Impact Report #3 of the Green Bond Baden-Württemberg

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Impact Report commissioned by the Ministry of Finance Baden-Württemberg

Results for Climate Change Mitigation, Climate Change Adaptation, Water & Marine Resources, Circular Economy, Pollution Prevention, Biodiversity & Ecosystems

Wuppertal Institut

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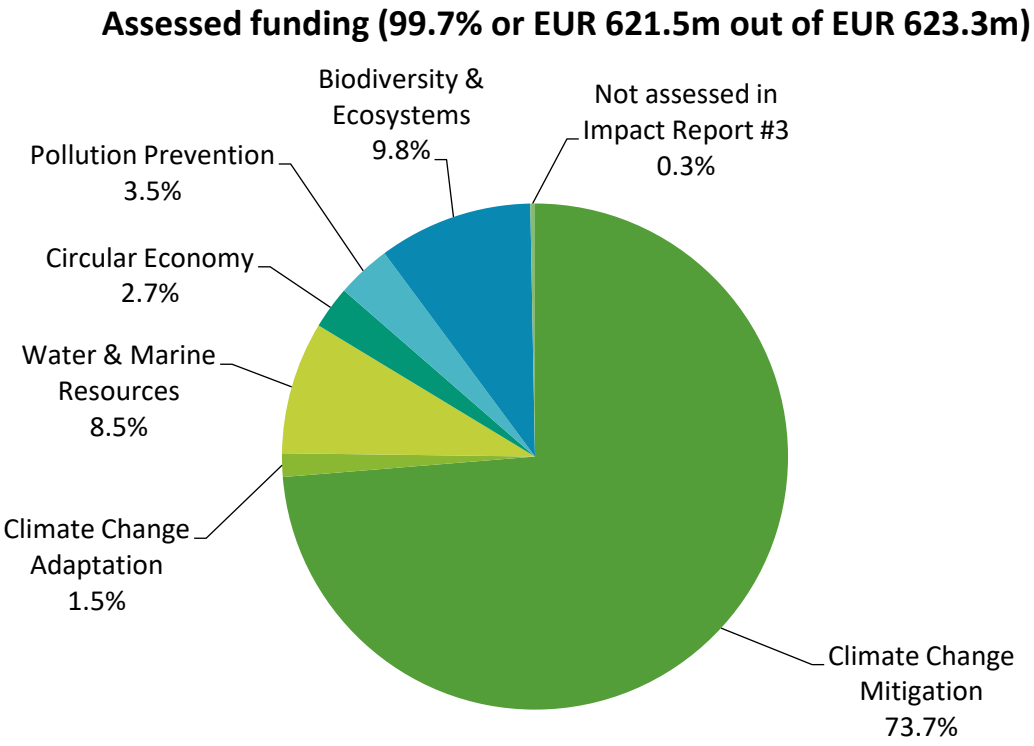
Executive Summary

The State of Baden-Württemberg issued its third Green Bond in June 2023 (#3) with a volume of 600 million Euro and referring to the state's expenditure in 2022 (EUR 623.3m). Wuppertal Institut has been commissioned with the impact reporting (#3) and evaluation of its compliance with the do-no-significant-harm (DNSH) criteria of the EU taxonomy regulation. The report describes the results of this assessment in line with the ICMA's Harmonised Framework for Impact Reporting (ICMA, 2022) as well as the European Green Bond Standard (European Parliament, 2023).

The Green Bond's impact orientation is aligned with the UN Sustainable Development Goals (SDGs), the state's sustainability strategy as well as the environmental objectives of the taxonomy regulation. The issuer has published an updated Green Bond Framework in June 2023, a second-party-opinion (SPO) and an allocation report (Ministerium für Finanzen Baden-Württemberg, 2023a, 2023b; MOODY'S Investors Service, 2023). The bond comprises 59 eligible projects, covering all six environmental objectives.



The report investigates positive contributions to overarching environmental objectives from 55 projects, representing 99.7% of the total financing. The majority of the assessed projects can be attributed to the objectives Climate Change Mitigation (26 projects, EUR 459.4m) and Biodiversity & Ecosystems (13 projects, EUR 61.4m). Another large portion is allocated to the objective Circular Economy with expenditures of EUR 21.6m for 6 projects. In total, 158 indicators were selected, qualified and quantified (see "Results"). The indicator-quality can be considered best-practice (quality C) for 33 projects, representing a "high likelihood of substantial contribution" to the taxonomy objectives. Moreover, an intermediate-outcome could be found in 12 of these 33 projects. We consider such desired outcomes (quality B) as "strong evidence for a substantial contribution" to the taxonomy objectives.

Risk Assessment for potential violations of DNSH criteria

None of the assessed projects in the Green Bond poses a high or even medium risk for significant damage to any of the objectives. It is therefore unlikely that any of the projects violates the DNSH criteria. The previous risk assessment for Bond #2 revealed 14 projects with low or minimal risks, of which 9 continue to be a part of Bond #3. 10 new projects have been assessed for the report at hand, of which 3 were associated with low or minimal risks as well (resulting in 12 projects overall for which DNHS violations cannot be entirely excluded or require some additional assessment to exclude these risks unambiguously).

Future reports will no longer investigate these risks from new projects, since the SPO provider will investigate the alignment with the technical screening criteria in detail.

Climate Change Mitigation

Expenditures of 460.3 million Euro or 73.8% of the eligible funding contributes to the objective of climate change mitigation. Out of these funding, 26 projects with an eligible amount of EUR 459.4m were assessed for the impact report (99.8% of EUR 460.3m). These expenditures can be associated with total investments of at least EUR 4,000m for all actors involved (e.g., if a project is financed with a share of 40% by the State but another 60% of the costs needed to be invested by others).

The project with the largest contribution is the construction of new buildings in the public building construction (22% of eligible amounts for climate change mitigation). It is estimated that 244,973 square meters of energy-efficient floor area were built with the help of the financing. Considering the increased energy-efficiency in the newly built buildings, we estimate that 7,547 tons of GHG emissions are saved per year in total, with an annual “financed” effect of 540 tons of CO_2-equivalents.

Another project with a substantial contribution is the expansion of broadband connections in the State of Baden-Württemberg (EUR 95.7m). It is estimated that 10,562 new connections were potentially realized with the help of the financing alone. This relates to approximately 88,800 connections overall for 2022. Considering the increased energy-efficiency of these connections, we estimate that 660 tons of GHG emissions are saved per year in total, with an annual "financed" effect of 78.5 tons CO_2-equivalents.

Other assessed measures in this category also contribute to the reduction of GHG emissions or enable other stakeholders to do so with the help of scientific research (e.g. by the Karlsruhe Reallabor for Sustainable Climate Protection), loans to SMEs (e.g. from the Enhanced Resource Efficiency Programme) or funding for local communities (e.g. for energy-efficient heat networks).

Climate Change Adaptation

Three projects contributing to climate change adaptation were selected by the issuer of which all three were assessed in the report. The expenditures in this category (EUR 9.3m) make up for 1.5% of the total EUR 623m. The "Timber Construction Initiative" promotes timber buildings, of which more than 5,700 could be approved in 2022. The actual activity itself is reported with 173 events with stakeholders held in this year. Through the project of silvicultural measures (expenditures of EUR 2.1m), we estimate that annually 1,400 tons of carbon are able to be absorbed (560 t C/a from financing alone) with an absolute of 119,900 tons of carbon stored in the forest (with 48,000 t C from financing alone).

Water & Marine Resources

Two projects were selected by the issuer in this category and both of them were quantified on the level of activities. In regard to the bond, 148 measures related to sewerage infrastructures were funded in 2022 with circa EUR 39m (100% financial share). In addition, another 87 measures can be related to the supply of clean water (with a funding of EUR 13.5m). In total, 195 communities in the State of BW profited from the programmes.

Circular Economy

All projects were assessed in this category. Although these projects represent a smaller portion of the Green Bond (EUR 17m), a clear contribution to the overall objective can be shown. Five nuclear power plants are currently under investigation for material recovery (from the project "RecTecKA") and 18 theses were finished as a consequence of the new hybrid Professorship for "Sustainability Research and Transformative Research". In addition, future potentials for phosphorus recovery from sewage sludge is estimated at 1,500 tons per year and the new research facility INATECH will house more than 110 employees in the future.

Pollution Prevention

The majority of projects could be assessed for the report at hand. Out of total expenditures of EUR 22.6m, five projects with EUR 21.6m (or 95.6%) could be associated with positive contributions towards the environmental objective. The largest contribution can be attributed to the project “remediation of contaminated sites” (EUR 14,7m), through which 24 communities received funding, and 34 measures of remediation were able to be implemented. Mobility-projects relate to the purchase of electric motorcycles for the state police (4 vehicles with total expenditures of EUR 0.37m in 2022), as well to the purchase of low- or even zero-emission public vehicles (21 approved purchases of low-emission vehicles), and lastly to the establishment of additional express bus lines (with additional passenger capacities of 5,500 with total expenditures of EUR 3.4m). The last project contributes to direct pollution control such as the installation of air filter cubes (reducing local air emissions by circa 10% through the operation of 94 air filters).

Biodiversity & Ecosystems

13 projects with expenditures of EUR 61.4m were assessed that contribute to the "protection and restoration of biodiversity and ecosystems". This represents all expenditures in this category and 9.8% of the total expenditures in the Bond. Five desired outcomes ("best-in-class" indicators) could be identified and quantified, all of which are associated with additional protected areas (12,500 ha as well as over 10,000 biotopes) or areas dedicated to sustainable farming (circa 202,000 ha). These projects with total expenditures of EUR 27.7m can be considered "strong evidence for a substantial contribution" to the EU taxonomy objective. Other projects in this category promote activities (e.g. 14 funded communities as part of the "Organic Model Regions in BW") or research related to organic farming (e.g. five scientific publications from the research programme "Organic Farming").

Outlook

A number of project indicators assessed here have been accumulated to show the overall effects over the course of three Green Bonds. We will continue to do so for the next report and assess whether additional projects can be accumulated in the same manner. The next report will also not include the heuristic risk assessment for DNSH violations, since the SPO provider will do so with its own methodology and assessment tools.

Results

The following tables list all indicators identified for the impact report of the third Green Bond Baden-Württemberg. The new projects in Bond #3 as well as an evaluation of the robustness of the indicators can be found in section 4.

Climate Change Mitigation

Climate Change Mitigation - Indicators	Indicator quality	signed amount [1]	Share of financing [2]	Eligibility for green bonds	allocated amount	Indicator name (all indicators refer to 1 year of funding from the State's budget)	Indicator unit	Annual Effects [3]	
Project Name [4]	[A-G]	million EUR	%	% of signed amount	million EUR			full effect	financed
Fast Cycling Routes (No 1)	C	0.76	100%	100%	0.73	km bicycle lanes	[km]	1.0	1.0
	E	0.76	100%	100%	0.73	funding for communities	[mEUR]	0.8	0.8
Planning and construction of cycle routes on state roads (No 2)	C	20.96	100%	100%	20.17	constructed cycle-paths	[km]	28.0	28.0
	E*	20.96	100%	100%	20.17	funding of cycle route construction	[mEUR]	21.0	21.0
Support program state initiative electromobility (No 3)	D	39.29	variable	100%	37.83	no of implementations by stakeholders (disbursements)	[1]	2105.0	n.a.
	E*	39.29	100%	100%	37.83	no of approvals for electromobility measures	[1]	576.0	576.0
	F	F1: minimal risk of violating generic climate change adaptation criteria | F2: minimal risk of violating regulatory criteria for a circular economy | F3: minimal risk of violating regulatory criteria for pollution prevention							
Funding of personnel in the field of sustainable mobility (No 6)	D*	2.82	50%	100%	2.71	no of job-equivalents for sustainable mobility personnel	[1]	71.7	35.9
	E	2.82	50%	100%	2.71	funding for sustainable mobility	[mEUR]	5.6	2.8
Support Program for Municipal Cycling and Pedestrian Infrastructure (No 7)	D*	15.54	10.3%	100%	14.96	communities funded	[1]	96.0	96.0
	E*	15.54	10.3%	100%	14.96	funding for communities	[mEUR]	150.9	15.5
Cycling Routes Network (No 8)	D*	2.71	100%	100%	2.61	communities funded	[1]	223.0	223.0
	E*	2.71	100.0%	100%	2.61	funding for communities	[mEUR]	2.7	2.7
Cycling Culture Initiative (No 9)	D*	2.69	100%	100%	2.59	communities funded	[1]	20.0	20.0
	E*	2.69	100.0%	100%	2.59	funding for communities	[mEUR]	2.7	2.7
GVFG Electrification Projects (No 13) [7]	E*	0.48	100%	100%	0.46	funding for electrification of rail traffic	[mEUR]	0.5	0.5
	F	F1: minimal risk of violating generic climate change adaptation criteria | F2: minimal risk of violating generic water and marine resources criteria | F3: minimal risk of violating regulatory criteria for a circular economy | F4: minimal risk of violating generic criteria for biodiversity and ecosystems							
Combi Solution City Railway Karlsruhe (No 14)	C	68.87	6%	100%	66.29	average reduction in travel time for public transport	[sec]	300.0	18.7
	D	68.87	6%	100%	66.29	traffic performance of more effective public transport system	[pkm]	316.2	19.7
	E*	68.87	6%	100%	66.29	funding for public rail transport	[mEUR]	1,104.6	68.9
	F	F1: minimal risk of violating specific criteria for water and marine resources | F2: minimal risk of violating generic criteria for biodiversity and ecosystems							
	G	G1: concordance with climate change adaptation criteria has not been ensured (yet) | G2: concordance with circular economy criteria could not be ensured | PP: concordance with pollution prevention criteria could not be ensured							
Funding programme climate protection plus (No 16)	B*	8.10	30%	100%	7.80	Annual GHG reductions	[t CO2e / a]	2,229.0	668.7
	C	8.10	30%	100%	7.80	GHG reduction per measure	[t CO2e / 1]	34.8	34.8
	D*	8.10	30%	100%	7.80	no of renovation measures	[1]	64.0	19.2
	E*	8.10	30%	100%	7.80	Funding for climate protection consulting & measures	[mEUR]	27.0	8.1
Regional centers of excellence for energy efficiency (No 23)	C*	0.82	n.a.	100%	0.79	evaluated energy efficiency measures in companies	[1]	33.0	n.a.
	D*	0.82	n.a.	100%	0.79	no of energy consultations in companies	[1]	107.0	n.a.
	E*	0.82	100%	100%	0.79	funding for consultations	[mEUR]	0.8	0.8
Enhanced Resource Efficiency Programme/ Combi loan [...] with climate bonus (No 24)	D*	2.00	100%	100%	1.93	no of loans by housebanks	[1]	77.0	77.0
	E*	2.00	100%	100%	1.93	funding for resource efficiency in SMEs	[mEUR]	2.0	2.0
Energy-efficient heat networks (No 25)	D*	2.43	100%	100%	2.34	communities funded	[1]	18.0	18.0
	E*	2.43	100%	100%	2.34	funding for communities	[mEUR]	2.4	2.4
	F	F1: minimal risk of violating generic climate change adaptation criteria | F2: minimal risk of violating generic water and marine resources criteria | F3: minimal risk of violating regulatory criteria for a pollution prevention | F4: minimal risk of violating generic criteria for biodiversity and ecosystems							
INPUT: Intelligent parking & underground garages (No. 26)	D*	2.82	100%	100%	2.71	projects funded	[1]	18.0	18.0
	E*	2.82	100%	100%	2.71	funding for projects	[mEUR]	2.8	2.8
	F	F1: minimal risk of violating generic climate change adaptation criteria | F2: minimal risk of violating generic criteria for biodiversity and ecosystems							

