A STUDY ON INSULATION'S POSITIVE IMPACT ON ENERGY EFFICIENCY AND EMISSION REDUCTIONS

Commissioned by:

The Foundation for Mechanical Insulation Education, Training, and Industry Advancement and the National Insulation Association

Mechanical Insulation
EDUCATION TRAINING ADVANCEMENT

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THE VOICE OF THE INSULATION INDUSTRY™

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Acronyms and Abbreviations

CO_2	carbon dioxide
CRB	curved radius block
CUI	corrosion under insulation
EPA	U.S. Environmental Protection Agency
ESG	environmental, social, and governance
ETS	emissions trading system
Foundation	Foundation for Mechanical Insulation Education, Training, and Industry Advancement
GHG	greenhouse gas
HVAC	heating, ventilation, and air conditioning
IPS	iron pipe sizes
L/F	linear feet
MTCO2e	metric tons of CO2 equivalent
NAIMA	North American Insulation Manufacturers Association
NIA	National Insulation Association
NO_2	nitrogen dioxide
Polyiso	polyisocyanurate
REC	renewable energy credit
SF	Square feet
SME	subject matter expert

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Study on Insulation's Positive Impact on Energy Efficiency and Emission Reductions

Executive Summary

Introduction

In 2023, the Foundation for Mechanical Insulation Education, Training, and Industry Advancement (Foundation) and the National Insulation Association (NIA) commissioned Industry Insights to perform an independent, third-party survey of manufacturers of ready to use insulation products for higher operating service temperatures to assess the amount of energy saved and the reduction in carbon and other greenhouse gas (GHG) emissions.

Purpose

This study was commissioned to determine the value and role of mechanical insulation systems in assisting industries in the United States and Canada to achieve and maintain their decarbonization goals. A secondary goal is to educate facility owners, engineering firms, government agencies, code officials, and others as to the value of mechanical insulation as energy-saving and decarbonization technology that should be prioritized.

Objective

The study objective was to answer two questions:

1. How much energy is saved, and GHG emissions reduced, over time by the use of mechanical insulation systems in the higher operating service temperatures in the commercial/building and industrial market segments?

2. Conversely, how much is at risk or lost due to under-insulated areas in the higher temperature market segments?

Background

While many have theorized the energy savings and reductions in GHG emissions realized by use of mechanical insulation systems in higher operating service temperature applications in the commercial/building and industrial market segments—as well as what is lost to under insulation—the industry has never had adequate

information to calculate the answers. The questions appear to be simple, but the answers have been considered unknown, and unknowable, until now.

Definitions and Methodology

Mechanical insulation is defined to encompass all thermal, acoustical, and personnel safety requirements for mechanical piping and equipment, and heating, ventilation, and air conditioning (HVAC) applications. The operating or service temperatures for those applications can range from cryogenic levels -423°F [-253°C] to above 1,000°F [538°C]. This study's scope examined mechanical insulation used at "higher operating service temperature," which was defined to be between 150°F (66°C) and 800°F (427°C). This study did not include some materials that were suitable for the full or a portion of the 150°F -800°F temperature range and did not include other operating temperature ranges.

The study covers a time span of 11 years, broken into three segments:

- 2017 to 2021,
- 2022, and
- 2023 to 2027.

Study Findings

This study confirms the important role mechanical insulation systems can play in helping our countries and companies achieve and maintain their decarbonization goals. The study points out the obvious and impressive savings, but it more importantly highlights what could be saved if mechanical insulation systems were viewed as a decarbonization technology that is proven and available for use now.

When one considers the potential of complete and intact mechanical insulation systems, the total energy savings and emission reduction findings are impressive, and the potential loss of even a portion of those savings should not be overlooked.

The study findings, summarized in *Table 1*, are extremely conservative and do not include possible benefits from partial or under-insulated areas and equipment.

