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MANUFACTURING EFFICIENCY

How Buy America Policy Can Boost Jobs Manufacturing Energy-Efficient Products

The Building Clean database supercharges efforts to find healthy, American-made products and highlights a broad range of energy-efficient housing products, illustrating the breadth and depth of America's energy-efficient product supply chain.

Acknowledgments:

Economic analysis for this report was prepared by Jim Barrett, PhD, Barrett Economics.

The BlueGreen Alliance Foundation would like to thank Jason Walsh, Lauren Asplen, Dana Parker, Roxanne Johnson, Michael Miranda, Michelle Manson, Joe Kendrick, Eric Steen, Matar Gueye, and Abby Harvey for their work.

Design by Winking Fish.

Errors remain the responsibility of the authors.

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EXECUTIVE SUMMARY

The American Council for an Energy Efficient Economy (ACEEE) calls energy efficiency "the heart" of a clean energy future.[1] Today energy efficiency is America's largest energy resource.[2] And, it has the potential to keep growing, with retrofits to existing buildings playing a major role. On the residential side, ACEEE estimates retrofits can save an average of 30% of a home's energy usage.[3] Improvements to residential buildings not only lower costs, but also increase quality of life. This is especially true in America's affordable housing where retrofits have been shown to be crucial to improving residents' health while extending the lifespan of the housing stock, something desperately needed with the nationwide affordable housing shortage.[4]

The United States continues to grapple with the economic repercussions of the COVID-19 pandemic. The country also needs quality jobs—a problem that existed before and separately from the pandemic—another benefit of energy efficiency retrofits. While many studies focus on the high number of construction and installation jobs created by retrofits, retrofitting also creates high-quality, community-sustaining manufacturing jobs.

This report examines the manufacturing job creation associated with residential deep retrofits. This study looks at direct and indirect manufacturing jobs in original equipment manufacturer (OEM) and supplier facilities in the United States. It does not include installation or induced jobs.

We find that two elements are needed to capture the full benefit of economic activity from retrofit spending:

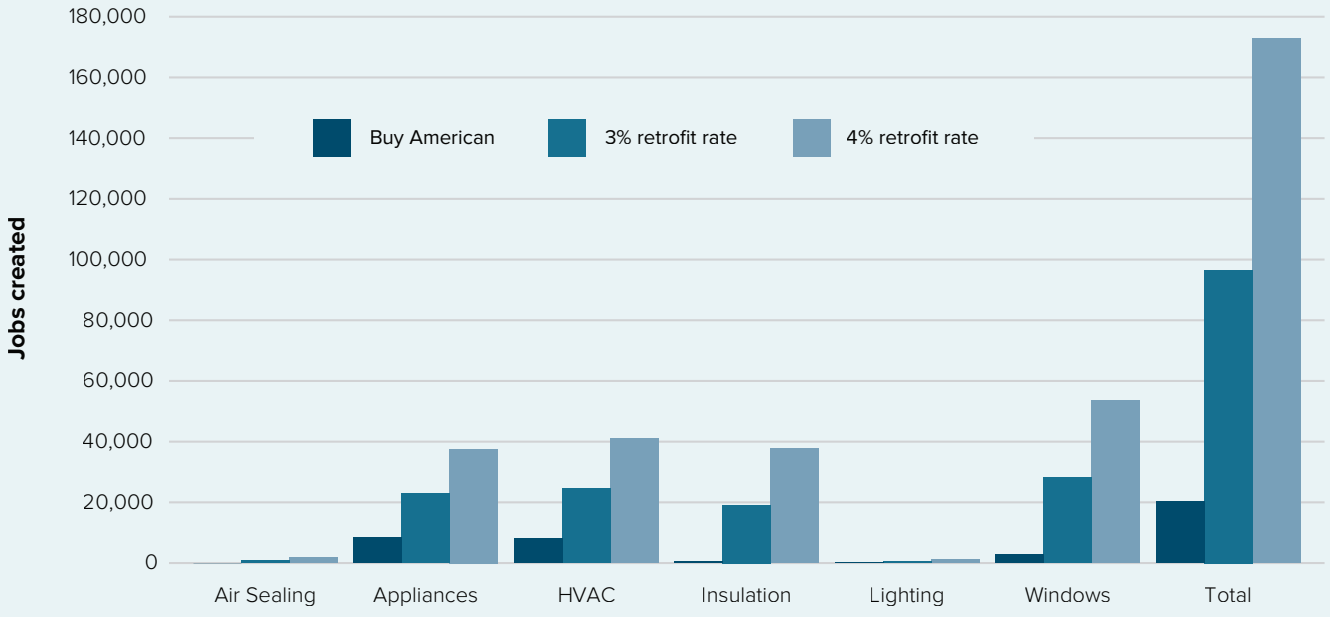
1. Going beyond typical weatherization into deep retrofits, which feature exterior continuous insulation; energy-efficient appliances; heating, ventilation, and air conditioning (HVAC); and windows; and
2. Adding a Buy American policy to retrofit spending to ensure that more of the products are manufactured domestically.

Increasing demand for American-made energy-efficient housing products would strengthen workers, their families, and the communities where manufacturing takes place.

Findings

- Strengthening all retrofits to full deep retrofits at the current estimated retrofit rate of 2% would support an estimated **132,000 manufacturing jobs**.
- Adding a Buy American policy to the deep retrofit improvements would create another **20,000 manufacturing jobs**.
- Additionally, increasing the deep retrofit rate from 2% to 4% with a Buy American policy would create more than **170,000 additional manufacturing jobs**.
- Of the various residential retrofit improvements available, **deep retrofit improvements show the greatest opportunity for manufacturing job creation**—with appliance and HVAC manufacturing topping the list.

Figure 1: Manufacturing Jobs Created Under Buy American and Increased Deep Retrofit Scenarios



Jobs created under the three deep retrofit scenarios modeled: implementing Buy American policy with estimated retrofit rate at 2%, implementing Buy American policy and increasing the retrofit rate to 3%, and implementing Buy American policy and increasing the retrofit rate to 4%. All values are new manufacturing jobs created in OEM and supplier firms.

BACKGROUND: WHY THIS STUDY IS UNIQUE

It is widely known that energy efficiency creates jobs throughout the economy. One high-profile study that demonstrates this is the annual U.S. Energy and Employment Report (USEER),[5] which examines existing jobs in the energy efficiency sector based on survey data of companies. The 2020 edition of the report included jobs associated with installation, building design, contract services, and manufacturing of efficiency products for a total of 2.38 million Americans working in the energy efficiency sector. In addition to quantifying existing efficiency jobs, other studies also have modeled the job creation and/or energy saving impact of potential new efficiency investments or policies.[6,7,8]

This analysis adds to the conversation in a few unique ways:

- ***Focus on residential deep retrofits.*** This study includes only manufacturing jobs associated with residential deep retrofits. By breaking out residential numbers, we can more clearly see the impact of greater investment in, and use of, government and utility-sponsored home energy efficiency programs. The implication for investment in low-income programs is especially important. Retrofits extend the lifespan of affordable housing, rather than letting it fall into total disrepair and being demolished, further reducing America's severely limited affordable housing stock. In addition to a 7 million unit[9] shortfall from demand for very-low income renters, more than 30 million units of U.S. housing are considered substandard, with severe physical or health hazards, such as dilapidated structures, poor heating, damaged plumbing, gas leaks, or lead.[10] Deep retrofits would help address a good number of those conditions.
- ***Disaggregation of jobs by energy conservation measure.*** The study breaks down jobs by specific energy efficient measures, which can be used to inform the design of energy efficiency programs. We also can see the impact of a Buy American policy by sector, highlighting where we have the opportunity to create the most jobs by requiring the purchase of U.S.-made building products.
- ***Focus on manufacturing jobs.*** While there are fewer manufacturing jobs than installation jobs in energy efficiency, manufacturing jobs are good, family-sustaining, and community-supporting jobs.

Manufacturing Jobs: Good Jobs That Sustain the Clean Economy and Communities

The USEER report found that manufacturing of energy efficiency products accounted for nearly 14% of all energy efficiency jobs in 2019, however manufacturing employment is only expected to increase by 0.6% in 2020.[11] This underscores the need to take steps to boost manufacturing jobs as we undertake efforts to increase the number of retrofits in the United States.

