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The Receipts

The Untold and Underappreciated Outcomes of Biden's Clean Energy Strategy

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Roosevelt Institute

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The Roosevelt Institute is a think tank, a student network, and the nonprofit partner to the Franklin D. Roosevelt Presidential Library and Museum that, together, are learning from the past and working to redefine the future of the American economy. Focusing on corporate and public power, labor and wages, and the economics of race and gender inequality, the Roosevelt Institute unifies experts, invests in young leaders, and advances progressive policies that bring the legacy of Franklin and Eleanor Roosevelt into the 21st century.

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Executive Summary

The Biden administration's industrial strategy unleashed a historic surge in clean energy investment, sustained strong wage growth, and contributed to historically low unemployment. Through the CHIPS and Science Act, the Infrastructure Investment and Jobs Act (IIJA), and the Inflation Reduction Act (IRA), the federal government paired large-scale financial incentives with statutory labor standards, tax incentives, and community benefits requirements to shape how firms invested in workers and communities.

Although this strategy did not translate into electoral success in 2024 and faced retrenchment under the second Trump administration, it was more economically successful, had more impact on US climate progress, and led to greater labor and community benefits than has been recognized. The Community Benefits Plan framework created by the Department of Energy (DOE) was remarkably effective in ensuring that the public would share in the rewards of historic federal industrial investments, with 74 percent of IIJA and IRA dollars invested in major clean energy projects tied to commitments to use formal labor and/or community agreements.

Prevailing wage and apprenticeship requirements and Community Benefits Plans embedded workforce, equity, and community considerations into project design and implementation. These mechanisms did not eliminate conflict. Instead, they created structured pathways for navigating trade-offs among speed, standards, workforce capacity, and community acceptance—often reducing implementation risk rather than increasing it.

This paper combines original data analysis with in-depth interviews of more than a dozen private-sector actors to assess how Biden-era clean energy policy affected firm decision-making and workforce and community strategy. This quantitative and qualitative data illustrates the effects of statutory labor standards, tax incentives, and the DOE's Community Benefits Plans with a focus on employment and wage data, apprenticeship expansion, and collective bargaining agreements.

On balance, the private sector was more receptive to Community Benefits Plan provisions than skeptics predicted. Many firms were willing to form labor partnerships, invest in new community engagement strategies, consider how to measure and mitigate harms of their projects, and make meaningful workforce investments. In addition, companies already operating under high-road models found that federal incentives validated, aligned with, and reinforced existing practices. DOE's Community Benefits Plan framework both catalyzed and expanded responsible project deployment —embedding labor standards and community engagement into core project development strategies rather than treating such standards as peripheral compliance exercises.

The focus on labor and community benefits proved a less consequential source of friction than widely assumed, with funding recipients citing primarily the issues of a steep learning curve and lack of expertise. More significant bottlenecks included permitting delays, US supply chain constraints, and the timelines of government contracting. Labor and community benefits did not impose excessive hardship on funding recipients and often resulted in previously unrealized project benefits as well as changes to core assumptions and business practices, even beyond the projects receiving funding. These are important lessons for future industrial policy design: Building in mechanisms to share benefits of industrial and infrastructure investments with workers and communities has more upside than downside potential.

The efforts of the Biden administration to tie climate investments to good jobs and broadly shared prosperity showed promising signs of success, but faced an attribution problem. Ignoring the successes, reverting back to technocratic approaches to climate policy, or chasing the new angle of affordability—without continuing to invest in coalition-building, organizing, state and local policy efforts, and successful project implementation on the ground—would be a mistake. In this period of policy retrenchment, there is an opportunity to rebuild the social and civic infrastructure that has frayed—expanding the organizing capacity needed to secure community and labor agreements, proving that such partnerships can accelerate project delivery, and reinforcing participatory democracy from the ground up.

Durable climate progress depends not only on capital investment but on organized constituencies capable of shaping and sustaining it. In a period where many advocates, funders, and policymakers are going back to the drawing board on climate strategy, this paper provides new data about what worked alongside insights about what could have worked better.

This paper is the second in a series of three papers. The first examined how the Biden administration steered the private sector toward clean energy and shared prosperity. The third will focus on strategic opportunities going forward.

Introduction

The Biden administration put clean energy manufacturing and labor power at the center of its agenda. This posture was not universally beloved, especially when the results of the 2024 election appeared to some to suggest that the agenda was a political loser. The Obama administration's chief economist, Jason Furman, suggested his successors were victims of a "post-neoliberal delusion" and failed to boost manufacturing employment or equipment purchases. In their widely cited 2025 book *Abundance*, Ezra Klein and Derek Thompson lamented that Biden's semiconductor and energy policy tried to steer benefits toward unions and labor-made products, rather

than simply to build things quickly. Pundits from Josh Barro to Matt Yglesias to Jonathan Chait to Eric Levitz to James Surowiecki pointed to the supposed electoral or policy liability of the pro-union posture. Even sympathetic observers have been critical: Mariana Mazzucato criticized the Biden administration for failing to translate investments into shared prosperity, and Dani Rodrik faulted Biden for focusing on manufacturing rather than the more employee-intensive service sector.

Some of these critiques are ideological more than empirical: Union households actually boosted their vote for the Democratic ticket relative to 2020, and *Abundance* appeared to simply recycle its authors' takes from 2023, before any CHIPS investments had even been launched. Other critiques fail to understand the mechanics and timelines of manufacturing. The average time from siting to breaking ground on construction to operating assembly lines ranges from 18 months for projects between $10 and $100 million to 28 months for projects valued over $100 million. Larger, more complex projects, such as automotive or semiconductor plants, can take up to four years. For incentives only approved by Congress in 2021–22, it could be 2025 or later before production workers (as opposed to construction workers) would be employed.

A sound postmortem analysis requires evidence, but evidence is also particularly important for evaluating future policy design. Some of the more diffuse but consequential elements of the Biden agenda have not been evaluated, leaving gaps in the political coroners' analyses. This paper narrows those gaps by assembling new evidence. It integrates published government and third-party data into original analysis, provides insights from previously unpublished data, and draws on original interviews with private-sector executives participating in DOE-funded programs to evaluate how effectively policy shifted practices and how durable those shifts could prove to be.

