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Impact analysis of the NRW.BANK.Green Bond 2018

Results of the evaluation of greenhouse gas emissions avoided through the NRW.BANK.Green Bond 2018 (ISIN: DE000NWB0AF3)

Authors:

Jens Teubler, Manuel Bickel, and Christa Liedtke

On behalf of

NRW.BANK

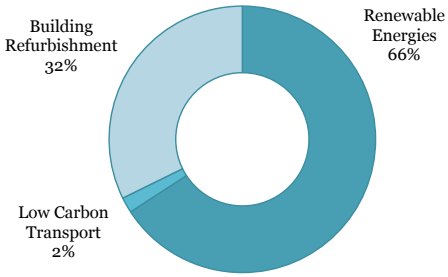
Wuppertal Institut

On behalf of NRW.BANK, Wuppertal Institute has analysed the impact of the asset pools of the NRW.BANK.Green Bond 2018. The analysed asset pool has a volume of EUR 500m. The projects selected fall into the category "Climate Mitigation".

This analysis assesses the pro-rata contributions to climate protection made by the refinanced investments. The projects relate to:

- expansion of renewable energy (wind energy, photovoltaics),
- refurbishment of buildings (residential, university clinics),
- low carbon transport (tram, electric mobility).

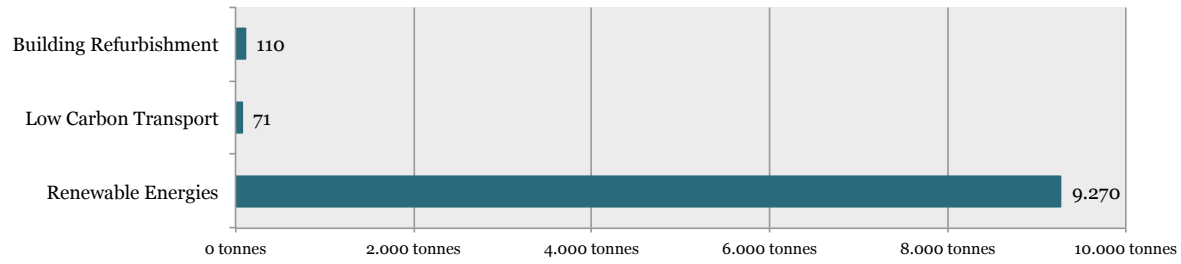
Climate Mitigation allocation of investments



It has been calculated that these projects will avoid greenhouse gas emissions of 3 million tonnes of CO_2 equivalents over the 10-year term of the NRW.BANK.Green Bond 2018. Considering the targeted savings of 226 million tonnes of CO2 equivalents according to the Climate Action Plan of Germany between the years 2018 and 2028[1], the savings achieved by projects in the asset pool represent about 1% of the German emission target for this period.

Measured by the size of the analysed asset pool of EUR 500m, 614 tonnes of CO_2 equivalents are saved per EUR 1m per year. In relation to the pro-rated financing, onshore wind turbine generators have proven to be the most efficient form of investment for the avoidance of greenhouse gas emissions in the NRW.BANK.Green Bond 2018 (928 tonnes per year and EUR 1m). All investments will continue to avoid greenhouse gases also beyond the maturity of the Bond.

CO2 equivalents saved by the investment of 1 million over a term of 10 years (based on the investment volume of EUR 500 million)



The impact analysis complies with the recommendations of the "Harmonized Framework for Impact Reporting[2]".

[1] The German Climate Action Plan states emission targets for the years 2014 and 2030. The estimation of the amount to be saved between 2018 and 2028 is based on a linear extraploation between the data points mentioned in the plan.
[2] Green Bonds - Working Towards a Harmonized Framework for Impact Reporting

The greenhouse gas emissions of wind turbine generators were calculated over their entire lifecycles. Due to the limited availability of data, the calculation for energy-efficient buildings covers only the upstream chains of the energy sources used and not the construction of the buildings itself. The electricity supplied by conventional energy sources (NRW or Germany) as well as the average heat demand requirements (electricity demand was not considered) of residential buildings and public buildings have been used as the benchmark for the calculation of the potential savings.