Table 1. Summary of Study Cumulative Findings

Cumulative Findings Without the Inclusion of Under-Insulated Areas			
Study Results – Savings			
Past 5 Years	Base Year	Next 5 Years	Total 11-Year Window
2017–2021	2022	2023–2027	2017–2027
Savings – Kbtu			
35,013,651,544,356	9,673,266,495,847	62,335,972,385,680	85,940,850,362,833
35.0 Trillion	9.7 Trillion	62.3 Trillion	85.9 Trillion
Dollar ($) Savings			
$91,035,494,015	$25,150,492,889	$162,073,528,203	$278,259,515,107
$91.0 Billion	$25.2 Billion	$162.1 Billion	$ 278.3 Billion
CO_2 Savings – lbs.			
5,441,121,449,993	1,503,225,613,455	9,687,010,108,735	16,631,357,172,182
5.4 Trillion	1.5 Trillion	9.7 Trillion	16.6 Trillion
CO_2 Savings – Metric Tons			
2,468,748,389	682,044,289	4,395,195,149	7,545,987,828
2.5 Billion	682.0 Million	4.4 Billion	7.5 Billion

The United States represents 91% +/- of the findings, and the Canadian portion equates to 9% +/-.

To ascertain how these results compare to other carbon reduction initiatives or GHG reduction equivalents, we turned to the U.S. Environmental Protection Agency (EPA) Greenhouse Gas Equivalencies Calculator.[1] Results appear in *Table 2*.

Table 2. Reduction in GHG and CO_2 Emissions from Mechanical Insulation Compared to Other Initiatives

	Potential Average Lost – Under-Insulated Areas			
	Past 5 Years	Base Year	Next 5 Years	Total 11-Year Window
Equivalencies	2017–2021	2022	2023–2027	2017–2027
Greenhouse Gas (GHG) Emissions from:				
Gasoline-powered passenger vehicles driven for 1 year	54.7 Million	15.1 Million	97.4 Million	167.3 Million
CO_2 Emissions from:				
Homes' energy use for 1 year	31.0 Million	8.6 Million	55.2 Million	94.8 Million
Barrels of oil consumed	568.9 Million	157.2 Million	1.00 Billion	1.7 Billion
Coal-fired power plants in 1 year	65	18	117	201
Natural gas-fired power plants in 1 year	618	171	1,100	1,889
GHG Emissions Avoided by:				
Wind turbines running for 1 year	68,396	18,896	121,767	209,059
Incandescent lamps switched to LEDs	9.3 Billion	2.6 Billion	16.6 Billiom	28.5 Billion
Carbons Sequestered by:				
Acres of U.S. forests in 1 year	293.3 Million	81.0 Million	522.2 Million	896.6 Million

A significant portion of the savings are at risk due to areas and equipment that are under insulated. ("Under insulated" is defined as items left uninsulated that could have been insulated or where insulation has been removed and not replaced, items that are either not code compliant or are compliant but do not follow the most current model

energy or building codes, items that are not specification compliant, and/or items that are damaged. More information is provided in the body of the report.) Multiple areas in both market segments were found to be under insulated. While the specific scope of those areas can only be determined on a facility-by-facility or project-by-project basis, the study examined the impact at various levels. The under-insulated areas offer an opportunity to regain potential loss of energy and reduction of carbon emissions while improving mechanical insulation systems in support of other areas, such as personnel safety, process control, mitigating corrosion under the insulation, etc.

On average, based upon the variable percentages of under-insulated areas, the potential loss equates to 10%: 1.7% for the commercial market segment, and 8.3% for the industrial market segment, for an approximate ratio of one to five (see *Table 3*).