Manufacturing is well recognized as a galvanizing force for community building, in addition to sustaining American innovation and competitiveness. Manufacturing jobs pay above average wages, especially for jobs that don't require college degrees.[12] The Economic Policy Institute finds a 13% premium in wages and benefits for manufacturing workers, compared to their non-manufacturing private industry counterparts.[13]

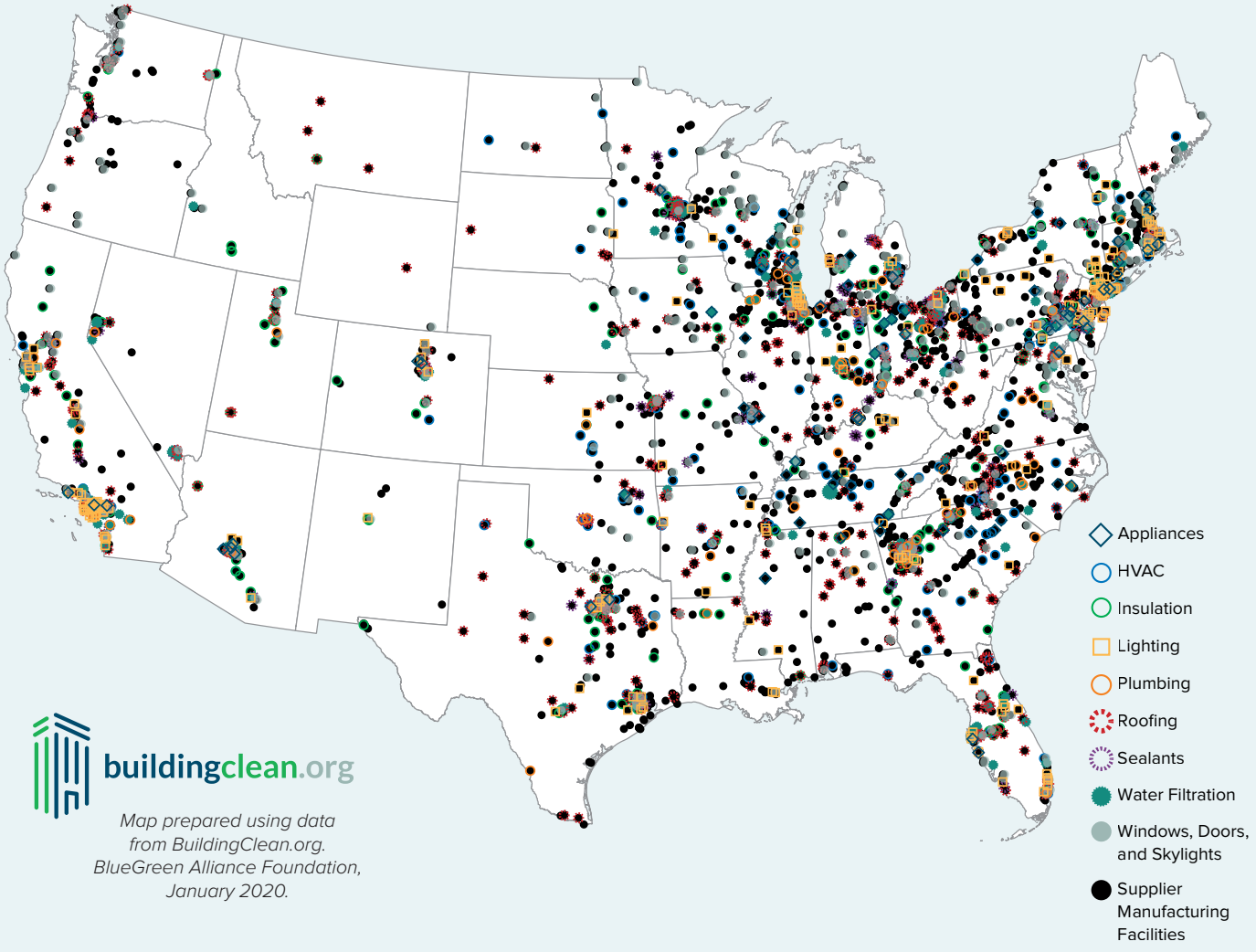
Manufacturing jobs support more indirect or supplier jobs than jobs in other sectors because producing goods requires many inputs. Additionally, the re-spending multiplier for induced jobs—jobs that result from the spending on consumption of goods and services—places manufacturing jobs at 454.9 for every 100 direct jobs, compared to 138.1 for construction.[14]

Manufacturing jobs tend to be more stable and remain in the community. Manufacturing has a larger share of private-sector economic activity than other sectors, fueling economic growth and tax revenue. These companies are more important than ever to rural communities in heavy manufacturing states—such as Ohio, Pennsylvania, Michigan, and Illinois—where almost one in four jobs in mostly rural counties are in manufacturing.[15]

Market Analysis: Energy-Efficient Product Manufacturing

U.S. manufacturing is active in all major energy-efficient product sectors. ENERGY Star is a government-backed symbol for energy efficiency, providing simple, credible, and unbiased information that consumers and businesses rely on to make well-informed decisions. The BlueGreen Alliance Foundation's Building Clean initiative has documented widespread U.S. manufacturing in each of the ENERGY STAR energy-efficient product categories: appliances, HVAC, insulation, lighting, roofing, sealants, and windows, doors, and skylights. Building Clean has also captured data on plumbing and water filtration systems.[16] This database includes manufacturers of products regardless of ENERGY STAR certification status, since newer products typically are more efficient than older ones and companies may not certify their products due to cost. This section summarizes the U.S. manufacturing footprint for relevant products used in efficiency measures modeled in this study.

Figure 2: Manufacturers of Energy-Efficient Building Products



APPLIANCES

Appliance manufacturing in the United States faces competition from imports and many manufacturers have chosen to offshore production. However, there is still a strong supply chain. Appliances are manufactured at large facilities that employ hundreds of people, many of which are in the Midwest and Mid-South. Some appliance manufacturers are investing in new U.S. manufacturing. For example, in 2019, General Electric Appliances—a Haier Company—invested $115 million in a Decatur, Alabama refrigerator factory[17] and $60 million in a Camden, South Carolina facility for water heater production.[18] LG recently opened their first U.S. facility in Clarksville, Tennessee, to manufacture washing machines.[19]

HVAC

HVAC systems include many different pieces of equipment that work in conjunction with each other. As a result there is a robust U.S. manufacturing industry, despite pressure from imports. Growth in the HVAC industry is driven by rising rates of new construction, but also by replacement of aging systems, energy efficiency regulations, and a growing interest in indoor air quality.[20] In 2019 Trane announced a $100 million expansion in their Columbia, South Carolina commercial products facility.[21]

INSULATION

While insulation manufacturing is mainly tied to new construction, stricter building codes and energy efficiency requirements are also driving growth.[22] According to research by the Harvard School of Public Health, about 46 million U.S. homes are under-insulated.[23] There is a large variety of materials in use today, and manufacturers are investing in research of new products that are effective and sustainable. Almost all insulation available in the U.S. market is made at a U.S. facility. In 2019, Knauf announced that it would invest $32 million in upgrading an idled manufacturing line to resume fiberglass insulation production in Albion, Michigan.[24]

AIR SEALING

Air sealing is a far smaller sector than others, but has a robust manufacturing presence in the United States. Sealant manufacturing is most common in areas with a strong chemical manufacturing presence, like Texas or the Midwest. For the purposes of this study, the air sealing sector covers spray-foam and pre-formed foam for weather-stripping or for use as a gasket or blocking.

LIGHTING

Lighting is one of the most complicated sectors. Solid-state lighting is dwarfed in the semiconductor trade category in which it resides, making it difficult to confidently arrive at a jobs number. Initially much of U.S. LED production was for specialty uses and not everyday commodity lighting in homes. However, that has been changing, and in some cases manufacturers have near-total vertical integration, challenging the notion that U.S. LED production could only be assembled with imported components.

WINDOWS

Other than a few specific exceptions, windows and parts in their supply chain are manufactured in the United States. Major players manufacture windows at large centralized plants, and are investing in their facilities. For example, Andersen Corporation recently invested $35 million in their replacement window facility in Cottage Grove, Minnesota, which will create 120 new jobs.[25] Window manufacturing also is highly local/regional to account for geographic weather variances.

Findings: Buy American Policy Makes a Difference

Our modeling considered two alternatives for the domestic content of the manufactured products used in deep retrofits. One is the default domestic content estimate based on national production and trade-flow data for individual commodities. The alternate approach is to consider what the impacts would be if all of the products were produced domestically under a Buy American policy linked to deep retrofit spending on energy-efficient products. This was modeled under an estimated 2% retrofit rate, as well as 3%, and 4% scenarios (see Figure 1).

For the purpose of this study, Buy American requires that the final product be manufactured or assembled in the United States. We previously found that the supply chain for energy-efficient products was very mature and only fluctuating due to pricing.[26] Because of the timing of this report, the impact from current trade developments and tariffs are not accounted for.

