the number, proportion (%) and area of the protected areas under qualified management.

The current report already includes the new indicator "number of biological stations"; further discussed and allocated to funding in the sustainability bond in section 6.6.

4.4 New Ecological Indicators

The following list of indicators could be identified with help of a literature research; mainly based on suggestions by TEAM Sustainability (Schostock, 2018). Table 4-1 shows the fields of actions as classified in the indicator report NRW (Landesregierung NRW (State Government of NRW), 2016a), potential fitting to the categories of the NRW Sustainability Bond as well as the possible sources of data. With exception of the number of qualified protected areas (biological stations), none of these indicators can be integrated at the moment due to lack of data. However, if data is collected and the related State's budget can be allocated, it might be possible to integrate these indicators into future reports.

Table 4-1: Set of new ecological impact indicators for future impact assessments

Fields of action	Categories in NRW Sustainability Bond	Operationalised Indicator	Potential source(s)
Protection of natural resources - Maintenance and safeguarding of sustainable and ecological water management: Ecological condition of surface waters, area of the nationwide biotope network	■ Flood protection and natural hydraulic engineering ■ Biodiversity/Biotop-network	Number and area (ha) of renatured water catchment basins	Water associations NRW
Maintenance and safeguarding of sustainable and ecological water management: ecological status of surface waters, endangered species, biodiversity and landscape quality	■ Flood protection and natural hydraulic engineering ■ Biodiversity/Biotop-network	Area (ha) of renatured floodplain areas	Water associations NRW
Land cultivation	■ Environmental and animal rights agriculture	Contamination of surface-near groundwater with antibiotics (ng/l)	State Agency for Nature, Environment and Consumer Protection NRW
Land cultivation	■ Environmental and animal rights agriculture	Pesticide pollution (µg/l), Chemical status of groundwater	Federal/State Working Group on Water
Land cultivation	■ Environmental and animal rights agriculture	Differentiation of „organic faming" into ecological, biological and sustainable	Chamber of Agriculture- NRW
Protection of natural resources – biodiversity + landscape quality Land cultivation	■ Biodiversity ■ Environmental and animal rights agriculture ■ EAFRD-programme	Increase of agricultural areas (%) with high nature value farmland	Geobasis NRW
Land cultivation	■ Environmental and animal rights agriculture	*(Animal Welfare) – still under development*	Chamber of Agriculture NRW
Land cultivation	■ Environmental and animal rights agriculture	Increase in the number of farms (next to the areas) in organic farming	Chamber of Agriculture NRW
Biodiversity	■ Biodiversity	Number and area of qualified protected areas (managed by Bio-Stations)	State Agency for Nature, Environment and Consumer Protection NRW

source: own compilation

5 Social Impact Indicators

The following chapter discusses impact quantification in the social dimension of the NRW sustainability bond. It is investigated what type of impacts can be identified and which of these impacts can potentially be quantified.

5.1 Two approaches to quantify social impacts in bond reporting

There are currently no established methods to account for social impacts that can be compared to standards for GHG reporting. The latter relies on a defined set of emission factors that represent the global warming potential of different greenhouse gases, a large variety of datasets and most importantly on the methodology for Life Cycle Assessments (LCA). Although there are options to integrate social effects into LCA (usually referred to as sLCA), data is lacking and only a small number of effects can be captured this way.

Against the background of data gaps, indirect or opaque cause-effect-relationships and a large number of potential benefits to society, two general approaches for social impact reporting in bonds can be differentiated.

1) Capturing and quantifying effects that can be covered with the help of scientific robust methods (based on comparable metrics and methods such as sLCA)
2) Classification and scaling of reported effects within measures

The first approach requires the selection of established indicators that can be applied to the bond. So far, there is no consensual methodology or even list of indicators for impacts, outputs, or outcomes in social impact reporting. However, a first reporting standard was developed that aligns the standards of green and social impact reports and includes a first list of indicators used in numerous reports (ICMA & The Social Bond Principles, 2018). Such a table of results includes the classification of each impact reported (along social bond categories), the SDG addressed, signed amounts and financial shares (see Figure 5-1 for an extract). While the current impact report does not include such a summary, it is planned to integrate this template into future reports.

Figure 5-1: Sample of a summary template for social impact reports according to ICMA et al. (2018)

Name	*Project Category*			*Target Population*	*Allocation information*					*Social Indicators*		
Project Name	**SBP Category**	**Sub-category**	**SDG Addressed** *(Goal & Target, as relevant)*	**Target Group**	**Signed amount** *(currency)*	**Share of Total Financing** *(percent)*	**Eligibility of Social Bond** *(% of signed amt.)*	**Allocated amount** *(currency)*	**Portfolio lifetime or budgetted years** *(years)*	**Indicator 1** *(#, unit of measure, absolute or relative)*	**Indicator 2** *(#, unit of measure, absolute or relative)*	**Indicator … n** *(#, unit of measure, absolute or relative)*
	a/	b/	c/	d/	e/	f/	g/	h/	i/	j/	j/	j/
ex. Sample Water Project	**Affordable basic infrastructure**	**Water**	*6.1*	*Underserved households with no water connection*	*USD 5 million*	*100%*	*100%*	*100%*	*5 years*	*1,000 households connected (absolute)*	*1 plant constructed (absolute)*	
		Sanitation/ sewage										
		Public transport										

source: ICMA & The Social Bond Principles, 2018

In terms of scientific robustness of social impact methods, a recent meta-study by Kühnen & Hahn (2017) finds in accordance with other authors that

- social performance measurement is usually not based on well-founded theories,
- worker-related issues tend to be the focus of assessments,
- and that the adaption of originally empirical methodologies could become a foundation for more scientific robust social impact pathways in the future.

The authors also found that there are gaps in the coverage of empirical evidence for social impacts across different sectors. While the empirical research for the manufacturing sector (in particular chemical manufacturing) is "diverse and investigates sLCA issues in various manufacturing subsectors", the utilities sector is often limited to social impacts of power generation rather than utilities for water and sewage. Figure 5-2 shows the most frequently addressed sLCA categories investigated in the study.

Figure 5-2: Most frequently addressed indicators according to Kühnen & Hahn (2017)

Subcategories	*Indicators*	*Typical measurement approaches in research*	*Rationale for inclusion, shortcomings, and recommendations*
Safe and healthy living conditions in local communities	Potential of accident risks	Narrative description	- Consensus in research on importance of health and safety aspects in SLCA - Potential of accident risks aims at anticipation and prevention of future accidents. - Local morbidity and human health depreciation aim at retrospective correction of business operations with negative health impacts on local community members. - Extant research often only vaguely mentions potential of accident risks without specification of detailed qualitative assessment criteria. - Causal ascription of local health damages to specific organizations and operations may be only limitedly possible. Future research needs to elaborate anticipatory (qualitative) risk assessment criteria for preventing potential health and safety issues, and validate the importance of DALY as health impact assessment approach in SLCA.
	Local morbidity and human health depreciation	DALYs of local community members	
Promoting social responsibility among value chain actors	Suppliers' compliance with human rights and codes of conduct	Verification on a semi-quantitative yes/no scale	- Indicators aim at promoting social responsibility by monitoring obligation of upstream and downstream value–chain actors to respect basic human rights in their business operations and eventually take corrective actions. - Complexity of many supply chains impedes an exhaustive monitoring; monitoring often limited to significant, upper-tier suppliers, and contractors. Because monitoring is retrospective, it should be enhanced by adding more measures related to training efforts to proactively avoid human rights issues.
	Screening of suppliers and downstream contractors on human rights	Number and percentage of actors screened	
Consumers' health and safety	Product health and safety	Consumer–related toxicity potential as measured in ELCA; DALYs of consumers	- Health and safety currently only consensual impact assessment category - Indicators related to consumers aim at measuring health damages when customers and consumer use a product. - Indicators related to workers aim at measuring health damages when workers pursue their occupation. - Extant research often only vaguely mentions product and occupational health and safety without further elaboration; quantitative measures of injuries, diseases, and fatalities only describe situational performance without an actual assessment of impacts on human health. Future research needs to validate importance of DALY as health impact assessment approach in SLCA and need to consider more anticipatory measures that assess efforts to protect workers and product users from health damages.
	Injuries, diseases, and fatalities	Number and percentage of affected consumers	
Workers' health and safety	Occupational health and safety	Worker–related toxicity potential as measured in ELCA; DALYs of workers	
	Injuries, diseases, and fatalities	Number and percentage of affe–cted workers	
Contribution to society's economic development	Employees and full-time equivalent employment	Number (and percentage) of (full-time) employees	- Indicators aim to assess how companies generate jobs in countries where supply–chain operations take place. - Focus on employment generation in research may be due to availability of data and may not necessarily represent an organization's true contribution to economic development if considered in isolation.
	Employment stability	Number and ratio of hires and dismissals	
Other	Stakeholders' satisfaction	Only generically mentioned	- Indicators aim at assessing subjective experiences or feelings of impacted stakeholders. - Extant research only vaguely refers to such subjective indicators without elaborating detailed measurement approaches.
	Stakeholders' sensory and aesthetic perceptions	Only generically mentioned	

Note: SLCA = social life cycle assessment; DALY = disability-adjusted life-years; ELCA = environmental life cycle assessment.

The second approach relies on reported data and budgets (here the State`s budget of North-Rhine Westphalia), but also on guidelines on how the reported effects can be attributed to investments. Apart from the report at hand, an example for such an approach would be the impact report by Clarke et al. (2018). Covering so-called Development Impact Bonds (DIBs), the reported data not only covers a wide range of financial data and parameters but also concrete targets on funding for hospitals or surgeries performed.

Out of a broad literature research conducted for the report at hand, the majority of bonds are either limited to a loan classification (providing information on the sectors and recipients) or are based on semi-quantitative methods (awarding scores for achieving thresholds). An example for extended loan information is the 2018 impact report by the International Financial Corporation (IFC, 2019), while a life-cycle-based scoring metric was developed for chemical products by the World Business Council for Sustainable Development (wbcsd, 2016).

5.2 Advantages and Disadvantages of both approaches

The main advantages of approach 1) are scientific robustness and replicability. In theory, this approach allows to monitor effects over a long period of time, compare different measures within a bond, but also to compare the effects of different bonds with each other. However, comparability can only be achieved by using a comparable data basis based on evidence as well as similar rules of attribution, allocation and for cut-offs. Therefore, in practice, two bonds would report the same indicators (e.g. number of jobs created) but could not be compared from the point of view of an investor or regulatory entity. Since the unification and standardization of GHG reporting just started (with still a long road ahead before climate effects of green bonds can be compared), it is questionable how long a similar process would take for social bonds.

The main disadvantage of this approach is its limitation in regard to the range of effects that can be reported. Many social projects or programs could “fall through the grid”, even if they are properly monitored in terms of e.g. the flow of investments, the number of participants or indicators of success. Another disadvantage of these scientific methods is often their complexity. The rules of calculation are more complex and require expert training to understand them, but they also rely on large datasets in the background (especially if traditional accounting is involved) and scientific evidence.

While the authors of this report clearly advocate for a common scientific methodology (especially for so-called co-impacts) and a common data basis that can be used for social bonds, we also argue that these additional effects in particular can be reported in a way that shows the attribution of financing and re-financing. Thus, the main advantage of approach 2) is its capability to report on almost any positive effect for society or the stakeholders targeted by a measure, project or program. Although all these effects require monitoring to a certain degree, data requirements are much lower, and the calculations are usually quite straightforward and transparent.

Clearly, comparing two different social bonds in such a way is not possible – unless regulators require similar effects to be monitored in a consistent manner. It is even difficult to compare the effects of two different measures within one bond, as different entities might be involved with different standards of reporting or projects with different goals are to be compared. This lack of comparability (and to some extent accountability towards investors), is therefore the main disadvantage of approach 2). In the long run, minimum reporting requirements (which effects need to be reported and which effects can be reported voluntarily) could facilitate comparisons or even the development of efficacy indicators (positive social effects in regard to the investment needed). For now, most effects captured in this way only provide additional information that might or might not be of relevance for investors and stakeholders.

However, some steps can be taken to ensure a high reporting quality in terms of

- traceability,
- quantifiability,
- scalability,
- and success of measures.

The following sections describe how the authors of this report operationalized approach 2).

5.3 Terminology

The following table provides a terminology that is used in the following sections and throughout the report.

Table 5-1: Terminology of Social Impact Reporting in NRW Sustainability Bond #6

Term	Usage in Social Impact Method
Measure	The starting point or "cause" in a cause-effect-chain for social impacts.
Project, Program or Initiative	Measure to achieve a positive effect for society. A project is usually the smallest category in an impact reporting, has a defined duration and target, and is re-financed by the bond. State programs or initiatives can be projects, too.
Social Impact	Social impacts are defined as positive outcomes for the society as a whole (societal perspective). They can include effects in other areas of sustainability such as the economy or environment.
Social Impact Indicator	A social impact indicator is any type of quantified social impact within this impact report.
Monitored Data	Some projects include a defined monitoring of the financial allocation or the effects of programs (in form of indicators). This type of data is referred to as monitored data. Some monitored effects can be based on estimates though (see anticipated effects).
Reported Data	Reported data is any type of data that can be found within a public available source. Monitored data (see section above) is a type of reported data.
Anticipated Effects	Anticipated effects are either monitored effects based on estimates for the current reporting year (to be reported ex-post later in a final report) or are based on ex-ante studies before the start of the program.
Quantifiability	Quantifiable effects have concrete values and units. Enumerability is the minimum requirement for quantifiable effects.
Scalability	Scalable effects increase with the amount of investments into measures in a consistent manner. So far, all scalable effects in the impact report increase in a linear manner on a per EUR basis.
Efficacy	The efficacy of a scalable effect describes the social impact on a per EUR basis. It is a unit that can be used to compare similar effects within one bond or to compare the effects of different bonds. So far, no social impacts were compared in this manner.
Third Party Assessment	Any type of impact that is reported elsewhere but cannot be directly quantified in line with other investments in the Sustainability Bond, can be reported in form of 3rd party assessments instead.
Costs	Costs refer to actual costs of measures but can also refer to maximum funding per unit (e.g. per participant) or the use of proceeds within national and European programs.
Lump sum	Lump sum is a cost factor that is directly attributed to an impact or unit of effects. Lump sums are often the basis for scaling of social impacts.

source: own definition

5.4 Best-needed Indicator

The first step is to define the characteristics of an ideal indicator for social bond and sustainability bond impact reporting. This so-called best-needed indicator is used as a point of reference to derive a hierarchy of potential indicators and to define the minimum requirements for impact reporting.

Based on the two different approaches discussed above, an ideal indicator has the following characteristics:

- The indicator represents a positive quantified outcome for the society as a whole and positive sustainable development.
- The most relevant societal outcomes of a project are covered by the indicator.
- The indicator can be traced back to investments in the bond (cause-effect relationship), including the share of financing by the issuer.
- The indicator can be scaled according to the amount of investment involved.
- Data for indicator quantification is publicly available.
- The indicator can be quantified in a scientific robust manner including a qualification of limitations, trade-offs (potential negative effects in other areas) and uncertainties.
- The quantification is transparent, can be replicated and verified.
- Indicator results of one project can be compared with other projects within the same bond as well as results in other bonds.

As of now, no indicator found in impact reports provides all these characteristics. Such an ideal indicator is therefore awarded with the indicator quality of “A+”; with A representing the highest quality and + indicating the missing availability of such an indicator. All other indicators are awarded qualities that indicate their quality in alphabetical order (similar to energy efficiency classes used for buildings) with A representing a best-available indicator and D representing an indicator that fulfills the minimum requirements to be quantified in the NRW Sustainability bond.

5.5 Information below the minimum requirements

The other point of reference is information on social effects that can be provided but cannot be defined as quantified impact. This quality is defined as grade E and checked by using a negative criteria list. If one of the following characteristics are fulfilled, no impact should be reported as quantified (although in can be reported in form of additional information or in form of 3rd party assessments):

- ☐ There is no expected positive outcome for the society as a whole or at least the target group of the measure.
- ☐ Negative trade-offs of the measure clearly outweigh the potential positive effects from the perspective of society.
- ☐ Effects cannot be quantified or are at least enumerable.
- ☐ Effects cannot be traced back to investments by the issuer or cannot be allocated to the share of investment by the issuer.

One example for such a project would be “*Measures to improve the quality of teaching and study at universities*” in the NRW Sustainability Bond #6.

From the use of proceeds of the NRW Sustainability Bond[14]

From winter semester 2006/07 until summer semester 2011, universities and colleges in North Rhine-Westphalia were allowed to charge tuition fees of up to EUR 500 per semester and student. These revenues were used for teaching and quality improvements. The aim of the state government is to provide unfettered access to quality education. Therefore, tuition fees have been abolished since winter semester 2011/12. In order to further improve the quality of higher education, funds for quality improvement of the same amount as the previous tuition fee revenues are provided to universities.

