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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November 2023

NIA National Insulation Association®

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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
FESI	Federation of European Insulation Societies
Foundation	Foundation for Mechanical Insulation Education, Training, and Industry Advancement
GHG	greenhouse gas
HVAC	heating, ventilation, and air conditioning
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
PSQ	pipe section quarters
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
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

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.

Table 5. Summary Results: Savings from Mechanical Insulation

Study Results: Savings from Mechanical Insulation	
Total 11-Year Window (2017–2027)	**Averaged Year**
Dollar ($) Savings	
$ 278.3 Billion	$25.3 Billion
Energy Savings in Kbtu	
85.9 Trillion	7.81 Trillion
CO_2 Savings in lbs.	
16.6 Trillion	1.51 Trillion
CO_2 Savings in Metric Tons	
7.5 Billion	682 Million
Cumulative Findings (Without the Additional Savings from Under-Insulated Areas)	

The results for the total study are enormous as shown in *Table 5*. The CO_2 reduction is the equivalent of a person not driving a vehicle for 1.7 billion years! It also equals the carbon sequestration power of 9.0 billion acres of forest, which would be 3.7 times larger than the United States. The amount of money saved would be higher than the GDP of some foreign countries, specifically more than Portugal ($254 billion in 2021) and some U.S. states, including Louisiana. The 85.9 trillion kbtus would be enough to light all of New York City for 6,266 years. Mechanical insulation systems are far more powerful than most people think, and it should be prioritized in facilities and plants. Every energy-savings or emissions-reduction plan should start with insulation systems evaluations and improvements.

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

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

Full Report 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.

Background

Decarbonization is the action phrase widely used in describing efforts to keep our planet from warming more than 1.5°C above pre-industrial levels. Most countries, including the United States and Canada, have goals to reach net zero emissions by 2050, meaning that all greenhouse gas (GHG) emissions produced are counterbalanced by an equal number of emissions that are eliminated.

There are two basic aspects to decarbonization. The first entails reducing the GHG emissions produced by the combustion of fossil fuels. This can be accomplished by preventing emissions through the use of zero-carbon renewable energy sources such as wind, solar, hydropower, geothermal, etc., and electrifying as many sectors as possible. However, electrification will increase the demand for power, which is expected to continue at an accelerated pace.

The second is energy efficiency that will reduce the demand for energy. 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 confirms the significant contribution the mechanical insulation market segment can make to energy efficiency, and accordingly carbon reduction initiatives. Renewable energy sources and electrification will not by themselves bring us to net zero emissions. Mechanical insulation can and should play a substantial role alongside the transition to renewable energy and electrification.

Achieving decarbonization goals is not simple and requires that multiple aspects of decarbonization be addressed. This study was commissioned to examine for the first time in the history of the mechanical insulation industry the impact mechanical insulation systems can have on reducing the demand for energy, increasing energy efficiency, and accordingly reducing GHG emissions.

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

If mechanical insulation systems are properly installed, inspected, and maintained in a timely and proper manner, the loss of between 220 million and 1.3 billion metric tons of carbon reduction potential could be averted over the 11-year span of the study.

Sometimes government agencies and companies focused primarily on developing revolutionary new energy efficiency and carbon reduction emerging technologies, which often take years to implement, overlook proven methods available now. They are focused on 10- and 20-year goals, potentially at the expense of what can be done today. Mechanical insulation is an emerged technology that is continually improving.

Resources should be allocated on a parity basis between the here and now and the future. Utilizing solutions that can be implemented immediately to take advantage of the emissions reductions they can deliver while we continue to work on the longer-term, technology-based solutions seems to be the best and shortest path to achieve net zero emissions.

Defining Mechanical Insulation Compared to Other Types of Insulation

All insulation types and industry segments are vitally important for various design objectives and considerations that are unique to specific projects within the residential, commercial, industrial, and marine industries.

If all insulation systems deliver energy saving and emission reduction benefits, why should mechanical insulation be looked at differently? The answer is simply related to temperature differential and heat loss/gain.

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, for example, -423°F [-253°C]) to above 1,000°F (538°C).

Other insulation industry segments typically are focused on building envelope applications and heating–cooling requirements for residential and commercial buildings, which have much lower operating/service temperatures.

The greater the temperature differential between ambient and service/operating temperature, the greater opportunity for energy savings and reducing carbon emissions. Accordingly, mechanical insulation applications, compared to other insulation segments on a unit basis, will yield much greater savings.

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?

While those questions have been asked for years, the industry has previously never had adequate visibility to the core information needed to calculate the answers. The questions appear to be simple, but the answers have been considered unknown, and unknowable, until now.

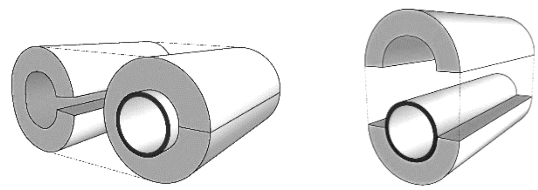
For the purposes of this study "higher operating service temperature" is defined to be processes operating between 150°F (66°C) and 800°F (427°C).

To understand the complexity of the questions, one needs to understand how the industry functions.

Generally, mechanical insulation manufacturers produce products in two forms: one in a ready-to-use form, and one requiring additional modification or fabrication before it is installed.

For the purposes of this study "ready-to-use" refers to sectional pipe insulation and board products that can be taken from the manufacturers' packaging and installed (see *Figure 1*).

Figure 1. Sectional Pipe Covering



Caption: Sectional pipe covering is where insulation has been molded or fabricated into one or two half sections to fit around a pipe or tube. For hinged and half sections, the insulation is either molded into two individual half sections or made in a full, round shape and then cut in a manner that provides a hinge-type arrangement.

- Most mechanical insulation materials can be used in a wide service temperature range.
- Manufacturers support the development of specifications for which they have knowledge of what the service temperature may be for that particular project or process. However, they do not know always know specifically what was used on the project and/or in maintenance applications.
- Distributors or fabricators typically do not know what material thickness or type is used on what service temperature, whether it be new construction or maintenance.
- Contractors do not maintain cumulative historical information as to what material thickness or type is used on what service temperature, whether it be new construction or maintenance.
- Materials are used across all climate zones for indoor and outdoor service, with varying protective coverings, etc.
- Mechanical insulation is used on many types of mechanical systems, with various energy sources and conversion efficiencies.
- An unknown fraction of mechanical insulation produced is used for "non-thermal" purposes, like noise control.

To answer the questions posed in the study objective, one needs data. Given how the industry functions, a methodology needed to be developed that would provide a prudent estimate. While the exact, finite answers may still be unknown (or unknowable), the industry now has reasonable "conservative" estimated answers to the questions.

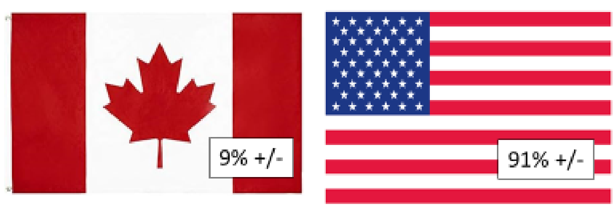
Methodology

The methodology consisted of multiple inter-related components and a combination of reported usage (herein referred to as factual data) and assumptions.

Given the reality of what little data was available, manufacturers that produced ready-to-use insulation were asked to provide their 2022 annual linear footage sales by pipe size and thickness, and square footage of board product by thickness. This information was considered factual data.

The data provided included the United States and Canadian mechanical insulation markets. While a breakdown between the two markets was not provided, historically, it has been suggested the Canadian market equates to approximately 10% of the United States market. Applying that assessment, the Canadian portion of the study results would equate to 9% +/- of the findings (*Figure 2*).

Figure 2. Study Included Data from Canada and the United States



Elastomeric type insulation was not included in the factual data. Its primary use is in the lower service temperature range. It is produced in sectional, ready-to-use forms and is used across multiple industry segments.

The exclusion of elastomeric and non-ready-to-use mechanical insulation material such as aerogel, cellular glass, polyisocyanurate (polyiso), ceramic fiber and other specialty fibers, and removable/reuseable insulation covers makes the results of this study extremely conservative by anyone's measure. Many of these non-ready-to-use materials are heavily used in commercial and industrial applications, particularly at extreme temperature ranges.

Separate from the current study, every 2 years since 1997, the NIA has conducted a survey to gauge the size of the mechanical insulation industry. By using the information from NIA's 2020–2022 survey, we were able to extrapolate insulation usage by using 2022 as a base year and looking backwards 5 years, and by using historical trends we could look forward 5 years, netting an 11–year window of information.

It was determined that looking both backwards and forward 5 years would result in more useful information than extending the analysis over a greater period.

Determining the energy, emissions, and dollars saved was accomplished with the use of the 3E Plus® software developed by the North American Insulation Manufacturers Association (NAIMA). The 3E Plus Insulation Thickness Program Version 4.0 simplifies the task of determining how much insulation is necessary to use less energy, reduce plant emissions, and improve process efficiency, calculating the economic, energy, and environmental savings provided by insulation systems. Specifically, 3E Plus translates energy losses into actual dollar amounts and calculates the number of pounds of GHGs (CO_2, NO_2, and the carbon equivalent) that are prevented from being released into the atmosphere through reduced fuel consumption.

Study Scope: Materials Included by Service Temperature

The study was based upon four ready-to-use materials from two primary groups at different service temperature ranges, locations, and protective coverings for the sole purpose of developing information with the 3E Plus software (see *Table 6*).

