Quantifying the energy and climate benefits of ROCKWOOL products for technical insulation

Prepared for:

ROCKWOOL®

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1. Introduction

The ROCKWOOL Group is a global leader in stone wool solutions. To assess the energy and carbon savings by the usage of sold ROCKWOOL technical insulation products, there is a need for a robust and transparent calculation methodology. Therefore, ROCKWOOL has asked Guidehouse Inc. to develop a methodology and calculate the energy and CO_2 emission savings of its technical insulation. Guidehouse developed this methodology independently of ROCKWOOL and approves the outcomes based on the underlying assumptions. Uncertainties and assumptions were made due to data limitations, as described in this document.

While there are currently no industry-wide standards for calculating avoided energy and emission savings, this methodology is aligned with the five-step framework for assessing avoided emissions outlined in the latest World Business Council for Sustainable Development (WBCSD) report, published in 2025. These steps include defining a time frame, setting a reference scenario, assessing the lifecycle emissions of both the solution and the reference scenario, calculating the avoided emissions, and validating the contribution legitimacy (1).

This document aims to transparently describe the calculation method of ROCKWOOL's energy and CO_2 emission savings, give a clear and concise overview of the inputs used, and describe which assumptions used to compensate for lack of publicly available data.

About Guidehouse

Guidehouse is purpose built to help commercial and public sector clients navigate complex challenges across industries and geographies with an integrated model that breaks down silos to maximize efficiency.

Consultants work with clients to 'imagine' a new future, team across our digital and technology services to 'build' new resilient solutions, and then often 'operate' programs for clients to ensure sustained value.

At Guidehouse, we're united by a shared commitment to purposeful impact. Moreover, our approach is rooted in an innovation-first mindset that ensures lasting change. The Sustainability Solutions team includes industry-leading experts in climate finance risks and opportunities, science-based targets, circular economy, lifecycle analysis, climate policy, adaptation strategy, biomass solutions, and carbon pricing.

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The energy and CO_2 emissions savings calculated using the approach described in this document, consist of the energy and CO_2 emission savings of ROCKWOOL products for technical insulation in the process industry over their different lifetime, and compared to a situation where no insulation is applied.[1] Since there are no mandatory regulations requiring pipe insulations, the

[1] Additional scenarios may be considered in the future to reflect varying compliance levels or partial insulation practices. However, using uninsulated pipes as the reference scenario remains the most effective approach as it is widely adopted in global energy audits and industry standards (e.g., EIIF in Europe, DOE in the U.S).

use of an uninsulated reference scenario is widely accepted and supported by research papers. For example, the European Industrial Insulation Foundation (EIIF) highlights the energy and CO_2 savings potential of industrial insulation in the EU using uninsulated pipes as the baseline (2), while a study by DNV on insulation calculation tools across U.S. states, compliant with ASTM C680[2], also adopts uninsulated pipes as the reference condition (3). These sources reinforce the validity of using uninsulated systems as the starting point for comparative analysis. This reference approach will be updated once regulations mandating pipe insulation are widely implemented, and our calculation methodology will be revised accordingly.

The high-level calculation approach is shown in section 2. In this approach, annual energy savings are defined as the reduction in heat loss with respect to an uninsulated pipe. CO_2 savings are calculated based on the direct emission factor of the current fuel mix[3]. Upstream emissions related to the extraction, production and transportation of these fuels are excluded from the calculation due to a high uncertainty of these emissions. Including these upstream emissions would lead to an estimated 5% to 20% increase of the resulting CO_2 savings[4].

[2] It is an international standard titled:"Standard Practice for Estimate of the Heat Gain or Loss and the Surface Temperatures of Insulated Flat, Cylindrical, and Spherical Systems by Use of Computer Program".
[3] Fuel mix has been incorporated into the decarbonisation process using the methodology outlined below.
[4] Information on share of upstream emissions: The range is based on a high-level assessment of different sources for the upstream impacts of fuels, including LCA software, public sources and the Dutch government and own Guidehouse research.