Although this project clearly has an expected positive outcome for society (improvement or at least maintenance of university education) and there are no expected negative trade-offs (as it replaces former funding from student tuitions), no enumerable effects are reported and these effects cannot be traced back to investments in the bond. The negative characteristic list would therefore be checked in the following manner:

- ☐ There is no expected positive outcome for the society as a whole or at least the target group of the measure.
- ☐ Negative trade-offs of the measure clearly outweigh the potential positive effects from the perspective of society.
- ☒ Effects cannot be quantified or are at least enumerable.
- ☒ Effects cannot be traced back to investments by the issuer or cannot be allocated to the share of investment by the issuer.

This means that, while any positive effect could be reported in form of supplementary information, it currently cannot be reported in form of a quantified impact – unless the benefiting institutions report these effects and allocate them to the State´s funding.

5.6 Hierarchy of Social Impact Indicators in NRW Sustainability Bond

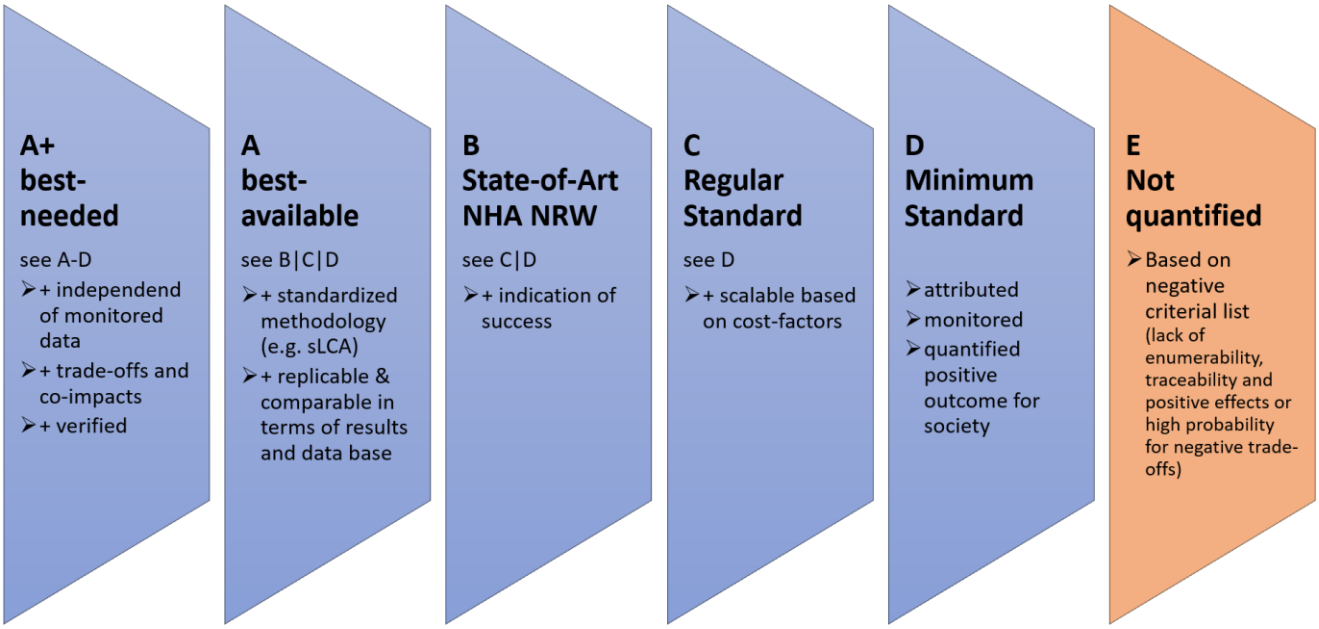
Based on this minimum standard, a first hierarchy of social impact-indicators was developed (see Figure 5-3). It shows the 3 categories of social impacts that are currently reported for the NRW Sustainability Bond, ranging from D (minimum standard) over C (regular standard) to B (State-of-Art). If an effect does not fulfill the minimum standard, it can still be reported (e.g. in form of 3rd party assessments) but not be defined as quantified impact.

B and C are both scalable and can thus be used to show effects in reference to the investment and over time (if e.g. the same project is funded over several bonds). A few impacts also clearly show a value of success (which is required for standard B), indicating not only a monitored accounting (e.g. the number of participants of a measure) but the achievement of goals (achieving the goals of the measure). The difference between indicators of accounting and success is sometimes fluent (e.g. comparing the number of students with the number of degrees), which is why standard C is chosen when in doubt.

The best-available standard A on the other hand cannot be allocated to funds in the bond so far. This would require a standardized method that allows to compare the social impact results of different bonds, also resulting in a value of efficacy (effect per EUR invested). The authors of this report plan to investigate potential grade A indicators for future bonds and further validate the classification system presented in this report.

[14] see https://www.nachhaltigkeit.nrw.de/fileadmin/download/Nachhaltigkeitsanleihe/Sustainability_Bond__6_Eligible_Assets.pdf

Figure 5-3: Suggested classification of social impact-indicators for Sustainability Bonds



5.7 Application of method on NRW Sustainability Bond #6

Numerous social impacts are reported throughout this report. Applying the here described classification, each impact can be associated with grad B to E, as shown in Table 5-2. A number of impacts is not included in this list, such as funding of social tickets in category C (lack of enumerability and traceability), integration centres for migrants (lack of traceability) or language courses at child care facilities (lack of monitored effects). Future impact reports will investigate if the issues can be solved in order to include them as a quantified and qualified impact in the impact report. It is also planned to include this impact qualification into the investor briefing on future bonds alongside other changes (see discussion in section 9).

Table 5-2: Assessment of social impacts in NRW Sustainability Bond #6

Bond Category	Impact	Grade	Rationale
Education & Sustainability Research	bachelor graduates	B	monitored success
	student places for first-year students	C	Scalable based on grants but no indication of success
	student places for master studies	C	Scalable based on grants but no indication of success
	education of geriatric nurses	C	Scalable based on grants but no indication of success
	return of researchers	B	monitored success
	students benefiting from the EU school program	B	monitored success
	student places for special education teachers	D	attributed student places but no means to scale or measure success
Inclusion & Social Coherence	occupational integration of people with disabilities	B	monitored success
	funding of day-care centers (plusKITA program)	C	Scalable based on grants but no indication of success
	education and work for young people & refugees	D	Attributed to anticipated number of participants but not scalable nor an indication of success
	social school workers	B	monitored success
	education and employment opportunities (ESF)	E	Monitored effects that cannot be directly allocated to funds in the bond
Sustainable Urban Development	broadband connections	B	Indication of success (connections) that is scalable

source: own estimation

6 Estimation of Impacts for NRW Sustainability Bond #6

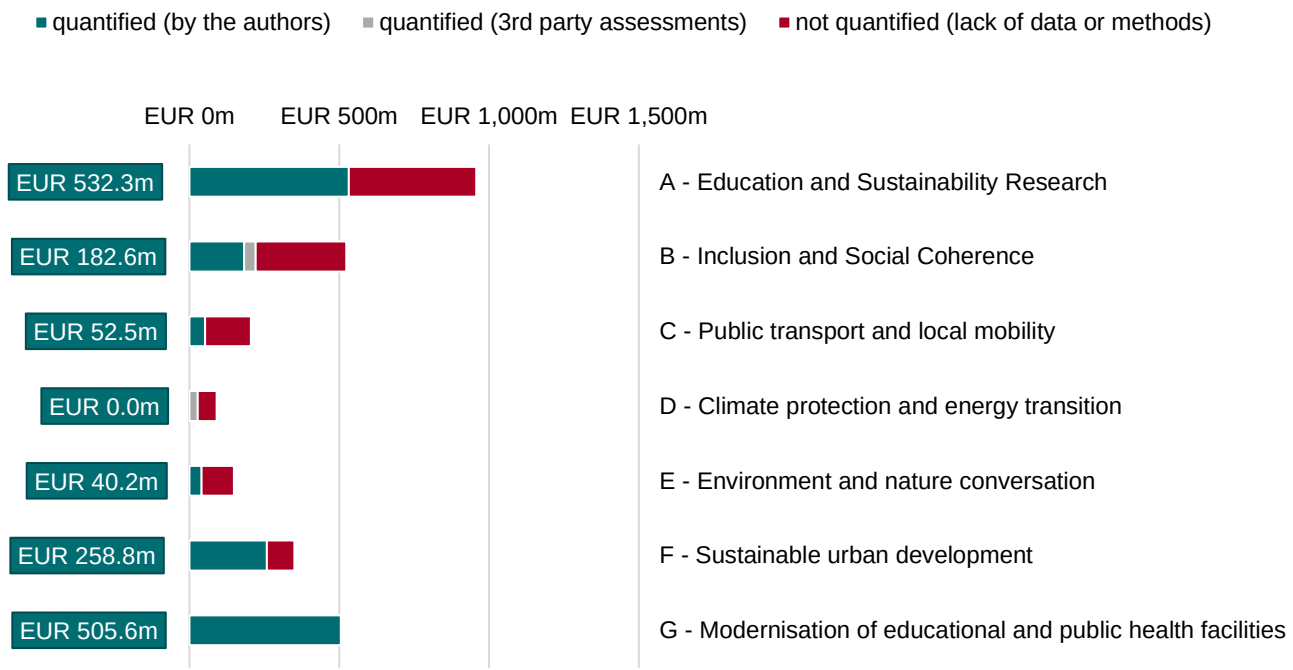
The NRW Sustainability Bond #6 provides environmental (green) and social benefits. The environmental impacts are mostly GHG reduction potentials achieved through energy efficiency measures and investments into means of transport with lower GHG emissions. Previous bonds also included quantifiable investments 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.

Figure 6-1 shows the project categories in the bond and quantifies the shares that could be directly associated with either environmental or social impacts. 56% or EUR 1.57bn of the overall investments could be directly quantified in the paper at hand. Additional EUR 66m (2%) has been assessed by third parties and is also reported in this briefing. The remaining EUR 1.14bn (41%) could either not be quantified due to lack of data or are not quantifiable at all within existing scientific frameworks.

All results 6-1 depicted in this report are based on model calculations, available data and assumptions described in the following sections. They are, for the most part, to be considered ***estimates***.

Figure 6-1: Breakdown of the quantified, quantifiable and non-quantified shares of the 2019 Sustainable Bond



source: own assessment based on methods and data in this report

6.1 Co-Impacts

The Sustainable Development Goals of the United Nations have 17 different goals and more than 100 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 highly 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 an investment in the State budget. The focus on GHG savings by modern buildings for example neglects the fact that university buildings are built and re-furbished 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 the 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 (including cost-benefit analysis) and already exists for some areas. However, it is still not far advanced even for well-researched areas such as energy-efficiency measures[15] and thus not feasible for the impact assessment of sustainable financing at the moment.

The report at hand therefore only quantifies single impacts in one particular area of the environment or society. However, quantifying possible co-impacts of the NRW Sustainability Bond is currently under investigations by the Wuppertal Institut and goes hand-in-hand with improvements in the mapping of SDGs (see chapter 8).

So far, a first set of implementation steps has been identified that build the basis for any further methodological work. Based on literature research and an internal workshop, the following steps should be integrated in order to be able to quantify co-impact within the Sustainability Bond NRW:

- Definition of goals of concrete measures
- Definition of stakeholders that benefit of the measure
- Description of system and status quo (before implementing a measure)
- Collection of immediate effects
- Collection of long-term or indirect effects
- Description of cause-effect-chains
- Identification and quantification of key indicators that represent these cause-effect-chains

[15] see e.g. https://combi-project.eu/ for an example of such a methodology

6.2 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.

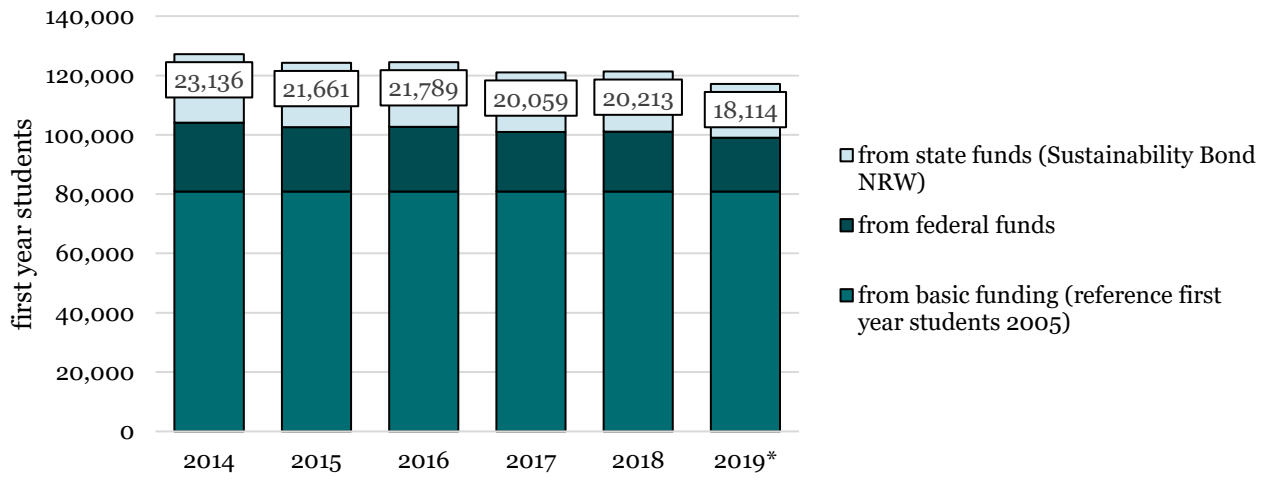
6.2.1 Volume in category A

The overall funds amount to EUR 957.2m. EUR 858.9m are invested into the expansion of universities consisting of funds for the Bund-Länder-Covenant for the expansion of universities (EUR 495.9m), training facilities for teachers and special education training (EUR 21.2m), measures to improve the quality of teaching and study at universities (EUR 249.0m), the return programme for highly qualified young researchers from abroad (EUR 3.6m), the promotion of equality at universities (EUR 2.6m) and professional training for geriatric nurses (EUR 86.6m). An additional EUR 31.0m are in support of "best in class" universities. Funds for innovation and sustainability research amount to EUR 49.9m and for consumer protection to EUR 17.4m. The report at hand quantifies the funds for the expansion of universities as part of the Bund-Länder-Covenant for the expansion of universities (State's share of the "Hochschulpakt") as well as funding for geriatric nurses, return programme for scientists and the EU School programme.

6.2.2 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 roughly 42,000 students each year between 2014 and 2018 (see Figure 6-2). Half of these students can be allocated to investments in the sustainability bond.

Figure 6-2: Allocation of funds for first-year students to the sustainability bond



source: IT.NRW (2018) and IT.NRW (2019); *based on first year students in the winter term 18/19 according to IT NRW 2019 and estimated first year students in the summer term 2019

The overall investments in the sustainability bond for the Hochschulpakt III (EUR 495.9m in 2019) also helped to increase the overall number of graduates and increased the capacities for master students. The report at hand allocates the remaining funds in the Hochschulpakt III after accounting for first-year students, because annual budgets also include funds from the previous programmes or might be the result of transfer postings between budget years. The estimated costs for additional first-year students are therefore used as basis for allocating additional funding for master student places, bachelor graduates and other purposes. The lump sum for one additional first-year student (compared to 2005) is 13,000 EUR each from State and federal funds (Heads of the Federal and State governments of Germany, 2014).

This funding is provided over a period of 4 years, resulting in EUR 117.7m of funding in the Sustainability Bond for 36.000 additional first-year students (EUR 3,250 per student and year).

The universities in NRW (including universities of applied sciences) also plan to provide capacities for additional 10,600 master student places in 2019/2020 (MKW NRW (Ministry of Culture and Science), 2016), receiving 10,000 EUR for each place over 2 years (or EUR 5,000 per year). These additional master student places equal funds in the Sustainability Bond of EUR 52.9m (see Table 6-2).