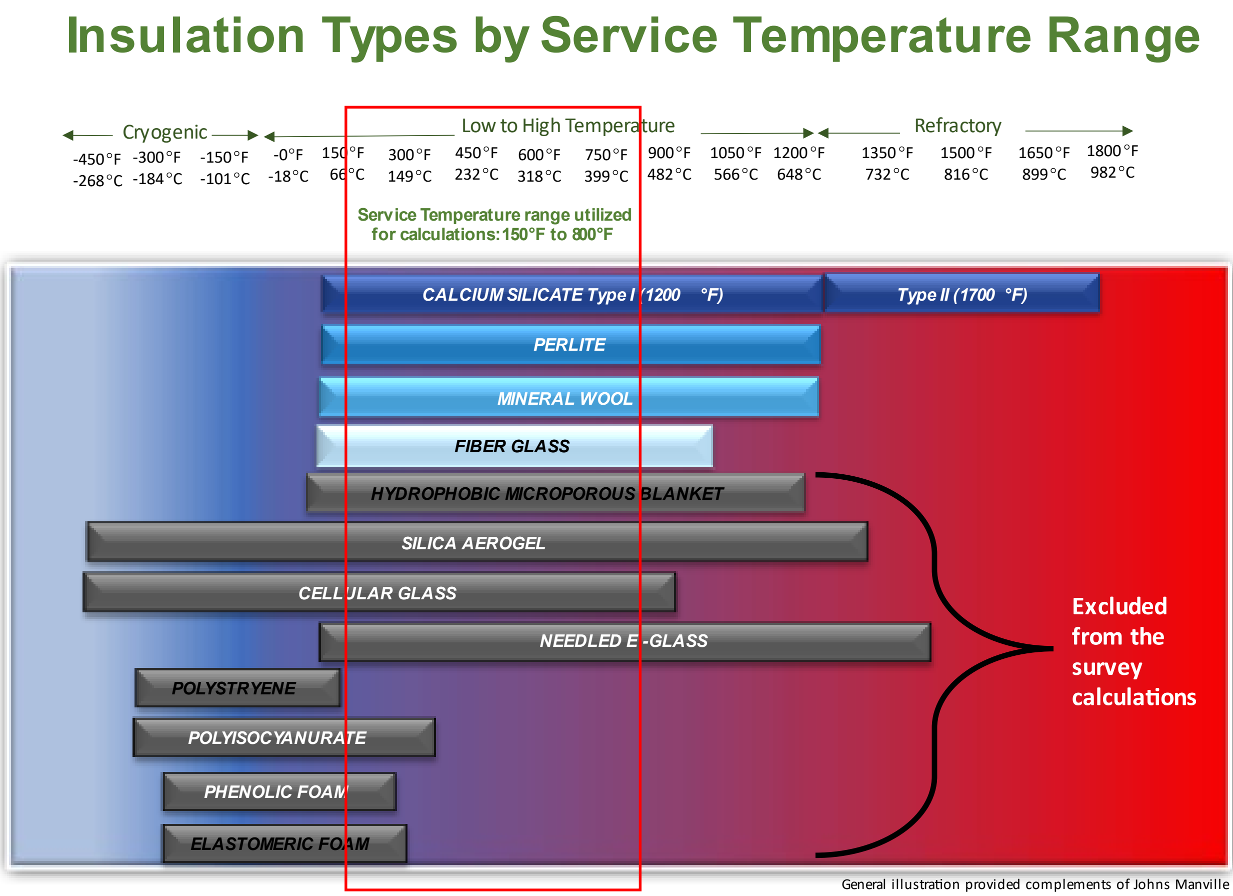
Table 6. Materials Included in Study

Material Group	Material Type	Location	Protective Covering
Fibrous (Mineral Fiber)	Fiber Glass	Indoors	ASJ Type of Jacket
Fibrous (Mineral Fiber)	Mineral Wool	Outdoors	Aluminum
Granular	Calcium Silicate	Outdoors	Aluminum
Granular	Expanded Perlite	Outdoors	Aluminum

The 3E Plus calculations were made in 50° increments for each of the service temperature ranges for insulation thicknesses 1"–3" in ½" increments from which an average was determined for each size.

Figure 3 graphically displays the materials that were included and not included in the study. The study's conservative approach is clearly visible from the graphic.

Figure 3. Overview of Materials Used/Not Used in Study



Note: Primary service temperature range can by product thickness and type. Check the minimum and maximum temperature range recommended by the respective manufacturer.

Iron Pipe Sizes (IPS) and board thicknesses used in the study are provided in Table 7 and Table 8.

Table 7. IPS Used in the Study

Title:	Rigid Pipe Insulation Outside Diameters					
	Single Layer Insulation Thickness - Normal					
IPS	1/2"	1"	1 1/2"	2"	2 1/2"	3"
1/2"						
3/4"						
1"						
1 1/4"						
1 1/2"						
2"		Included in Study				
2 1/2"		Included in Study				
3"		Included in Study				
3 1/2"		Included in Study				
4"		Included in Study				
5"		Included in Study				
6"		Included in Study				
7"		Included in Study				
8"		Included in Study				
10"		Included in Study				
11"						
12"		Included in Study				
14"						
16"						
18"						
20"						
22"						
24"						
30"						
Source: National Insulation Association's "Estimator's Handbook"						
3rd Edition, page 51						

Table 8. Board Thicknesses Used in the Study

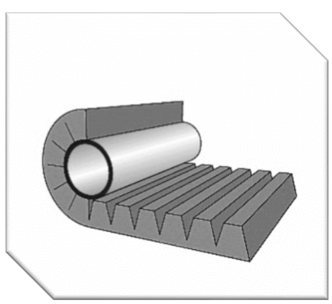
Flat Board Insulation Thickness–Normal					
1/2"	1"	1 1/2"	2"	2 1/2"	3"
	Included in Study				

The limited IPSs and thicknesses again underscore how conservative the findings are, as there is a significant volume of larger sizes, especially in the industrial higher temperature ranges. Those large-diameter applications often exhibit more extreme heat loss and energy savings.

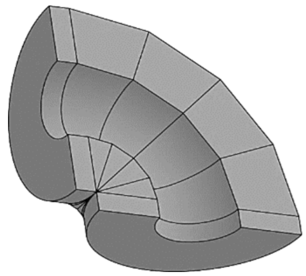
As previously described, mechanical insulation is available in various forms (see examples in *Figure 4)*. The study included several of those forms, noted in **bold print** in the following list of the respective fibrous and granular materials. It was assumed that all insulation was installed in a single layer application.

- Sectional Pipe Covering
  - **Hinged and Half Sections**
  - Quads or Pipe Section Quarters (PSQ)
  - **V-Groove Pipe Covering** – board from which v-groove was fabricated was included as a board product versus a sectional pipe covering
  - Slip-on
  - Wrap-Around Single or Multiple Layers
- Additional Pipe Covering and Equipment Forms
  - **Mitered, Routed, Stovepipe, and Contoured Fittings –** fittings as a standalone item were not included, but the sectional pipe covering from which they are traditionally fabricated was included
  - **Scored Insulation Block**
  - **V-Groove Insulation Block**
  - Curved Radius Block (CRB) or Curved Segments and Beveled Lags
  - **Flat Block and Lags**
- Insulation Material Form Definitions
  - Engineered Head Segment
  - Pipe and Tank Wrap
  - **Board**
  - Blanket or Sheet

Figure 4. Examples of Different Forms of Insulation



Caption: V-Groove Pipe Covering is where insulation board has been shaped by cutting a series of "Vs" and laminated to an insulation fabric or other facing materials, which then allows it to be wrapped around a pipe.



Caption: There are several different methods of fabricating fittings. One is a "mitered" fitting, which is when pipe insulation of a specific pipe size and insulation thickness has been cut in shapes or segments to form a tight fit around the fitting.

The final assumption involved estimating the percentage of under-insulated areas.

Impact of Under-Insulated Areas

The savings to be realized by use of mechanical insulation are at risk due to the existence of under-insulated areas. For the purposes of this study and report, "under-insulated mechanical insulation systems" is defined to include the following:

- Items left uninsulated that could have been insulated (unions, flanges, valves, etc.)
- Items that are not code compliant
- Items that are code compliant but do not follow the most current model energy or building codes
- Items that are not specification compliant
- Insulation removed for maintenance and/or other purposes and not replaced
- Insulation removal for maintenance and/or other purposes exposing the remaining insulation system to potential damage
- Improper and/or untimely maintenance
- Improper insulation system replacement
- Installation quality issues
- Items that are damaged by/as a result of:
    - Other crafts working on site
    - Weather-related events (wind, hail, flooding, etc.)
    - Moisture intrusion or intrusion of other contaminants (product, oil, grease, etc.)
    - Mechanical equipment (forklifts, scaffolding, ladders, etc.)
    - Maintenance and/or other facility personnel
    - Environmental elements (corrosive or contaminant environment)
    - Being used as a walking surface or work platform (pipe rack, for example)

- System penetration performed for inspection purposes (destructive testing) and not properly/promptly repaired
- Washdown or similar occurrence
- Fire or similar events

The questions are, how much is under insulated? And over time, does the problem create a much bigger number?

Again, what that percentage is by industry segment, facility, or nationally is unknown and—to some degree of certainty—unknowable. Most facilities will acknowledge the problems exist, but they typically do not have a formal estimate as to their magnitude. Even the general estimates vary greatly, depending on whom you ask.

The discussion and degree of under-insulated areas applies to ALL mechanical insulation systems, although the industrial segment typically represents a larger percentage versus the commercial segment. Many of the insulated piping systems in the commercial segment are located in wall cavities or above ceilings, and accordingly are not exposed to weather elements or potential mechanical or personnel abuse on a regular basis.

