The Remodeling Industry and Energy Retrofits: Capacity and Awareness for Change

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ABSTRACT

This report reviews the residential repair and improvement industry's capacity in relation to the contemporary need for energy decarbonization within existing homes. The paper compares an estimate of one supply dimension (the current number of residential remodeling payroll establishments and their productivity rates) to two measures of residential energy retrofit demand (estimates of energy retrofit projects appropriated by the 2021 Infrastructure Investment and Jobs Act and 2022 Inflation Reduction Act, and total counts of homes built prior to 1980 before modern energy codes). By comparing these measures of potential supply and expected demand, the paper contributes to policy debates around the industry's current capacity to deliver national residential decarbonization.

The variety of remodeling establishments that could provide energy retrofits has increased absolutely and proportionally to the existing housing stock nationally and in almost every state. Consequently, there is sufficient industrial supply to perform the likely quantity of projects demanded from the current federal assistance and incentives programmed for the next ten years. However, there are only a handful of states where the local supply of professional residential energy efficiency and electrification services could meet a broader need, such as the energy retrofitting of all homes built before the era of modern energy building codes. Including the broader range of remodeling organizations such as specialty trade and self-employed (e.g., "handymen") remodelers—along with a more inclusive pool of skilled occupations—could ameliorate this scenario in the short term and mitigate against the long-term organizational and workforce bottlenecks that are causing alarm.

Introduction

In 2022, residential energy scholars and program practitioners were increasingly reading news pieces that would alarm them: simply, there were not enough workers to decarbonize the nation. Using various sources and anecdotes, journalists repeated the headline that the current numbers of firms and workers were insufficient to manually execute the massive decarbonization effort expected in our nation's current homes on the timeline needed to meet our climate goals. A primary source for the news coverage came from a 2020 white paper released by the advocacy group, Rewiring America (Griffith and Calish 2020). The piece, released before the legislative productivity resulting in the 2021 Infrastructure Investment and Jobs Act (IIJA) and the 2022 Inflation Reduction Act (IRA), referenced a wide range of employment growth opportunities that would expand because of widespread decarbonization of the U.S. economy. The report's acknowledged cause of the job gap were the expected rates of departures of workers in relevant occupations, particularly in the construction trades, over the next decade combined with diminishing numbers of entrants into the pipeline.

The story has since taken on multiple forms in the media and was subsequently highlighted by advocates and policymakers on all sides of the decarbonization policy debate. By focusing on electricians in particular, variations of the story borrowed similar statistics to make

their projections. For example, a follow-up report to the Rewiring America white paper took current federal projections for job openings in key occupations as the underlying metric to estimate a gap of one million electricians that would be needed (Wyent 2022).[1] Those who argued that the national climate goals and its requisite energy, transportation, and building sector decarbonization were either too ambitious or too expedited used the perceived fact to note the practical bottlenecks of national legislation and the need to pump the brakes on expansive incentives or requirements (Ramkumar 2023). Others noted the critical opportunity that decarbonization represents for job growth that, in theory, represented a counterpoint for naysayers to decarbonization.

A subset of this group of advocates noted the employment potential for key demographic groups in trades in which they had historically not been employed (Renwick 2023). Much of the advocacy narrative has echoed the "green jobs" rhetoric dating back two decades. However, that early wave of the green jobs movement focused on the simultaneous benefits of decarbonization and job growth while the current version has focused on filling job gaps to decarbonize (BW Research 2020).

Ultimately, despite the recent attention, the announcement of capacity gaps is old news. The increasingly constrained job training and hiring rates across the construction industry's occupations (in which most decarbonization-related jobs are classified), the dominance of white and Hispanic men holding the jobs historically, and their well-documented aging are a decades-long trend. Depictions of extended waits and worker shortages for electrification projects also rarely mentioned that this trend was pervasive across the residential remodeling industry throughout the pandemic and post-pandemic era (Joint Center for Housing Studies 2023).

Previous study

Beyond the persistent challenges associated with the demand for energy repairs, improvements, and deep retrofits among homeowners and landlords, the supply side of these services is vastly understudied. There have been few if any studies that surveyed the current operations of the residential repair and remodeling industry with any eye towards assessing its capacity to meet a specific goal for existing homes' performance. Much of this gap can be attributed to the dominant scholarship focus on the energy performance of new buildings, though the growth of energy-efficiency program requirements by states on their utilities beyond retail product purchases and the creation of the national Home Performance with ENERGY STAR program helped shape some questions about the nature of the industry in the early 2000s (Bordner, R. et al. 2000; PATH 2002).

But a growth in both theoretical and empirical study on operational barriers to energy-related residential home remodeling began in the years after the 2008 recession in which new construction starts had plummeted. Prior to these early studies, the industrial organization and capacity questions had largely been ignored (DOE BBNP 2012; Thorne 2003). Much of this work was funded by the U.S. Department of Energy (DOE) and its Better Buildings Neighborhood Program which contributed some key insights into the non-quantifiable challenges to residential energy retrofits as well as the technological methods of accomplishing them (Less

[1] This study assumes a national shortage of 40,000–80,000 electricians by distributing the Bureau of Labor Statistics' 10-year projections of 800,000 electrician job openings over the next decade, plus an author-estimated additional 125,000 utility line worker job openings to generate the estimated one million gap in electricians. The study also later assumes 100 million houses to be electrified through 2040, with 30 hours of labor per house.

and Walker 2014). The largest portion of this scholarship focused on the state of retrofit and repair programs, their customer models, and their effectiveness (Cluett and Amann 2016).