Table 6-1: 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 2019/2020 (2019)
RWTH Aachen	7,146 students	1,232 students
FH Aachen	1,830 students	328 students
Uni Bielefeld	3,282 students	524 students
FH Bielefeld	760 students	121 students
Uni Bochum	5,981 students	590 students
FH Bochum	618 students	133 students
Uni Bonn	4,609 students	833 students
Hochschule Bonn-Rhein-Sieg	830 students	139 students
Uni Dortmund	4,430 students	660 students
FH Dortmund	1,016 students	189 students
Uni Duisburg-Essen	4,570 students	575 students
Uni Düsseldorf	1,731 students	313 students
FH Düsseldorf	873 students	165 students
Hochschule Gelsenkirchen	1,045 students	164 students
Uni Hagen	1,616 students	95 students
FH Hamm-Lippstadt	210 students	90 students
Uni Köln	5,712 students	763 students
Sporthochschule Köln	404 students	67 students
FH Köln	2,156 students	378 students
Uni Münster	5,482 students	891 students
FH Münster	1,800 students	331 students
Hochschule Niederrhein	1,194 students	216 students
TH Ostwestfalen-Lippe	560 students	97 students
Uni Paderborn	3,546 students	428 students
FH Rhein-Waal	577 students	121 students
FH Ruhr-West	494 students	139 students
Uni Siegen	3,413 students	455 students
FH Südwestfalen	792 students	143 students
Uni Wuppertal	3,389 students	402 students
in TOTAL	70,066 students	10,582 students

source: based on (MKW NRW (Ministry of Culture and Science), 2016)

Bachelor graduates are funded with EUR 4,000 each, which requires an additional EUR 248m from the funds in the Sustainability Bond. The remaining EUR 538m are attributed for example for the professional education of geriatric nurses (EUR 86.6m for ca. 21,500 nurses[16]) or the return programme for scientists. This programme encourages young scientists to return to North Rhine-Westphalia. With up to EUR 1.25m each over five years, they have the opportunity to establish a junior research group at a university in North Rhine-Westphalia. In 2019, 14[17] such junior research groups where financed within the EUR 3.6m of the bond.

Another EUR 2.3m are attributable to the EU School programme. Within this scheme, primary school pupils receive a portion of fruit and vegetables several times a week or can buy milk at a reduced price. In NRW a minimum of 230 000 pupils benefit from the programme. With the EUR 2.3m, a minimum of 10,700 pupils is funded.

Table 6-1 shows the overall results for category A.

Table 6-1: Allocation of funding in category A and quantification of effects

Category	Share	volume (2019)	Effect
Other funding in category A (e.g. for best-in-class universities)	36%	EUR 347.6m	*no quantification*
Funding of graduates	26%	EUR 248.0m	62,000 graduates
Funding of first-year students in NRW	12%	EUR 117.7m	36,000 students
Funding of the professional education of geriatric nurses	9%	EUR 86.6m	21,500 nurses
Other measures for the enlargement of universities	8%	EUR 77.3m	*no quantification*
Funding of master studies	6%	EUR 52.9m	10,600 students
Training facilities for the education of special education teachers	2%	EUR 21.2m	2,300 study places
Funding of the return for highly qualified young researchers	1%	EUR 3.6m	14 research groups
EU School program	*<1%*	EUR 2.3m	10,700 pupils
in TOTAL	**100%**	**EUR 957.2m**	**-**

source: own compilation based on data in this report

[16] Based on 2018

[17] One project did not meet the criteria in the bond and was excluded.

6.3 B: Inclusion and Social Coherence

Project category B on 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.

6.3.1 Volume in category B

The total volume of category B amounts to EUR 528.8m. The largest share (61% or EUR 321.6m) is attributed to "Language skills in early childhood, family centres and non-contributory day care". This includes numerous projects and programmes regarding language courses at child-care facilities, the promotion of cooperation of family formation and counselling centres with family centres and the exemption to contribution for parents for the last day care year. The rest of the investments in B are used for "Inclusion, integration and qualification" (EUR 159.9m or 30%) and "Social school work" (EUR 47.3m or 9%).

About 28% of this volume could be quantified in the report at hand (see Figure 6-1), 7% is reported elsewhere. However, for about 65% 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).

EUR 25m into "language course at child facilities" on the other hand, will be quantified in the future. This programme is currently under evaluation, including an analysis of the funding spent and its effects. The duration of this study (SEIKA-NRW) is from 2015 to 2020[18].

Table 6-2 shows the break-down in funds that were quantified in this report, funds that were quantified based on other reports and funds without a potential for quantification.

Table 6-2: Quantified and quantifiable volume in category B

Sub-Categories	Investment volume	quantified (this report)	quantified (other reports)	not quantifiable
Inclusion, integration, and qualification	EUR 159.5m	EUR 54.9m	EUR 38.5m	EUR 66.5m
Language skills in early childhood, family centres and non-contributory day care	EUR 242.9m	EUR 45.m	-	EUR 276.6m
School social work	EUR 47.3m	EUR 47.3m	-	-
in Total	EUR 528.8m	EUR 147.2m	EUR 38.5m	EUR 343.1

source: own compilation

[18] https://www.dji.de/ueber-uns/projekte/projekte/sprachbildung-und-entwicklung-im-kita-alltag-seika-nrw.html

6.3.2 Third Party Assessments in category B

The European Social Fund (ESF) promotes education and employment opportunities also aiming at social inclusion and reduction of poverty in NRW. The most current implementation report refers to monitored effects from 2014 to 2018 (MAGS NRW (Ministry of Labour, Health and Social Affairs), 2019). Out of EUR 7.5bn until 2020, the federal states in Germany receive EUR 4.8bn for measures aiming at

- providing work and existence-securing loans,
- a chance to get a good school degree,
- protecting from poverty by means of better education and employment opportunities.

The Federal State of NRW receives EUR 1.25bn between 2014 and 2020, with EU funding of EUR 627m, funding by others of EUR 477m and direct funding by the State of EUR 150m. This represents a share of investments of ca. 12%.

So far (until 2018), ca. 35,000 people participated in NRW of which the majority were able to either find a job or educate themselves. A wide range of programs and initiatives are part of the funding, such as (list not exhaustive) SME consultancy for skilled workers, state initiatives to fair working conditions, projects for securing skilled workers, individual projects for integration, advice on professional development, basic language courses.

An explicit example of this funding is the programme "Kooperative Ausbildung an Kohlestandorten", aimed at apprenticeships for young people in regions with coal sites. In 2017, the State of NRW provided EUR 0.73m out of a larger co-financed fund of ca. EUR 3.3m (MAGS NRW (Ministry of Labour, Health and Social Affairs) & C. Ehlert, personal communication, 15 January 2019). As 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.

Although investments in the NRW Sustainability Bond #6 cannot directly be allocated to the outcome of the ESF in form of a scalable impact-indicator, the EUR 38.5m in 2019 continue to contribute to the effects shown in Table 6-3.

Table 6-3: Third party assessments for ESF (common output indicators from 2014-2018)

Priority Axis	Share of Funds	Reported Effects for 2014-2018 in NRW
Priority A (promoting employment and supporting labour mobility)	56%	■ 847 participants still looking for work ■ 4,343 participants in school-based or professional education ■ 1,565 participants achieving a qualification ■ 4,864 participants in jobs after participating
Priority B (promoting social inclusion and combating poverty and all forms of discrimination)	21%	■ 890 participants still looking for work ■ 2,111 participants in school-based or professional education ■ 5,322 participants achieving a qualification ■ 7,951 participants in jobs after participating
Priority C (investment in education, skills, and lifelong learning)	19%	■ 323 participants still looking for work ■ 1,729 participants in school-based or professional education ■ 2,991 participants achieving a qualification ■ 1,663 participants in jobs after participating
Priority D (technical help)	4%	■ 116 new employees ■ 92,337 ESF projects supported ■ 193 publications

source: (MAGS NRW (Ministry of Labour, Health and Social Affairs), 2019)

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

The EUR 4.9m funding for the "Occupation integration of people with disabilities" are part of a co-funding for newly created jobs in NRW. So far, around 300 inclusion companies in NRW provide a total of around 7,500 jobs. Attributing a maximum funding of EUR 20,000 for each newly created job, these EUR 7.7m represent about 245 new jobs for people with disabilities (see Gesellschaft für innovative Beschäftigungsförderung mbH, 2018) for further information on the programme).

6.3.4 Social schoolwork (quantified social impact in category B)

About 9% of the overall investments in category B is used to promote the education and participation for disadvantaged children. By doing so, the State of NRW continues financing on social schoolwork that has been discontinued by the Federal Government in 2014. Initially provided for 3 years (until 2017), funding is now secured until 2021 (Bildungsportal des Landes NRW, 2019).

The State programme provides ca. EUR 47.3m per year to 53 cities and municipalities in order to provide assistance for targeted youth work and reducing 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 from 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 causally 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 on an 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 47.3m in the bond amount to potential 730 jobs for school social workers.

6.3.5 PlusKITA (quantified social impact in category B)

In order to provide fair educational opportunities for all children from the very beginning, EUR 45.0m are invested in day-care facilities. These facilities have a high proportion of families with difficult starting conditions in their environment that receive additional support. Since the year 2014/2015, these plusKITAs will receive at least EUR 25,000 per calendar year. There are currently around 1,700 plusKITAs in North Rhine-Westphalia. The funds are used for additional personnel to promote individual support of the children's potential, which is oriented towards the everyday life of their families: Coordinated pedagogical concepts and forms of action, parental work appropriate to the target group, a fixed contact person for integration into the local network structures and special further education and training measures, etc. are tasks of plusKITAS that go beyond the activities of regular day care centres.

6.3.6 Start in Education and Work (quantified social impact in category B)

There are currently around 23,000 young refugees living in North Rhine-Westphalia who are only tolerated or permitted in the municipalities and who are unable to benefit, or only to a limited extent, from the support offered by employment promotion. The programme "Start in education and work" was launched in 2019 with a funding volume of EUR 50.0m, which is intended to support people with individual support needs, especially young refugees aged 18 to 27, on their way to training and work with the help of special support offers. It is expected that 13,700 young refugees will benefit from the programme.

6.4 C: Public Transportation and Local Mobility

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

6.4.1 Volume in category C

The volume in category C totals EUR 205.3m, of which EUR 134.5m are invested into public transportation for students and pupils, EUR 30.8m 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 (State Parliament 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 52.5m or 25.6% of this category were directly allocated with quantifiable effects on the climate (quantified effects).

6.4.2 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 (FM NRW (Ministry of Finance), 2016). The Public Transport Act of North Rhine-Westphalia stipulates in Section §11a (1) that EUR 134.5million per year is to be invested for this purpose. Of this amount, at least 87.5% is used to offset the cost of tickets. Of this EUR 117.7m, approximately EUR 21.8m is used for semester tickets (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.

The remaining EUR 95.9m are used for funding into trainee and pupil tickets. 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 regularly use a car or have a driving licence at all. On the other hand, the investments into urban and non-urban cycle paths (EUR 30.8m) are fully taken into account for quantification as they all relate to the costs of construction.

6.4.3 Data basis and calculation of the GHG reduction of semester tickets

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

In order to determine the total costs for the semester ticket and the share of the bond in the total costs, the quantity of tickets sold for each year (2014 to 2019) is offset against the ticket price as well as the costs for the regional expansion (EUR 120m) and added to the investments from the bond.

Table 6-4 shows the result of this calculation. The shares of the total costs calculated in this way also correspond to the share of the bond in the expected reductions for greenhouse gases. The data were collected both on the basis of data from the Ministry of Finance in NRW and on the basis of tariff data (see (KCM NRW, 2019) for the most recent data).

Table 6-4: Calculation of the share of expenses for semester tickets from the bond in the total costs for semester tickets

Reference year	2014	2015	2016	2017	2018	2019
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.	1.21m pcs.	1.21m pcs.*
Price of the semester ticket with NRW extension	EUR 46.00	EUR 48.10	EUR 49.50	EUR 50.90	EUR 52.80	EUR 54.60
Income from semester tickets with NRW extension	EUR 50.83m	EUR 55.60m	EUR 58.88m	EUR 61.46m	EUR 64.05m	EUR 66.23m
State financing share (NHA NRW; constant over four years)	EUR 21.04m	EUR 21.04m	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	EUR 148.53m	EUR 148.53m*
Total costs semester ticket	**EUR 207.18m**	**EUR 218.20m**	**EUR 225.57m**	**EUR 230.36m**	**EUR 233.59m**	**EUR 236.62m**
Share of NHA NRW in total costs	*10.2%*	*9.6%*	*9.3%*	*9.1%*	*9.0%*	*9.2%*

*source: own calculation, *based on numbers of 2018 as no more recent data was available*

Based on data from the Federal Environment Agency, 142 g CO_2e per car-km are assumed for the GHG reduction through avoided car-km (Umweltbundesamt (UBA), 2016). In total (see Table 6-5), between 99,500 and 109,174 tonnes of CO2e per year can thus be avoided, of which 9,800 to 10,100 tonnes of CO2e per year are attributable to investments in the bond.

Table 6-5: THG reduction potential for the promotion of semester tickets in the NHA NRW

Year of bond issuance	2014	2015	2016	2017	2018	2019
Total GHG reduction potentials for semester tickets in NRW	99,450 t CO_2e/a	104,040 t CO_2e/a	107,050 t CO_2e/a	108,676 t CO_2e/a	109,174 t CO_2e/a	109,174 t CO_2e/a
THG reduction potentials for the NHA NRW (Share in %)	10,100 t CO_2e/a (10.2%)	10,030 t CO_2e/a (9.6%)	9,990 t CO_2e/a (9.3%)	9,927 t CO_2e/a (9.1%)	9,820 t CO_2e/a (9.0%)	10,048 t CO_2e/a (9.2%)

source: own calculation

6.4.4 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 saved 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, therefore, 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 (2012-2016) of the added cycle paths in municipal construction load is EUR 209,000 per km.

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

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

Cycle path	Length	Cost
RS1 Duisburg - Hamm	101 km	EUR 184m
RSW Mittleres Ruhrgebiet Gladbeck - Bottrop -Essen	17 km	EUR 39m
Regio Velo Isselburg-Bocholt - Velen	61 km	EUR 39m
RSW OWL Minden-Herford	50 km	EUR 26m
RSW Aachen-Herzogenrath-Kerkrade	30 km	EUR 21m
RSW Köln-Frechen	8 km	EUR 6m
RSW Neuss-Düsseldorf-Langenfeld/Monheim	31 km	EUR 32m
Average cost per km	1 km	EUR 1.16m

source: own calculation based on web publications

For the GHG reduction by avoided car-km 142 g CO_2e per car-km are assumed (Umweltbundesamt (UBA), 2016). Table 6-7 shows the results of the analysis for GHG reduction by cycle path construction within the NHA.

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

Table 6-7: Built-up cycle paths and GHG reduction potential through cycle path construction in the bond

	Effect	2014	2015	2016	2017	2018	2019
Non-urban fast cycle paths	Annual GHG reduction	0 t CO_2e/a	744 t CO_2e/a	658 t CO_2e/a	580 t CO_2e/a	501 t CO_2e/a	846 t CO_2e/a
	GHG reduction over lifetime (30 years)	0 t CO_2e	22,322 t CO_2e	19,737 t CO_2e	17,387 t CO_2e	15,038 t CO_2e	25,376 t CO_2e/a
	Kilometres built up	0.0 km	8.2 km	7.2 km	6.4 km	5.5 km	9.3 km
Urban cycle paths	Annual GHG reduction	2,668 t CO_2e/a	2,746 t CO_2e/a	2,406 t CO_2e/a	3,350 t CO_2e	4,132 t CO_2e/a	5,231 t CO_2e/a
	GHG reduction over lifetime (30 years)	80,032 t CO_2e	82,386 t CO_2e	72,186 t CO_2e	100,433 t CO_2e	123,972 t CO_2e	156,926 t CO_2e/a
	Kilometres built up	48.8 km	50.2 km	44.0 km	61.2 km	75.5 km	95.6 km

source: own calculation

6.5 D: Climate Protection and Energy Transition

The investment volume in category D amounts to EUR 91.2m. 25% or EUR 23.2m of this sum are allocated State investments in the European Regional Development Fund (ERDF). The effects of these funds are reported in the current implementation report for NRW and therefore refer to the budget year 2018 (MWIDE NRW (Ministry of Economy, Innovation, Digitalisation and Energy), 2019).

EUR 63.3m (or 69% 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 4.7m or 5% of the investments. These funds are used to help companies in order to reduce energy use, GHG emissions, waste, and water use. They are part of the public funding for Effizienz-Agentur NRW efa+ and Ökoprofit NRW.

Table 6-8 lists all investments in category D and their breakdown into quantifiable assets as well as assets which effect were reported elsewhere (see next section). Unfortunately, none of the investments in this category could be quantified directly in the report at hand.

Table 6-8: Quantified and quantifiable volume in category D

Sub-Categories	Investment volume	quantified (this report)	quantified (other reports)	not quantifiable
Climate protection and renewable energies	EUR 86.5m	-	EUR 23.2	-
Resource Efficiency	EUR 4.7m	-	EUR 4.7m	-
in Total	EUR 91.2m	-	EUR 27.9m	-

source: own compilation

6.5.1 Third party assessments in category D

Category D covers a number of measures leading to GHG emission reductions that cannot be fully integrated in this report. The resulting ecological effects, however, were partly estimated by the participating institutions themselves.