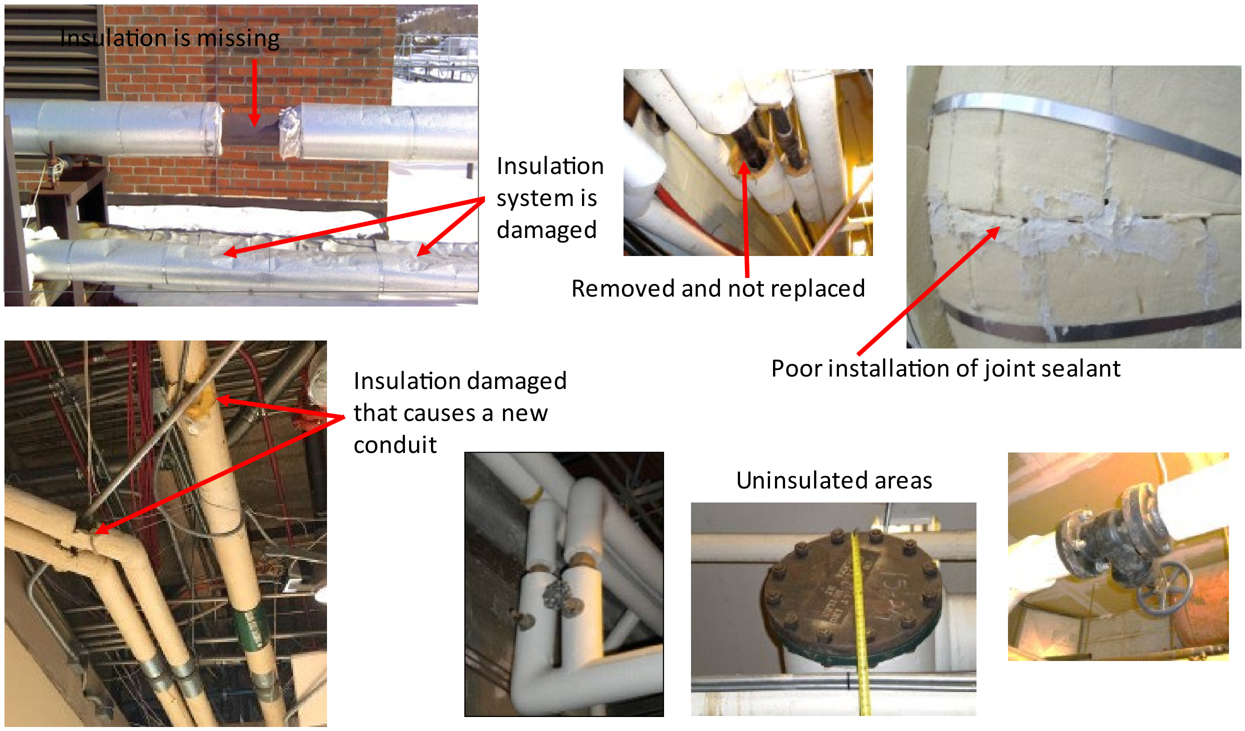
History has proven that mechanical insulation systems are under insulated for any number of reasons. The study attempts to recognize that by providing examples of the energy lost and emissions released based upon different percentages by market segment on a year-over-year basis. This approach yields a cumulative effect over the 11-year window from an industry perspective.

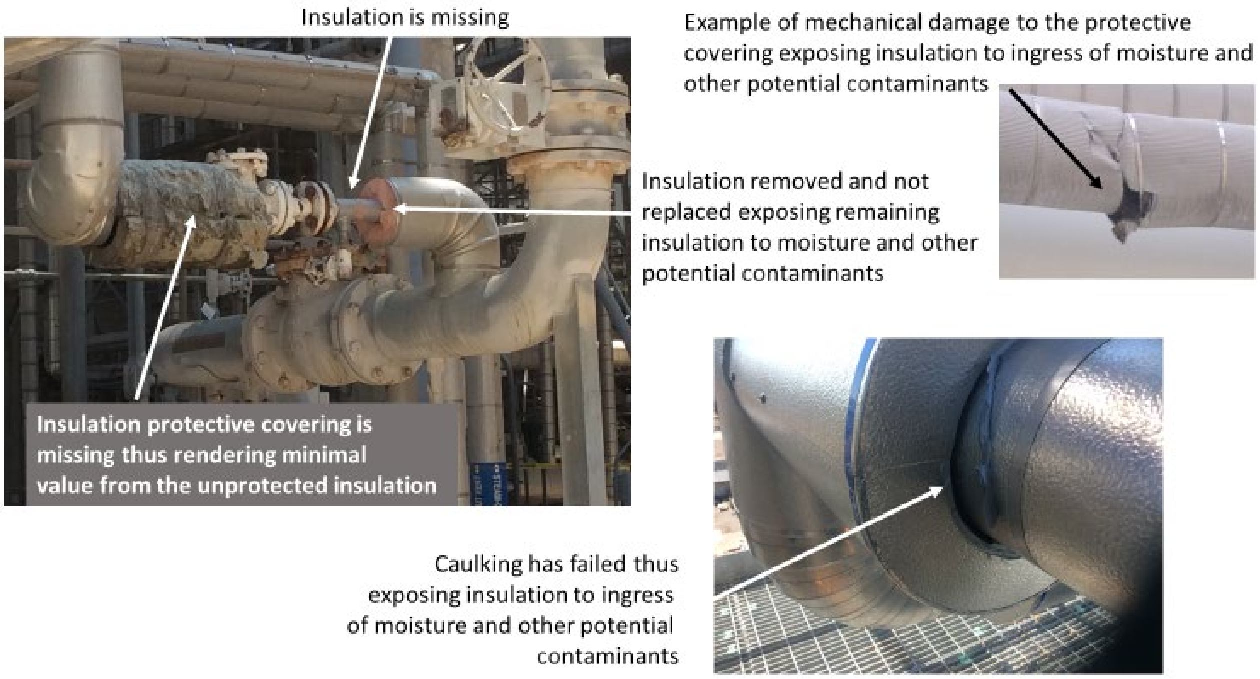
Each facility or project would need to determine its estimated percentage of under-insulated areas. The percentage example used in the study does not imply that every facility has that degree of under-insulated areas—some will have less, and some may have more.

A level of energy efficiency has been considered by the professionals who have designed and specified the insulation system. In order for an insulation system to be as effective as anticipated, it needs to remain as close to each component's manufactured state as possible, and the system to be intact and operating as designed.

As with all facility systems, mechanical insulation systems require regular inspection, and prompt/proper maintenance. Lack of proper and prompt maintenance only makes the problem worse. What today may be a simple repair could become a major problem tomorrow. Additionally, there are other potential consequences, such as personnel and process safety concerns, process control, and corrosion under insulation (CUI) to consider.

Unfortunately, many facilities have not taken a continuous, proactive approach to maintaining mechanical insulation systems, so the magnitude of under-insulated areas may be above the examples used in the study.

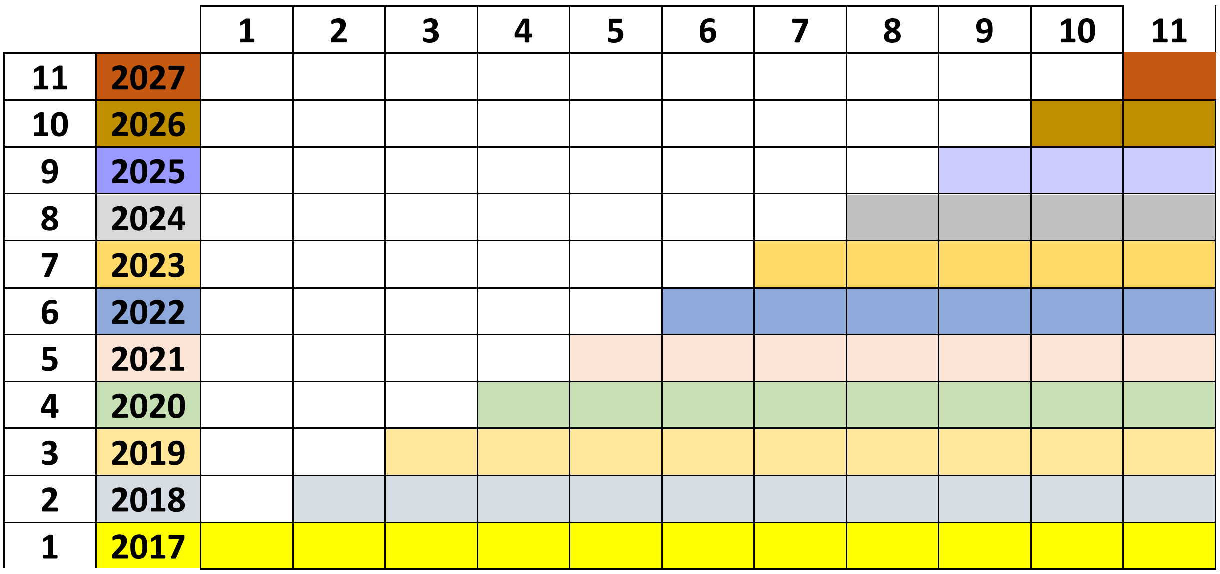




It is important to note that the study results are cumulative, beginning in 2017 and ending in 2027. Cumulative, for purposes of the study, means successive inclusion from year to year. In summary, what exist in one year will exist in the next year, and every year thereafter, unless an event happens that changes the basis of the information.

For example, if a mechanical insulation system is saving 1 metric ton of carbon emissions in 2021, it is assumed it will save the same amount in 2022, 2023, and each year thereafter. Similarly, if 2% of the insulation system is under insulated in 2021, 2% will be under insulated in 2022 and each year thereafter.