Section 1 provides an overview of the legislative and budgetary context and outlines our methodology, including the quantitative data sources and the design of our qualitative interviews. Section 2 presents the quantitative analysis, examining trends in investment, employment, and wages during the Biden administration. We show that the "manufacturing pipeline"—including the supply of construction labor and registered apprenticeships—was already well developed by the end of 2024.

Section 3 analyzes the central mechanisms through which clean energy investments translated into improved outcomes for workers and communities, focusing on statutory requirements, tax incentives, and agency discretionary funding conditions. Section 4 presents findings from original interviews with funding recipients, assessing how companies that received federal support navigated the incentives, conditionalities, and administrative frictions of industrial policy, and how they evaluated its strengths and weaknesses.

Across both the quantitative evidence and developers' own accounts, we find no support for the claim that pro-labor and community standards were deal-breakers.

Section 1: Background and Methodology

From Emergency Stabilization to Structural Transformation

The Biden administration took office inheriting an economy still destabilized from the COVID-19 pandemic. The $1.9 trillion American Rescue Plan (ARP), passed in March 2021, alongside the bipartisan $2.2 trillion CARES Act of 2020, injected the economy with fiscal support and helped drive one of the tightest labor markets in US history. Within the first year of the Biden administration, unemployment had fallen from 6.4 percent to 4.0 percent, eventually reaching levels not seen since 1969 and remaining below 4 percent for two and a half consecutive years (Figure 1). The unemployment rate for Black workers fell below 5 percent for the first time since recordkeeping began in 1972.

Sustained labor market tightness generally results in favorable conditions for workers. Not only are workers more easily able to find jobs, but low levels of unemployment increase competition for workers, thus boosting wages and other benefits. For the lowest earners, compensation increases, the availability of employment benefits improves, and opportunities arise to climb up the job ladder to take on new responsibilities.[1]

Figure 1: Unemployment Fell to the Lowest Rate in 55 Years

Monthly unemployment rate of those aged 16 or over, seasonally adjusted

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Source: Federal Reserve Bank of St. Louis

[1] Katherine S. Newman and Elisabeth S. Jacobs, *Moving the Needle: What Tight Labor Markets Do for the Poor* (University of California Press, 2023).

The large-scale economic stimulus of the American Rescue Plan was the opening salvo of the Biden administration's broader economic strategy. The administration sought to run the economy "hot" through expansionary fiscal policy designed to reduce unemployment and strengthen wage growth. Three additional major pieces of legislation followed (described below), each advancing an investment strategy aimed at creating jobs and raising wages while simultaneously pursuing climate, technology, and infrastructure objectives.

The US Climate Industrial Policies: IIJA, CHIPS, and IRA

The legislative architecture of the IIJA, CHIPS, and IRA offers an early window into how incentives, institutional alignment, and contested interests were translated into policy design. Rather than focusing narrowly on emissions reductions, the laws structured funding to influence investment decisions, supply chains, workforce systems, and regional economic outcomes—expanding the set of actors with a material stake in the clean energy transition.

The **Infrastructure Investment and Jobs Act (IIJA)** passed the Senate with bipartisan support and was signed into law on November 15, 2021. The IIJA allocated $1.2 trillion over five years, with $550 billion in new spending, to modernize America's infrastructure. It directed major investments toward roads, bridges, public transit, rail, ports, broadband, water systems, zero-emission buses, and clean energy, including for both energy infrastructure and supply chains.[2] The funding was distributed across multiple federal agencies, with the overwhelming majority moving through the US Department of Transportation. IIJA funds were distributed through a dual approach: formula-based allocations to states and localities and discretionary grants, administered by the federal agencies for targeted investments.

Some clean energy programs were implemented through formula funding, including electric vehicle charging infrastructure, weatherization assistance, and support for energy efficiency. The US Department of Energy (DOE) committed the vast majority of its $62 billion in energy funds to the private sector through loans and competitive grants for demonstration and deployment projects. The goal was to build climate-resilient infrastructure and support the development of domestic supply chains for emerging clean energy technology, including batteries, hydrogen, and carbon management.

[2] The IIJA included $110 billion for roads, bridges, and major projects; $39 billion to modernize transit systems; $66 billion for passenger and freight rail; $17 billion for ports and waterways; $65 billion to expand broadband access; and $73 billion to overhaul the electrical grid and support clean energy initiatives.

The **CHIPS and Science Act**, passed in August 2022, allocated about $280 billion to strengthen US leadership in research, innovation, and semiconductor manufacturing, responding to supply-chain vulnerabilities and global competition—particularly with China. About $52 billion was dedicated to boosting domestic chip production, which had fallen from 36 percent in 1990 to about 10 percent in 2020. The law also created a 25 percent investment tax credit (ITC) and incentives for the manufacturing of semiconductors, as well as for the manufacturing of the specialized tooling equipment required in the semiconductor manufacturing process.[3] Beyond semiconductors, the law authorizes $174 billion for R&D, scientific research, regional technology hubs, and STEM education to reinforce the nation's high-tech industrial base. The DOE's Office of Science was authorized to receive $50.3 billion over five years, as well as an additional $17.6 billion for science and innovation purposes, focusing on key technology areas including carbon capture[1] [2] , resource efficiency, and low-emission steel production.

The **Inflation Reduction Act (IRA)**, also enacted in August 2022, represented the largest climate investment in US history. It aimed to cut greenhouse-gas emissions, lower health-care costs, and reform corporate taxation. Most funding supported clean energy deployment and domestic manufacturing of technologies such as electric vehicles, batteries, and renewable components through loans, grants, and tax credits. While the clean energy and climate provisions were initially estimated to cost $370–$500 billion in new spending and tax incentives,[4] offsetting this cost was greater savings in health care and increased revenues from tax enforcement. The IRA was projected to ultimately reduce the federal deficit by $58 billion. After the initial cost estimate, Congressional Budget Office (CBO) revised its projections in January 2025, reporting that the clean energy tax subsidies could amount to $825 billion by 2035. In these revised projections, the investment and production tax credits (ITC and PTC) would increase deficits by about $300 billion.

