The Impact of the Roofing Industry on the American Economy

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Executive Summary

The American roofing industry occupies an essential role in the construction, repair, and maintenance of every standing structure in the United States. As such, it provides and supports employment, incomes, and economic activity across the U.S. economy. All told, the three major segments of the roofing industry – roofing manufacturing, roofing wholesaling, and roofing contractors – were responsible for nearly 1 million jobs in 2018.

- Those three major parts of the industry directly employed 269,311 Americans in 2018.
- Their suppliers across 19 economic sectors employed another 390,033 Americans to produce the inputs of goods and services used to manufacture, wholesale, install, and repair roofing.
- Those 659,344 workers earned wages and salaries totaling $39.4 billion in 2018.
- The goods and services purchased with those wages and salaries were produced by another 313,525 workers, who earned $16.8 billion in 2018.
- All states benefited in 2018 from roofing industry-related jobs – ranging from 109,929 jobs in California with average wages of $67,305 and 86,832 jobs in Texas paying an average of $65,578, to 28,379 North Carolinians earning an average of $50,418, 19,682 Missourians earning $51,090, 3,312 Montanans earning $64,582, and 1,594 Alaskans earning $56,391.
- All told, the roofing industry supported employment for 972,869 Americans who earned wages and salaries averaging $57,777 and totaling $56.2 billion in 2018.

In recent years, the roofing industry has outperformed most other sectors and industries based on a range of important economic measures.

- The median wage paid by roofing manufacturers in 2018, at $22.27 per hour, was 34% higher than overall manufacturing ($16.58) and 21% higher than all private businesses ($18.48).
- Roofing manufacturers also produced value-added equal to 48.6% of its output, 30.3% higher than all manufacturing (37.3%) and equivalent to all private businesses (48.8%).
- Roofing contracting's value-added equaled 54.5% of its output in 2018, 17.5% higher than all construction (46.4%).
- Jobs, wages, payrolls, and sales all grew much faster in the roofing contracting industry than across the construction sector, all industries, and all private businesses.
- Similarly, jobs and payrolls grew faster in the roofing wholesaling industry than across construction, all industries, and all private businesses.

Roofing manufacturers purchased their inputs in 2018 from 20 economic sectors across the economy.

- Producers of nondurable goods contributed 27.4% of those inputs, and producers of equipment and other durable goods accounted for another 17.2 percent of the inputs.

- Another 12.6% of the inputs purchased by roofing manufacturers came from wholesale trade companies, transportation and warehousing firms, and companies that provide professional, technical, and corporate management services.

- The major industry sources of the inputs for roofing manufacturing included the petroleum refining companies, iron and steel mills, durable goods merchants, glass and glass product producers, plastic manufacturers, and trucking and rail transportation companies.

- The largest source of inputs for roofing manufacturing was the value-added provided by the roofing manufacturers, which accounted for 35.1% of all their inputs and was equal to 48.6% of their sales.

Roofing manufacturers also provided inputs in 2018 for 20 industries across the economy.

- Construction companies accounted for 61.1% of the output of roofing manufacturing, principally to build transportation structures such as parking garages and highways and streets, to maintain and repair commercial and industrial buildings, to build single and multi-family residences, and to repair and maintain those residences.

- Other major sectors using products from roofing manufacturers reached across the economy, including producers of durable and nondurable goods, healthcare organizations, businesses providing professional and technical services, and transportation and warehousing companies.

Roofing manufacturers have developed and produced a number of innovative roofing materials and products that help conserve energy and water and help reduce greenhouse gases and other dangerous pollutants. These innovations include technologies for cool or white roofing that reflects heat, green roofing that incorporates vegetation, blue roofing that captures and treats rainwater, and black roofing that incorporates photovoltaic solar technologies.

In one important respect, these results are conservative. The analysis describes the immediate economic ecosystem for the roofing industry; yet, other industries play more indirect but important roles. In a leading example, insurance companies finance a large share of residential and commercial roofing repairs and replacements. In the process, they employ thousands of inspectors and other employees. Input-output analysis does not cover the sources of the finances or credit used to purchase inputs or outputs, so the role that insurers play in the roofing industry is not part of the economic network measured in this study.

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The Impact of the Roofing Industry on the American Economy

Robert Shapiro with Siddhartha Aneja[1]

I. Introduction

The roofing industry – its manufacturers, wholesalers, and contractors – affects most parts of the American economy. Its products are part of every standing structure from homes, factories, and apartment and office buildings to airports, schools, hospitals, and every other type of commercial, industrial, or public building. In recent years, the roofing industry has been a strong growth industry. Part of the construction sector, the roofing industry has outperformed overall construction and all private businesses, measured by growth in employment, wages, and sales. Similarly, roofing manufacturing has outperformed overall manufacturing as measured by wages gains and value-added as a percentage of total output or sales.

The production of roofing products and the services that sell, install, and maintain them rely on inputs of many other goods and services, so many other industries rely on demand from roofing manufacturers, roofing wholesalers, and roofing contractors. In 2018, the inputs purchased by roofing manufacturers included $3.0 billion from petroleum refiners that produce the asphalt for asphalt roofing, $2.8 billion in durable goods, $859 million in services by wholesale trade companies, $757 million from iron and steel mills and ferroalloy manufacturers, $565 million in services by transportation and warehousing businesses, $330 million in professional and technical services, and $274 million from glass and glass products producers.

As a result, the roofing industry and its associated suppliers employ or support the jobs of close to one million Americans and pay them substantial wages and salaries. All told, the roofing industry directly employed 269,311 Americans in 2018 – 33,344 people employed by roofing manufacturers, 26,217 in roofing wholesaling, and 209,750 people in roofing contracting – and paid $14.7 billion in wages and salaries. Other industries employed an additional 390,033 people to produce the goods and services used as inputs by the roofing industry – 200,393 jobs producing inputs for roofing manufacturers, 28,131 jobs producing inputs for roofing wholesalers, and 161,509 jobs producing inputs for roofing contractors. They paid those workers $24.7 billion in wages and salaries. All told, the roofing industry in 2018 was directly responsible for the employment of 659,344 Americans who earned $39.4 billion. In addition, those workers spent wages and salaries averaging $57,903 in 2018 on goods and services across the economy; and their spending of roofing-related earnings supported or "induced" jobs for an additional 313,325 Americans, who earned $16.8 billion from their wages and salaries. Table 1 summarizes the jobs and income provided or supported by the roofing industry in 2018.

Table 1. Employment and Earnings Provided or Supported by the Roofing Industry, 2018

	Jobs	Wages and Salaries
Direct Employment by the Roofing Industry	269,311	$14,688,134,669
Associated Employment by Its Suppliers	390,033	$24,723,898,240
Additional Induced Employment	313,325	$16,797,367,069
Total	**972,869**	**$56,209,399,969**

[1] We gratefully acknowledge the support provided by Standard Industries. The analysis and conclusions are ours alone.

The economic impact of the roofing industry also reaches the industries that use its products and services. Nearly two-thirds of the production of roofing manufacturers, totaling $9.2 billion in 2018, were inputs for the construction industry. The construction industry principally used roofing inputs to build and repair transportation structures such as parking garages and materials used in highways and streets, to build office and commercial structures, and to maintain and repair industrial, residential, and commercial buildings. Other sectors that use the outputs of roofing manufacturers include producers of durable and nondurable goods and governments.

Recent years also have seen significant innovations in roofing materials and approaches. Cooling or "white" roofs that reflect heat, "green" roofs that incorporate vegetation, and "black" roofs that integrate photovoltaic technologies all can produce energy savings and reduce pollution. In addition, "blue" roofs can relieve storm-related stresses on sewer systems that exacerbate flooding and can provide new sources of drinking water and irrigation. These technologies provide new opportunities for roofing manufacturing to grow and promote social welfare.