Solar Battery Storage Systems (No 27)	C*	7.54	n.a.	100%	7.25	renewable storage capacity added	[MWh]	n.a.	20.1
	E*	7.54	n.a.	100%	7.25	funding for renewable battery capacity	[1]	n.a.	7.5
HyFab BW (No 28 & No 58)	C	4.45	n.a.	100%	4.28	no of future employees (researchers)	[1]	10.0	n.a.
	E*	4.45	24%	100%	4.28	funding for research infrastructure	[mEUR]	18.3	4.5
	G	G1: concordance with climate change adaptation criteria has not been ensured (yet)							
Notably energy-efficient new buildings in the public building construction (No 34) [5]	B	101.84	7%	100%	98.03	GHG emission reduction compared to 1990	[Δ%]	94.0	6.7
	C*	101.84	7%	100%	98.03	GHG emissions avoided per year	[t CO2e / a]	7,547.0	540.0
	D*	101.84	7%	100%	98.03	energy-efficient net floor area added	[squ-m]	244,073.6	17,464.6
	E*	101.84	7%	100%	98.03	funding for public buildings	[mEUR]	1,423.2	101.8
	G	G1: concordance with climate change adaptation criteria has not been ensured (yet)							
Notably energy-efficient restructuring measures in the public building construction (No 35) [5]	B	20.62	7%	100%	19.85	GHG emission reduction compared to 1990	[Δ%]	73.0	5.5
	C*	20.62	7%	100%	19.85	GHG emissions avoided per year	[t CO2e / a]	440.1	33.0
	D*	20.62	7%	100%	19.85	energy-efficient net floor area added	[squ-m]	54,202.0	4,063.5
	E*	20.62	7%	100%	19.85	funding for public buildings	[mEUR]	275.1	20.6
	F	F1: minimal risk of violating specific criteria for water and marine resources | F2: minimal risk of violationg specific criteria for a circular economy							
	G	G1: concordance with climate change adaptation criteria has not been ensured (yet)							
autoKite (No 38)	C	1.17	-	100%	1.12	technology readiness level of protytpe	-	5.0	5.0
	D*	1.17	49%	100%	1.12	no of publications	[1]	5.0	2.4
	E*	1.17	49%	100%	1.12	funding for research (kite for maritime wind energy)	[mEUR]	2.4	1.2
CAMPUS high i - [...] (No 40)	B	0.32	n.a.	100%	0.31	future GHG reduction (estimated, building 1)	[t CO2e / a]	630.9	n.a.
	E*	0.32	100%	100%	0.31	no of funded projects	[1]	4.0	4.0
KARLA - Karlsruhe Reallabor for Sustainable Climate Protection (No 41)	C*	0.34	78%	100%	0.33	no of published peer-reviewed articles	[1]	1.0	0.8
	D*	0.34	78%	100%	0.33	no of activities (presentations, articles, etc.)	[1]	41.0	31.8
	E*	0.34	78%	100%	0.33	funding for projects & activities	[mEUR]	0.4	0.3
Climate Connect industrial area Donautal (KliConn) (No 42)	D*	0.23	15%	100%	0.22	no of workshops conducted	[1]	29.0	4.3
	E*	0.23	15%	100%	0.22	funding for climate change mitigation strategies	[mEUR]	1.6	0.2
Reallabor for climate-neutral Reutlingen (Klima-RT-LAB) (No 43)	D*	0.32	n.a.	100%	0.31	no of projects (measure bundles)	[1]	19.0	n.a.
	E*	0.32	n.a.	100%	0.31	funding for real-world laboratories	[mEUR]	n.a.	0.3
Mobility Living Lab (MobiLab) Stuttgart (No 44)	B	0.94	27%	100%	0.91	reduction of GHG emissions	[Δ%]	0.3	0.1
	C	0.94	n.a.	100%	0.91	no of jobs (mobility-authority)	[1]	5.0	n.a.
	D*	0.94	27%	100%	0.91	no of projects	[1]	10.0	2.7
	E*	0.94	27%	100%	0.91	funding for real-world laboratories	[mEUR]	3.5	0.9
New Resrarch building high Efficiency Solar Cells (No 57)	C	0.70	2%	100%	0.67	no of persons working at site in the future (approved)	[1]	68.0	1.4
	D*	0.70	2%	100%	0.67	research building construction (and equipment)	[%]	100.0	2.1
	E*	0.70	2%	100%	0.67	funding for research infrastructure	[mEUR]	34.0	0.7
	G	G1: concordance with climate change adaptation criteria has not been ensured (yet)							
State funding of broadband (No 60)	B	95.75	12%	100%	92.17	GHG reductions of broadband systems compared to conventional connections	[t CO2e / a]	660.0	78.5
	C	95.75	12%	100%	92.17	energy savings from network access compared to conventional connections	[MWh / a]	436.1	51.9
	D*	95.75	12%	100%	92.17	additional broadband connections	[1]	88806.0	10562.5
	E*	95.75	12%	100%	92.17	funding for broadband	[mEUR]	805.0	95.8
Energy-efficient State housing funding (No 61)	C	54.91	50%	100%	52.86	no of funded housing units (45% to 60% reduction of primary energy demand compared to reference buildings)	[1]	810.0	407.7
	D	54.91	50%	100%	52.86	Share of non-refundable grants for NZEB	[%]	100.0	100.0
	E*	54.91	50%	100%	52.86	Funding for nearly-zero-energy-buildings (NZEB)	[mEUR]	109.1	54.9
	F	F1: minimal risk of violating regulatory criteria for circular economy | F2: minimal risk of violationg specific, generic, or regulatory criteria for pollution prevention							
	G	G1: concordance with climate change adaptation criteria has not been ensured (yet) | G2: condordance with criteria for preservation of biodversity & ecosystems has not been ensured (yet)							
TOTAL FUNDING - Climate Change Mitigation [6]	E	**459**	**11%**	**100%**	**442**	**induced project costs and capital** [6]	**[mEUR]**	**4001**	**459**

* accumulative indicators (**annual financed effects** can be summed up over more than one impact report)

[1] Represents "allocated amount" in the ICMA (2021) Standard (p. 62, "c/"). For the issuer, this refers to the actual annual expenditure (net, only funds from the State's budget).

[2] These allocated costs refer to the total funding (e.g. when reporting number of projects) or total costs (e.g. when reporting effects), including perennial cost fractions when the overall share of the State is at 100%.

[3] "full effect" refers to the (annual) indicator value for the entire project, while the "financed effect" refers to the attribution of the State in the given year only.

[4] Projects can be listed more than once if more than one indicator is reported. The number in brackets refers to the number of the project in the project list of the issuer.

[5] The GHG effects (B and C) are estimated with the help of a simplified model. Due to the use of primary energy demands of the building, the effects are likely to be underestimated in terms of actual savings.

[6] The share of financing is not known for each project or cannot be quantified for this granularity. In these cases, the share of financing was approximated for the purpose of this indicator.

[7] The funding here no longer actively electrifies additional rail tracks, but is used to pay out the remaining costs. It is therefore merely included to indicate its risks.

Climate Change Adaptation

Climate Change Adaptation - Indicators	Indicator quality	signed amount [1]	Share of financing [2]	Eligibility for green bonds	allocated amount	Indicator name (all indicators refer to 1 year of funding from the State's budget)	Indicator unit	Annual Effects [3]	
Project Name [4]	**[A-G]**	**million EUR**	**%**	**% of signed amount**	**million EUR**			**full effect**	**financed**
Funding Program Klimopass (No 17)	C*	0.57	65%	100%	0.55	no of climate change adaptation measures	[1]	24.0	15.6
	D*	0.57	65%	100%	0.55	no of analyses & consultations	[1]	13.0	8.5
	E*	0.57	65%	100%	0.55	funding for climate change adaptation (CCA) measures	[mEUR]	0.9	0.6
Silvicultural measures (No 52)	B*	2.11	40%	100%	2.03	annually absorbed carbon (carbon sink)	[t C/a]	1,400	560
	C*	2.11	40%	100%	2.03	stored carbon (biomass above and below ground) [5]	[t C]	119,900	48,000
	D*	2.11	40%	100%	2.03	promoted forest area	[ha]	1,205	482
	E*	2.11	40%	100%	2.03	funding for afforestation and reforestation	[mEUR]	5.3	2.1
Timber Construction Initiative BW (No 53)	C*	6.67	n.a.	100%	6.42	no of approved timber buildings	[1]	5784.0	n.a.
	D*	6.67	100%	100%	6.42	no of events	[1]	173.0	173.0
	E*	6.67	100%	100%	6.42	funding for sustainable construction	[mEUR]	6.7	6.7
TOTAL - Climate Change Adaptation	E	**9**	**73%**	**100%**	**9**	**induced project costs and capital [6]**	**[mEUR]**	**13**	**9**

* accumulative indicators (**annual financed effects** can be summed up over more than one impact report)

[1] Represents "allocated amount" in the ICMA (2021) Standard (p. 62, "c/"). For the issuer, this refers to the actual annual expenditure (net, only funds from the State's budget).

[2] These allocated costs refer to the total funding (e.g. when reporting number of projects) or total costs (e.g. when reporting effects).

[3] "full effect" refers to the (annual) indicator value for the entire project, while "financed" multiplies this effect with the share of total project financing.

[4] Projects can be listed more than once if more than one indicator is reported. The number in brackets refers to the number of the project in the project list of the issuer. Some project names were shortened for a better display.

[5] The stored carbon continues to be stored (and has been stored in the past) unless forest is removed or otherwise changed. Only additional protected areas can add to this indicator in the future.

[6] The share of financing is not known for each project or cannot be quantified for this granularity. In these cases, the share of financing was approximated for the purpose of this indicator.

Water and Marine Resources

Water and Marine Resources - Indicators	Indicator quality	signed amount [1]	Share of financing [2]	Eligibility for green bonds	allocated amount	Indicator name (all indicators refer to 1 year of funding from the State's budget)	Indicator unit	Annual Effects [3]	
Project Name [4]	**[A-G]**	**million EUR**	**%**	**% of signed amount**	**million EUR**			**full effect**	**financed**
Sewerage infrastructure investments (No 21)	C*	38.76	100%	100%	37.31	no of implemented measures	[1]	148.0	148.0
	D*	38.76	100%	100%	37.31	no of funded communities	[1]	120.0	120.0
	E*	38.76	100%	100%	37.31	funding for remediation activities	[mEUR]	38.8	38.8
Water supply (No 22)	C*	13.97	100%	100%	13.45	no of implemented measures	[1]	87.0	87.0
	D*	13.97	100%	100%	13.45	no of funded communities	[1]	75.0	75.0
	E*	13.97	100%	100%	13.45	funding for remediation activities	[mEUR]	14.0	14.0
TOTAL - Water and Marine Resources	E	**53**	**100%**	**100%**	**50.8**	**induced project costs and capital [5]**	**[mEUR]**	**53**	**53**

* accumulative indicators (**annual financed effects** can be summed up over more than one impact report)

[1] Represents "allocated amount" in the ICMA (2021) Standard (p. 62, "c/"). For the issuer, this refers to the actual annual expenditure (net, only funds from the State's budget).

[2] These allocated costs refer to the total funding (e.g. when reporting number of projects) or total costs (e.g. when reporting effects).

[3] "full effect" refers to the (annual) indicator value for the entire project, while "financed" multiplies this effect with the share of total project financing.

[4] Projects can be listed more than once if more than one indicator is reported. The number in brackets refers to the number of the project in the project list of the issuer.

[5] The share of financing is not known for each project or cannot be quantified for this granularity. In these cases, the share of financing was approximated for the purpose of this indicator.

Circular Economy

Circular Economy Indicators	Indicator quality	signed amount [1]	Share of financing [2]	Eligibility for green bonds	allocated amount	Indicator name (all indicators refer to 1 year of funding from the State's budget)	Indicator unit	Annual Effects [3]	
Project Name [4]	[A-G]	million EUR	%	% of signed amount	million EUR			full effect	financed
Industrial dismantling of battery modules and electric motors (DeMoBat) (No 18)	C	1.68	100%	100%	1.61	no of scientific publications	[1]	12.0	12.0
	D*	1.68	100%	100%	1.61	no of dissemination events	[1]	5.0	5.0
	E*	1.7	100%	100%	1.61	funding of research for circular economy in e-mobility	[mEUR]	1.7	1.7
Phosphorus recovery from sewage sludge (No 19)	C	2.74	23%	100%	2.64	future potentials of recovered phosphorus	[t/a]	1500.0	342.9
	D*	2.74	23%	100%	2.64	building construction (fertilizer recovery plant)	[%]	100.0	22.9
	E*	2.74	23%	100%	2.64	funding for research buildings (circular economy)	[mEUR]	12.0	2.7
Professorship for Sustainability Research and Transformative Research (No 39)	C*	0.06	100%	100%	0.06	finished theses	[1]	18.0	18.0
	E*	0.06	100%	100%	0.06	funding for research (circular economy)	[mEUR]	0.1	0.1
RecTecKA - Recycling of technology metals from the dismantling of nuclear facilities (No 46)	D	0.02	100%	100%	0.02	no of nuclear plants to be dismantled	[1]	5.0	5.0
	E*	0.02	100%	100%	0.02	funding for material recovery research	[mEUR]	0.0	0.0
Strategy for sustainable bio-economy (No 51)	D	12.30	100%	100%	11.84	number of events held	[1]	18.0	18.0
	E	12.30	100%	100%	11.84	funding for bio-economy	[mEUR]	12.3	12.3
New Research Building INATECH (No 56)	C	0.15	1%	100%	0.14	no of future employees	[1]	113.0	0.7
	D*	0.15	1%	100%	0.14	building construction (research)	[%]	100.0	0.6
	E*	0.15	1%	100%	0.14	funding for research buildings (circular economy)	[mEUR]	26.0	0.2
	G	G1: concordance with climate change adaptation criteria has not been ensured (yet)							
TOTAL Circular Economy	E	17	33%	100%	16.3	induced project costs and capital [7]	[mEUR]	52	17

* accumulative indicators (**annual financed effects** can be summed up over more than one impact report)

[1] Represents "allocated amount" in the ICMA (2021) Standard (p. 62, "c/"). For the issuer, this refers to the actual annual expenditure (net, only funds from the State's budget).

[2] These allocated costs refer to the total funding (e.g. when reporting number of projects) or total costs (e.g. when reporting effects).

[3] "full effect" refers to the (annual) indicator value for the entire project, while "financed" multiplies this effect with the share of total project financing.

[4] Projects can be listed more than once if more than one indicator is reported. The number in brackets refers to the number of the project in the project list of the issuer.