2. Methodology

Energy and CO_2 savings over the lifetime of ROCKWOOL products for technical insulation are calculated based on sales and application inputs. Calculations are carried out for four product applications: Heating Ventilation and Air Conditioning (HVAC), industrial low temperature, industrial medium temperature, and industrial high temperature. Results are then segmented into four regions: North America, Western Europe, Eastern Europe and Russia, and Asia (countries in Southeast Asia, China, India) and Others (Africa, Middle East, and South America).[5]

The calculation methodology and the input values are schematically depicted below. This methodology is used to calculate both the energy savings and the CO_2 emissions savings.

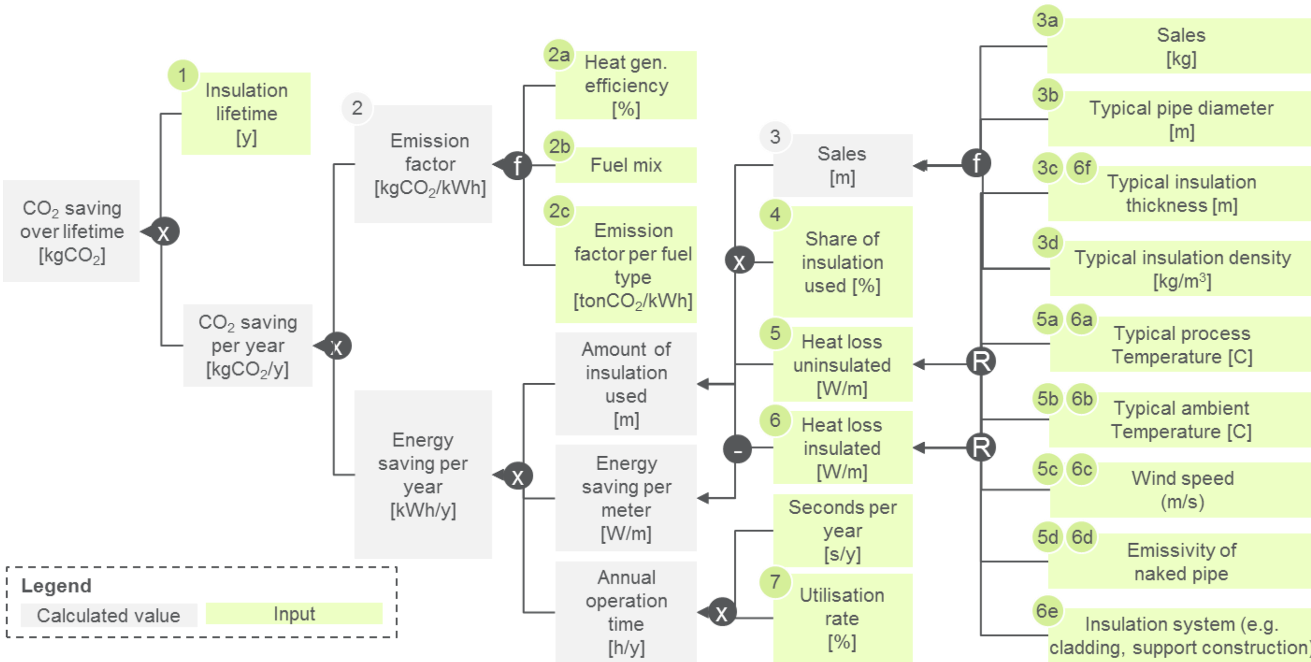

Figure 1 - Calculation methodology

2.1 Rationale behind inputs

For each of the four application groups, a set of generic and specific assumptions is applied (see table below). For industrial applications, the figures shown are derived from more detailed inputs for each relevant application. Where high uncertainty exists for a particular input, a conservative assumption is chosen, resulting in the lowest estimated energy and emissions savings.

Concerning insulation **lifetime** $_{(1),}$ conservative 10-, 15-, 20- and 25-year lifespans are used for the high, medium, low temperature range and HVAC respectively. These figures align with the European Industrial Insulation Foundation (EIIF) study "the insulation contribution to decarbonise

[5] This regional breakdown was chosen for alignment with sales responsibilities and with ROCKWOOL's annual report.

industry", which assumes 15 years across all industries. While low temperature applications may exceed this average, applying 15 years for medium temperature and 10 years for high temperature keeps the overall assumption consistent with EIIF. This approach also reflects the National Insulation Association (NIA) (4), which assumes a higher average lifetime of 20 years for industries, including HVAC, suggesting that low temperature industrial purposes typically fall within this range.