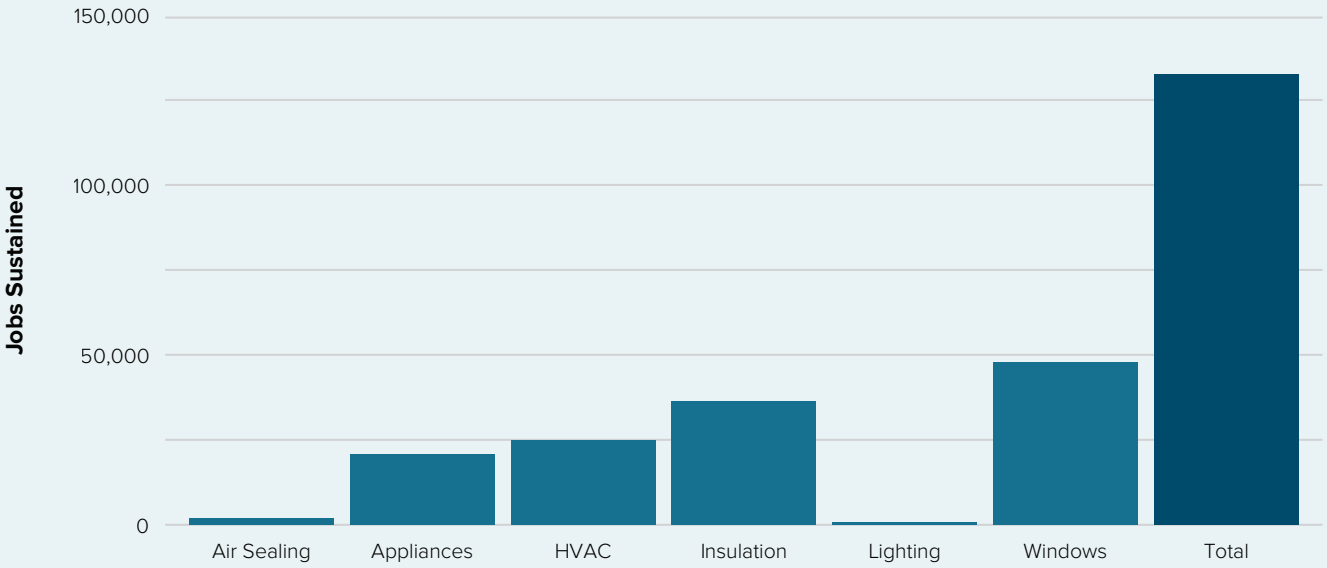
While we found no example of a complete Buy American policy in use, localities are starting to recognize the benefits of capturing more local energy efficiency building product manufacturing jobs. Utilities in Illinois[27] and Michigan[28] are supporting local manufacturers by incentivizing the purchase of state-manufactured products with bonus rebates through their energy efficiency programs. Even if needed products are not manufactured in state, the premise of buying local could easily be extended to Buy American to source the product domestically, if not locally.

The current retrofit rate is estimated to be about 2%, however current retrofits are more likely to be conventional weatherization which does not achieve the same level of efficiency improvements. Our baseline scenario instead models full deep retrofits across the United States, which would support an estimated 132,000 manufacturing jobs, as shown in Figure 3. Our research showed that then adding Buy American policy would create an additional 20,000 manufacturing jobs across the nation. Jobs in this context refers to *direct and indirect manufacturing jobs* in OEM and supplier facilities in the United States, and does not include installation or induced jobs.

Deep retrofits—which go beyond typical weatherization to include exterior continuous insulation, energy-efficient appliances, HVAC, and windows—show the most opportunities for manufacturing job creation, with appliance and HVAC manufacturing topping the list. Manufacturing jobs from air sealing, insulation, and windows show relatively little growth, as those components already are largely manufactured in the United States.

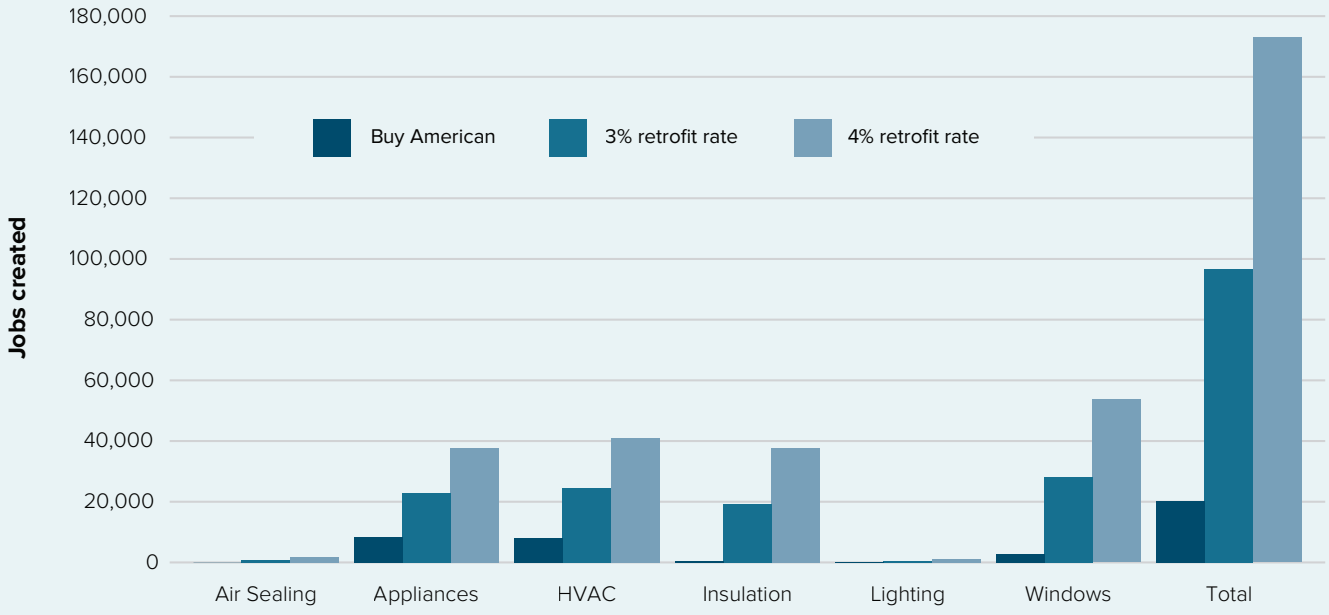
As expected, increasing retrofit rates increased manufacturing jobs, with 172,000 additional manufacturing jobs by combining Buy American with a doubled deep retrofit rate of 4%. This is shown in Figure 4. In addition, Figure 5 breaks out the relative increase in jobs for specific products to provide additional data for energy efficiency program designers.

Figure 3: Manufacturing Jobs Supported by Full Deep Retrofits at the Estimated 2% Retrofit Rate (without Buy American)



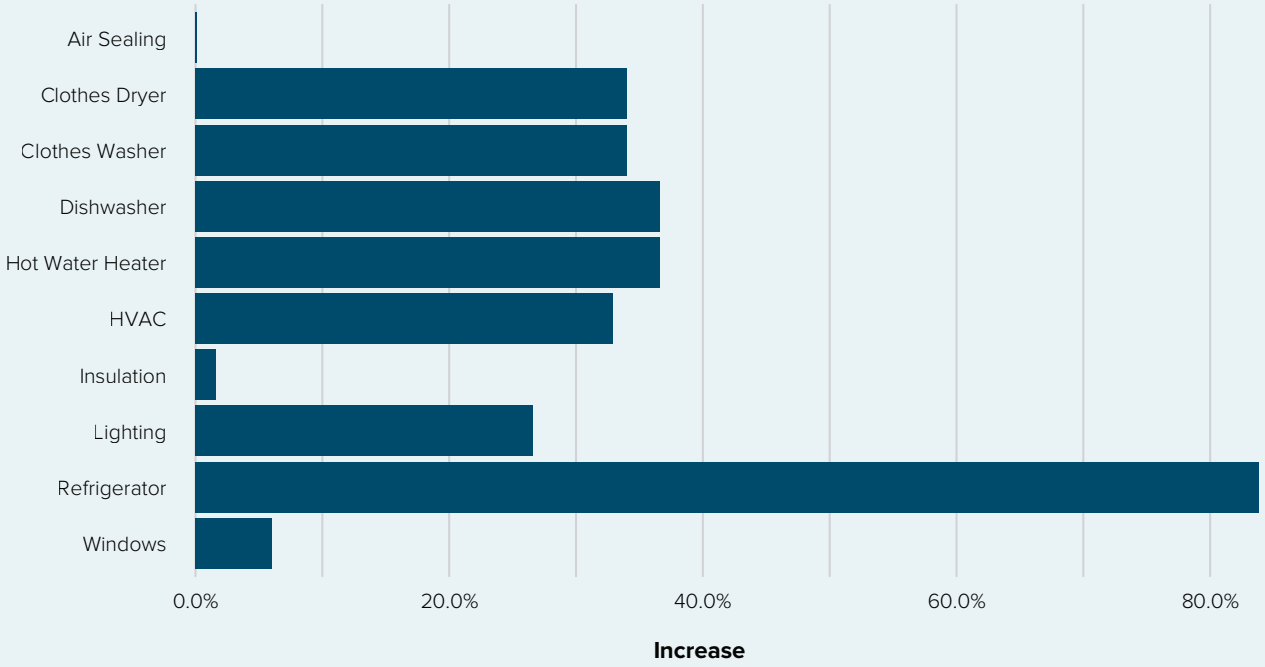
Jobs supported by implementing full deep retrofits across the United States at the estimated 2% retrofit rate without a Buy American policy. Jobs here refers to direct and indirect manufacturing jobs in OEM and supplier facilities in the United States, and does not include installation or induced jobs.