Finally, our findings should be seen as conservative. The input-output analysis describes the roofing industry's direct economic ecosystem and does not account for industries that play more indirect supporting roles. Insurers pay for a substantial share of roofing repairs and replacements and in the process employ thousands of inspectors and other insurance company employees. However, how businesses pay for inputs or final products – through insurance, business revenues, equity, or debt – is not covered by an industry's input-output network. We further note that our analysis relies on the industry classifications used by the Census Bureau and Bureau of Economic Analysis (BEA), and their categories may obscure some input sources and output users. For example, big box stores purchase and sell large amounts of roofing materials. While they do not appear explicitly in this study, their purchases are captured in the wholesale trade industry category for the outputs of roofing manufacturing, and their sales are captured as suppliers for roofing contractors.

II. The Economic Dimensions of the Roofing Industry

The roofing industry has three major sub-industry segments: roofing manufacturing, roofing wholesalers, and roofing contractors. While much of our analysis will focus on roofing manufacturing, we begin by analyzing the broad economic dimensions and state of each segment.

Roofing Contracting

The Census Bureau, the BEA, and the Bureau of Labor Statistics (BLS) collect and issue data on various economic aspects of roofing manufacturing, wholesaling, and contracting. The Census Bureau's NAICS system classifies the roofing contracting industry as part of the Construction sector, and Census collects detailed data on the industry and sector every five years as part of its economic census of businesses. The contribution to the Gross Domestic Product (GDP) by each industry and sector are captured in their "value-added," which measures the unique value produced by an industry or sector apart from its inputs from other industries. An industry's value-added as a percentage of its sales measures its contribution to the economy. Data from the 2017 Economic Census show that value-added as a percentage of sales was substantially higher in the roofing contracting industry than the overall construction sector. (Table 2 below)

Table 2: Value-Added, Roofing Contracting Industry, and the Construction Sector, 2017[2]

	Roofing Contracting	Construction
Value-Added	$22,287,880,000	$926,715,369,000
Sales	$40,886,755,000	$1,999,109,623,000
Value-Added / Sales	54.5%	46.4%

The roofing contracting industry also has experienced very strong growth in recent years. Data from the Economic Census of 2012 and 2017 and data from the BEA show that the roofing contracting industry grew much faster over those years than all industries in the number of businesses, employment, total payrolls, and sales. (Table 3 below)

Table 3: Growth in Business Establishments, Employment, Payrolls, and Sales, Roofing Contracting and All Industries, 2012 to 2017[3]

	Roofing Contracting 2012	Roofing Contracting 2017	Growth - Roofing Contracting	Growth - All Industries[4]
Firms	16,613	19,305	16.2%	5.8%
Employees	149,605	177,254	18.5%	10.8%
Payrolls	$6,175,375,000	$9,121,117,000	47.7%	22.7%[5]
Sales	$28,218,737,000	$40,886,755,000	44.9%	15.6%[6]

The BLS issues data on employment and hourly wages for the roofing contracting industry, the construction sector, and all private businesses. Table 4A below shows that from 2016 to 2019, job growth was substantially faster in the roofing contracting industry than in the overall construction sector or all private businesses.[7] Table 4B shows that the median hourly wage was consistently higher in roofing contracting than all private businesses and grew faster in the roofing contracting industry than in overall construction and all private businesses.

Table 4A: Employment in Roofing Contracting, Construction and Private Businesses, 2016 and 2019

	2016	2019	Growth
All Private Businesses	118,846,300	125,009,370	5.2%
Construction	6,687,380	7,439,360	11.2%
Roofing Contracting	189,490	218,100	15.1%

[2] U.S. Census Bureau (2020-A).
[3] *Ibid*.; U.S. Census Bureau (2020-B).
[4] U.S. Census Bureau (2020-C).
[5] Federal Reserve Bank of St. Louis (2020-A).
[6] Federal Reserve Bank of St. Louis. (2020-B).
[7] U.S. Bureau of Labor Statistics (2020-A).

Table 4: Median Hourly Wages in Roofing Contracting, Construction and Private Businesses

	2016	2019	Growth
All Private Businesses	$16.84	$18.25	8.4%
Construction	$21.46	$23.57	9.8%
Roofing Contracting	$18.65	$21.34	14.4%

Roofing Wholesalers

The Census date for wholesalers is part of the "Roofing, Siding, and Insulation Material Wholesale Industry" segment of the Wholesale Sector.[8] Those data cover 2012 to 2017, and BLS data show its jobs and payrolls grew faster than in construction or all private businesses.

Table 6: Jobs and Payroll Growth in Roofing, Siding, and Insulation Material Wholesale

	2012	2017	Growth
Employment	30,965	43,506	40.4%
Payroll	$1,831,622,000	$2,838,806,000	55.0%

Roofing Manufacturing

Assessing the roofing manufacturing industry involves more extensive analysis. The statistical agencies do not issue data on roofing manufacturing as an industry. Therefore, we construct it from data on larger industries that include the main segments of roofing manufacturing, based on basic materials used to manufacture roofing. A research company, Fredonia Group, analyzed sales and market shares for seven main types of manufactured roofing.[9] (Table 7 below)

Table 7: Types of Manufactured Roofing, 2018

Type	Sales	Share
Asphalt	$7,380,000,000	46.1%
Metal	$4,015,000,000	25.1%
Bitumen	$1,560,000,000	9.8%
Plastic	$1,100,000,000	6.9%
Rubber	$600,000,000	3.8%
Concrete Tile	$470,000,000	2.9%
Wood	$325,000,000	2.0%
Other	$550,000,000	3.4%
Total	**$16,000,000,000**	**100.0%**

[8] U.S. Census Bureau (2020-A); U.S. Census Bureau (2020-D).
[9] Furst, Zielenski, and Mouhanna (2019).

Each principal material used for manufactured roofing is produced by a discrete industry that is measured by the Census Bureau, and the data on those industries include the segments of the roofing manufacturing industry that uses those materials. We compiled those data and aggregated them after adjusting for each segment's share of total roofing manufacturing production or sales.

The most common type of roof is asphalt, which accounted for 46.1 percent of all sales of manufactured roofing in 2018. Asphalt roof manufacturing is part of the "asphalt shingle and coating materials manufacturing" industry (Census NAICS Industry Number 324122). Census data show that the total industry's sales were $11,532,038,000 in 2018; according to the Fredonia Group analysis, sales of asphalt shingle roofs totaled $7,380,000,000 in 2018 or 64.0 percent of those total industry sales.[10] To estimate the number of firms, employees, total payroll, and value-added for asphalt roofing manufacturing, we apply that 64.0 percent share to the number of firms, employees, payroll, and value-added for the larger asphalt shingle and coating materials manufacturing industry. BLS does not report the median wage for the asphalt shingle and coating materials manufacturing industry. The asphalt shingle and coating materials manufacturing industry is itself a segment of the petroleum and coal products manufacturing industry, and we use the median wage data for that industry as a proxy for asphalt roof manufacturing. Table 8 below presents the results for this segment of roofing manufacturing.

Table 8: Basic Economic Data on Asphalt Roofing Manufacturing, 2018

	Asphalt Shingle and Coating Material Manufacturing	Asphalt Roofing Manufacturing
Employees	10,371	6,637
Firms	128	82
Payroll	$729,460,000	$466,822,499
Value-Added	$5,627,388,000	$3,601,282,223
Sales or Revenues	$11,532,038,000	$7,380,000,000
Median Wage	$31.73 per hour	$31.73 per hour

We conducted the same analysis for other segments of roofing manufacturing. Metal roofing manufacturing is part of the "architectural and structural metals manufacturing" industry group (NAICS Industry Number 3323). Sales of metal roofs in 2018 totaled $4,105,000,000, or 4.1 percent of all $98,150,968,000 revenues for the architectural and structural metals manufacturing industry.[11] Applying the approach described above, we estimate the numbers of firms, their employment, payroll and value-added for the metal roofing segment of roofing manufacturing in 2018. Table 9 below presents those results. BLS does not report the median wage for the architectural and structural metals manufacturing industry, so we use the larger industry group of which it is a part, the fabricated metal product manufacturing industry.