The so-called One Big Beautiful Bill (OBBB) of 2025 shortened the timeline for qualifying wind and solar projects and changed the rules for sourcing supplies from entities of foreign concern. These changes are projected to reduce spending in energy and natural resources by $21 billion over 10 years, while increasing budget deficits by $3.4 trillion by 2034. The CBO estimated that the original IRA tax credits increased wind and solar development by about 50 percent between 2024 and 2026. Under the OBBA, however, investment in wind and solar will likely decline by mid-2026. Whereas the original IRA was projected to reduce emissions by as much as 44 percent below 2005 levels, the OBBA reduces that to 24 percent, on par with a business-as-usual trajectory.

[3] Taxpayers may elect to treat the credit as a payment against tax ("direct pay"). The credit is provided for property that is placed in service after December 31, 2022, and for which construction begins before January 1, 2027.

[4] The Congressional Budget Office initially estimated $370 billion, and McKinsey estimated $500 billion.

Together, the IIJA, CHIPS, and IRA formed a comprehensive industrial policy agenda designed to rebuild US infrastructure, accelerate the clean energy transition, and reestablish leadership in domestic manufacturing and innovation capacity. Across the three laws, this investment constituted roughly $2 trillion in new federal spending over ten years. Crucially, these investments were not designed as purely economic interventions. Embedded throughout the legislative text and reinforced through executive orders were explicit goals, standards, and incentives intended to shape how capital moved and who ultimately benefited from public spending. Funding was tied to community benefits, high-quality job creation, and equitable workforce pathways, directing resources toward places long excluded from economic growth and ensuring workers had access to career-track training and good jobs. These design choices were not incidental; they were signals meant to influence investment behavior, institutional participation, and the distribution of costs and benefits.

Quantitative Data

This report draws on data from a wide range of sources to reveal the impact of Biden-era climate industrial policy. For figures of private investment in clean projects, whether announced or actually under construction, we rely on data from the Clean Investment Monitor produced by the Rhodium Group and MIT's Center for Energy and Environmental Policy Research (CEEPR). While the Rhodium Group and CEEPR publish many of their own graphics, the ones contained in this paper incorporate our independent analysis, for example to map investments eligible for the IRA prevailing wage and apprenticeship bonus by state and technology.

To portray the strength of employment and wage growth in the United States, we use Bureau of Labor Statistics (BLS) data. Unless otherwise credited, these graphs were made using independent calculations of BLS data. In each case, the series number of the data used in these calculations is noted below each graph. We accessed details of construction spending through the US Census Bureau's historical spending data and adjusted for inflation using the BLS's producer price index for construction materials and components.

In addition to BLS data, we secured periodic snapshots of aggregated certified payroll data collected by DOE for Davis–Bacon Act compliance. Davis–Bacon requires that workers on federally supported construction projects are paid no less than Department of Labor published prevailing wages. In addition, they must be paid weekly, with payroll records certified as accurate by their employers submitted to the funding agency on a weekly basis. To facilitate compliance and reduce reporting burden, DOE under Biden procured a centralized reporting tool through a third-party provider called LCPtracker, which has been capturing payroll data since mid-2024.

To show the significant increase in the energy sector's workforce after 2021, we combine total private employment data provided by the BLS with employment in the energy-sector data originally generated by the Department of Energy as part of its US Energy & Employment Report (USEER). Given that the Trump administration has hindered data collection from government websites, these analyses use data assembled by former staff at the US Department of Energy's Office of Energy Jobs, including an author of this paper. We use data on historic unionization rates provided by Union Stats.

Finally, to consider the impact of the IRA tax incentives on the growth of registered apprentices, we compare Clean Investment Monitor data for projects eligible for IRA prevailing wage and apprenticeship (PWA) funding against the growth in the number of new registered apprentices in the PWA-eligible construction trades. Apprenticeship data is from the Registered Apprenticeship Partners Information Database System (RAPIDS) and augmented by data secured from the state of California via a public records request. While these data are useful for comparing the relative number of new apprentices in union versus nonunion programs year over year, other data sources indicate they do not capture the full universe of construction apprenticeships in the United States. Therefore, for comparison, we include further estimates from North America's Building Trades Unions, which are collected directly from their members and show a higher number of union apprentices.

Qualitative Interviews

We garnered insights from 14 semi-structured interviews with executives in companies that have received IIJA- or IRA-funded loans, tax credits, or grants from the DOE for clean energy manufacturing, supply chain, and demonstration projects. Interviews were 45 minutes in length, took place between July and December 2025, were conducted over Zoom, and were recorded for note-taking purposes. All interviews used the same interview template, produced before we conducted the interviews (see Appendix A). Using DOE project databases, we identified major projects and found contacts for the project sponsor, using personal introductions from former DOE staff, LinkedIn, and Google searches.

We interviewed every company that agreed to an interview, and most requested anonymity. Given political sensitivities and ongoing uncertainty surrounding potential project cancellations, all interviews are anonymized. To provide structure and allow readers to identify overlaps or differences in our interviewees' answers, we organize these interviews alphabetically, from **Interview A** to **Interview N**. Interview quotations have been edited for clarity and, where necessary, to remove information that could identify the interviewed company.

Across our interviews, we talked to companies based in three of the four US census regions—South, Midwest, and West—and five of the eight Bureau of Economic Analysis regions—Southeast, Southwest, Great Lakes, Plains, and Far West. These companies are involved in a range of different industries, including (but not limited to) mining; the production of electric cars, batteries, and solar panels; hydrogen capture and storage; and electricity infrastructure and grid components. The companies' investments ranged in size, and the federal share of these investments ranged from $60 million to well over $2 billion, with all but two of the interviewed companies receiving a federal share over $100 million.