Figure 4: Manufacturing Jobs Created Under Buy American and Increased Deep Retrofit Scenarios



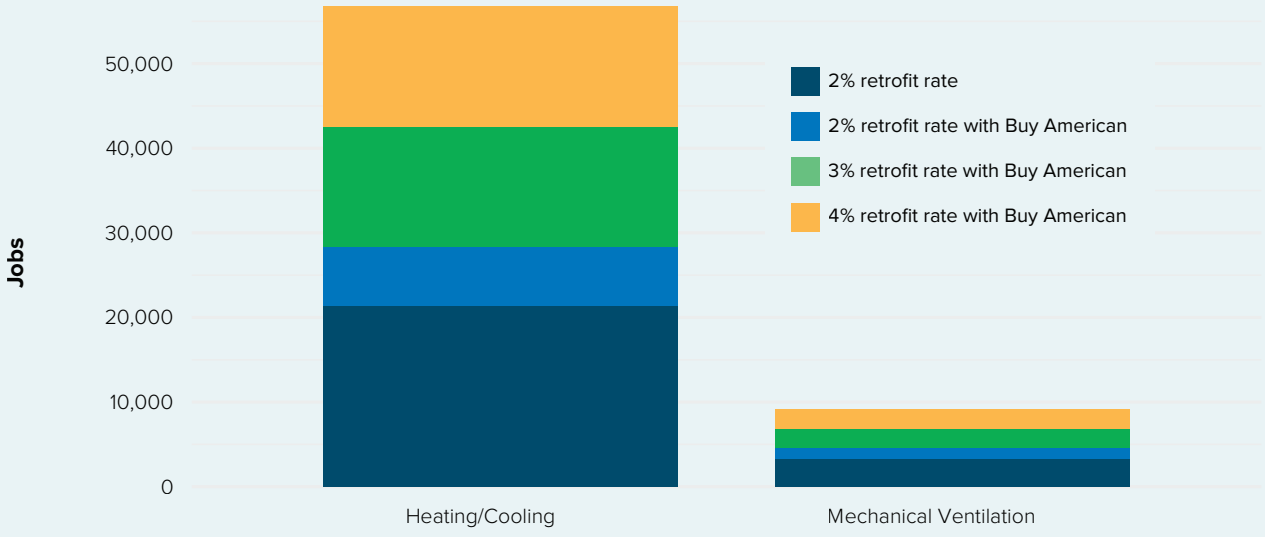
Jobs created under the three deep retrofit scenarios modeled: implementing Buy American policy with estimated retrofit rate at 2%, implementing Buy American policy and increasing the retrofit rate to 3%, and implementing Buy American policy and increasing the retrofit rate to 4%. All values are new manufacturing jobs created in OEM and supplier firms.

Figure 5: Relative Increase in Manufacturing Jobs Making Specific Products Due to Buy American



Relative increase in jobs by category between our model of full implementation of deep retrofits with the estimated 2% retrofit rate and our model assuming Buy American is applied.

Figure 6: HVAC Manufacturing Jobs Broken Down by Component



Jobs sustained under the full implementation of deep retrofits with the current 2% retrofit rate and additional jobs created under the three scenarios modeled.

The Importance of HVAC Measures

HVAC accounts for more than half the energy use in the average single-family home and is an important part of an energy efficiency retrofit.[29]

In this analysis, a ducted furnace and air conditioning system was replaced with an ENERGY STAR air source heat pump, which was the least expensive ENERGY STAR heating and cooling system within the equipment cost dataset. The efficiency of heating and cooling systems have continued to climb, so replacing systems installed decades ago with a new system can dramatically reduce energy consumption.[30]

Ventilation is included within the HVAC acronym. Some use the term HVAC to refer to only heating and air conditioning systems, even though heating, air conditioning, and ventilation systems are typically installed by the same mechanical contractor. Ventilation is key for adequate indoor air quality and essential for building durability, as it removes moisture. Typical ventilation systems such as bath fans and kitchen range hood fans that push air out of the building are referred to as local exhaust ventilation, and their main purpose is to remove "bad" air from specific locations. Larger residential buildings might have common area ventilation systems that supply outdoor air into corridor spaces. These typical ventilation systems increase heating and cooling use, as they exhaust conditioned—heated and cooled—air out of the building or bring unconditioned, outdoor air into the building.[31]

In this analysis, an energy recovery ventilator was installed as part of the deep energy retrofit. Energy recovery ventilators (ERV) and heat recovery ventilators (HRV) are two examples of balanced ventilation systems, which are generally considered the best method of ventilation. Balanced ventilation systems push an equal continuous volume of indoor air out of the building while pushing outdoor air into the building. HRVs and ERVs efficiently achieve balanced ventilation by indirectly pre-heating or pre-cooling the incoming outdoor air with the conditioned indoor air that it is pushing out. The difference between an HRV and an ERV is that the ERV also indirectly balances the humidity in the incoming outdoor air with the humidity in the conditioned indoor air that it is pushing out. Therefore, an ERV will not bring in very humid outdoor air in the summer or very dry outdoor air in the winter. Due to the "free" pre-heating or pre-cooling of the incoming outdoor air, HRVs and ERVs are the most effective and energy efficient ventilation systems.[32]

Not all possible deep energy retrofit measures were included in this analysis due to various reasons, such as lack of cost data and building types examined. One HVAC measure that was not included is duct air sealing and insulation. Existing ducts that are not insulated and/or leaky can typically only be improved during a gut-rehab—which allows access to the ducts. Air sealing only a few sections of ducts that are accessible can lead to unbalanced duct air leakage and internal building pressure, which can impact building durability. Aerosol-type duct air sealing is possible, but nationally representative cost data is not available. Programmable and smart thermostats also were not included due to lack of cost data.

Ensuring Good, Safe Jobs for All

Though manufacturing jobs tend to be better paying and have higher wages, those elements are not universally true. All workers should receive a livable wage, good benefits, proper training, and safe working conditions. For decades approaches such as community workforce agreements and local hire provisions have been used to create a more diverse and inclusive workforce in the construction industry—running the gamut from hotels to public infrastructure.

Recently, state and local governments have adopted some of these same approaches. For example, Indianapolis, links subsidies to wage amounts and provision of child care.[33] Meanwhile, Detroit's incentives combine number of jobs and job skill level based on amount of salary.[34] Though steps in the right direction, enforcement, and impact have yet to be seen. Moreover, they do not address disadvantaged workers.

With the help of special legal provisions that give U.S.-made transportation equipment priority in bidding, the group Jobs to Move America has signed job equity agreements with several manufacturers of new public transit equipment, which will help ensure the jobs created are available to workers of color and in communities of color.

Another approach is to link public procurement with not just Buy American provisions but to also require manufacturing bidders to provide quality jobs, investment in American plants, and employment opportunities to underrepresented groups. Funding for pre-apprenticeship programs for local disadvantaged communities, low-income households, and veterans also can ensure that manufacturers provide skilled trade job opportunities for all.

CONCLUSION

With the right policies in place, energy efficiency could be a driver of significant growth of manufacturing jobs in the United States. Our findings show that strengthening all retrofits to full deep retrofits, at the current estimated retrofit rate of 2%, would support an estimated **132,000 manufacturing jobs. Deep retrofit improvements show the greatest opportunity for manufacturing job creation**—with appliance and HVAC manufacturing topping the list.

Building on that by adding a Buy American policy to the deep retrofit improvements would create another **20,000 manufacturing jobs**. And coupling Buy American policy with an increase of the deep retrofit rate from 2% to 4% would create more than **170,000 additional manufacturing jobs**.

Finally, it is vital to focus on making sure that the manufacturing jobs created provide a livable wage, good benefits, proper training, and safe working conditions.

APPENDIX I: METHODOLOGY

Step 1: Estimate Costs of Products

Using National Renewable Energy Laboratory (NREL) data present in the BEopt™ (Building Energy Optimization Tool), we estimated per-unit equipment cost necessary to perform different deep retrofit energy conservation measures in single family, small multifamily, and large multifamily buildings.

We used the costs of each individual energy efficiency component as inputs to the model. To obtain the cost of each component, three prototypical buildings representing single-family buildings, small multifamily buildings (two to four units), and large multifamily buildings (five or more units) in the United States were developed based on typical building characteristic data from the NREL ResStock database,[35] the U.S. Energy Information Administration 2015 Residential Energy Consumption Survey,[36] and the U.S. Census Bureau 2017 American Housing Survey.[37]

The three prototypical buildings were then built within the NREL BEopt™ software with the characteristics found within Table 1. A BEopt™ file was created for each of the three buildings, which included both the typical existing home conditions and deep energy retrofit measures that would be common given the building type. The BEopt™ report function was then used to calculate the product cost—without labor costs—of each component necessary to perform these retrofit measures. BEopt™ references the NREL National Residential Efficiency Measures Database[38] to calculate product and labor costs.