Table 6-9 shows the results of the business support 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. While the projects themselves are beyond the scope of this analysis, some of their results are reported here in form of third-party assessments. The table 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. As the current ERDF report was not available at the time of the impact report, investments and effects still refer to the timeframe from 2014 until 2018.

Table 6-9: Overview of quantified effects in category D from other reports

Type	Funding in NRW Sustainability Bond	Investments outside the Sustainability Bond	Environmental Savings*
	#1 to #6	for budget years 2014-2019	
Effizienz Agentur NRW efa+ (as part of resource efficient economy)	circa EUR 30m	EUR 63.5m in the scope of resource efficiency (validated)	79,853 tons of CO2e
			17,891 tons of material resources
			560,266 m^3 of water
		EUR 578.2m in the scope of financing (validated)	183,210 tons of CO2e
			33,169 tons of material resources
			217,329 m^3 of water
Ökoprofit NRW (as part of resource efficient economy)	circa EUR 1.5m	EUR 72.2m	102,901 tons of CO2e
			10,791 tons of waste
			511,630 m^3 of water
ERDF (2014-2020) (priority axis 3 on CO2 reduction)	circa EUR 34.9m** (ca. 24% of overall funding)	only for budget years 2014-2018 (no report for 2019 as of yet)	
		circa EUR 114m	675,720 tons of CO2e (estimates until 2018)

**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).*

*** previous reports showed the sum of all ERDF funding in the context of NRW Sustainability Bonds; this value refers to the estimated share for priority axis 3 only*

source: correspondence with related agencies and (MWIDE NRW (Ministry of Economy, Innovation, Digitalisation and Energy), 2019))

6.6 E: Environmental protection and nature conversation

Within project category E, a total of EUR 148.3m from the NHA NRW #6 was invested in measures that contribute to the protection of natural resources and biodiversity as well as sustainable agriculture and land use. Thus, this category refers to SDG 2 (end hunger) and 15 (sustainable use of terrestrial ecosystems), with additional positive links to SDG 6, 11, 12 and 13.

The following projects are integrated in the category:

- Soil protection (EUR 3.4m)
- Protection of nature (EUR 32.2m)
- Flood protection and river restoration (EUR 66.7m)
- Responsible Agriculture (EUR 6.7m)
- European Agricultural Fund for Rural Development – EAFRD (State's share with EUR 39.3m)

6.6.1 Investment volume taken into account

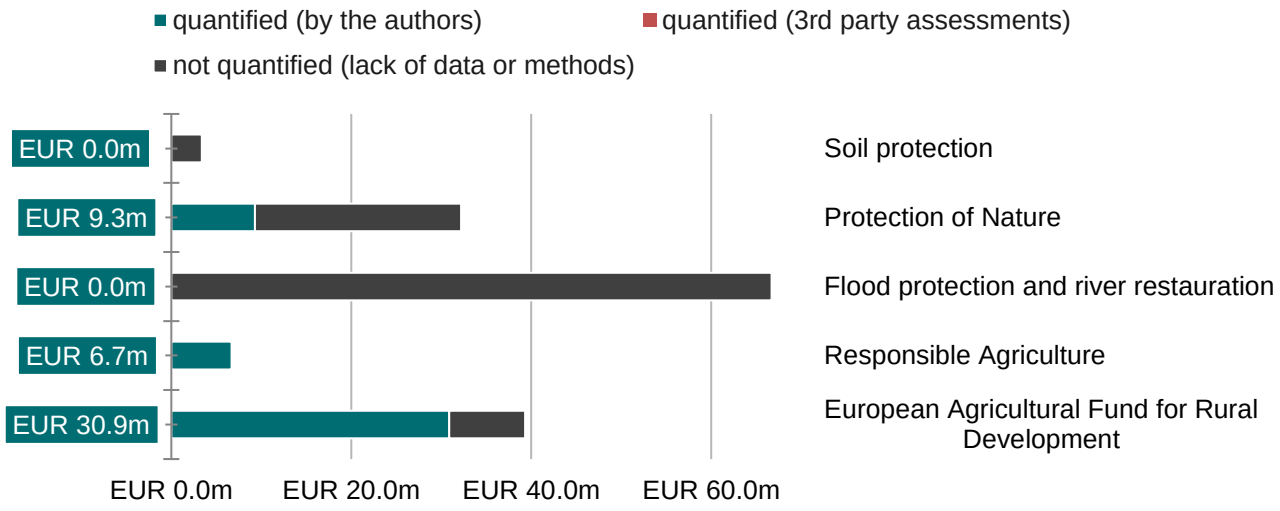
Previous impact assessments focused on sustainable land use as an indicator that was attributed to overall investments in the EAFRD and as well as responsible agriculture. It was based on an average factor calculated from reports in 2015 and 2016. This simplification was necessary as relevant monitoring reports for the European Fund were not available at that time. Since the data availability has improved in this area, it is now possible to report the effects in more detail (see next section on attribution).

Of the total volume of EUR 148.3m, EUR 28.4m (of which EUR 21.6m are part of the EAFRD) can be attributed to sustainable land use such as promoting diverse cultures in agriculture, development of protective stripes, nature conservation of grasslands, organic farming or compensating farmers when faced with environmental restrictions (e.g. in mountain areas). EUR 4.3m could also be attributed to promoting animal-friendly husbandry, such as summer grazing or rearing on straw. An additional EUR 9.3m (as part of category “protection of nature”) were allocated to the preservation of Biological Stations in the State (allocated to protection of nature).

Therefore, about 28% of the investments can be attributed to quantified indicators. The other subcategories also partly lead to sustainable land use (e.g. areas for flood protection) or nature conservation. For these subcategories, however, it was (yet) not possible to directly allocate investments to individual measures with a corresponding quantifiable effect. As the EAFRD also promotes education and rural development, it also needs to be investigated if additional social impacts can be reported in this category in the future.

Figure 6-3 shows the investments, divided into the corresponding projects, as well as the investment volumes that could be associated with quantifiable data.

Figure 6-3: Overview of the investment shares for projects within category E for which sustainable land use could be quantified.



source: own assessment based on calculations in this report

6.6.2 Attribution in the EAFRD

The EAFRD program promotes rural areas from 2014-2020 with overall funds of EUR 1.2bn for NRW (EUR 421m until 2018). The program consists of 20 measures in 6 priorities, focusing on the preservation and development of rural areas worth living in and the development towards sustainable, rural agriculture. The current implementation report for the federal EAFRD program refers to the implementation between 2014 and 2018 (MULNV NRW (Ministry for Environment, Agriculture, Nature and Consumer Protection), 2019b).

Sustainable Agriculture

In terms of sustainable land use, the following measures in priority 4 can be directly associated with promoted areas in the fund and therefore for the development of a more accurate sustainable land use indicator:

- M10: Agri-environment and climate measures (diverse cultures in agriculture, nature conservation on grassland, extensive grassland use, etc.)
- M11: Organic farming (introduction/maintenance)
- M12: Compensation under Natura 2000 (compensation for agricultural land with environmental restrictions)
- M13: Compensation for mountain areas (if naturally and environmentally disadvantaged)

So far (until 2018), public funds of EUR 231.5m have been spent for these measures; promoting an area of 449,743 ha and representing 55% of the overall funds of EUR 421m until 2018. As a result, EUR 1m promotes 1,943 ha of sustainable land use.

Out of a total investment of EUR 39.3m in the bond, about EUR 21.6m therefore promote sustainable land use for an area of 41,969 ha.

Animal Protection

Priority 3 includes measures to promote animal protection in agriculture. In 2018, funds of EUR 18.2m were used to promote 251,543 animals in summer grazing and rearing on straw (13,821 animals per EURm). Overall, about 11% of the EAFRD can be attributed to these effects.

Out of a total investment of EUR 39.3m in the bond, about EUR 4.4m are therefore associated with animal protection in agriculture, promoting ca. 60,000 animals.

Sustainable Forestry

Another EUR 7.7m are attributed to measures aimed at strengthening the resilience and ecological value of forest ecosystems. Representing 1.8% of the overall funds, ca. 1,000 such measures have been promoted until 2018.

6.6.3 Sustainable Land Use

Two measures can be attributed with sustainable land use in the NRW Sustainability Bond: NRW funds for sustainable agriculture in the European Agricultural Fund for Rural Development (EAFRD) and responsible agriculture. Previous reports attributed 100% of both measures to promoted sustainable areas based on other literature.

Considering the more detailed implementation reports available for measures until 2018, a lower factor of sustainable land use was calculated. In addition, only 43% of the EAFRD funds were attributed to this indicator, while other funds could be associated with additional effects such as measures into sustainable forestry. As a result, 40,000 ha can be attributed to the current bond (see Table 6-10).

Table 6-10: Indicator "Sustainable Land Use" in NRW

Subcategory	Investment volume (2019)	Area supported per year (2019) (estimated)
Responsible Agriculture	EUR 6.8m	13,212 ha
EAFRD	EUR 21.6m	41,969 ha
in TOTAL	**EUR 28.4m**	**55,181 ha**

source: own calculation based on MULNV NRW (Ministry for Environment, Agriculture, Nature and Consumer Protection) (2019b)

6.6.4 Animals in animal-friendly husbandry

The different aspects of animal welfare can be captured with different types of indicators that either relate to practices (e.g. space allowances, dehorning of cattle, feeding, handling etc.) or are measured directly on the animal (e.g. lameness in dairy cows). Any type of sustainable financing should focus on practices ("improving the standard") while guaranteeing that animals are healthy and show no disorders ("do no harm").

The project "National Animal Welfare Monitoring", which is funded by the Federal Ministry of Food and Agriculture, currently develops the basis for indicator-based monitoring and reporting on the status quo and development of animal welfare in livestock farming in Germany (see also section 4.2).

As a new indicator in the report at hand, it could be calculated how animal-friendly husbandry is promoted by measures in the bond. EUR 4.3m in category E (out of State funding for the EAFRD) can

be associated with these measures, resulting in 60,300 animals that benefit from summer grazing and rearing in straw. This indicator is but a starting point for future impact reporting on issues of animal welfare.

Table 6-11: Indicator „Number of Animals in animal-friendly husbandry" in NRW

Subcategory	Investment volume (2019)	Number of Animals (2019) (estimated)
EAFRD	**EUR 4.4m**	**60,300**

Source: own calculation based on MULNV NRW (Ministry for Environment, Agriculture, Nature and Consumer Protection) (2019b)

6.7 Biological Stations

The tasks of Biological Stations include the protection and care of the flora and fauna as well as the landscape in the respective local working area (in addition to the activities of the district, the towns and municipalities) as well as nature conservation education and the associated public relations work. In addition to their scientific expertise and sound knowledge of the area, they are in close contact with land users and the rest of the population. Biological Stations, in coordination with the landscape authorities, now look after more than half of all nature reserves in NRW by recording changes in flora and fauna and planning, coordinating and in some cases carrying out maintenance and development measures to improve the protected areas. They canvass for management contracts and advise and support land managers within the framework of contractual nature conservation. Biological stations raise considerable amounts of third-party funds which contribute to value creation in the rural region.

Out of a total investment volume of EUR 32.2m in the bond category "protection of nature" (for measures in the fields of nature conservation, landscape management and biodiversity), EUR 9.3m can be allocated to so-called Biological Stations (MULNV NRW (Ministry for Environment, Agriculture,Nature and consumer protection), 2019a). This funding is mainly required to maintain 39 such stations throughout NRW (www.biostationen-nrw.com, 2020).

Table 6-12: Indicator „Number of Biological Stations" in NRW

Subcategory	Investment volume (2019)	Number of Biological Stations funded
Protection of Nature	**EUR 9.3m**	**39**

Source: Ministry for Environment, Agriculture, Nature and Consumer Protection of North Rhine-Westphalia, 2019; www.biostationen-nrw.com, 2020

6.8 3rd party assessment: Organic Farming in NRW

The area of responsible agriculture is not limited to sustainable land use, as funding is also provided for organic farming techniques or reducing the use of fertizilizers and plant protection products. There is currently not enough data, to allocate any of these effects to quantifiable indicators within the Sustainability Bond NRW #6. However, positive developments in this area can be at least partially attributed to the State's budget and subsequently the category responsible agriculture in the bond.

In its Organic Agriculture Strategy 2020, the NRW state government has set itself the goal of expanding organic farming in line with the continuously increasing demand, further developing the necessary framework conditions for organic farmers and supporting better networking of all players active in the organic market (MULNV NRW (Ministry for Environment, Agriculture,Nature and consumer

protection), 2015b). The indicator for this is the share of organically used agricultural land in the total agricultural area. The Federal Government's objective on the other hand, is to increase the share of organic farmland to 20% of total agricultural land by 2030 (Federal Ministry for nutrition and agriculture (BMEL9, 2109).

After the development of the proportion of organically farmed land in NRW stagnated or even declined slightly in the years 2011 to 2015, a steady increase has been recorded since 2016 both in terms of area and organic farms (Landwirtschaftskammer Nordrhein-Westfalen, 2019).

Table 6-13 shows the development in the State.

Table 6-13: Development of organic farming in NRW from 2016-2018

Category	2016	2017	2018
Share of organically farmed area in total agricultural area (relative)	77,990 ha (5.4%)	82,487 ha (5.7%)	85,320 ha (5.9%)
Number of organic farms (relative)	1,978 (6.4%)	2,071 (6.7%)	2,161 (7.0%)

source: Landwirtschaftskammer Nordrhein-Westfalen, 2019

6.9 F: Sustainable Urban Development

6.9.1 Broadband Expansion

The state of NRW invests EUR 258.8m into the expansion of broadband connections (50 Mbit/s and more) for households, but also companies and public institutions. These investments are provided in form of co-funding; in particular for communities where such infrastructure projects are currently not feasible from an economic point of view. This expansion is not only funded by state governments in Germany, but also from a federal point of view (up to 50 % from federal funds and up to 40 % from state funds). It is the goal of the federal as well as states' government to achieve a nearly 100 % broadband coverage in Germany in a foreseeable future.

Although broadband expansion is not necessarily directly economic feasible (in turns of direct revenues for communities), it is assumed that it prevents external costs in the future, while also providing additional benefits even in the most rural areas. Positive effects range from economic growth, efficiency and productivity gains to additional employment. As such, broadband expansion contributes to an economic sustainable development, but also higher life quality in schools and households (Wernick & Bender, 2016).

While these impacts cannot be measured in direct relation to the investments in the sustainability bond, the number of additional access points can be estimated. A 2013 study 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 the remaining 5 % up to 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 (that already expanded their broadband accessibility) were selected to calculate a ratio between funding broadband expansion and resulting access points for households, companies and institutions (see Table 6-14). This covers more than 50,000 access points with an overall funding of EUR 100m.

Related to the EUR 258.8m in the Sustainability Bond NRW #6 (from the states' 2019 budget), it can thus be estimated that these investments help to provide more than 129,000 broadband connections in North Rhine-Westphalia.

Table 6-14: Funding for broadband connections in selected regions in NRW

Region	Federal Funds	Other Funds	Overall Funding	house-holds	compa-nies	institu-tions	overall access	Funds per ac-cess
Unit	EUR	EUR	EUR	amount	amount	amount	amount	EUR
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 Mön-chengladbach	4,515,513	0	4,515,513	2,279	161	7	2,447	1,845
Kreis Reck-linghausen	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	0	35	0	35	6,806
All selected projects	EUR 95m	EUR 6m	EUR 101m	45,089	4,636	558	50,283	**1,998**

source: selected (NRW) regions from Breitbandatlas (https://www.bmvi.de/SharedDocs/DE/Artikel/DG/breitbandatlas/breitbandatlas.html)

6.10 G: Modernisation of educational and public health facilities

Category G covers funding for buildings of universities and university clinics (new buildings and refurbishment). Increasing the energy efficiency in these buildings (in particular for the end-use of heat) is one of its major goals. Table 6-15 shows the investments by the State as well as their listing in the States' budget.

Table 6-15: Investments in project category G

Topic	Title	Budget items	Investments
Modernisation of university buildings	Modernisation of university buildings	# 06 100 891 20, 06 110 685 20, 894 20	EUR 157.4m
Modernisation of university clinical buildings	Conservation and remediation of existing facilities	# 06 102 TG 63, 06 103-108 891 20	EUR 150m
	Enlargement and other investments	# 06 103-108 891 30	EUR 198.2m
in total			EUR 505.6m

source: use of proceeds for NRW Sustainability Bond #6

6.10.1 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 rents.