Section 2: The Underappreciated Economic Outcomes of Biden's Climate Industrial Policies

Incentives and Strong Policy Signals Attracted Unprecedented Levels of Investment in Clean Energy

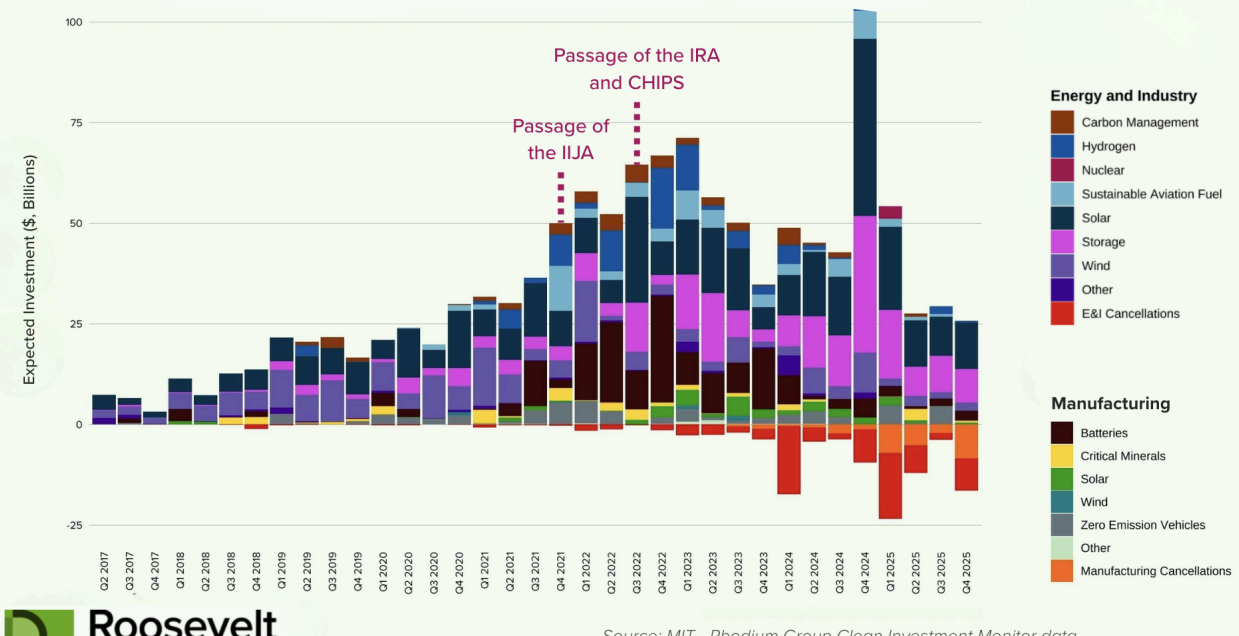
The climate industrial strategy was extraordinarily effective in crowding in private-sector investment—that is, leveraging public capital to attract, rather than displace, more private capital. This crowding-in effect signals investor confidence and long-term capital commitment, reflecting a shift in investor expectations about market demand, the long-term viability of domestic clean energy manufacturing, and a reassessment of the risks of irreversible investments. As one industry executive said, the IRA "undeniably accelerated investment" by moving the company past the internal hand-wringing about multi-decade capital investments.

CHIPS manufacturing grants have led to more than $600 billion in private investments since 2020. These investments were distributed across over 130 projects in 28 states and were projected to create and support over 122,000 construction jobs followed by over 69,000 long-term facility jobs in the domestic semiconductor industry.

On the clean energy side, investment announcements in manufacturing, deployment, and industrial decarbonization projects hit an all-time high following the passage of the Inflation Reduction Act, peaking at $104 billion in Q4 2024. Figure 2 shows clean energy–related private capital investments announced by quarter. Announced investments in the 12 quarters following the passage of IIJA were 2.4 times that of the previous 12 quarters, rising from $288 billion (between Q4 2018 and Q3 2021) to $695 billion (between Q1 2022 and Q4 2024). While cancellations grew by $56 billion in 2025, new investments ($137 billion) outpaced cancellations, likely due to wind and solar developers responding to the OBBB's accelerated timelines for IRA tax incentives.

Figure 2: Clean Investment Announcements Hit an All-Time High under Biden

Investment in manufacturing, energy deployment, and industrial decarbonization technologies by announcement date



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Source: MIT - Rhodium Group Clean Investment Monitor data

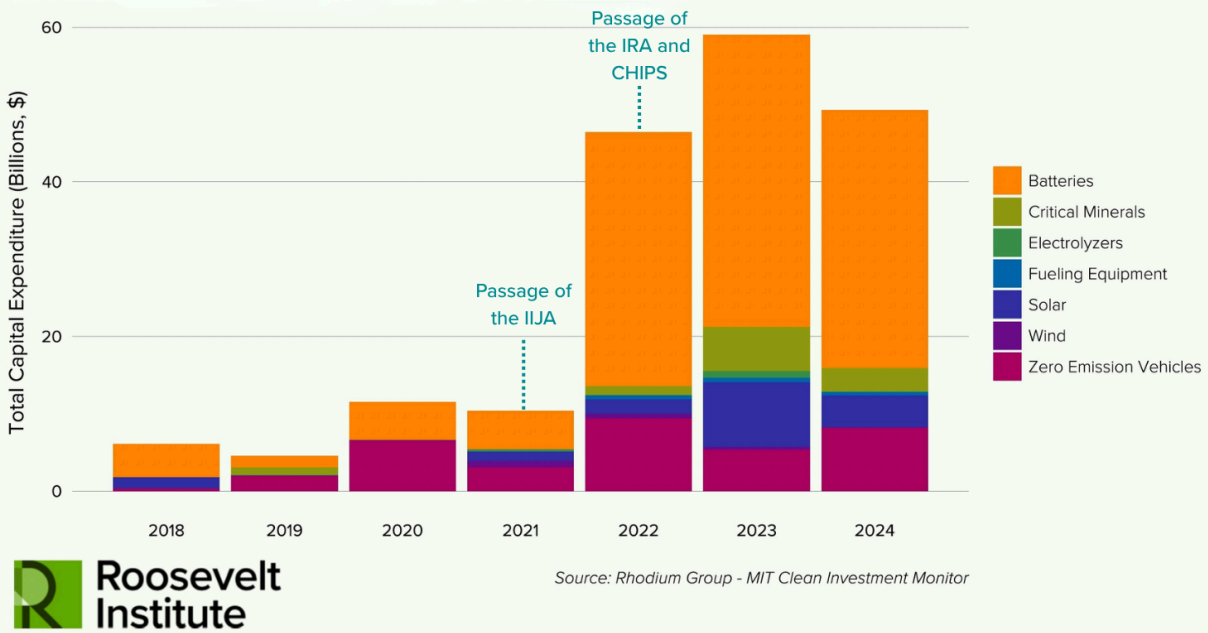
Responses to incentives and policy signals were not simply companies making investment announcements. Throughout the Biden administration, billions of dollars of projects began construction. Figure 3 shows the manufacturing investments by factory construction start date, emphasizing that the explosive growth of clean energy manufacturing and critical minerals announcements post IRA translated into actual steel in the ground and construction jobs. Within clean energy, manufacturing investments went from less than $5 billion in 2019 to almost $60 billion in 2023 by construction start date, with battery manufacturing investments leading the expansion (Figure 3). Projects on which construction started over the four years from 2021 to 2024 totaled $165 billion.