Pollution Prevention

Pollution Prevention - Indicators	Indicator quality	signed amount [1]	Share of financing [2]	Eligibility for green bonds	allocated amount	Indicator name (all indicators refer to 1 year of funding from the State's budget)	Indicator unit	Annual Effects [3]	
Project Name [4]	**[A-G]**	**million EUR**	**%**	**% of signed amount**	**million EUR**			**full effect**	**financed**
Public Air Solutions - Filter Cubes (No 5)	C	0.99	100%	100%	0.96	site-specific reduction of air emissions (N20, PM) [5]	[Δ%]	10.0	10.0
	D	0.99	100%	100%	0.96	no of air filters in operation [6]	[1]	94.0	94.0
	E*	0.99	100%	100%	0.96	funding for low-emission mobility	[mEUR]	1.0	1.0
Establishment of express bus lines in the Stuttgart region (No 10)	C	2.20	30%	100%	2.12	capacity for passengers	[1]	5,500.0	1,646.1
	E*	2.20	30%	100%	2.12	funding for low-emission mobility	[mEUR]	7.3	2.2
	F	F1: minimal risks of violating the generic criteria for climate change adaptation							
Low-emission bus transportation (No 12)	D*	3.35	100%	100%	3.23	approved purchases of low-emission vehicles	[1]	21.0	21.0
	E*	3.35	100%	100%	3.23	funding for low-emission mobility	[mEUR]	3.4	3.4
Remediation of contaminated sites (No 20)	C*	14.69	100%	100%	14.14	implemented measures of remediation	[1]	34.0	34.0
	D*	14.69	100%	100%	14.14	funded communities	[1]	24.0	24.0
	E*	14.69	100%	100%	14.14	funding for remediation activities	[mEUR]	14.7	14.7
E-Mobility in the car pool of BW police - purchase of motorcycle with electric motor (No 59)	D*	0.37	100%	100%	0.35	purchase of electric vehicles	[1]	4.0	4.0
	E*	0.37	100%	100%	0.35	funding for low-emission mobility	[mEUR]	0.4	0.4
TOTAL Pollution Prevention	E	**22**	**78%**	**100%**	**20.8**	**induced project costs and capital [7]**	**[mEUR]**	**28**	**22**

* accumulative indicators (**annual financed effects** can be summed up over more than one impact report)

[1] Represents "allocated amount" in the ICMA (2021) Standard (p. 62, "c/"). For the issuer, this refers to the actual annual expenditure (net, only funds from the State's budget).

[2] These allocated costs refer to the total funding (e.g. when reporting number of projects) or total costs (e.g. when reporting effects), including perennial cost fractions when the overall share of the State is at 100%.

[3] "full effect" refers to the (annual) indicator value for the entire project, while the "financed effect" refers to the attribution of the State in the given year only.

[4] Projects can be listed more than once if more than one indicator is reported. The number in brackets refers to the number of the project in the project list of the issuer.

[5] Estimated effect for different circumstances. The actual evaluated effects can be found at: https://vm.baden-wuerttemberg.de/de/service/presse/pressemitteilung/pid/wirksamkeit-der-luftfiltersaeulen-bestaetigt/.

[6] Air filter can and have been decommissioned. Therefore the value is not accumulative but refers to the given budget year.

[7] The funding here no longer actively electrifies additional rail tracks, but is used to pay out the remaining costs. It is therefore merely included to indicate its risks.

Biodiversity and Ecosystems

Biodiversity and Ecosystems Indicators	Indicator quality	signed amount [1]	Share of financing [2]	Eligibility for green bonds	allocated amount	Indicator name (all indicators refer to 1 year of funding from the State's budget)	Indicator unit	Annual Effects [3]	
Project Name [4]	[A-G]	million EUR	%	% of signed amount	million EUR			full effect	financed
Biotope mapping (No 29)	B	3.97	100%	100%	3.82	increase in biotopes	[%]	0.02	0.02
	D*	3.97	100%	100%	3.82	number of updated/new biotopes	[1]	10,082.0	10,082.0
	E*	3.97	100%	100%	3.82	funding for nature conservation and biodiversity	[mEUR]	4.0	4.0
Non-productive investments in conservation (No 30)	B	15.42	73%	100%	14.84	additional protected/enhanced eco-friendly area [5]	[ha]	9,461.8	9,461.8
	D	21.12	100%	100%	20.33	funded projects for nature conservation and biodiversity	[1]	5,120.0	5,120.0
	E*	21.12	100%	100%	20.33	funding for nature conservation and biodiversity	[mEUR]	21.1	21.1
Nature conservation contracts (No 31)	D	9.96	50%	100%	9.59	no of projects	[1]	6,506.0	3,253.0
	E*	9.96	50%	100%	9.59	funding for nature conservation and biodiversity [6]	[mEUR]	19.9	10.0
Expansion of the statewide biotope network (No 32)	C*	1.89	16%	100%	1.82	improved area from nature conservation	[ha]	1,840.0	288.0
	D*	1.89	16%	100%	1.82	no of measures for expanding biotopes	[1]	1,058.0	165.6
	E*	1.89	16%	100%	1.82	funding for nature conservation and biodiversity	[mEUR]	12.1	1.9
Special Programme for Biodiversity (No 33)	B	4.78	75%	100%	4.60	additional protected/enhanced eco-friendly area [5]	[ha]	2,891.6	2,168.7
	D*	6.37	100%	100%	6.13	funded projects for nature conservation and biodiversity	[1]	1,677.0	1,677.0
	E*	6.37	100%	100%	6.13	funding for nature conservation and biodiversity	[mEUR]	6.4	6.4
Investing in properties with importance for environmental protection (No 36)	B	2.56	100%	100%	2.47	increase in natural protected area in the State of BW	[%]	0.01	0.01
	C*	2.56	100%	100%	2.47	additional protected area	[ha]	120.5	120.5
	E*	2.56	100%	100%	2.47	funding for nature conservation and biodiversity	[mEUR]	2.6	2.6
Nationalpark Black Forest, new construction visitor and information center (No 37)	D*	1.79	4%	100%	1.72	building construction for environmental education	[%]	100.0	4.3
	E*	1.79	4%	100%	1.72	funding for environmental education	[mEUR]	41.5	1.8
	G	G1: concordance with climate change adaptation criteria has not been ensured (yet)							
Research Programme Organic Farming (No 47)	C*	0.27	100%	100%	0.26	no of scientific publications	[1]	5.0	5.0
	D*	0.27	100%	100%	0.26	no of held events	[1]	29.0	29.0
	E*	0.27	100%	100%	0.26	funding for organic/sustainable farming	[mEUR]	0.3	0.3
Aid for pruning of meadow orchards (No 48)	C*	2.90	38%	100%	2.79	number of pruned trees	[1]	193,000.0	72,688.3
	E*	2.90	38%	100%	2.79	funding for organic/sustainable farming	[mEUR]	7.7	2.9
Preserving steep-hill grassland (No 49)	C*	5.49	100%	100%	5.28	promoted area for organic/sustainable farming	[ha]	44,402.0	44,402.0
	D*	5.49	100%	100%	5.28	number of applicants	[1]	7,878.0	7,878.0
	E*	5.49	100%	100%	5.28	funding for organic/sustainable farming	[mEUR]	5.5	5.5
Preserving manually cultivable vineyards (No 50)	B	1.03	28%	100%	0.99	increase (annual) in organically farmed area in the State of BW	[%]	51.8%	14.5%
	C*	1.03	28%	100%	0.99	additional organically farmed area	[ha]	343.0	96.0
	E*	1.03	28%	100%	0.99	funding for organic/sustainable farming	[mEUR]	3.7	1.0
Organic Model Regions in BW (No 54)	D	0.89	92%	100%	0.86	number of funded communities	[1]	14.0	12.9
	E*	0.89	92%	100%	0.86	funding for organic/sustainable farming	[mEUR]	1.0	0.9
Organic Farming (No 55)	C*	3.15	6%	100%	3.03	promoted area for organic/sustainable farming	[ha]	157,460.0	9,853.1
	D*	3.15	6%	100%	3.03	number of applicants	[1]	4,261.0	266.6
	E*	3.15	6%	100%	3.03	funding for organic/sustainable farming	[mEUR]	50.3	3.1
TOTAL Biodiversity and Ecosystems	E	**61**	**35%**	**100%**	**59.1**	**induced project costs and capital [7]**	**[mEUR]**	**176.9**	**61.4**

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[2] These allocated costs refer to the total funding (e.g. when reporting number of projects) or total costs (e.g. when reporting effects), including perennial cost fractions when the overall share of the State is at 100%.

[3] "full effect" refers to the (annual) indicator value for the entire project, while the "financed effect" refers to the attribution of the State in the given year only.

[4] Projects can be listed more than once if more than one indicator is reported. The number in brackets refers to the number of the project in the project list of the issuer.

[5] Not all funded projects are monitored for changes of promoted/enhanced areas. The attribution of expenditures is estimated as a fraction of all measures and has therefore been adjusted accordingly.

[6] Share of financing unknown. Typical threshold for most contracts at 50% according to law (assumption here).

[7] The share of financing is not known for each project or cannot be quantified for this granularity. In these cases, the share of financing was approximated for the purpose of this indicator.

Zusammenfassung

Das Land Baden-Württemberg hat im Juni 2023 seinen dritten Green Bond (#3) mit einem Volumen von 600 Mio. Euro aufgelegt, der sich auf die Ausgaben des Landes im Jahr 2022 (623,3 Mio. Euro) bezieht. Das Wuppertal Institut wurde mit der Wirkungsberichterstattung (#3) und der Bewertung der Einhaltung der Do-No-Significant-Harm-Kriterien (DNSH) der EU-Taxonomie-Verordnung beauftragt. Dieser Bericht beschreibt die Ergebnisse der Bewertung in Übereinstimmung mit den Leitlinien für die Wirkungsberichterstattung der ICMA (ICMA 2022) sowie dem europäischen Green Bond Standard (European Parliament, 2023).

Die Wirkungsorientierung des Green Bonds steht im Einklang mit den UN-Zielen für nachhaltige Entwicklung (SDGs), der Nachhaltigkeitsstrategie des Landes sowie den Umweltzielen der Taxonomie Verordnung. Der Emittent hat im Juni 2023 ein aktualisiertes Green Bond Framework, eine Second-Party-Opinion (SPO) und einen Allokationsbericht veröffentlicht (Ministerium für Finanzen Baden-Württemberg, 2023a, 2023b; MOODY'S Investors Service, 2023). Die Anleihe umfasst 59 förderfähige Projekte, die alle sechs Umweltziele abdecken.

Der Bericht untersucht die positiven Veränderungen bei 55 Projekten, die 99,7 % der Gesamtfinanzierung ausmachen. Der Großteil der bewerteten Projekte kann den Zielen "Klimaschutz" (26 Projekte, 459,4 Mio. EUR) sowie "Schutz und Wiederherstellung der Biodiversität" (13 Projekte, 61,4 Mio. EUR) zugeordnet werden. Ein weiterer großer Teil entfällt auf das Ziel "Kreislaufwirtschaft" mit Ausgaben von 21,6 Mio. EUR für 6 Projekte. Insgesamt wurden 158 Indikatoren ausgewählt, qualifiziert und – größtenteils quantifiziert (siehe "Results"). Die Qualität der Indikatoren kann bei 33 Projekten als Best Practice (Qualität C) angesehen werden, was eine "hohe Wahrscheinlichkeit eines wesentlichen Beitrags" zu den Zielen der Taxonomie bedeutet. Darüber hinaus konnte bei 12 dieser 33 Projekte eine gesellschaftliche Wirkung attestiert werden. Wir betrachten solche gewünschten Auswirkungen oder "desired outcomes" (Qualität B) als "starke Belege für einen wesentlichen Beitrag" zu den Zielen der Taxonomie.

Risikobewertung für mögliche Verstöße gegen die DNSH-Kriterien

Keines der geprüften Projekte im Rahmen der Grünen Anleihe birgt ein hohes oder auch nur mittleres Risiko für eine erhebliche Beeinträchtigung eines der Ziele. Es ist daher unwahrscheinlich, dass eines der Projekte gegen die DNSH-Kriterien verstößt. Die frühere Risikobewertung für Anleihe #2 ergab 14 Projekte mit geringen oder minimalen Risiken, von denen 9 weiterhin Teil von Anleihe #3 sind. Für den vorliegenden Bericht wurden 10 neue Projekte bewertet, von denen 3 ebenfalls mit geringen oder minimalen Risiken verbunden waren (was insgesamt 12 Projekte ergibt, bei denen Verstöße gegen die DNHS-Kriterien nicht vollständig ausgeschlossen werden können oder eine zusätzliche Bewertung erfordern, um diese Risiken eindeutig auszuschließen).

Künftige Berichte werden diese Risiken bei neuen Projekten nicht mehr untersuchen, da der SPO-Anbieter die Übereinstimmung mit den technischen Screening-Kriterien im Detail untersuchen wird.

Klimaschutz

Ausgaben in Höhe von 460,3 Millionen Euro bzw. 73,8 % der förderfähigen Mittel tragen zum Ziel der Eindämmung des Klimawandels bei. Von diesen Mitteln wurden 26 Projekte mit einem förderfähigen Betrag von 459,4 Mio. Euro für den Wirkungsbericht bewertet (99,7 % der 460,3 Mio. Euro). Diese Ausgaben können mit Gesamtinvestitionen von mindestens 4.000 Mio. Euro für alle Akteure in Verbindung gebracht werden.

Das Projekt mit dem größten Beitrag ist der Neubau von öffentlichen Gebäuden (22% der förderfähigen Beträge für den Klimaschutz). Es wird geschätzt, dass mit Hilfe der Finanzierung eine Fläche von 245.000 m² energieeffiziente Gebäudegrundfläche gebaut wurden. Angesichts der erhöhten Energieeffizienz der neu gebauten Gebäude schätzen wir, dass insgesamt 7.547 Tonnen Treibhausgasemissionen pro Jahr eingespart werden, mit einem jährlichen „finanzierten" Effekt von 540 Tonnen CO_2-Äquivalenten.

Ein weiteres Projekt mit einem erheblichen Beitrag ist der Ausbau von Breitbandanschlüssen in Baden-Württemberg (95,7 Mio. Euro). Es wird geschätzt, dass mit Hilfe der Finanzierung allein 10.560 neue Anschlüsse realisiert wurden. Dies entspricht insgesamt etwa 88.800 Anschlüsse für das Jahr 2022 unter Berücksichtigung aller Ausgaben. Unter Berücksichtigung der erhöhten Energieeffizienz dieser Anschlüsse schätzen wir, dass insgesamt 660 Tonnen Treibhausgasemissionen pro Jahr eingespart werden, was einem jährlichen „finanzierten" Effekt von 78,5 Tonnen CO2-Äquivalenten entspricht.

Andere bewertete Maßnahmen in dieser Kategorie tragen ebenfalls zur Verringerung der THG-Emissionen bei oder ermöglichen es anderen Akteuren. Dazu gehören beispielsweise wissenschaftliche Forschung (z. B. durch das Karlsruher Reallabor für nachhaltigen Klimaschutz), Darlehen für kleine und mittelständische Unternehmen (z. B. aus dem Programm für verbesserte Ressourceneffizienz) oder Finanzhilfen für lokale Gemeinden (z. B. für energieeffiziente Wärmenetze).

Anpassung an den Klimawandel

Drei Projekte, die zur Anpassung an den Klimawandel beitragen, wurden vom Emittenten ausgewählt und in diesem Bericht bewertet. Die Ausgaben in dieser Kategorie (9 Mio. EUR) machen 1,5 % der gesamten 623 Mio. EUR aus. Die "Holzbau-Initiative" fördert Holzbauten, von denen bis 2022 mehr als 5.700 genehmigt werden konnten. Die eigentliche Aktivität wird mit 173 Veranstaltungen mit Interessenvertretern in diesem Jahr angegeben. Durch das Projekt „Forstwirtschaftliche Maßnahmen" schätzen wir, dass jährlich 1.400 Tonnen Kohlenstoff absorbiert werden können (wovon 560 Tonnen „finanziert" sind) und insgesamt 119.900 Tonnen Kohlenstoff im Wald gespeichert werden (48.000 Tonnen nur basierend auf den Ausgaben des Landes).

Nachhaltige Nutzung von Wasser- und Meeresressourcen

In dieser Kategorie wurden vom Emittenten zwei Projekte ausgewählt, die beide auf der Ebene der Aktivitäten quantifiziert wurden. Im Rahmen der Anleihe wurden 148 Maßnahmen im Zusammenhang mit der Abwasserinfrastruktur im Jahr 2022 mit rund 39 Mio. EUR (100%iger Finanzierungsanteil) gefördert. Darüber hinaus sind insgesamt 87 Maßnahmen im Zusammenhang mit der Versorgung mit sauberem Wasser zu nennen (mit einer Finanzierung von 13,5 Mio. EUR). Insgesamt profitierten 195 Gemeinden im Land BW von den Programmen.