[10] U.S. Census Bureau (2020-E).
[11] *Ibid.*

Table 9: Basic Economic Data on Metal Roofing Manufacturing, 2018

	Architectural and Structural Metal Manufacturing	Metal Roofing Manufacturing
Employees	359,090	14,689
Firms	12,980	531
Payroll	$19,338,170,000	$791,054,374
Value-Added	$49,825,819,000	$2,038,193,483
Sales or Revenues	$98,150,968,000	$4,015,000,000
Median Wage	$19.44 per hour	$19.44 per hour

Bitumen roofing manufacturing is a segment of the "asphalt paving mixture and block manufacturing" industry (NAICS Industry Number 324121). Sales of bitumen roofs totaled $1,560,000,000 in 2018 or 11.1 percent of the $14,023,784,000 in sales for the entire asphalt paving mixture and block manufacturing industry.[12] We accordingly adjust the data for the larger industry to estimate the number of firms, employment, payrolls, and value-added for bitumen roofing manufacturing in 2018. Table 10 below presents those results. BLS does not report median wage data for the asphalt paving mixture and block manufacturing industry, so we use median wage data for petroleum and coal products manufacturing, which includes the asphalt mixture and block manufacturing industry.

Table 10: Basic Economic Data on Bitumen Roofing Manufacturing, 2018

	Asphalt Paving Mixture and Block Manufacturing	Metal Roofing Manufacturing
Employees	16,013	1,781
Firms	507	56
Payroll	$1,054,918,000	$117,348,647
Value-Added	$5,070,488,000	$564,039,013
Sales or Revenues	$14,023,784,000	$1,560,000,000
Median Wage	$31.73 per hour	$31.73 per hour

The next segment of roofing manufacturing is plastic roofing, which is part of the "other plastics products manufacturing" industry (NAICS Industry Number 326199). Sales of plastic roofs totaled $1,100,000,000 in 2018 or 1.1 percent of the total $99,332,628,000 in sales by the larger manufacturing industry.[13] Again, we use this share to derive estimates of the number of firms, employment, payrolls, and value-added for plastic roofing manufacturers industry in 2018. Table 11 below presents those results. Since BLS does not report median wage data for the other plastics product manufacturing industry, we use the wage data for the larger plastics manufacturing industry.

[12] *Ibid.*
[13] *Ibid.*

Table 11: Basic Economic Data on Plastic Roofing Manufacturing, 2018

	Other Plastic Product Manufacturing	Plastic Roofing Manufacturing
Employees	379,181	4,199
Firms	5,380	60
Payroll	$17,287,408,000	$191,439,099
Value-Added	$52,651,266,000	$583,055,072
Sales or Revenues	$99,332,628,000	$600,000,000
Median Wage	$17.26 per hour	$17.26 per hour

Rubber roofing manufacturing is a segment of the "other rubber product manufacturing" industry (NAICS Industry Number 326299). Sales of rubber roofs totaled $600,000,000 in 2018 or 5.7 percent of the total $10,618,766,000 in sales by all other rubber product manufacturers.[14] As before, we apply this share to derive estimates of the number of firms, employment, payrolls, and value-added for the rubber roofing manufacturing industry in 2018. Table 12 below provides those results. BLS does not report median wage data for the other rubber product manufacturing industry, so we use the wage data for the larger "rubber product manufacturing" industry.

Table 12: Basic Economic Data on Rubber Roofing Manufacturing, 2018

	Other Rubber Product Manufacturing	Rubber Roofing Manufacturing
Employees	30,147	1,703
Firms	607	34
Payroll	$1,651,317,000	$93,305,587
Value-Added	$5,255,346,000	$296,946,707
Sales or Revenues	$10,618,766,000	$600,000,000
Median Wage	$19.99 per hour	$19.99 per hour

We next analyze roofing tile manufacturing, which primarily involves concrete tile roofing. Concrete roofing tile manufacturing is part of the "other concrete product manufacturing" industry (NAICS Industry Number 327390). Sales of concrete roofs totaled $470,000,000 in 2018 or 3.5 percent of the total $13,241,175,000 sales by the other concrete product manufacturing industry.[15] We apply this share to derive the estimated number of firms, employment, payrolls and value-added for concrete roofing tile manufacturing in 2018. Table 13 below presents the results. BLS does not report median wage data for the other concrete product manufacturing industry, so we use the wage data for the "cement and concrete product manufacturing" industry, which includes other concrete product manufacturing.

[14] *Ibid.*
[15] *Ibid.*

Table 13: Basic Economic Data for Concrete Tile Roofing Manufacturing, 2018

	Other Concrete Product Manufacturing	Concrete Tile Roofing Manufacturing
Employees, all year	57,614	2,045
Establishments	2,057	73
Number of Firms	1,683	60
Annual Payroll	$2,951,637,000	$104,769,357
Value Added	$7,941,985,000	$281,903,453
Sales or Revenue	$13,241,175,000	$470,000,000
Median wage	$19.38 / hour	$19.38 / hour

The final segment of roofing manufacturing is wood roofing manufacturing, which is a segment of the "wood product manufacturing" subsector (NAICS Industry Number 321). Sales of wood roofs totaled $325,000,000 in 2018 or 0.3 percent of the total $114,844,686,000 sales by all wood product manufacturers.[16] Using this share, we derive estimates of the number of firms, employment, payrolls, and value-added for the wood roofing manufacturing industry in 2018. Table 14 below presents those results. For the median wage estimate, we use the median wage for the wood products manufacturing industry.

Table 14: Basic Economic Data for Wood Roofing Manufacturing, 2018

	Wood Product Manufacturing	Wood Roofing Manufacturing
Employees	403,796	1,143
Number of Firms	13,409	38
Annual payroll	$17,589,445,000	$49,776,527
Value added	$50,715,502,000	$143,520,251
Sales or Revenues	$114,844,686,000	$325,000,000
Median wage	$15.84 per hour	$15.84 per hour

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We can now construct estimates of the basic economic dimensions of the total roofing manufacturing industry. To do so, we aggregate the results of our analysis of the industry segments, weighting each segment by its share of total roofing manufacturing sales, and adjust the results to account for the other 3.4 percent of roofing manufactured from other materials. Table 15 presents the results: We estimate that in 2018, the roofing manufacturing industry employed 33,344 people in 891 firms earning a median wage of $22.27 per hour and a combined payroll of $1,879,110,515. The industry generated $7,776,248,752 in value-added on total sales of $16,000,000,000.

[16] *Ibid.*

Table 15: Basic Economic Data for the Roofing Manufacturing Industry, 2018

	Roofing Manufacturing
Employees	33,344
Number of Firms	891
Annual Payroll	$1,879,110,515
Value-Added	$7,776,248,752
Sales or Revenues	$16,000,000,000
Median Wage	$22.27

With these results, we can compare the roofing manufacturing industry with all manufacturing and all private businesses. (Table 16 below) This analysis shows that in 2018, value-added as a share of sales or revenues was substantially higher in the roofing manufacturing industry than across all manufacturing and equal to that measure for all private businesses. The median wage was 34.3 percent higher in roofing manufacturing in the roofing manufacturing industry than across all manufacturing and 20.5 percent higher than for across private businesses.

Table 16: Value-Added, Sales, and Median Wages in the Roofing Manufacturing Industry, All Manufacturing, and All Private Businesses, 2018[17]

	Roofing Manufacturing	All Manufacturing	All Private Businesses
Value-Added	$7,776,248,752	$2,321,200,000,000	$15,920,000,000,000
Sales - Output	$16,000,000,000	$6,217,000,000,000	$32,631,095,000,000
(Value-Added / Sales)	48.6%	37.3%	48.7%
Median Wage	$22.27	$16.58	$18.48

Innovation in Roofing Manufacturing: Sustainable Roofing

Roofing manufacturing has also been a source and beneficiary of recent innovation through the development of new materials and approaches to roofing that conserve water and energy and reduce pollution. These developments provide opportunities for the roofing industry to both grow and promote social welfare. These environmentally beneficial and sustainable roofs fall into four broad categories, often referred to by color: White or cool roofs with high solar reflectivity; green roofs with integrated vegetation; blue roofs that capture rainwater, and black roofs that integrate photovoltaic panels for electricity.