The rise in irreversible investment suggests that, beyond discrete subsidy uptake,[5] firms were incorporating federal incentives and policy signals into broader strategic assessments about the location and scale of productive capacity. These investment trends are a revealing indicator of the influence of policy to shift and unleash private investment in targeted sectors.

[5] Batteries and hydrogen received considerable funding for grants in IIJA. Over $6 billion was allocated for battery material processing and $8 billion for domestic hydrogen hubs.

Figure 3: Clean Energy Manufacturing Actual Investments Increased Substantially

Investments in manufacturing by factory construction start date



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Source: Rhodium Group - MIT Clean Investment Monitor

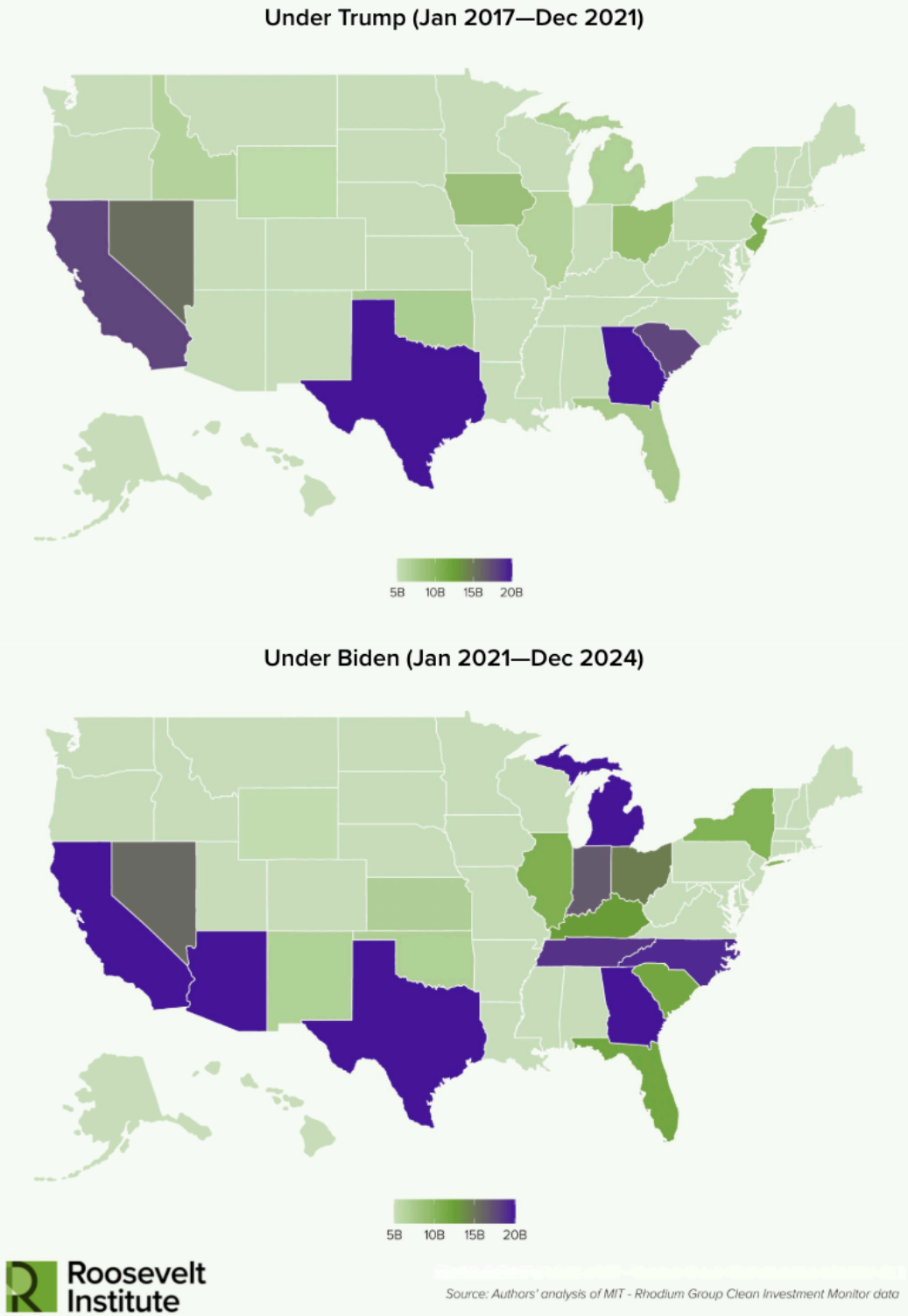
Clean Energy Investment Expanded Across the Country

In addition to spurring clean energy investments, the funding expanded to more states, signaling that more communities are economically benefiting from the clean transition. Figure 4 compares the cumulative size and distribution of clean energy investments by state under the first Trump administration and under the Biden administration. During Trump's first term, 6 states received $10 billion or more, with 2 states exceeding $20 billion; in Biden's term, 15 states received $10 billion or more, and 5 states exceeded $20 billion.

Investment increased most noticeably across the Midwest and upper South. Under Trump, not a single Midwestern or upper South state had clean projects for which capital expenditures exceeded $10 billion. During the Biden administration, projects totaling more than $10 billion either began construction or became fully operational in Illinois, Indiana, Kentucky, Michigan, North Carolina, Ohio, and Tennessee (Figure 4).