Some of this work, fortunately, also referenced the operational challenges faced by the service providers, including the remodelers, installers, repair people, and related occupation and their employer establishments as a contributor to program implementation. Key industrial capacity challenges were identified in this wave of scholarship, including:

- contractor education and certification (DOE 2010)
- sales and marketing expenditures for the providers to convert leads into voluntary energy-retrofits (including the costs of audit tools and of auditor labor) (McIlvaine et al. 2013)
- deliberations over the priority energy measures to include in a project and resulting extensive management and transaction costs for selecting them (Bardhan et al. 2014)
- potential liability for final home performance and quality, particularly when only a few energy measures are implemented (Cluett and Amann 2014) and, repeatedly,
- the quantity and skill quality of trained and specialized employees (Goldman 2010).

That early work would soon be supplemented by another surge of interest in retrofits ten years later as existing buildings efforts took on new efforts given the new national decarbonization goals established by the White House—ones that required sufficient energy efficiency, electrification, and related improvements in existing homes as much as if not more than new ones (NASEM 2021 and 2023). Many of the same barriers to industrial capacity for new home performance requirements were identified as had been decades before, particularly with regarding the increasingly perceived crisis in the construction workforce. This work was particularly relevant given the increase in energy-related work across the remodeling industry overall and its broad diffusion across different geographic and market segments through the country—a fact that demonstrates a growth in awareness and knowledge of specific energy-related interventions by the formal remodeling industry beyond the specialized occupations and establishments.

However, a new wave of studies explored the industrial capacity challenges with more nuance about both the operations and practices of the contemporary home remodeling industry. For example, the challenge for remodelers and equipment installers to prepare consistent solutions since each home requires some level of customization (therefore relying on site-specific innovations rather than standardized ones) was increasingly documented along with the consequent levels of communication, delay, and liability for providers to service each property owner adequately (PNNL 2022). A particular thread in this scholarship has been the disproportionately larger costs to the remodeler or home improvement provider for energy retrofit work given the “soft costs” incurred by the remodeler including the home-specific diagnostic assessments and performance modeling as well as the post-construction auditing as well as the regular training and specialized equipment that energy-focused remodelers must take on as the costs of doing business (Chan, Less, and Walker 2021).

In short, this scholarship provides evidence that high-performance energy remodeling requires a significant amount of additional work in addition to a higher level of professional skill to execute it. These added costs, then, make energy-related remodeling more expensive to deliver than other non-energy specific repairs and improvements—further making it a specialized offering rather than standard fare. This recent scholarship also shows that the increasing policy interest in home energy retrofits has created or at least exacerbated some of the preexisting

workforce and organizational barriers. For example, even where homeowner and occupant incentive and assistance programs are created, they add additional requirements on the provider to administer them that may not be fully reflective of their costs. Further, the increasing use of new technology both for the retrofit itself as well as to manage the various trades and resulting assessments for energy improvements continues to surpass the capacity and skill of current trades and establishments and create a wider gap between practice and practitioner (Casquero-Modrego, Chan, Less, and Walker 2022; Less, Casquero-Modrego, and Walker 2022). Understanding the balance between the aspirational state of affairs with its technical demands and the current capacity of extent remodeling, repair, and home improvement establishments—and providing adequate policy and program procedures to weigh that balance—will require even further study (Walker, Casquero-Modrego, and Less 2023).

But what exactly *is* that current capacity? Though the nascent scholarship in existing housing's energy transformation over the last two decades has identified fundamental industrial and operational challenges in the residential remodeling, repair, and installation industry, there have been few attempts to quantify the scale of those challenges and the gaps they create with regard to the potential demand for decarbonization. The most recent stage of evolution in national policy benefits from both strategically understanding these challenges, as well as preliminary estimates of what they are. A deeper analysis of the practices within the current residential repair and improvement sector has been missing.

The supply-side capacity of the remodeling industry

We explore one of those distinct industrial characteristics that have been identified in the literature as fundamental challenges to residential decarbonization: the industry's operational organization.[2] Residential remodeling is a prolific industrial sector in the U.S., not to mention a particularly old one. Despite its age, however, the industry continues to grow. Over the last decade, the total number of firms has significantly increased, with almost 128,000 formal residential remodeling establishments according to most recent estimates (Figure 1).[3] This number vastly exceeds the total establishment count of the previous high in 2007.

[2] This study is part of a larger set of research projects conducted by the Joint Center for Housing Studies on the implementation challenges associated with current energy retrofit incentive programs in relation to the characteristics and conditions of the remodeling services industry.

[3] Note that this number as estimated with County Business Pattern data is generally corroborated with the equivalent rates in the respective years from the Economic Census. For 2012, for example, the CBP data estimate 89,045 residential remodelers with payrolls in the US, while the Economic Census for the same year estimates 80,300 general building contractors working in residential construction with a majority of receipts from remodeling activity. Through the Census, we can also estimate that an additional 144,600 specialty trade contractors are estimated to have been working in remodeling in 2012. Note that neither of these estimates do not include non-payroll organizations which, through the Nonemployer Statistics data, we assume to add an additional 182,700 actors working as general remodelers plus approximately 308,400 specialty trade actors in remodeling the same year.

