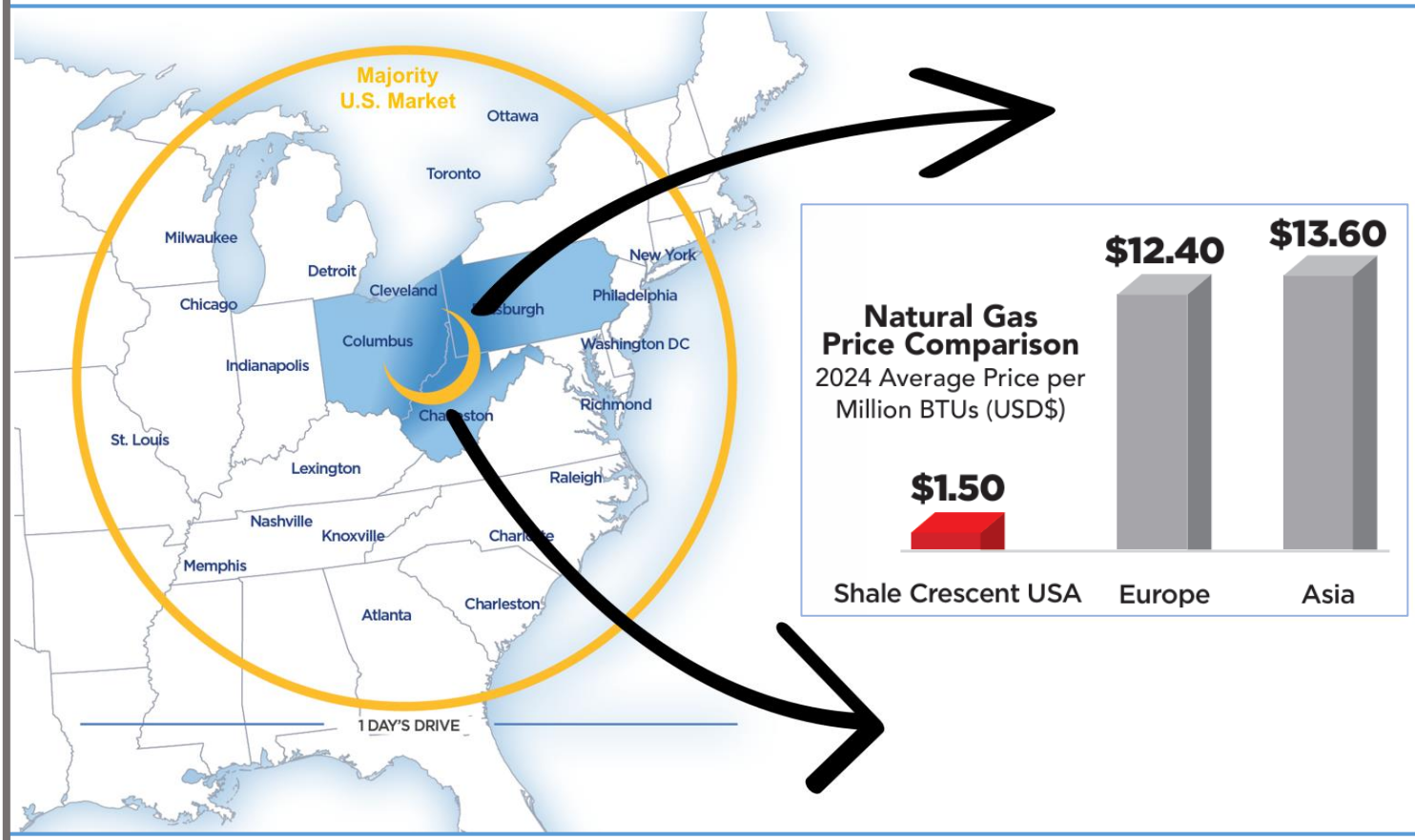
A New Opportunity for European Energy-Intensive Manufacturers

The Shale Crescent USA Energy/Feedstock Advantage

January 2025 – A REPORT BY SHALE CRESCENT USA

U.S. Investment & European Export of Intermediary or Finished Product



Long-term and Fundamental Shifts have Changed the Playing Field

Shale Crescent USA
THE OHIO VALLEY ENERGY ADVANTAGE

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EXECUTIVE SUMMARY

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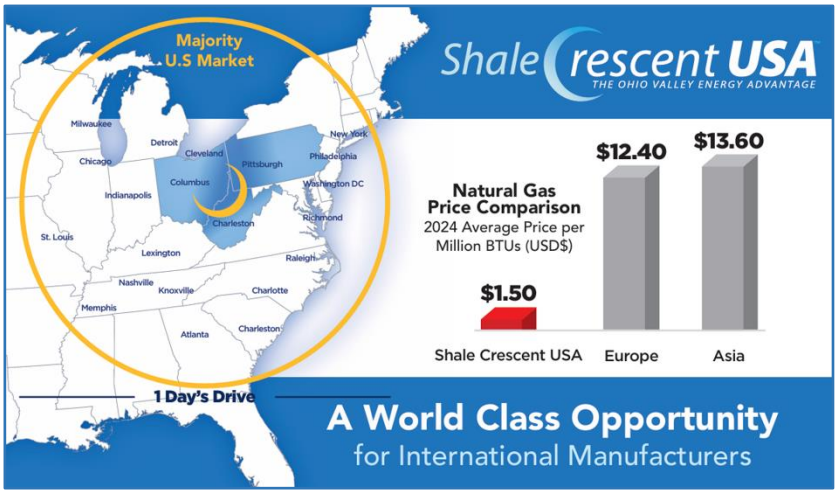
Introduction

There exists a new opportunity for European energy-intensive manufacturers to capitalize on low-cost American natural gas and natural gas liquids (feedstock). Manufacturers the world over are actively searching for reliable supplies of affordable energy and petrochemical feedstocks. The U.S. possesses energy in abundance. However, the sources of energy are not spread evenly across the country. There is a prime industrial region with abundant low-cost natural gas and natural gas liquids. **The Shale Crescent USA (Ohio, West Virginia, Pennsylvania) presents a new investment opportunity and feedstock lifeline for the European petrochemical industry.**

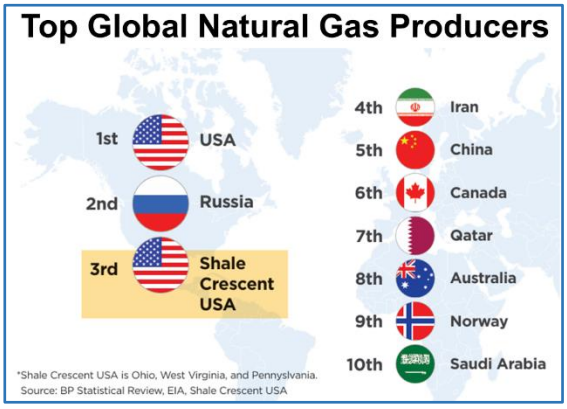


Feedstock and energy are the largest cost drivers of petrochemical-based goods, and they have a dramatic impact on profitability. **The Shale Crescent USA (SCUSA) region has the lowest natural gas prices in the industrialized world.** This report demonstrates that the Shale Crescent USA region's proximity to low-cost raw materials coupled with direct access to American consumer markets is unique and these two factors provide manufacturers with significant emissions and cost reductions. **These world class assets are fundamental and will continue for the foreseeable future.**

Abundant U.S. energy, favorable U.S. industrial policies, and increasing problems with the Chinese manufacturing model are stirring global investment into the U.S. market. European manufacturers are committing to significant investments**. There is a growing opportunity for European-based manufacturers to capitalize on the U.S.'s low-cost energy & markets while also supporting European-based operations.** As Germany is the industrial heartland of Europe, the Shale Crescent USA is the industrial heartland of America.

What has changed: Location of global energy sources and price disparity

The global economy has changed drastically in recent years. **Historically, Europe has relied on Russian energy, a China-driven customer base, and American security to operate efficiently. This is no longer a reality:** Russian energy is limited; economic relations with China are unstable; and the U.S. is prioritizing domestic investments. This paradigm shift favoring American operations has accelerated in recent years.

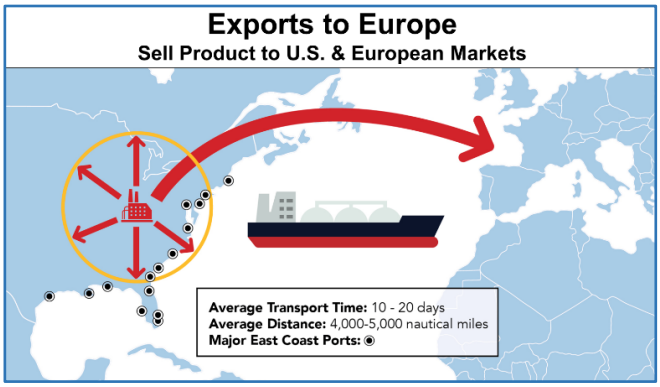


The shale gas revolution in America has led to low-cost natural gas and natural gas liquids. If Ohio, West Virginia, and Pennsylvania (SCUSA) were a country, **it would be the third greatest natural gas producing country in the world.** SCUSA combined now produce over one-third of the American natural gas supply, and it produce more natural gas than Texas. Europe is energy-scarce and is reliant on global supply chains to import LNG and feedstocks.

The Shale Crescent USA is the only region in the world where an energy intensive manufacturer can build on top of their feedstock supply and in the center of their customers, thus eliminating the costs and emissions associated with transporting feedstock and finished products. In 2024, natural gas prices in Europe averaged $12.41 per million British thermal units (MMBtu). The average price in Asia was $13.59 per

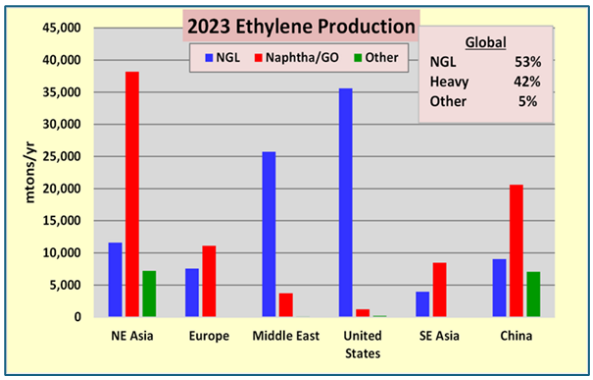
MMBtu, and in the U.S. it was $2.19 per MMBtu. Compare this to SCUSA, where the average 2024 price of natural gas was $1.55 per MMBtu, the lowest in the industrialized world. **European Natural Gas on average was 8 times greater than the price in the SCUSA region.** Since the advent of the shale gas revolution in 2008, natural gas prices have declined so markedly that in the SCUSA region the MMBtu barrel of oil energy equivalent has sold for around $9.00. Compare this to the 2024 average global oil price of $80.00 per barrel.

What is the opportunity: Servicing U.S. and European markets - Exporting intermediary production



Germany and other industrial economies throughout Europe are concerned that the reindustrialization of the U.S. will lead to a deindustrialization in Europe. This does not have to be the case. **A new model is developing that creates 'win-win' opportunities for both the U.S. and Europe**. The rest of the world covets low-cost U.S. LNG, but America's infrastructure and policy have impeded the export of energy molecules in their raw form. However, there is another method to take advantage of U.S. energy, as follows: **1)** A European-based manufacturer strategically expands into the SCUSA market; **2)** The manufacturer consumes low-cost natural gas and feedstocks to produce a higher intermediary product such as ethylene, propylene, ammonia, methanol, polyethylene, polypropylene, etc; **3A)** A percentage of the intermediary product is sold into the robust U.S. industrial market; **3B)** The intermediary product is transported by barge or rail to the Gulf Coast or East Coast ports and exported to Europe; **4)** The intermediary product is sold directly into the European market or used as feedstock in the production of other products. **The ability to transport and export product out of the Shale Crescent USA region is common and logistically friendly.**

A case study on ethylene



The SCUSA region is ideally positioned for substantial expansion of petrochemical assets, which would unlock the value chain of ethane, ethylene, and various ethylene derivatives. Over the next decade and beyond, *Ethylene Strategies International* predicts that rising global crude prices coupled with low U.S. natural gas prices will give ethylene production from NGL's a competitive edge, particularly in North America. Global markets for ethylene and ethylene derivatives are anticipated to grow faster than GDP. Marginal cost producers will continue to face significant financial pressures from low-cost producers. U.S. ethane supply is a very competitive feedstock into international crackers. Monthly U.S. export volumes of ethane exceeded 500,000 barrels per day (b/d) multiple times in 2023 with approximately 100,000 b/d consistently heading to Europe (U.K., Norway, Sweden, & Belgium). U.S. ethylene is also exported to Europe & normally lands in Northwest Europe (NWE) below the European spot price for ethylene.

Why now?

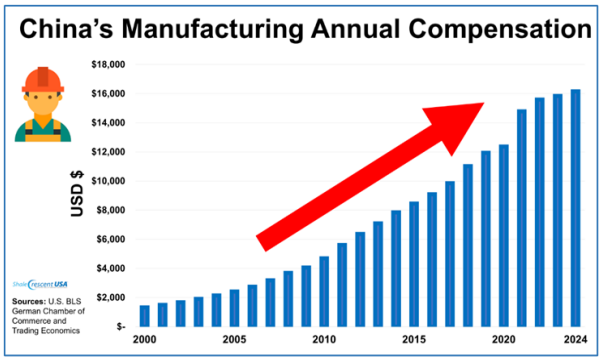
The accessibility of American shale gas, reduced emissions opportunities, prioritization of 'Made in America' industrial policies, increasing volatility of Asian-based global supply chains, ease of transportation and exports, are long-term fundamental shifts that are disrupting the current global manufacturing model. As a result, major U.S. investments are underway.

Sustainability and emissions advantages: ESG (Environment, Social, and Governance) performance has become an integral part of business operations and investment decisions. This report highlights the natural ESG advantage that SCUSA–based manufacturers enjoy based on location and type of feedstock used. Manufacturing in the region eliminates the significant transportation emissions that burden many global-based manufacturers who must import raw materials and export finished goods via transcontinental supply chains. SCUSA located manufacturers are already natural

leaders in sustainability and can significantly reduce their environmental impact without having to change their core business practices. New entrants have an opportunity to capitalize on this emissions reduction.