Table 1: Typical Building Characteristics, Deep Retrofit Measures, and the Associated IMPLAN Sector

	Typical Existing Home			Deep Energy Retrofit Improvements			IMPLAN Sectors		
Measures	**Single-Family Buildings**	**2-4 Unit Buildings** **3 Unit Building Modeled**	**5+ Unit Buildings** **8 Unit Apartment Modeled**	**Single-Family Buildings**	**2-4 Unit Buildings** **3 Unit Building Modeled**	**5+ Unit Buildings** **8 Unit Apartment Modeled**	**Single-Family Buildings**	**2-4 Unit Buildings** **3 Unit Building Modeled**	**5+ Unit Buildings** **8 Unit Apartment Modeled**
Air Sealing	Air Leakage Rate of 15 ACH50		No Improvement Included	Air Sealing to an Air Leakage Rate of 10 ACH50		No Improvement Included *Typical air sealing work can be limited in this building type*	Urethane and other foam product (except polystyrene) manufacturing		
Dwelling Unit Mechanical Ventilation	None			Installation of a Energy Recovery Ventilator (ERV) with a Total Recovery Efficiency of 70% *Whole-home ventilation by indirectly conditioning the incoming outdoor air with the conditioned indoor air that it is pushing out*			Air purification and ventilation equipment manufacturing		
Ceiling/ Roof and Unfinished Attic Insulation	Unfinished Vented Attic with R-30 Insulation		Uninsulated Roof	Added R-30 Fiberglass Insulation Total Insulation Value of R-60		R-15 Extruded Polystyrene (XPS) Rigid Insulation Installed on the Roof	Mineral wool manufacturing		Polystyrene foam product manufacturing
Lighting	100% Incandescent Lighting			100% LED Lighting			Semiconductor and related device manufacturing		
Heating and Cooling System	Furnace and a Central A/C System			Air Source Heat Pump Heating Efficiency of 8.5 HSPF Cooling Efficiency of SEER 15 Least expensive ENERGY STAR Heating and Cooling System			Air conditioning, refrigeration, and warm air heating equipment manufacturing		

	Typical Existing Home			Deep Energy Retrofit Improvements			IMPLAN Sectors		
Exterior Wall Cavity Insulation	Uninsulated Exterior Wall Cavities 2x4, 16" o.c. construction			R-13 Fiberglass Insulation blown into the Exterior Wall Cavities 2x4, 16" o.c. construction			Mineral wool manufacturing		
Exterior Wall Siding and Continuous Insulation	Siding No Continuous Insulation	Brick No Continuous Insulation		- Existing Siding Removed - R-15 Extruded Polystyrene (XPS) Rigid Continuous Insulation Installed - Fiber-Cement Siding Installed	No Improvement Possible		Polystyrene foam product manufacturing and Paperboard container manufacturing"		
Hot Water Heater	31-49 Gallon Standard Tank Water Heater			50 Gallon Heat Pump Water Heater Least expensive high efficiency water heater			Other major household appliance manufacturing		
Clothes Dryer	Typical Existing Appliances			Ventless Heat Pump Clothes Dryer Least expensive ENERGY STAR Clothes Dryer 1 per unit		Ventless Heat Pump Clothes Dryer Least expensive ENERGY STAR Clothes Dryer 3 clothes dryers serving 8 units	Household laundry equipment manufacturing		
Clothes Washer	Typical Existing Appliances			Least expensive ENERGY STAR Clothes Washer 1 per unit		Least expensive ENERGY STAR Clothes Washer 3 clothes washers serving 8 units	Household laundry equipment manufacturing		
Dishwasher	Typical Existing Appliances	Dishwashers Are Not Typically Installed in this Building Type	Typical Existing Appliances	Least expensive ENERGY STAR Dishwasher	No Improvement Included Dishwashers Are Not Typically Installed in this Building Type	Least expensive ENERGY STAR Dishwasher	Other major household appliance manufacturing		Other major household appliance manufacturing
Refrigerator	Typical Existing Appliances			Least expensive ENERGY STAR Refrigerator			Household refrigerator and home freezer manufacturing		
Windows	Double-Glazed, Non-metal Frame, Air Filled	Single-Glazed, Metal Frame		Low-E Coating, Double-Glazed, Insulated Frame, Air Filled, Low Solar Heat Gain Least expensive ENERGY STAR (North-Central Climate Zone) Windows			Wood windows and door manufacturing		
UNIT CHARACTERISTICS									
Unit Floor Area (SQFT)	2,160	960	792	2,160	960	792			
Unit Exterior Wall Area (SQFT)	1,536	1,024	464	1,536	1,024	464			
Unit Window Area (SQFT)	187	64	70	187	64	70			

Step 2: Job Estimates by Efficiency Measure and Building Type

Once we obtained the costs for each component, we associated the products required for each with the IMPLAN sectors that produce them for modeling the impacts of increased demand for those products. The estimates developed for this report are based on input output analysis using the 2017 national model from the IMPLAN group. We then aggregated these components into six categories of energy efficiency retrofit measures: air sealing; appliances; HVAC; insulation; lighting; and windows.

We applied these estimates to the IMPLAN model to determine the labor required to manufacture the required components and the indirect manufacturing labor required to manufacture parts and materials in the supply chain for these products per unit in each housing type. To estimate jobs sustained by retrofits under the status quo, we applied IMPLAN's RPC domestic content ratios to the model to include only jobs that would be created in the United States.

Step 3: Modeling Job Creation Potential

Finally, we determined the number of units of each housing type that would be retrofitted under a 2% deep retrofit rate based on data from the 2017 American Housing Survey,[39] which we used as a baseline scenario. We then multiplied these values by our per-unit job creation estimates to estimate total job creation. Additionally we modeled scenarios where the retrofit rate was 3% and 4%.

Note: The current national retrofit rate is unknown,[40] but estimated to be about 2% if multifamily renovations are considered. The current rate is more likely to include conventional weatherization and not deep retrofits, thus our baseline scenario does not model the status quo but instead models a strengthening from conventional to deep retrofits at the 2% rate.

Table 2: Housing Units by Type

Building Type	Total Number of Units	2% Retrofit Rate	3% Retrofit Rate	4% Retrofit Rate
Single-Family Home	94,870,000	1,897,400	2,846,100	3,794,800
Small Multi-Family (2-4 units)	9,744,000	194,880	292,320	389,760
Large Multi-Family (5+ units)	24,321,000	486,420	729,630	972,840

Data from the American Housing Survey showing total number of units of each type, as well as the number retrofitted under the current estimated 2% rate and our 3% and 4% accelerated scenarios.

Notes

It is important to note that this analysis considered only the employment impacts of manufacturing energy efficiency equipment and other measures associated with the costs to produce the equipment needed for expanded deep retrofits. It did not assess any additional costs associated with the expanded deep retrofit scenarios nor model the source of funding. Similarly, we do not consider any of the economic impacts that would result from the installation or energy savings benefits generated by the investments. This analysis is solely focused on residential energy efficiency measure implementation and explicitly does not consider how increased energy efficiency might benefit the economy more broadly.

In performing job impact analyses such as these, there are typically three types of jobs to account for: direct, indirect, and induced. In this conservative analysis, we exclude induced jobs entirely. Additionally, instead of presenting our results as direct and indirect jobs like many other studies on this topic, we retain only manufacturing jobs, which include both direct and indirect jobs in manufacturing sectors created by manufacturing activity. In the example of a window upgrade, our manufacturing jobs include the work done at the window manufacturing company, as well as work done at manufacturing companies supplying materials and components to the window manufacturing company, but not any work done by transportation, sales, or administrative staff along the supply chain.

APPENDIX II: APPLIANCE COST & COUNTRY OF ASSEMBLY SURVEY

Our survey of ENERGY STAR refrigerators, clothes dryers, and clothes washers found that United States assembled models are cost-competitive with foreign assembled and that often the least expensive energy-efficient models are assembled in the United States.

This survey of three types of residential appliances collected retail list pricing from an independent source and collected model country of assembly, through manufacturer data and visiting leading chains of big-box hardware stores.