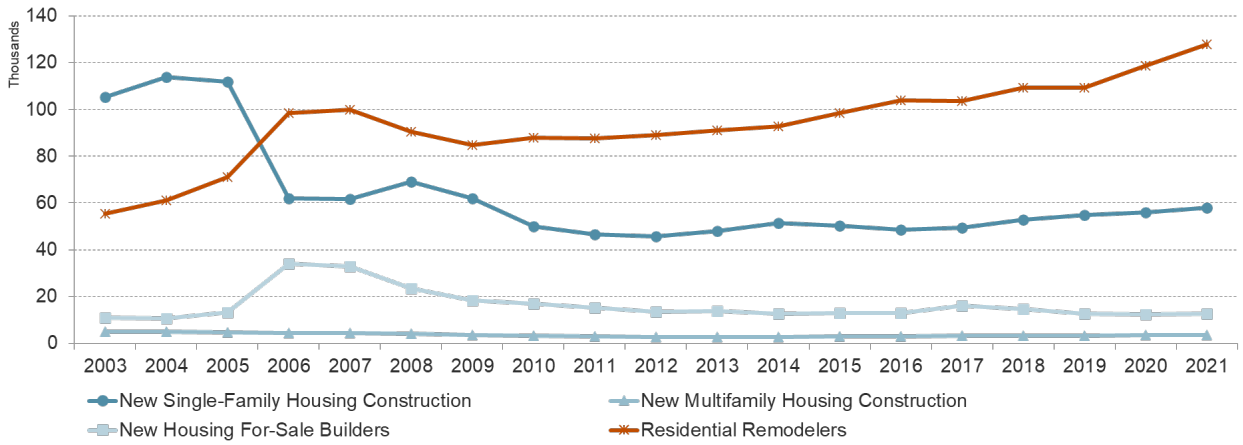

Figure 1. Number of Residential Building Construction Establishments in All Sectors. Data include payroll establishments and exclude specialty trade remodeling contractors. *Source*: JCHS tabulations of US Census Bureau, Statistics of US Businesses, County Business Patterns.

The counts of residential remodeling establishments do not include the specialty trade payroll establishments or the self-employed contractors and specialty tradespeople (e.g., "handymen") that provide the bulk of home repairs, improvements, and remodeling activity in the U.S. Yet, most formal governmental programs have focused on training, recruiting, and contracting only with the formal remodeling establishments with payrolls for a wide range of reasons, not the least of which is their administrative capacity for program compliance along with licensing and insurance requirements.[4]

When considering the proportion of remodelers to the overall housing stock—for example, by the number of remodelers available to serve 10,000 existing housing units—we see even further evidence of the industry's recent expansion. Nationally, there were 6.7 remodelers for every 10,000 homes in 2012. This rate increased to 8.9 remodelers for every 10,000 homes by 2021, a 2.2 percentage increase. Almost every state followed suit, with more remodeler establishments being created over that time than the increase in homes. Though these numbers generally increased within most states, there is still some variability in their total counts in relation to the number of homes (Figure 2). While there is a national average of 8.9 remodelers for every 10,000 homes, for example, there is an average of 2.6 remodelers for every 10,000 homes in Mississippi (the lowest ratio) and 16.1 remodelers for every 10,000 homes in Wyoming (the highest).

[4] For additional description of the various types and sizes of organizations that provide residential remodeling services beyond the formal remodeling establishments with payrolls, see Will 2016.

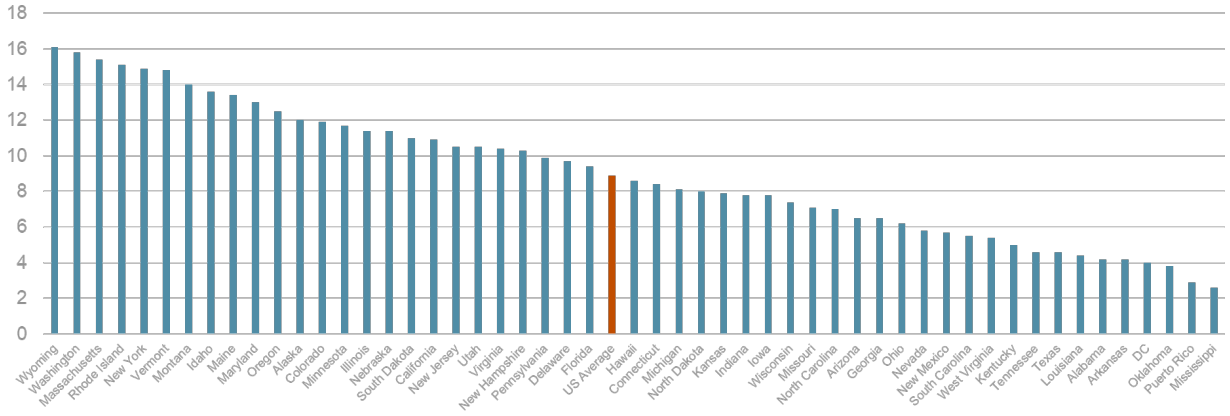

Figure 2. Number of Remodeling Establishments Per 10,000 Housing Units by State, 2021. Includes only establishments that reported revenue. US totals include Northern Mariana , Guam, Samoa, or US Virgin Islands
Source: U.S. Census Bureau, 2021 County Business Patterns (NAICS 236118) and 2021 ACS 1-year estimates.