U.S. industrial policy: 'Made in America' is a growing priority. As well as the current administration, each of the past two presidential administrations prioritized American manufacturing in its own way. New bills introduced during the Biden administration, such as the Investment and Jobs Act (IIJA), Inflation Reduction Act (IRA), and CHIPS Act, have stimulated new manufacturing investment. These bills have established thresholds of 'Made in America' content required to qualify for tax subsidies. The nearly $1 trillion IRA aims to stimulate investment into many different new energy technologies. In the bill, are subsidies for manufacturers as long as certain 'Made in America' criteria are met. **European manufacturers of all types are eligible and thus they can capitalize on these significant incentives.**

China's eroding manufacturing advantages: China, the manufacturer of the world, is losing its historic labor cost advantage. Manufacturing wages during the past 25 years have increased nearly tenfold, and they continue to rise. Geopolitical concerns and strict government oversight are also discouraging new investment. **European and U.S. emissions goals do not align with the Chinese manufacturing model.** In China, coal is the primary source of energy, and naphtha is the feedstock for many petrochemicals. Consequently, Chinese production creates significantly more emissions than equivalent operations in the U.S. **The U.S. as a whole produces less than half the CO_2 emissions that China produces.**



Exports and U.S. transportation: The U.S. benefits from robust river and rail systems. Goods are easily moved throughout the country and exported. **As Germany is the industrial heartland of Europe, the Shale Crescent USA is the industrial heartland of America.** The SCUSA region sits in an area containing half of the U.S. population and is considered to be the country's logistical center. Chemical products from the region are distributed throughout the country and across the globe. The manufacturing facilities of many petrochemical companies are located along the Ohio River and/or adjacent to rail corridors. **Like the Danube and Rhine rivers, the Ohio River is large and can accommodate significant commercial activity such as transporting finished products by barge.** There are many major East Coast ports capable of transloading and shipping petrochemical-based products. Exporting products to Europe is a common and logistically friendly operation.

Why Shale Crescent USA?

Shale Crescent USA is the only area of the world where an energy intensive manufacturer can build on top of their feedstock supply and also be located in the center of a concentrated customer base, thus minimizing transportation costs and associated emissions. **The advantages are fundamental and will continue for the foreseeable future.**

European manufacturers are well positioned to capitalize on new strategic Investment opportunities to expand into the American market. The transportation and export infrastructure of the U.S. also makes it feasible for European-based operations to import intermediary products sourced and produced from low-cost U.S. natural gas and feedstock. Companies of different types and all over the world are currently pursuing this model. This report does not provide a comprehensive study or business plan for investment in the Shale Crescent USA; rather, it aims to create awareness of growing opportunities for European-based energy-intensive manufacturers to capitalize on world-class assets.

REPORT

A New Opportunity for European Energy-Intensive Manufacturers

The Shale Crescent USA Energy/Feedstock Advantage

January 2025: A Report by Shale Crescent USA

1. INTRODUCTION

There exists a new opportunity for European energy-intensive manufacturers to capitalize on low-cost U.S. natural gas and natural gas liquids (feedstock). **Manufacturers the world over are actively searching for reliable supplies of affordable energy and petrochemical feedstocks.** The U.S. possesses energy in abundance. However, the sources of energy are not spread evenly across the country. There is a prime industrial region with abundant low-cost natural gas and natural gas liquids. **The Shale Crescent USA (Ohio, West Virginia, Pennsylvania) presents a new investment opportunity and feedstock lifeline for the European petrochemical industry.**

Feedstock and energy are the largest cost drivers of petrochemical-based goods, and they have a dramatic impact on profitability. **The Shale Crescent USA (SCUSA) has the lowest natural gas prices in the industrialized world.** This report demonstrates that the SCUSA region's **1)** proximity to low-cost raw materials coupled with **2)** direct access to U.S. consumer markets is globally unique, and these two factors provide manufacturers with significant emissions and cost reductions. **These world class assets are fundamental and will continue for the foreseeable future.**

Favorable U.S. industrial policies, increasing labor rates in China, and abundant U.S. energy are stirring global investment into the U.S. market. European manufacturers are committing to significant investments. **There is a growing opportunity for European-based manufacturers to capitalize on the United States' low-cost energy and markets while also supporting European-based operations**.

This report is a summary of numerous and recent authoritative industry studies & official databases. It has been assembled & edited by industry professionals. For more information, please contact Shale Crescent USA.

These world class assets are fundamental & will continue for the foreseeable future.

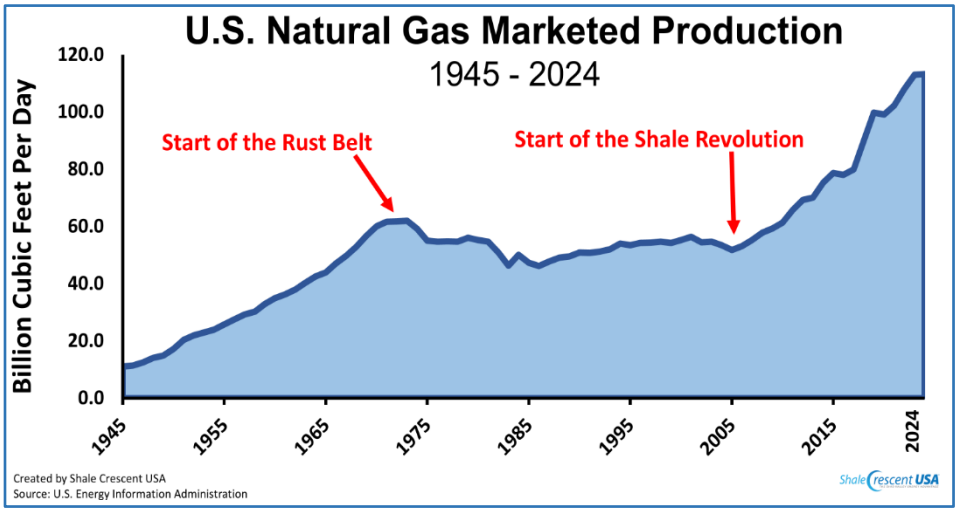
2. U.S. ENERGY MARKETS

The U.S. is a prolific producer of both oil and clean natural gas. **As a result of the shale revolution, the country has been transformed from a net importer to a net exporter of oil and natural gas.**[1] Due to continued technological advances, the natural gas industry is setting record levels of production. This new energy supply has driven down prices, reduced risk for large consumers, revitalized the industrial heartland of America, and created significant long-term opportunities to onshore energy-intensive manufacturing.

Within the U.S., the greatest producing region is in the Shale Crescent USA. It is here where a majority of both energy feedstock supply and demand for manufactured products are concentrated in the same greater SCUSA region. The low energy cost environment has created an unprecedented economic and environmental advantage for petrochemical and plastics-based manufacturing operations.

Development and growth of U.S. energy and markets

Historically, the U.S. has been a major energy producer and a significant contributor to global oil and gas supplies. **The first commercial wells in the world were drilled in the Ohio, West Virginia, and Pennsylvania region.** During the period from the 1970s to the early 2000s, American oil and gas production took a back seat to foreign imports of energy. The Arab Oil Embargo of the 1970s and the energy crisis of the 1990s and early 2000s contributed to America's reliance on imported energy from the Middle East OPEC members.



However, due to a technological advancement**—horizontal drilling—**a dramatic shift in natural gas production occurred in the early 2000s. The newly developed ability to drill through underground shale formations unlocked trapped oil and gas resources. Current technology allows the drill bit to remain within the most prolific reservoir rock over 90% of the time, and it enables the drilling of laterals of up to 8,000 meters. **Today, the U.S. produces more gas than any other country in the world.** In 2024, U.S. natural gas production averaged 113 Billion Cubic Feet per Day (BCF/D),[2] far surpassing its previous peak in the 1970s. Since the early stages of the 'shale revolution' in 2005, U.S. production of natural gas has doubled.

In the United States, natural gas has four primary markets. In order of greatest consumption to least, they are **1)** Electric power generation; **2)** Industrial consumption (feedstock and heat); **3)** Residential and commercial use (space heating); and **4)** LNG (Liquified Natural Gas) exports. In 2024, LNG exports constituted over 10% of all U.S. production, approximately 12BCF/D.[3] New dedicated pipelines and export facilities have enabled a dramatic increase in U.S. LNG exports over the past eight years. Infrastructure will play a significant factor in America's ability to grow LNG exports. However, **proposed infrastructure buildouts and cross-country pipeline projects have been met with significant resistance in the past decade, which could limit further growth of LNG exports.**

The other three markets (power generation, feedstock, and space heating) share the remaining domestic natural gas consumption. Market demands are always fluctuating, but, **historically, the market closest to the source of production of natural gas has experienced priority and advantages over competing markets.** The economic benefit of proximity to supply is analyzed later in this report.

[1] EIA: https://www.eia.gov/naturalgas/data.php#imports

[2] EIA: https://www.eia.gov/dnav/ng/hist/n9050us2m.htm

[3] EIA: https://www.eia.gov/dnav/ng/hist/ngm_epg0_evt_nus-z00_mmcfa.htm

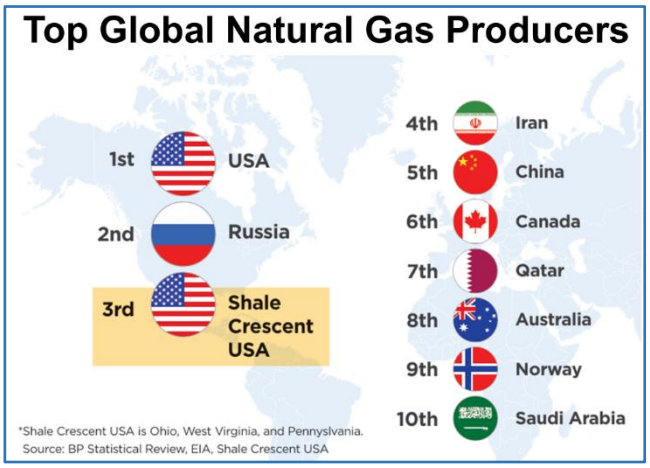
3. SHALE CRESCENT USA: ENERGY AND FEEDSTOCK-RICH

A global enery leader

The supply and pricing of natural gas are not the same across the U.S. Some regions are more energy and feedstock advantaged than others. **None are more advantaged than the Shale Crescent USA region, where both natural gas and natural gas liquids are oversupplied.**

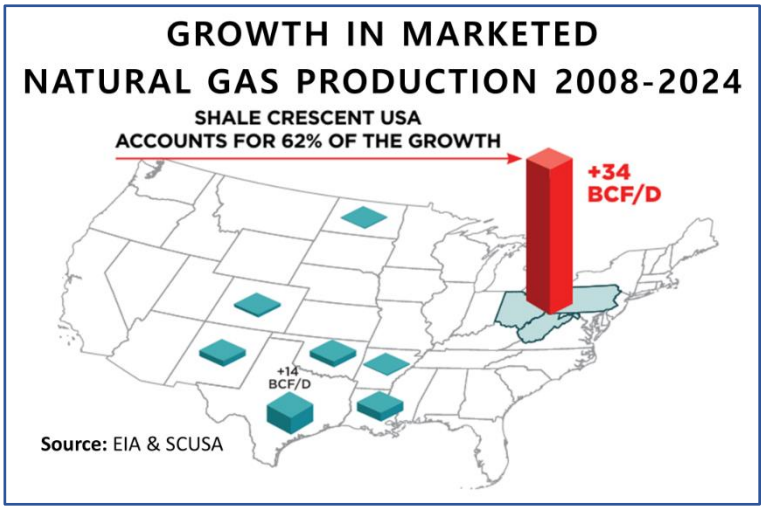
The states of Ohio, West Virginia, and Pennsylvania are global leaders in energy production. **Combined, these three states are the third most productive natural gas–producing region in the world**. The two regions that produce more natural gas are the rest of the United States and Russa.

The chart to the right lists the ten most productive natural gas–producing countries in the world, which account for 70 percent of global production. Between them, the U.S. (including SCUSA) and Russia account for over 40 percent.[4]



To put in perspective how much natural gas is produced from the energy-dense SCUSA region, **the three SCUSA states produce well over one & a half times (1.5x) as much natural gas as China, whose land mass is 30 times larger.**[5] China is a significant producer of industrial and petrochemical products, **but it has to acquire and import much of its feedstock from other regions such as the U.S. and the Middle East**. As in all energy-importing countries with industrialized economies, this leads to increased supply chain & operating risks and higher prices.

The U.S.'s dominant feedstock-producing region



The three states currently produce about 32 percent of U.S. natural gas production.[6] In 2010, that figure was only three percent. The region is the greatest natural gas–producing region in the country. To illustrate, the well-known energy state of Texas, with twice the land mass of the three states combined, produces less at about one quarter of U.S. production. Since 2008, 62 percent of the growth in natural gas production has come from the SCUSA region. The shale revolution has changed the way energy moves in the U.S. Energy used to be imported from Texas into the SCUSA region. The SCUSA region no longer imports natural gas and energy; it now exports it to other parts of the country and the world. **The region's abundant supply of natural gas and feedstock has created the most reliable and lowest-cost natural gas environment for industrial users in the U.S. and world.** Industrial manufacturers in the SCUSA region enjoy significant advantages. These advantages will be covered in depth later in this report.

The region's abundant supply of natural gas and feedstock has created the most reliable and lowest-cost natural gas environment for industrial users in the U.S. and world.

[4] Energy Institute: https://www.energyinst.org/statistical-review/resources-and-data-downloads

[5] Energy Institute: https://www.energyinst.org/statistical-review/resources-and-data-downloads

[6] EIA: https://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_VGM_mmcf_a.htm

The Shale Crescent USA region is also rich in natural gas liquids (ethane, propane, butane). There is enough ethane production to support at least four world-scale cracker plants. S&P Markit forecasts that the **SCUSA region will continue to account for over one-third of U.S. natural gas productions through 2050. In addition, NGL production will increase 20% to 0.72 million barrels per day through 2050.** This energy shift has occurred in only the past few years.

The new natural gas and feedstock supply has fundamentally disrupted energy flows in the U.S. and the word.

The new natural gas and feedstock supply has fundamentally disrupted energy flows in the U.S. and the word. Regional companies must be aware of the global manufacturing shift occurring as a result of this energy evolution. The magnitude and pace of this shift will require swift planning and action by American and European manufacturers to leverage the favorable conditions for significant economic gains.