Refurbishments are also not restricted to energy-efficiency measures alone but cover for example requirements for safety or health measures. It is therefore necessary to estimate the shares for actual GHG mitigation potentials from

- the construction of new (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 2019, but do not allow to differentiate into these four segments with GHG relevance. Therefore, additional information on the States' investments are drawn from the budget, that allow to allocate the funding in higher detail.

6.10.2 Investments into GHG relevant measures in category G

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

The States' budget for 2019 lists EUR 134.m for HKoP (assumed to be mainly used for new buildings and building extensions) and EUR 29.7m for HMoP (assumed to be mainly used for refurbishment). Out of EUR 157.4m investments in the bond, it is therefore assumed that 81 % are used for new buildings and 19% are used for refurbishment measures.

Both investments are assumed to use 52 % of their funds for equipment (assumption by the Ministry of Finance). 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, Jahn, & Clausnitzer, 2011).

As a result, EUR 64.6m are direct investments into new general university buildings and EUR 6.4m investments into energy refurbishment in the same segment.

Investments into clinical university buildings are listed individually in the States' budget and can therefore be used to generate a more specific allocation. Based on the 2019 listings for Bonn, Münster, Cologne, Aachen, Düsseldorf, and Essen, 59.9% of the funds are used for new buildings and 24.7 % for refurbishment measures. Considering also a reference energy refurbishment ratio of 53.6 % (based on the "Bettenturm Münster"), the following funds are allocated: EUR 208.5m are used for new buildings, EUR 46.1m for energy refurbishment and EUR 53.7m for other purposes such as equipment. Table 6-16 shows the resulting investments in category G into measures with direct GHG mitigation potential and other measures.

Table 6-16: Allocation of funding with GHG relevance in category G for the Sustainability Bond 2019

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 61.9m	EUR 89.4m
	Energy Refurbishment	EUR 6.1m	
Clinical university buildings	New and Extensions	EUR 208.5m	EUR 53.7m
	Energy Refurbishment	EUR 46.1m	

source: own allocations based on information provided by the Finanzministerium das Landes Nordrhein-Westfalen (Ministry of Finance NRW) and the 2019 budget of the State of North Rhine-Westphalia

6.10.3 Specific GHG emission factors for general and clinical university buildings

Table 6-17 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 6-17: Emission factors for the heat demand in university buildings

Energy source	Emission factor (without upstream)	Data source	Spatiality	Share in buildings
Gas*	202 g CO2e/kWh	FfE (2010)	Germany	55.8 %
Oil, light*	266 g CO2e/kWh	FfE (2010)	Germany	23.1 %
District heating	229 g CO2e/kWh	(Agentur für Erneuerbare Energien e.V., 2014)	NRW	21.1 %
Electricity	820 g CO2e/kWh	LAK (2015)	NRW	0.0 %
Emission Factor	**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

6.10.4 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 (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 6-18 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 6-18: 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/(m²a)	108.5 kWh/(m²a)	80 %
1977 - 1983	209.9 kWh/(m²a)	107.4 kWh/(m²a)	6 %
1984 - 1995	167.9 kWh/(m²a)	104.9 kWh/(m²a)	6 %
from 1995 onward	129.6 kWh/(m²a)	104.9 kWh/(m²a)	8 %
Heat energy savings		**117.2 kWh/(m²a)**	**100 %**

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

Linking the data in Table 6-18 and Table 6-17 results in GHG emission savings of 26 kg CO_2e per m² for new university buildings when compared to the building stock (222 g CO_2e per kWh at a difference of 117.2 kWh/(m²a)).

6.10.5 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 m^2 per EURm (see also Table 6-19).

Table 6-19: Construction of useful 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 f. Kalverbenden/Zentr.	EUR 12.5m	3,900 m^2	100 %	312.0E-6 m^2/€
RWTH Aachen, auditorium centre Claßenstr. (R 6)*	EUR 45.0m	14,000 m^2	100 %	311.1E-6 m^2/€
Univ. Dortmund, Replacement New Building Chemistry/Physics (EE)	EUR 82.3m	14,661 m^2	100 %	178.1E-6 m^2/€
FH Niederrhein, Replacement new multi-building (EE)	EUR 20.0m	6,900 m^2	75 %	258.8E-6 m^2/€
FH Bielefeld, Replacement new construction, network expansion (EE)	EUR 279.3m	60,400 m^2	100 %	216.3E-6 m^2/€
FH Düsseldorf, ENB 1. BA*	EUR 170.0m	54,000 m^2	100 %	317.6E-6 m^2/€
in Total	**EUR 609m**	**153,861 m^2**	**average (weighted)**	**250 m^2 per million euro**

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 & Stratmann, 2014), the EUR 61.9 million bond investment will potentially build 15,500 m^2 of building space, which could lead to annual savings of 403 t CO_2e. GHG emissions are reduced by up to 21,100 t CO_2e compared with existing buildings and over the life of the building.

6.10.6 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 m^2 of usable space are required, analogous to new buildings in general universities. The information on the construction costs determined or estimated is taken from the budget for Title Groups 06 103 to 06 108 (each Title 891 30). The corresponding floor areas are taken from the websites of the individual clinics. All construction measures are assumed to have a 100 % share of funding, which means that the simple average of total investment and total net floor area can be used to determine the cost factor.

Table 6-20: Net additional floor space for investments6-2 in new buildings in university clinics

Intentions	Building costs	Net floor area	Specific cost factor
Köln: CIO Zentrum (ambulant)	EUR 77.9m	13,500 m^2	312.0E-6 m2/€
Aachen: Erweiterungsgebäude für intensive Operationspflege	EUR 41.2m	8,643 m^2	311.1E-6 m2/€
Düsseldorf: Medizinisches Forschungszentrum I	EUR 79.9m	19,650 m^2	178.1E-6 m2/€
Düsseldorf: Medizinisches Forschungszentrum II	EUR 26.2m	7,970 m^2	258.8E-6 m2/€
Bonn: Neubau Eltern-Kind-Zentrum	EUR 71.9m	11,787 m^2	216.3E-6 m2/€
Bonn: Neurologie, Psychiatrie und Palliativmedizin (NPP)	EUR 64.6m	12,842 m^2	317.6E-6 m2/€
Sum	**EUR 361.6m**	**74,392 m^2**	**206 m^2 per EUR m**

source: own calculations on the basis of the NRW 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 the EUR 208.5 million bond will potentially create 42,900 m^2 of building space (see Table 6-20), which could lead to annual savings of 1,118 t CO_2e.

GHG emissions are reduced by up to 73,800 t CO_2e compared with existing buildings and over the life of the building.

6.10.7 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 (A. Krewald, personal communication, 2017). Construction costs of EUR 87.9 m were incurred to renovate a 52,300 m^2 site. Thus, investments of EUR 10.5m lead to the redevelopment of 6,250 m^2 (at costs of EUR 1,680 per m^2). The share of the energy-related renovation quota is already taken into account in the allocation of investments.

Taking into account the general heating energy demand in universities (see chapter 6.10.4) and a reduction in heating energy demand of probably 88 kWh/m^2 (NF 1-6 buildings), potential GHG reductions of 19.6 kg CO_2e per m2 are achieved.

A total of 72 t CO_2e per year are saved in this way. GHG emissions could be reduced by up to 1,400 t CO_2e over a service life of 20 years (EnEV stipulates financial amortisation).

6.10.8 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 a number of data are available:

- The construction costs for façade works (energetic refurbishment) amount to EUR 20.6 million.
- The total construction costs amount to EUR 38.5 million with a subsidy amount of EUR 45.9 million.
- The estimated transmission heat loss before completion of works is 2.23 W/(m^{2}K) and 0.62 W/(m^{2}K) 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 6-21 can be determined.

Table 6-21: 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_2e/kWh
GHG reduction potential per bed	**702 kg CO_2e per bed and year**

source: own calculation

With investments of EUR 46.1 million for energy-related refurbishment, an estimated 1,950 beds will be refurbished, which would lead to annual GHG savings of 1370 t CO_2e. If a service life of 20 years is also assumed here, GHG emissions can be reduced by a total of 27,400 tonnes of CO_2e.

6.10.9 Summary of results for category G

Table 6-22 summarises the results in category G for the NHA NRW #6.

Table 6-22: Results of the impact assessment in category G

Measure	Investments in the bond for GHG reduction	Annual GHG reduction	GHG reduction potential over service life
Construction of new university buildings	EUR 61.9m	403 tons CO_2e / a	20,147 tons CO_2e
Refurbishment of university buildings	EUR 6.1m	72 tons CO_2e / a	1,435 tons CO_2e
Construction of new university clinical buildings	EUR 208.5m	1,118 tons CO_2e / a	73,782 tons CO_2e
Refurbishment of university clinical buildings	EUR 46.1m	1,371 tons CO_2e / a	27,413 tons CO_2e

source: own calculation

7 GHG Savings: Key Figures and long-term development

The following sections list key figures of climate change mitigation in the Sustainability Bond NRW #6 as well as previous bonds. It compares the GHG saving effects to the investments and over time.

7.1 Efficiency of GHG savings in Sustainability Bond NRW #6

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

Each investment is usually provided with a technical lifetime in this process. 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 have to be dismantled or refurbished again (with expected lifetimes of 20 years and more).

Table 7-1 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 only relate to annual spending in the budget (or rather the demand of students for 1 ticket per semester).

Urban cycle paths on the other hand show a moderately smaller effect for the budget year 2019, but are expected to reduce the demand for car travel for 30 years and more (leading to overall savings of more than 157,000 tons of GHG).

Table 7-1: GHG savings of measures in the project categories C and G

Measure	GHG savings per year	GHG savings over Lifetime	average Lifetime (assumption)
	tons CO2e per year	*tons CO2e in total*	*years*
Non-urban fast cycle paths	846	25,376	30
Urban cycle paths	5,231	156,926	30
Student tickets	10,049	10,049	1
New university buildings	403	20,147	50
University buildings (refurbishment)	72	1,435	20
New university clinical buildings	1,118	73,782	66
University clinical buildings (refurbishment)	1,371	27,413	20

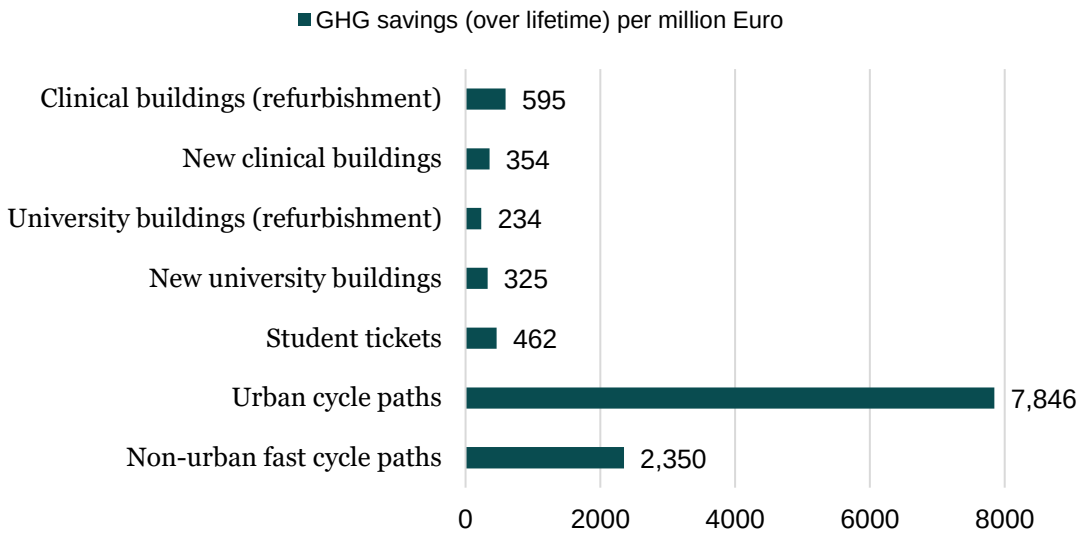
source: own calculation based on methods and data depicted in this report

By relating the GHG savings over lifetime to the money invested (as well as re-financed in the bond), it can be shown which measures are the most efficient. The highest efficiency measured in GHG savings per million euros invested (see Figure 7-1), 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 tracks would still have a normalised efficiency of ca. 2350 tons per EURm at a lifetime of only 10 years). This high efficiency cannot be attributed to large climate protection effects for cycling alone (or the underlined empirical data used to calculate the effects). Partly responsible for this effect are also the costs of different measures with particular high costs for building construction and refurbishment.

However, focusing on the comparison of these efficiencies can be misleading. Buildings, in particular the building types in the bond, provide co-benefits that affect numerous areas of sustainable development. Clinical and non-clinical university buildings prevent health hazards, improves research capabilities and patient care. The same is true for over EUR 134.5m invested into public transportation for pupils and students (of which only EUR 21.7m were directly allocated 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 in fact additional GHG savings as a whole. The calculation scheme at hand for example assumes that old buildings are replaced by new buildings funded by the State's budget. If this is not the case or if energy savings for heat are partly or overcompensated by additional demand for electricity, the resulting net effect can be negative for the climate as the overall GHG emissions of a university or clinic increase instead.

Figure 7-1: Normalised[19] efficiency of climate protection measures for quantified investments



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

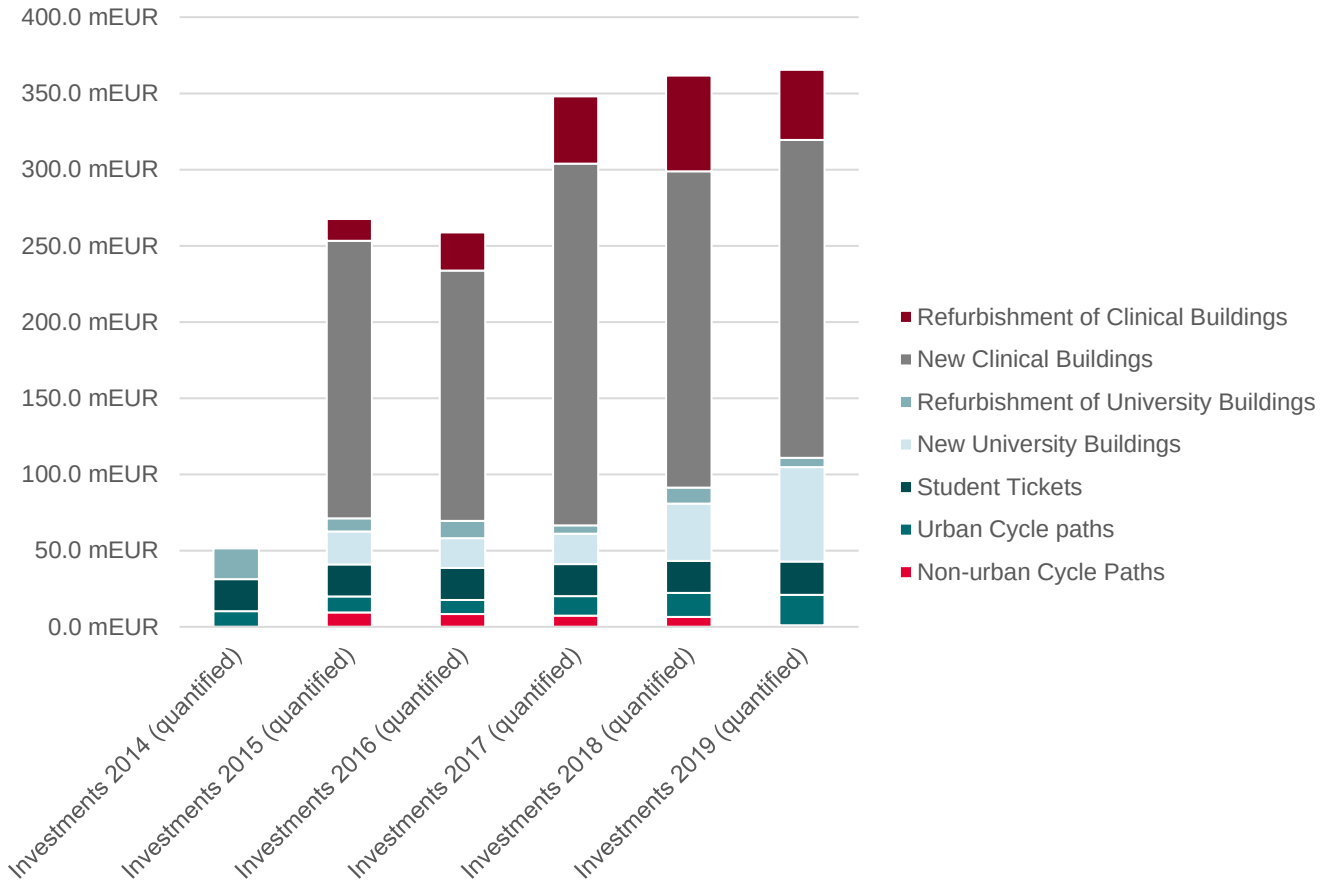
[19] The efficiency factors refer to the assessed investments only and the GHG savings over the assumed average lifetime of measures.