	Input	Application			
		HVAC	Low T	Med. T	High T
1. Insulation lifetime		25	20	15	10
2. Emission factor per region & industry	2. Emission factors	0.125gCO_2/kWh - 0.341 gCO_2/kWh			
	2a. Heat generation efficiency	100%			
	2b. Fuel mix	Accounted for decarbonisation			
	2c. Emission factor per fuel type	Coal: 0.341, Gas: 0.202, Oil: 0.279 and Biofuels: 0 gCO_2/kWh			
3. Sales in meters	3a. Sales (kg)	Confidential			
	3b. Pipe diameter (mm)	27	168	219	356
	3c. Insulation thickness (mm)	30	50	150	320
	3d. Insulation density (kg/m^3)	100			
	3e. Sales breakdown	Confidential			
4. Share of insulation used in emission reduction		88%	98%		
5. Heat loss of naked pipe	5. Heat loss/m naked pipe	34	1166	6165	26334
	5a. Process temperature	55	150	350	550
	5b. Ambient temperature	20	20	24	24
	5c. Wind speed	0 m/s	0.5 m/s		
	5d. Naked pipe emissivity	0.6			
6. Heat loss per m. insulated pipe		6	80	162	324
7. Utilisation rate		5%-68%	40-90%		

Table 1 – Overview application methods

To calculate the **emission factor of each application in each region** **(2)**, the following inputs are factored in: the heat generation efficiency *(2a)*, the fuel mix of each industry where insulation is applied *(2b)*, and the emission factor of that fuel *(2c)*.

As heat generation efficiency *(2a)* is typically very high, a conservative estimate of 100% is used. Lower efficiencies would lead to higher outcomes, as more fuel is needed to generate the same amount of heat.

The fuel mix per industry where insulation is applied *(2b)* is based on the IEA **(5)** World Energy Balances, incorporating projected decarbonization for each fuel type. Future fuel mix developments are estimated using a linear trend based on historical data from the latest publicly available IEA reports (2017–2019), applying the average annual percentage change across these years. The analysis focuses on coal and coal products (including peat), oil products, natural gas, and biofuel and waste, with regional segmentation aligned to the World Energy Balance structure. To validate these projections, we reviewed region-specific regulations and policy frameworks where available (e.g. EU Green Deal and Fit-for-55 package).

The emission factors for each fuel type **(2c)** are based on the 2019 refinement of the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, covering coal, gas, and oil **(6)** (see table 1). Since 2019, these guidelines have not been updated, and the emission factors remained consistent. Moreover, the IPCC's emission factors closely align with those published by the German Environmental Agency in 2024, verifying their continued accuracy **(7)**.

The **sales in meters** **(3)** for each application are based on ROCKWOOL technical insulation sales data in kg (3a), typical pipe diameter (3b), typical insulation thickness (3c), insulation density (3d) and, for industrial purposes, a breakdown of sales over different temperature applications (3e).

ROCKWOOL sales data (3a) and typical pipe diameter per application (3b) are provided by ROCKWOOL. Guidehouse does not validate the data but conducts a general review by comparing the data with the previous year's figures and scanning the document for any reference errors.[6]

Insulation thickness (3c) for industrial applications has been based on the minimum thickness needed to reach a safe surface temperature of 50°C, corresponding to a heat loss of 22, 82, 87 and 90 W/m^2 for HVAC (Operating temperature of 55°C), industrial low temperature (Operating temperature of 150°C), industrial medium temperature (Operating temperature of 350°C), and industrial high temperature (Operating temperature of 550°C) respectively. This data is based on ROCKASSIST (**8**), which is ROCKWOOL's internal reporting system for technical insulation based on the VDI 2055 standards. According to the EIIF study "climate protection with rapid

[6] ROCKWOOL entities in Russia and Switzerland operate on different SAP systems, resulting in less detailed input data. Consequently, some columns in the respective Excel file in the column "ROCKWOOL sales data" may indicate missing information. Nevertheless, the necessary data for further calculations can be obtained from these entities, which is why the smaller granularity of the data is not an issue.

payback” (9), this is the typical thickness applied in industry. For HVAC a typical thickness of 30 mm is used, based on an expert assumption from ROCKWOOL. [7]

For insulation density *(3d)* a value of 100kg/m3 is used, based on ROCKWOOL sales data and the density of each product type.