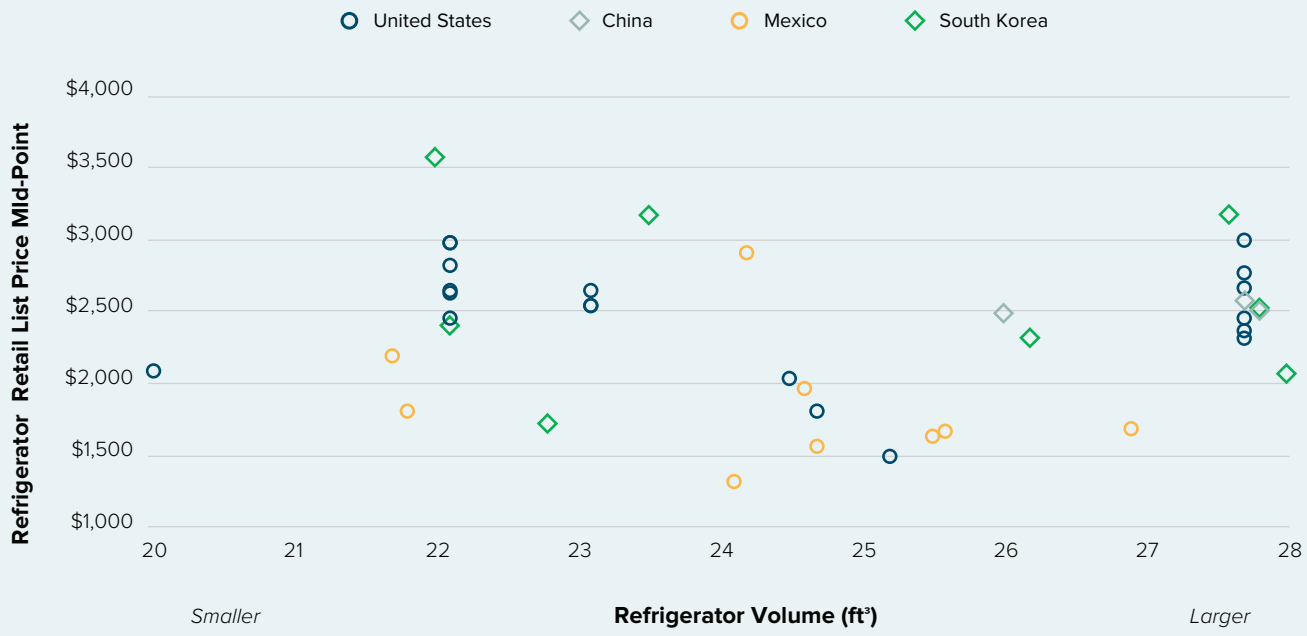
Following our findings are some resources on how to find U.S. manufactured appliances to support American manufacturing.

Refrigerators

Due to the high proportion of foreign residential refrigerators sold in the United States, increasing the purchase of American-made refrigerators would have an outsized impact on manufacturing job creation. In this report, Figure 5 (Relative Increase in Manufacturing Jobs Making Specific Products Due to Buy American) highlights that there would be an 80% relative increase in U.S. refrigerator jobs by implementing Buy American, which is the largest increase we found, and double the increase of every other product we analyzed.

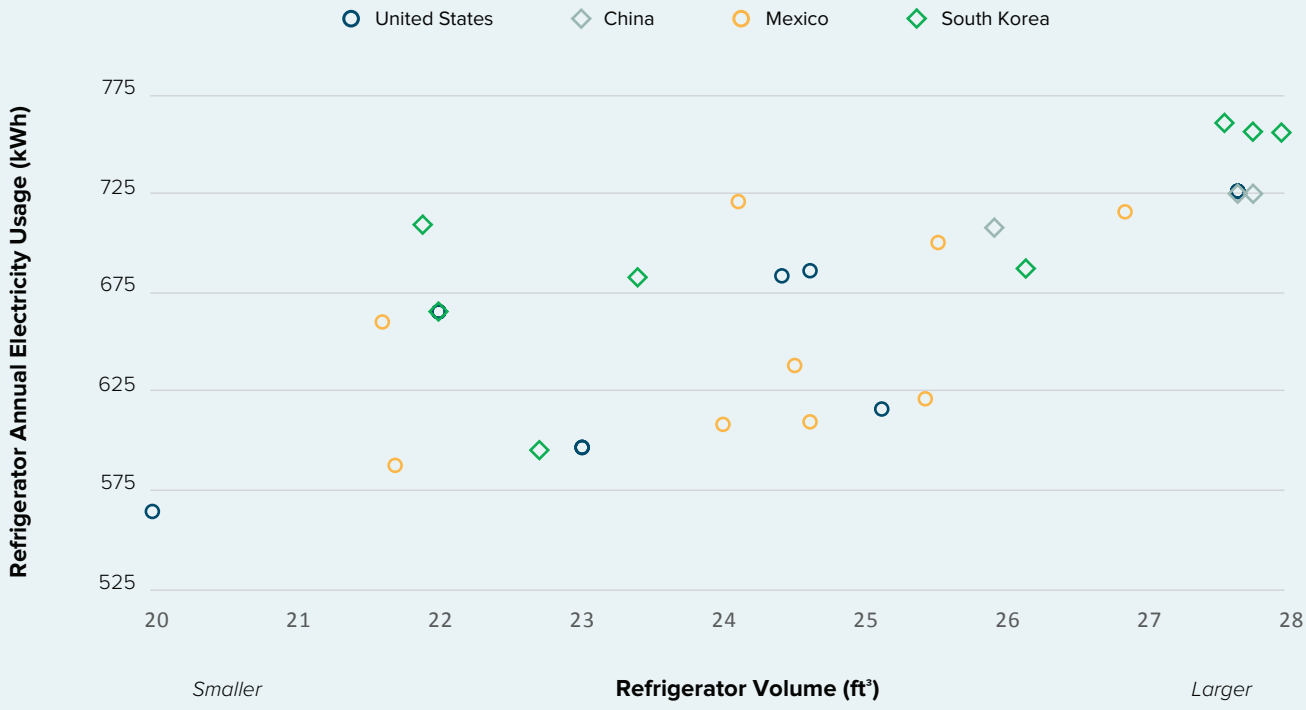
We found that ENERGY STAR refrigerators assembled in the United States are cost-competitive with foreign assembled ENERGY STAR refrigerators, with a U.S. assembled refrigerator being the second least expensive within our survey of 39 energy-efficient refrigerator models. The 39 models were assembled in China, Mexico, South Korea, and the United States.

Figure 7. Refrigerator Retail List Price Mid-Point, by Volume & Country of Assembly



Four of the six most energy-efficient ENERGY STAR refrigerator models within the survey are assembled in the United States. A U.S. assembled refrigerator is also the most energy-efficient refrigerator within the survey of 39 ENERGY STAR refrigerators. The annual electricity usage of the 39 models ranged from 563 to 760 kiloWatt-hours.

Figure 8. Refrigerator Annual Electricity Usage, by Volume & Country of Assembly



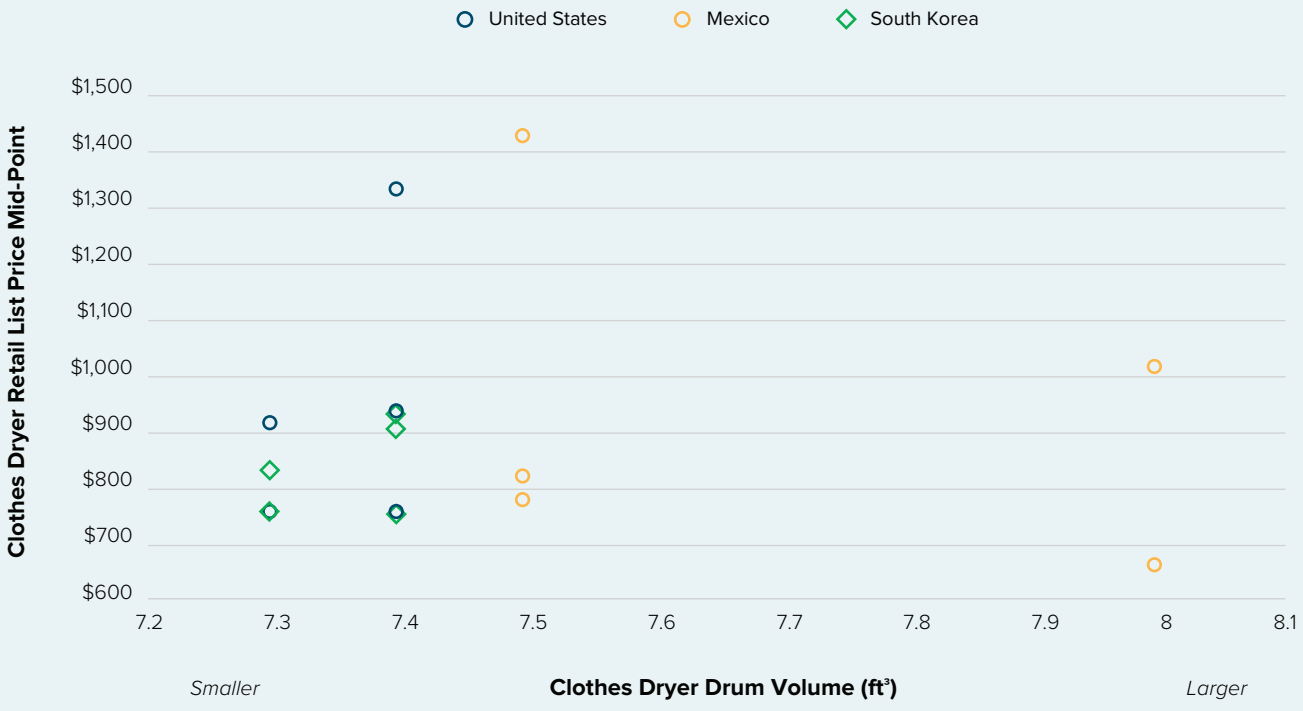
The 39 ENERGY STAR refrigerator models within the survey are from six brands, of which three brands had models within the survey that were assembled in the United States.