4. GLOBAL NATURAL GAS/FEEDSTOCK PRICE COMPARISON

Energy and feedstock availability is an absolute necessity to operate petrochemical and energy-intensive manufacturing. The cost of energy and feedstock is the primary factor affecting the economic vitality and profitability of manufacturing operations. Many of the petrochemicals produced are commodities and, thus, the producers compete considerably on price and deliverability of the finished product. **Manufacturers who pay substantially higher prices for their feedstocks are at a significant disadvantage to their competitors.**

For some petrochemicals, the feedstock comprises approximately half of the total cost of production. For ethylene produced in the U.S. from ethane, the cost of feedstock can range from 40 to 60 percent of the finished product[7]. Up to 80 percent of the cost of polyethylene (PE) production, can depend on the costs of the feedstock and the type of energy used.

U.S. natural gas: A price advantage over the rest of the world

Natural gas and natural gas liquids have become the world's low-cost hydrocarbon opportunity. In much of the world and for the last several decades, natural gas and crude oil have run parallel in price. This level field has been supported by the use of both fuels as commodities which have significant offtake in various demand markets. Price deviations have occurred when the supply of natural gas has become more abundant than that of oil. Since the shale revolution, the price of natural gas has dropped dramatically & no longer runs in close parallel with oil. **In 2024, the price of American natural gas compared to global oil was roughly 1 to 50[8], far greater than the historical ratio of 1 to 8.** For producers who use natural gas liquids (NGLs) as feedstock, this has led to significant cost advantages over oil/naphtha-consuming competitors.

Natural gas and natural gas liquids have become the world's low-cost hydrocarbon opportunity.

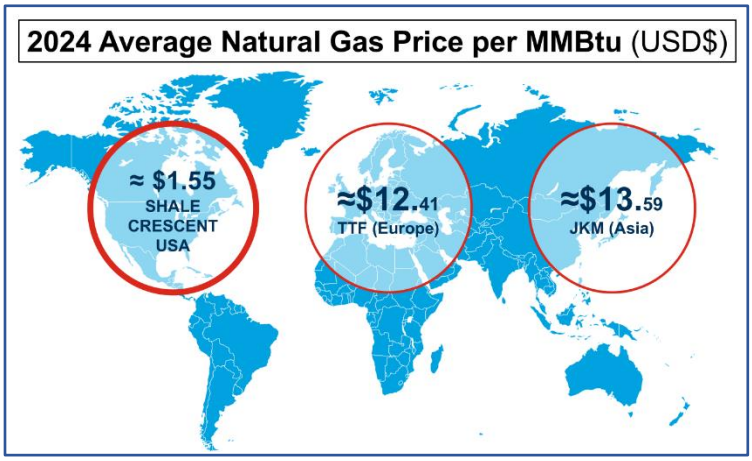
Shale Crescent USA: Lowest-cost natural gas

Within the SCUSA region, there is an even greater price advantage compared to the rest of the world and the rest of the U.S. Energy supply and prices are not the same across the U.S. Some regions are in short supply, while others have it in plenty. The cheapest natural gas within the populated and industrialized U.S. is in SCUSA. During 2024, when the average price of U.S. natural gas was $2.19 per MMBtu, in SCUSA the average price of natural gas was $1.55 per MMBtu.

Since the start of the shale revolution, 62 percent of the new natural gas supply has come from the SCUSA region. This new supply of natural gas has driven U.S. prices down by 65 percent[9].

2024 global natural gas price comparison:

- Shale Crescent USA = **$1.55 per MMBtu**
- U.S. (Henry Hub) = **$2.19 per MMBtu**
- Dutch TTF Market = **$12.41 per MMBtu**
- Asia JKM Market = **$13.59 per MMBtu**



The SCUSA price represents over an 85 percent discount to the European price. **Thus, in 2024, on average, European customers paid nearly eight times more than customers in the SCUSA region.**

For over a decade, gas consumers in the SCUSA region have experienced the benefit of prices well below those in the rest of the American market and the rest of the world. Based on abundant supply and the lack of need for long-haul transportation, **SCUSA is projected to continue to be the lowest-cost natural gas and NGL consumer region.**

SCUSA is projected to continue to be the lowest-cost natural gas and NGL consumer region.

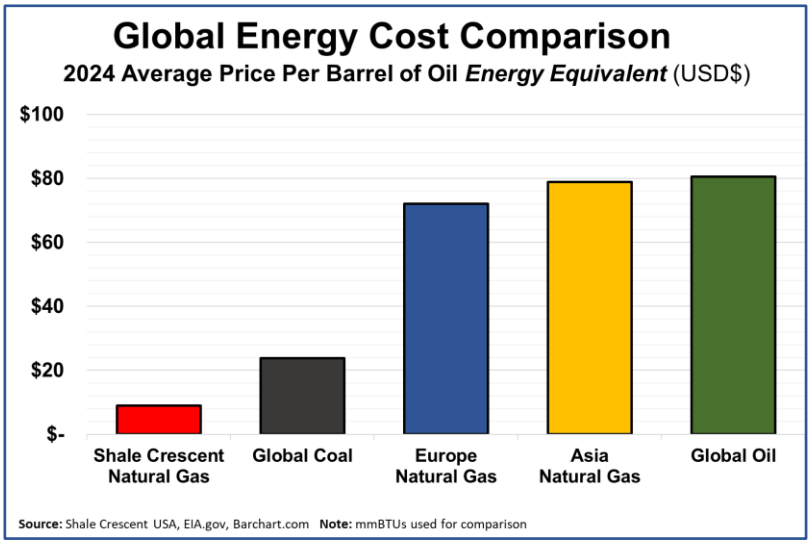
[7] IHS Markit: Benefits, Risks, and Estimated Project Cash Flows: Ethylene Project Located in the Shale Crescent USA versus the US Gulf Coast

[8] https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=M

[9] https://shalecrescentusa.com/resources/market-resources/ (Natural Gas Savings to End Users)

Shale Crescent USA: Lowest-cost hydrocarbons

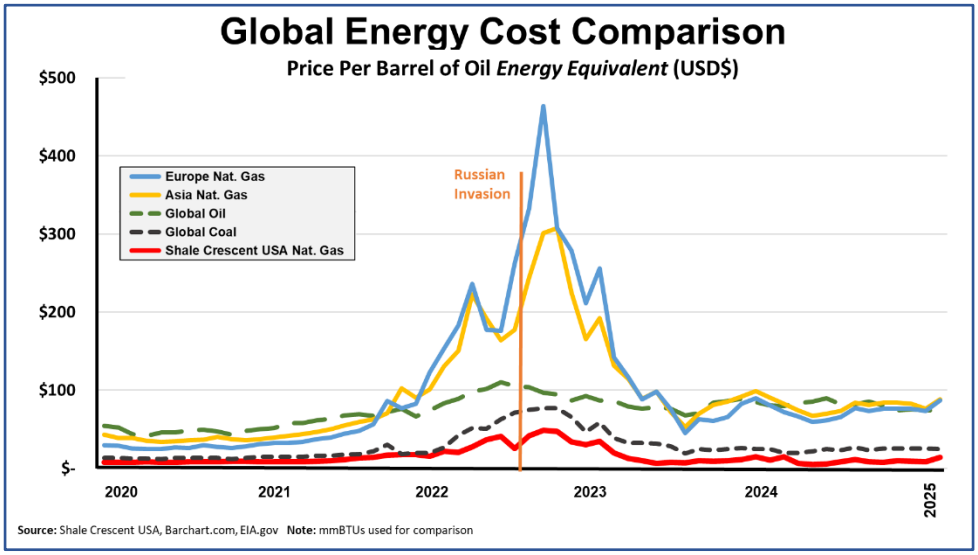
When examining global natural gas markets, as well as comparing them to global coal and oil prices, it is clear that **Shale Crescent USA natural gas and NGLs are the lowest-cost hydrocarbons in the industrialized world.** The prices have declined significantly over the past decade, and they are now lower than the prices of both coal and oil.



To compare hydrocarbon prices, the energy forms must be set equal on an energy content BTU basis. The standard rule of thumb to compare oil to natural gas is that one (1) MMBtu of natural gas multiplied by six (6) is approximately equivalent to one (1) barrel of oil on an energy content basis. This rule of thumb also applies to the pricing of the two feedstocks, for which, as stated earlier, the historical ratio has been 1 to 8. Historically, natural gas prices in dollars per MMBtu multiplied by 8 would roughly equal crude oil prices in dollars per barrel (bbl). However, in 2024, the price of natural gas in SCUSA was $1.55 per MMBtu, the average price of Brent Crude was $80.53 per barrel[10]. Oil costs over 50 times more than natural gas, far exceeding the long-term historical trend of 8 to 1. Shale development in the U.S. has fundamentally disrupted energy prices. **In 2024, the average price for a barrel of oil energy equivalent of natural gas was $9.00 in the SCUSA region.**

Over the past four years, there has been a growing separation between U.S. natural gas prices and those in the rest of the world. The chart indicates that this trend was occurring even before the Russian invasion of Ukraine.

Manufacturers in the SCUSA region enjoy stable prices, reduced volatility, and lower risks compared to global competitors. This predictability allows for better forecasting of feedstock availability and pricing, resulting in smoother operations and improved production planning.



In 2024, the average price for a barrel of oil energy equivalent of natural gas was $9.00 in the SCUSA region.

Industrial energy consumer price advantage: Directly sourcing feedstock from producers

In the U.S., large energy consumers have the option and benefit of dealing directly with the companies that produce natural gas and NGLs. Thus, industrial consumers can avoid the use and, ultimately, the cost (fees/tariffs) of long-haul pipelines. The result is lower prices, as displayed above. In SCUSA, historical manufacturing areas with robust infrastructure and transportation systems are located in the heart of the new natural gas production region. **Manufacturers, both new and established, can source feedstock that has been extracted nearby or literally from the ground beneath their manufacturing facilities.**

[10] https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=M

Royal Dutch Shell recently built a cracker plant about 50 kilometers northwest of Pittsburgh, Pennsylvania[11]**.** The facility became operational in 2023 and it benefits greatly from its proximity to abundant, low-cost ethane supplies. Shell consumes 100,000 barrels of ethane feedstock daily to produce ethylene and, ultimately, polyethylene. Two short pipelines (the 'Falcon gathering lines') were built specifically to supply this world-class facility. **Shell avoided long-haul pipeline fees and transportation by sourcing their feedstock directly from the natural gas and NGL-producing companies**.

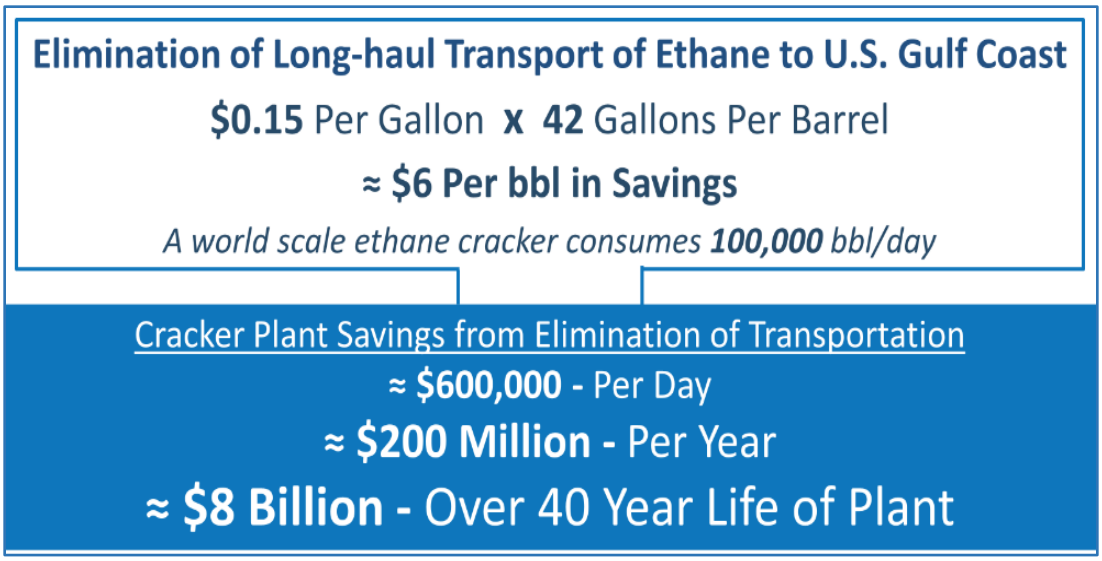
Transportation does not add value to a product. A back-of-the-envelope analysis provided below highlights the significant opportunity for petrochemical consumers when transportation costs are eliminated.