As the name suggests, cool roofs use a reflective white coating that results in lower roof surface temperatures. Since heat radiating from roofs increase a building's cooling load, white roofs reduce the energy and equipment required to cool a building – although they also marginally increase energy consumption for heating in colder climates.[18] Studies of white roofs accordingly

[17] U.S. Bureau of Economic Analysis (2020-A); Bureau of Economic Analysis (2020-B); U.S. Bureau of Labor Statistics (2020-B).
[18] Levinson and Akbari (2009).

show that their net energy savings depend on the climate, although they produce net energy savings in all climates in the United States except remote regions of Alaska.[19] One study found that retrofitting 80 percent of the roofs for U.S. commercial buildings would produce net annual energy savings of 10,400 GWh which in turn would offset 6.23 megatons of CO^2, equivalent to the CO^2 output of 1.2 million cars.[20]

Blue roofing provides active and passive ways to collect, manage and discharge rainwater, primarily for flat roofs. This technology could be especially useful in areas with frequent storms that strain sewer systems and threaten flooding.[21] The simplest type of blue roofing uses a flow control drain to detain water for up to 24 hours, and more elaborate types involve "rainwater harvesting systems" (RHS) that actively collect rainwater for irrigation and drinking water (after treatment). RHS are used widely in arid climates globally and, here, in advanced green buildings. Blue roofing may play a larger role if, as expected, climate changes strain municipal water systems.

Green roofs, as the name suggests, incorporate vegetation into a multilayered roofing system that includes a structural deck, a waterproofing layer, a drainage system, a filter layer, soil, and plants.[22] Green roofing also can provide water management benefits as well as energy savings by reducing building heat, but it also may require stronger structural elements and thus raise costs.[23] Studies have established that at this time, green roofs are less cost-efficient in the short term than types of other sustainable roofing, but can provide significant value over the long term, including social benefits by reducing air and noise pollution.[24] The Environmental Protection Agency has found that by lowering temperatures and reducing energy use, "green roofs can help reduce concentrations of several pollutants that affect air quality, climate, and health," including ozone, carbon monoxide, sulfur dioxide, nitrogen oxides, and lead.[25]

Finally, the most common and fast-growing category of sustainable roofing is so-called black roofs equipped with photovoltaic (PV) or solar energy technologies. Rising electricity prices, lower hardware costs, and concerns about climate change have all driven the growth in solar roofing.[26] As recently as 2017, the U.S. solar industry added jobs at 17 times the rate of the overall economy, although its employment declined from that peak in 2018 and 2019.[27] Its growth could accelerate if hardware and installation costs fall further with the development of solar shingles, as expected. This roofing shingle technology, also known as Building-Integrated PV, closely resembles traditional roofing, improves cell power output, and eliminates the need for a conventional PV "ribbon."[28] Researchers estimate that installing PV panels on 25 percent of roofs in the United States could produce 525 billion kWh of clean electricity or roughly half of the expected energy generation from all U.S. coal-fired power plants in 2020.[29]

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[19] *Ibid*.
[20] *Ibid*.
[21] Hammond (2017).
[22] Tabatabaee, Mahdiyar, Durdyev, Mohandes, and Ismail (2019).
[23] Berardi (2014).
[24] Lilauwala and peck (2015); Gargari, Bibbiani, Fantozzi and Campiotti (2016).
[25] Environmental Protection Agency. (2018).
[26] Hammond (2017).
[27]International Renewable Energy Agency (2017); International Renewable Energy Agency (2019).
[28] Shravan and Chunduri (2019).
[29] Kirby (2015); Warmsted, Dennis (2019).

III. The Roofing Manufacturing Industry and Its Suppliers

The roofing manufacturing industry operates in an economic ecosystem with many other industries and has substantial impact on the sectors, industries, and companies that supply its inputs. To trace these effects, we use input-output matrices developed by the BEA to track the source and value of each good and service used to produce the roofing manufacturing industry's output.[30]

This analysis must address complex issues of classification and measurement. The BEA input-output tables do not include a distinct roofing manufacturing industry. Therefore, we again use the larger industries that include each of the material-based segments of roofing manufacturing, such as the asphalt shingles and coating materials manufacturing industry (asphalt roofing) and the architectural and structural metal manufacturing industry (metal roofing). Further, the outputs of roofing manufacturing are purchased primarily by companies in the construction sector, and the Census Bureau's NAICS system disaggregates the construction sector into industries based on function, so the sector includes the roofing contractor industry. However, the BEA input-output accounts disaggregate the industries in the construction sector by the types of structures constructed, such as the "office and commercial structure" industry and the "educational and vocational structure" industry. Further, the broad wholesaling category cannot be disaggregated. Lastly, while BEA issues input-output data by *sector* on an annual basis, the most recent input-output data by *industry* were issued for 2012. Since this analysis requires annual industry data to derive the inputs for the roofing manufacturing industry, we adjust those industry data for the growth in roofing manufacturing from 2012 to 2018.

We begin by using an approach similar to the one used to derive the basic economic dimensions of roofing manufacturing: We created Use tables for each of the seven larger industries that include the seven material-based segments comprising roofing manufacturing, weighted each result for the segment's share of the total sales of the larger industry, and aggregated the results after weighting each segment for its share of total roofing manufacturing. (Table 7 above provides those shares.) In this way, we can establish the industries that provide the inputs for each of the larger industries that include the segments of roofing manufacturing. This composite analysis tells us which industries rely on demand from roofing manufacturers and the extent they do so.

We illustrate this analysis by tracing the sectors that contribute inputs to asphalt roofing manufacturing through the asphalt shingle and coating material manufacturing industry. The input-output matrices show the 16 sectors that produce inputs or intermediate goods for asphalt shingle and coating material manufacturers, led by the Nondurable Goods sector that provides 33.7 percent of those inputs and the Durable Goods sector that provides 10.3 percent of those inputs. (Table 17 below) All told, the inputs from 16 sectors account for 62.2 percent of the asphalt shingle and coating material manufacturing industry's total output, and the remaining 37.8 percent represents the industry's value-added.

[30] U.S. Bureau of Economic Analysis (2020-C).

Table 17: Inputs for the Asphalt Shingle and Coating Material Industry, By Sector

Sector	Share
Nondurable Goods	33.7%
Durable Goods	10.3%
Wholesale Trade	4.9%
Transportation and Warehousing, Excluding Postal Service	4.5%
Management of Companies and Enterprises	1.7%
Professional and Technical Services	1.7%
Finance and Insurance	1.3%
Mining	1.1%
Real Estate and Rental and Leasing	0.7%
Utilities	0.7%
Administrative and Waste Services	0.5%
Information	0.4%
Other Services, Except Government	0.3%
Accommodation and Food Services	0.2%
Construction	0.1%
Government	0.1%
Industry's Value-added	*37.8%*
Total Output	**100.0%**

We created similar tables to track the sectors that provide the inputs for the other industries that include the six other material-based segments of roofing manufacturing and, as noted, we weighted the results for each segment's share of the larger industry's revenues and each segment's share of total roofing manufacturing revenues. Those six tables are available on request. We aggregated those results to establish and measure the contributions by other sectors of inputs for the roofing manufacturing industry. (Table 18 below) This analysis shows that in 2018, 27.4 percent of the roofing manufacturing industry's output came from nearly $4.4 billion in inputs from the nondurable goods sector, and 17.2 percent of the industry's output came from $2.75 billion in inputs from the durable goods sector. All told, 19 sectors provided $10,386,980,800 in inputs for roofing manufacturing, corresponding to 64.9 percent of the industry's revenues. The remaining 35.1 percent of the industry's output, or $5,613,019,200, reflects the value-added provided by roofing manufacturers.

