

QUANTIFYING THE CLIMATE AND ENERGY BENEFITS OF ROCKWOOL PRODUCTS FOR TECHNICAL INSULATION



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 (formerly Navigant and Ecofys) to develop a methodology and calculate the energy and CO₂ emission savings of its technical insulation. Guidehouse developed this methodology independently of ROCKWOOL and approves the outcomes, given the underlying assumptions and acknowledging that there are uncertainties and assumptions made where a lack of data exists, as described in this document.

Because no industry standard exists to calculate energy and emission savings, this document aims to transparently describe Guidehouse's calculation method of ROCKWOOL's energy and CO₂ emission savings, give a clear and concise overview of the inputs used, and describe which assumptions the Guidehouse team used to compensate for lack of data.

The energy and CO₂ emissions savings calculated using the approach described in this document, consist of the energy and CO₂ emission savings of ROCKWOOL products for technical insulation in the process industry over their complete lifetime, and compared to a situation where no insulation is applied.

The high-level calculation approach is shown on page 2. In this approach, annual energy savings are defined as the reduction in heat loss with respect to an uninsulated pipe. CO₂ savings are calculated based on the direct emission factor of the current fuel mix¹. 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 CO₂ savings².

About Guidehouse

Guidehouse is a leading global provider of consulting services to the public and commercial markets with broad capabilities in management, technology, and risk consulting. We help clients address their toughest challenges and navigate significant regulatory pressures with a focus on transformational change, business resiliency, and technology-driven innovation. Across a range of advisory, consulting, outsourcing, and digital services, we create scalable, innovative solutions that prepare our clients for future growth and success. Headquartered in McLean, VA., the company has more than 8,000 professionals in over 50 locations globally. Guidehouse is a Veritas Capital portfolio company, led by seasoned professionals with proven and diverse expertise in traditional and emerging technologies, markets, and agenda-setting issues driving national and global economies.

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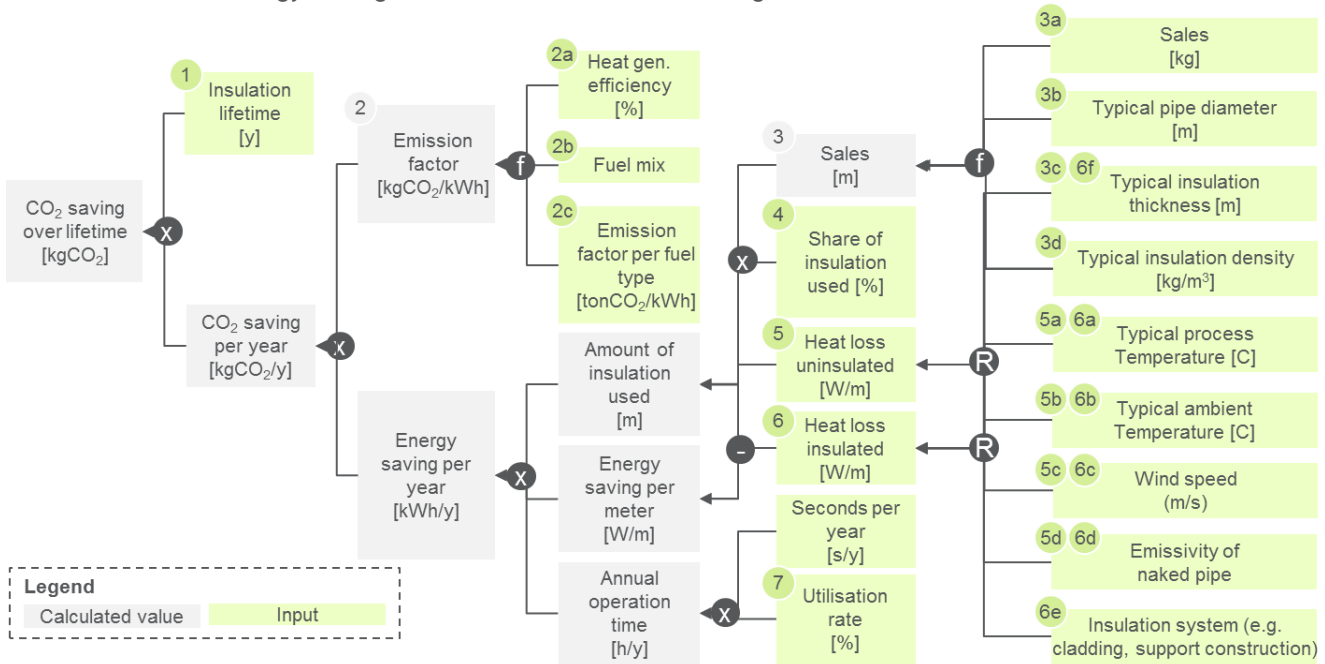
¹ Fuel mix is not corrected for expected changes in this mix over time and, therefore, does not take the potential decarbonisation of this fuel mix into account. However, the fuel mix will be updated every 3 years.

² Range is based on a high-level assessment of different sources for the upstream impacts of fuels, including LCA software, public sources (like UK Defra and the Dutch government) and own Navigant research.

Methodology

Energy and CO₂ 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 (HVAC, industrial low temperature, industrial medium temperature and industrial high temperature) and four regions (Europe, North America, Asia, and Other).