Promotion of wind energy

The newly built wind farms considered in the Green Bond asset pool with a total capacity of 358 MW (onshore) were realised with a promotion portion of 56.6%. The WTGs produce an estimated 587.6 GWh of electricity per year. Over a period of ten years, the wind farms in the Green Bond asset pool (EUR 326m) avoid 3 million tonnes of CO_2 equivalents.

Promotion of photovoltaic systems

An amount of EUR 3m of the Bond asset pool relates to the construction and expansion of PV power plants (open field and roof installations). Based on an output of 3.1 MW, 23.7 thousand tonnes of CO_2 equivalents are avoided over a period of ten years.

Promotion of energy-efficient residential buildings

The refurbishment of residential buildings in North Rhine-Westfalia contained in the Green Bond asset pool total EUR 47m with an estimated promotion share of 90%. Compared to the existing building stock, this helps to avoid about 6.1 thousand tonnes of CO2 equivalents over a period of ten years.

Promotion of the refurbishment and construction of clinical buildings

A total of EUR 114m is made available for the reconstruction and refurbishment of university clinics. Compared to existing buildings, these measures reduce the greenhouse gas emissions by about 11.6 thousand tonnes of CO2 equivalents over a period of ten years.

Promotion of low carbon transport via tram

In 2018, NRW.BANK provided EUR 4m to purchase twelve energy and climate-efficient trams (Variotrams) in Bochum and an additional amount of EUR 2.2m for modernization of interlocking systems. The investment in trams helps to avoid about 569 tonnes of greenhouse gas emissions over a period of ten years. This measure is part of a larger order of a total of 42 Variotrams by 2020.

Promotion of low carbon transport via electric vehicles

In 2018, NRW.BANK provided EUR 3m to purchase eight battery-supported busses and one electric car. In addition, car parks were equipped with electric recharging stations. These measures help to avoid about 99 tonnes of greenhouse gas emissions over a period of ten years.

The Annex lists the results, methods and data used for the analysis.

Annex

Renewable Energy (RE)	Signed Amount	Share	Eligibility for green bonds	RE Component	Min. Credit period	Annual energy generation		Renewable energy capacity added		Annual GHG emissions reduced/avoided	
Project name	**million EURO**	**%**	**% of signed amount**	**% of signed amount**	**in years**	**GWh/a**		**MW**		**in 1,000 tonnes of CO2-equivalents**	
						100%	**financed**	**100%**	**financed**	**100%**	**financed**
Wind energy, onshore NRW	326.2	56.6%	100%	100%	10	587.6	325.5	358.1	202.6	546.6	302.8
Solar power, photovoltaics, NRW	3.0	100%	100%	100%	10	2.7	2.7	3.1	3.1	2.4	2.4
Building Refurbishment and Low Carbon Transport	**Signed Amount**	**Share**	**Eligibility for green bonds**	**EE Component**	**Min. Credit period**	**Annual energy savings**				**Annual GHG emissions reduced/avoided**	
Project name	**million EURO**	**%**	**% of signed amount**	**% of signed amount**	**in years**	**GWh/a**				**in 1,000 tonnes of CO2-equivalents**	
						100%	**financed**			**100%**	**financed**
Refurbishment of private buildings	47.0	90.0%	100 %	74%	10	2.6	2.3			0.68	0.61
Refurbishment of public buildings	114.3	n.a.[3]	100%	45%	10	n.a.	4.9			n.a.	1.16
Low Carbon Transport, tram	4.0	12.2%[4]	100%	n.a.	10	n.a.	n.a.			0.47	0.06
Low Carbon Transport, electric vehicles	3.2	100%	100%	n.a	10	n.a.	n.a.			0.01	0.01