Table 18: Inputs for the Roofing Manufacturing Industry, By Sector, 2018[31]

Sector	Share	Amount
Nondurable Goods	27.4%	$4,384,810,636
Durable Goods	17.2%	$2,754,913,419
Wholesale Trade	5.4%	$858,622,271
Transportation and Warehousing, Excluding Postal Service	3.5%	$565,045,514
Professional and Technical Services	2.1%	$330,900,087
Management of Companies and Enterprises	1.6%	$257,541,752
Administrative and Waste Services	1.3%	$207,393,248
Mining	1.2%	$186,126,447
Finance and Insurance	1.1%	$173,851,522
Real Estate and Rental and Leasing	1.1%	$170,955,582
Utilities	1.1%	$175,021,519
Agriculture, Forestry, Fishing, and Hunting	0.5%	$72,364,434
Information	0.5%	$75,223,652
Accommodation and Food Services	0.3%	$45,712,612
Other Services, Except Government	0.3%	$51,188,423
Construction	0.2%	$25,038,792
Noncomparable Imports and Rest-of-the-World Adjustment	0.2%	$25,400,093
Government	0.1%	$11,952,114
Other	0.1%	$14,918,682
Value-added by Roofing Manufacturing	*35.1%*	*$5,613,019,200*
Total Output	**100.0%**	**$16,000,000,000**

Using this analysis, we can measure the impact of roofing manufacturing on other sectors based on the shares of their outputs that are sold as inputs for roofing manufacturers. The input-output analysis showed that the roofing manufacturing industry, while relatively small, plays an outsized role in the sales of sectors that supply its inputs in 2018. The $16 billion in sales by roofing manufacturers represented five one-hundredths of one percent (0.0005 percent) of the $32.63 trillion in total sales by all private businesses, including sales as inputs to other businesses, final sales to other businesses, and final sales to consumers. However, the sales of inputs to roofing manufacturers by each of their supplier sectors represented a far larger share of each of those sector's total sales. (Table 19 below) Similarly, the $16 billion in production by roofing manufacturers represented eight one-hundredths of one percent (0.0008 percent) of U.S. GDP or total production of $20.49 trillion in 2018. Again, the sales of inputs to roofing manufacturers from their supplier sectors as a share of each of those sector's total production or output far exceed the roofing manufacturing industry's share of GDP.

[31] These numbers do not coincide precisely with data presented earlier on the roofing manufacturing industry, because here we apply 2012 BEA data to overall 2018 industry output, whereas before we used 2018 Census data.

Table 19: Share of the Total Production of Various Sectors Used as Inputs by the Roofing Manufacturing Industry, 2018

Sector	Total Sector Sales or Output	Share Used by Roofing Manufacturing
Noncomparable Imports and Rest-of-the-World Adjustment	$3,273,000,000	0.78%
Nondurable Goods	$3,002,610,000,000	0.15%
Durable Goods	$2,998,334,000,000	0.09%
Management of Companies and Enterprises	$617,290,000,000	0.04%
Transportation and Warehousing, Excluding Postal Service	$1,297,731,000,000	0.04%
Wholesale Trade	$2,020,058,000,000	0.04%
Mining	$569,884,000,000	0.03%
Utilities	$653,628,000,000	0.03%
Administrative and Waste Services	$1,104,723,000,000	0.02%
Agriculture, Forestry, Fishing, and Hunting	$449,114,000,000	0.02%
Scrap, Used and Secondhand Goods	$8,765,000,000	0.02%
Finance and Insurance	$2,964,629,000,000	0.01%
Information	$1,461,105,000,000	0.01%
Other Services, Except Government	$916,558,000,000	0.01%
Professional and Technical Services	$3,131,817,000,000	0.01%

The Impact of Roofing Manufacturing on the Industries that Provide Its Inputs

We can refine this analysis by focusing on the principal industries within those sectors that supply the inputs of goods and services used to manufacture roofing. Once again, we approach this analysis through the larger manufacturing industries that include the seven main segments of roofing manufacturing: Asphalt shingle and coating materials manufacturing (asphalt roofing), architectural and structural metals manufacturing (metal roofing), asphalt paving mixture and block manufacturing (bitumen roofing), other concrete products manufacturing (concrete and clay tile roofing), other plastic products manufacturing (plastic roofing), other rubber products manufacturing (rubber roofing), and wood products manufacturing (wood roofing).

As before, we illustrate this approach using the asphalt shingle and coating materials manufacturing industry. The input-output analysis finds that inputs from the petroleum refining industry account for 30.0 percent of the output of the asphalt shingle and coating material industry because asphalt shingles use products refined from petroleum. This industry-level analysis also highlights the inputs of service industries such as rail and truck transportation and corporate management services. Table 20 below presents the ten principal industries that supply the inputs for this larger industry that includes asphalt roofing manufacturing. Comparable tables for the industries that contribute the inputs for the larger manufacturing industries that include the other six segments of roofing manufacturing are available on request.

Table 20: Inputs for Asphalt Shingle and Coating Material Manufacturing, by Industry, 2018

Industry	Share
Petroleum Refineries	30.0%
Miscellaneous Nonmetallic Mineral Products	4.2%
Glass and Glass Product Manufacturing	3.3%
Petroleum and Petroleum Products	2.4%
Rail transportation	1.8%
Truck transportation	1.7%
Management of companies and enterprises	1.7%
Asphalt shingle and coating materials manufacturing	1.7%
Other durable goods merchant wholesalers	1.1%
Other nonmetallic mineral mining and quarrying	0.9%
Other industries	13.4%
Value-added by Asphalt Shingle and Coating Materials Manufacturers	*37.8%*
Total output	**100.0%**

We adjusted each of these results for the roofing manufacturing segment's share of the larger industry's total production aggregated those results, weighting them based on each segment's share of roofing manufacturing revenues. Table 21A below provides the results. The industry that contributes the most inputs to roofing manufacturers is petroleum refining, followed by iron and steel mills and ferroalloy manufacturing. The value-added created by roofing manufacturers, equal to 35.1 percent of their total production or sales, far exceeds the contributions of any of their supplier industries.

Table 21A: Inputs for the Roofing Manufacturing Industry, by Industry, 2018

Industry	Share	Amount
Petroleum Refining	19.0%	$3,046,063,971
Iron and Steel Mills and Ferroalloy Manufacturing	4.7%	$757,431,326
Miscellaneous Nonmetallic Mineral Products	2.1%	$342,299,720
Other Durable Goods Merchant Wholesalers	1.9%	$307,219,648
Glass and Glass Product Manufacturing	1.7%	$273,944,553
Management of Companies and Enterprises	1.6%	$257,541,752
Truck Transportation	1.5%	$243,349,576
Petroleum and Petroleum Products	1.5%	$242,965,834
Plastics Material and Resin Manufacturing	1.5%	$240,289,058
Rail Transportation	1.2%	$192,033,970
Other Industries	28.0%	$4,483,841,393
Value-added by Roofing Manufacturing	*35.1%*	*$5,613,019,200*
Total Output	100.0%	$16,000,000,000

As we did with sectors, we use these results to gauge the impact of roofing manufacturing on industries that provide its inputs. The industries that rely most on demand from the roofing manufacturing industry are manufacturers of miscellaneous nonmetallic mineral products, manufacturers of glass and glass products, and iron and steel mills and ferroalloy manufacturers. Their inputs for roofing manufacturers account, respectively, for 7.4 percent, 1.0 percent, and 0.5 percent of their total sales or production. (Table 21B below).

Table 21B: Impact of Roofing Manufacturing on its Principal Industry Suppliers, 2018[32]

Industry	Amount	Share of Industry's Total Production
Miscellaneous Nonmetallic Mineral Products	$342,299,720	7.4%
Glass and Glass Product Manufacturing	$273,944,553	1.0%
Iron and Steel Mills and Ferroalloy Manufacturing	$757,431,326	0.5%
Petroleum Refineries	$3,046,063,971	0.4%
Plastics Material and Resin Manufacturing	$240,289,058	0.3%
Rail Transportation	$192,033,970	0.2%
Other Durable Goods Merchant Wholesalers	$307,219,648	0.1%
Truck Transportation	$243,349,576	0.1%
Petroleum and Petroleum Products	$242,965,834	0.1%
Management of Companies and Enterprises	$257,541,752	Less than 0.1%
Other Industries	$4,483,841,393	Each Less than 0.1%

IV. Roofing Manufacturing and the Industries Using Its Products

The economic ecosystem for roofing manufacturing also includes the sectors and industries that use its outputs. Here, we use input-output analysis to identify those sectors and industries and the extent to which they use the production of roofing manufacturers. As before, we apply a composite approach based on the sectors that use products produced by the larger industries that manufacture the materials for roofing manufacturing. We illustrate this process with the sectors that use the outputs from the asphalt shingle and coating material manufacturing industry. (Table 22 below) The construction sector dominates the purchases of that industry's products, accounting for 87.4 percent of the total production by asphalt shingle and coating materials manufacturers.