But even within this one component of the sector composed of formal remodeling establishments with payroll, there is wide variation in composition and structure. Indeed, the most fundamental industrial characteristic of the U.S. residential remodeling sector is its fragmentation—that is, in the diversity of its actors' geographic service area, size as measured by financial revenue and number of employees, and firm-level productivity in terms of project leads and churn (Will and Baker 2007). In fact, the sector's fragmentation has been the subject of industrial analyses that attempt to apply a standard lens or seek to promote a specific residential strategy as much as the fodder of anecdotes of home and property owners of how constrained the industry's capacity is, particularly in relation to urgent repair and improvement demand such as decarbonization measures. The industry's statistical profile corroborates its characterization as fragmented.[5]

The most commonly cited metric for this characterization is the dominance of firms with small numbers of employees—in residential remodeling's case, less than five employees. Though remodelers with over 20 employees commanded over 28 percent of the market in 2020, the number of small firms has grown. In fact, the growth in establishments described earlier is almost entirely due to establishments with fewer than five employees (Figure 3). The segment of smallest establishments grew by over 30 percent from its pre-recession boom.

[5] There are three primary challenges in trying to measure the number of remodelers, repairers, installers and related sector organizations (as opposed to occupations) in the residential remodeling, repair, and improvement sector: 1) there are many actors that work in both new and existing residential constructions, consequently researchers most distinguish them based on the proportion of revenues coming from existing housing activity (i.e., over 50 percent of receipts from remodeling as done by JCHS); 2) many firms are actually specialty or trade contractors such as general HVAC companies or electricians whose work may exceed the traditional occupational definitions since they manage projects and the establishment itself but that are not always counted as "remodelers" because they are not general building contractors; and 3) many firms are actually self-employed individuals (e.g., "handymen") with no formal employees or payroll. Consequently, the sources noted will alternate between them.

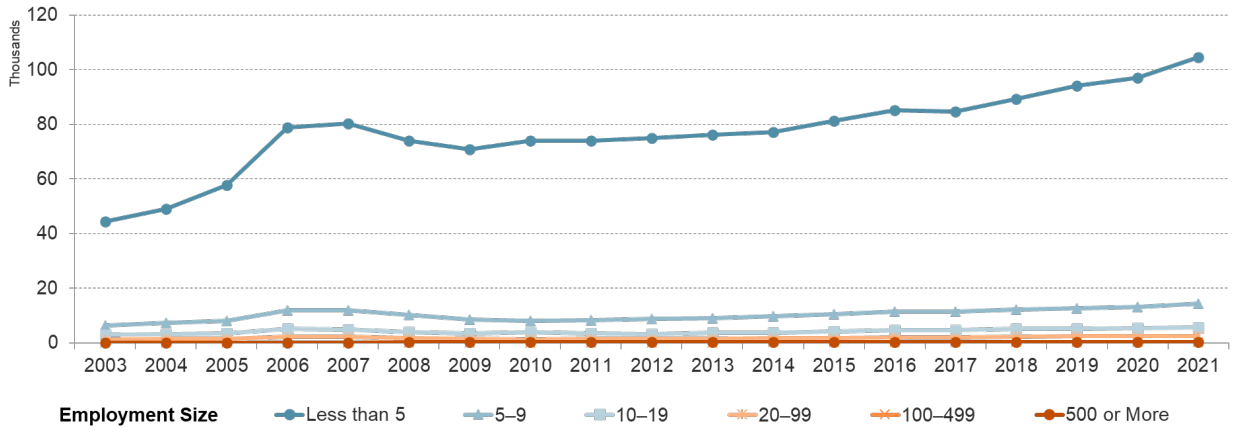

Figure 3. Number of Residential Remodeler Establishments. Data include payroll establishments and exclude specialty trade remodeling contractors. *Source*: JCHS tabulations of US Census Bureau, Statistics of US Businesses, County Business Patterns, 2003-2021. (NAICS 236118).

At last count, further, all states' formal payroll remodeling establishment counts were dominated by the small establishments employing fewer than five individuals as well (Figure 4). In 2021, establishments that employed less than 5 individuals made up 82 percent of all remodeler establishments across the country, and no state dramatically exceeded or fell under this rate: 89 percent of remodeler establishments in Illinois employed less than 5 individuals (the highest across states) while establishments of this type made up 70 percent of the industry in Nevada (the lowest).