Clothes Dryers

In our report, Figure 5 shows that there would be a 30% relative increase in U.S. clothes dryer jobs by implementing Buy American.

ENERGY STAR clothes dryers assembled in the United States are cost-competitive with foreign assembled ENERGY STAR clothes dryers. We found that clothes dryers assembled in the three countries (Mexico, South Korea, and the United States) within our clothes dryer survey, had models priced throughout the survey's price range.

Figure 9. Clothes Dryer Retail List Price Mid-Point, by Volume & Country of Assembly



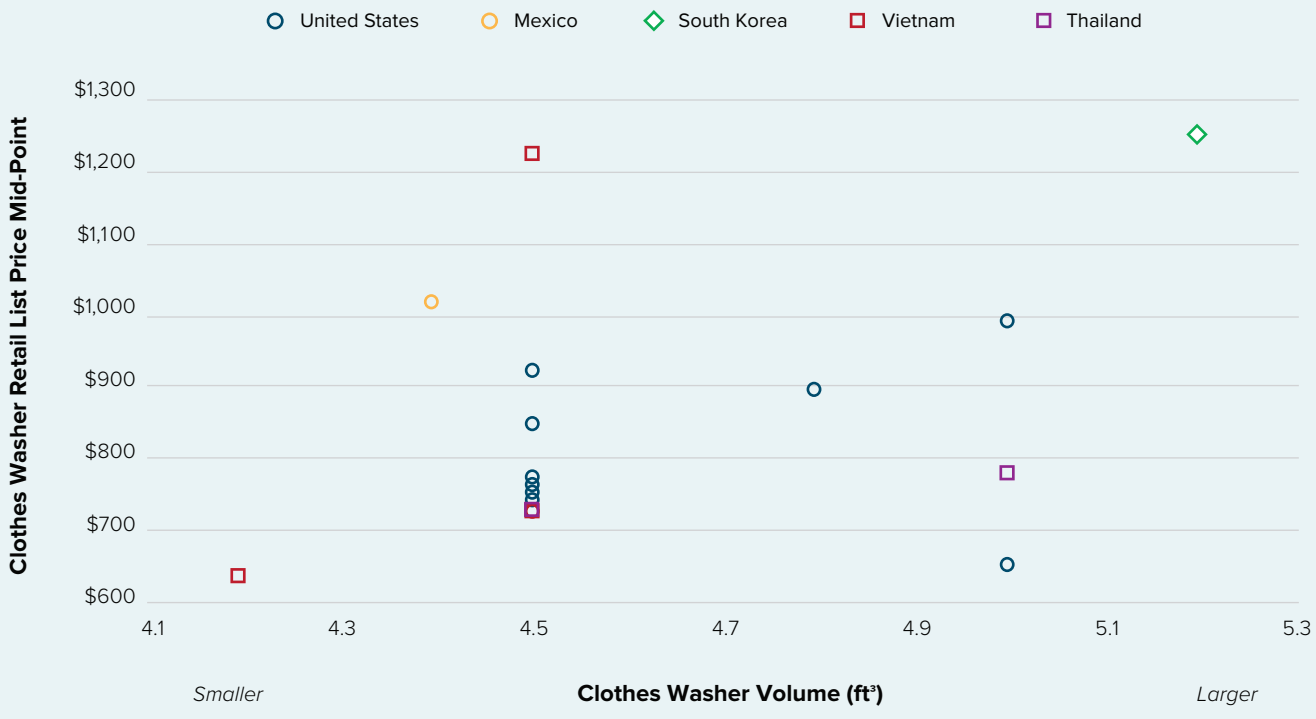
The 15 ENERGY STAR clothes dryer models within the survey are from six brands, of which two brands had models within the survey that were assembled in the United States.

Clothes Washers

Figure 5 within our report shows a 30% relative increase in U.S. clothes washer jobs by implementing Buy American.

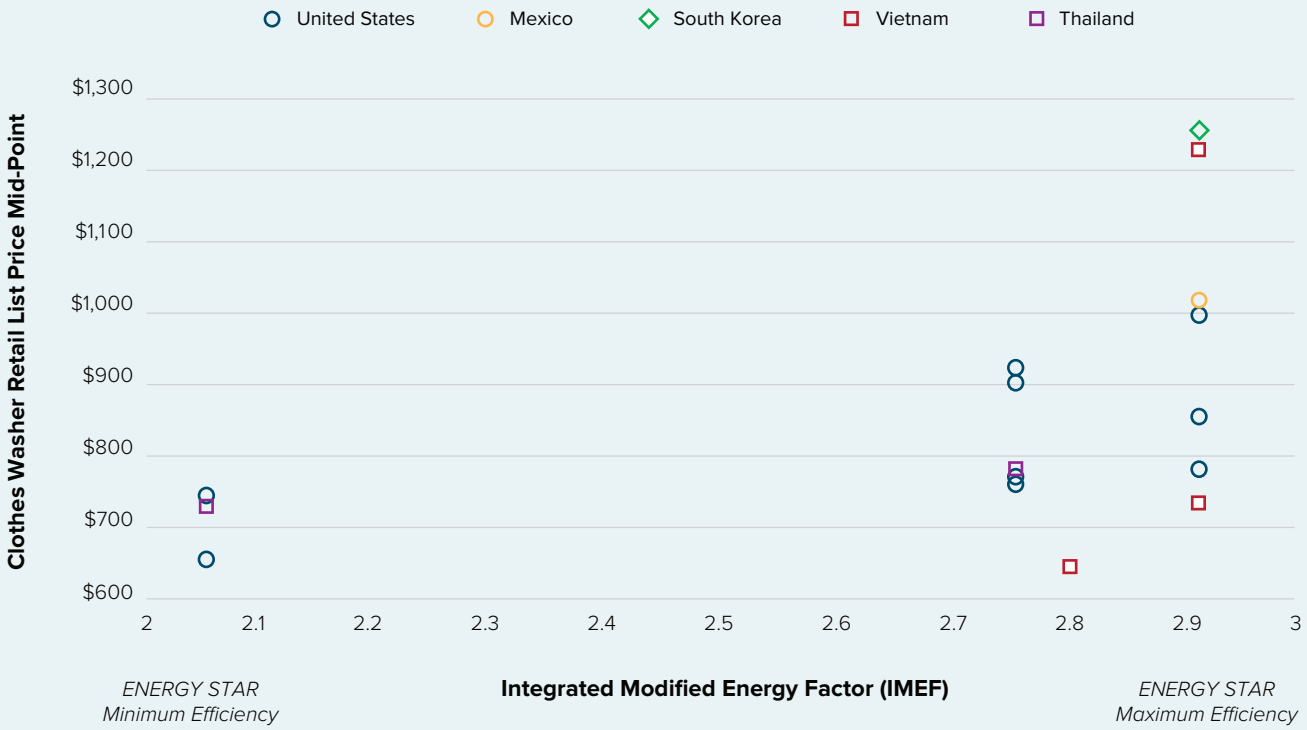
ENERGY STAR clothes washers assembled in the United States are cost-competitive with foreign assembled ENERGY STAR clothes washers, with a U.S. assembled clothes washer being the second least expensive clothes washer within our survey of 16 energy-efficient models. The 16 models were assembled in five countries, Mexico, South Korea, Thailand, United States, and Vietnam.

Figure 10. Clothes Washer Retail List Price Mid-Point, by Volume & Country of Assembly



U.S. assembled clothes washers are also cost-competitive when the level of energy efficiency is considered, with U.S. assembled clothes washers being the least expensive or second least expensive when comparing models with the same or similar Integrated Modified Energy Factor (IMEF). IMEF is a measure of energy efficiency, the higher the IMEF, the more energy-efficient the clothes washer.[41]

Figure 11. Clothes Washer Retail List Price Mid-Point, by IMEF & Country of Assembly



The 16 ENERGY STAR clothes washer models within the survey are from six brands, of which four brands had models within the survey that were assembled in the United States.