[32] Total industry commodities in 2018 were estimated by multiplying the total industry commodities for roofing in 2012 by the sectors' rates of growth from 2012 to 2018.

Table 22: Sectors Using Outputs from the Asphalt Shingle and Coating Material Manufacturing Industry, 2018

Sector	Share
Construction	87.4%
Government	4.1%
Information	1.9%
Administrative and Waste Services	1.8%
Nondurable Goods	1.8%
Health Care and Social Assistance	1.1%
Other Services, Except Government	0.4%
Other Final Uses	1.5%

We performed the same analysis to identify the sectors that use the outputs of the architectural and structural metals manufacturers (metal roofing), asphalt paving mixture and block producers, (bitumen roofing), other concrete manufacturers (concrete roofing), other plastic products manufacturers (plastic roofing), other rubber products producers (rubber roofing), and wood products manufacturers (wood roofing). Those tables are available on request. We adjusted, aggregated, and weighted the results as before, and find that 20 sectors use the outputs of the roofing manufacturing industry. (Table 23A below) Purchases by the construction sector, the durable goods sector, and governments used more than 81 percent of the industry's output in 2018.

Table 23A: Principal Sectors Using Products from the Roofing Manufacturing Industry, 2018

Sector	Share	Use of Roofing Manufacturing Outputs
Construction	64.1%	$9,929,081,337
Durable Goods	10.2%	$1,583,191,432
Government	6.9%	$1,074,749,346
Nondurable Goods	4.2%	$655,038,140
Information	2.2%	$334,605,532
Health Care and Social Assistance	1.8%	$281,431,890
Professional and Technical Services	1.8%	$271,005,938
Administrative and Waste Services	1.7%	$262,850,205
Other Services, Except Government	1.1%	$165,216,864
Transportation and Warehousing, Excluding Postal Service	0.9%	$142,003,692
Wholesale Trade	0.9%	$134,524,349
Accommodation and Food Services	0.7%	$101,453,798
Mining	0.7%	$111,700,840
Arts, Entertainment, and Recreation	0.5%	$72,643,816
Real Estate and Rental and Leasing	0.4%	$55,624,425

Retail Trade	0.4%	$64,253,581
Agriculture, Forestry, Fishing, and Hunting	0.1%	$15,013,517
Educational Services	0.1%	$10,750,924
Management of Companies and Enterprises	0.1%	$11,439,659
Other Final Uses	1.3%	$206,423,939
Total	**100.0%**	**$15,483,003,226**

Finally, we refine these results by analyzing which sectors depend most on the outputs of roofing manufacturing as intermediate goods for their own production. This analysis shows that the outputs of roofing manufacturers account for 1.3 percent of the total inputs for the construction sector, followed as above by the durable goods and Government sectors. (Table 23 B)

Table 23B: Roofing Manufacturing Industry Outputs
As a Share of the Inputs for Production by Various Sectors, 2018

Sector	All Intermediate Inputs	Share from Roofing Manufacturing
Construction	$769,264,000,000	1.29%
Durable Goods	$1,871,940,000,000	0.08%
Government	$1,417,594,000,000	0.08%
Administrative and Waste Services	$459,311,000,000	0.06%
Arts, Entertainment, and Recreation	$135,126,000,000	0.05%
Other Services, Except Government	$302,440,000,000	0.05%
Information	$765,723,000,000	0.04%
Mining	$277,169,000,000	0.04%
Health Care and Social Assistance	$986,885,000,000	0.03%
Nondurable Goods	$2,023,901,000,000	0.03%
Professional and Technical Services	$829,511,000,000	0.03%
Accommodation and Food Services	$512,455,000,000	0.02%
Transportation and Warehousing,	$608,001,000,000	0.02%
Wholesale Trade	$828,615,000,000	0.02%
Agriculture, Forestry, Fishing and Hunting	$280,176,000,000	0.01%
Educational Services	$114,015,000,000	0.01%
Retail Trade	$735,936,000,000	0.01%
Total	**$12,918,062,000,000**	**--**

Use of Roofing Manufacturing Products by Construction Industries

Since 64.1 percent of the output of roofing manufacturing was purchased and used by the construction sector in 2018, we refine that analysis by examining the industries within that sector that use those outputs. The construction sector is comprised of industries distinguished by types of

structures or construction activity, such as transportation structures, residential structures, and nonresidential maintenance and repairs. We applied our composite approach based on the extent to which the various construction industries use the products produced by the larger industries that manufacture the materials for roofing manufacturing. As before, those materials cover asphalt roofing, metal roofing, bitumen roofing, concrete tile roofing, plastic roofing, rubber roofing, and wood roofing. Those tables are available on request. We adjusted each result for roofing manufacturing's share of the larger industry's production and aggregated the results, weighting them for each segment's share of total roofing manufacturing output.

This analysis shows that in 2018, three construction industries used $6.95 billion of all roofing manufacturing outputs – transportation structures and highways and streets, the nonresidential maintenance and repair industry, and the multi-family residential structure industry. (Table 24A below) Those three industries accounted for 67.9 percent of all roofing manufacturing products used in construction and 44.9 percent of all roofing manufacturing products.

Table 24A: Use of Outputs from Roofing Manufacturers
By Industries in the Construction Sector, 2018

Construction Industry	Share	Purchases
Transportation Structures and Highways and Streets	19.4%	$3,000,646,249
Nonresidential Maintenance and Repair	17.5%	$2,705,842,187
Other Residential Structures (Multi-family Buildings)	8.0%	$1,245,039,186
State and Local Government (other services)	4.4%	$682,185,009
Residential Maintenance and Repair	4.1%	$638,071,638
Office and Commercial Structures	3.3%	$504,858,349
Other Nonresidential Structures	2.9%	$446,616,763
Single-family Residential Structures	2.6%	$406,949,648
Educational and Vocational Structures	2.1%	$320,339,274
Power and Communication Structures	1.8%	$284,225,227
Non-Construction Industries and other Final Uses	*33.9%*	*$5,248,229,696*
Total	**100.0%**	**$15,483,003,226**

Finally, we further refine this analysis by focusing on the extent to which each construction industry used the products of roofing manufacturing as intermediate inputs. (Table 24B below) Those roofing products accounted for 1.0 percent or more of the intermediate inputs used in four construction industries – transportation structures, nonresidential maintenance and repair, residential maintenance and repair, and office and commercial structures.

Table 24B: The Use of Products from the Roofing Manufacturing Industry As Intermediate Inputs by Industries in the Construction Sector, 2018

Construction Industry	All Intermediate Inputs	Share from Roofing Manufacturing
Transportation Structures and Highways and Streets	$80,402,369,602	3.73%
Nonresidential Maintenance and Repair	$147,081,825,540	1.84%
Residential Maintenance and Repair	$58,361,867,630	1.09%
Office and Commercial Structures	$48,925,427,160	1.03%
Other Residential Structures (Multi-Family Buildings)	$132,886,573,232	0.94%
Educational and Vocational Structures	$42,292,021,329	0.76%
Other Nonresidential Structures	$71,855,992,263	0.62%
Power and Communication Structures	$51,824,405,587	0.55%
Single-family Residential Structures	$77,065,001,871	0.53%
State and Local Government Structures (other services)	$370,108,972,133	0.18%

V. Roofing Industry Related Employment and Incomes

Based on our analysis of the economic ecosystem for roofing manufacturing, we can also determine the impact of each part of that ecosystem on jobs. The roofing industry creates direct employment for the employees of roofing wholesalers, roofing manufacturers, and roofing contractors. As the source of demand for their inputs, roofing manufacturers also are responsible for the jobs in other sectors and industries that produce the inputs for their industry. In addition, those directly employed in the roofing industry or employed producing inputs for roofing manufacturers spend the wages and salaries they earn from those jobs on other goods and services. In this way, the roofing industry is also indirectly responsible for the jobs required to produce those goods and services. All told, more than 972,000 Americans were employed in 2018 in jobs tied directly or indirectly to the roofing industry.