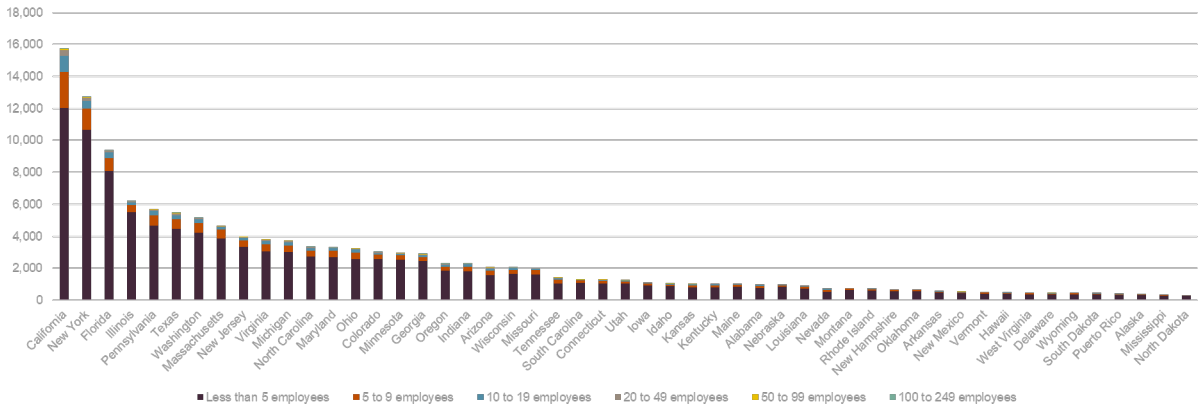

Figure 4. Number of remodeling establishments with payroll by state and payroll size, 2021. Estimates are only for remodeling establishments with employees and do not include specialty trade establishments or self-employed, nonpayroll individuals in either general remodeling or specialty trades. *Source*: JCHS tabulations of U.S. Census Bureau, 2021 County Business Patterns.

With this grounding in the number of remodeling service providers, we then estimate how many projects they can deliver annually and, in turn, over a ten-year period such as that supported by IIJA and IRA resources in particular and demanded by national decarbonization goals in general. Based on homeowner repair and improvement data published as far back as 2007, there is an average of 58.5 million repair, improvement and remodeling projects conducted every year across all project types (JCHS 2023). We estimate that an average of over 31.8 million projects (over 54 percent) were in categories that have some effect or relevance to a

home's energy performance across those fifteen years. If we reduce the do-it-yourself (DIY) share of these projects, we can assume that remodeling professionals of different types have been involved in at least 80 percent of projects overall—or 25.4 million projects by very rough estimates.

These broad numbers for remodeling production, however, do not provide an adequate picture of energy-related projects for a range of reasons. First, in addition to the fact that many professional remodeling projects are conducted in the same house and simultaneously, the scale, complexity, and costs of these individual projects vary widely (Table 1). For example, the average expenditure for a roof replacement in 2021 cost approximately $10,046 suggests that projects as large as full roof replacements to smaller patch jobs as reported by owners are included. Similarly, the average expenditures for replacing a central air conditioning ($6,093) and heating equipment ($4,485) in 2021 blurs the range of air treatment repairs and equipment replacements that are occurring in U.S. homes.

Table 1. Homeowner improvement expenditures for select project types, 2017 and 2021

	2017			2021		
Type of Home Improvement Project	Number of Projects (000s)	Average Per Project Expenditure ($)	Total Expenditures ($M)	Number of Projects (000s)	Average Per Project Expenditure ($)	Total Expenditures ($M)
Roofing	3,383	7,674	25,962	3,804	10,046	38,212
Siding	968	5,054	4,893	1,111	7,694	8,549
Windows or Doors	3,722	3,442	12,808	4,071	4,353	17,724
Insulation	1,356	1,483	2,010	1,456	1,984	2,890
Electrical System	2,244	1,473	3,304	2,817	1,942	5,471
Central AC	2,741	5,113	14,017	2,974	6,093	18,118
Built-In Heating Equipment	2,224	3,790	8,428	2,651	4,485	11,890
Water Heater	3,551	976	3,467	3,916	1,308	5,124
TOTAL	20,189	--	74,889	22,800	--	107,978

Source: JCHS tabulations of 2017 and 2021 American Housing Survey data.

Second, energy-related projects require more skill and more extensive safety requirements and are thus much less likely to be DIY. We calculate that there were over 22.8 million energy-specific repair and improvement projects conducted in existing homes in 2021, a slightly higher count than the over 20.2 million energy projects from four years prior in 2017. That production volume averages 25.3 projects across all remodeler organizations for the year, or just over 2 projects a month—a rate comparable to a similar study.[6] However, we must make a few assumptions about the production of each type of organization size; establishments employing less than 5 employees (both remodeling and specialty) are assumed to perform two

[6] McIlvaine et al. 2013 analyze responses to a RESNET survey of 702 industry stakeholders including HERS raters (77.5%), specialty trade establishments, and general contracting establishments and found that 61.9 percent of respondents reported having between 1 to 9 jobs (that is, projects) per month.

projects per month, 24 projects per year. This rate reflects the average rate derived above and is intentionally conservative. In turn, we assume that establishments with 5-9 employees could be expected to produce five projects per month, or 60 projects per year on average; establishments with 10-19 employees could produce 100 projects per year; establishments with 20-49 employees could produce 200 projects per year; establishments with 50-99 employees could produce 500 projects per year; and establishments with 100+ employees could produce 1000 projects per year. We also conservatively use only the 2021 estimates for general remodeling payroll establishments to then gauge an annual and then 10-year project completion rate nationally and in each state

Based on those assumptions, the total potential energy retrofit projects that could be accomplished by current remodeler establishments with payroll over the next ten years is estimated to be over 46.9 million projects nationally, distributed across states based on their current remodeler pool and size from 53,720 projects in the District of Columbia at the lowest end to 6,561,600 projects in California on the highest (Figure 5).