Why feedstock & natural gas costs less in the Shale Crescent USA: Avoidance of transportation

Ethane is a commodity, and the price is set in the Gulf Coast (Mont Belvieu). The price paid by ethane consumers on the Gulf Coast at the end of the ATEX pipeline covers the cost of the ethane itself as well as the cost of transport. Customers in the SCUSA region pay the market price *less* the cost of transport to the Gulf Coast. **SCUSA–based ethane cracker plants and other regional NGL consumers avoid pipeline transport costs and purchase their feedstock for less than the Gulf Coast market price.**

The average market price of ethane in 2023 was roughly $0.25 per gallon or approximately $10.50 per barrel. There are 42 gallons in a barrel (bbl). The ATEX pipeline fee to transport ethane from SCUSA to the Gulf Coast is around $0.15/gallon, or just over $6.00/bbl. The price paid for ethane by a SCUSA–based cracker plant is the Gulf Coast market price minus the ATEX transport costs. SCUSA ethane consumers enjoy prices well below Gulf Coast prices. Depending on contracts, cracker plants on the Gulf Coast can currently attribute over 50 percent of their cost for feedstocks to transportation. **IHS Markit predicts that ethane will be accessible in the long term in the SCUSA region at a discount of at least 25 percent compared to Gulf Coast prices.**[12]

For an ethane cracker plant that consumes 100,000 bbls of ethane daily, the savings from not requiring transport of the feedstock are approximately $600,000 a day, $200 million per year, and $8 billion over the life of the facility. This same principle of pipeline/transport avoidance costs applies to natural gas and other natural gas liquids. **Based on their location, energy-intensive consumers in the SCUSA region have a substantial cost advantage over consumers located in the rest of the U.S. and the world.**



[11] https://www.shell.us/about-us/projects-and-locations/shell-polymers.html

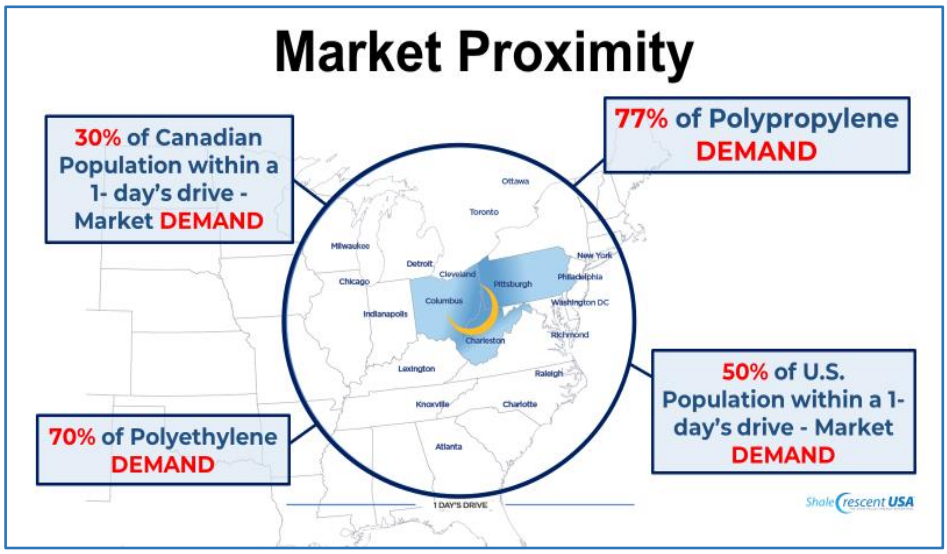
[12] IHS Markit: Benefits, Risks, and Estimated Project Cash Flows: Ethylene Project Located in the Shale Crescent USA versus the US Gulf Coast https://shalecrescentusa.com/resources/market-resources/

5. OPPORTUNITIES FOR EUROPEAN MANUFACTURERS

Manufacturing in the U.S. is expanding, and opportunities for international manufacturers continue to strengthen due to many factors, the most important of which has been the reliable supply of energy. Other factors such as proximity to markets, pro-industrial policies, overall stability, geopolitical risks, the strength of the American market, the ease of transportation, and export opportunities to international markets are leading to U.S. investments and reindustrializing at an unprecedented rate.

5.1 PROXIMITY TO SUPPLY AND MARKET

The greater Shale Crescent USA region is a historic manufacturing center. The very first oil-producing wells in the world were in Pennsylvania, Ohio, and West Virginia. During the second half of the 1800s, this region supplied the world and was the location of the primary market for oil. Downstream petrochemical industry operations were developed near the abundant source of feedstock supply. **Today, plastics and petrochemical manufacturing operations are clustered in the greater SCUSA region, where 70 percent of polyethylene and 77 percent of polypropylene resin consumption and most of American petrochemical demand is located.**[13]



In addition to being a historic oil and gas producing region and now a global oil and gas leader, the greater SCUSA region also contains one of the largest economies in the world. Fifty percent of the American and 30 percent of the Canadian population live within a day's drive.[14] **Many of the largest American cities and markets lie within a 1,000 kilometer radius of the center of the region**. There is substantial infrastructure and industrial activity throughout the entire value chain process from commodity to intermediary products to final industrial and consumer products. From the extraction of natural gas and NGLs to the finished consumer product, there are opportunities and markets for new manufacturers. **Said differently, from the 'Wellhead to Walmart', there are advantages.**

From the wellhead to Walmart, there are advantages.

Location advantage benefits: Cost and emissions savings

Typically, manufacturers must choose to locate next to either their supply/feedstock or their demand/customers. **In the greater SCUSA region, manufacturers have both supply and demand in the same place.** The resulting logistical advantage creates two primary benefits: 1) the elimination of long-haul transport costs; and 2) the elimination of emissions associated with long-haul transport.

Utilizing SCUSA energy supplies to manufacture in the region is both more cost-competitive and sustainable. Companies that locate in the Shale Crescent USA region reduce their costs & carbon footprints.

In the greater SCUSA, manufacturers have both supply & demand in the same place.

[13] IHS Markit: https://shalecrescentusa.com/wp-content/uploads/2019/12/ShaleCrescent-ExecutiveSummary-12March20181.pdf

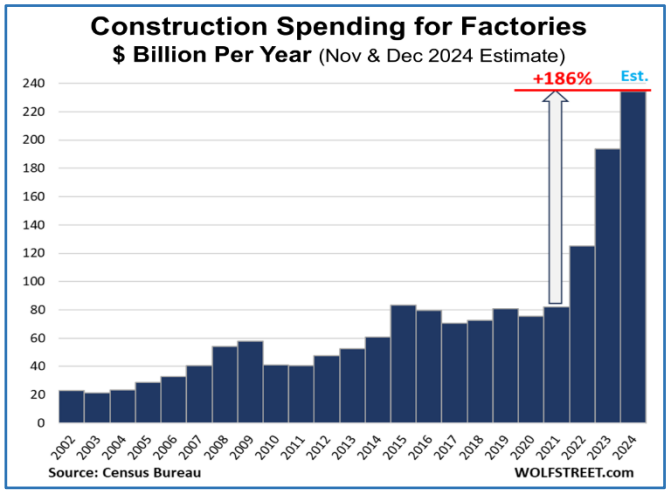
[14] Polymer Alliance Zone: https://pazwv.org/why-the-polymer-alliance-zone/#proximity

5.2 GROWING INVESTMENT – FAVORABLE INDUSTRIAL POLICY

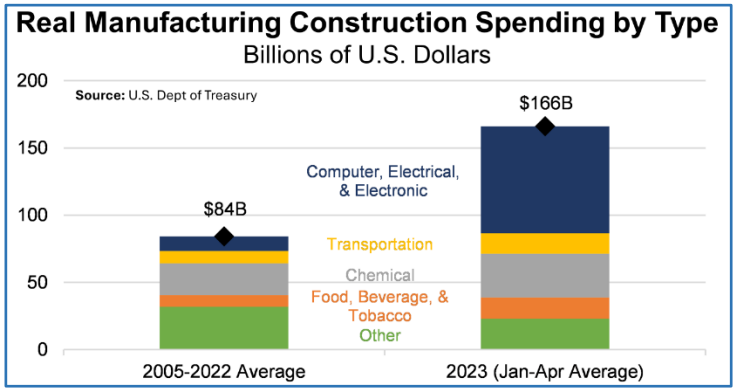
'Made in the USA' is in, and offshoring is out. Presidents Obama, Trump, and Biden have each prioritized American manufacturing in their own way. Their efforts have been accelerated by the emergence of a long-term energy advantage for the U.S. Add the desire to shorten supply lines, the impact of COVID-19, and rising labor rates in China. **The outcome has been significant U.S. investment.** The shift in American tax policies and subsidies for manufacturing has become a significant concern for European-based entities. It is becoming harder for international companies to compete with U.S.-based operations. **Significant incentives have been created, and foreign companies are beginning to capitalize on them.**

Public policy: Stimulating manufacturing investment

New bills such as the Investment and Jobs Act (IIJA), Inflation Reduction Act (IRA), and CHIPS Act have stimulated new manufacturing investment. These bills have established thresholds of 'Made in America' content required to achieve the tax and other subsidies on offer**. According to the U.S. Census Bureau, manufacturing construction spending in the U.S. approached $240 billion in 2024**[15]**.** Government policies have played a significant role in attracting and incentivizing the onshoring of manufacturers. Infrastructure, clean energy, and electrification have been the focus of investments. However, the surge in computer/electronic manufacturing construction has not displaced spending in other manufacturing segments such as chemical, transportation, and food and beverage manufacturing.[16]



The surge in manufacturing construction is unique to the United States. Japan, Germany, the United Kingdom, and Australia have seen various trends in manufacturing construction, but none have mirrored the substantial growth observed in the U.S. The U.S. continues to be the only industrialized economy with a robust energy supply creating more stability and risk avoidance for manufacturing investment. **European manufacturers are eligible to capitalize on the incentives if they invest in the U.S. and meet the required criteria.**



Inflation Reduction Act: 'Made in America' Criteria (EVs)

The IRA is a nearly $1 trillion bill that aims to stimulate investment in many different new energy technologies. For example, a primary focal point and beneficiary of the bill is the manufacturing of electric vehicles. New EVs are eligible to receive subsidies up to and in the form of $7,500 of tax credits if they meet specific 'American Made' criteria:

- Final assembly must take place in North America.
- In 2023, 40 percent of the critical battery raw materials used, such as lithium, must come from North America or a country with which the United States has a free trade agreement, or must have been recycled in North America. This quota will increase by 10 percent each year until it reaches 80 percent in 2027. In addition, starting in 2025, critical minerals must not come from Russia, China, or any other 'foreign entity of concern.'[17]

[15] https://wolfstreet.com/2024/12/02/factory-construction-spending-boom-soars-to-new-record-16-yoy-242-since-2019-result-of-a-corporate-strategic-rethink/

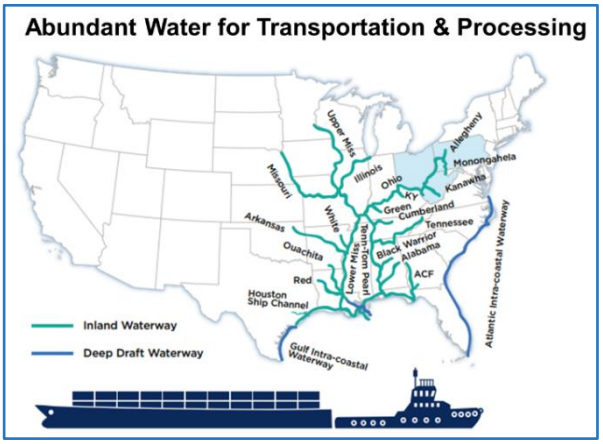
[16] https://home.treasury.gov/news/featured-stories/unpacking-the-boom-in-us-construction-of-manufacturing-facilities

[17] https://english.bdi.eu/article/news/the-inflation-reduction-act-climate-protection-with-a-catch

- Credit is reduced or eliminated if a certain percentage of the critical minerals utilized in battery components are not extracted or processed in the U.S. or a free trade agreement country or recycled in North America.[18]

5.3 EASE OF TRANSPORTATION WITHIN U.S. AND EXPORTING TO EUROPEAN MARKETS

Global Exports: Barge Transportation



Shale Crescent USA benefits from robust transportation infrastructure in the forms of river, rail, and road. The region sits at the center of 50 percent of the American population and is considered to be the country's logistical center. Chemical products from the region are distributed throughout the country and around the globe. Many petrochemical manufacturing facilities are located along the Ohio River or adjacent to rail systems. **Like the Danube and Rhine, the Ohio River is large and can accommodate significant commercial activity relating to the transportation by barge of finished products.** And as Germany is the industrial heartland of Europe, the SCUSA is the industrial heartland of America.

The Ohio River is 1,580 kilometers long. It begins in Pittsburgh, Pennsylvania, and ends in the Mississippi River. The average depth of the river is 7.3 meters. Chemical and bulk products are transported south on the Ohio River to the Mississippi River and then to the Gulf Coast. There, the products are transloaded to ocean-going vessels.

The Ohio River System (4,020 kilometers of navigable waterways throughout the Midwest & East region) moves $41 billion of goods each year. Annually, 270 million tons of coal, chemicals, aggregates, and agricultural, industrial, and petroleum products are transported along the river system [19], accounting for 35 percent of the nation's waterborne commerce.[20]

Europe's busiest river, the Rhine, is comparable to the Ohio River in size, volume, and traffic. The Rhine is 1,230 kilometers long and is used to transport nearly 200 million tons across the Dutch/German border each year.[21] It is estimated that $77 billion of goods are transported each year throughout the European waterways.[22] Of all the waterways, the Rhine River is the greatest contributor to economic impact and goods transported.

Metrics	Ohio River	Rhine River
Length	1,580 kilometers	1,230 kilometers
Average Depth	7.3 meters	2 - 10 meters
$ Value of Transports	$41 Billion *Ohio River System*	$77 Billion *European Waterways*
Tonnage	270 million Tons	200 million Tons
Discharge	7,960 m^3/s	2,900 m^3/s
Type of Product	Aggregates, Industrial, Chemical, Coal, Petroleum	Aggregates, Industrial, Chemical, Petroleum

Like the Danube and Rhine, the Ohio River is large and can accommodate significant commercial activity relating to the transportation by barge of finished products.

[18] https://bipartisanpolicy.org/blog/inflation-reduction-act-summary-energy-climate-provisions/

[19] https://agtransport.usda.gov/stories/s/Barge-Dashboard/965a-yzgy

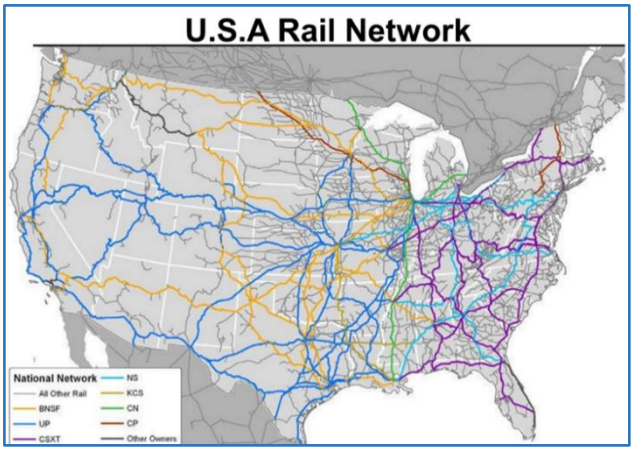
[20] https://www.lrd.usace.army.mil/Missions/Navigation/Ohio-River/

[21] https://www.reuters.com/markets/europe/german-industry-changes-tack-river-rhine-runs-drier-2023-07-26/

[22] https://www.brusselstimes.com/270523/low-rhine-levels-risk-leaving-germany-waterways-unnavigable

Global exports: Rail transportation

There is a robust railroad transportation network throughout the U.S. Spanning nearly 225,000 kilometers, the U.S. freight rail network efficiently transports approximately 1.6 billion tons of cargo each year. According to the U.S. Department of Transportation, this expansive rail network contributes around 28 percent of the nation's total freight movement in terms of weight and distance.[23] **In 2023, 2.1 million carloads of plastics, fertilizers, and other chemicals were moved by rail.**[24]



The SCUSA states of Ohio, West Virginia, and Pennsylvania are at the heart of where the industrial revolution commenced in the U.S. There is legacy industry and infrastructure throughout the region. Cities such as Cleveland, Ohio (the home of Rockefeller's Standard Oil company), and Pittsburgh, Pennsylvania (the home of Carnegie Steel), became centers for industry and commerce. Over the past 175 years, there has been a substantial transportation build-out throughout the region, especially in the form of railroads.