Table 3. The Cost of Under-Insulated Areas

	Summary of Cumulative Findings vs. Potential Loss Due to Under-Insulated Areas – Both Market Segments			
	Study Results – Savings			
	Past 5 Years	Base Year	Next 5 Years	Total 11-Year Window
	2017–2021	2022	2023–2027	2017–2027
	Dollar ($) Savings			
	$91,035,494,015	$25,150,492,889	$162,073,528,203	$278,259,515,107
Average Potential Loss				
Commercial Market Segment	$ (1,529,396,299)	$ (422,528,281)	$ (2,722,835,274)	$ (4,674,759,854)
Percent of Total Savings	*-1.7%*	*-1.7%*	*-1.7%*	*-1.7%*
Industrial Market Segment	$ (7,541,773,421)	$ (2,083,299,161)	$ (13,425,090,586)	$ (23,049,163,168)
Percent of Total Savings	*-8.3%*	*-8.3%*	*-8.3%*	*-8.3%*
Combined Total	$ (9,071,169,720)	$ (2,505,827,442)	$ (16,147,925,860)	$ (27,723,923,022)
Percent of Total Savings	**-10.0%**	**-10.0%**	**-10.0%**	**-10.0%**
	CO_2 Savings – Metric Tons			
	2,468,748,389	682,044,289	4,395,195,149	7,545,987,828
Average Potential Loss				
Commercial Market Segment	(41,474,973)	(11,458,344)	(73,839,279)	(126,772,596)
Percent of Total Savings	*-1.7%*	*-1.7%*	*-1.7%*	*-1.7%*
Industrial Market Segment	(204,494,658)	(56,496,002)	(364,068,665)	(625,059,325)
Percent of Total Savings	*-8.3%*	*-8.3%*	*-8.3%*	*-8.3%*
Combined Total	(245,969,631)	(67,954,346)	(437,907,944)	(751,831,921)
Percent of Total Savings	**-10.0%**	**-10.0%**	**-10.0%**	**-10.0%**

How do these results compare to other carbon reduction initiatives or GHG reduction equivalents? The answers are provided in *Table 4*.

Table 4. Summary of Potential Loss Compared to Other Carbon or GHG Reduction Initiatives

	Potential Average Lost – Under-Insulated Areas			
Equivalencies	Past 5 Years 2017–2021	Base Year 2022	Next 5 Years 2023–2027	Total 11-Year Window 2017–2027
Greenhouse Gas (GHG) Emissions from:				
Gasoline-powered passenger vehicles driven for 1 year	54.7 Million	15.1 Million	97.4 Million	167.3 Million
CO_2 Emissions from:				
Homes' energy use for 1 year	31.0 Million	8.6 Million	55.2 Million	94.8 Million
Barrels of oil consumed	568.9 Million	157.2 Million	1.00 Billion	1.7 Billion
Coal-fired power plants in 1 year	65	18	117	201
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Wind turbines running for 1 year	68,396	18,896	121,767	209,059
Incandescent lamps switched to LEDs	9.3 Billion	2.6 Billion	16.6 Billiom	28.5 Billion
Carbons Sequestered by:				
Acres of U.S. forests in 1 year	293.3 Million	81.0 Million	522.2 Million	896.6 Million

Conservatively, the study results indicate a potential "average loss" from under-insulated areas in a combination of the market segments of 751 million metric tons of carbon over the 11-year span of the study. That equates to more than 827,000,000 carbon offsets (1 ton = 1 carbon offset).

This simply should not be overlooked by companies, industries, or governing agencies. The opportunity is there—the technology is real and proven. Mechanical insulation represents a massive and immediately available GHG reduction opportunity.

Recommendations

As decarbonization efforts continue to be developed and implemented, energy efficiency is more important than ever. The impact all insulation industry segments can contribute to that effort should not be overlooked or underappreciated.

This study's ultimate purpose is to educate facility owners, engineering firms, government agencies, code officials, and others as to the value of mechanical insulation as an energy-saving and decarbonization technology that should be prioritized, and not something that is simply taken for granted.

The discussion as to the value of having clear, concise, and complete mechanical insulation specifications, inspecting initial installations, having industry-endorsed application and repair/replacement standards, utilization of updated codes, maintaining insulation in a timely and proper manner is not new. But those discussions are more important now than ever before.

Mechanical insulation can help businesses, states, provinces, and countries obtain their regulatory or voluntary carbon reduction goals now, tomorrow, and for years to come only if mechanical insulation systems are viewed as a contributing technology.