Figure 5. Cumulative Impact over an 11-Year Time Period



While to some, *Figure 5* may represent a compounding effect, it simply shows addition on a year-by-year basis. Over time, the energy and emissions savings or loss become larger and larger.

As an example, if a section of pipe or a series of pipe fittings are not insulated that could be insulated in Year 4, and remain(s) uninsulated, the loss continues year after year until they are insulated. If they are insulated in Year 8, the loss has been incurred for 4 to 5 years, but the chain has been broken, so the loss will not be incurred in Years 9 to 11 and beyond. The sooner an under-insulated occurrence is addressed, the better. The impact over the 11-year window clearly exhibits the negative results of not maintaining an insulation system and highlights the underappreciated potential loss due to under-insulated areas.

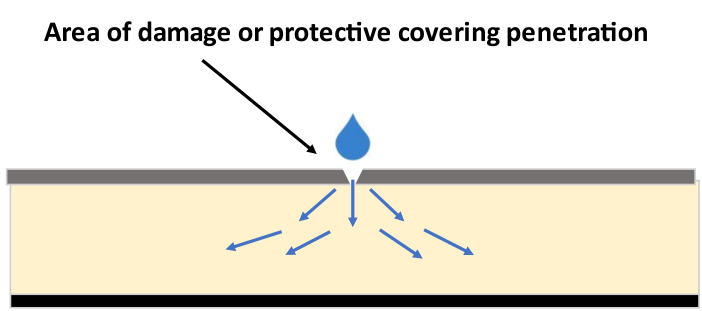
Mechanical insulation systems are not a "one and done" initiative. You do not install it and forget it. The negative impact of areas not insulated is easy to understand. The efficiency impact of damaged insulation is another story and is always subject to varying opinions and interpretations as to the scope and extent of efficiency loss.

Mechanical insulation is primarily used to limit heat gain or loss from surfaces operating above or below ambient temperatures. The theory of heat transfer is the core topic behind each insulation design objective, other than noise abatement.

Damage to the protective covering (jacket), compression of the insulation, and certainly the entrance of moisture into the insulation system will impact the energy efficiency of the insulation system, not to mention potentially leading to pipe support damage due to excess weight, potential mold growth, safety-related issues, and the development of CUI, etc.

Moisture can migrate within and/or around an insulation system, thus impacting the insulation system efficiency over a larger area than just the area of damage. The extent of migration will depend on many factors: the type of insulation, the position of the damaged area (vertical or horizontal), the operating and ambient environment conditions, just to name a few. For more reasons than one, if the system has been compromised, moisture needs to be kept out, or removed, as rapidly as possible. The presence of moisture, in any form, in an insulation system will negatively impact the efficiency of the system (see *Figure 6*).

Figure 6. Moisture Intrusion in an Insulation System



Caption: If the insulation system is damaged and/or the protective coveringpenetrated, allowing the entrance of moisture, the impact on the adjacent area could be substantial. The thermal conductivity of water is many times higher than the conductivity of the average thermal insulation.

The degree of impact willvary, depending on the extent of the damage, type of insulation, operating and ambient conditions, whether the damage occurred on a vertical or horizontal area, the amount of time the damaged has existed, and a host of other factors.

The efficiency level of the insulation used is important in finding the amount of heat loss. The actual level of efficiency can only be determined on case-by-case basis and may require product testing. The are varying opinions as to the level of efficiency lost when an insulation system is compromised. The study results for damaged insulation were based on an efficiency factor of 50%.

3E Plus® Calculations

The 3E Plus calculations were based on the following parameters.

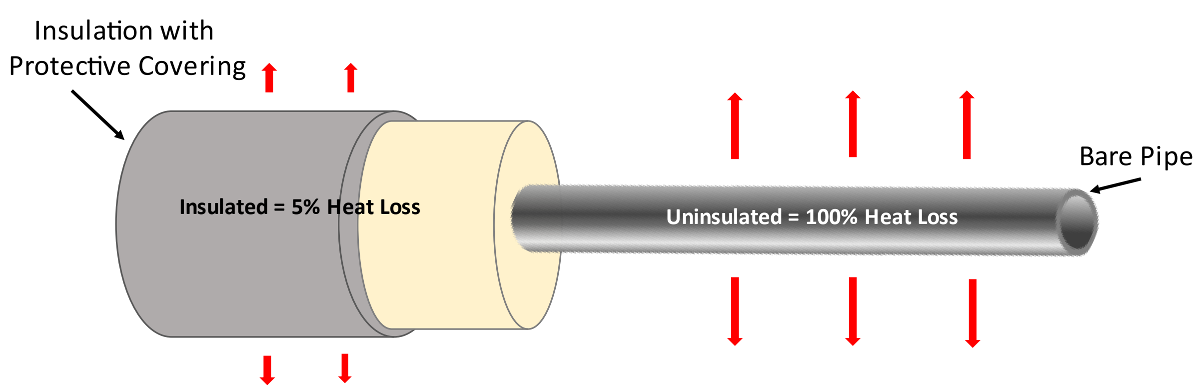
- Natural gas fuel priced at $2.00 Mcf, which was the U.S. monthly average for January 2023. All forms of fuel cost can vary widely from week to week, geographically, and by provider.

- 75% fuel source efficiency
- 6,600 hours of annual operation, or 75% of a year (a full year would be 8,760 hours)
- Average wind speed of 9 mph for outdoor applications (based on the average from 20 of the largest U.S. cities for industrial employment)
- Average ambient temperature of 60°F for outdoor applications (also based on the average from 20 of the largest U.S. cities for industrial employment)
- Average ambient temperature of 75°F, with a wind speed of 1 mph, for indoor applications
- Operating service temperature ranges included within the scope of the study in 50° increments

With any insulation system, one can determine a practical and economical thickness of insulation that yields 95% of the heat savings—recognizing an intrinsic heat loss of 5%. In other words, it is not practical or economical to increase insulation thickness beyond certain levels (see *Figure 7*).

The study used 3E Plus to determine the savings, and the intrinsic heat loss was not included in the study. The reported losses do not include the residual (intrinsic) heat loss from insulated surfaces, only the loss for missing or damaged insulation. This approach allows the results to reflect only the impact of the insulation system.

Figure 7. Heat Loss Comparison: Insulated vs. Uninsulated Pipe



Caption: If the insulation system is damaged, and/or the protective covering penetrated, allowing the entrance of moisture, the heat loss increases, including from potentially impacted adjacent areas. The extent of impact can only be determined by inspection and conducting an energy appraisal.

Findings

Cumulative Results

The cumulative study results focus on the savings as determined based on the ready-to-use insulation qualities reported by the participating manufacturers for the base year (2022), and the savings for the past 5 years and the next 5 years on a cumulative basis without any under-insulated areas (see *Table 9*).

Table 9. 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
CO2 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
CO2 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

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[2] (see *Table 10*).

Table 10. Reduction in GHG and CO2 Emissions from Mechanical Insulation Compared to Other Initiatives

	Savings			
	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	549.4 Million	151.8 Million	978.1Million	1.7 Billion
CO_2 Emissions from:				
Homes' energy use for 1 year	311.1 Million	86 Million	553.9 Million	951 Million
Barrels of oil consumed	5.7 Billion	1.6 Billion	10.2 Billion	17.4 Billion
Coal-fired power plants in 1 year	661	183.0	1,176	2,020
Natural gas-fired power plants in 1 year	6,204	1,714	11,044	18,962
GHG Emissions Avoided by:				
Wind turbines running for 1 year	686,474	189,653	1,222,153	2.1 Million
Incandescent lamps switched to LEDs	93.6 Billion	25.9 Billion	166.6 Billion	286.0 Billion
Carbons Sequestered by:				
Acres of U.S. forests in 1 year	2.9 Billion	813.3 Million	5.2 Billion	9.0 Billion

Standalone Results

The standalone results are included to demonstrate the impact over a single year, plus another year, etc., without the cumulative impact. While the savings are impressive, they are not reflective of the true impact of mechanical insulation systems over an extended period of time (see *Table 11*).

Table 5. Standalone Results

Standalone 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			
4,811,967,056,838	**937,728,698,235**	**5,126,997,543,321**	**10,876,693,298,394**
4.8 Trillion	**937.7 Billion**	**5.1 Trillion**	**10.9 Trillion**
Dollar ($) Savings			
$12,511,114,348	**$2,438,094,615**	**$13,330,193,613**	**$28,279,402,576**
$12.5 Billion	**$2.4 Billion**	**$13.3 Billion**	**$ 28.3 Billion**
CO_2 Savings – lbs.			
747,779,680,633	**145,723,039,706**	**796,735,418,232**	**1,690,238,138,570**
747.8 Billion	**145.7 Billion**	**796.7 Billion**	**1.7 Trillion**
CO_2 Savings – Metric Tons			
366,558,667	**71,432,863**	**390,556,578**	**828,548,107**
366.6 Million	**71.4 Million**	**390.6 Million**	**828.5 Million**

Mechanical insulation systems are not a 1- or 5-year initiative. Properly designed, installed, and maintained mechanical insulation systems will last longer than the 11-year span upon which the cumulative results included within the study are based. While calculations were not made on what the results of a 20-year time horizon would be, it would certainly be double the cumulative results exhibited in this report.

Potential Losses: Under-Insulated Areas

The next objective was to examine the potential emissions losses on a cumulative basis as a result of under-insulated areas. A significant portion of study savings are at risk due to areas that are under insulated. There are multiple areas in both market segments that are 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. Under-insulated areas negatively impact the total potential savings of mechanical insulation systems and impact other areas, such as personnel safety, process control, development of corrosion under the insulation, etc.