7.2 GHG Savings from 2014 to 2019

A number of project categories have been part of the NRW Sustainability Bond for several years now. They also relate to the same or extended programmes, allowing to compare the effects from the budget years 2014 to 2019. 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 six-year portfolio.

The budget expenditures related to the NRW bond has increased continuously over these 6 years from EUR 50m in 2014 to EUR 365.5m in 2019 (see Figure 7-2; only accounting for investments directly associated with GHG savings). The largest increase in investments can be allocated to new and refurbished clinical buildings: quantifiable investments increased from EUR 196m in 2015 to EUR 255m in 2019.

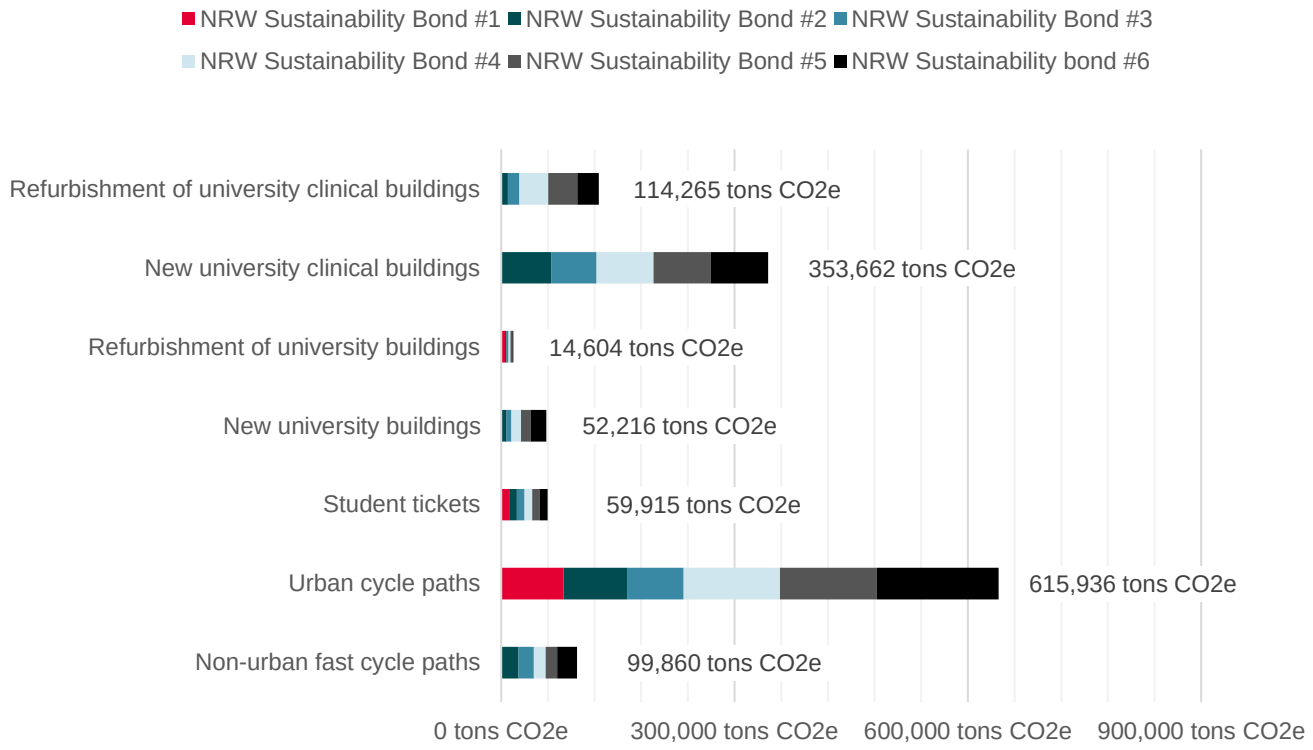
Figure 7-2: Quantifiable investments for climate protection projects from 2014 to 2019 in the portfolio of NRW Sustainability Bonds



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

Over the course of six years (2014 – 2019) EUR 1,652m were invested, inducing potential GHG savings of ca. 1.3 million tons CO_2e over the assumed lifetime of the measures (see Figure 7-3). About 54% of these savings could be attributed to the construction of cycle paths in NRW alone, while the construction of new clinical buildings makes up another 35% of the overall financed savings.

Figure 7-3: GHG savings over lifetime of projects from 2014 to 2019 in the portfolio for NRW Sustainability Bonds



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

8 Tool for SDG Mapping

A relatively new challenge for sustainability bond issuance and impact reporting is the matching of financial products with their anticipated impact on the 17 UN Sustainable Development Goals or SDGs (2015). Although there are guidelines and principles (e.g. social bond principles) that provide first proposals on integrating these goals into the reporting, a common approach has not been established yet. This section of the report describes some of the more promising approaches for mapping financed projects to the SDGs and provides a first "SDG Mapping Tool" for facilitating the mapping process by the issuers.

The aim of the tool presented here is to allow for a quick, but robust and unerring assignment of single measures as well as project families to the SDGs that is consistent with the state of art, and incorporates the fact that measures can contribute to more than one SDG to a different extent.

8.1 Challenges of SDG Mapping

The SDGs cover a wide range of issues and consist of 169 sub-goals. Although each of the 17 main goals focuses on one area of sustainable development, there are many overlaps between the goals. This way, pursuing one goal can attribute to other goals at the same time (enhancing the effects). However, it is also possible that measures for sustainable development lead to conflicting objectives (see Figure 8-1 for an example on types of interactions).

Figure 8-1: Seven types of interactions according to Nilsson et al. 2016

Interaction label	Meaning
+3 Indivisible	Progress on one target automatically delivers progress on another
+2 Reinforcing	Progress on one target makes it easier to make progress on another
+1 Enabling	Progress on one target creates conditions that enable progress on another
±0 Consistent	There is no significant link between two targets' progress
−1 Constraining	Progress on one target constrains the options for how to deliver on another
−2 Counteracting	Progress on one target makes it more difficult to make progress on another
−3 Cancelling	Progress on one target automatically leads to a negative impact on another

source: (Nilsson et al., 2018)

These types of interactions make it harder to assign projects to SDGs. It requires the analyst to prioritize potential outcomes and to decide between goals for sustainable development. It is also quite possible to overlook objectives when confronted with 169 sub-goals that potentially interact with each other as well. Any type of mapping method therefore needs to simplify the process by means of clustering and the use of concise and mutual exclusive criteria.

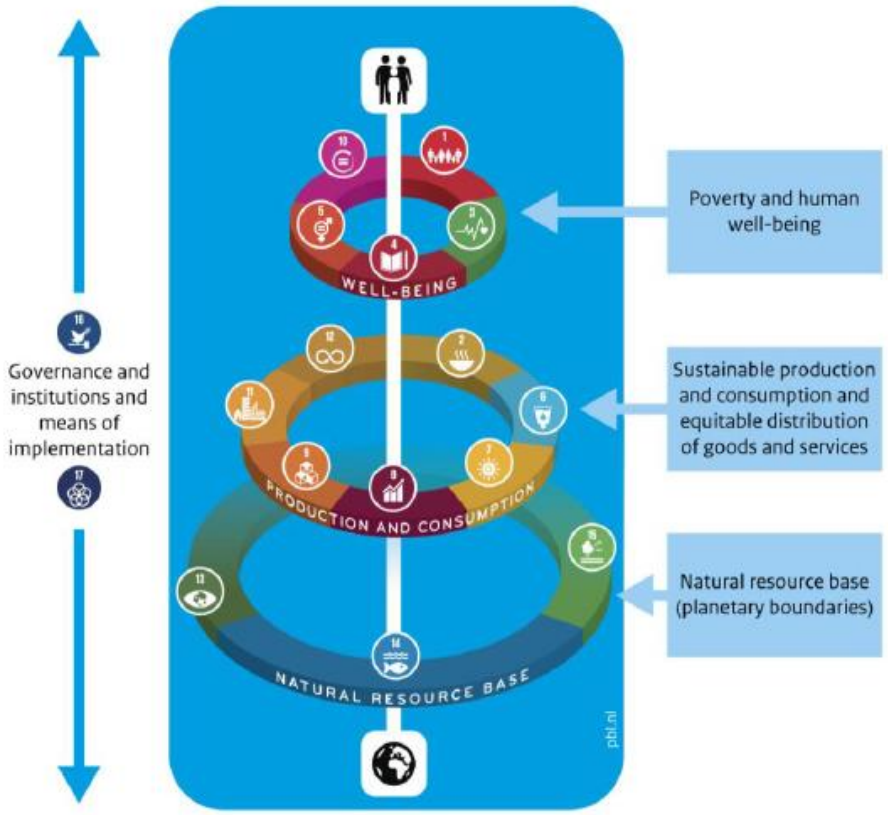
One way to cluster the SDGs is by looking at them from the perspective of planetary boundaries, such as suggested by Rockström et al. (2009). The authors of this well-cited study define a so-called "safe operating space" for nine planetary boundaries that humanity is ought to navigate when interacting with nature. An example for such a safe space is to keep the climate change concentration in the atmosphere below 350 ppm or to limit the fixation of N_2 to 35 Tg per year (Steffen et al., 2015).

Lucas & Wilting (2018) applied this thinking to the SDGs by introducing a model of clustering that ranges between "well-being", "production and consumption" and the "natural resource base" (see

Figure 8-2). The authors then allocate the operating space to nations and deduct national targets from different point of views or so-called equity principles.

Although this approach is promising in terms of developing targets, it is only partially possible to use it as a guide rail for SDG mapping, as its clustering does not account for potential interactions within one level. For this, a more thorough look at the rationale of cause and effects between single projects and measures is necessary.

Figure 8-2: Classification and clustering of SDGs according to Lucas et al. (2016) and Lucas & Wilting (2018)



source: P. Lucas et al. (2016)

8.2 Cause-effect between projects and SDGs

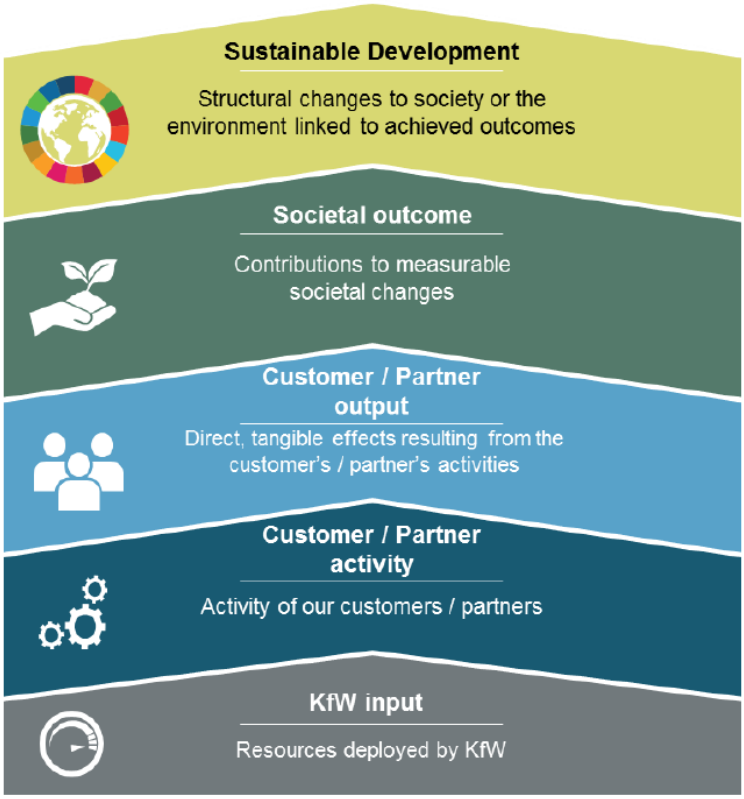
Indicators for SDGs describe targets on national or global levels. It is rather unlikely that a single measure or project already provides quantifiable data to that end (e.g. reducing food losses in a country). It is therefore but a step along the cause-effect chain that requires additional indicators but also a mapping process that links projects to the general outcome for society.

The SDG mapping by the German KfW Group[20] (Dangelmaier, 2019) is a good example how the rationale of the cause-effect chain can be allocated to projects, or in this case, loans. It introduce the intermediate steps of activities (in this case loan recipients), the output of these activities and the outcome in form of measurable societal change (see Figure 8-3). Following this rationale, each of these

[20] The KfW bank is a public agency that provides domestic funding in Germany and finances international projects (see https://www.kfw.de/kfw.de-2.html).

steps can be classified (e.g. NACE[21] codes for loan recipients), clustered (in this case product categories by the banking group) and related to outcomes for the society in form of impact indicators.

Figure 8-3: SDG Mapping by the KfW group



Source: (Dangelmaier, 2019)

This approach requires a common data set and consistent classification of each step, which is currently not available in the sustainable bond market. However, it can be used as a best practise that might be applied in a similar way once the harmonization process for social bond reporting developed in a similar way. Nonetheless, it clearly shows that the gaps between anticipated project outcomes and their impact on the sustainable development can be closed in a pragmatic manner.

Another example, already tailored to the needs of the bond market, is the current ICMA (International Capital Market Association) suggestion for SDG mapping, as described in Odaro (2020). This mapping process complements and builds on previous guidelines for the Green Bond Principles (GBP), Social Bond Principles (SBP) and the Sustainability Bond Guidelines (SBG). The authors provide a first mapping table that links project categories in these guidelines to example indicators as well as the main SDG goals (see Figure 8-4 for an extract of this table). Although it is suggested to analyse each project individually, this table provides a quick solution to the SDG mapping challenges that is consistent with any prior reporting and could even be applied to bonds in the past. The clustering here is based on the principles mentioned above, matching the financing or re-financing of projects to different types of project groups such as food security, pollution prevention and control or socioeconomic advancement and empowerment. Because some project categories are linked to more than

[21] NACE is the standard classification system of economic activities in the European Community and stands for (in French): **n**omenclature statistique des **a**ctivités économiques dans la **C**ommunauté **e**uropéenne.

one SDG, it also possible to represent the multi-dimensional nature of the SDGs (overlaps between SDGs).

Figure 8-4: Extract of the SDG Mapping table by the ICMA

SDG	SBP Project Categories[12]	GBP Project Categories[13]	Example Indicators
	• Access to Essential Services (1.4) • Affordable Housing (1.4) • Socioeconomic Advancement and Empowerment (1.1, 1.2, 1.3, 1.4, 1.5)	• Climate Change Adaptation (1.5)	1.1 Number of products and services serving low-income groups 1.2 Number of people provided with access to financial services, including microfinance 1.4 Number of people provided access to clean energy
	• Access to Essential Services (2.3) • Affordable Basic Infrastructure (2a) • Food Security (2.1, 2.2, 2.3, 2c) • Socioeconomic Advancement and Empowerment (2.3, 2.5, 2a, 2c)	• Climate Change Adaptation (2.4) • Environmentally Sustainable Management of Living Natural Resources and Land Use (2.4) • Terrestrial and Aquatic Biodiversity Conservation (2.5)	2.1 Number of people provided with safe, nutritious and sufficient food 2.2 Ecologically sustainable agricultural production per hectare (tonnes) 2.4 Products with certified improvements in nutritional value 2.4 Number of people and/or enterprises (e.g. companies or farms) benefitting from measures to mitigate the consequences of floods and droughts

Source: Odaro (2020)

Both approaches introduce a cause-effect relationship between activities and impact on the sustainable development. They are, to some extent, indicator based and could therefore be also integrated into impact reporting if data is available.

However, they require an existing set of indicators already mapped to individual goals and do not deal with potential interactions between SDGs. In addition, none of these methods account for the scale of the effects. The following section therefore introduces a framework which enables to

- map projects to SDGs,
- account for interactions between SDGs,
- and anticipate the scale of the effect.

8.3 Framework for the SDG Mapping Tool

Basis for the framework in this report is a recent study on the operationalization of SDG transformation arenas (Sachs et al., 2019) that incorporates complementary actions by governments, civil society, science and businesses. Sachs et al. (2019) suggest *"Six Transformations to achieve the Sustainable Development Goals",* meant to *"identify priority investments and regulatory challenges, calling for action by well-defined parts of government working with business and civil society".*

These transformations were formed under the following five criteria:

- mutually exclusive and collectively exhaustive
- systems-based
- aligned with government organization
- easily communicable
- few in number

The authors start by identifying key interventions for the desired outcome of every SDG, drawing on established relationships in literature or using statistical relationships between SDG outcomes. Interventions describe the "*investments and regulatory changes*" and therefore the "*deep, deliberate, long-term structural changes in resource use, infrastructure, institutions, technologies and social relations that must be undertaken in a short period of time*" in order to substantiate the six transformations and therefore achieve the SDGs (Sachs et al., 2019, p. 5,7). To counter potential trade-offs while implementing interventions, the authors propose a set of principles to be taken into consideration at any given instance. First, the "leave-no-one-behind goal" is to be regarded with every intervention, thus ensuring that inequalities due to gender, race, ethnicity, or other factors are accounted for. Secondly, achieving human well-being is to be decoupled from environmental degradation and should follow principles of circularity and decarbonization.