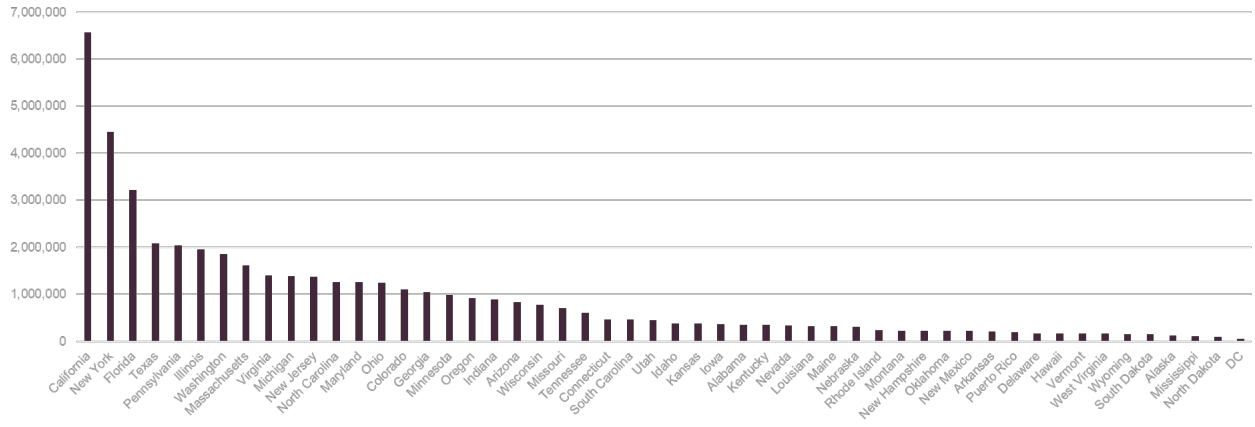

Figure 5. Estimated Residential Establishment's Total Potential 10-Year Energy Retrofit Projects by State, 2022-2032. Estimates are for remodeling establishments with employees of all payroll sizes, and do not include specialty trade establishments or self-employed, nonpayroll individuals in either general remodeling or specialty trades. *Source*: JCHS tabulations of US Census 2021 County Business Patterns.

The demand for energy retrofit projects

These total project numbers that can be produced by the suppliers of energy remodeling are then compared to projections for the demand on two measures: the first for the projected growth in demand from the IIJA and IRA financial incentives, the second based on a definition of need for residential energy improvement need assuming that all homes built before 1980 (the first energy codes) will need some level of energy-related repair or improvement.

For the former, the authors rely on estimates using average counts for Weatherization Assistance Program project costs (for IIJA estimates serving households with 2021 annual incomes under two times the poverty rate, or the equivalent of 30 percent of area median income), income tabulations for IRA energy rebates based on the DOE guidance for serving low-income households issued in October 2023 (for IRA rebate estimates serving households with incomes between 30 and 80 percent of area median income receiving double rebate values, and those with households from 80 to 150 percent of area median income for standard rebate values);

and RMI estimates (for IRA tax credits assumed to primarily serve households with annual median incomes above 150 percent of area median income) (Martín et al. forthcoming). These figures resulted in a total of 9.1 million estimated energy retrofit projects for the country from the IIJA and IRA resources over the next ten years. These projects are based on the income distributions across state populations assuming full take up of all programs—resulting in a low of 28,502 projects in Wyoming and a high of 848,450 projects in California (Figure 6).

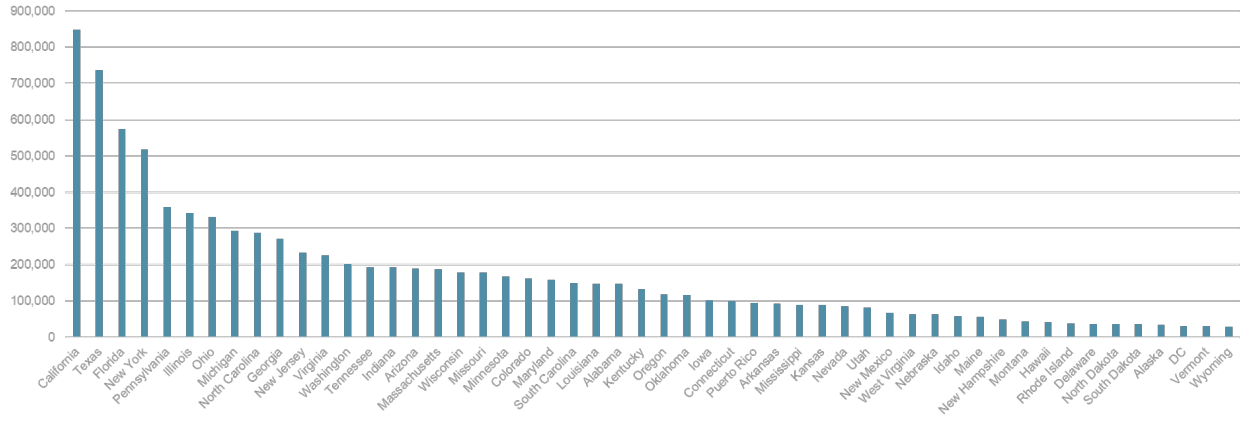

Figure 6. Estimated Demand for Energy Retrofit Projects from IIJA and IRA by State, 2022-2032 *Source*: JCHS tabulations of IIJA/IRA estimates 2022-2032 and American Community Survey 5-Year Estimates, 2022.