Most rail activity in the United States is for the movement of goods. Europe's rail system primarily serves passengers. In addition, and due to regulation, the total length of a freight train is, on average, half that of an American freight train. The cost of transport is typically higher per ton and per rail car in Europe than in the U.S. Europe's rail network is roughly 200,000 kilometers.[25] **Recent studies have shown that the cost of transporting freight in Europe is twice the cost in the U.S.**(4.6 cents per Revenue Ton Mile [RTM] in the U.S. compared to 9.7 cents per RTM in Europe).[26]

From the Shale Crescent USA, manufacturers can efficiently transport and export bulk, consumer, and liquid products by rail to one of the nearby East Coast ports to be shipped internationally. Travel distance by rail to an East Coast port can range between 100 and 1000 kilometers. For example, the distance by rail from Pittsburgh, Pennsylvania, to the Port of Philadelphia is approximately 550 kilometers.

Global exports: Ports and ocean transport

The U.S. is a net importer of consumer-based goods but a net exporter of natural gas, NGLs, and petroleum products. The U.S. has eight major East Coast ports, four are capable of transloading and shipping petrochemical-based products[27]. **Exporting from the U.S. to Europe is common and logistically friendly.** A cargo ship takes 10 to 20 days to cross the Atlantic. It is 4,300 nautical miles from the Port of Philadelphia to the Port of Hamburg[28]. For comparison, it takes 15 to 25 days for a cargo ship to travel 15,000 to 20,000 nautical miles from the U.S. to China.

In the mid-2010s, INEOS built a fleet of massive ocean-going vessels to transport low-cost SCUSA ethane from the Port of Philadelphia on the East Coast to the UK. These 'Dragon Ships' are 180 meters long and are capable of transporting an aggregate of 40,000 barrels of liquid ethane a day across the Atlantic.[29] The introduction of these ships to transport ethane was unprecedented, and it has highlighted the potential for large-scale transportation of NGLs and petrochemical-based products.

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[23] https://railroads.dot.gov/rail-network-development/freight-rail-overview

[24] https://www.aar.org/facts-figures#:~:text=Freight%20rail%20accounts%20for%20around,2040%20%E2%80%94%20a%2030%25%20increase

[25] https://www.statista.com/statistics/451812/length-of-railway-lines-in-use-in-europe-eu-28/#:~:text=Between%201990%20and%202020%2C%20the,High%2Dspeed%20rail%20defies%20trend

[26] https://www.railwayage.com/freight/canada-rail-rates-among-lowest-in-world-report/

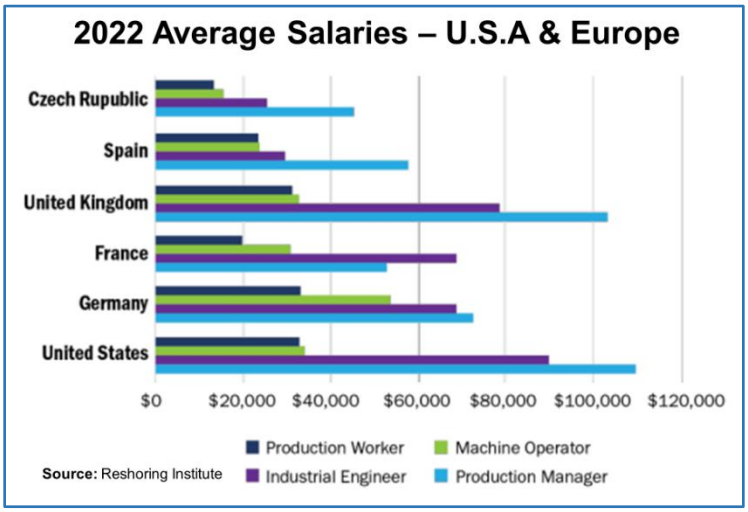
[27] https://www.bts.gov/archive/publications/bts_fact_sheets/october_2010/entire

[28] http://ports.com/sea-route/

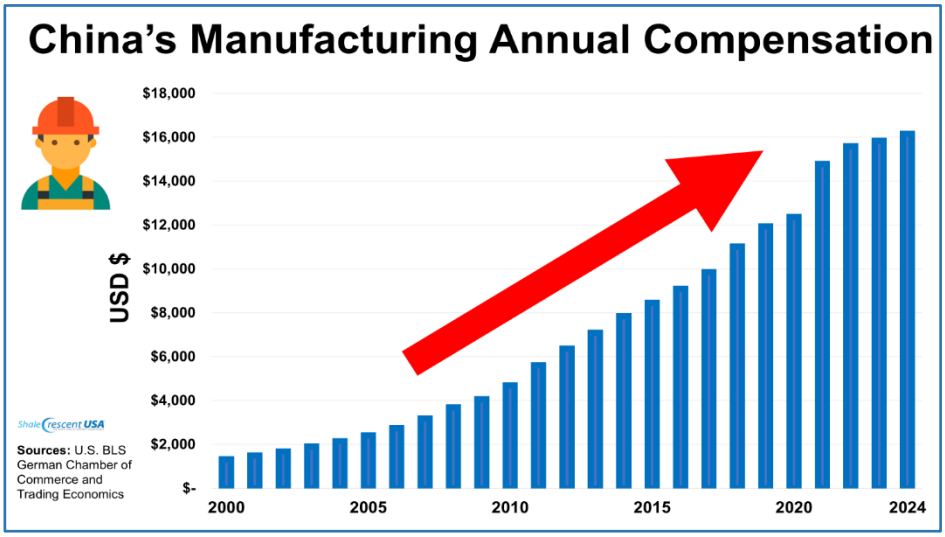
[29] https://www.ineos.com/inch-magazine/articles/issue-10/enter-the-dragons/

5.4 LABOR COST COMPARISON

Wages are a significant cost driver for manufacturing operations and must be considered when investigating competitive advantages. The cost of labor is wide and will likely range between 5 and 40 percent of the total cost of manufacturing a product. The variance in the percentage of labor cost is influenced by the overall cost of the product and the cost of other inputs such as feedstocks, electricity, and overhead expenses. **Recent research reveal that American manufacturing salaries are on average slightly higher than European-based salaries.**



As manufacturers focus on competitiveness and pursue investments across the world, the significant rise in China's labor rates must also be considered. **Over the past two decades, China's manufacturing wages have increased nearly tenfold, and they continue to rise.**[30] Annual wage increases in China's manufacturing industry of over 10 percent have been consistent for the last 25 years. **This trend in China's manufacturing wages equates to a doubling of wages every seven to eight years.** From 2020 to 2021 alone, China's wage rates jumped significantly, increasing by 20 percent.



China is rapidly losing its competitive advantage. There are several reasons why future investments in China may no longer produce the high margin returns they did in the past. **The rising cost of labor is a chief factor.**

> ***China is rapidly losing its competitive advantage…The rising cost of labor is a chief factor.***

[30] Trading Economics: https://tradingeconomics.com/china/wages-in-manufacturing

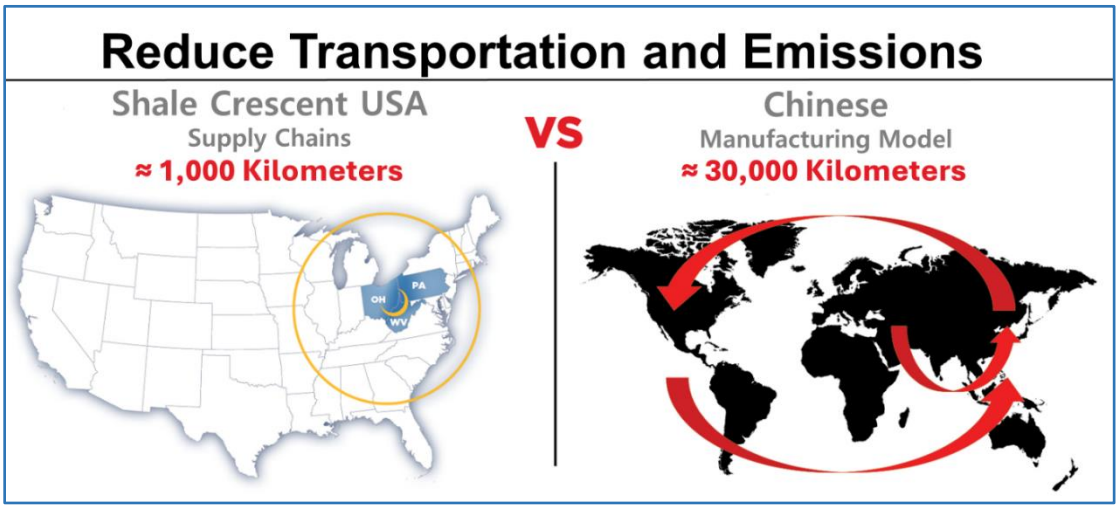
6. SUSTAINABILITY AND EMISSIONS ADVANTAGES

In an environmental context, sustainability means meeting the needs of the present without compromising the ability of future generations to meet their own needs. When companies think of sustainability, they typically think of what it will cost and how they can afford to meet carbon and other emission reduction targets. **By thinking differently and creatively, companies can lower emissions and reduce costs.** The pandemic, wars in Europe and the Middle East, and blockages in the Suez Canal and Red Sea have highlighted the vulnerability instability of global supply chains.

By thinking differently and creatively, companies can lower emissions and reduce costs.

Most societies have learned from experience that forests need management and that trees shouldn't be cut down for timber without planting new trees to replace them. Without conservation, animals can be hunted to extinction, and overfishing puts future catches at risk. The lesson is that bad things happen when people and companies only take from the environment. They must give back. Sustainability is about more than simply changing fuels or "energy transitions"; it is about using all the available resources to create quantifiable improvements. People and companies are learning to put more into their relationship with the environment than they take out. The SCUSA region is a unique opportunity for companies.

In 2023, SCUSA published a comprehensive report on the opportunities available for onshoring the manufacturing of plastic-based goods currently made in China. The report demonstrated that when manufacturers can establish operations above reservoirs of energy and feedstock and close to large markets, there is an opportunity to develop a regional supply chain with unique and profound advantages. **The resulting supply chain is more dependable, delivery is quicker, and the time, costs, and emissions involved in transporting materials over 30,000 kilometers are eliminated**. The report also highlighted that the three major cost drivers—energy, raw materials, and transportation—have changed in favor of U.S.–based manufacturing, which can now be done more sustainably and at a lower cost, with increased profitability. By taking advantage of the abundant energy resources in the SCUSA, companies can reduce their costs and increase both profitability and sustainability.



China gets most of its energy and feedstock from the Middle East, which is a boat ride and land travel that is over 10,000 kilometers away. Their manufacturing is done under Chinese environmental law, and coal is the primary fuel used to generate electricity. Based on emissions data from Statista and the U.S. Energy Information Administration, **U.S.-produced electricity produces at least 26 percent less emissions than Chinese electricity.** Chinese-made products must then be shipped to America and then transported by rail or truck to reach consumers—another 15,000 to 20,000 kilometers of transportation emissions. **The U.S. as a whole produces less than half the CO_2 emissions that China produces.** [31]

The U.S. as a whole produces less than half the CO2 emissions that China produces.

[31] BP Statistical Review: https://www.bp.com/en/global/corporate/energy-economics.html

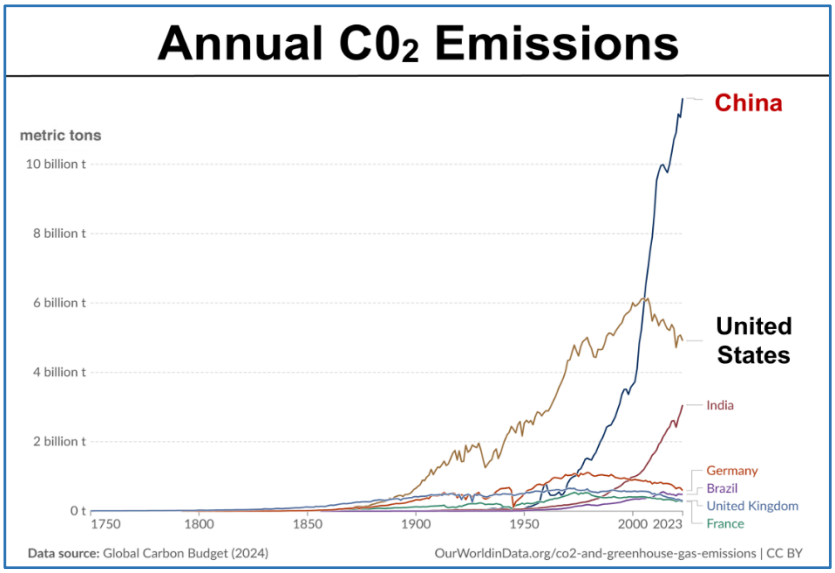
Plastic products made in SCUSA using energy and raw materials from the region and sold within a day's drive incur costs and emissions associated with only 800 to 1,600 kilometers of transportation. Being located in SCUSA presents a long-term competitive and emissions advantage. **Transportation is a cost to the manufacturer and consumer that doesn't add value to the product.**

Transportation is a cost to the manufacturer and consumer that doesn't add value to the product.

The opportunity for short plastics and petrochemical regional supply chains in the U.S. didn't exist 15 years ago. Many companies are still unaware of the energy and feedstock advantages of the SCUSA region and the opportunity to reduce emissions by operating in that region. At a recent conference, a speaker from a large U.S. petrochemical company spoke about their goal of reducing Scope 2 and 3 emissions by having their vendors meet specific environmental requirements. When asked if the distance of the vendors from their manufacturing plant was considered, the executive looked perplexed and responded, "We hadn't thought about that!"

Companies in the SCUSA region are just beginning to take advantage of regional supply chains. During the COVID-19 pandemic, some regional manufacturers replaced their international suppliers with suppliers based in the region. These companies have reported increased profitability and sustainability. Using energy and feedstock from the SCUSA region imparts long-term emissions and cost advantages.

China is the world's largest emissions producer.[32] The former U.S. climate czar, John Kerry said, "…almost 90 percent of all of the planet's global emissions come from outside of U.S. borders. We could go to zero tomorrow and the problem isn't solved." Chinese emissions have yet to peak. The current solution seems to be to hope China will meet its climate targets. But hope is not a strategy. Replacing imports from China with U.S.-made plastics and petrochemical products from the Shale Crescent USA is a workable strategy. **U.S. plastics and petrochemical manufacturing can be part of a solution to reduce global greenhouse gas emissions.**



U.S. plastics and petrochemical manufacturing can be part of a solution to reduce global greenhouse gas emissions.