Figure 8-5 shows the six transformation paths developed by the authors and described in the following sections.

Figure 8-5: Six SDG Transformations according to Sachs et al. (2019)

1: Education, gender, and inequality

Education has been underinvested in many countries, including high income countries. The first transformation deals with interventions in the education system as "*education builds human capital, which in turn promotes economic growth, the elimination of extreme poverty, decent work, and overcoming gender and other inequalities*" (ibid.: 2).

2: Health, well-being, and demography

The second Transformation "*promotes key investments in health and wellbeing*" designed and implemented by ministries (ibid.: 2). Health systems need to offer interventions with the focus on primary health care. Further interventions outside the health sector have to target the social determinants of health, for instance changing social norms and promoting healthy lifestyles.

3: Energy decarbonization and sustainable industry

The third transformation *"aims to ensure universal access to modern energy sources, decarbonize the energy system by mid-century in line with the Paris Agreement and reduce industrial pollution of the soil, water and air [...]. Decarbonizing energy systems requires integrated approaches across power generation, transmission, buildings, transport and industry" (ibid.: 2).*

In this transformation trade-offs have to be anticipated as pursuing access and affordability might counteract energy decarbonisation or rebound effects. Interventions have to anticipate these trade-offs and apply the principles of "leave-no-one-behind", circularity and decoupling (ibid.: 4).

4: Sustainable food, land, water, and oceans

The fourth transformation is concerned about sustainable land use and food systems. Today, these sectors account for a quarter of greenhouse-gas emissions and cause persistent hunger, malnutrition, obesity as well as biodiversity loss and overfishing (ibid.: 4). The three intervention areas deal with resilient agriculture systems and fisheries, the conservation and restoration of forests, soils, peat lands, wetlands, savannahs, coastal marine lands and other ecosystems and at last the curbing of food insecurity and hunger (ibid.: 5). Trade-offs have to be anticipated as "increases in agricultural production may exacerbate biodiversity loss and water scarcity" (ibid.: 4).

5: Sustainable cities and communities

By 2050, around 80% of the human population will live in cities. Meeting the triple objective of being economically productive, socially inclusive, and environmentally sustainable will require essential interventions in urban development. Interventions for this transformation must ensure water supply, sanitation, sewage, and waste disposal. They must also target efficient and sustainable mobility including infrastructures. Cities and communities must also be safe and healthy settlements, accommodate rising populations, increase resource-use efficiency and the overall quality of life.

6: Digital revolution for sustainable development

Digital technologies disrupt nearly every sector of the economy. The sixth SDG Transformation *therefore "calls for a comprehensive set of regulatory standards, physical infrastructure and digital systems to capture the benefits of the digital revolution for the SDGs while avoiding the many potential pitfalls"* (ibid.: 6).

From there, the authors describe intermediate outputs. These intermediate outputs describe the outcome required for the achievement of the SDGs. To identify how interventions contribute to the achievement of one SDG, the authors surveyed existing literature and scored the relationship between intermediate outputs and the SDGs on a 4-point-scale:

- 3 – Directly targets SDG: output directly addresses the SDG
- 2 – Reinforcing: output is necessary for achieving the SDG
- 1 – Enabling: output enables the achievement of the SDG
- 0 – Neutral: output does not interact significantly with the SDG

The scoring process involves the consideration of studies for each SDG and score (shown in the supplementary data of the study). For SDG 2 on ending hunger for example, outputs that directly target the SDG (Score 3) are increases in sustainable and resilient food production (esp. among small farmers), food supplementation programmes or income support programmes for the poor. Reinforcing outputs (Score 2) are advances in crop varieties and farming practises, energy decarbonisation, universal access to water or the advancement of digital technologies. Enabling outputs (Score 1) on the other hand stem from improved education, equal energy access or urban resilience.

Figure 8-6 shows the resulting scoring table of the study. Here, each intermediate output is referenced with a score in each SDG, representing the overlaps between SDGs but also the strength of effects from outputs.

Figure 8-6: Scoring Table for the six transformation paths by Sachs et al. (2019)

Transformation	Principal line ministries involved in Transformations	SDG interventions	Intermediate Outputs	Relationship with specific SDGs															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Education, Science and technology, Family and social affairs	Early childhood development Primary and secondary education Vocational traning and higher education	Education and human capital	2	1	2	3	3	1	1	2	2	2	1	1	1	1	1	1	1
		Social protection system and labour standards	Decent work and income support to vunlerable groups	3	3	2	1	2	1	2	3	1	3	1	1	2	2	2	1	0
		Research and development	Innovation	1	2	1	1	1	1	2	2	3	1	1	2	2	1	1	1	2
2	Health	Universal health coverage Healthy behaviours and social determinants of health and well-being	Public health services	2	3	3	2	3	0	0	2	1	2	1	1	0	0	0	1	0
3	Buildings/construction, Energy, Environment, Transport	Acces to clean Energy	Energy acces for all	2	1	2	2	2	1	3	2	3	2	3	2	3	1	2	1	0
		Zero-carbon electricity generation Energy efficiency Electrification and zero-carbon fuels Curbing pollution	Energy decarbonization	1	2	2	0	1	2	3	2	2	2	2	3	3	2	2	2	1
4	Agriculture, Environment, Fisheries and marine resources, Forestry, Health, Water and natural resources	Efficient and resilient agricultural systems and fisheries that support healthy diets and farm livelihoods Protection of terrestrial and marine biodiversity, including forests Healthy food promotion and regulation Trade and supply chains consistent with sustainable development Integrated land-use and water management	Sustainable land-use, oceans, and food systems	2	3	3	1	2	3	1	2	1	2	2	3	3	3	3	1	1
5	Transport, Urban development, Water and sanitation	Urban access to water, sanitation and waste management Sustainable mobility and transport networks More compact settlements	Transport, water and sanitation infrastructure services	2	2	2	2	2	3	1	2	3	2	3	3	2	2	2	0	0
		Urban adaptation and resilience	Urban resilience	1	1	1	1	1	2	1	1	2	2	3	1	3	0	0	1	0
6	Science and technology, Telecommunications	Universal broadband and informationtechnology infrastructure Digital inclusion, skills, privacy protection and universal identity Mobilizing digital technologies to achieve all SDGs	Digital technologies and infrastructure	2	2	2	2	1	1	2	2	3	2	2	2	2	1	1	1	2

source: supplementary material in Sachs et al. (2019)

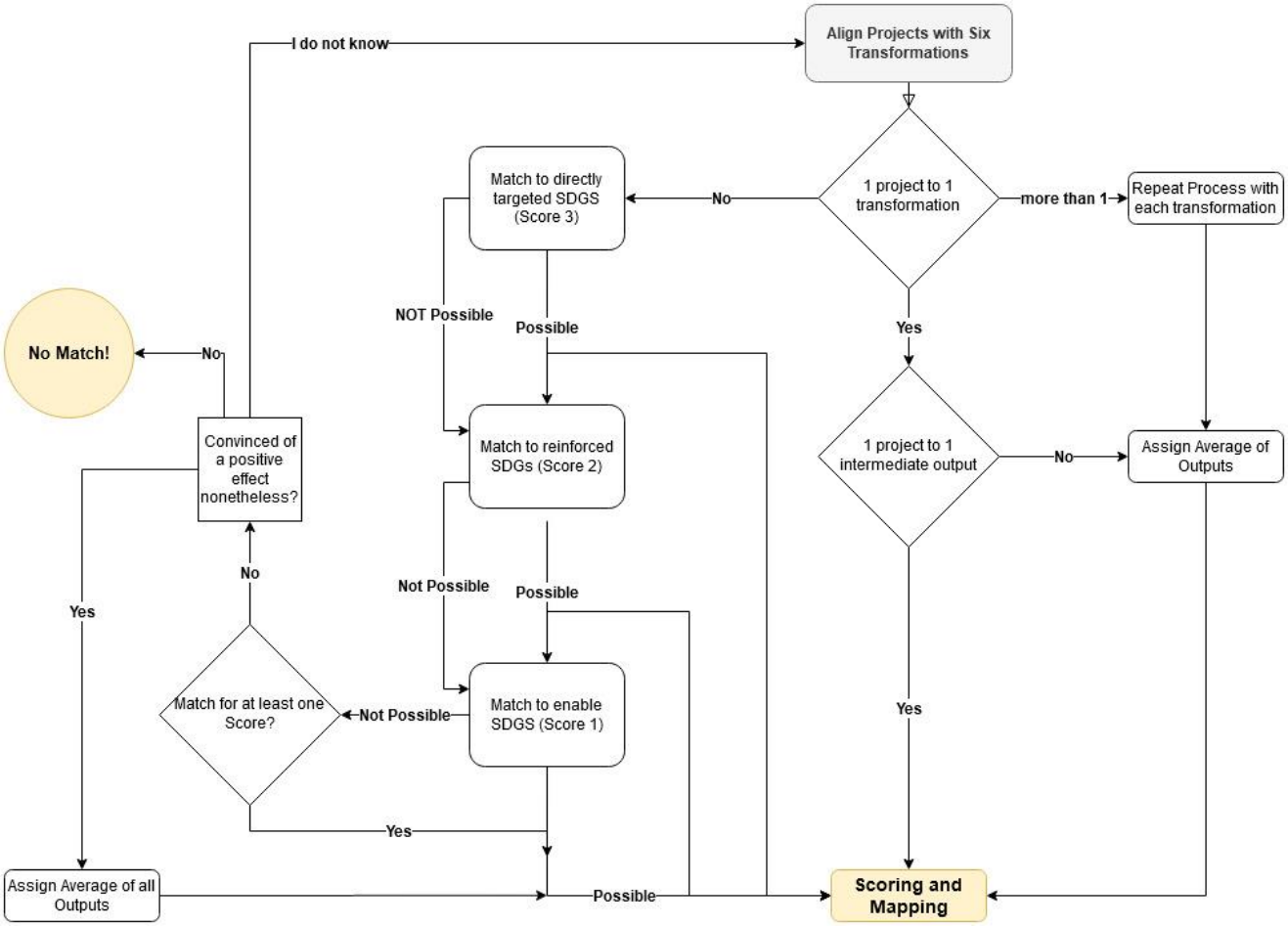
8.4 Decision Making for SDG Mapping Tool

With the study by Sachs et al. (2019) as basis, it is possible to match projects or measures with one or more of the six transformations and subsequently intermediate outputs and the SDGs.

The following flow chart shows the underlying decision process (see Figure 8-7). First, each project is matched to one of the six transformations and if this is possible, to intermediate outputs and thus mapping and scoring of related SDGs. If, in this process, more than one intermediate output is expected to change (or there is no clear distinction), average scoring and mapping is applied.

If on the other hand, no transformation path can be chosen or is suitable, a more detailed mapping takes places. In this case, the analyst is advised to match and score the project directly, following the interventions and criteria described in Sachs et al. (2019). This individual matching starts with any SDG that is directly affected (Score 3) and ends with any SDG that is only enabled (Score 1). If none of the SDGs can be matched to the project in this manner, but the analyst is still convinced of its potential positive outcome, average scoring across the matching table can be used. However, it is more likely that there is either no clear outcome or that the rougher matching to one of the six transformation paths is more feasible.

Figure 8-7: Flow chart of Mapping Process



source: own compilation

The result of this process is a consistent mapping table of projects that are aligned with their individual score for each SDG (from 0 to 3).

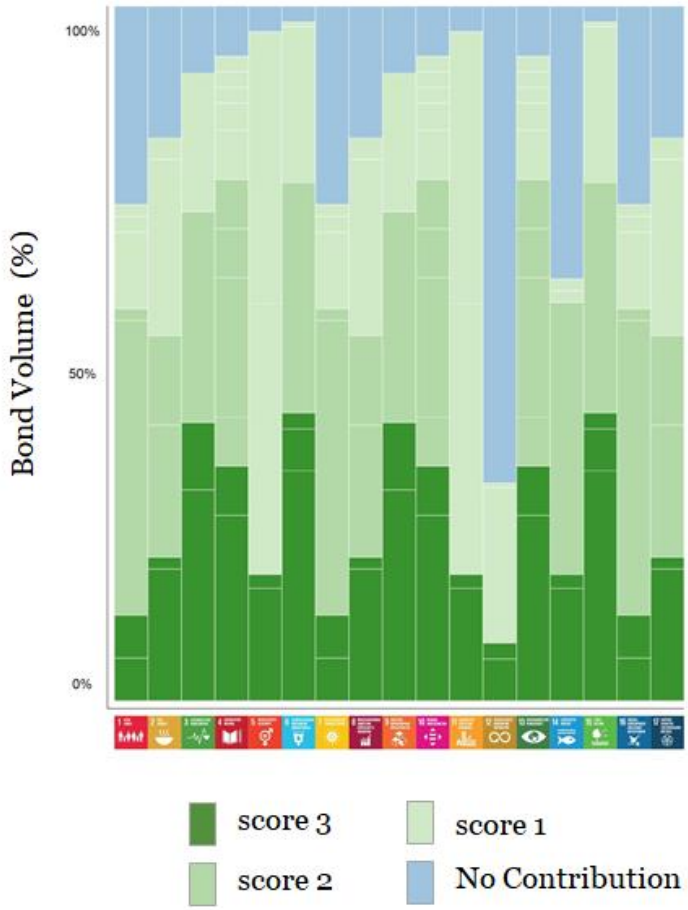
8.5 Allocation and Visualization

So far, each project contributes individually to the achievement of SDGs and regardless of the funding involved. The next step is therefore to consider that projects contribute differently within a portfolio.

In the best case, one project could make up 100% of the overall bond volume and directly affect (Score 3) one or more SDGs, while at least enabling the other SDGs (Score 1). If one of two projects both contribute to the same SDGs to the same extent, each would contribute with their share of the overall financing. Attribution (Scoring) of each project to each SDG can therefore be directly allocated according to the share in overall financing (with 100% of the budget if scores of 0 are considered as well).

Figure 8-8 shows an example how such a visualization could look like, when several projects are mapped using the process described before and are allocated accordingly. The authors of this report plan to test and advance this method in the future by developing a tool that calculates the results automatically.

Figure 8-8: Example of visualization of SDG Mapping Results



source: own compilation

9 Discussion

The report at hand refers to the 6th Sustainability Bond and is the 5th impact assessment by the Wuppertal Institut (starting with NRW Sustainability Bond #2 in 2016). Over this period, methods have been improved and newly developed to broaden the range of quantifiable indicators. At the same time, the bond has developed as well, especially regarding the size, diversity of projects and reporting on the use of proceeds. For the first time also, the issued NRW Sustainability Bond referred to the budget plan of the year of issuance instead of the final expenditures in the State's budget of the previous year.

This change in financial allocation also impacted the reporting. Monitoring usually takes place after the fact, therefore making it more difficult to connect the re-financing of current projects with their appropriate impact. Against this background, a first social impact methodology was developed that should facilitate social impact quantification in the future, both in terms of quality and robustness of the reported results. Introducing a qualifiable scale from A+ (best-needed) to D (minimum standard), it is now possible to differentiate between different types of indicators for social impacts which in turn allows to scale these impacts based on investments. Several new social impact indicators could be introduced in the process such as beneficiaries (students) in the EU school programme, funding of day-care centres or the qualification of young people and refugees. Furthermore, it was also possible to integrate monitored effects (3rd party assessment) of the European Social Fund.

New indicators were also discussed in the area of ecological impacts. Out of a wide range of potential indicators for potential future use, 2 new indicators were introduced: maintenance of biological stations and animal-friendly husbandry. This led to a more precise allocation of funding and attribution of effects by projects in category E (protection of natural resources). It is intended to further investigate impact indicators in this area for future reports, in particular identifying additional indicators for organic farming and animal welfare.

Reporting on GHG effects as well as indicators introduced in earlier reports continued. Projects funded over the course of six years, are expected to avoid GHG emission of more than 1.3 million tons of CO_2-equivalents during their lifetime (with over 50% attributed to the construction of cycle paths). In terms of direct effects, results on avoided GHG emissions range from 72 tons (refurbishment of university buildings) to 10,049 tons per annum (student tickets).