While the study results were based on upon four ready-to-use materials from two primary groups, those groups of materials are NOT the only ones subject to under-insulated areas.

The industrial segment represents a larger percentage of under-insulated areas than the commercial segment. Many of the insulated piping systems in the commercial segment are located in wall cavities or above ceilings, and so are not exposed to weather elements or potential mechanical or personnel abuse on a regular basis.

In addition, the scope of the study did not include operating temperatures below 150°F or piping below 2" IPS, which excludes a significant portion of the commercial market and portions of the industrial market.

Often, mechanical insulation has not been installed in some areas, or it has been removed for one reason or another. Further, all mechanical insulation can be damaged. The study attempts to accommodate these points by using a consistent methodology to determine the potential loss of energy and emission reduction opportunities.

Each facility or project would need to determine its estimated percentage of under-insulated areas. The percentages used in the study do not imply that every facility has that level of under-insulated areas—some will have less, and some may have more.

Recognizing the risk level difference between the market segments, a potential loss percentage scale was developed (see *Table 12*).

Table 6. Potential Loss Percentage Scale

Commercial Market Segment	Industrial Market Segment
2.0%	5.0%
4.0%	10.0%
6.0%	15.0%
8.0%	20.0%
10.0%	25.0%
N/A	30.0%

Because the exact breakdown between market segments is unknown, through a series of estimates, assumptions, and extrapolations the total savings was allotted between the two market segments.

For each potential percent of under-insulated areas, calculations were made as follows:

- 50% of the percentage was assumed to contain no insulation, and
- 50% of the percentage was assumed to be damaged and the insulation system performing at a 50% efficiency level, which may be a conservative approach.

The results are shown in Table 13 and Table 14 on the following pages.

Table 7. Cumulative Savings vs. Potential Loss from Under-Insulated Areas – Commercial Market Segment

		Summary of Cumulative Findings vs. Potential Loss Due to Under-Insulated Areas — COMMERCIAL MARKET SEGMENT			
		Study Results – Savings			
		Past 5 Years	Base Year	Next 5 Years	Total 11-Year Window
		2017–2021	2022	2023–2027	2017–2027
		Dollar ($) Savings			
		$91.0 Billion	$25.2 Billion	$162.1 Billion	$ 278.3 Billion
		CO_2 Savings – Metric Tons			
		2.5 Billion	682.0 Million	4.4 Billion	7.5 Billion
Potential Loss %	% Total Potential Savings	Dollar ($) Savings Loss			
2.0%	0.60%	$ 546,212,964	$ 150,902,957	$ 972,441,169	$ 1,669,557,091
4.0%	1.10%	$ 1,001,390,434	$ 276,655,422	$ 1,782,808,810	$ 3,060,854,666
6.0%	1.70%	$ 1,547,603,398	$ 427,558,379	$ 2,755,249,979	$ 4,730,411,757
8.0%	2.20%	$ 2,002,780,868	$ 553,310,844	$ 3,565,617,620	$ 6,121,709,332
10.0%	2.80%	$ 2,548,993,832	$ 704,213,801	$ 4,538,058,790	$ 7,791,266,423
Average		$ 1,529,396,299	$ 422,528,281	$ 2,722,835,274	$ 4,674,759,854
		$ 1.5 Billion	$ 422.5 Million	$ 2.7 Billion	$ 4.7 Billion
Potential Loss %	% Total Potential Savings	CO_2 Savings – Metric Tons Loss			
2.0%	0.60%	14,812,490	4,092,266	26,371,171	45,275,927
4.0%	1.10%	27,156,232	7,502,487	48,347,147	83,005,866
6.0%	1.70%	41,968,723	11,594,753	74,718,318	128,281,793
8.0%	2.20%	54,312,465	15,004,974	96,694,293	166,011,732
10.0%	2.80%	69,124,955	19,097,240	123,065,464	211,287,659
Average		41,474,973	11,458,344	73,839,279	126,772,596
		41.5 Million	11. 5 Million	73.8 Million	126.8 Milion

Table 8. Cumulative Savings vs. Potential Loss from Under-Insulated Areas – Industrial Market Segment

		Summary of Cumulative Findings vs. Potential Loss Due to Under-Insulated Areas — INDUSTRIAL MARKET SEGMENT			
		Study Results – Savings			
		Past 5 Years	Base Year	Next 5 Years	Total 11-Year Window
		2017–2021	2022	2023–2027	2017–2027
		Dollar ($) Savings			
		$91.0 Billion	$25.2 Billion	$162.1 Billion	$ 278.3 Billion
		CO_2 Savings – Metric Tons			
		2.5 Billion	682.0 Million	4.4 Billion	7.5 Billion
Potential Loss %	% Total Potential Savings	Dollar ($) Savings Loss			
5.0%	2.40%	$ 2,184,851,856	$ 603,611,829	$ 3,889,764,677	$ 6,678,228,363
10.0%	4.70%	$ 4,278,668,219	$ 1,182,073,166	$ 7,617,455,826	$ 13,078,197,210
15.0%	7.10%	$ 6,463,520,075	$ 1,785,684,995	$ 11,507,220,502	$ 19,756,425,573
20.0%	9.40%	$ 8,557,336,437	$ 2,364,146,332	$ 15,234,911,651	$ 26,156,394,420
25.0%	11.80%	$ 10,742,188,294	$ 2,967,758,161	$ 19,124,676,328	$ 32,834,622,783
30.0%	14.30%	$ 13,018,075,644	$ 3,596,520,483	$ 23,176,514,533	$ 39,791,110,660
Average		$ 7,540,773,421	$ 2,083,299,161	$ 13,425,090,586	$ 23,049,163,168
		$ 7.5 Billion	$ 2.1 Billion	$ 13.4 Billion	$ 23.0 Billion
Potential Loss %	% Total Potential Savings	CO_2 Savings – Metric Tons Loss			
5.0%	2.40%	59,249,961	16,369,063	105,484,684	181,103,708
10.0%	4.70%	116,031,174	32,056,082	206,574,172	354,661,428
15.0%	7.10%	175,281,136	48,425,145	312,058,856	535,765,136
20.0%	9.40%	232,062,349	64,112,163	413,148,344	709,322,856
25.0%	11.80%	291,312,310	80,481,226	518,633,028	890,426,564
30.0%	14.30%	353,031,020	97,532,333	628,512,906	1,079,076,259
Average		204,494,658	56,496,002	364,068,665	625,059,325
		204.5 Million	56.5 Million	364.1 Million	625.1 Million

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, or an approximate ratio of 1 to 5.

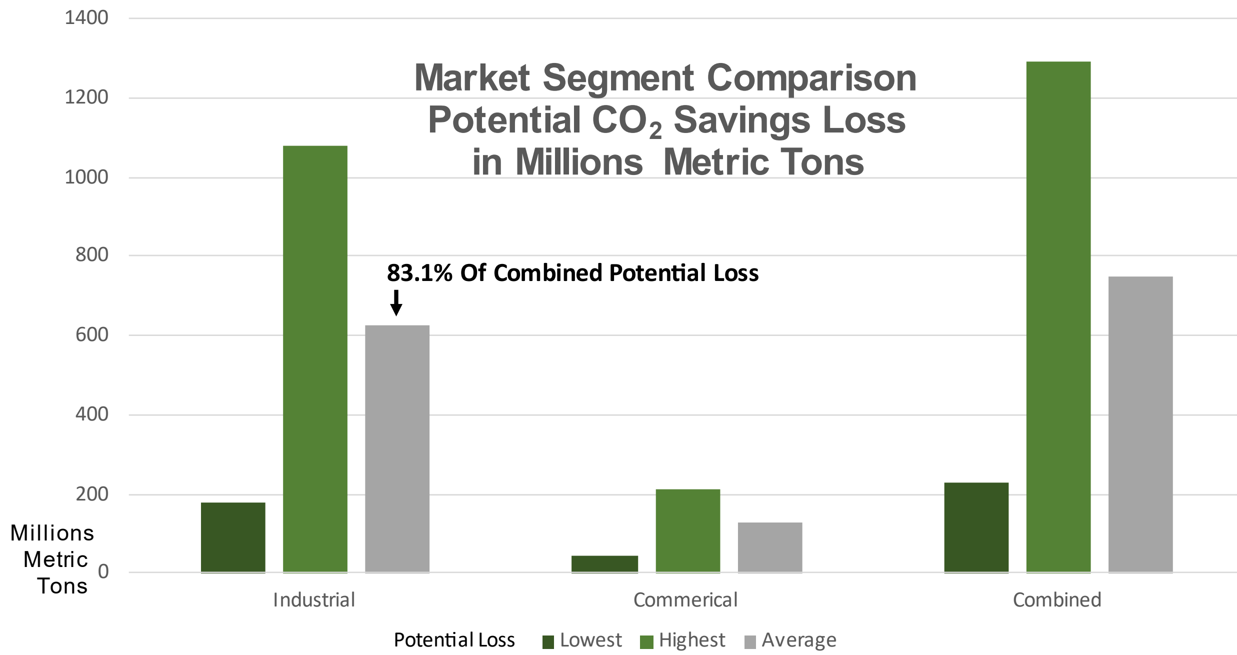
A summary of the cumulative savings compared to the potential loss due to under-insulated areas for both markets is provided in *Table 15*.

Table 9. Cumulative Savings vs. Potential Loss from Under-Insulated Areas – Industrial Market Segment

	Summary of Cumulative Findings vs. Potential Loss Due to Under-Insulated Areas – Both Market Segments			
	Study Results – Savings			
	Past 5 Years 2017–2021	Base Year 2022	Next 5 Years 2023–2027	Total 11-Year Window 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%

Figure 8 illustrates the lowest, highest, and average potential losses of CO_2 savings in the two market segments. The industrial segment represents 83.1% of the combined potential average.