Wandel zur Kreislaufwirtschaft

Alle in dieser Kategorie finanzierten Projekte wurden auch bewertet. Obwohl diese Projekte nur den zweitkleinsten Teil des Green Bond ausmachen (17 Mio. EUR), kann ein deutlicher Beitrag zum Gesamtziel nachgewiesen werden. So werden derzeit fünf Kernkraftwerke auf ihre stoffliche Verwertung hin untersucht (aus dem Projekt "RecTecKA"). Zudem wurden im Rahmen der neuen Hybridprofessur für "Nachhaltigkeitsforschung und Transformative Forschung" 18 Abschlussarbeiten abgeschlossen. Darüber hinaus wird das künftige Potenzial für die Rückgewinnung von Phosphor aus Klärschlamm auf 1.500 Tonnen pro Jahr geschätzt, und die neue Forschungseinrichtung INATECH wird in Zukunft mehr als 110 Mitarbeiterinnen und Mitarbeiter beherbergen.

Vermeidung von Umweltverschmutzung

Die Mehrzahl der Projekte konnte für den vorliegenden Bericht bewertet werden. Von den Gesamtausgaben in Höhe von 22,6 Mio. EUR konnten fünf Projekte mit 21,6 Mio. EUR (oder 95,6 %) mit positiven Veränderungen in Verbindung gebracht werden. Der größte Beitrag kann dem Projekt „Sanierung kontaminierter Standorte“ zugeschrieben werden (14,7 Mio. Euro), durch das 24 Gemeinden finanzielle Unterstützung erhielten und 34 Sanierungsmaßnahmen umgesetzt werden konnten. Mobilitätsprojekte beziehen sich auf den Kauf von Elektromotorrädern für Landespolizei (4 Fahrzeuge mit Gesamtausgaben von 0,37 Mio. Euro im Jahr 2022), den Kauf von emissionsarmer oder sogar emissionsfreier öffentlicher Fahrzeuge (21 genehmigte Käufe von Niedrigemissionsfahrzeugen mit Gesamtausgaben von 3,35 Mio. Euro) und schließlich die Einrichtung zusätzlicher Schnellbuslinien (mit zusätzlichen Passagierkapazitäten von 5.500 Sitzen und Gesamtausgaben von 3,35 Mio. Euro). Das letzte Projekt trägt zum direkten Umweltschutz durch die Installation von Luftfiltern bei (Verringerung der lokalen Luftemissionen um ca. 10% durch den Betrieb von 94 Luftfiltern).

Schutz und Wiederherstellung der Biodiversität

Es wurden 13 Projekte mit Ausgaben von 61,4 Mio. EUR bewertet, die zum Schutz und zur Wiederherstellung der biologischen Vielfalt und der Ökosysteme beitragen. Dies entspricht allen Ausgaben in dieser Kategorie und 9,8 % der Gesamtausgaben in der Anleihe. Fünf gewünschte gesellschaftliche Auswirkungen („Best-in-Class"-Indikatoren) konnten identifiziert und quantifiziert werden, die alle mit zusätzlichen Schutzgebieten (12.500 ha sowie 10.000 Biotope) oder Flächen für nachhaltige Landwirtschaft (ca. 202.000 ha) verbunden sind. Diese Projekte mit Gesamtausgaben von 27,7 Mio. EUR können als "starker Beleg für einen wesentlichen Beitrag" zum Umweltziel angesehen werden.

Andere Projekte in dieser Kategorie fördern Aktivitäten (z. B. 14 geförderte Gemeinden im Rahmen der "Modellregionen für den ökologischen Landbau") oder forschen im Zusammenhang mit dem ökologischen Landbau (z. B. fünf wissenschaftliche Veröffentlichungen aus dem Forschungsprogramm "Ökologischer Landbau").

Ausblick

Eine Reihe von Projektindikatoren, die hier bewertet wurden, wurden kumuliert, um die Gesamtwirkung über den Zeitraum von drei Green Bonds aufzuzeigen. Wir werden dies für den nächsten Bericht fortsetzen und prüfen, ob weitere Projekte auf die gleiche Weise kumuliert werden können. Der nächste Bericht wird zudem keine heuristische Risikobewertung für DNSH-Verstöße enthalten, da der SPO-Anbieter dies mit seiner eigenen Methodik und seinen eigenen Bewertungsinstrumenten evaluieren wird.

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List of Abbreviations

Abb	Abbreviation
No or no	Number or amount
BW	Baden-Württemberg
GHG	Greenhouse Gas
GWP	Global warming potential
PEF	Primary energy factor
PED	Primary energy demand

1 Scope and Structure of the Report

The external reviewer (Wuppertal Institut) has conducted an impact assessment of the third Green Bond of the State of Baden-Württemberg (Impact Report #3) from 2023. All funding is related to the state's 2022 expenditure. Effects are usually restricted to the year 2022 but can, in some cases, refer to future effects as well (e.g., ex-ante from plants under construction). Most effects take place within the geographical borders of the state, although some projects can lead to benefits in other countries. The objectives of the report are defined by the issuer as listed below:

- Review of compliance with do-no-significant-harm principle
- Impact Assessment in line with ICMA framework and EU Green Bond Standard
- Consideration of indicators proposed by issuer as well as suitable metrics found in the taxonomy regulation
- Quantification of indicators were possible, both for full and financed effects
- Transparent description of methods and data
- Continuous and further development of methodology
- Summary of results in form of an executive summary

The Green Bond Framework of the issuer (Ministerium für Finanzen Baden-Württemberg, 2023b) is in line with the EU taxonomy, which by itself is aligned to the environmental objectives of the EU environmental action program (EAP). Some of these objectives address slightly different targets at once such as the sustainable use of water bodies compared to the protection of marine resources. We use a matching table (see Table 1-1), to condense and abbreviate the targets in the report at hand. Each abbreviation or short-term relates to all targets defined by each objective.

Table 1-1: matching table for environmental objectives in the EU taxonomy regulation

Environmental objective	Short name	Abbreviation
Climate change mitigation	Climate Change Mitigation	CM
Climate change adaptation	Climate Change Adaptation	CA
The sustainable use and protection of water and marine resources	Water & Marine Resources	WM
The transition to a circular economy	Circular Economy	CE
Pollution prevention and control	Pollution Prevention	PP
Protection and restoration of biodiversity and ecosystems	Biodiversity & Ecosystems	BE

Source: own compilation

The full report has four main sections: Validation of Do-No-Significant-Harm, Methodology, Data and Results, Discussion and Outlook.

2 Validation of Do-No-Significant-Harm

The issuer's Green Bond Framework intends to address (if eligible programs and projects are available in a given year) all six environmental objectives in the European Union as defined by the EU Taxonomy regulation[1]. This is achieved by describing and assigning eligible projects to one of the objectives (termed "significant contribution" in the language of the regulation). A second-party opinion (SPO) was published that corroborates this contribution (MOODY'S Investors Service, 2023).

In line with Article 17 of that regulation, the issuer also discusses alignment with the "do no significant harm" criteria (abbreviated DNSH in the language of the regulation) to any of the other five objectives. The issuer's framework states in this regard:

> *"Fulfilment of "do-no-significant-harm" criteria as specified in the EU Taxonomy for sustainable economic activities in Article 17: Eligible green projects should, to a reasonable extent, be assessed to comply with the Do No Significant Harm ("DNSH") criteria. Such assessment is carried out by relevant experts within the ministries associated with the respective expenditures, to the best of their abilities. Demonstrating full alignment with the DNSH criteria may be challenging or unfeasible for certain public expenditure programmes, such as subsidy programmes and tax relief schemes. In such cases, any gaps in relation to alignment with the EU Taxonomy, e.g. due to lack of information, will be communicated transparently"*
> (Ministerium für Finanzen Baden-Württemberg, 2023b, p. 11)

The report at hand is part of this communication by investigating whether any of the projects in the bond poses a high risk of violating these criteria.

2.1 Validation method

The Taxonomy applies to economic activities that are mainly classified according to NACE[2] codes and focused on companies. The projects in the Green Bond on the other hand mostly refer to state programs. Although there are companies involved (e.g., when financially incentivized or profiting from free counselling services), the logic of the Taxonomy does not fully comply as some of the effects will occur outside of the funding and fiscal responsibility of the state. In addition, only parts of the entire economy are eligible to Taxonomy criteria (e.g., agricultural activities are currently not included).

It is therefore not feasible to review whether these programs are in line with specific do-no-significant-harm criteria, unless

- there is a high probability for considerable damage ("high risk"),
- the project or program can be clearly matched to a NACE category where DNSH criteria are well-defined,

[1] The environmental objectives of the EU taxonomy regulation are originally based on the 7th Environment Action Programme EAP (http://data.europa.eu/eli/dec/2013/1386/oj).

[2] NACE (Nomenclature statistique des activités économiques dans la Communauté européenne) is the most common classification system for economic activities in the EU. It is almost exclusively used for European Statistics or European Input-/Output-Tables.

- and these DNSH criteria include requirements beyond national or European environmental regulation and laws[3].

The approach outlined here consists of a 4-step process. First (1), we evaluate whether there is either "no risk", "low risk" or "high risk" for violating the heuristic DNSH criteria in Article 17 of the Taxonomy regulation. Secondly (2), we check for the availability and feasibility of specific DNSH criteria in cases where a risk is anticipated (projects outside the taxonomy can still have a high risk but cannot be reviewed here). Thirdly (3), specific DNSH criteria are evaluated where applicable with the goal of conclusively identifying projects with a high risk. Fourthly (4), an individual risk assessment is conducted when a minimal risk of DNSH violations was identified in steps 1 to 3 or if both the risk evaluation in step 1 indicated a risk and such a risk could not be excluded due to being subject to generic DNSH criteria in the taxonomy.

2.2 Summary of risk assessment for projects in previous impact reports

The previous risk assessment (Teubler & Schekira, 2023) evaluated DNSH criteria for 14 projects in the 2nd Green Bond after excluding all other projects either heuristically (step 1 of the methodology) or due to a lack of compliance with economic activities in the EU taxonomy (step 2 of the methodology). 9 of these 14 projects are also part of Green Bond #3 and are shown in Table 2-1.

Table 2-1: DNSH evaluation of projects from risk assessment that are applicable to the Taxonomy Regulation

(att: highlighted in 1st evaluation | reg: regulatory requirements | gen: generic requirements | spe: specific requirements in Taxonomy regulation)

Project	DNSH Risk	DNSH Type	Assessment of specific risks
Notably energy-efficient new buildings in the public building construction	**CA: cannot be excluded**	CA: att, gen	none
Notably energy-efficient restructuring measures in the public building construction	**CA: cannot be excluded** WM: minimal risk CE: minimal risk PP: no risk	CA: att, gen WM: spe CE: reg, spe PP: reg	WM: it is unlikely that public buildings exceed water usage in accordance with Appendix E of Taxonomy CE: required rates in accordance with national targets/regulations (e.g., KrWG); only requirements for backfilling poses a very small risk
Electrification Hochrheinbahn	CA: minimal risk WM: minimal risk CE: minimal risk PP: minimal risk BE: minimal risk	CA: gen WM: gen CE: reg PP: att, reg, spe BE: gen	PP: generic principle & risk attributed in first evaluation step; it can be safely assumed that measures are in place to reduce noise and other emissions during construction (specific criteria)

[3] It can be safely assumed that companies and other actors only receive funding if they comply to national and European environmental laws.

Project	DNSH Risk	DNSH Type	Assessment of specific risks
GVFG Electrification Projects	CA: minimal risk WM: minimal risk CE: minimal risk PP: minimal risk BE: minimal risk	CA: gen WM: gen CE: reg PP: att, reg, spe BE: gen	PP: generic principle & risk attributed in first evaluation step; it can be safely assumed that measures are in place to reduce noise and other emissions during construction (specific criteria)
HyFab BW - New Building	**CA: cannot be excluded**	CA: att, gen	none
INPUT - Intelligent network link of parking garages and underground garages	CA: minimal risk CE: minimal risk BE: minimal risk	CA: gen CE: att, spe BE: gen	CE: given the fact that the systems are installed in parking garages with the help of public funds, it is unlikely that no waste management plan is in place that ensures compliance with the waste hierarchy
New Research Building INATECH	CM: no risk **CA: cannot be excluded**	CM: att, reg CA: att, gen	CM: any publicly funded building should comply with the generic requirements on energy performance and this particular building is not dedicated to fossil fuel extraction, use or transport
E-Mobility in the car pool of BW police - purchase of pedelecs	CM: no risk CA: minimal risk CE: minimal risk	CM: att, no CA: gen CE: spe	CE: given the fact that these are publicly purchased e-bikes, it is very likely that batteries and/or electronics are treated according to the waste hierarchy and German regulations for potentially hazardous waste
Establishment of express bus lines in the Stuttgart region	CM: no risk CA: minimal risk CE: minimal risk	CM: att, no CA: gen CE: spe	CE: In cases where electric or H-fueled vehicles are used on the express lines, it is very likely that batteries and/or electronics are treated according to the waste hierarchy and German regulations for potentially hazardous waste

Source: own compilation and assessment

2.3 Step 1: Heuristic risk assessment

Article 17 of the Taxonomy defines significant harm to environmental objectives in a more heuristic manner. Step 1 of the validation process is an expert review by the authors to check whether there is a high risk in any of the projects.

Two types of definitions are necessary for that process. Firstly, the term *high risk* needs to be defined. Secondly, the description of the harm criteria needs to be framed in the form of *control questions* that can be easily and, more importantly, clearly evaluated. The third and final step is applying these criteria to all projects in the Green Bond.

2.3.1 Definition of high risk

Most of the DNSH criteria refer to environmental risks[4]. A full environmental risk assessment (ERA) is an extensive process, requires state-of-art methodologies and data and is usually conducted by a team of experts for different areas of protection (see Suter, 2001 for a comparison between environmental monitoring and risk assessment). This type of assessment is outside of the scope of the report at hand. Instead, high risk is defined by comparing the consequences (damages) of the project with the current status quo or the most common alternative:

> Projects have a high risk of violating DNSH if the magnitude of the potential damage and the likelihood for its occurrence are unequivocally higher (above reasonable variation) than the current practice or economic activity (including absence of these activities).

The restriction for "[...] reasonable variation [...]" refers to the comparison of systems that are very similar. This usually leads to small differences of effects also (e.g., of caused GHG emissions) that are mainly caused by variability of input parameters or their co-dependence on other systems. Both probability and potential damage should be higher not only in some, but in all cases ("unequivocally") or at least it cannot be ruled out by the reviewing expert.

The two parts of the definition (magnitude and likelihood) are evaluated separately, so there can also be a *high likelihood of some damage* and a *small likelihood of significant*[5] *damage*. We distinguish three cases:

1 | no risk: there is no high likelihood or significant damage anticipated
2 | low risk: there is either a high likelihood or significant damage anticipated
3 | high risk: both high likelihood and significant damage are anticipated

As a consequence, projects deemed to have "no risk" in any of the objectives are not further investigated. Only projects with "low risk" or "high risk" are further processed for step 2 (Applicability of Taxonomy), step 3 (Evaluation of DNSH criteria) and step 4 (Identification of indicators).