The challenge for the business and finance communities, as well as policymakers, is to identify how best to use the time and resources we have—especially solutions that are available now—to advance the changes needed.

Next Steps

While each business, company, agency, etc., may have unique circumstances, structures, and procedures to consider, there are a few common "next steps" that should be considered in determining how and to what level mechanical insulation can help achieve their decarbonization goals.

1. Commit to investigating and developing a better understanding as to the benefit(s) of mechanical insulation and the consequences of not having up-to-date specifications and dealing with improper installation and/or insufficient or improper maintenance.

    a. Designate an individual(s) or team to become the subject matter expert(s) (SMEs) on mechanical insulation systems for the operating systems within your company or the respective scope of work or service.

    b. Develop specific responsibilities and goals for the SMEs and target short- and long-term schedules for accomplishing them (accountability).

    c. Give the SMEs the education and/or training resources to accomplish their goals.

    d. Elevate the role of SMEs to establish their importance and the value of the technology and knowledge they represent.

    e. Communicate internally and externally the appointment of the SMEs and their objectives.

2. With the support of internal SMEs and the help of external resources (manufacturers, contractors, fabricators, associations, etc.), complete a thorough and objective review of current project or company specifications or standards and develop recommended changes, if any.

    a. Develop a listing of needed company and/or industry resources and work to support the development of those resources.

    b. Develop an ongoing project or company specifications or standards review process in order to ensure they remain current and relevant.

    c. Support the development of mechanical insulation industry application standards.

   d. Support the development of broad-based and specific mechanical insulation educational resources and the potential development of governmental agencies or energy company incentives.

   e. Support the development of mechanical insulation educational programs at the college/university and trade school levels.

3. Develop and implement specific mechanical insulation energy efficiency and emission reduction appraisals/audits with inspectors and appraisers certified in those fields.

   a. Monitor their results

4. Determine the internal and/or external hurdles or barriers to implementing mechanical insulation energy and carbon reduction initiatives.

   a. Develop suggested means by which to overcome those obstacles.

5. Commit to and maintain a commitment to continuing education related to all aspect of mechanical insulation systems for the operating systems and environments specific to the company, agency, or area of operations.

6. Hold internal company/department meetings to educate all parties on the value of mechanical insulation to your organization, the environment, and the local community, as well as the consequences of missing and/or damaged insulation.

7. Share your success with others. There is great value in sharing best practices or case studies with others. Your organization benefits from being recognized as a leader and helps others in addressing climate change.

8. "Inspect what you expect," not only in terms of monitoring and recording progress of specific plans, but also with initial installation and maintenance processes. If mechanical insulation is not installed or repaired/replaced properly, the expected benefits may not be realized, and it could lead to other areas of concern and additional unexpected cost.

9. Develop an annual inspection and maintenance program for existing facilities. This will benefit short- and long-term operational and capital budget planning, and the information could be used in internal and external climate change/sustainability programs.

10. Ensure you have transition plans to transfer the mechanical insulation expertise and technology. Often, whether by right-sizing, downsizing, attrition, changes in responsibility, changes of ownership, or mergers, etc.

knowledge is lost. That is especially true with mechanical insulation. The decarbonization and other benefits of mechanical insulation is not limited by time, but if the knowledge of past successes, barriers, and challenges—as well as installation and/or maintenance programs—is lost, even for a short period of time, it could be costly, and progress potentially sidelined, which could lead to back-peddling on many already implemented and successful initiatives.

Conclusion

This study confirms the contribution the mechanical insulation industry can make to decarbonization efforts. It is available now, and it impacts every state, county (province), city, labor group, all direct or indirect related businesses, and this and future generations. If only we think about mechanical insulation differently.

It is hoped that this study and report can be the impetus for change.

Contact

For more information, visit www.insulation.org/carbon or www.insulationeducationfoundation.org.

For interview requests or more information on the study and mechanical insulation, contact Michele M. Jones at the National Insulation Association at 703-464-6422 or research@insulation.org.

Citations:

1 https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results