Figure 4: Clean Investment was Higher—and More Geographically Diverse—Under Biden

Total announced capital investment by state for projects under construction or operational

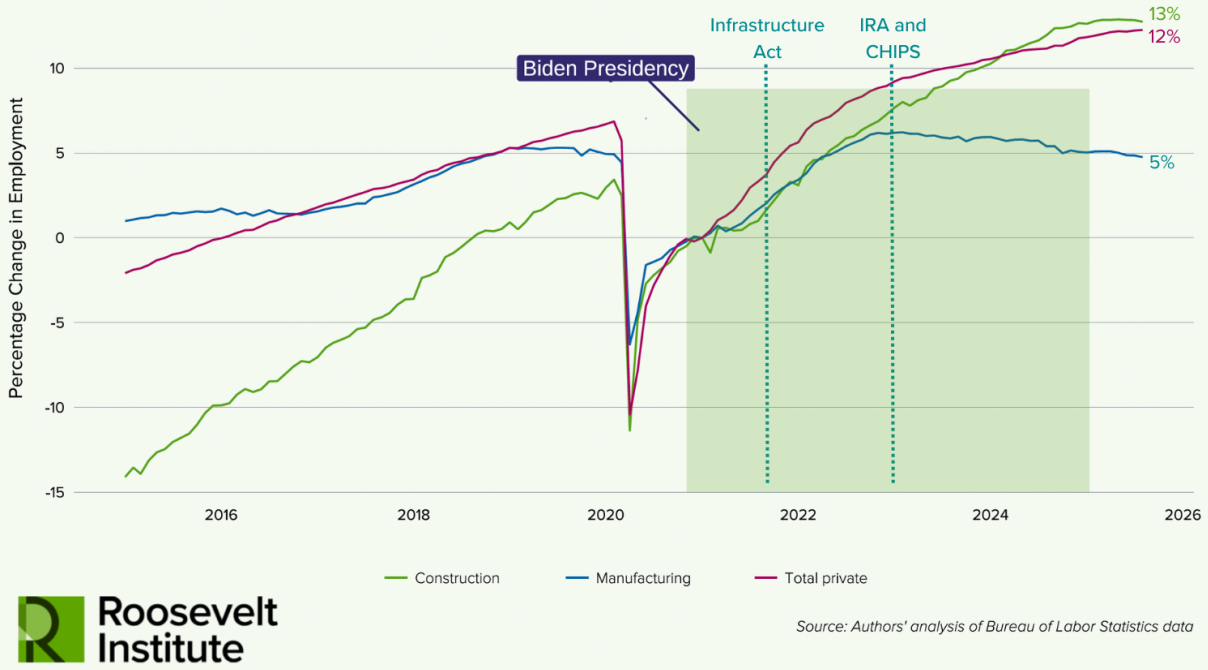


Construction Employment Hit an All-Time High, and Construction for Manufacturing Increased Exponentially

The Biden administration broke every significant construction record while in office and oversaw historic investment and employment in the construction industry. Construction spending overall grew 30 percent from 2021 to 2024. The considerable investment in the construction sector during the Biden administration led to record high employment in the sector. As Figure 5 shows, the construction workforce was 13 percent larger in January 2025 compared to January 2021, outpacing the growth rate (12 percent) for private-sector jobs overall.

Figure 5: The Biden Administration Brought Construction Employment to Its Highest Level Ever

Total private employees, seasonally adjusted, change compared to January 2021



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Source: Authors' analysis of Bureau of Labor Statistics data

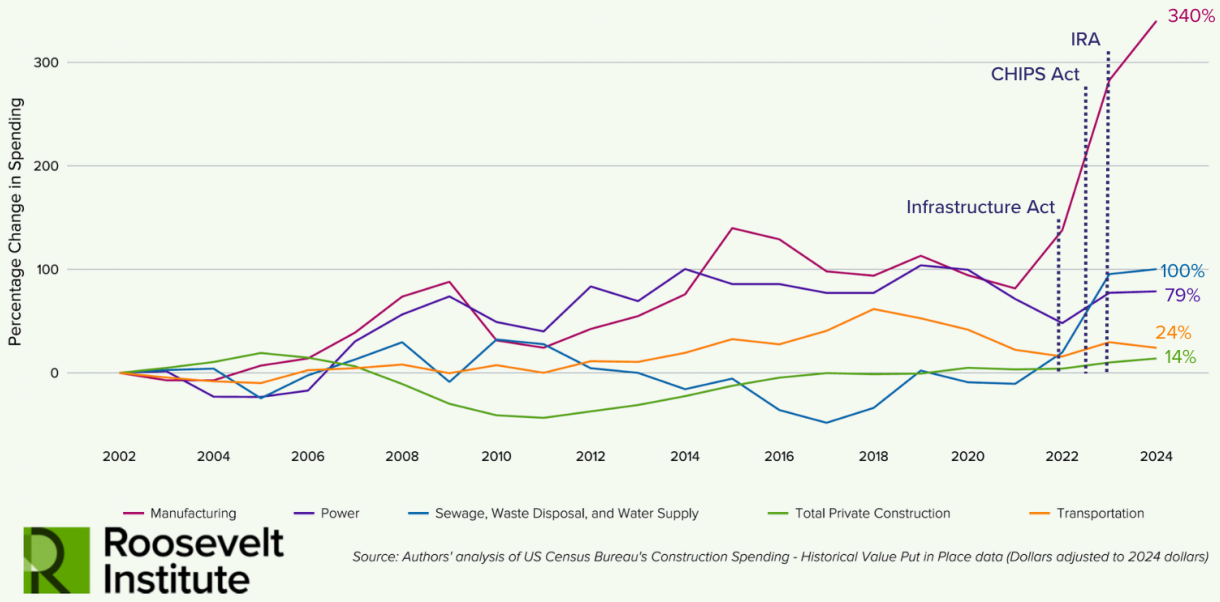
The growth in manufacturing jobs over this period was less impressive. After its post-COVID rebound, the manufacturing workforce remained largely consistent in size throughout 2023 and 2024, declining slightly. Whereas the number of private-sector jobs grew quickly throughout 2021 before slowing somewhat in the years thereafter, the construction workforce continued to grow steadily throughout the 2021–25 period, supported by investments from IIJA, CHIPS, and IRA.

The meteoric rise in factory construction in particular stands out. Figure 6 shows the anomalous departure from historic trends over President Biden's term: Construction spending on manufacturing facilities more than tripled from 2021 to 2024. Spending on

factories, warehouses, logistics hubs, and other manufacturing facilities grew from $97 billion to $235 billion a year.

The pattern of construction spending shows that firms were committing capital to manufacturing facilities and infrastructure. Most factories take anywhere between 18 months and four years to be built, delaying actual manufacturing employment. Manufacturing facility construction and the growth of related construction jobs is clear evidence of future growth of the manufacturing industry long before the majority of production jobs materialize.