Figure 8. Potential Loss of CO2 Savings in Both Market Segments



Caption: This illustrates what the chart above depicts, and the range of potential losses at the high, low and average points.

Table 16 shows how these results compare to other carbon reduction initiatives and GHG reduction equivalents.

Table 10. Comparing Loss from Under-Insulated Areas to Other Carbon and GHG Reduction Initiatives

	Savings			
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	549.4 Million	151.8 Million	978.1Million	1.7 Billion
CO_2 Emissions from:				
Homes' energy use for 1 year	311.1 Million	86 Million	553.9 Million	951 Million
Barrels of oil consumed	5.7 Billion	1.6 Billion	10.2 Billion	17.4 Billion
Coal-fired power plants in 1 year	661	183.0	1,176	2,020
Natural gas-fired power plants in 1 year	6,204	1,714	11,044	18,962
GHG Emissions Avoided by:				
Wind turbines running for 1 year	686,474	189,653	1,222,153	2.1 Million
Incandescent lamps switched to LEDs	93.6 Billion	25.9 Billion	166.6 Billion	286.0 Billion
Carbons Sequestered by:				
Acres of U.S. forests in 1 year	2.9 Billion	813.3 Million	5.2 Billion	9.0 Billion

The service operating temperature range of 150 to 600°F represented 80%+/- of the total savings and potential loss due to under-insulated areas. That is significant because many facilities do not experience process temperatures above that range.

The industry saving results are nothing less than incredibly impressive, while the numbers for potential lost energy/dollars/emissions are equally impressive for all the wrong reasons. Determining the dollars saved, or lost, was not the primary objective of this study; however, the numbers speak for themselves—especially when one considers that typically the return on investment with mechanical insulation ranges from a few weeks to less than a year. Unfortunately, insulation repair and replacement maintenance programs are most often considered a bottom-line expense, and the investment return is not considered.

The question that always arises when looking at studies of this magnitude is: What does this mean to me?

That is a valid question, especially when trying to relate the study findings to a much smaller scale or single facility as an example. To answer the question, one would need specific information relevant to the facility.

In an effort to answer that question, we developed a hypothetical scenario. While reading this, keep in mind a small oil refinery could have more than 1,000,000 linear feet of insulated piping.

- A facility has 5,000 equivalent linear feet (L/F) of 4" IPS at service temperatures ranging between 250 to 600°F, with 1–3" insulation.
- The insulation is missing or damaged on the 5,000 L/F to the extent that its thermal value is not a consideration.
- Using the same methodology as applied in the survey, the impact/loss over 1 year would be as shown in *Table 17*.

Table 11. Savings Lost in 1 Year by Facility in Hypothetical Scenario

	Energy, KBTU	Dollars	CO_2 Emissions
5,000 L/F - 4" IPS 1"–3" Thickness, 250–600°F	**82,569,750**	**$213,269**	**12,749,125 lbs. 5,785 Metric Tons**

Table 18 compares the loss experienced by the facility in the hypothetical scenario over 1 year to what would be lost from other carbon or GHG reduction initiatives.

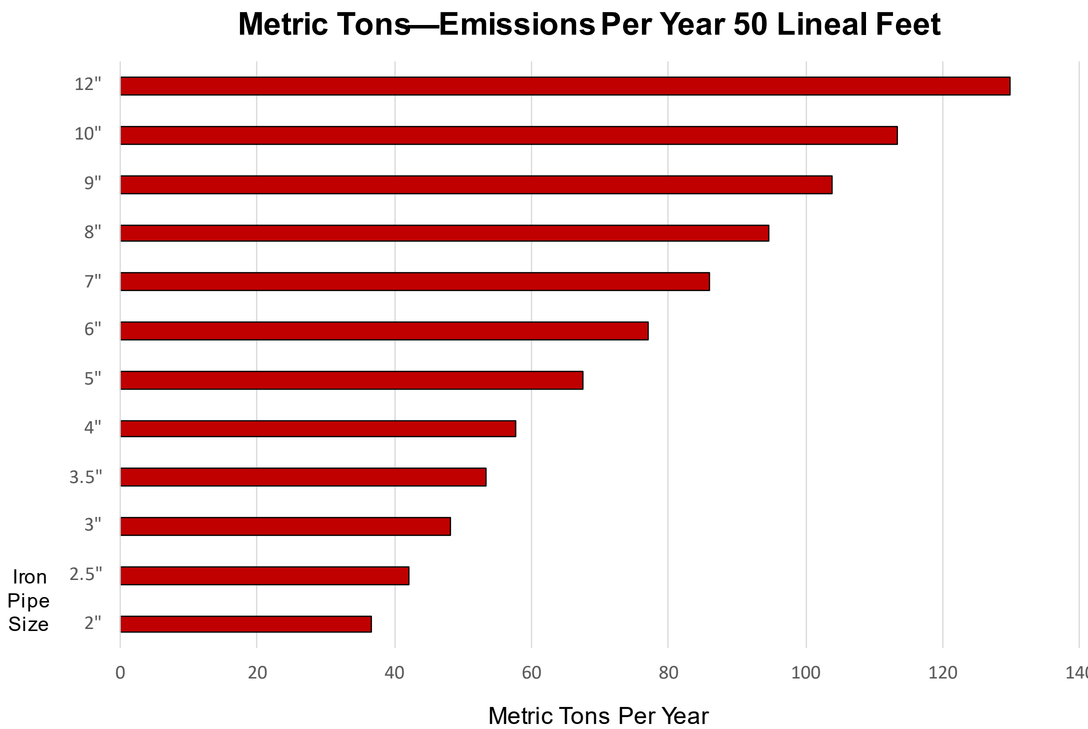
Table 128. Comparing Loss from Facility in Hypothetical Scenario to Other Carbon and GHG Reduction Initiatives

	Lost 1 Year
Equivalent to Greenhouse Gas (GHG) Emissions from:	
Gasoline-powered passenger vehicles driven for 1 year	1,287
Equivalent to CO_2 Emissions from:	
Homes' energy use for 1 year	729
Barrels of oil consumed	13,380
Coal-fired power plants in 1 year	0.002
Natural gas-fired power plants in 1 year	0.015
Equivalent to GHG Emissions Avoided by:	
Wind turbines running for 1 year	1.6
Incandescent lamps switched to LEDs	219,257
Equivalent to Carbon Sequestered by:	
Acres of U.S. forests in 1 year	6,899

Considering the study results from a different perspective, if a facility contained 10 L/F of iron pipe (2"–12" IPS), for each insulation thickness (1"–3" thickness, or 5 thickness) operating at the service temperature range between 250 to 600°F that was uninsulated or damaged to the extent that its thermal value is not a consideration, how many extra metric tons of CO_2 emissions would be generated annually?

Using the same methodology as the survey, the impact for 50 L/F of piping by pipe size, in terms of the emissions over 1 year, would be as shown in *Figure 9*.

Figure 9. Emissions Per Year for 50 Lineal Feet



Note: 1" insulation thickness was not included on 9"–12" IPSs.

Mechanical Insulation and Emissions Trading Systems (Carbon Offsets and Credits)

Trading in GHG emissions started in the late 1990s with the "Prototype Carbon Fund" as an offshoot of the Kyoto Agreement, and hundreds of billions of dollars have been exchanged since then. Today, this activity is referred to as an "Emissions Trading System" (ETS) with the instrument being a "carbon offset" (or, somewhat interchangeably, a "carbon credit"). A carbon offset is a reduction or removal of emissions of carbon dioxide that can be traded for currency or to compensate for ("offset") emissions made elsewhere.

GHG emissions savings are nearly universally evaluated based on the equivalent Metric Tons of CO_2 equivalent ($MTCO_2e$) reduced by the measure, with 1 $MTCO_2e$ representing the removal of 1 ton of carbon dioxide (or its equivalent in other GHGs). The other common measure is Renewable Energy Credits (RECs), which are applied to power generation systems and measured in MWh.

ETS are broadly applied in two categories: compliance markets and voluntary carbon markets. Compliance markets exist as a result of regulation, and participants in those markets are generally given an emissions allowance. They must purchase offsets or permits or pay fines if they emit more than their allowance. Voluntary markets involve companies that wish to purchase "green credibility" or otherwise offset their emissions for environmental, social, and governance (ESG) or marketing purposes. For example, if a company goes over the prescribed emissions limit, it must buy or use saved credits to stay under the emissions cap. If a company stays under that cap, it can save or sell those credits. This is often referred to as the cap-and-trade market—with the cap being the amount of GHGs a regulatory body will allow to be released into the atmosphere for that particular segment or entity. Compliance markets in 2023 include California, 11 Eastern U.S. states that are part of the Regional Greenhous Gas Initiative (RGGI.org), the European Union, the Republic of Korea, parts of China, New Zealand, Singapore, and Japan. Voluntary markets are generally driven by corporate pledges and trade in offsets valued based on both the level of GHG mitigation and the credibility of the certifying body.

Carbon reduction projects typically fall into two general categories: avoidance or removal. An example of avoidance would be not clearing a wooded area to build a new facility (harder to verify, and generally undervalued). Examples of removal would be adding insulation thickness or layers to a pipeline to reduce radiant energy loss, as well as nature-based solutions that naturally sequester carbon in the environment, and other technology-based projects, most often new technologies, that increase efficiencies or reduce emissions.

The energy efficiency arena is where the argument can and should be made that mechanical insulation is a carbon reduction technology.