The calculation methodology and the input values are schematically depicted below. This methodology is used to calculate both the energy savings and the CO₂ emissions savings.



Rationale Behind Inputs

For each of the four application groups, several generic and specific assumptions are made (see the table below). For industrial applications, the number shown in the table is built up from more granular inputs per application where applicable. In case high uncertainty exists on a specific input, the most conservative option is used i.e. leading to the lowest energy and emission saving.

Concerning insulation **lifetime (1)**, conservative 10, 15, 20 and 25 year lifespans are used for the high, medium, low temperature range and HVAC respectively. This is in line with the numbers used in the EEIF study “Climate protection with rapid payback³, which assumes 15 years across all industries. Low temperature applications can have longer lifetimes than this average and using 15 years for medium temperature and 10 years for high temperature, the overall lifetime is in line with this number. It is also in line with the numbers assumed by the National Insulation Association (NIA)⁴, which assumes a higher average lifetime of 20 years for industries, but also includes HVAC, so low temperature industrial purposes are expected to be around the average of this range.

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 the 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.

³ More information can be retrieved from: <http://www.eiif.org/?Studies/14>

⁴ More information can be retrieved from: <https://insulation.org/>

The fuel mix of each industry where insulation is applied (2b) is based on IEA⁵ data. Regional numbers for Europe, North America, Asia (including Russia) and other regions are distinguished and based on a combination of countries with available data. For power plants, the emission factor of the fuel of the power plant is used. Please note that the fuel mix has been based on current data and does not take the effect of the expected decarbonization of this fuel mix over the lifetime of the insulation products into account. Taking decarbonization into account will decrease the resulting emission savings.

The emission factor of each fuel type (2c) is based on the 2019 refinement of the 2006 IPCC⁶ Guidelines for National Greenhouse Gas Inventories. The emission factor of biomass is set at 0, to only include CO₂ emissions from fossil fuels.

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 and are not further validated by Guidehouse.

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/m² for HVAC, industrial low temperature, industrial medium temperature and industrial high temperature respectively. According to the EIIF study “Climate protection with rapid payback”⁷, 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. 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.

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.

		Input	Application			
			HVAC	Low T	Med. T	High T
1. Insulation lifetime (years)			25	20	15	10
2. Emission factor per region & industry	2. Emission factor per region & industry		0.125 gCO ₂ /kWh - 0.341 gCO ₂ /kWh, Depending on fuel mix			
	2a. Heat generation efficiency		100%			
	2b. Fuel mix		Varying per industry			
	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	1103	6050	23842	
	5a. Process temperature (°C)	55	150	350	550	
	5b. Ambient temperature (°C)	20	20	24	24	
	5c. Wind speed	0 m/s	0.4 m/s			
	5d. Naked pipe emissivity		0.6			
6. Heat loss per m. insulated pipe		6	80	162	324	
7. Utilisation rate			5-68%	23-90%		

⁵ International Energy Agency, more information can be retrieved from: <https://www.iea.org/>

⁶ Intergovernmental Panel on Climate Change, more information can be retrieved from: <http://www.ipcc.ch>

⁷ More information can be retrieved from: <http://www.eiif.org/?Studies/14>

To calculate the **amount of insulation that is used (4)**, a waste percentage of 2% is assumed. Today, the Product Environmental Footprint Category Rules (PEFCR) for thermal insulation products and the French mineral wool association FILMM use 2% as a default. For HVAC, an additional 10% is subtracted, to account for the insulation of pipes for cold tap water. This is a high-level estimate provided by ROCKWOOL, which has not been verified by Guidehouse. The parameter is not critical, as even doubling the amount will only decrease the overall outcome by less than 1%.

The **heat loss of a non-insulated pipe (5)** is calculated using the Rockassist tool⁸, based on the VDI 2055 standards. 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 the far majority of HVAC insulation sales being in Europe and the number should be revised for other regions if sales increase there.

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 is hard 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, which has been confirmed by Guidehouse building experts.

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 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 therefore possibly not representative, but we believe that the current average is conservative also considering the fact that the measurements are taken at inland locations and during relatively good weather. 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 located 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 FIW⁹, 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 steels 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 the emission saving.

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 system¹⁰ 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.

⁸ Can be retrieved from: <http://www.rockassist.com>

⁹ Forschungsinstitut für Wärmeschutz, more information can be retrieved from: <http://www.fiw-muenchen.de/>

¹⁰ 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.

The inputs for **utilization rate (7)** differ per application. For HVAC, the number is based on a Guidehouse building expert's assumption of heating hours per year for different climate zones and a distribution of these climate zones over the regions that are assessed. In cold climate zones this is 6000 hours per year, for moderate climate zones 2500 and 0 hours in warm climates. Cooling is not taken into account as up to 2019, ROCKWOOL technical insulation products are mainly suitable for heating. For industrial purposes a load factor of 90% is used. According to Guidehouse industry expertise, this assumption is valid under the condition that most of ROCKWOOL's insulation is applied in larger industries that typically run continuously, taking only limited downtime for e.g. maintenance into account. For power plants, the utilization rate is based on an estimate of hours that a power plant is running based on IEA¹¹ data for generation and generation capacity.

¹¹ International Energy Agency, more information can be retrieved from: <https://www.iea.org/>