Shale Crescent USA (SCUSA) was a **finalist for the 2024 Platts Global Energy Award** in *Energy Transition – Downstream*, competing with industry leaders such **as Valero, Repsol, and Bharat Petroleum**. **SCUSA's approach prioritizes total results over only fuel sources.** This approach embraces innovative technologies and leverages strengths to drive overall emissions reduction and economic efficiency.

A prime example is a recent investment from an **Indian company constructing a facility in the Ohio Valley.** The company will manufacture its product using SCUSA natural gas and butane—a shift from producing the product in India with Middle Eastern imports and then shipping the final product to America. **This transition lowers costs and significantly reduces carbon footprints.**

The facilities being built in the SCUSA today are among the most profitable, secure, and emissions friendly manufacturers in the world.

The facilities being built in the SCUSA today are among the most profitable, secure, and emissions friendly manufacturers in the world.

[32] Global Carbon Budget: https://ourworldindata.org/co2-emissions

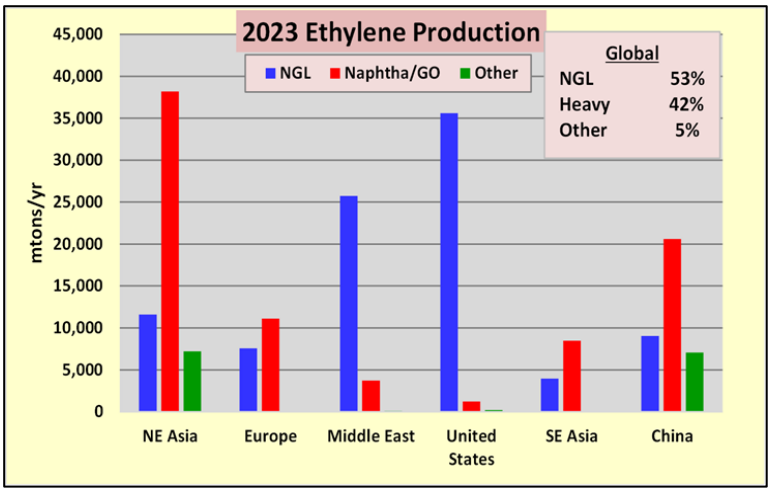
7. CASE STUDY ON ETHYLENE & EXPORTING INTERMEDIARY PRODUCTS

Germany and other industrial economies throughout Europe are concerned that the reindustrialization of the U.S. will lead to a deindustrialization in Europe. This does not have to be the case. **A new model is developing that creates 'win-win' opportunities for both the U.S. and Europe**. The rest of the world covets low-cost U.S. LNG, but America's infrastructure and policy have impeded the export of energy molecules in their raw form. However, there is another method to take advantage of U.S. energy, as follows: **1)** A European-based manufacturer strategically expands into the SCUSA market; **2)** The manufacturer consumes low-cost natural gas and feedstocks to produce a higher intermediary product such as ethylene, propylene, ammonia, methanol, polyethylene, polypropylene, etcetera; **3A)** A percentage of the intermediary product is sold into the robust U.S. industrial market; **3B)** The intermediary product is transported by barge or rail to the Gulf Coast or East Coast ports and exported to Europe; **4)** The intermediary product is sold directly into the European market or used as feedstock in the production of other products. **The ability to transport and export product out of the Shale Crescent USA region is common and logistically friendly.**

Case Study on Ethylene

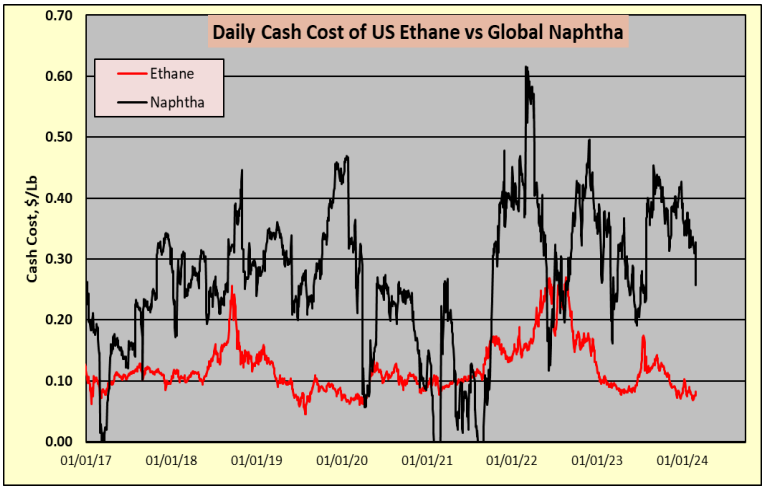
*The following section on the ethane value chain, ethylene production, and exports is from the expert work of **Ethylene Strategies International** (ESI). ESI is a leading advisor to many of the world's largest petrochemical producers and provides confidential one-on-one consulting/advising to help companies evaluate, design and implement business strategies in the olefins markets. In addition, they offer a weekly analysis and reports on data, news, information, third party analysis, and industry insights that impact the energy and petrochemical markets and their prices. Please visit www.energy-strat.com to learn more.*

Currently, the SCUSA region's production exceeds 1 billion cubic meters per day (Bcm) [36 Bcf/d], surpassing all countries except Russia and the rest of the U.S. This increased production has also led to the discovery of natural gas liquids, including some of the world's cheapest sources of ethane. **Ethane is now being piped from the region to Canada, the East Coast for European export, and the U.S. Gulf Coast for global export.** Additionally, a world-class ethylene cracker has commenced operations in the region.



Ethylene Strategies International, L.P., (ESI) has conducted an integrated analysis of the region's resource base, production outlook, and infrastructure. **Their findings suggest that the region is ideally positioned for substantial expansion of petrochemical assets, which would unlock the value chain of ethane, ethylene, and various ethylene derivatives that are ultimately transformed into everyday consumer goods.** These projects not only create jobs but also generate more employment opportunities as they move further down the value chain.

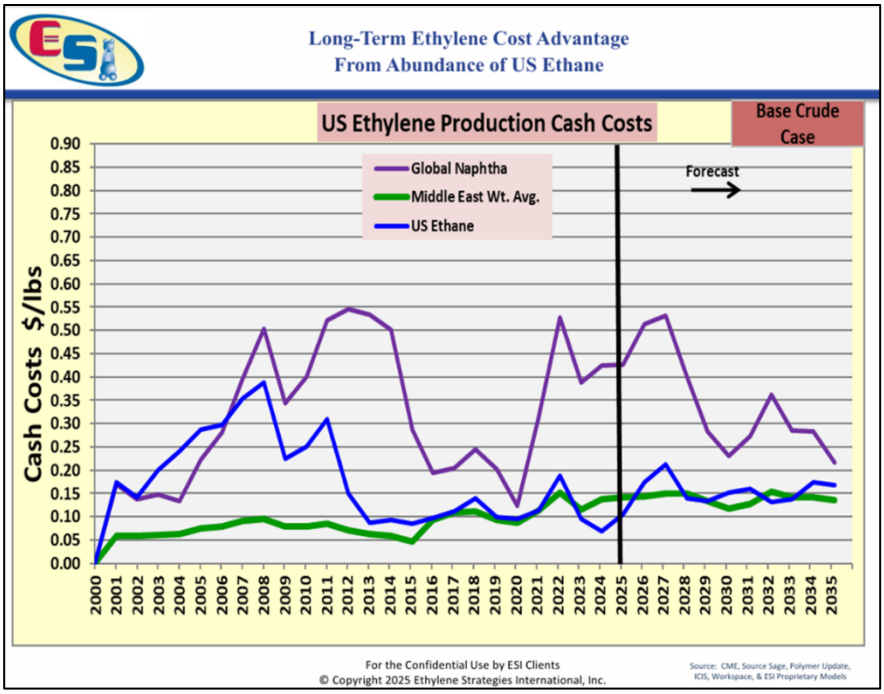
Most of the world uses oil-based naphtha to produce ethylene. In the U.S., the process starts "Upstream" with the extraction of the natural gas and NGLs. Extracted molecules are then piped to "midstream" processing plants and fractionators where they are separated into purity products (ethane, propane, butane). The resulting products (i.e., ethane) are then piped to a 'downstream' ethane cracker plant where it is converted to ethylene and ultimately into derivative products such as polyethylene resin or ethylene oxide. Polyethylene is responsible for about 60 percent of the global ethylene demand.



The ethane value chain's key chemical component is ethylene, a reactive hydrocarbon characterized by a carbon-to-carbon double bond, which allows it to act as a glue with other chemicals, including itself, creating longer chained chemicals with unique and more stable properties. The simplicity and ability to glue other molecules together reliably and repeatedly positions ethylene as one of the most important building block chemicals.

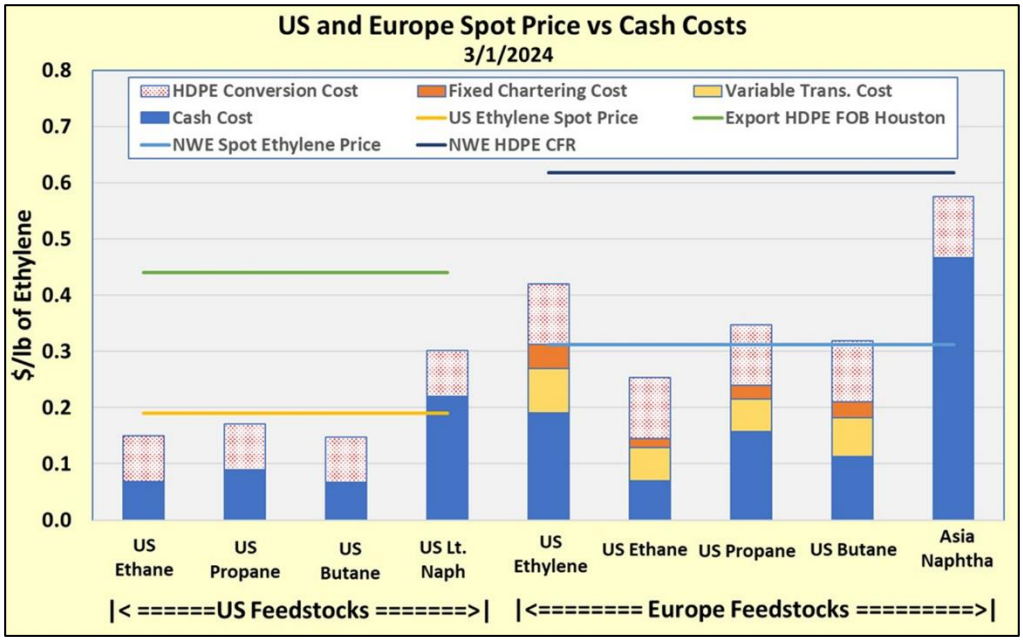
Over the next decade and beyond, ESI predicts that rising global crude prices coupled with low U.S. natural gas prices will give ethylene production from NGL's a competitive edge, particularly in North America. The U.S. and the Middle East primarily produce ethylene from NGL's, mainly ethane but also propane and butane. As the Middle East's ethane sources are not expanding, the overall amount of Naphtha cracking has increased in Asia and is projected to continue to rise.

A chart showing the cash cost to produce ethylene from U.S. ethane versus Naphtha, which is primarily used in Asia and Europe, reveals that ethane has consistently outperformed naphtha, except during certain severe events that temporarily favored naphtha economics.



The U.S. ethylene production's ultra-competitive position emerged as shale resources increased supply and is projected to persist beyond our forecast horizon of 2030. **Global markets for ethylene and ethylene derivatives are anticipated to grow faster than GDP, and marginal cost producers will continue to face significant financial pressures from low-cost producers.**

U.S. hydrocarbon gas liquid (HGL) production represents more than 7% of global liquid petroleum supply, and the vast majority of the U.S. supply is produced from Natural Gas Liquids (NGL's). 90%+ of North American ethylene capacity is based upon the NGL feedstocks and most new capacity is ethane based cracking capacity. The nearby graphic shows a comparison of the various feedstocks to the U.S. and European crackers with resultant costs to produce polyethylene (PE) and the margin from the cash costs to produce the ethylene and the spot price. The graph below is a snapshot of a single day using spot prices. The cash cost is defined as the feedstock cost + the variable Opex cost + fixed Opex cost – Co-product credits. The Co-product credit can be very volatile for propane feedstock because the cracker process can produce ~17% propylene (high conversion process) to 23% propylene (low conversion process) and propylene continues to have a very volatile spot price in the U.S. petrochemical market. The relatively large difference in cash cost calculation for propane between the U.S. and Europe is mostly explained by the co-product credit.



U.S. ethane supply is a very competitive feedstock into international crackers. Monthly export volumes of ethane exceeded 500,000

barrels per day (b/d) multiple times in 2023 with ≈100,000 b/d consistently heading to Europe (U.K., Norway, Sweden, and Belgium).

U.S. ethylene is also exported to Europe and normally lands into Northwest Europe (NWE) below the European spot price for ethylene. **The lower costs of feedstocks and energy in the U.S. provides incentive for petrochemical producers to site capacity in the prolific shale basins in Appalachia to produce base chemicals like ethylene for both export to Europe and to produce finished goods for the U.S. market domestically.**

ESI offers its clients a range of historical analyses and economic outlooks. These include a daily snapshot of U.S. cracking economics for each feedstock, weekly outlooks comparing the U.S. with the rest of the world, and long-term forecasts through 2030. ESI also conducts custom studies for clients with unique requirements.

8. MANUFACTURERS ACTIVELY INVESTING IN THE SHALE CRESCENT USA

The U.S. has always been a major consumer of both industrial and consumer manufactured products. **The country is currently witnessing a remarkable surge in construction spending for all types of manufacturing facilities.** The surge can be attributed to unprecedented energy supply, relative stability compared to other regions of the world, and a policy environment providing direct funding for tax incentives to both public and private manufacturing construction.