We know the direct employment in each segment of the industry: The Census Bureau and BLS report that in 2018, roofing manufacturers employed 33,344 people, roofing wholesale services employed 14,967 people,[33] and roofing contracting services employed 209,750 people.[34] The Economic Policy Institute (EPI) provides the most recent analysis of "employment multipliers" for each industry in 2019: The number of supplier jobs in industries that provide inputs for each job in the industry using the inputs.[35] We use employment multipliers to estimate jobs in the supplier industries for each segment of the industry that rely on demand from that segment.

Based on data from the Census NAICS Association, roofing wholesalers employed 14,967 people in 2018. We adjusted those data to include roofing-related employment by a large privately-held wholesaler of roofing, siding and insulation products, ABC Supply. With that adjustment,

[33] We estimated this number from the broader Roofing, Siding, and Insulation Wholesale Industry, with 46,286 employees, again adjusted for employment in roofing wholesaling at ABC Supply. ABC Supply (2020).
[34] U.S. Census Bureau (2020-E); U.S. Bureau of Labor Statistics (2020-A).
[35] Bivens, Josh (2019).

we estimate the roofing wholesaling employed 26,217 people in 2018. The employment multiplier for the wholesale trade industry is 1.073 jobs for every wholesaler job, so the 26,217 jobs in roofing wholesale supported an estimated 28,131 jobs by its suppliers. Similarly, the employment multiplier for the roofing contracting industry is 0.88, so the 209,750 jobs in that industry supported an estimated 184,580 additional jobs in its supplier industries -- including, for example, big box stores and other retailers. However, this result also needs adjustment because some inputs for the roofing contractor industry come from roofing wholesalers. To avoid double-counting those jobs, we adjust the supplier-related employment for roofing contractors by reducing the 184,580 estimate by the direct employment of roofing wholesaling times the 0.88 employment multiplier, bringing the estimated supplier-related employment for roofing contractors to 161,509 jobs.

Calculating the employment required to produce the inputs purchased by roofing manufacturers is more complicated. Our analysis established the extent to which other industries supply inputs for roofing manufacturers, including the petroleum refinery industry, iron and steel mills and ferroalloy manufacturers, the trucking transportation industry, and many others. To estimate the numbers of supplier jobs directly associated with demand from the roofing manufacturers, we use established the employment multipliers for different industries, from which we can calculate the number of additional jobs created by an industry's suppliers for every direct job in that industry.[36] For example, every job in the petroleum and coal manufacturing industry, which includes asphalt roofing manufacturing and bitumen roofing manufacturing, supports 9.5 jobs in the industries that supply its inputs, and each job in the other plastic product manufacturing industry which includes plastic roofing manufacturing supports 1.7 additional jobs in industries that produce its inputs. We calculated the supplier jobs for each segment, weighted them for each segment's share of roofing manufacturing sales, and found that every direct job in roofing manufacturing supports an average of 6.0 jobs to produce the necessary inputs. Since roofing manufacturers employed 33,344 people in 2018, their demand for inputs supported an additional 200,393 jobs in supplier industries.

All told, the roofing industry and its associated suppliers were responsible for the employment of 659,344 people in 2018. Table 25 below presents the breakdown.

Table 25: Direct Employment by the Roofing Industry and Employment Directly Supported by the Roofing Manufacturing Industry, 2018

Industry	Employment
Roofing Manufacturing	33,344
Suppliers for Roofing Manufacturing	200,393
Roofing Wholesaler Services	26,217
Suppliers for Roofing Wholesalers	28,131
Roofing Contracting Services	209,750
Suppliers for Roofing Contracting	161,509
Total	**659,344**

[36] Bivens, Josh (2019).

The EPI analysis also measured the "induced employment multipliers" for each industry, which refer to the numbers of jobs supported by the incomes earned and spent by an industry's employees and the employees that produce its inputs.[37] In an example provided by EPI researchers, the employment in construction industry "support(s) jobs in restaurants and diners where construction workers eat, grocery stores where they shop for food, and doctors' offices where they pay for medical services." The number of those jobs induced by any industry depends on the industry's direct employment, the employment multiplier for its suppliers, and the wages and salaries paid by the industry and its suppliers. For example, every 100 jobs in roofing wholesaling support 107.3 additional jobs in its supplier industries, and the wages earned and spent by those 207.3 employees support or induce an additional 95.1 jobs. The induced employment multiplier for the roofing wholesaler industry, therefore, is 0.459 (95.1/207.3): Each employed person in roofing wholesaling and each employed person in an associated job in its supplier industries purchase goods and services that require the additional employment of 0.459 people. Total employment by roofing wholesalers and their associated suppliers was 54,348 in 2018, and that employment induced an estimated 24,932 additional jobs.

Similarly, every 100 jobs in the roofing contracting industry supported an additional 88 jobs in the industries that supply roofing contractors, and those 188 jobs indirectly induced the employment of another 89.6 people. The induced employment multiplier for roofing contracting, therefore, is 0.477. Based on total employment by roofing contractors and their associated suppliers of 371,259 people in 2018, those jobs induced an estimated 176,940 additional jobs. Lastly, every 100 jobs in roofing manufacturing supported an additional 601 jobs to produce the inputs for roofing manufacturers, and those 701 jobs indirectly induced the additional employment of 335 people. The induced employment multiplier for roofing manufacturing, therefore, is 0.478. Given that the employment by the roofing manufacturing industry and its associated suppliers totaled 233,737 jobs in 2018, those jobs induced an estimated 111,652 additional jobs.

All told, the employment of 659,344 people in the American roofing industry in 2018 induced or supported the employment of an additional 313,525 people in 2018. Therefore, roofing industry related employment totaled 972,869 in 2018. Table 26 below presents a summary of the direct and indirect employment arising from the operations of the roofing industry in 2018.

Table 26: Total Roofing Industry-Related Employment, By Segment, 2018

Industry	Employment
Jobs in Roofing Manufacturing and Associated Suppliers	233,737
Jobs Induced from Roofing Manufacturing and Associated Suppliers	111,652
Jobs in Roofing Wholesaling Services and Associated Suppliers	54,348
Jobs Induced from Roofing Wholesalers and Associated Suppliers	24,932
Jobs in Roofing Contracting Services and Associated Suppliers	371,259
Jobs Induced from Roofing Contracting and Associated Suppliers	176,940
Total	**972,869**

[37] *Ibid.*

Roofing-Related Employment and Incomes by State

We also can estimate how those 972,869 jobs were distributed across the 50 states and the District of Columbia, and how much income was earned in each state by people employed directly or indirectly by the roofing industry. The Census Bureau issues data on the distribution of employment by industry and state. We use those data to distribute by state the 659,344 jobs in roofing manufacturing, wholesaling and contracting and in the other industries that produce the inputs for the roofing industry, and the 313,525 jobs induced by the income earned by the employees of the industry's three primary segments and the employees in their associated supplier jobs.[38] All states have substantial roofing-related employment, ranging from 109,929 jobs in California and 86,832 jobs in Texas, to 1,923 jobs in Vermont and 1,594 jobs in Alaska. Population is a major factor in the state-by-state distribution of this employment, but some aspects of the roofing industry are concentrated. For example, California and Texas account for 21 percent of the nation's population and 50 percent of all roofing supplier jobs in petroleum refining. All told, 19 states have higher roofing-related employment than would be expected based solely on population.