The impact analysis is confined to the avoidance of greenhouse gas (GHG) emissions on the basis of IPPC 2007 (GWP 100a). The calculations for the renewable energy plants are based on two different types of wind turbine generators and one PV site over the lifecycle (20 years each). 1,641 gross full load hours p.a. and a building cost flat rate of EUR 1,567/kW for onshore wind energy were taken as the basis[5]. For PV systems, the economic data of the site in Grottenkamp (Steinfurt)[6] and the average operational performance of the sites in North Rhine-Westphalia (NRW) were taken as the basis[7]. For calculating GHG savings by renewables the electricity mix in NRW from conventional sources served as the reference. The potential savings in the heat consumption of residential buildings are based on the average energy consumption of residential buildings in NRW and estimated costs for the partial and full refurbishment of multi-family homes[8] as well as a full refurbishment efficiency of 35% (reduction in primary energy requirements), assuming a calculated promotion portion for the energy efficiency measures of 74%; this reflects the underlying assumption that 90% of the construction costs are covered by promotion funds and that one in ten buildings is not only maintained and energy-refurbished but is also made barrier-free. The energy efficiency potential for refurbished clinics is based on information provided by Universitätsklinikum Münster for transmission heat losses and construction costs of the facade refurbishment of the bed towers as well as on literature on the heating energy saving potential in the refurbishment of existing clinics in Germany[9]. The avoidance of greenhouse gases through buildings results from the specific greenhouse gas equivalents for heat generation from gas and heating oil in Germany as well as electricity generation and district heat supply in NRW[10]. All factors comprise the upstream chains of the energy sources but not the lifecycles of the infrastructure required for conversion. The conservative estimate of the greenhouse gas efficiency of the new Variotrams in Bochum is based on the results of an eco-balance of the tram manufacturer, generic data sets for the production of trams and the operating results for the entire network of Bochum-Gelsenkircher Straßenbahnen Aktiengesellschaft (BOGESTRA) in 2017. The calculation of savings in the field of electric vehicles is based on the difference of carbon factors for production of conventional and electric vehicles[11] and the difference between carbon factors for consuming petrol or diesel[12] and consuming electricity from the average electricity mix in NRW for comparable distances typically covered in practice and operational performance as reported by the Kraftfahrt Bundesamt (Federal Motor Vehicle Transport Authority), ADAC (German Automobile Club), and public transport facilities.

[3] As the promotion amounts invested form part of larger financing packages, the total savings cannot be quantified here (marked as "not available").
[4] Based on the total investment sum per tramcar used in the Impact analysis of the NRW.BANK.Green Bond for 2016.
[5] Fraunhofer IWES (2018). Wind Energy Report 2017 (and personal correspondence with IWES)
[6] https://www.wn.de/Muensterland/Kreis-Steinfurt/Steinfurt/3236521-Photovoltaikanlage-auf-ehemaliger-Hausmuelldeponie-im-Grottenkamp-Sonnenstrom-fuer-250-Haushalte
[7] https://www.foederal-erneuerbar.de/landesinfo/bundesland/NRW/kategorie/solar/auswahl/813-durchschnittliche_ja/#goto_813
[8] ARGE e.V. (2012). Typical energy consumption figures of German residential buildings, IWU-Tagung Darmstadt and ARGE e.V. (2016). Refurbishment or new building, GRE-Kongress Kassel
[9] BMVBS (2013): "Systematische Datenanalyse im Bereich der Nichtwohngebäude – Erfassung und Quantifizierung von Energieeinspar- und CO2-Minderungspotenzialen", BMVBS online publication, No. 27/2013, Federal Ministry of Transport, Construction and Urban Development as well as Mathias Kabus (Energieagentur.NRW): "Energetische Sanierung und Optimierung von Krankenhäusern".
[10] Energy balances of the federal states, as at 23. December 2015, http://www.lak-energiebilanzen.de as well as Forschungsstelle für Energiewirtschaft e.V. (2011): "Basisdaten zur Bereitstellung und Umwandlung von Brennstoffen"
[11] The carbon factors for production of vehicles have been taken from the data provided by the COMBI project „Calculating and Operationalising the Multiple Benefits of Energy Efficiency in Europe", https://combi-project.eu/, in particular, from Work Package 4, „Methodology and quantification of Resource impacts from energy efficiency in Europe"
[12] Carbon factors of fossil fuels taken from Umweltbundesamt (2016): „CO2-Emissionsfaktoren für fossile Brennstoffe"