U.S. Shale gas: Unlocking unprecedented opportunity for petrochemical investment

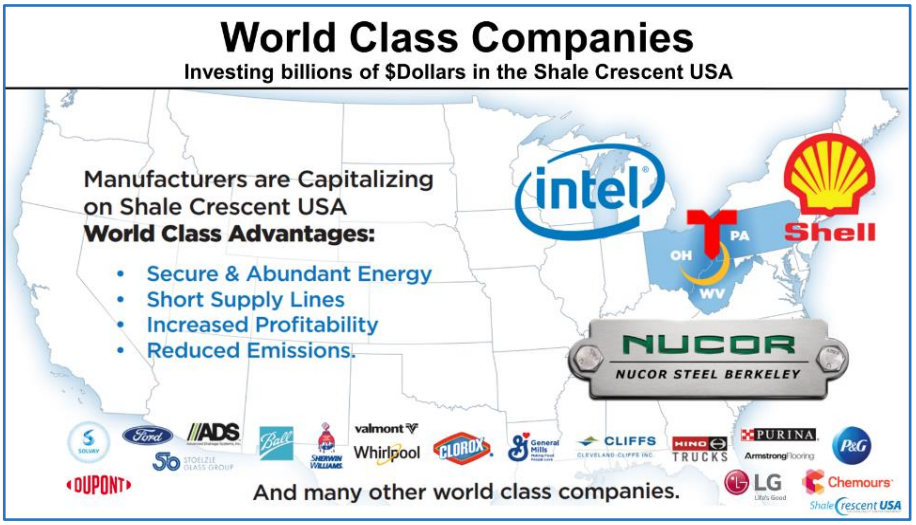
Over the past decade, shale gas has played a pivotal role in the significant growth of the American chemical industry. As stated, abundant and cost-effective natural gas and natural gas liquids are driving companies to construct new chemical facilities and increase production within the U.S. **Since 2010, as a result of shale development, the industry has committed $109 billion to 235 completed and operational projects**. Additionally, there are nearly 120 projects currently under construction or in the planning phase. The total cumulative investments across these 355 projects are $208 billion. **Notably, 69 percent of the total expenditures is foreign direct investment or includes a foreign partner**.[33]

Notably, 69 percent of the total expenditures is foreign direct investment or includes a foreign partner.[1]

World-class investments: In the Shale Crescent USA

International manufacturers of all types continue to choose the SCUSA region for new investment and expansion. Low-cost energy and proximity to market have become their competitive advantage.

- **Royal Dutch Shell Chemicals** in 2023 completed the first U.S. cracker plant built outside the Gulf Coast in 50 years. The plant, located in Pennsylvania, is estimated to have cost over $8 billion.
- **Intel Corporation** is currently building a $20 billion semiconductor facility in Ohio. They chose Ohio based on energy reliability, abundant water, and logistical advantages.
- **Nucor Steel** is building a $4 billion facility in West Virginia. They chose the region for its low-cost energy supply and proximity to customers.

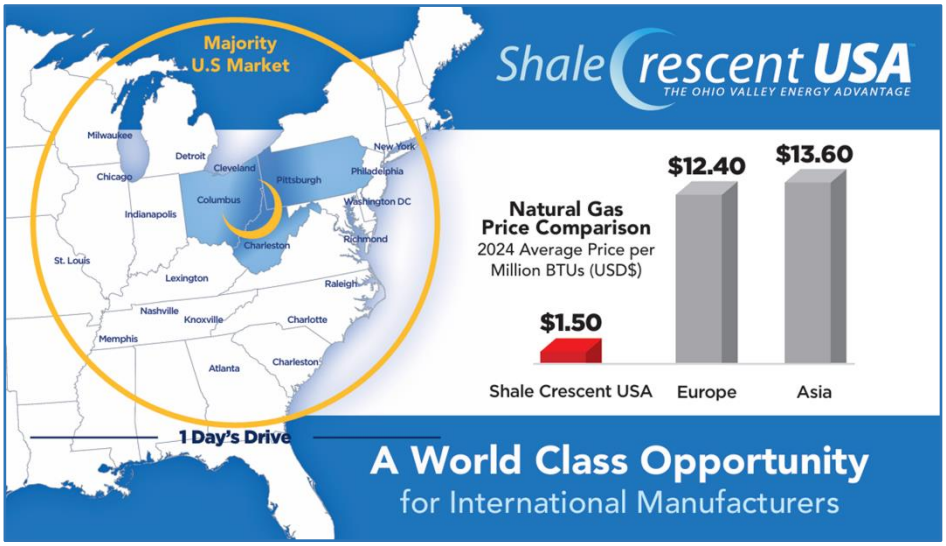


Investments by international and domestic manufacturers are underway throughout the region. **The legacy manufacturing infrastructure, new energy supplies, and incentives have created a favorable environment for new entrants to capitalize on the opportunity.**

[33] https://www.americanchemistry.com/chemistry-in-america/news-trends/blog-post/2022/natural-gas-american-chemistry

9. CONCLUSION

The Shale Crescent USA is the only region in the world where an energy intensive manufacturer can build on top of their feedstock supply and in the center of their customers, thus eliminating the costs and emissions associated with transporting feedstock and finished products. The industry dense three states and the highly populated surrounding region have extreme manufacturing competitive advantages based on location that cannot be competed away. The US shale gas revolution has made SCUSA the third-largest natural gas–producing region in the world and the source of the cheapest natural gas and natural gas liquids in the world. **These long-term fundamental advantages in amidst a mixture of favorably changing global conditions have aligned and created a unique and new opportunity for the European petrochemical industry**. Tax incentives, new public policies stimulating manufacturing investments (such as IIJA, IRA, and the CHIPS Act), the established transportation infrastructure network connecting SCUSA to the rest of the country as well as U.S. export ports, China's rapidly growing labor cost, reduced emissions based on U.S. feedstock, and threats to global supply chains – **all these factors have created a globally unique opportunity for establishing manufacturing operations in the SCUSA region.**



These reasons are why manufacturers from around the world are aggressively investing into the United States. Energy supply, reduced risks, sustainability, and increased profitability are chief motives for the development that is underway. In addition to direct investment in to the U.S**., a new export model is forming that will allow European manufacturers to capitalize on low-cost Shale Crescent USA energy other than LNG: 1)** Establish operations in the SCUSA region; **2)** Take advantage of a secure supply of low-cost natural gas energy and feedstock to produce an intermediary product; **3A)** Take advantage of proximity to significant U.S. market demand by selling a percentage of that product to American customers; **3B)** Transport the remainder by barge to the Gulf Coast or by rail to the East Coast for export to Europe; **4)** Sell the intermediary product directly into the European market or use it as feedstock in the production of other products.

Conditions and investment opportunities are at an all-time high for energy intensive manufacturing into the U.S and more specifically the Shale Crescent USA region. Manufacturers can expect to benefit from low-cost energy abundance, reduced volatility risks, increased sustainability, shorter supply lines, and greater profitability. **The world class assets that have created this ideal manufacturing scenario are fundamental and will continue for the foreseeable future.**

The Shale Crescent USA is the only region in the world where an energy intensive manufacturer can build on top of their feedstock supply and in the center of their customers, thus eliminating the costs and emissions associated with transporting feedstock and finished products.

10. NEXT STEPS

10.1 CONTACT US

For more (no cost) verified industry research, to speak with members of our team, or to connect with our broad network of leading companies in the Energy, Transportation, Manufacturing, and Site Selection Industries

Contact Us:

www.ShaleCresentUSA.com

info@shalecrescentusa.com

1 (888) 529 - 1650

Greg Kozera: Director gkozera@shalecrescentusa.com (304) 545 - 7259

Nathan Lord: President nlord@shalecrescentusa.com (740) 350 - 0346

10.2 SHALE CRESCENT USA THE ORGANIZATION

Shale Crescent USA:

Shale Crescent USA (SCUSA) is a tax-exempt 501(c)(4) organization with leadership that includes a network of senior-level management and experts in the energy and manufacturing industries, economic development, academia, and private investment. SCUSA was established in 2016 to promote the region of Ohio, Pennsylvania, and West Virginia that sits atop two of the most prolific natural gas fields in the United States (the Marcellus and Utica fields). SCUSA is devoted to promoting the region's abundant natural resources in an effort to attract the investment of global companies and related supply chain operations that can support and sustain high-wage jobs in Ohio, West Virginia, and Pennsylvania.

The organization identifies and conducts industry-specific research that informs: (1) investment in existing domestic energy-intensive industries ranging from the production of commodity petrochemicals to the manufacturing of plastic-based finished consumer goods; (2) onshoring and reshoring of global supply chain operations; and (3) expansion of existing stateside energy-intensive manufacturing that advances regional prosperity while addressing global climate effects and strengthening national security.

Since 2016, SCUSA has designed and commissioned industry research that examines key indicators for potential investment in the energy and manufacturing supply chain. This investigation – which examines factors related to supply and demand, manufacturing operations, international imports, logistics, labor, and sustainability – has produced data that show the Shale Crescent USA to be one of the most profitable and resilient locations in which to build petrochemical plants and other downstream manufacturing, substantially exceeding the advantages of the Gulf Coast. Unlike the Gulf Coast or other global supply chain regions, the SCUSA region has both robust supply of feedstock and high customer demand for chemical and plastics-based products. This creates significant logistics, economics, and environmental advantages over other regions of the world. SCUSA has published validated reports and prepared materials and presentations derived from this data to educate the petrochemical and associated industries through peer engagement.

SCUSA has recently expanded its research and prospect development to include downstream plastics manufacturing. By attracting manufacturers and ancillary environmental support companies to the region,

SCUSA, in effect, brings the operation of the entire supply chain to the center of the country's largest end market. Shared proximity to both raw materials and market has the potential to make Shale Crescent USA one of the most economic and sustainable petrochemical and manufacturing hubs in the world. Eliminating global transportation and significantly decreasing national transportation will result in reduced emissions, energy efficiency, reduced costs, inventory advantages, and opportunities to develop and expand based on the unique advantage of possessing both world-class supply and demand within the same region, Shale Crescent USA.

COMPREHENSIVE ANALYSIS OF QUALITY DATA TO DRIVE PROFITABILITY AND GROWTH:

Shale Crescent USA has invested over a million dollars in market research to provide quality data to C-level executives in the energy industry.[34] SCUSA understands that C-level executives tasked with meeting growth and profitability goals must consider a myriad of variables supported by quality data. SCUSA's subject-matter experts can translate data, analyze influential variables, and develop qualified projections. As veteran practitioners, these experts have intimate knowledge of the energy industry, ensuring an analysis that considers complex systems, volatile markets, and transnational operations.

- **(2016)** *The Natural Gas Resource Advantage of the Shale Crescent USA*
- **(2017)** *Understanding U.S. Chemical Industry Investments*
- **(2018)** *Benefits, Risks, & Estimated Cash Flows: Ethylene Project in the SCUSA vs the U.S. Gulf*
- **(2019)** *Estimated Logistics Benefits of the SCUSA vs U.S. Gulf for Natural Gas, Propane, & Butane*
- **(2020)** *Natural Gas Savings to U.S. End-Users: Industrial, Commercial, Electric, Residential*
- **(2020)** *U.S. Manufacturing Jobs: Directly tied to Oil and Gas Production in the Shale Crescent USA*
- **(2021)** *Extreme Weather Impacts on the Industrial U.S. Gulf Coast. SCUSA Advantaged*
- **(2023)** *Global Economic Factors Favor U.S. Plastic-Product Manufacturing over China- Based Operations*
- **(2025)** *A New Opportunity for European Energy-Intensive Manufacturers*
- **(2025)** *Proposed: ESG Enhancer: Emissions Savings Created by Eliminating Long-haul Transportation*

10.3 CONTRIBUTORS:

Nathan Lord: President, Shale Crescent USA

Contact: nlord@shalecrescentusa.com

Nathan is the President of Shale Crescent USA. In this role, he works closely with the organization's board of directors to develop strategic industry research and deliver qualified data to guide the investment decisions of energy-intensive industries. He oversees all operations, strategy, marketing, and fund development for the organization. Nathan is a fierce advocate for the long-term benefits of energy and manufacturing investment along the Ohio River Valley including economic development, high-wage jobs, and improved quality of life for generations to come. He earned his Bachelor of Science in Finance from Marietta College and an MBA from Liberty University.

Tom Gellrich: CEO and Founder, Topline Analytics

Contact: tom.gellrich@toplineanalytics.com

Tom Gellrich is an energy industry expert who specializes in the investigation of downstream opportunities related to the shale gas revolution on chemicals, plastics, and manufacturing. His presentations and whitepapers have been extensively quoted and continue to receive international attention. As a chemical engineer with ExxonMobil, Tom designed ethylene and propylene compressors. Later, he held a variety of positions in strategic planning, business management, and business consulting with Total-Arkema. He was instrumental in the founding of Elemica, a B2B service for the chemical industry, where he served as managing director of European operations in the late 2000s. In 2012, Tom launched his consulting company, Topline Analytics, where he works today.

[34] Shale Crescent USA: https://shalecrescentusa.com/resources/market-resources/

Joe Eddy: Former CEO and Owner, Eagle Manufacturing, SCUSA Director

Contact: jceddy@heritageholdingsllc.net

Joe Eddy recently retired as President/CEO of Eagle Manufacturing Company in Wellsburg, WV, and Executive VP of Justrite Safety Group in Chicago, IL, after 23 years of service. He currently owns and manages an energy development company, Enhanced Technologies LLC, and a real estate development trust, Heritage Holdings LLC. He is the past chairman of the West Virginia Manufacturers Association and the WVMA Education Foundation. He has served on the Federal Reserve Bank of Richmond-Industry Advisory Board, National Association of Manufacturers Board, National Institute of Standards & Technology-MEP Advisory, West Virginia Economic Development Authority Board, and WVU's Global Supply Chain Advisory Committee. Joe is an executive committee member and strategic advisor to Shale Crescent USA. In 2012, with Joe as CEO, Eagle ranked #5 nationally in *Chief Executive*'s Best Private Companies for Leaders. In 2015, Eagle won the National Association of Manufacturers' Sandy Trowbridge Award for Excellence in Community Service, and in 2016 the President's E-Award for Excellence in Export Growth, and the "Top Manufacturing Brand" in West Virginia (one of the Top 50 Brands in the U.S.), and in 2018 the Governor's Award for Smart Advanced Manufacturing. Joe earned his Bachelor of Science in Petroleum Engineering from Marietta College and has completed advanced studies at the University of Wyoming and University of Chicago.