The second metric of energy remodeling need is derived by home age. Theoretically, almost any of the over 143 million housing units existing in the U.S. today requires some level of tuning up regarding energy performance—though clearly the depth of intervention is shallower for newer homes built to higher building codes. If using the age of a home's original construction as a metric for the need for a home energy improvement and, in turn, the demand for at least one energy repair and remodeling service, the over 73.2 million homes (or, over 51 percent of all U.S. homes) built before the creation and mass adoption of energy codes for residential construction in the early 1980s could be viewed as the priority demand (Figure 7). This demand includes a state low in Alaska of 122,891 homes needing an energy retrofit because of their age of original construction up to a state high in California of 8,288,438 homes.

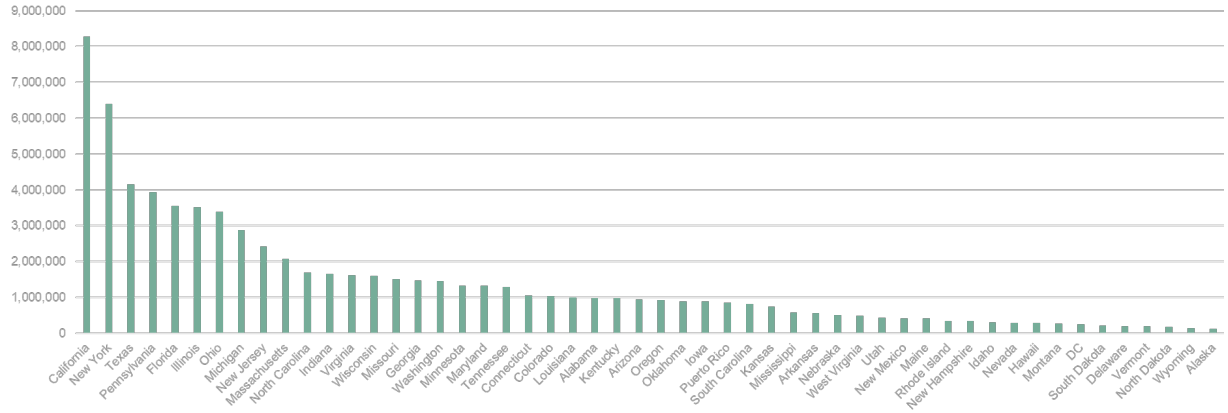

Figure 7. Estimated Total Demand for Energy Retrofit Projects Among Pre-1980 Homes by State, 2022-2032. *Source*: JCHS tabulations American Community Survey 5-Year Estimates, 2022.

Demand versus supply

Comparing the projected 10-year project supply against these two measures of 10-year project demand provides preliminary estimates about the remodeling industry's capacity regarding organizational productivity. We quantify this comparison by simply calculating the share of supply to demand in each state, a value of 100 percent depicting an equilibrium in which the supply meets the demand while a higher percentage would mean that demand for energy retrofits would outstrip the supply beyond the current residential remodeling establishment's capacity as hypothesized by advocates.

For IIJA and IRA-induced energy retrofit demand, the likely demand quantity of home improvements anticipated by just the current federal incentives over the next decade is the equivalent of only 19 percent of the industry's current capacity as defined by remodeling establishments alone—that is, reasonably within the current industry's purview even without counting for the significantly higher number of other remodeling organizations that could accomplish this work (Figure 8). Further, in no single state does that specific definition of IIJA- and IRA-induced demand exceed the industry's current capacity (that is, exceed 100 percent). However, this demand is equivalent to a significant share of the industry capacity in states such as Mississippi (where IIJA and IRA households' demands would be the equivalent of 77 percent of the local remodeling establishments' capacity), the District of Columbia (56 percent), Oklahoma (53 percent), and Puerto Rico (49 percent). There, the near-term demand could significantly strain local residential service suppliers.

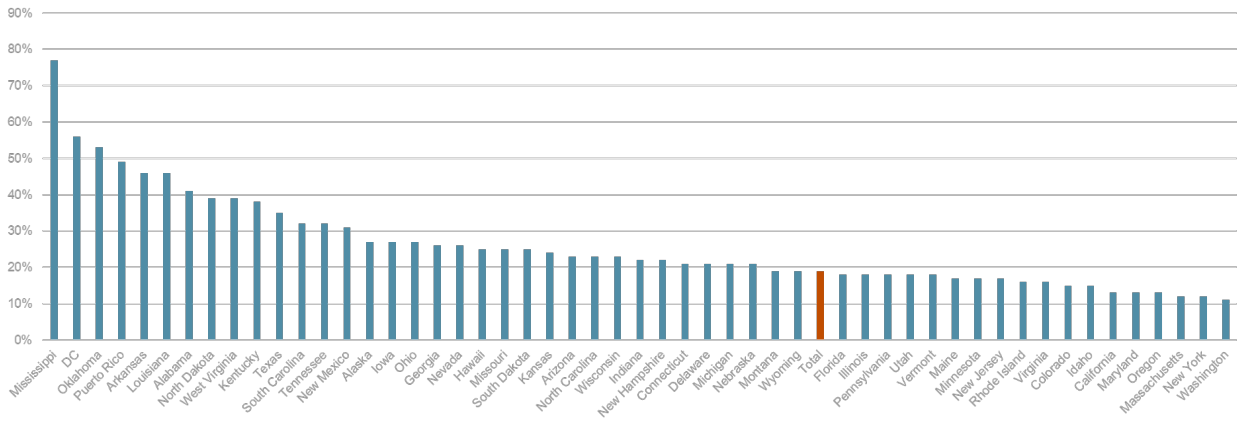

Figure 8. Estimated Residential Establishment's Total Potential 10-Year Energy Retrofit Project Supply as Percentage of the Total Demand for Energy Retrofit Projects from IIJA and IRA by State, 2022-2032. *Source*: JCHS tabulations of US Census 2021 County Business Patterns, IIJA/IRA estimates 2022-2032, and American Community Survey 5-Year Estimates, 2022.