2.3.2 Control Questions

We distinguish four types of DNSH criteria:

- heuristic criteria (heu): the set of DNSH definitions described in Art. 17 of the regulation
- regulatory criteria (reg): criteria for DNSH violations that refer to adhering to European or national laws and regulations
- generic criteria (gen): criteria for DNSH violations (formulated in the annex of the regulation) that require an individual assessment but do not refer to specific economic activities

[4] We refer to risks on the environment and not to risks from the environment for health. Another term that can be used instead is "ecological risks".

[5] We use the term "significant" in line with its use in the EU Taxonomy ("significant contribution") rather than its formal meaning in statistics. Synonyms for its use are "considerable" or "noteworthy".

- specific criteria (spe): specific technical criteria for DNSH violations that refer to the economic activity they are associated with

The following Figure 2-1 shows the heuristic criteria for significant-harm in the EU Taxonomy regulation. These are used to develop control question for the first evaluation step.

Figure 2-1: article 17 of the Taxonomy Regulation

Article 17

Significant harm to environmental objectives

1. For the purposes of point (b) of Article 3, taking into account the life cycle of the products and services provided by an economic activity, including evidence from existing life-cycle assessments, that economic activity shall be considered to significantly harm:

(a) climate change mitigation, where that activity leads to significant greenhouse gas emissions;

(b) climate change adaptation, where that activity leads to an increased adverse impact of the current climate and the expected future climate, on the activity itself or on people, nature or assets;

(c) the sustainable use and protection of water and marine resources, where that activity is detrimental:

(i) to the good status or the good ecological potential of bodies of water, including surface water and groundwater; or

(ii) to the good environmental status of marine waters;

(d) the circular economy, including waste prevention and recycling, where:

(i) that activity leads to significant inefficiencies in the use of materials or in the direct or indirect use of natural resources such as non-renewable energy sources, raw materials, water and land at one or more stages of the life cycle of products, including in terms of durability, reparability, upgradability, reusability or recyclability of products;

(ii) that activity leads to a significant increase in the generation, incineration or disposal of waste, with the exception of the incineration of non-recyclable hazardous waste; or

(iii) the long-term disposal of waste may cause significant and long-term harm to the environment;

(e) pollution prevention and control, where that activity leads to a significant increase in the emissions of pollutants into air, water or land, as compared with the situation before the activity started; or

(f) the protection and restoration of biodiversity and ecosystems, where that activity is:

(i) significantly detrimental to the good condition and resilience of ecosystems; or

(ii) detrimental to the conservation status of habitats and species, including those of Union interest.

2. When assessing an economic activity against the criteria set out in paragraph 1, both the environmental impact of the activity itself and the environmental impact of the products and services provided by that activity throughout their life cycle shall be taken into account, in particular by considering the production, use and end of life of those products and services.

Source: European Commission, 2022

Based on this description, the following control questions are used for evaluation:

Is there a high risk that this project or program (taking the life cycle into account) [...]

- (**Climate Change Mitigation**) [...] leads to additional greenhouse gas emissions?
- (**Climate Change Adaptation**) [...] leads to adverse impacts of climate change on people, nature or assets?
- (**Water & Marine Resources**) [...] harms the good environmental status of water bodies or marine waters?
- (**Circular Economy**) [...] leads to inefficiencies in the use of materials and natural resources, increases the generation, incineration or disposal of waste or the long-term disposal of waste causes harm to the environment?
- (**Pollution Prevention and Control**) [...] leads to an increase in the emission of pollutants into water, land or air?

- (**Biodiversity and Ecosystems**) [...] harms the good condition of biodiversity and ecosystems (including the conservation status of habitats and species)?

2.3.3 Systems for comparison

The control questions always refer to the activities financed and a system for comparison. These systems or reference systems are selected to represent a logic of intervention. They usually refer to the Status Quo of systems that are intentionally to be improved or even replaced. However, in some cases the absence of these activities is the best system of comparison (e.g., when referring to the construction of new buildings).

2.3.4 Assessment of heuristic risks for new projects in Green Bond #3

Applying the definition for risk and the control questions, an assessment of these heuristic risks was conducted for 10 new projects in the current Bond. The full assessment for all 10 projects and programs can be found in the Annex, while the following table summarizes the results for all 3 projects that have a "low risk" (no "high risk" was identified). The assessment was conducted for all DNSH categories other than the category the project was mapped to by the issuer.

All projects relate to the comparison with the absence of the activities. It is assumed that these measures therefore cause additional damages to the other environmental objectives with all other things being equal. However, none of these risks is considered to be both high in magnitude and likelihood (the pre-requisite for medium or high risks).

Table 2-2: results of the heuristic risk assessment with the help of control questions related to Art. 17

(CM: Climate Change Mitigation; CE: Transition to Circular Economy; PP: Pollution Prevention and Control; BE: Protection of Biodiversity and Ecosystems)

Project	Obj.	risk	System for comparison	Reasoning
Combi Solution City Railway Karlsruhe (No 14)	CM	low	no changes to the public mobility infrastructures	entails a tunnel construction that could cause considerable damage but is unlikely in the city centre | construction work comes with primary material extraction | increased mobility on streets is likely to increase pollution slightly
Energy-efficient State housing funding (No 61)	CM	low	no construction of new residential buildings	modern buildings could be more vulnerable to global warming | there is also a small chance that additional buildings lead to significant disruptions in existing ecosystems
Funding Program Klimopass (No 17)	CA	low	no climate-change adaptation measures	it cannot be excluded that the measures negatively affect climate change mitigation (e.g. via changes to land-use), water-bodies or existing biotopes

Source: own assessment

2.4 Step 2: Applicability of EU Taxonomy for new projects

All 3 projects with a "low risk" attribution are also covered by the Taxonomy. The following table lists all projects, their applicability and the objectives covered by either generic or specific DNSH criteria.

Table 2-3: applicability of projects from risk assessment for EU Taxonomy

Project	Applicability	Activity in Taxonomy	Objectives with DNSH criteria (gen, spe)
Combi Solution City Railway Karlsruhe (No 14)	yes	6.14 - Infrastructure for rail transport	CA, WM, CE, PP, BE
Energy-efficient State housing funding (No 61)	yes	7.10 - Construction of new buildings	CA, WM, CE, PP, BE
Funding Program Klimopass (No 17)	yes	9.30 - Consultancy for physical climate risk management and adaptation	CM, WM, CE, PP, BE

Source: own assessment in comparison with EU Taxonomy Technical Screening Criteria

2.5 Step 3: Evaluation of DNSH criteria for new projects

The next step is to identify whether any of these criteria require efforts beyond existing laws or regulation in Germany. We distinguish three types of DNSH criteria for that purpose:

- (1) Specific technical criteria in the context of activities
- (2) Regulatory criteria in the context of activities
- (3) Generic criteria requiring project-specific assessments

Criteria of type (1) are assessed individually as shown in Table 2-4.

For criteria of type (2), a "minimal risk" is assumed. All projects in the risk assessment adhere to national regulations and it is very likely that these regulations are in accordance with the European requirements described in the Taxonomy.

For criteria of type (3), individual risk assessments would be necessary to fully comply with the taxonomy. This is not possible due to lack of data and methodology. Instead, we distinguish three additional cases. First, "minimal risk" is assigned, if the original heuristic risk assessment from step 1 did not reveal a higher probability or a higher damage potential. Secondly, we assign "significant harm cannot be excluded" if these objectives were indeed considered to have "low risk" in the original assessment. Thirdly, "no risk" is assigned if the generic requirements of the Taxonomy are in line with German law and regulation.

As a result, 2 out of a total of 10 new projects in the Green Bond can be associated with a noteworthy risk (other than "minimal") of DNSH violations. The identified issues refer to civil engineering (tunnel construction for project No 14) or building construction (project 61). In each of these cases, it cannot be ensured that material climate change adaptation as well as violations of targets for biodiversity and ecosystems are accounted for by the responsible

stakeholders. In addition, it can also not be ensured that project No 14 is in line with the generic requirements for a circular economy.

In the next and final step of the validation, it is evaluated whether additional hazard-indicators are necessary to manage the remaining risks.

Table 2-4: DNSH evaluation of projects from risk assessment that are applicable to the Taxonomy Regulation

(att: highlighted in 1st evaluation | reg: regulatory requirements | gen: generic requirements | spe: specific requirements in Taxonomy regulation)

Project	DNSH Risk	DNSH Type	Assessment of specific risks
Combi Solution City Railway Karlsruhe (No 14)	**CA: significant harm cannot be excluded** WM: minimal risk **CE: significant harm cannot be excluded** **PP: significant harm cannot be excluded** BE: minimal risk	CA: gen, att WM: gen CE: reg, spe, att PP: reg, gen, att BE: reg, gen	CE: no information available that attests to the fact that tunnel and other construction activities adhere to the regulatory as well as specific requirements
Energy-efficient State housing funding (No 61)	**CA: significant harm cannot be excluded** WM: no risk CE: minimal risk PP: minimal risk **BE: significant harm cannot be excluded**	CA: gen, att WM: spe CE: reg PP: gen, reg, spe BE: reg, gen, att	WM: there is a high probability that some portion of the building exceed the requirements for water consumption, but residential buildings are exempt from this regulation PP: some buildings might exceed the maximum thresholds, but it is unlikely for new energy-efficient buildings dedicated to affordable/social housing; there is still a minimum risk (regulatory) though
Funding Program Klimopass (No 17)	CM: no risk WM: no risk BE: no risk	CM: spe, att WM: no, att BE: no, att	CM: It is highly unlikely that any of the measures implemented as a consequence of grants will in any way be connected to the production, storage or transport of fossil fuels

Source: own assessment

2.6 Step 4: Individual risk assessment for new projects

Hazards or rebounds in the impact report indicate the risk for target conflicts and in particular potential violations of the DNSH criteria of the EU taxonomy. They are subject to an individual assessment if significant harm to other objectives cannot be ruled out.

The validation of the issuer's DNSH assessment in the report at hand identified 2 projects where this type of risks can occur. For project No 14 (Combi Solution Railway Karlsruhe) generic risks to CA, CE and PP could not be excluded. Looking at the project[6], it is reasonable to assume that potential violations of pollution prevention date back to the actual construction (which has been finished) and are now not higher than the traffic before the

[6] https://www.karlsruhe.de/stadt-rathaus/aktuelles/meldungen/kombiloesung-abgeschlossen-tunnel-erfuellt-die-prognosen

tunnel construction (they could, in fact, be lower now). There is also no plausible reason to assume that the measures violated climate change adaptation, since all above-ground changes have been planned to be restored to their original condition. The same is true for any ecosystems (unlikely to exist in the city centre anyway).

Regarding project 61 (energy-efficient State housing funding), the same conditions apply as for other building projects assessed in previous bonds:

> *"The State of Baden-Württemberg (as issuer) is aware of these (and other building-related) risks and has not only developed a climate-adaptation strategy but also monitors its progress (Ministerium für Umwelt, Klima und Energiewirtschaft Baden-Württemberg & LUBW Landesanstalt für Umwelt Baden-Württemberg, 2021; Ministerium für Umwelt, Klima und Energiewirtschaft Baden-Württemberg & LUBW Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Württemberg, 2015). In our opinion, these measures ensure (at least for now) that no additional climate risks are caused by these projects that constitute a "significant harm"."*

2.7 Summary of DNSH risks

We concur with the assessment of the issuer that none of the projects in the Green Bond pose a high or even medium risk for significant damage to any of the environmental objectives. Minimal risks could be identified for 2 out of 10 new projects, both of which are concerned with construction activities. There is no evidence that any of these violations occur.

3 Methodology

The following sections first present the methodology (indicator classification, robustness criteria, adaptation of ICMA framework), followed by a description of the selection and quantification of indicators in each of the six environmental objectives.

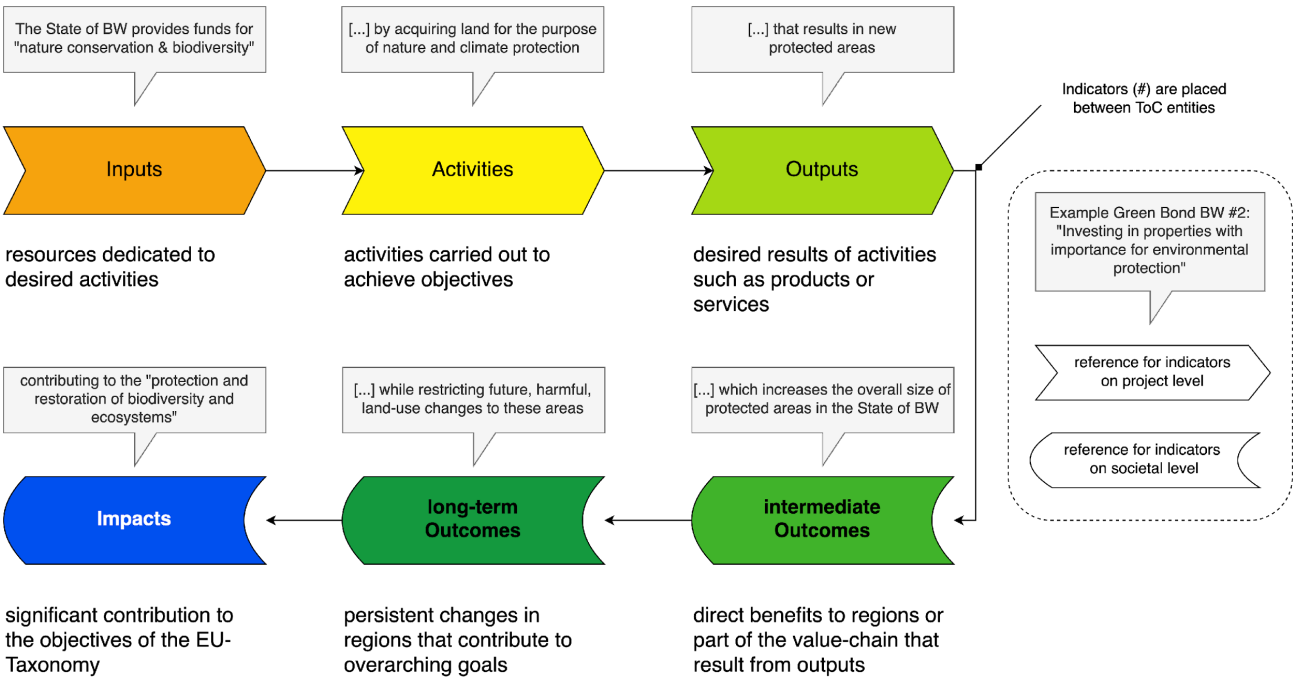
3.1 Indicator Quality

The impact assessment at hand not only identifies and selects key performance indicators of the projects financed, but also qualifies them in relation to their societal or ecological relevance. Any quantifiable metric can be assessed in its ability to contribute to targets or to measure success.

We apply a theory-of-change (ToC) logic for that purpose which is in line with other assessments by the authors (Ministerium für Finanzen Baden-Württemberg, 2023b, p. 11) as well as current practices for SDG mapping (Dangelmaier, 2019). At its core, a ToC allows the distinction of different types of indicators depending on their position in a cause-effect chain. The following figure shows our terminology and examples for them.

The current figure was updated according to the progress in the project. It now shows where indicators are located in the ToC and how indicator quality not only depends on its location but also on the level of attribution by different actors along the value chain. For example, the funding of communities, so they can implement measures to improve cycling and pedestrian mobility, is considered an indicator with quality E (*by State of BW or its agencies*), while the number of implemented measures by these communities (*by project stakeholders*) would be considered a D indicator.

Figure 3-1: terminology and logic for indicator quality in Green Bond Baden-Württemberg
(own compilation based on Teubler, 2022)



Source: own compilation

Any project, program or measure in the Green Bond can achieve every type of indicator quality (one project can have more than one indicator). However, providing evidence for changes on a societal level and tracking these changes back to financing is very difficult. In most cases, inputs and activities are the only indicators that can be reported without the use of models and assumptions on the additionality of these measures. As a rule of thumb, data and method requirements increase with higher indicator quality (up to a point where most projects cannot be robustly related to societal outcomes).