Wally Kandel: Former SVP, Solvay, and Co-founder, Shale Crescent USA

Contact: wkandel@shalecrescentusa.com

Wally Kandel is a retired Senior Vice President at Solvay and served as the North American Director of Group Engineering and Construction. Wally earned his Bachelor of Science in Petroleum Engineering from Marietta College. Wally's career began at Chevron / Chevron Phillips where he worked for 20 years before joining Solvay in 2007. He has been in leadership roles in both the upstream oil and gas industry as well as the downstream petrochemical industry. He has worked in these industries for over 30 years including work on four continents. He is a co-founder, volunteer director, and strategic advisor for Shale Crescent USA.

Greg Kozera: Sales and Marketing Director, Shale Crescent USA

Contact: gkozera@shalecrescentusa.com

Greg Kozera is the Director of Sales and Marketing for Shale Crescent USA. In this role, he promotes the organization's research efforts across the globe through media channels, conferences, appearances, and executive-level meetings. Greg works directly with manufacturers who want to capitalize on the region's advantages. He is a professional engineer and an environmentalist with more than 40 years of experience in the natural gas and oil industry. Greg is a leadership expert, professional speaker, and the writer of numerous published articles. Kozera is the author of the books *Just the Fracks Ma'am* and *Learned Leadership*.

Jerry James: President, Artex Oil, and Co-founder, Shale Crescent USA

Contact: jjames@artexoil.com

Jerry James has served as President of Artex Oil Company since 1995. Prior to assuming his current role, he held positions with various major oil companies in Texas, Louisiana, and Wyoming. Jerry has served as President of the Ohio Oil and Gas Association (OOGA) and previously served as chairman of the Ohio Oil and Gas Energy Education Program (OOGEEP). Jerry earned his Bachelor of Science in Petroleum Engineering from Marietta College in 1980 where he graduated Magna Cum Laude. He is a Registered Professional Engineer in Ohio, Kentucky, West Virginia, and Pennsylvania. Jerry is a member of the Society of Petroleum Engineers as well as the Society of Petroleum Evaluation Engineers. He is co-founder, volunteer board member, and strategic advisor for Shale Crescent USA.

Mark Woods: President, Ethylene Strategies International

Contact: mwoods@esic2.com

Mark Woods has 30+ years of experience in the Chemicals and Oil and Gas businesses. In 1995, Mark became the commercial manager for Phillips' Ethylene Business which became Chevron Phillips Chemical. Mark was responsible for over $2 billion in annual sales as the Ethylene Director. During his tenure, Mark successfully negotiated over 8 billion pounds of ethylene sales into long term contracts and sold/purchased over 1 billion pounds of short term spot ethylene. In 2007, Mark identified a significant need in the North American Ethylene market for an independent consultant to provide strategy development, analytical modeling, and commercial trading expertise. Ethylene Strategies International, L.P. (ESI) is structured to provide confidential one-on-one consulting/advising to help companies evaluate, design and implement business strategies in the olefins markets. Mark developed a set of proprietary models made up of a collection of supply and demand and statistical trading model's. ESI licenses these models to participants in the ethylene, ethylene derivative, and natural gas liquids markets. ESI also works with senior management teams to provide a strategic advisory service.

Harry Moser: President, Reshoring Innitiative

Contact: harry.moser@reshorenow.org

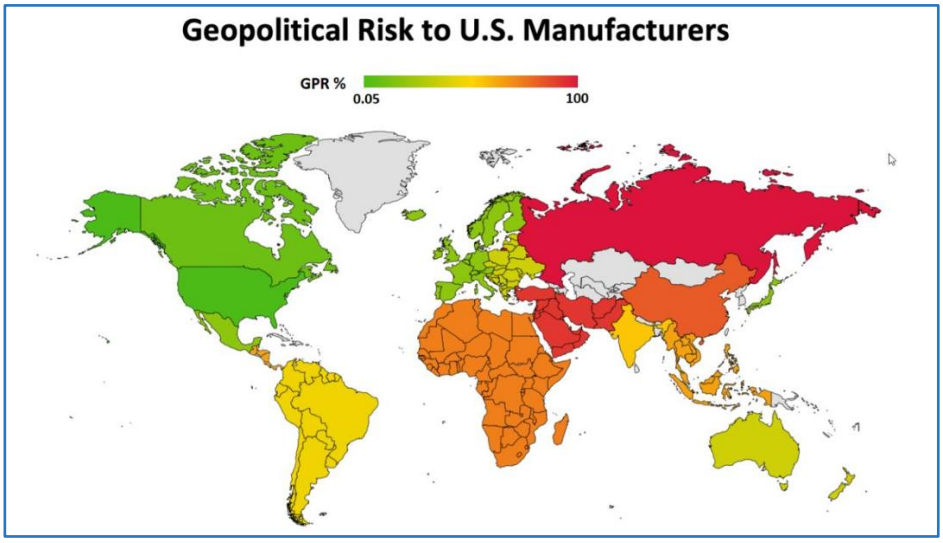
After twenty-five years at the helm of GF Agie Charmilles, now GF Machining Solutions, as North American president and subsequently chairman emeritus, Harry founded the Reshoring Initiative. Harry was inducted into the Industry Week Manufacturing Hall of Fame 2010 and was named Quality Magazine's Quality Professional of the year for 2012. Harry is frequently quoted in the Wall Street Journal, Forbes, New Yorker and USA Today and seen on Fox Business, MarketWatch and other national TV and radio programs. He earned a BS in Mechanical Engineering and an MS in Engineering at MIT in 1967, as well as an MBA from the University of Chicago in 1981.Harry and the Reshoring Initiative focus primarily on bringing back as much manufacturing as possible, at the current U.S. level of competitiveness. Secondarily, they work to improve U.S. competitiveness, by advocating for needed policy changes and by strengthening the U.S. skilled workforce.

11. APPENDIX

GEOPOLITICAL RISKS: THE RESHORING INNITIATIVE

The following section on 'Geopolitical Risks' is from the thorough work of the Reshoring Initiative. This organization produces an annual geopolitical risk ranking and evaluation of thirteen major countries/economies. This report includes evaluations only on the U.S., Europe, and China. For the full 'Geopolitical Risks' report last updated on 8/21/23 please visit the www.reshorenow.org.

Firms are exposed to external geopolitical risk by the global actions of the countries that they do business with and of neighboring countries, e.g., other Asian countries might be impacted by U.S.- China conflict. **The importance of factoring in geopolitical risk when making sourcing decisions for your business has surged in the last few years.** Naturally, predicting future events is inexact and the assessment of risk is subjective. Below are appraisals of the geopolitical risk to U.S. firms sourcing materials within the U.S. and Europe for assembly or sale in the U.S. In the heading of each section, we include our estimate of risk. **Geopolitical risk (GPR)** is the probability in one year of a major disruption in trade resulting in the cessation of imports from that country to the U.S. as a result of an adverse geopolitical event.



These appraisals can be used as a starting point for assessing your geopolitical risk exposure. Please note that geopolitical realities are constantly changing. Therefore, it is important to do a detailed assessment of the specific countries that your firm is or is considering sourcing from, particularly in the cases where we have provided only broad regional estimates.

United States of America: (GPR: 0.05%/year)

Sourcing from within the United States carries a minimal degree of geopolitical risk. As the preponderant power in global affairs for the past thirty to seventy years, the international system has evolved in a way that best serves U.S. economic and political interests. Among large nations, the U.S. is uniquely positioned with peaceful neighbors and vast ocean borders defended by the world's most powerful Navy. Furthermore, the U.S. enjoys a far-reaching professional diplomatic corps, history's most advanced military, and an immense degree of cultural influence around the globe. Financially, the U.S. dollar is a safe and widely held reserve currency against which most commodities are priced. These factors make the U.S. an incredibly stable country geopolitically. If any changes occur, they are likely to be relatively minor and have proportionate effects on U.S. businesses.

The geopolitical threats facing the United States come at the tail ends of the distribution. However improbable, black swan events like a terrorist attack of a similar scope to 9/11 would impact U.S. industry immensely but briefly. Even more unlikely, but orders of magnitude more devastating, would be an event such as the use of a weapon of mass destruction either by state or nonstate actors. But, because such events are extremely unlikely, the overall level of geopolitical risk that the U.S. faces remains limited.

Currently the U.S. is contending with an extremely polarized domestic political environment. Both left- and right-wing positions are based further from median voters and hardline partisans are finding few points of commonality amidst the growing "Culture War". This divide is both the result of, and perpetuates, the rise of populist candidates who introduce policy uncertainty every election cycle. Despite this division, domestic companies still face minimal risk when operating and sourcing within the United States as policy shifts are unlikely to impact domestic commerce in any meaningful way.

While the U.S. has many critics, most foreign countries view the U.S. as the best available option for global leadership and mutual prosperity. Countries that seek to change the status quo do not yet have the capability to meaningfully threaten a U.S. commerce led world. For these reasons, there is an exceedingly low level of geopolitical risk for American firms doing business with other American based firms.

Europe: (GPR: 0.5%/year)

Sourcing in Europe is mildly risky for U.S. firms. European countries are, by and large, stable politically and confer upon their citizens a great deal of public welfare. Geopolitical risks for U.S. firms sourcing in Europe stem from many European countries' energy dependence, proximity to Russian aggression, and domestic unrest. Geopolitical risk in Europe varies across countries, with Eastern Europe generally being riskier than Western Europe.

Many European countries are dependent on the import of foreign sourced fossil fuels to meet their energy demand. This presents a geopolitical risk to manufacturers because energy availability is dependent on global supply chains which are susceptible to disruption. More, when European countries source from geopolitical rivals, they run the risk of their access to energy being manipulated for political reasons.

Europe is currently at its highest risk of conflict in decades. Russia's invasion of Ukraine and covert actions in Moldova highlight the most clear and present danger facing Europe. Eastern European countries are at the most risk of Russian aggression, however through NATO membership, many Western European states are exposed to the same risk due to NATO's collective defense obligation, recently strengthened by the NATO membership of Finland and Sweden.

Undoubtedly, in the highly unlikely event that it would occur, a continental European war would be catastrophic and effectively halt any business activity in the region. However, the strengthening of NATO in response to Putin's invasion of Ukraine will further reduce the likelihood of a credible Russian threat to any NATO country. In any event, despite being the largest member of NATO, the U.S. doesn't face the same level of risk as Europe due to its geographic distance from the potential conflict zone.

Additionally, there are considerable domestic fissures within European countries, notably in Eastern Europe but also to a lesser extent in Western Europe. Tensions are still high in the Balkan countries with Serbia and Kosovo experiencing violence. There are frequent protests throughout Western and Central Europe that can be disruptive to labor availability and logistics. When U.S. firms invest in Europe, they assume the risk of having their production occasionally disrupted due to popular movements.

American firms can operate in Europe with a low degree of geopolitical risk. When compared to U.S.-based manufacturing, European sources carry a greater degree of risk as discussed above, however they are far less risky than many alternatives.

China (GPR: 3.5%/year)

China (GPR: 3.5%/year) Sourcing products from China carries a considerable amount of geopolitical risk. Geopolitically, China seeks to revise the global order into one that is aligned primarily with Beijing. The main routine risks to firms who do business with China stem from four areas: authoritarian governance, favoritism to Chinese competitors, the desire to reclaim Taiwan, and susceptibility to international sanctions.

The authoritarian Chinese Communist Party (CCP) controls national industrial policy, meaning that systematic IP theft, unfair trade practices, and forced industry shutdowns are implicit in doing business in China. Because of this control, suppliers exist in a condition of increasing policy uncertainty which produces risks of delays to, or the complete shutdown of, shipments to the U.S. Steadily increasing authoritarian control over industry also presents firms with the risk of expropriation in the event of a major geopolitical incident; it may become impossible to recover product and both physical and financial capital from China.

China also poses a risk to industry through its increasingly aggressive intent to reclaim Taiwan. In recent years, China has amassed a military capacity focused on the invasion of Taiwan. Chinese brinksmanship puts it at risk of war with the U.S. which has committed to aiding the island in the event of a Chinese invasion. The necessity to hedge against an invasion of Taiwan is reflected in a quote by S&P Global's Paul Bingham:

> "By diversifying [supply chains] you're buying insurance, which is really what it boils down to, so that your business can survive if there is ever an enormous disruption in the relationship with China."

Moreover, a conflict over Taiwan would "result in human and economic damage on a far greater scale than observed in Ukraine today" per Dr. Michael Klare of Hampshire College. A Taiwan conflict would completely

sever supply chains to the U.S. from China and Taiwan, leaving American firms scrambling to find alternative sources. As they currently stand, cross-strait tensions are very high as reflected in rising shipping prices between mainland China and Taiwan where rates have ballooned to rival trips of much greater distances.

Despite these increased tensions, a Chinese invasion of Taiwan is hardly a certainty. *Foreign Policy* magazine polled 979 scholars of International Relations asking about the likelihood of a Chinese invasion within the next year, 71% said that it was unlikely. When the same cohort was asked about the probability of a U.S.-China war within the next 10 years given the current political relationship, the average response was 24.11%.

In addition to the risk of war, there is the potential for voluntary economic decoupling between the U.S. and China. The U.S. Council on Foreign Relations has stated that "the United States and China are headed toward a substantial, though not complete, decoupling." A breakdown in trade of that scale would raise the risk of a U.S.-China conflict and the accompanying deleterious effects on the businesses involved. China is at risk of international sanctions due to the fact that it engages in repressive and genocidal domestic policies in Xinjiang and Tibet and pollutes the environment more than any other country. These behaviors are viewed unfavorably by international regulators, increasing the risk of economically damaging sanctions being placed on China for as long as that activity persists. Furthermore, existing Section 301 tariffs could be increased and applied to more products, making imports totally uncompetitive.

Sanction-associated risks are particularly salient when considering China's Anti-Foreign Sanctions Law which codified a number of unappealable retaliatory measures that can be taken to punish businesses from countries that impose sanctions on China.

Adding these other risks to *Foreign Policy's* aforementioned assessment of China's 24.11% 10-year risk of invading Taiwan, we estimate the overall risk to U.S. firms to be around 35% over 10 years or about 3.5% per year. The magnitude of U.S. imports from China further increases the risk. Imports from China, adjusted to the U.S. price level, equal about 30% of U.S. manufacturing output. If all those imports are cut off to all U.S. companies, it will take years for domestic sources to fill the gap.

U.S. firms should evaluate these risks when making sourcing decisions in China. If the risks and costs associated with CCP control, cross-strait brinksmanship, or exposure to sanctions are viewed as too high, reshoring becomes an excellent option.

For more (no cost) verified industry research, to speak with members of our team, or to connect with our broad network of leading companies in the Energy, Transportation, Manufacturing, and Site Selection industries,

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