For the second measure of possible demand—that is, the likely need for energy retrofits among all homes built before modern energy codes starting in 1980, we find a very different story. The demand for retrofitting these homes nationally is equivalent to 156 percent of the national remodeling industry's capacity—meaning it would take either a significant growth in capacity (on the order of 56 percent) to accomplish even one retrofit per home for these homes

within the next ten years, or an additional 5 to 6 years beyond the ten years would be needed assuming the current industry works at full capacity in delivering these retrofits (Figure 9).

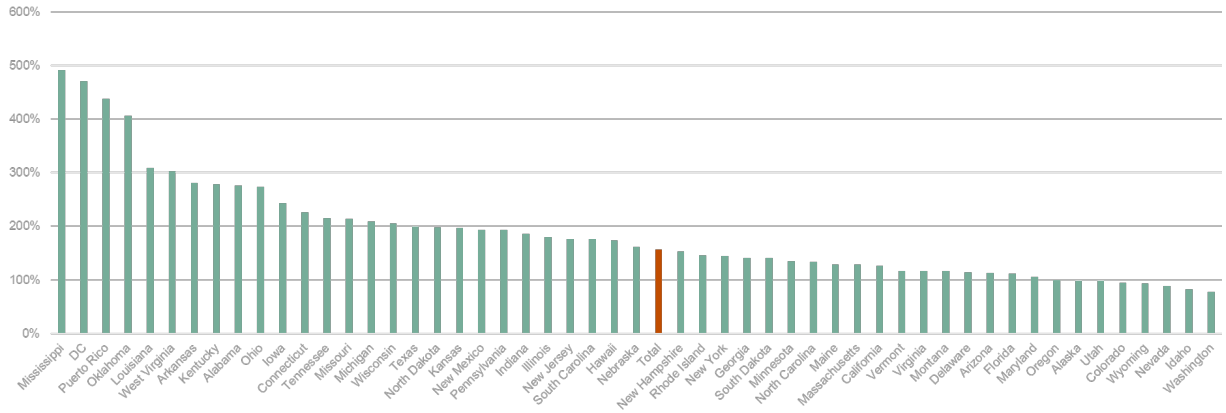

Figure 9. Estimated Residential Establishment's Total Potential 10-Year Energy Retrofit Project Supply as Percentage of the Total Demand for Energy Retrofit Projects Among Pre-1980 Homes by State, 2022-2032. *Source*: JCHS tabulations of US Census 2021 County Business Patterns, IIJA/IRA estimates 2022-2032, and American Community Survey 5-Year Estimates, 2022.

In comparison, there are some states including Mississippi, Puerto Rico, and Oklahoma with older housing stocks and insufficient remodeler establishments that would need either quadrupling and even quintupling of current capacity to retrofit homes in the next ten years or the equivalent extension of time.

Summary

On the whole, remodeling organizations have benefited from being inextricably linked to their markets—both the composition of neighborhoods' housing and households as well as the highly variable regulatory conditions that shape residential repair and improvements interventions from local permitting of projects (when inconsistently pulled) to requirements on basic access to homes and workers, and even their own licensing. The local variability and vernaculars of housing have perpetuated a sectoral organization that is generally ill-equipped for broad policy implementation (Egbu 1999).

But what does the current organizational composition mean for national decarbonization goals? The persistent fragmentation has many implications for the industry's capacity to manage existing work and to take on new charges such as energy-specific repairs and improvements. This paper focuses on individual repair and improvement organizations (including the general contractor and specialty trade establishments working in remodeling as well as the non-payroll "handymen" services that are both generalists and specialists)—organizational types that often compete for similar work and whose products differ primarily by scale and complexity. But there are other institutional actors such as new residential construction establishments or small commercial building remodelers that often enter the residential repair and improvement sector as economic conditions change.

Accounting for much of that flexibility, this paper estimates that the organizations and the workforce that could provide energy retrofits have been growing in proportion to the number of existing homes, and that the addition of new work for energy improvements over the next ten

years from recent federal legislation is likely within its capacity. Whether that flexibility is realized will depend on many understudied factors, such as organizations' awareness of the market, their interest and motivation (including financial incentives) in pivoting to new lines of work, and the growth in their other traditional lines of business over that time.

Though the recent legislation from IIJA and IRA was not intended to serve that quantity of homes within its ten-year appropriations, a long-term scenario in which the demand for energy retrofits could exceed the supply of energy service providers might occur as the timeframe for meeting national decarbonization goals in 2050 approaches. For longer-term goals that have a finite timeframe—such as decarbonization of all U.S. homes by 2050, however, the current industry capacity is likely to be limited.

Flexibility and transferability between organizations and occupations could become critically strategic paths. Programs that enable this pivot, such as the State-Based Home Energy Efficiency Contractor Training Grants, will help—but they require sufficient financial resources as well contractor incentives to make the transition viable and comprehensive. With additional investments in new technologies for both equipment and materials as well as installation methods within existing homes, a wider pool of providers in the already idiosyncratic industrial sector of residential remodeling could more easily reach national goals.

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