Methodology

This survey collected retail list pricing, country of assembly, volume, energy efficiency metrics, and other characteristics of numerous refrigerator, clothes dryer, and clothes washer models. The country of assembly was collected using two methods. One method used was visiting two different U.S. leading chains of big-box hardware stores in Washington DC and recording the country of assembly listed on the name-plate of each model that was on display in the store. The two big-box hardware stores were visited in January and March 2020 for refrigerators and March and July 2020 for clothes dryers and clothes washers. The second method used the GE Appliances Made in America website as a resource to collect the country of assembly for a subset of refrigerators[42] and clothes washers[43] that are "Made in America."

Appliance model volume, energy efficiency metrics, and retail list pricing was collected from the ENERGY STAR Certified Product Finder webpages for refrigerators[44], clothes dryers[45], and clothes washers[46], which provides retail list pricing from retailers across the United States. The retail list pricing from the ENERGY STAR Certified Product Finder webpages were recorded on three days in February and March 2020 for refrigerators, and on two days in July and August 2020 for clothes dryers and clothes washers. The retail list pricing for each model was typically displayed as a range and the mid-point of that range was used in this analysis of retail list pricing. The retail list price range potentially reflects pricing differences between different retailers, different regions of the United States, and/or different finishes (white, black, stainless steel, etc.) of those specific models. One clothes washer model and four refrigerator models did not have a retail list price range, but rather a retail list price, which was used in the analysis.

REFRIGERATORS

This survey determined the country of assembly and collected retail list pricing for 41 refrigerator models. One refrigerator model was removed due to it not having an icemaker, and all the remaining models within the sample have icemakers. One side-by-side refrigerator model was also removed, with the remaining 39 models all having a bottom-mounted freezer.

All 39 refrigerator models included in the survey have a bottom-mounted freezer, automatic defrost, and an icemaker. The 39 models are the size of typical residential refrigerators, with a volume ranging from 20 to 28 cubic feet. Of the 39 models, 29 models have a Thru the Door Dispenser and 11 models have Wi-Fi Connectivity, of which two have a Display Screen.

The 39 models were assembled in four countries, which includes three assembled in China, nine assembled in Mexico, eight assembled in South Korea, and 19 assembled in the United States.

CLOTHES DRYERS

This survey determined the country of assembly and collected retail list pricing for 16 clothes dryer models. One clothes dryer model was removed due to it having a drum volume of 4.3 ft^3, with all the remaining models within the sample having a drum volume of between 7.3 to 8.0 ft^3.

All 15 clothes dryer models included in the survey are vented, non-heat pump clothes dryers, and are the size of typical residential clothes dryers, with a drum volume ranging from 7.3 to 8.0 cubic feet. The annual electricity usage of the 15 clothes dryer models only differed by 1 kiloWatt-hour. Of the 15 models within the survey, only one model, the most expensive U.S. assembled model, featured Wi-Fi Connectivity.

The 15 models were assembled in three countries, with exactly five models having been assembled in each country, Mexico, South Korea, and the United States.

CLOTHES WASHERS

This survey determined the country of assembly and collected retail list pricing for 18 clothes washer models. Two clothes washer models were removed due to having a volume of 2.2 and 2.4 ft^3, with all the remaining models within the sample having a volume of between 4.2 to 5.2 ft^3.

All 16 clothes washer models included in the survey are front or top loaded clothes washers and are the size of a typical residential clothes washer, with a volume ranging from 4.2 to 5.2 cubic feet.

The 16 models were assembled in five countries, which includes one assembled in Mexico, one assembled in South Korea, two assembled in Thailand, nine assembled in the United States, and three assembled in Vietnam.

HOW TO FIND U.S. ASSEMBLED APPLIANCES

Several brands assemble appliances in the United States. Included is a compiled list of brands and countries of assembly of appliances that we collected during this survey. It should be noted that this is not a complete listing, as not all appliance manufacturers list the country of assembly on their products.

Table 3. Country of Assembly for Some Brands of ENERGY STAR Appliances

Brand	Refrigerator	Clothes Dryers	Clothes Washers
Amana (Whirlpool)		United States	United States
Bosch	China	Poland	Germany
Electrolux		Mexico	Mexico
Frigidaire (Electrolux)	Mexico		
GE Appliances	Mexico United States	China Mexico	China United States
Hotpoint (GE Appliances)		Mexico	
KitchenAid (Whirlpool)	United States		
LG	China Mexico South Korea	South Korea	South Korea Thailand Vietnam
Maytag (Whirlpool)	Mexico	United States	United States
Roper (Whirlpool)		United States	United States
Samsung	China Mexico South Korea Thailand	Mexico	Thailand United States Vietnam
Whirlpool	Mexico United States	United States	United States

Many brands that manufacture products in the United States also manufacture in other countries. The easiest way to confirm that the model you are buying was assembled in the United States is to go to your local appliance retailer and look for *Made in America* or *Assembled in the U.S.A.* labels, like the examples below.

EXAMPLES OF U.S. ASSEMBLED LABELS

We found that not all models assembled in the U.S. carry the labels above, so at your local retailer, look for *Made in America*, *Assembled in the U.S.A.*, or similar wording on the name-plate/serial-number label on the appliance. For refrigerators, the name-plate is typically high on an interior sidewall and for clothes dryers and washers, the name-plate is typically on the rim of the door/lid opening or sometimes high on the side or back of the appliance. Be careful not to mistake a U.S. address on the name-plate for U.S. assembled, as foreign manufactures have U.S. offices or subsidiaries.

The GE Appliances Made in America website[47] is a resource to find their Made in America appliances, including refrigerators, clothes washers, electric ranges, wall ovens, and dishwashers. As of September 23, 2020, the GE Appliances Made in America website lists 93 refrigerators that are Made in America, of which 63 are ENERGY STAR labeled, and ten clothes washers that are Made in America, of which nine are ENERGY STAR labeled. GE Appliances claims that some products have up to 90% U.S. content.

Another resource to confirm an appliance model's country of assembly is the specification sheet for that model, as some manufacturers list the country of assembly. Specification sheets can be found on the manufacturer's website and some retailers also provide this information on specific appliance models on their websites.

You can find additional information and manufacturing locations of U.S. manufacturers of clothes dryers, clothes washers[48], and refrigerators[49], of all sizes along with custom and high-end models, in our Building Clean database. The Building Clean database (www.BuildingClean.org) contains more than 4,500 manufacturing facilities producing building products across the United States.

APPENDIX III: U.S. MANUFACTURING

Appendix III looks at what kinds of building products are sparsely or not made in the U.S. and might offer manufacturing opportunities for domestic companies. It also includes a list of known gaps in supply chain components and materials that U.S. manufacturers have identified as barriers to making their product with higher domestic content.

Table 4: Building Products With Little to No Known U.S. Manufacturing

Market Sector	Finished Product
Appliances	Heat Pump Clothes Dryers
Appliances	Induction Ranges and Cook-Tops
Appliances	Heat Pump Hot Water Heaters
Appliances	Low-GWP (Global Warming Potential) Refrigerant Heat Pump Hot Water Heaters
Building Enclosure	Autoclaved Aerated Concrete Unit Masonry
Countertops	Engineered-Quartz or Cultured-Marble Countertops
Countertops	Polymethyl Methacrylate (PMMA) and Acrylic Solid Surface Countertops
Flooring	Natural Linoleum Tiles, Sheets and/or Liquid Applied Flooring
Flooring	Residential PVC-Free Resilient Flooring with no ingredients of concern
Flooring	Residential Rubber Flooring with no ingredients of concern
HVAC	Low-GWP (Global Warming Potential) Refrigerant Heat Pump Heating and Cooling Systems, Window/Room and Central A/C Systems
HVAC	Smaller Capacity Furnaces
HVAC	Mini-Split Ductless Heat Pumps (heating and cooling)
HVAC	Window/Room Air Conditioners, De/Humidifiers
HVAC	Multi-family and commercial scale VRF Heat Pump (heating, cooling and hot water) Systems
HVAC	Multi-family and commercial scale Low-GWP (Global Warming Potential) Refrigerant VRF Heat Pump (heating, cooling and hot water) Systems
Insulation	Formaldehyde Free Mineral Wool
Insulation	Halogen-Free Polyisocyanurate rigid board insulation for non-roof applications (exterior wall, etc.)
Lighting	Residential LED Fixtures
Paint/Wallcoverings	GreenSeal-11 certified or Alkylphenol Ethoxylates (APE) free paint

Table 5: Building Products Made in the U.S. and Corresponding Supply Chain Gaps

Market Sector	Finished Product	Supply Chain Gaps
Appliances	Stoves, Ranges	cast iron grates
Appliances	Hot Water Heaters	blower motors, controls, gas valves, circuit boards
Lighting	LED Bulbs	diodes, boards
HVAC	Ventilation, Exhaust Fans	small motors, wire, connectors, custom harness assemblies, glass
HVAC	In-Wall Heating Products	gas valves, pumps and control modules
HVAC	Geothermal	coils, controls

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