This study confirms the magnitude of carbon emissions that be saved if industry and governments view a continual and verifiable maintenance program for mechanical insulation as a decarbonization technology.

Conservatively, the study indicates a potential average loss of 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 and it is available now. The 3E Plus software makes it easy to calculate the energy savings and the resulting emissions reduction provided by mechanical insulation. The savings are verifiable.

Is mechanical insulation a new technology? No, but energy efficiency improvements have been made, and new products and systems are continually introduced.

The mechanical insulation industry is now well positioned to quantify its decarbonization potential. The decarbonization value of mechanical insulation dwarfs many of the GHG projects often in the headlines and needs to be re-examined and viewed differently by companies, regulatory bodies, carbon exchange firms, and others. Mechanical insulation offers a massive and immediate GHG reduction opportunity.

Final Analysis

The data presented in this study and report confirm that no matter how much piping or square feet of equipment in a facility are not insulated that should be, or have damaged insulation that should be repaired, the energy savings and resulting carbon emissions reduction opportunities are substantial—and they are available now.

Mechanical insulation can play a vital role in helping companies achieve and maintain their carbon reduction goals. The study confirms, while looking at only a very limited aspect of insulation's available applications, the impact the mechanical insulation industry has and can have on energy efficiency and the reduction of GHG emissions.

What if all insulation types were included across a wider service temperature range (ambient to 1,200°F), the facilities were operating beyond 9 months of the year, or if the under-insulated areas were fewer, etc.? There are many additional "what if" scenarios.

The impact over an 11-year window clearly exhibits the negative results of not maintaining or upgrading an insulation system, let alone not insulating critical applications to begin with or updating your facility to the latest energy and/or building codes.

Therein lies the struggle between studies and reality. In this case, the study confirms the savings and losses on a conservative basis; but, in reality, the savings and losses are most likely much more massive.

Decarbonization versus Sustainability

What is sustainability, and what impact does the mechanical insulation industry have on it? The EPA describes sustainability as follows:

Sustainability is based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. To pursue sustainability is to create and maintain the conditions under which humans and nature can exist in productive harmony to support present and future generations.[3]

Decarbonization is a vital component of, at minimum, maintaining—and hopefully improving—the conditions under which we live, work, and play.

Sustainability is not just about creating new technologies to combat the environmental challenges facing us in this decade and century, but also about examining existing technologies and how to improve them and implement change now.

We hear about the long list of challenges humanity faces every day: energy, food, clean air and water, and health, to name a few. Great progress is being made in developing useful new technologies to assist with these, but can we—or should we—solely rely on hoping for new technologies to work? History has proven that new technologies are tossed aside, or they do not deliver the expected large-scale impact on the environment.

Achieving sustainability and decarbonization goals will not be simple. It will require all stakeholders to work toward preserving what is a complicated environmental system. Sometimes business and sustainability goals are in conflict by the reality of day-to-day business. Fortunately, they do not have to be since mechanical insulation can advance both at the same time! This study's data can be used to promote immediate action which can accelerate progress for both business and sustainability goals.

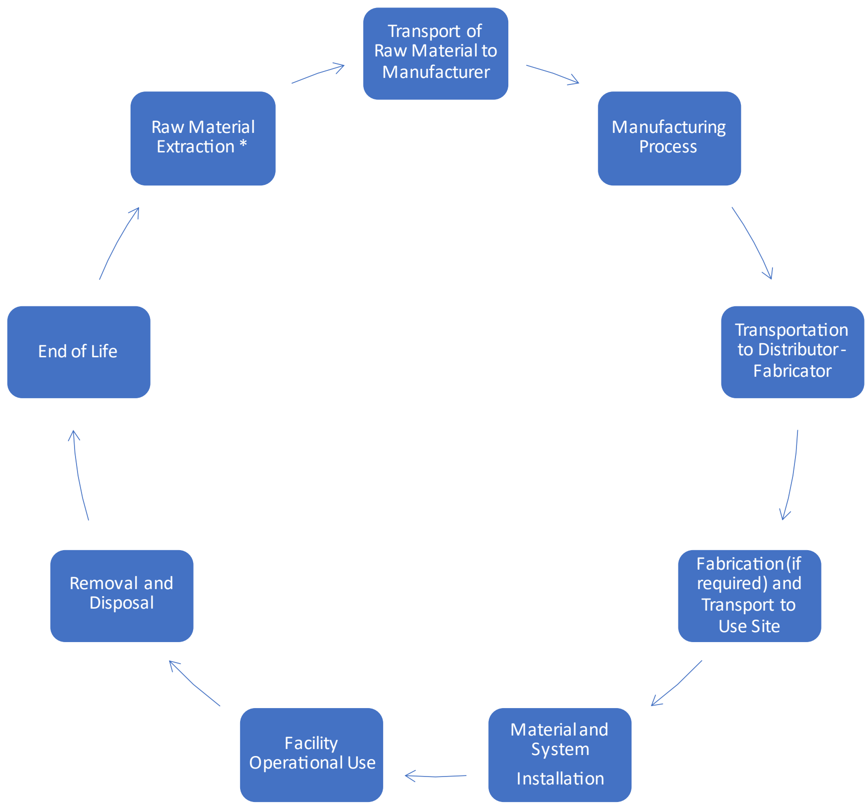
The study findings confirm that mechanical insulation should be considered more prominently as a primary product and tool to be used to immediately improve sustainability and decarbonization efforts.

Embodied Energy or Carbon

The terms "embodied energy" and "embodied carbon" refer to the total impact of all GHG emissions attributed to a material during its life cycle (cradle to grave), to include the energy from raw material manufacturing and/or extraction, processing, transporting, and fabrication. The term "embodied" within itself indicates the energy consumed and CO_2 emitted during the material's creation, use, and disposal.

While each type of mechanical insulation material, including all components of an insulation system, may have a different life cycle profile*, Figure 10* provides a general overview of the mechanical insulation life cycle.

Figure 10. Mechanical Insulation Life Cycle



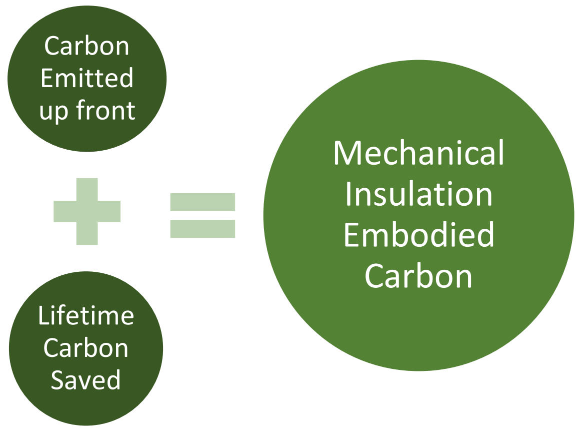
*Depending on the type of material, the term "extraction" may not apply. There also may be additional steps in the life cycle that are not included in this illustration.

With climate change on the minds of just about everyone—from consumers to engineering firms, facility owners, and federal and state regulators—it is not surprising that embodied carbon is becoming an important measurement for all construction materials, including all forms of insulation. Many companies are striving to achieve carbon-neutral or net-zero carbon targets, making the discussion of embodied carbon ever more important.

For insulation products, especially mechanical insulation, the up-front carbon emissions should be compared to the longer-term carbon emission savings achievable from the use of those products.

As the study results suggest, the emissions savings realized with the use of mechanical insulation have the potential to more than offset the embodied carbon of the material itself (see *Figure 11*).

Figure 11. Mechanical Insulation Emissions Reduction Potential Help Offset Materials' Embodied Carbon



When examining the embodied carbon over the life cycle of a mechanical insulation system, the return is nothing less than impressive and again highlights the advantages of proper installation and maintenance. Some refer to this as "environmental stewardship."

Facility owners and designers need to consider the embodied carbon of the materials being used, as well as the construction of the structure itself. Once built, embodied carbon from building materials is locked into place, provided the insulation system is properly and timely maintained.

Energy Efficiency and Carbon Reduction Audits or Appraisals

Mechanical insulation energy appraisals generally include the resulting carbon emissions reduction achieved by the insulation systems. However, depending upon the technology being considered, there are programs that are singularly focused.

Implementing energy efficiency and emission reduction goals are similar objectives in many ways, however emission reduction goals tend to be focused on the longer term, and the associated projects of higher cost. The longer term focus may be due to the cost component, which necessitates planning for the required capital, which in turn may require life cycle benefit and investment return analysis.

When considering either energy efficiency and/or emission reduction goals, the practicality of implementation is always a factor.

When one considers cost, return on investment, and practicality, mechanical insulation is one of the few initiatives that rises toward the top of the list, if not to the very top.

If it is a new construction project, increasing insulation thickness is simple; and depending upon when in the construction cycle that decision is made, the additional cost would be incremental. If the decision is made later in the construction cycle, the cost could be higher but still practical and economical.

In the maintenance field, the economics and practicality come down to a simple equation. The economics have been proven time and time again, and the practicality is dependent upon accessibility and management's commitment to an ongoing, proactive maintenance program.

Obtaining operational funding is often simpler than obtaining capital funding; however, management's view of each may be totally different. Operational funding impacts the monthly bottom line, which may create hurdles that are difficult to overcome when the investment's financial and/or carbon reduction return is not considered. Often, the consequences of maintaining mechanical insulation, beyond energy and emission loss, are not considered. These additional consequences include process control, personnel and process safety, and prevention of CUI.

All industrial and commercial buildings and private and government facilities sectors can benefit: public and private school systems, universities/colleges, healthcare facilities, military installations, power and process industries, oil and gas industries, data process centers, chip and other manufacturing facilities, etc. No company, community, etc. is excluded from receiving the potential benefits of mechanical insulation systems.