In addition, the Green Bond BW is unique in the way that it aims to contribute to all six environmental objectives of the EU Taxonomy regulation while also adhering to the regulation's do-no-significant-harm criteria. This is a potential for target-conflicts that the methodology needs to address. We therefore introduce two additional types of indicators that should be reported if these target conflicts are likely: hazard-indicators and rebound-indicators. Both are measures of probability and damage, intended to be control variables when re-financing green projects. Hazards indicate the risk for significant-harm to the five other objectives and rebounds the compensation or even over-compensation of target contribution. An example for such a direct rebound would be the financing of energy-efficiency measures in companies that in turn lead to additional energy use from expanding the economic activity.

Hazard-indicators are, for the purpose of reporting, specified as a qualitative indicator (quality F) for a certain project, if this project is associated with any risks according to the risk assessment in section 2. Rebound-indicators are described if a violation of DNSH criteria cannot be excluded or is considered to be a low risk or higher.

All indicators are color-coded and classified from A to G based on the logic of European energy-efficiency classifications (see Table 3-1). In theory, indicators could also measure and track impacts which represent the persistent improvement of overarching goals. We did not include the possibility in the table shown here. If needed, such an indicator could be classified as A+, but we currently see no option how the impact assessment of a Green Bond could provide evidence for that.

Table 3-1: color-coded indicator quality for indicators in the report at hand

Color Code	Indicator Quality	Interpretation for Reader
long-term outcomes	A	**best-needed** (unequivocal evidence for substantial contribution)
intermediate outcomes	B	**best-in-class** (strong evidence for substantial contribution)
outputs	C	**best practice** (high likelihood of substantial contribution)
activities	D	**high standard** (indication of substantial contribution)
inputs	E	**minimum requirement** (aligned with EU Taxonomy objectives)
hazards	F	minimal risks for DNSH
potential rebounds	G	to be investigated in order to ensure DNSH compability

Source: own compilation

3.2 Criteria for Robustness of Reporting

Each reported value depends on the robustness of the input data for indicator quantification. We differentiate five types of robustness ranging from 1 (best) to 5 (lowest) as shown in Table 3-2. The main criterion is the necessity of calculation or models (robustness of 2, 3 or 4) and the availability of primary data (robustness of 1 or 2). Primary data in this context are actual reported values (e.g., in monitoring reports), official statistics as well as any direct data input by the issuer or the related state agencies (e.g., eligible expenditures from the state's budget). Secondary data mainly consists of scientific findings and reports as well as press releases by state ministries and agencies. Auxiliary variables are data that are needed to convert or estimate results. They can be of high quality (e.g., global warming potentials in IPCC reports) but are independent of the systems assessed in each category. The final and lowest robustness is attributed to data that required calculation by 3rd parties but cannot be replicated due to lack of data or reporting on the method used. The lowest robustness is also attributed to effects that relate to future planning (e.g. the number of researchers in a facility under construction).

Most indicators of high quality are expected to show a lower robustness, because they are usually not measured directly and require the use of models and additional secondary data. On the other hand, most low-quality indicators usually exhibit a high robustness. Only few data points and calculations are needed, or they are even directly part of the underlying framework (such as agreed funding in a regulation).

Table 3-2: robustness criteria for data collection and quantification

Robustness	Criteria	Examples
1	primary data (directly reported or monitored)	number of approved grants for broadband expansion
2	directly calculated from primary data	energy use of buildings based on energy demand per floor area and year
3	calculated with the help of secondary data, auxiliary variables, share of financing assumptions	GHG savings from direct input on the energy demand of buildings before and after renovation
4	estimated on the basis of models or relations that simplify the cause-effect-relationships	promoted organic farming area based on funding per hectare in a regulation
5	results from 3rd party reporting without the possibility for validation or future effects	number of families benefiting from funding for agroforestry projects

Source: own compilation

3.3 Adaptation of ICMA reporting template

We use the templates provided by the International Capital Market Association (ICMA) as a basis for our own reporting (ICMA, 2022) but adapted them to the needs of a Green Bond

issued by a federal state in Germany. Apart from providing information on the quality of indicators, we set-up the following conventions.

- In our first convention, we assume that the eligibility for Green Bonds is 100% in all cases, as corroborated by a SPO and the issuer's framework (see summary).
- In our second convention, we omit the information on the lifetime of projects. All parts of the impact reporting refer to the expenditures in the state's budget for one year. Some projects (usually state programs) exceed the lifetime of one year and some related systems are anticipated to show benefits well beyond the scope of state financing. In addition, not all funds in the state's yearly expenditure cover direct investments or costs from the same budget year but can also include allocations from previous budget years (as approved grants could be funded later on). We think that providing a value for the project lifetime would obscure these effects rather than increase transparency.
- Thirdly, all effects are reported on an annual basis. The reason for that is partially based on the reasoning for our second convention (omittance of project lifetime). However, reporting annual effects also allows to accumulate effects over several bonds.
- Our fourth convention is an extension of the reporting template. We distinguish between "full effects" and "financed" effects. Not all established full effects can also be attributed to financed effects and vice versa. For the most part though, financed effects are a direct result from the "share of financing" provided in the results tables in the annex.

3.4 Update of the reporting template

The current impact report is the third conducted by Wuppertal Institute. Many projects funded by the state of Baden-Württemberg have been repeatedly assessed in the previous two reports (both regarding DNSH risks and the desired outcomes).

We decided to incorporate these previous findings in a more concise manner. Both the risk assessment and the estimation of indicators is now separated into two parts as shown in table 3-3. Thus, the recurring projects are not explained in detail in this report again but summarized. New projects, which haven’t been in the previous bonds, get their own sub-section with explanations and indicators like all projects previously.

Table 3-3: handling of previous assessed and new projects for impact report #3

Chapter	Reference	Depiction in current report
Risks I	recurring projects	summary of previous assessment
Risks II	new projects	full reporting for each assessment step
Indicators I	recurring projects	written and tabled summary for each category
Indicators II	new projects	sub-section for each new project

Source: own compilation

3.5 Selection criteria for accumulation

The current report is the first to accumulate the results for some indicators of projects that have been included in at least one other impact report.

Only a small portion of indicators are eligible for such an aggregation, since many indicators

- can only be quantified in an absolute manner (e.g. distance-to-target) or relate to ex-ante estimations of future absolute effects (e.g. jobs in future research buildings) or
- cannot be clearly attributed to the year of budget allocation (e.g. bicycle pathways).

We thus decided to focus the accumulation on indicators that (i) belong to neither of these categories and (ii) correspond to at least the output-level of the projects (quality C or higher).

4 Data and Results

The following sections describe the results for projects that could be associated with inputs (E), activities (D), outputs (C), intermediate-outcomes (B) or long-term outcomes (A) (see also section 3.1) in each of the six environmental objectives:

- Climate Change Mitigation (CM)
- Climate Change Adaptation (CA)
- Water and Marine Resources (WM)
- Circular Economy (CE)
- Pollution Prevention (PP)
- Biodiversity and Ecosystems (BE)

For 4 out of 59 projects, no such assessment could be made due to lack of data or lack of a plausible Theory-of-Change. All of these projects are considered to be "eligible" and there is no reason to assume that these projects do not contribute to the overarching objectives.

4.1 Accumulated effects over Bond #1, #2 and #3

Some of the projects have received funding for a longer time period and have already been successfully assessed in the previous impact reports #1 and #2. We selected 13 such projects that each achieved, at least, an indicator quality of C and summed up the effect with the highest quality. The following Table 4-1 shows the results and conveys to the reader how projects in the Green Bond Baden-Württemberg also contribute to long-term desired changes in the State (and therefore indirectly, the financing thereof).

Table 4-1: accumulative indicators in impact reports (IR) #1, #2, #3
(only three projects have been present in all three impact reports)

Project*	Objective*	Indicator*	Quality*	IR #1-#3
Research Programme Organic Farming	BE	no of scientific publications	C	5.9
Aid for pruning of meadow orchards	BE	number of pruned trees	C	284,188
Preserving manually cultivable vineyards	BE	additional organically farmed area	C	146 ha
Preserving steep-hill grassland	BE	promoted area for organic/sustainable farming	C	91,242 ha
Investing in properties with importance for environmental protection	BE	additional protected area	C	253 ha
Professorship for Sustainability Research and Transformative Research	CE	finished theses	C	25.0

Project*	Objective*	Indicator*	Quality*	IR #1-#3
KARLA - Karlsruhe Reallabor for Sustainable Climate Protection	CM	no of published peer-reviewed articles	C	0.8
Solar Battery Storage Systems	CM	renewable storage capacity added	C	30 MWh
Notably energy-efficient restructuring measures in the public building construction	CM	GHG emissions avoided per year	C	98 t CO2e/a
Notably energy-efficient new buildings in the public building construction	CM	GHG emissions avoided per year	C	875 t CO2e/a
Remediation of contaminated sites	PP	implemented measures of remediation	C	74
Water supply	WM	no of implemented measures	C	145
Sewerage infrastructure investments	WM	no of implemented measures	C	274
* All names, units, objectives, values, and quality selections refer to the newest impact import at hand (if there have been changes at all)				

Source: own compilation

4.2 Climate Change Mitigation

This section describes the assessment of effects regarding the objective “climate change mitigation”. In total, 26 projects were assessed that contributed to 77 indicators, of which 40 indicators achieve an indicator quality of D or higher. 22 projects have been assessed the same way as last year’s bond (see section 4.2.1). Only the four new projects get their own respective sections with explanations of data and methods.

For 6 projects, so-called desired outcomes (indicator quality B) could be identified that represent “strong evidence for a substantial contribution” to the environmental objective of “climate change mitigation”.

The following Table 4-2 lists these six projects and their desired outcomes. It also shows how long-term benefits as “unequivocal evidence for substantial contributions” could be potentially ensured.

Table 4-2: Best-in-Class or Best-Needed indicators for Green Bond Baden-Württemberg #3 in the area of "Climate Change Mitigation"

Project	**Strong evidence for substantial contribution** (Quality B)	**Criteria for unequivocal evidence** (Quality A)
No 16: Funding programme climate protection plus	annual GHG reductions	The actual GHG reductions are not overcompensated by other interventions in the State.
No 34: Notably energy-efficient new buildings in the public building construction	GHG emission reduction compared to 1990	The total GHG emissions of public buildings in the State of BW decreased and continues to decrease in the future.
No 35: Notably energy-efficient restructuring measures in the public building construction	GHG emission reduction compared to 1990	The total GHG emissions of public buildings in the State of BW decreased and continues to decrease in the future.
No 40: CAMPUS high i - Intelligent and user-oriented planning processes for climate neutrality in buildings	future GHG reduction (estimated, building 1)	The GHG reductions become reality, while the total GHG emissions of the campus decrease and continues to decrease in the future.
No 44: Mobility Living Lab (MobiLab) Stuttgart	reduction of GHG emissions	Planned reductions are achieved and maintained
No 12: state funding of broadband	GHG reductions of broadband systems compared to conventional connections	The total GHG emissions from data transfer in the State of BW decreased and continues to decrease in the future.

Source: own compilation

The following sections describe which data and methods were used for this assessment. For some of the projects, savings in greenhouse gas (GHG) emissions could be estimated as an indicator for the contribution to climate protection goals (out of a total of estimated annual GHG savings of 5,000 tons, circa 450 tons could directly be attributed to financing). In each of these cases, the global warming potential over 100 years (GWP 100a) was used as a metric. The GWP is the standard for calculating GHG effects and expressed in kg of CO_2-equivalents. The reports by the International Panel on Climate Change (IPCC) are the main source for the corresponding GWP factors for greenhouse gases.

4.2.1 Summary of recurring projects

The following table shows the results for all projects that have already been assessed in the previous report and for which no new calculation method had to be developed. Although the values have changed, their sources and reasoning has not. This means that (i) each indicator refers to the same source for primary data (usually the issuer or a related agency) and that (ii) each indicator with a robustness lower than 1 was calculated in the same manner as described previously in Teubler & Schekira (2023).

table 4-1: Projects from previous bonds in climate change mitigation
(*changed from E to D in current report)

Project	Indicator	Q_R	Effect $_{full}$	Effect f_{in}
No 1: Fast cycling routes	bicycle lanes	C_1	1 km	1 km
	funding for communities	E_1	EUR 0.8m	EUR 0.8m
No 2: Planning and construction of cycle routes on state roads	constructed cycle-paths	C_1	28 km	28 km
	funding of cycle route construction	E_1	EUR 21m	EUR 21m
No 3: Support program state initiative electromobility	no of implementations by stakeholders (disbursements)	D_1	2,105	not available
	no of approvals for electromobility measures	E_1	EUR 576m	EUR 576m
No 7: Municipal Cycling and Pedestrian Infrastructure Program	communities funded	D_1*	96	96
	funding for communities	E_1	EUR 151m	EUR 151m
No 8: Cycling routes network	communities funded	D_1*	223	223
	funding for communities	E_1	EUR 2.7m	EUR 2.7m
No 9: Cycling Culture Initiative	communities funded	D_1*	20	20
	funding for communities	E_1	EUR 2.7m	EUR 2.7m
No 13: GVFG Electrification Projects	additional electrified railway	D_1	no physical changes in 2022	
	funding for electrification of rail traffic	E_1	EUR 0.5m	EUR 0.5m
No 23: Regional centers of excellence for energy efficiency	evaluated energy efficiency measures	C_1	33	not available
	energy consultations in companies	D_1	107	not available
	no of arranged consultation	E_1	EUR 0.8m	EUR 0.8m
No 24: Enhanced Resource Efficiency Programme/Combi loan for SMEs with climate bonus	no of loans by housebanks	D_1	77	77
	funding for resource efficiency in SMEs	E_1	EUR 2m	EUR 2m
No 25: Energy-efficient heat networks	communities funded	D_1*	18	18
	funding for communities	E_1	EUR 2.4m	EUR 2.4m
No 26: INPUT: Intelligent parking & underground garages	no of projects funded	D_1*	18	18
	funding for projects	E_1	EUR 2.8m	EUR 2.8m
No 27: Solar Battery Storage Systems	renewable storage capacity added	C_4	Not available	20.1 MWh
	funding for renewable battery capacity	E_1	Not available	EUR 8m
No 28 & No 58: HyFab BW	no of future employees (researchers)	C_5	10	Not available
	funding for research infrastructure	E_1	EUR 18.3m	EUR 4.4m
No 34: energy-efficient new buildings in the public building construction	GHG emissions compared to 1990	B_3	94%	6.7%
	GHG emissions avoided per year	C_3	7,547 t CO2e/a	540 t CO2e/a
	energy-efficient net floor area added	D_3	244,073 m^2	17,464 m^2
	funding for public buildings	E_1	EUR 1,423m	EUR 101.8m

Project	Indicator	Q_R	Effect full	Effect f_{in}
No 35: energy-efficient restructuring measures in the public building construction	GHG emissions compared to 1990	B_3	73%	5.5%
	GHG emissions avoided per year	C_3	440 t CO2e/a	33 t CO2e/a
	Energy-efficient net floor area added	D_3	54,202 m^2	4,064 m^2
	Funding for public buildings	E_1	EUR 275.1m	EUR 20.6m
No 40: CAMPUS high I – Campus made intelligent	future GHG reductions (estimated, building 1)	B_5	631 t CO_2e/a	not available
	no of funded projects	D_1*	4	4
	funding for climate neutrality in buildings	E_1	EUR 0.3m	EUR 0.3m
No 41: KARLA – Karlsruhe Reallabor for Sustainable Climate Protection	no of published peer-reviewed articles	C_1	1	0.78
	no of activities (presentations, articles, etc.)	D_1	41	31.8
	funding for projects & activities	E_1	EUR 0.4m	EUR 0.3m
No 42: KliConn - Climate Connect Industrial area Donautal	no of workshops conducted	D_1	29	4.31
	funding for climate change mitigation strategies	E_1	EUR 1.6m	EUR 0.2m
No 43: Reallabor for climate-neutral Reutlingen	no of projects (measure bundles)	D_1	19	not available
	funding for real-world laboratories	E_1	not available	EUR 0.32m
No 44: Mobility Living Lab Stuttgart (MobiLab)	Reduction of GHG emissions	B_1	33%	not available
	no of jobs	C_1	5	not available
	no of projects	D_1	10	2.7
	Funding for real-world laboratories	E_1	EUR 3.5m	EUR 0.9m
No 57: High Efficiency Solar Cells	no of persons working at site in the future (approx.)	C_5	68	1
	research building construction (and equipment)	D_1	100 %	2 %
	funding for research infrastructure	E_1	EUR 34m	EUR 0.7m
No 60: State funding of broadband	GHG reductions of broadband system compared to conventional connections	B_4	660 t CO_2e/a	78 t CO_2e/a
	Energy savings from network access compared to conventional connections	C_3	436 MWh/a	52 MWh/a
	Additional broadband connections	D_1	88,806	10,563
	Funding for broadband	E_1	EUR 805m	EUR 96m

Source: own calculation based on previous reporting and methods

The following section describes the newly assessed projects, their effects according to the indicator-quality and evaluate the robustness of these effects. Models and proxy data were required for 1 out of 5 new projects.