Figure 6: Annual Construction Spending Rose Considerably After 2021, Driven by Manufacturing Construction
Change in annual aonstruction spending, compared to 2002



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Source: Authors' analysis of US Census Bureau's Construction Spending - Historical Value Put in Place data (Dollars adjusted to 2024 dollars)

Policies take time to translate into results that appear in economic data. These lags are precisely why near-term deployment metrics are a poor proxy for whether incentives are inducing durable capital commitment. The economy under Biden exhibited strong indicators of a manufacturing boom, but before production workers are hired, investments move through planning, permitting, and construction—meaning tomorrow's manufacturing jobs first appear as growth in professional services and construction employment.

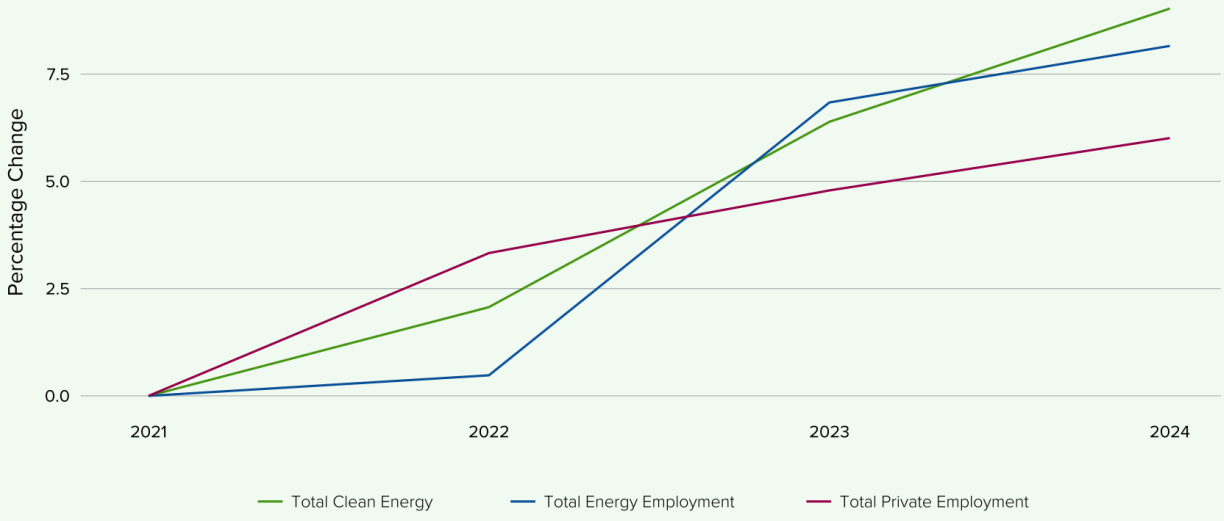
Energy-Sector Employment Outpaced the Economy Generally

Having lost jobs due to the declining energy demands caused by the COVID pandemic, the energy sector had fully rebounded by the end of 2024. Energy jobs grew every year

of the Biden administration, adding 941,000 jobs since the end of 2020 to total 8.5 million jobs. Clean energy investments powered job growth in the sector. The lion's share of energy job growth (72 percent) after the passage of IIJA and IRA was in clean energy, representing over 450,000 net new jobs in clean energy. Jobs in clean energy now represent nearly 44 percent of all US energy jobs. This shift reflects a reorientation of energy investment toward domestic manufacturing, construction, and supply chains upstream of generation, as well as growth of zero-emission sources of electricity generation. While the US labor force grew by over 5 percent between the ends of 2021 and 2024, growth in the energy sector posted around 8 percent and clean energy around 9 percent (Figure 7).

Figure 7: Clean Energy Investments Drove Job Growth in the Energy Sector

Percent change in total number of employees, compared to 2021



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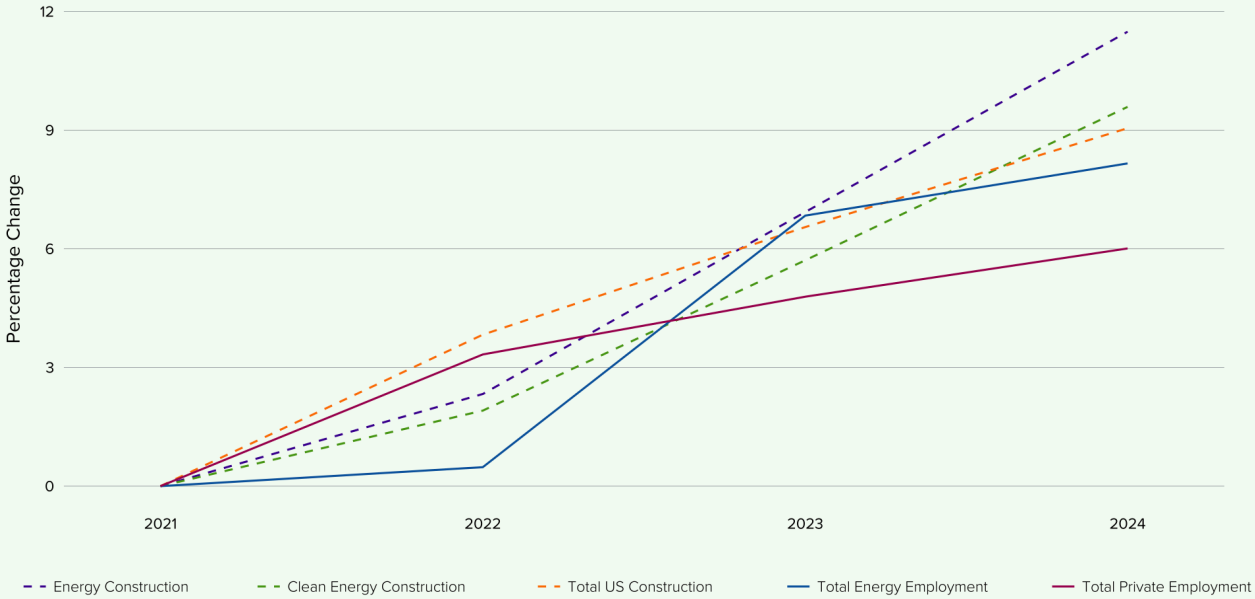
Source: Authors' analysis of BLS and USEER data

Growth in construction jobs, while strong overall, was even stronger in the energy sector. Between 2021 and 2024, energy construction employment grew by over 11 percent, and clean energy construction grew almost 10 percent. Both outpaced construction employment overall (Figure 8), signaling that the Biden administration's support for the sector through its industrial strategy had a significant impact. Notably, "energy jobs" defined in the US Energy and Employment Report do not include the construction of new energy supply chain structures or manufacturing facilities—given the historically high levels of manufacturing facility construction spending, including such jobs would likely result in a significantly higher figure.