We also estimated the income generated by roofing-related jobs in each state, using the median annual wage and salary income in 2018 for employees in each primary segment of the roofing industry -- $52,713 for roofing contracting,[39] $56,355 for roofing manufacturing, and $66,843 for roofing wholesalers.[40] For other roofing-related jobs, we use median wages and salaries for all employment by state. All told, the 972,869 people employed in roofing-related jobs in 2018 earned more than $56.2 billion from those jobs. This includes $16,442,885,538 earned by employees in roofing manufacturing and its suppliers, $3,259,551,593 earned by employees in roofing wholesaling and its suppliers, $19,709,595,768 earned by employees in roofing contracting and its suppliers, and $16,797,367,069 earned in 2018 by people in jobs induced by the roofing industry. Table 27 presents those earnings for each segment of roofing-related employment.

Table 27: Total Wages and Salaries Earned in the Roofing Industry, By Segment, 2018

Industry	Jobs	Total Wages and Salaries
Roofing Manufacturers	33,344	$1,879,110,525
Associated Suppliers to Roofing Manufacturers	200,393	$14,563,775,013
Roofing Wholesalers	26,217	$1,752,417,073
Associated Suppliers to Roofing Wholesalers	28,131	$1,507,134,520
Roofing Contractors	209,750	$11,056,607,061
Associated Suppliers to Roofing Contractors	161,509	$8,652,988,707
Jobs Induced by the Roofing Industry	313,525	$16,797,367,069
Total	**972,869**	**$56,209,399,969**

[38] U.S. Census Bureau (2020-A); U.S. Census Bureau (2020-E). The employment in certain parts of roofing manufacturing does not correspond to the Census Bureau. To estimate the geographic distribution of roofing manufacturing jobs not from the asphalt shingles and coating materials manufacturing industry, therefore, we applied the distribution of all manufacturing employment. To estimate the distribution of all induced jobs for roofing, we use the distribution of all jobs in the broader economy.

[39] See Table 3 above, here adjusted for inflation.

[40] See Table 6 above, here adjusted for inflation.

All wage and salary income in the United States totaled $8,367.4 billion in 2018, so the income earned from roofing-related jobs was 0.67 percent of all payroll, while roofing-related employment accounted for 0.62 percent of all employment.[41]

Finally, we distribute roofing-related employment and the median wage and salary income from that employment by state. Since the wages and salaries of all types of employment differ from state to state, a state's ranking for roofing-related income is not the same as its ranking for roofing-related employment. For example, New Jersey ranks 10th in the total income earned from roofing-related jobs and 13th in the number of those jobs, while Indiana ranks 15th in statewide income earned from those jobs and 11th in the number of those jobs.[42] Table 28 presents the roofing-related employment in each state, ranked in descending order, with the average earnings for all roofing-related jobs in each state and the total income earned from those jobs in each state.

Table 28: Roofing Related Employment and Incomes, by State, 2018

State	Roofing-Related Jobs	Mean Wages and Salary	Total Income
California	109,929	$67,305	$7,398,803,571
Texas	86,832	$65,578	$5,694,259,591
Florida	62,261	$49,979	$3,111,702,595
New York	46,526	$64,240	$2,988,835,270
Pennsylvania	43,827	$55,692	$2,440,802,515
Ohio	41,778	$54,554	$2,279,155,081
Illinois	40,085	$60,712	$2,433,601,326
Michigan	29,707	$53,229	$1,581,255,080
North Carolina	28,379	$50,418	$1,430,803,300
Georgia	27,550	$52,048	$1,433,910,731
Indiana	25,246	$51,200	$1,292,625,702
Washington	24,963	$66,452	$1,658,832,146
New Jersey	23,009	$64,285	$1,479,153,603
Virginia	22,639	$55,019	$1,245,580,396
Wisconsin	21,488	$52,414	$1,126,292,322
Massachusetts	20,313	$65,336	$1,327,176,133
Tennessee	20,199	$50,331	$1,016,616,182
Minnesota	20,108	$55,944	$1,124,903,712
Missouri	19,682	$51,090	$1,005,561,292

[41] Federal Reserve Bank of St. Louis (2020-A); U.S. Census Bureau (2020-F).

[42] All told, 13 states rank higher among all 50 states in statewide income earned from roofing-related jobs than their ranking for the number of those jobs, and 24 states rank lower in statewide income from roofing-rated jobs than their ranking for roofing-related employment.

Colorado	19,074	$55,264	$1,054,084,581
Arizona	18,720	$51,544	$964,926,570
Maryland	16,201	$56,196	$910,450,207
Louisiana	16,118	$80,230	$1,293,178,975
Oregon	14,542	$54,263	$789,079,457
South Carolina	14,005	$48,860	$684,278,413
Alabama	13,711	$49,009	$671,974,757
Kentucky	12,520	$48,378	$605,676,352
Oklahoma	11,687	$57,997	$677,791,314
Kansas	11,279	$56,269	$634,640,357
Utah	11,054	$56,638	$626,082,872
Iowa	10,901	$50,126	$546,416,355
Connecticut	9,836	$64,649	$635,888,520
Arkansas	9,206	$47,444	$436,788,376
Nevada	7,978	$48,099	$383,754,592
Mississippi	7,262	$44,779	$325,200,225
Nebraska	6,759	$48,780	$329,711,907
New Mexico	4,886	$47,587	$232,486,811
Idaho	4,683	$48,829	$228,662,583
New Hampshire	4,237	$56,480	$239,330,126
Hawaii	3,950	$49,287	$194,709,255
Maine	3,918	$49,116	$192,458,971
West Virginia	3,718	$47,868	$177,992,478
Montana	3,312	$64,582	$213,902,573
Rhode Island	2,925	$52,872	$154,674,923
Delaware	2,858	$56,318	$160,942,202
South Dakota	2,755	$46,958	$129,377,451
North Dakota	2,307	$51,436	$118,651,666
Wyoming	2,291	$75,672	$173,397,352
District of Columbia	2,137	$78,719	$168,221,390
Vermont	1,923	$49,357	$94,924,231
Alaska	1,594	$56,391	$89,873,580
United States	**972,869**	**$57,777**	**$56,209,399,969**

VI. Conclusions

This study of the American roofing industry, with particular attention to roofing manufacturing, demonstrates that an industry of modest size can generate broad economic effects and benefits. The range of those effects and benefits reflects, first, the essential role of the industry's products and services in virtually all standing structures. Nearly two-thirds of the products produced by roofing manufacturers, totaling $9.2 billion in 2018, were used by construction companies, principally to build, repair and maintain transportation structures such as parking garages and highways and streets, homes, offices factories, and commercial buildings. Other industries, including manufacturers of durable and nondurable goods, used the remaining one-third of roofing industry products as part of their inputs.

The roofing industry's broad effects and benefits also reflect its role as a source of demand for more than 20 industries that produce its inputs. In 2018, these supplier industries sold $10.4 billion in outputs to roofing manufacturers, which includes inputs from the petroleum refinery industry, iron and steel mills, glass products producers, equipment and other durable goods manufacturers, wholesale trade companies, transportation and warehousing businesses, and professional and technical service firms.

The roofing industry also has significant effects for employment. Through its three primary segments – manufacturing, wholesaling, and contacting services – the roofing industry also directly employed 269,311 people in 2018. Their median wages and salaries substantially exceeded the median wages and salaries for all manufacturing workers, all construction industry workers, and all workers across private businesses. In addition, the suppliers for the roofing industry employed an additional 390,033 people to produce the goods and services used to manufacture, wholesale, and install roofing. All told, the 659,344 workers employed in the roofing industry and by its direct suppliers earned $39.4 billion in 2018. Finally, producing the goods and services purchased with those earnings created jobs for an additional 313,325 workers, who in turn earned $16.8 billion. All told, the roofing industry in 2018 was responsible for the jobs of 972,869 Americans who earned wages and salaries totaling $56.2 billion.

The roofing industry has also been a source of recent growth. In recent years, employment and payrolls grew faster in every segment of the roofing industry – manufacturing, wholesaling, and contracting – than in overall construction, overall manufacturing, and across all private businesses. Further, the value-added as a share of output is higher in the roofing manufacturing industry than the overall manufacturing sector. Finally, through the development of cool roofs, green roofs, blue water-capturing roofs, and solar power-enabled roofs, roofing manufacturers have become a source of important innovations to help conserve water and energy and reduce pollution.

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