For the breakdown of sales over different temperature applications *(3e)*, ROCKWOOL technical insulation does not have specific sales data. The numbers are based on a conservative estimate made by ROCKWOOL.

To calculate the **amount of insulation that is used** **(4)**, a waste percentage of 2% is used. This assumption is based on the Product Environmental Footprint Category Rules (PEFCR) (10), which is part of the European Commission’s Single Market for Green Products initiative for thermal insulation products and a report by the European Insulation Manufacturers Association (EURIMA) (11). KNAUF (12) also assumes a loss of materials in construction site of 2% in its product environmental declaration, which is verified until 2026.

The **heat loss of a non-insulated pipe** **(5)** is calculated using the Rockassist tool, as mentioned previously. The number is based on inputs on process temperature *(5a)*, ambient temperature *(5b)*, wind speed *(5c)* and uninsulated pipe emissivity *(5d)*.

Typical process temperature *(5a)* for industrial purposes is provided by ROCKWOOL and confirmed by Guidehouse experts on power plants and industry. This temperature is 150°C for low temperature processes, 350°C for medium temperature processes and 550 °C for high temperature processes. For HVAC, the temperature of 55°C is based on the most typical temperature range in which heating systems operate in Europe of 35-70 °C, according to Guidehouse’s building expertise. This is also in line with the maximum return temperature needed for a condensing boiler to operate in the condensing regime. The focus on European systems here is justified by most HVAC insulation sales being in Europe. The number is revised for other regions if sales increase.

The ambient temperature *(5b)* for industrial purposes is based on the input of ROCKWOOL, stating 70% of the insulation is applied outside and 30% inside a building. This estimate poses difficulties to verify but falls within the range of distribution expected by Guidehouse industry experts. Based on industry experts and ROCKWOOL measurements, an inside temperature of 45°C is assumed in medium and high temperature applications and 30°C in low temperature applications. An outside temperature of 15°C is assumed, leading to an average ambient temperature of 24 °C for medium and high temperature applications and 20°C for low temperature applications. For HVAC, a typical building temperature of 20°C is used.

For the wind speed *(5c)* for industrial applications the same distribution of inside (30%) versus outside (70%) application is applied. Based on ROCKWOOL measurements at customer sites, a

[7] This is not a critical assumption, as even a significant change such as doubling the number will lead to less than a 3% decrease in overall outcome.

wind speed of 0 m/s is used inside a building and 0.5 m/s outside a building, leading to an average of 0.4 m/s. The number of measurements is limited and may not be fully representative. The number of measurements is limited and may not be fully representative, but the current average is considered conservative, particularly since the measurements were taken at inland locations and during relatively favorable weather conditions. The 0.5 m/s wind speed outside a building is based on the median value of all measurements, which is more conservative than the average for this set of measurements. For HVAC, a conservative windspeed of 0m/s is assumed as pipes are in sheltered locations inside a building.

As emissivity of an uninsulated pipe $_{(5d)}$, 0.6 has been used for all applications. This number is confirmed by FIW (**13**) based on the following statement: “For the calculation of average heat losses of uninsulated pipes in process technology, an average emissivity of 0.6 can be used.” The steel used (without stainless steels) will be more or less oxidized in the uninsulated state and have an emissivity >0.6. With the use of an average emissivity of 0.6, the calculated heat losses are evaluated moderately. This moderate evaluation leads to a conservative estimate of emission savings.

The **heat loss of an insulated pipe** $_{(6)}$ is calculated the same as the heat loss of an uninsulated pipe, using the Rockassist tool, based on the VDI 2055 standards. The same inputs as an uninsulated pipe are used ($_{6a, 6b, 6c, 6d}$) as well as the insulation thickness $_{(6f)}$ described earlier under $_{(3c)}$. Next to that, inputs on the type of insulation system[8] that ROCKWOOL used in previous calculations are used. As these inputs have very limited impact on the overall outcome, inputs of previous calculations by ROCKWOOL are used without further verification of Guidehouse.