4.2.2 Funding for personnel in the field of sustainable mobility

The state funds staff positions for municipalities in the area of sustainable mobility (KEA-BW, 2023). In 2022, expenditures of EUR 2.82m were attributed to this project, which constitutes circa 50% of the overall costs.

One additional indicator has been identified and assessed.

- Based on the maximum grants for each position (EUR 78,600 according to KEA-BW, (2023)), it can be estimated that the funding guarantees 35.9 jobs financed and 71.1 jobs in total (indicator with quality D).

The following table lists the results and evaluates the robustness.

Table 4-3: results for the project "Funding of personnel in the field of sustainable mobility (No 6)"

indicator	quality	full effect	financed effect	robustness
no of job-equivalents for sustainable mobility personnel	D	72	36	3
funding for sustainable mobility	E	EUR 6m	EUR 3m	1

Source: own calculation based on lump sums in KEA-BW, (2023)

4.2.3 Combi Solution City Railway Karlsruhe

The combi solution for the city of Karlsruhe comprises of several construction projects (over eleven years) that were intended to further develop the local tramway and urban rail system. It involved — among other efforts — a new tunnel beneath the city center.

In 2022, the state of Baden-Württemberg funded the project with EUR 68.9m which represents about 6% of the total costs for the entire system.

Two additional indicators have been identified and assessed.

- The average travel time for public transport could be reduced by five minutes according to the local transport association (KVV, 2022). This constitutes an output-indicator (C) with a low robustness.
- The traffic performance for public transports increases (or has increased) by 316 pkm per year (according to issuer and related agency), which represents an activity-indicator (D) with a high robustness.

The following table lists the results and evaluates the robustness.

Table 4-4: results for the project "Combi Solution City Railway Karlsruhe (No 14)"

indicator	quality	full effect	financed effect	robustness
average reduction in travel time for public transport	C	300 sec	19 sec	5
traffic performance of more effective public transport systems	D	316 pkm	20 pkm	1
funding for public rail transport	E	EUR 1.105m	EUR 69m	1

Source: own compilation based on issuer data and public information

4.2.4 Funding programme climate protection plus

The programme climate protection plus comprises of several measures intended to contribute to the State's target for climate change mitigation. It includes direct measures for energy and

climate efficiency, refurbishment of buildings as well as qualification and information programmes. In 2022, the programme was funded with EUR 8.1m which represents a 30% share of financing according to the issuer and the related agency.

Three additional indicators have been identified and assessed.

- The programme is likely to contribute to annual GHG savings of more than 2,200 tons of CO2e annually (according to issuer and related agency). This constitutes an intermediate outcome (B) with a high robustness.
- Each measures saves – on average – 35 tons of CO2e, which can be understood as output-indicator with a high robustness.
- Overall, 64 measures have been implemented in 2022. This activity-indicator (D) has a high robustness as well (data according to issuer and related agency).

The following table lists the results and evaluates the robustness.

Table 4-5: results for the project "Funding programme climate protection plus (No 16)"

indicator	quality	full effect	financed effect	robustness
annual GHG reductions	B	2,229 t CO2e/a	669 t CO2e/a	1
GHG reduction per measure	C	35 t CO2e/1	35 t CO2e/1	1
no of renovation measures	D	64	19	1
funding for climate protection consulting & measures	E	EUR 27m	EUR 8m	1

Source: own compilation based on issuer data

4.2.5 autoKite

The Ministry of Science, Research and the Arts (MWK) of the state of Baden-Württemberg is funding the joint project autoKite as part of a contribution to the development and utilization of sustainable energy sources. It aims to investigate the fundamentals of kites as a drive for airborne wind energy in the maritime sector. In 2022, the state funded the projects with EUR 1.2m, which represents a share of financing of 49% according to the issuer and the related agency.

Two additional indicators have been identified and assessed.

- The technology achieved a technology readiness level of 5 (technology validated in relevant environment) according to the researchers. This constitutes an output-indicator (C) with a high robustness.
- The researchers have published five relevant conference papers according to the issuer and the related agency, which represents an activity-indicator with a high robustness as well.

The following table lists the results and evaluates the robustness.

Table 4-6: results for the project "autoKite (No 38)"

indicator	quality	full effect	financed effect	robustness
technology readiness level of prototype	C	5	5	1
no of publications	D	5	2.5	1
funding for research (kite for maritime wind energy)	E	EUR 2.4m	EUR 1.2m	1

Source: own compilation based on issuer data

4.2.6 Energy-efficient State housing funding

The State housing subsidy is financed by federal financial assistance, a grant contribution from L-Bank, and state funds. The portion of state funds reported as eligible for the Green Bond concerns the financing over several years of subsidized projects for the construction and acquisition of socially tied new housing in the budget year 2022. The state funded the project with EUR 54.9m, which represents a share of financing of circa 50% according to the issuer and the related agency.

Two additional indicators have been identified and assessed.

- The number of funded housing units, with a 45% to 60% reduction of primary energy demand compared to reference buildings. This represents an output-indicator (C) with a high robustness based on data by the responsible agency.
- The share of non-refundable grants for NZEG (Nearly zero-energy house), which constitutes an activity-indicator (D) with a high robustness as well.

The following table lists the result and evaluates the robustness.

Table 4-7: results for the project "Energy-efficient state housing funding (No 61)"

indicator	quality	full effect	financed effect	robustness
No of funded housing units	C	810	407.7	1
Share of non-refundable grants for NZEB	D	100 %	100 %	1
Funding for nearly-zero-energy-buildings (NZEB)	E	EUR 109.1m	EUR 54.9m	1

Source: own compilation based on issuer data

4.3 Climate Change Adaptation

This section describes the assessment of effects regarding the objective “climate change adaptation”. Three eligible projects with total expenditures of EUR 9.3m could be assessed. 10 indicators were identified in total, of which 7 indicators at least related to activities.

For one project, a desired outcome could be reported that represent positive societal changes beyond the scope of direct project results (annual absorbed carbon from silvicultural

measures). This can be considered “strong evidence for substantial contributions” towards the environmental objectives of the EU taxonomy (with an additional 2 projects showing a “high likelihood of substantial contribution”). The following table lists this project and its desired outcome. It also shows how long-term benefits as “unequivocal evidence for substantial contributions” could be ensured. These criteria are going to be investigated for any project in this list that is also part of the next Green Bond.

Table 4-8: Best-in-Class indicators for Green Bond Baden-Württemberg #3 in “Climate Change Adaptation”

Project	**Strong evidence for substantial contribution** (Quality B)	**Criteria for unequivocal evidence** (Quality A)
No 52: Silvicultural measures	annual absorbed carbon (carbon sink)	regulations are in place that ensure a continuous protection of forests that are resilient to climate change

Source: own compilation

4.3.1 Summary of recurring projects

The following table lists all projects that are part of the current Green Bond, but already have been assessed in the previous impact report. Changes are thus limited to the actual values and, in some cases, to the quality and robustness of indicators.

Table 4-9: projects from the previous Green Bond towards “Climate Change Adaptation”

Project	Indicator	Q_R	Effect $_{full}$	Effect $_{financed}$
No 53: Timber Construction Initiative BW	No of approved timber buildings	C_1	5,684	Not available
	No of events	D_1	173	173
	Funding for sustainable construction	E_1	EUR 6.7m	EUR 6.7m

Source: own compilation based on issuer data

The following section describes the newly assessed projects, their effects according to the indicator-quality and evaluate the robustness of these effects. Models and proxy data were required for 1 out of 2 new projects.

4.3.2 Funding Program Klimopass

The aim of the funding program KLIMOPASS is to support municipalities in Baden-Württemberg, as well as small and medium-sized enterprises, in initiating adaptation to climate change and implementing specific adaptation measures. In 2022, the state funding for this program amounted to EUR 0.6m EUR, which represents a share of financing of 65% according to the agency.

Two additional indicators have been identified and assessed.

- The number of climate change adaptation measures, which is reported as an output-indicator (C) with a high robustness based on primary data by the responsible agency.

- The number of CCA (climate change adaptation) analyses and consultations, which represents an activity-indicator (D) with a high robustness as well.

The following table lists the indicators and evaluates the robustness.

Table 4-10: results for the project "Funding Programme Klimopass (No 17)"

indicator	quality	full effect	financed effect	robustness
No of climate change adaptation measures	C	24	16	1
No of CCA analysis and consultations	D	13	8.5	1
Funding for climate change adaptation (CCA) measures	E	EUR 0.88m	EUR 0.57m	1

Source: own compilation based on issuer data

4.3.3 Silvicultural Measures

This project supports the afforestation and reforestation of forests in the state of Baden-Württemberg. In 2022, the state's share of financing was 40%, amounting to EUR 2.1m. This sum includes expenses for seedlings and planting of seeds and sowing, as well as any necessary follow-up work, cultural safeguarding measures, growth covers, and irrigation measures.

Three additional indicators have been identified and assessed:

- The annually absorbed carbon, as forest acts as a carbon sink, represents an intermediate outcome-indicator (B) with a lower robustness. The estimated 1,400 t C/a (or 560 t C/a from financing alone) are based on a proxy of 1.16 C / (ha*a) for "remaining forests" according to UBA, (2020, p. 631).
- The total stored carbon in biomass above and below ground, which is reported as an output-indicator (C) with a lower robustness. The estimated 119,900 t C (or 48,000 from financing alone) is based on the statistical value of 99.45 t/ha stored carbon in biomass in Germany according to FAO, (2020, p. 37).
- The area of promoted forest area which is a combination of afforestation and reforestation and represents an activity-indicator (D) with a high robustness due to primary reporting by the responsible agency.

The following table lists the results and evaluates the robustness.

Table 4-11: results for the project "Silvicultural measures (No 52)"

indicator	quality	full effect	financed effect	robustness
Annually absorbed carbon (carbon sink)	B	1,400 t C/a	560 t C/a	3
Stored carbon (biomass above and below ground)	C	119,900 t C	48,000 t C	3
Promoted forest area	D	1,205 ha	482 ha	1
Funding for afforestation and reforestation	E	EUR 5.3m	EUR 2.1m	1

Source: own compilation based on issuer data and literature

4.4 Water and Marine Resources

This section describes the assessment of effects regarding the objective “sustainable use and protection of water and marine resources”. Both eligible projects with total expenditures of EUR 52.7m could be assessed. 6 indicators were identified in total, of which 4 indicators at least relate to activities. Both projects were associated with at least a “high likelihood of substantial contribution” (indicators with quality C) by implementing a total of 235 measures for sewerage infrastructures and water supply.

In this year’s bond, no new project for this category was added.

4.4.1 Summary of recurring projects

The following table lists all projects that are part of the current Green Bond, but already have been assessed in the previous impact report. Changes are thus limited to the actual values and, in some cases, to the quality and robustness of indicators.

Table 4-12: projects from previous Green Bonds towards “Water and Marine Resources”

Project	Indicator	Q_R	Effect $_{full}$	Effect $_{financed}$
No 21: Sewerage infrastructure investments	No of implemented measures	C_1	148	148
	No of funded communities	D_1	120	120
	Funding for remediation activities	E_1	EUR 38.8m	EUR 38.8m
No 22: Water supply	No of implemented measures	C_1	87	87
	No of funded communities	D_1	75	75
	Funding for remediation activities	E_1	EUR 13.97m	EUR 13.97m

Source: own compilation based on issuer data

4.5 Circular Economy

This section describes the assessment of effects regarding the objective “transition to a circular economy”. All 6 projects with total expenditures of EUR 17.0m could be assessed. 16 indicators were identified in total, of which 9 indicators at least related to activities and 1 project could be associated with potential, but neglectable DNSH risks. 4 projects were

associated with at least a “high likelihood of substantial contribution” (indicators with quality C).

4.5.1 Summary of recurring projects

The following table lists all projects that are part of the current Green Bond, but already have been assessed in the previous impact report. Changes are thus limited to the actual values and, in some cases, to the quality and robustness of indicators.

Table 4-13: projects from the previous Green Bond towards “Circular Economy”

Project	Indicator	Q_R	Effect full	Effect financed
No 19: Phosphorus recovery from sewage sludge	Future potentials of recovered phosphorus	C_5	1,500 t/a	343 t/a
	Building construction (fertilizer recovery plant)	D_1	100 %	22.9 %
	Funding for research buildings (circular economy)	E_1	EUR 12m	EUR 2.7m
No 39: Professorship for Sustainable Research and Transformative Research	Finished theses	C_1	18	18
	Funding for research (circular economy)	D_1	EUR 0.1m	EUR 0.1m
No 46: RecTecKA – Recycling of technology metals from the dismantling of nuclear facilities	No of nuclear plants to be dismantled	D_1	5	5
	Funding for material recovery research	E_1	EUR 0.02m	EUR 0.02m
No 51: Strategy for sustainable bio-economy	Number of events held	D_1	18	18
	Funding for bio-economy	E_1	EUR 12.3m	EUR 12.3m
No 56: New Research Building INATECH	No of future employees	C_5	113	0.7
	Building construction (research)	D_1	100 %	0.6 %
	Funding for research buildings (circular economy)	E_1	EUR 26.0m	EUR 0.2m

Source: own compilation

The following section describes the one newly assessed project, its effects according to its indicator-quality and evaluates the robustness of these effects. No models were required to quantify these effects.

4.5.2 Industrial dismantling of battery modules and electric motors (DeMoBat)

The aim of this research project is to demonstrate the feasibility of industrial and automated disassembly of battery modules and electric drive units. The state's share in 2022 was 100% with a funding of EUR 1.7m. Two additional indicators have been identified and assessed.

- The number of scientific publications, that have been published in 2022. This is reported as an output-indicator (C) with high robustness based on data by the responsible agency.
- The number of dissemination events about the project, which represents an activities-indicator (D) with high robustness as well.

The following table lists the results and evaluates the robustness.