When considering other technologies, existing or emerging, the inclusion of mechanical insulation in the process will not only reduce emissions but it also often can improve the financial return on investment by months or even years, depending upon the technology being considered and the scope of the insulation requirements.

Driven by a need to operate more cleanly, and enabled by increasingly accessible renewable energy technologies, many companies are pursuing their own energy independence, going "off grid" (as it is sometimes referred to). Some businesses generate excess energy in their manufacturing processes. Regardless of the approach, insulation needs to be an integral component of the design, storage, and maintenance requirements to achieve the expected energy efficiency and carbon reduction results.

Businesses also need to consider the benefits and/or consequences of not including and maintaining insulation systems. Mechanical insulation systems are not a single-benefit technology, and they should never be viewed as such.

Conclusion and Next Steps

The study results are not surprising to those within the mechanical insulation industry. The magnitude of savings, and of what could be lost, is the data the industry has been missing. An important takeaway from the study is that the energy and emission findings are conservative by any measure.

This study provides the industry aggregate data that has never before been available, although there are hundreds of case studies that confirm the energy savings, emission reduction, and return on investment on specific items or even processes.

This study began with two core questions. In answering those questions, its ultimate purpose is to educate facility owners, engineering firms, government agencies, code officials, and others as to the value of looking at mechanical insulation as a critical energy saving technology and not something that is simply taken for granted.

Many appear to believe that replacing or repairing insulation on a few valves or a section of pipe will not make that big a difference in decarbonization efforts. Therein may be one of the biggest mistakes. It does make a big difference, especially when one considers all the valves or sections of pipe in a facility and not just one. Look at the whole puzzle, not just one piece.

This study offers a view of the industry's potential for the first time—looking at the industry holistically rather than focusing on individual parts. Each uninsulated or damaged area plays its own important role, but agencies and companies need to look more at the full potential impact of mechanical insulation systems to effect major change.

This study confirms and expands on the results of the August 2022 Insulation Opportunity Study conducted by ICF, a global advisory and technology services provider. That study was commissioned by the Insulation Industry Trade Associations Coalition, which included the NIA, to assess the state- and national-level energy and emissions impacts and economic benefits that could accrue from the installation of code-compliant insulation in the residential, commercial, and industrial building sectors.

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

We look back at the bulk of potential conflicting specifications, lack of accepted application standards, improper installations, and the degree of under-insulated areas and we ask, why or how did this happen?

That answer comes to a few basic topics for most applications.

- Lack of understanding and appreciation that mechanical insulation systems require continual inspection and maintenance.
- Primary focus on capital cost with new construction, often at the expense of future operational and maintenance cost considerations.

- Lack of full appreciation of the consequences of improper installation and maintenance until problems occur.
- No consideration of the investment aspect (financial and emissions reduction return on investment components) of maintaining an insulation system, potentially creating barriers for change.
- Hurdles created by seemingly conflicting business and decarbonization/sustainability objectives.
- Lack of knowledge and education related to understanding all aspects of mechanical insulation systems.
- Limited or lack of understanding by government and other influential bodies of the value of education and support related to looking as mechanical insulation as a proven and effective decarbonization technology.

The solutions are complex, there are many opinions as to the best path to follow, and effective change will take time. But the one change that can happen immediately is to view mechanical insulation as a proven technology that will help achieve a company's—and a country's—decarbonization and sustainability objectives. All we have to do is think about mechanical insulation differently. It is a technology that is available now, and systems will only improve.

The study conservatively confirms the value of mechanical insulation and the contribution of the mechanical insulation industry to saving energy and reducing GHG emissions; but perhaps more importantly, it highlights what is or could be lost.

Achieving short- and long-term decarbonization goals is not simple. Continuing the research and development of new, revolutionary energy efficient and carbon reduction technologies is important, but we should put equal focus on solutions that are available now.

Mechanical insulation will help businesses and states/provinces obtain their regulatory or voluntary carbon reduction goals now, tomorrow, and for years to come, if only it is recognized as a primary contributing technology and not taken for granted.

One facility at a time making a commitment to look at mechanical insulation in new construction, and existing facilities viewing it as a technology that needs to be maintained, can make a difference now. Taking small steps can lead to significant, large-scale results. To achieve decarbonization, all aspects of the economy must change—from how energy is generated to how we produce and deliver goods and services; and how we manage lands, our businesses, and our lives.

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.

Table 19. Summary Results: Savings from Mechanical Insulation

Study Results: Savings from Mechanical Insulation	
Total 11-Year Window (2017–2027)	**Averaged Year**
Dollar ($) Savings	
$ 278.3 Billion	$25.3 Billion
Energy Savings in Kbtu	
85.9 Trillion	7.81 Trillion
CO_2 Savings in lbs.	
16.6 Trillion	1.51 Trillion
CO_2 Savings in Metric Tons	
7.5 Billion	682 Million
Cumulative Findings (Without the Additional Savings from Under-Insulated Areas)	

The results for the total study are enormous as shown in *Table 19*. The CO_2 reduction is the equivalent of a person not driving a vehicle for 1.7 billion years! It also equals the carbon sequestration power of 9.0 billion acres of forest, which would be 3.7 times larger than the United States. The amount of money saved would be higher than the GDP of some foreign countries, specifically more than Portugal ($254 billion in 2021) and some U.S. states, including Louisiana. The 85.9 trillion kbtus would be enough to light all of New York City for 6,266 years. Mechanical insulation systems are far more powerful than most people think, and it should be prioritized in facilities and plants. Every energy-savings or emissions-reduction plan should start with insulation systems evaluations and improvements.

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 aspects 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.

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, direct or indirect related business, and this and future generations—if only we think about mechanical insulation systems differently.

That is potentially the industry's greatest challenge. It is hoped that this study and report can be the impetus for change.

Citations and Resources

Citations

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

[2] *https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results*

[3] *https://www.epa.gov/sustainability/learn-about-sustainability#care*

Resources

3E Plus®

3E Plus® is a software developed by the North American Insulation Manufacturers Association (NAIMA). The 3E Plus Insulation Thickness Program Version 4.0 simplifies the task of determining how much insulation is necessary to use less energy, reduce plant emissions, and improve process efficiency, calculating the economic, energy, and environmental savings provided by insulation systems. Specifically, 3E Plus translates energy losses into actual dollar amounts and calculates the number of pounds of GHGs (CO_2, NOx, and carbon equivalent) that are prevented from being released into the atmosphere through reduced fuel consumption.

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Download 3E Plus: www.3eplus.org
For 3E Plus software support, email **3eplus@naima.org**

Industry Measurement Survey

This survey is conducted every 2 years to measure the size of the insulation industry. Since the first survey was completed in 1997, the goal of the survey is to obtain valuable data regarding sales, market size, and growth for the U.S. commercial and industrial mechanical insulation market. The surveys only include data on the commercial and industrial markets, not residential. The surveys are anonymous through a third party and therefore are not company or product specific. To read the latest and past survey and other insulation research visit the web page below.

www.insulation.org/about-insulation/market-data-articles

Parties Involved

Report Commissioned By:

The Foundation for Mechanical Insulation Education, Training, and Industry Advancement

The Foundation for Mechanical Insulation Education, Training, and Industry Advancement (Foundation) is a tax-exempt 501(c)(3) organization. The Foundation's primary purpose is to develop and implement strategies and recommend processes to advance and expand the commercial and industrial insulation industry through objectives such as introducing NIA to the commercial/industrial construction community; promoting the value of insulation to audiences including specifiers, architects, engineers, plant owners, facility managers, building owners, government bodies, and allied associations; and establishing NIA as the industry resource for information on mechanical, commercial, and industrial insulation systems.

The Foundation is managed by the professional staff of the National Insulation Association and overseen by a Board of Directors, which includes Foundation President David J. Cox (Owens Corning); Foundation Treasurer John Lamberton (Irex Contracting Group); Foundation Secretary Marc Napolitano (Insulation Materials Corporation); and Board Members Jack Bittner (Johns Manville), Wally Blewitt (Knauf Insulation), R. Dean Burows (DKB, Inc.), Matt Hymer (Midwest Materials Company), Joe Leo (Atlantic Contracting & Specialties, LLC), Jon Perry (Specialty Products & Insulation).

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National Insulation Association

The National Insulation Association® (NIA) is a not-for-profit trade association representing merit (open shop) and union contractors, distributors, laminators, fabricators, and manufacturers that provide thermal insulation, insulation accessories, and components to the commercial, mechanical, and industrial markets throughout the nation. Since 1953, the Northern Virginia-based association has been the voice of the insulation industry, dedicated to keeping the commercial and industrial

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Ron King is a Past President, and Honorary Member, of the National Insulation Association (*www.insulation.org*), the World Insulation and Acoustic Organization (WIACO), and the Southwest Insulation Contractors Association (SWICA). He was awarded the NIA's President's Award in 1986 and again in 2001. He is a 50-year veteran of the commercial and industrial insulation industry, during which time he held executive management positions at an accessory manufacturer and specialty insulation contractor. He retired (2004) as the Chairman, CEO and President of a large national insulation distributor/fabricator. He currently serves as a full-time consultant to the NIA on a variety of educational, outreach and governmental initiatives, including coordinating many allied association alliance-partnership activities. He is a Past Chairman of the National Institute of Building Sciences' National Mechanical Insulation Committee and Consultative Council. He is NIA's liaison to the Federation of European Insulation Societies (FESI), which represents the European mechanical insulation market. Ron is currently Head Instructor for NIA's Thermal Insulation Inspector Certification Program™ and is a frequent industry author and speaker. He also serves as a Director and Advisor on several private company boards.

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