The inputs for **utilization rate** $_{(7)}$ vary by application. For HVAC, the estimate is based on Guidehouse building expertise regarding annual heating hours across different climate zones and their distribution within the assessed regions. In cold climate zones, heating is assumed to operate for 6000 hours per year, in moderate climates for 2500, and 0 hours in warm climates. Cooling is not considered in the methodology, as ROCKWOOL insulation products are mainly suitable for heating. For industrial explications, a 90% load factor is applied. According to Guidehouse industry expertise, this assumption reflects the continuous operation of large industrial facilities where ROCKWOOL insulation is typically installed, accounting only for limited downtime such as maintenance. For the utilization of power plants, utilization rates are estimated based on the number of operating-hours derived from the most updated IEA data (**13**) for electricity generation and electricity capacity. Future decarbonisation trends for electricity generation and capacity are incorporated using projections from the World Energy Outlook 2024 under the announced pledge scenario. This source offers regional forecasts for changing generation mixes of gas, coal, and renewables. However, as the 2024 edition lacked sufficient detail on the electricity generation mix of bioenergy, data from earlier editions (2020) was used to maintain methodological consistency by using the World Energy Outlook series as the sole source. Annual bioenergy growth rates were calculated using regional Statista data from 2024.

[8] Rockassist default inputs on the insulation system are used, with additionally plant related thermal bridges and, in case of high temperature, a support construction through spacer, flat steel 30mmx3mm, intermediate layer on cold side.

A weighted average is calculated over the insulation lifetime (10–25 years). For electricity capacity, due to limited data availability, two sources are combined: capacity data from the World Energy Outlook and annual growth rates to project future capacity, supplemented by The International Renewable Energy Agency (IRENA) data for renewable capacity (**14/15**).

Appendix A. References

1. More information on the avoided emissions methodology from the World Business Council for Sustainable Development can be retrieved from: https://www.wbcsd.org/resources/guidance-on-avoided-emissions-helping-business-drive-innovations-and-scale-solutions-towards-net-zero/

2. More information on the European Industrial Insulation Foundation (EiiF) study can be retrieved from: EiiF_Study_2021.pdf

3. More information on the DNV pipe insulation savings calculator report review can be retrieved from: MA20C14-G-PINSUL_Insulation-Savings-Tool-Report_Final_02.14.2024.pdf

4. More information on the lifespan of the insulation can be retrieved from: https://insulation.org/

5. More Information on the data set "World Energy Balances" from the International Energy Agency, can be retrieved from: https://www.iea.org/data-and-statistics/data-product/world-energy-balances

6. More information on stationary combustion values from the IPCC report: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf/

7. More information on CO2 emission factors by the German Environmental agency: co2_ef_liste_2025_brennstoffe_und_industrie_final.xlsx

8. More information on ROCKASSIST can be retrieved from: http://www.rockassist.com

9. More information can be retrieved from: Home | EiiF

10. More information can be retrieved from: https://www.filmm.org

11. More information on the waste percentage of 2% from the EURIMA report can be retrieved from here https://www.eurima.org/uploads/files/modules/articles/1678707364_EURIMA_CN2050%20Roadmap_February%202023.pdf

12. More information on the assumed loss of materials can be retrieved from: https://www.knauf.co.uk/-/media/isolator-test-reports/knauf-insulation-rocksilk-ewi-slab-epd.pdf?la=en&hash=BBA8B17CE69904F27D6FDB6824E91DD4&hash=BBA8B17CE69904F27D6FDB6824E91DD4

13. Forschungsinstitut für Wärmeschutz, more information can be retrieved from: http://www.fiw-muenchen.de/

14. International Energy Agency, more information on the "World Energy Outlook" data set can be retrieved from: World Energy Outlook 2024 – Analysis - IEA (the extended data set was used

15. More information on the electricity capacity can be retrieved from: Renewable capacity statistics 2025