Upcoming reports are going to provide new indicators and further validate the methodology. The following tasks are planned:

- Introduction of new ecological indicators in line with the NRW Sustainability Strategy,
- Further development of the social impact methodology and introduction of new social indicators,
- Introduction of generic result tables for social impact reporting as suggested by the International Capital Market Association,
- Further Development of the method for SDG Mapping,
- Incorporation of suggestions in the final reports on Sustainable Finance by the different Expert Groups in Germany, Europe, and the UN (e.g. from the EU taxonomy).

10 References

AGEB. (2013). Anwendungsbilanzen für die Endenergiesektoren in Deutschland in den Jahren 2011 und 2012 mit Zeitreihen von 2008 bis 2012. *Studie Beauftragt Vom Bundesministerium Für Wirtschaft Und Technologie, Projektnummer*, *23*(11).

Agentur für Erneuerbare Energien e.V. (2014). *Spezifische CO2-Emissionen der Fernwärmeerzeugung—Wärme—NRW - Daten und Fakten zur Entwicklung Erneuerbarer Energien in einzelnen Bundesländern*. föderal erneuerbar. https://www.foederal-erneuerbar.de/landesinfo/bundesland/NRW/kategorie/waerme/auswahl/734-spezifische_co2-emis

BDLA. (2020). *Resolution für ein eigenständiges Förderprogramm für die urbane grün-blaue Infrastruktur*. https://www.bdla.de/dokumente/bundesverband/nachrichten-13/2019-7/547-fachverbaende-resolution-heilbronn-final-20190624/file

Bernstein, L., Pachauri, R. K., Reisinger, A., & Intergovernmental Panel on Climate Change. (2008). *Climate change 2007: Synthesis report*. IPCC.

Bildungsportal des Landes NRW. (2019). *Weiterfinanzierung der sozialen Arbeit an Schulen im Rahmen des Bildungs- und Teilhabepakets*. https://www.schulministerium.nrw.de/docs/FamilieBildung/Bildungs-und-Teilhabepaket/Kontext/Schulsozialarbeit-isdBuT/index.html

Clarke, L., Chalkidou, K., & Nemzoff, C. (2018). *Development Impact Bonds Targeting Health Outcomes* (p. 35).

Connor, R., Coates, D., Uhlenbrook, S., & Koncagül, E. (2018). *Weltwasserbericht der Vereinten Nationen 2018 – Wasser natürlich bewirtschaften – Zusammenfassung*. https://www.unesco.de/sites/default/files/2018-04/WWDR_2018_german-2.pdf

Dangelmaier, U. (2019). *Das SDG-Mapping der KfW Bankengrupp (Hintergrundinformationen und Methodikerläuterung)*. 13.

Deilmann, C., Behnisch, M., Dirlich, S., Gruhler, K., Hagemann, U., Petereit, R., & Petereit, K. (2013). Systematische Datenanalyse im Bereich der Nichtwohngebäude–Erfassung und Quantifizierung von Energieeinspar-und CO 2-Minderungspotenzialen [Systematic data analysis in the area of non-domestic buildings–recording and quantification of energy saving and CO 2 reduction potentials]. *BMVBS Online Publication*, *27*(2013), 1–201312202611.

Federal Ministry for nutrition and agriculture (BMEL9. (2109). *Zukunftsstrategie ökologischer Landbau*. https://www.bmel.de/SharedDocs/Downloads/Broschueren/Zukunftsstrategie-oekologischer-Landbau.pdf?__blob=publicationFile

FfE. (2010). *Basisdaten von Energieträgern*. Forschungsstelle für Energiewirtschaft e.V. https://www.ffe.de/download/wissen/186_Basisdaten_Energietraeger/Basisdaten_von_Energietraegern_2010.pdf

FM NRW (Ministry of Finance). (2016). *Zweite Nachhaltigkeitsanleihe des Landes Nordrhein-Westfalen Verwendung der Erlöse Informationen zu den geeigneten Projekten*.

FM NRW (Ministry of Finance). (2018). *Website—NRW budget for 2017 (including supplementary budget)* [Interactive]. Haushalt.Fm.Nrw.De. http://www.haushalt.fm.nrw.de/grafik/index.php?type=2

Gabler, A., Vorreiter, N., Kotlenga, S., Mahnoli, F., Nägele, B., & Pagels, N. (2017). *Evaluation des Programms Soziale Arbeit an Schulen in Nordrhein-Westfalen*. 247.

Gesellschaft für innovative Beschäftigungsförderung mbH. (2018). *Landesprogramm „Integration unternehmen!“ NRW Kurzinformationen*.

Heads of the Federal and State governments of Germany. (2014). *Verwaltungsvereinbarung_Hochschulpakt_III_vom_11.12.2014.pdf*. https://www.bmbf.de/files/Verwaltungsvereinbarung_Hochschulpakt_III_vom_11.12.2014.pdf

Hebel, E. von, Jahn, K., & Clausnitzer, K.-D. (2011). *Der energetische Sanierungsbedarf und der Neubaubedarf von Gebäuden der kommunalen und sozialen Infrastruktur* [Abschlussbericht].

ICMA. (2019). *Handbook-Harmonized-Framework-for-Impact-Reporting-WEB-100619.pdf*. https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/June-2019/Handbook-Harmonized-Framework-for-Impact-Reporting-WEB-100619.pdf

ICMA, & The Social Bond Principles. (2018). *Working Towards a Harmonized Framework for Impact Reporting for Social Bonds*. https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/June-2019/Framework-for-Social-Bond-Reporting-Final-06-2019-100619.pdf

IFC. (2019). *Social Bond Impact Report FINANCIAL YEAR 2018*. International Finance Corporation. https://www.ifc.org/wps/wcm/connect/b8f067fc-bd5c-4d48-9408-f6f820018a28/IFC+Social+Bond+Impact+Report+FY18_FINAL_03132019.pdf?MOD=AJPERES

Intergovernmental Panel on Climate Change. (2014). *IPCC: Greenhouse gas emissions accelerate despite reduction efforts—Many pathways to substantial emissions reductions are available*. http://www.ipcc.ch/pdf/ar5/pr_wg3/20140413_pr_pc_wg3_en.pdf

ISS ESG (former ISS-oekom). (2019). *5._Nachhaltigkeitsanleihe_SPO_LandNRW_final.pdf*. https://www.nachhaltigkeit.nrw.de/fileadmin/download/5._Nachhaltigkeitsanleihe_SPO_Land-NRW_final.pdf

IT.NRW. (2018). *Studierende Haupthörerinnen und Haupthörer nach Hochschularten*. https://www.it.nrw/node/1070/pdf

Jedicke, E. (2017). *Grün-blaue Infrastruktur im urbanen Raum – Bürgerinitiative statt Hoffnungslosigkeit*. https://www.nul-online.de/artikel.dll/nul10-17-02-inhalt-01_NTU1ODQ5MA.PDF

Jens Teubler, Oskar Reutter, Katrin Bienge, & Lena Hennes. (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.

Karfusehr, C., Kayser, A., & Hein, Dr. A. (2018). *Themenbericht Antibiotika im Grundwasser viehstarker Regionen Niedersachsens* (Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN), Ed.). https://www.nlwkn.niedersachsen.de/download/140350/Themenbericht_Antibiotika_2018_Daten_2015-2017_.pdf

KCM. (2015). *Sozialtickets in NRW*. Kompetenzcenter Marketing NRW.

KCM NRW. (2019). *NRW-Tarifreport 2018/2019* [Jahresbericht]. Kompetenzcenter Marketing NRW. https://www.kcm-nrw.de/fileadmin/kcm/Dateien/PDF/NRW_TarifReport_2017.pdf

Krewald, A. (2017). *Daten zur Sanierung von Gebäuden der Ruhr-Universität Bochum* [Personal communication].

Kühnen, M., & Hahn, R. (2017). Indicators in Social Life Cycle Assessment: A Review of Frameworks, Theories, and Empirical Experience. *Journal of Industrial Ecology*, *21*(6), 1547–1565. https://doi.org/10.1111/jiec.12663

LAK. (2015). *Energiebilanzen der Bundesländer*. Länderarbeitskreis Energiebilanzen.

Landesregierung NRW (State Government of NRW) (Ed.). (2016a). *Nachhaltigkeitsindikatoren Nordrhein-Westfalen Bericht 2016*.

Landesregierung NRW (State Government of NRW). (2016b). *Sustainability Strategy for North Rhine-Westphalia*. State Government of North Rhine-Westphalia. https://www.nachhaltigkeit.nrw.de/fileadmin/download/Nachhaltigkeitsstrategie/NHS_EN_v17_Screen_Einzelseiten.pdf

Landtag NRW (State Parliament NRW). (2017). *Kleine Anfrage: Beabsichtigt die schwarz-gelbe Landesregierung in NRW die Landesförderung der Sozialtickets zu streichen?* https://www.landtag.nrw.de/Dokumentenservice/portal/WWW/dokumentenarchiv/Dokument/MMD17-717.pdf

Landwirtschaftskammer Nordrhein-Westfalen. (2019, July 2). *Entwicklung des Ökolandbaus in NRW*. https://www.oekolandbau.nrw.de/fileadmin/redaktion/PDFs/Fachinfo/Markt/2019/2019-07_Entwicklung%C3%96kolandbau_NRW_bis2018_Grafik_GP.pdf

Lucas, P. L., & Wilting, H. C. (2018). *Using planetary boundaries to support national implementation of environment-related Sustainable Development Goals*. https://doi.org/10.13140/RG.2.2.15143.80806

Lucas, P., Ludwig, K., Kok, M., & Kruitwagen, S. (2016). *Sustainable Development Goals in The Netherland: Building Blocks for Environmental Policy for 2030*. PBL Netherlands Environmental Assessment Agency.

MAGS NRW (Ministry of Labour, Health and Social Affairs). (2019). *Jährlicher Durchführungsbericht für das Ziel 'Investitionen in Wachstum und Beschäftigung'* (p. 82).

MAGS NRW (Ministry of Labour, Health and Social Affairs), & Ehlert, C. (2019, January 15). *Written correspondence (Kooperative Ausbildung an Kohlestandorten)* [Personal communication].

MKW NRW (Ministry of Culture and Science). (2016). *Hochschulvereinbarung und Hochschulverträge*. https://www.mkw.nrw/hochschule-und-forschung/hochschulen/hochschulvereinbarung-und-hochschulvertraege

Müller, M. (2011). *Das NRW-Semesterticket – Akzeptanz, Nutzung und Wirkungen dargestellt am Fallbeispiel der Universität Bielefeld [The NRW semester ticket – acceptance, use and impact by the example of the university Bielefeld]*. Wuppertal Inst. für Klima, Umwelt, Energie. http://nbn-resolving.de/urn:nbn:de:bsz:wup4-opus-39366

MULNV NRW (Ministry for Environment, Agriculture, Nature and consumer protection) (Ed.). (2015a). *Biodiversitätsstrategie NRW*. https://www.umwelt.nrw.de/fileadmin/redaktion/Broschueren/biodiversitaetsstrategie_nrw_broschuere.pdf

MULNV NRW (Ministry for Environment, Agriculture, Nature and consumer protection). (2015b). *Öko-Landwirtschafts-Strategie NRW 2020*. https://www.umwelt.nrw.de/fileadmin/redaktion/PDFs/landwirtschaft/oeko_landwirtschafts_strategie_nrw_2020.pdf

MULNV NRW (Ministry for Environment, Agriculture, Nature and consumer protection). (2019a). *Kapitel 10 030 (Agrarwirtschaft, Forstwirtschaft, Naturschutz und Landschaftspflege)*. https://www.haushalt.fm.nrw.de/daten/hh2019.ges/daten/pdf/2019/hh10/kap030.pdf

MULNV NRW (Ministry for Environment, Agriculture, Nature and consumer protection). (2019b). *Jährlicher Durchführungsbericht | Germany—Rural Development Programme (Regional)—North Rhine-Westphalia* (p. 266) [Implementation Report]. https://www.umwelt.nrw.de/fileadmin/redaktion/PDFs/landwirtschaft/laendl_entwicklung/NRW-Programm_Laendlicher_Raum_September_2019.pdf

MWIDE NRW (Ministry of Economy, Innovation, Digitalisation and Energy). (2019). *Jährlicher Durchführungsbericht im Rahmen des Ziels 'Investitionen in Wachstum und Beschäftigung'*. https://www.efre.nrw.de/fileadmin/user_upload/Durchfuehrungsbericht_2018_01.pdf

MWVLW RP (Ministry of Economics, Transport, Agriculture and Viticulture Rhineland-Palatinate) (Ed.). (2018). *Nachhaltigkeitsstrategie Rheinland-Pfalz – Indikatorenbericht 2017*. https://mwvlw.rlp.de/fileadmin/mwkel/Abteilung_2/8206/02_Nachhaltigkeitsstrategie_Rheinland-Pfalz/2017_Indikatorenbericht_Rheinland-Pfalz.pdf

Nilsson, M., Chisholm, E., Griggs, D., Howden-Chapman, P., McCollum, D., Messerli, P., Neumann, B., Stevance, A.-S., Visbeck, M., & Stafford-Smith, M. (2018). Mapping interactions between the sustainable development goals: Lessons learned and ways forward. *Sustainability Science*, *13*(6), 1489–1503. https://doi.org/10.1007/s11625-018-0604-z

Nino, F. S. (2016). Sustainable development goals—United Nations. *United Nations Sustainable Development*. http://www.un.org/sustainabledevelopment/sustainable-development-goals/

Odaro, D. (2020). *Mapping-SDGs-to-Green-Social-and-Sustainability-Bonds06-2019-100619.pdf*. https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/June-2019/Mapping-SDGs-to-Green-Social-and-Sustainability-Bonds06-2019-100619.pdf

Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K., Tignor, M., & Miller, H. (2007). *IPCC fourth assessment report: Climate change 2007 (AR4)*. Cambridge University Press, Cambridge, UK. Retrieved from www. ipcc. ch.

Regionalverband Ruhr. (2014). *Machbarkeitsstudie RS1 Radschnellweg Ruhr Regionalverband [Feasibility study of the RS1 cycle path]*. http://www.rs1.ruhr/fileadmin/user_upload/RS1/pdf/RS1_Machbarkeitsstudie_web.pdf

Rockström, J., Steffen, W., Noone, K., Persson, \AAsa, Chapin III, F. S., Lambin, E., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., & others. (2009). Planetary boundaries: Exploring the safe operating space for humanity. *Ecology and Society*, *14*(2).

Sachs, J. D., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N., & Rockström, J. (2019). Six transformations to achieve the sustainable development goals. *Nature Sustainability*, *2*(9), 805–814.

Schostock, D. (2018). *Verbesserungshinweise des TEAM Nachhaltigkeit zum NRW-Nachhaltigkeitsindikatorenbericht* (Wuppertal Institut für Klima, Umwelt, Energie gGmbH, Ed.).

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., De Vries, W., De Wit, C. A., & others. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, *347*(6223), 1259855.

Stibbe, J., & Stratmann, F. (2014). *Bau- und Instandsetzungsbedarf in den Universitäten—Soll-Ist-Vergleich für den Zeitraum 2008 bis 2012*. Forum Hochschule. http://www.dzhw.eu/pdf/pub_fh/fh-201405.pdf

The World Bank et al. (2015, December). *Green Bonds Working Towards a Harmonized Framework for Impact Reporting*. http://treasury.worldbank.org/cmd/pdf/InformationonImpactReporting.pdf

TÜVRheinland, atesio GmbH, & TU Dresden. (2013). *Szenarien und Kosten für eine kosteneffiziente flächendeckende Versorgung der bislang noch nicht mit mindestens 50 Mbit/s versorgten Regionen*. https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/kostenstudie-zum-breitbandausbau.pdf?__blob=publicationFile&v=5

Umweltbundesamt (UBA). (2016). *Vergleich der Emissionen einzelner Verkehrsmittel im Personenverkehr Bezugsjahr 2014 tremod 5.63*. https://www.umweltbundesamt.de/sites/default/files/medien/376/bilder/dateien/vergleich_der_emissionen_einzelner_verkehrsmittel_im_personenverkehr_bezugsjahr_2014_tremod_5_63_0.pdf

wbcsd. (2016). *Social Life Cycle Metrics for Chemical Products*. World Business Council for Sustainable Development. http://docs.wbcsd.org/2016/11/Social_Metrics_Report.pdf

Wernick, C., & Bender, C. (2016). Die Rolle der Kommunen beim Breitbandausbau im ländlichen Raum aus ökonomischer Sicht. *WIK-Bericht Im Auftrag Des BMWi, Bad Honnef*.

www.biostationen-nrw.com. (2020, January 24). *List of Biological Stations NRW*. https://www.biostationen-nrw.com/wp-content/uploads/2020/01/Mitgliederstationen_Stand_24_01_2020.pdf