Table 4-14: results for the project "industrial dismantling of battery modules […] (No 18)"

indicator	quality	full effect	financed effect	robustness
No of scientific publications	C	12	12	1
No of dissemination events	D	5	5	1
Funding of research for circular economy in e-mobility	E	EUR 1.7m	EUR 1.7m	1

Source: own compilation based on issuer data

4.6 Pollution Prevention

This section describes the assessment of effects regarding the objective "pollution prevention and control". 5 out of 6 projects with total expenditures of EUR 21.6m could be assessed (99% of all expenditures in this category). A total of 13 indicators were identified, of which 7 indicators are at least related to activities.

Three projects could be associated with output-indicators (quality C) and thus with a "high likelihood of substantial contribution" to the environmental objective. Two of these projects (public air solutions and express bus lines in Stuttgart) will be investigated for intermediate or even long-term outcomes in the future.

No new projects were added to the Green Bond this year in this category.

4.6.1 Summary of recurring projects

The following table lists all projects that are part of the current Green Bond, but already have been assessed in the previous impact report. Changes are thus limited to the actual values and, in some cases, to the quality and robustness of indicators.

Table 4-15: projects from previous Green Bond for "Pollution Prevention"

Project	Indicator	Q_R	Effect full	Effect financed
No 5: Public Air Solutions – Filter Cubes	Site-specific reduction of air emissions	C_4	10 Δ%	10 Δ%
	No of air filter in operation	D_1	94	94
	Funding for low-emission mobility	E_1	EUR 0.99m	EUR 0.99m
No 10: Establishment of express bus lines in the Stuttgart region	Additional express bus line length	C_3	no physical changes in 2022	
	Funding for low-emission mobility	E_1	EUR 2.93m	EUR 2.2m
No 12: Low-emission bus transportation	Approved purchases of low-emission vehicles	D_1	21	21
	Funding for low-emission mobility	E_1	EUR 3.35m	EUR 3.35m
No 15: Intelligent public transport in Baden-Württemberg	Funding for low-emission mobility	E_1	EUR 0.99m	EUR 0.99m
No 20: Remediation of contaminated sites	Implemented measures of remediation	C_1	34	34
	Funded communities	D_1	24	24
	Funding for remediation activities	E_1	EUR 14.69m	EUR 14.69m
No 59: E-Mobility in the car pool of BW police – purchase of motorcycle with electric motor	Purchase of electric vehicles	D_1	4	4
	Funding for low-emission mobility	E_1	EUR 0.37m	EUR 0.37m

Source: own compilation

4.7 Biodiversity and Ecosystems

This section describes the assessment of effects regarding the objective "protection and restoration of biodiversity and ecosystems". All 13 projects with total expenditures of EUR 60.2m could be assessed. Overall, 36 indicators were identified, of which 22 indicators at least related to activities.

For 5 out of 13 projects, desired outcomes could be reported that represent positive societal changes beyond the scope of the projects. They are "strong evidence for substantial contributions" towards the environmental objectives of the EU taxonomy (with an additional 5 projects showing a "high likelihood of substantial contribution"). The following table lists these five projects and their desired outcomes. It also shows how long-term benefits as

"unequivocal evidence for substantial contributions" could be ensured. These criteria are going to be investigated for any project in this list that is also part of the next Green Bond.

Table 4-16: Best-in-Class indicators for Green Bond Baden-Württemberg #3 in "Biodiversity and Ecosystems"

Project	**Strong evidence for substantial contribution** (Quality B)	**Criteria for unequivocal evidence** (Quality A)
No 29: Biotope mapping	increase in biotopes in the State of BW confines of the project	regulation needs to ensure that other actors (such as land-owners and municipalities) manage or preserve these biotopes
No 30: Non-productive investments in conservation	additional protected/enhanced eco-friendly area	regulation and funding must exclude any future productive use of the habitats and conserved lands
No 33: Special Programme for Biodiversity	additional protected/enhanced eco-friendly area	evaluation and monitoring are needed to ensure that the additional area is and remains "enhanced" in terms of the preservation of biodiversity and ecosystems
No 36: Investing in properties with importance for environmental protection	increase in natural protection area in the State of BW	regulation must ensure that the land remains protected for several decades and that other land-use is restricted in the affected regions
No 50: Preserving manually cultivable vineyards in steep slope and terraced areas	increase in organically farmed land in the State of BW	regulation and funding must ensure that the cultivation restrictions remain in place for the foreseeable future.

Source: own compilation

4.7.1 Summary of recurring projects

The following table lists all projects that are part of the current Green Bond, but already have been assessed in the previous impact report. Changes are thus limited to the actual values and, in some cases, to the quality and robustness of indicators.

Table 4-17: Projects from previous Green Bond for "Biodiversity and Ecosystems"

Project	**Indicator**	**Q_R**	**Effect** $_{full}$	**Effect** $_{financed}$
No 29: Biotope mapping	Increase in biotopes	B_1	2.2 %	2.2 %
	Number of updated/new biotopes	D_1	10,082	10,082
	Funding for nature conservation and biodiversity	E_1	EUR 3.97m	EUR 3.97m
No 30: Non-productive investments in conservation	Additional protected/enhanced eco-friendly area	B_3	9,462 ha	9,462 ha

Project	Indicator	Q_R	Effect full	Effect financed
	Funded projects for nature conservation and biodiversity	D_1	5,120	5,120
	Funding for nature conservation and biodiversity	E_1	EUR 21.1m	EUR 21.1m
No 31: Nature conservation contracts	No of projects	D_1	6,505	3,253
	Funding for nature conservation and biodiversity	E_1	EUR 19.9m	EUR 10.0m
No 33: Special Programme for Biodiversity	Additional protected/enhanced eco-friendly area	B_3	2,892 ha	2,892 ha
	Funded projects for nature conservation and biodiversity	D_1	1,677	1,677
	Funding for nature conservation and biodiversity	E_1	EUR 6.4m	EUR 6.4m
No 36: Investing in properties with importance for environmental protection	Increase in natural protected area in the state of BW	B_1	1.0%	1.0%
	Additional protected area	C_1	121	121
	Funding for nature conservation and biodiversity	E_1	EUR 2.6m	EUR 2.6m
No 37: Nationalpark Black Forest, new construction visitor and information center	Building construction for environmental education	D_1	100%	4,3%
	Funding for environmental education	E_1	EUR 41.5m	EUR 1.8m
No 47: Research Programme Organic Farming	No of scientific publications	C_1	5	5
	No of held events	D_1	29	29
	Funding for organic/sustainable farming	E_1	EUR 0.3m	EUR 0.3m
No 48: Aid for pruning of meadow orchards	Number of pruned trees	C_1	193,000	72,688
	Funding for organic/sustainable farming	E_1	EUR 7.7m	EUR 2.9m
No 49: Preserving steep-hill grassland	Promoted area for organic/sustainable farming	C_1	44,402	44,402

Project	Indicator	Q_R	Effect full	Effect financed
	Number of applicants	D_1	7,878	7,878
	Funding for organic/sustainable farming	E_1	EUR 5.5m	EUR 5.5m
No 50: Preserving manually cultivable vineyards in steep slope an terraced areas	Increase in organically farmed area in the state of BW	B_1	7.5%	2.1%
	Additional organically farmed area	C_1	24ha	7 ha
	Funding for organic/sustainable farming	E_1	EUR 3.7m	EUR 1m
No 54: Organic Model Regions in BW	Number of funded communities	D_1	14	13
	Funding for organic/sustainable farming	E_1	EUR 1m	EUR 0.9m

Source: own compilation

The following sections describe all assessed new projects, their effects according to their indicator-quality and evaluate the robustness of these effects. No models were used to quantify the effects, although auxiliary variables were used to estimate the attribution to "financed" compared to "full" effects in some cases.

4.7.2 Expansion of the state-wide biotope network

The aim of this project is the preservation and expansion of the biotope network, as a dense network of interconnected habitats and biotopes is of great importance to counteract the negative trend of loss of biodiversity and to sustainably secure the survival of the communities of species. The state funded the project with EUR 1.9m, which represents a share of 16% of the overall project-funding. Two additional indicators have been identified and assessed.

- The area that benefitted from nature conservation, which is reported as an output-indicator (C) with high robustness and is based on data by the responsible agency.
- The number of measures that went towards expanding biotopes, which is an activity-indicator (D) with high robustness as well.

The following table lists the indicators and evaluates the robustness of the results.

Table 4-18: results for the project "Expansion of the state-wide biotope network (No 32)"

indicator	quality	full effect	financed effect	robustness
Improved area from nature conservation	C	1,840 ha	288 ha	1
No of measures for expanding biotopes	D	1,058	166	1
Funding for nature conservation and biodiversity	E	EUR 12.1m	EUR 1.9m	1

Source: own compilation based on issuer data

4.7.3 Organic Farming

Baden-Württemberg promotes organic farming, since it represents a significant market opportunity for local farmers and contributes to environmental targets. This project was funded with EUR 3.15m in 2022 by the state, which represents a 6% share of the total financing, according to the related agency. Two additional indicators have been identified and assessed.

- The area promoted for organic and sustainable farming, which constitutes an output-indicator (C) with a high robustness, since it was directly reported by the responsible agency.
- The number of applicants that have been funded through the project, which represents an activity-indicator (D) with a high robustness as well.

The following table lists the indicators and evaluates the robustness of the results.

Table 4-19: results for the project "Organic Farming (No 55)"

Indicator	quality	full effect	financed effect	robustness
Promoted area for organic/sustainable farming	C	157,460 ha	9,853 ha	1
Number of applicants	D	4,261	267	1
Funding for organic/sustainable farming	E	EUR 50.3m	EUR 3.1m	1

Source: own compilation based on issuer data

5 Discussion and Outlook

The report on the first Green Bond Baden-Württemberg provided a proof-of-concept for an impact assessment of a Green Bond based on the EU taxonomy. The second report expanded on this and updated the methodology. The third report investigates additional projects and re-evaluates some of the previous indicators. It also provides the first list of effects that could be accumulated over more than one Green Bond.

The 10 new projects could all be assessed in terms of indicators above the funding level (quality D or better). Novel indicators (by comparison with already existing metrics in the market) are travel time reductions for a mobility project in Karlsruhe, the reporting of the technology readiness level for a research project (Autokite) and improved areas for nature conservation for biotopes in the State. The latter has been explicitly discussed in the dissertation of the main author as the missing link for a causal connection between funding by the State and explicit measures towards the State's biodiversity target by all involved actors (Teubler, 2024a). It thus complements the already existing Green Bond project of biotope mapping in a cohesive and productive way.

The re-evaluation of indicators in the current Green Bond mainly focused on indicator-quality shifts. A number of effects has previously been considered to be an input (E) in the system, rather than an induced activity (D). Some of these inputs have now become activities because they indicate not only a clear physical materialization, but also a distinct later point in time after the original funding has been improved.

The accumulation of effects, novel in the current impact report, has been introduced, but restricted to outputs (indicator-quality C on the level of projects). Both the criteria for accumulation (see section 3.5) as well as the more complex causal relationships on the societal level require a more thorough investigation before additional effects can be accumulated. This will be part of the next impact report for Green Bond #4.

The next impact report will also expand on the underlying methodology for Theories-of-Change. While it is not feasible to conduct full credence assessments in line with the Bayesian methodology in Teubler (2024a) for all projects in the Bond, it is planned to highlight some of the projects towards the objectives of sustaining biodiversity in this manner. This will involve explicated, and multi-stranded, causal pathways towards the State's targets and a plausibility assessment for the contribution of the State's funding to the anticipated effects.

The next report will also no longer contain the heuristic risk assessment for DNSH violations, as the SPO provider of the issuer will do so according to their own evaluation methodology.

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7 Appendix

7.1 Heuristic risk assessment

(+ indicates attributed risks | - indicates substantial contribution and thus no risk assessment |
MAG: high magnitude if violation occurs | LH: high likelihood for some form of violation)

Project in Green Bond (no: number of project)	Status Quo: System for Comparison	Risk of DNSH	CM		CA		WM		CE		PP		BE	
			MAG	LH	MAG	LH	MAG	LH	MAG	LH	MAG	LH	MAG	LH
Funding of personnel in the field of sustainable mobility (No 6)	personnel allocated to other tasks including EU-T goals	no risk	-	-	o	o	o	o	o	o	o	o	o	o
Combi Solution City Railway Karlsruhe (No 14)	no changes to the public mobility infrastructures	low risk	-	-	+	o	o	o	o	+	o	+	o	o
Funding programme climate protection plus (No 16)	no greenhouse gas reduction measures	no risk	-	-	o	o	o	o	o	o	o	o	o	o
autoKite (No 38)	no research for maritime wind energy	no risk	-	-	o	o	o	o	o	o	o	o	o	o
Energy-efficient State housing funding (No 61)	no construction of new residential buildings	low risk	-	-	o	+	o	o	o	o	o	o	+	o
Funding Program Klimopass (No 17)	no climate-change adaptation measures	low risk	o	+	-	-	o	+	o	o	o	o	o	+
Silvicultural measures (No 52)	no a- or re-forestation measures	no risk	o	o	-	-	o	o	o	o	o	o	o	o
Industrial dismantling of battery modules and electric motors (DeMoBat) (No 18)	no dismantling of batteries or research related to it	no risk	o	o	o	o	o	o	-	-	o	o	o	o
Expansion of the statewide biotope network (No 32)	no expansion of biotopes or temporarilly protected areas	no risk	o	o	o	o	o	o	o	o	o	o	-	-
Organic Farming (No 55)	conventional farming	no risk	o	o	o	o	o	o	o	o	o	o	-	-

Source: own assessment

7.2 Generic DNSH criteria

Objective	Criteria	Abb	Additional Information
Climate Change Adaptation (CA)	The activity complies with the criteria set out in Appendix A to this Annex.	GEN-CA	The physical climate risks that are material to the activity have been identified from those listed in the table in Section II of this Appendix by performing a robust climate risk and vulnerability assessment with the following steps: (a) screening of the activity to identify which physical climate risks from the list in Section II of this Appendix may affect the performance of the economic activity during its expected lifetime; (b) where the activity is assessed to be at risk from one or more of the physical climate risks listed in Section II of this Appendix, a climate risk and vulnerability assessment to assess the materiality of the physical climate risks on the economic activity; (c) an assessment of adaptation solutions that can reduce the identified physical climate risk. [...]
Water and Marine Resources (WM)	The activity complies with the criteria set out in Appendix B to this Annex.	GEN-WM	Environmental degradation risks related to preserving water quality and avoiding water stress are identified and addressed with the aim of achieving good water status and good ecological potential as defined in Article 2, points (22) and (23), of Regulation (EU) 2020/852, in accordance with Directive 2000/60/EC of the European Parliament and of the Council and a water use and protection management plan, developed thereunder for the potentially affected water body or bodies, in consultation with relevant stakeholders. Where an Environmental Impact Assessment is carried out in accordance with Directive 2011/92/EU of the European Parliament and of the Council and includes an assessment of the impact on water in accordance with Directive 2000/60/EC, no additional assessment of impact on water is required, provided the risks identified have been addressed.
Protection and restoration of biodiversity and ecosystems (BE)	The activity complies with the criteria set out in Appendix D to this Annex.	GEN-BE	An Environmental Impact Assessment (EIA) or screening has been completed in accordance with Directive 2011/92/EU15. Where an EIA has been carried out, the required mitigation and compensation measures for protecting the environment are implemented. For sites/operations located in or near biodiversity-sensitive areas (including the Natura 2000 network of protected areas, UNESCO World Heritage sites and Key Biodiversity Areas, as well as other protected areas), an appropriate assessment, where applicable, has been conducted and based on its conclusions the necessary mitigation measures are implemented.

Source: based on https://ec.europa.eu/sustainable-finance-taxonomy/taxonomy-compass