Figure 8: Energy-Sector Construction Outpaced the National Average

Percent change in total number of construction employees, compared to 2021



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Source: Authors' analysis of BLS and USEER data

Clean Energy Manufacturing Grew at a Rate Five Times the Industry Average

In the clean energy sector, manufacturing employment figures reveal a glimmer of success. While manufacturing employment overall remained sluggish under the Biden administration, in part because of the time it takes to establish new production facilities, energy manufacturing growth proved stronger between 2021 and 2024 (Figure 9). Growth of clean energy jobs in the manufacturing industry deviated from national economy-wide trends since 2021, with a growth rate of 9.5 percent, more than five times higher than the industry average of 1.8 percent over the same period.

Figure 9: Growth in Clean Energy Manufacturing Deviated from Economy-Wide Trends
Percent change in total number of manufacturing employees, compared to 2021

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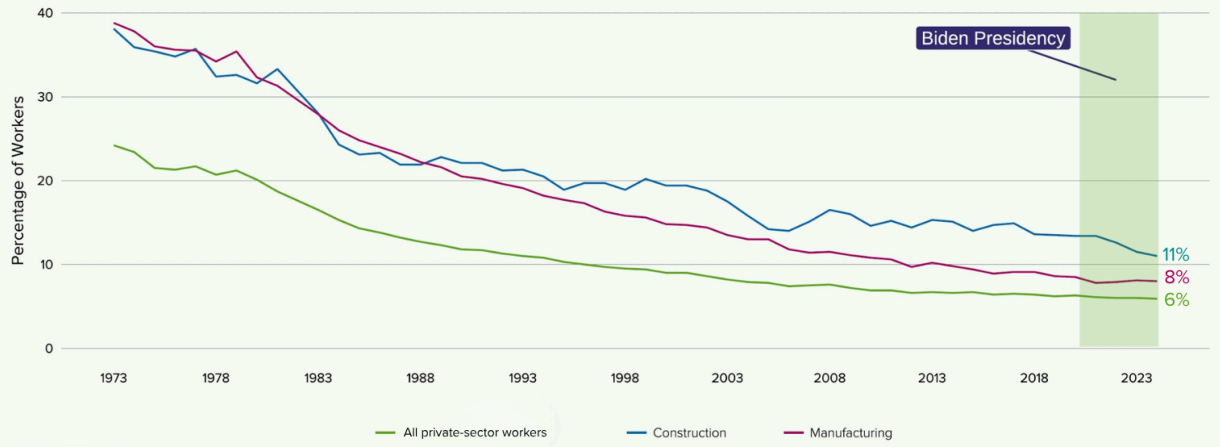
Source: Authors' analysis of BLS and USEER data

Energy Sector Saw Steady Growth in Union Jobs Amid Mixed Results Overall

Although there was a significant uptick in union activity between 2021 and 2024, economy-wide unionization rates did not reverse the trends of gradual decline, and the overall share of private-sector union membership fell from 6.3 percent to 5.9 percent (Figure 10).

The energy sector showed a different trend, with union representation increasing from 11 percent to 11.7 percent. In 2024, 34 percent of the net new energy jobs were covered by collective bargaining agreements. The divergence between economy-wide union trends and outcomes in the energy sector suggests that tying public investment to labor standards supports alignment and increased partnerships between employers and labor unions.

Figure 10: The Construction and Manufacturing Industries Have Seen a Steady Decline in Union Membership
Percent of workers that are members of unions



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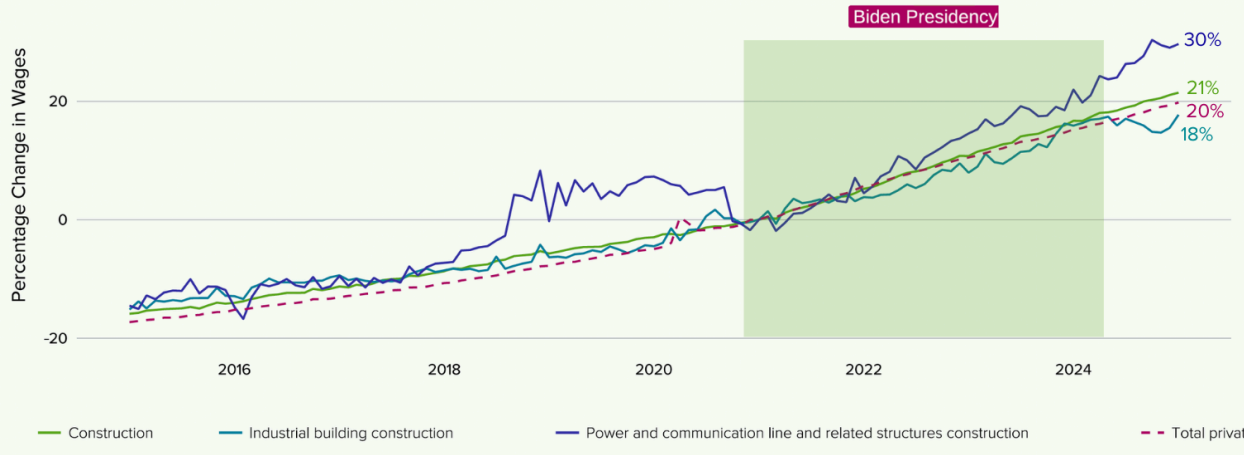
Source: Barry T. Hirsch, David A. Macpherson, and William E. Even, Union Membership, Coverage, and Earnings from the CPS, (Union Stats, 2025).

For Most Construction Jobs, Strong Wage Growth Dampened the Lingering Effects of Inflation

As construction employment grew, wages went up. Wages for all private-sector employees increased 20 percent from 2021 to 2025. Wages in the construction industry grew as well, with construction wages associated with certain energy projects (power lines and related structures) far outpacing average wage growth (Figure 11).

Figure 11: Under Biden, Wages in the Construction Industry Grew Substantially
Percent change in average hourly earnings, seasonally adjusted, compared to January 2021



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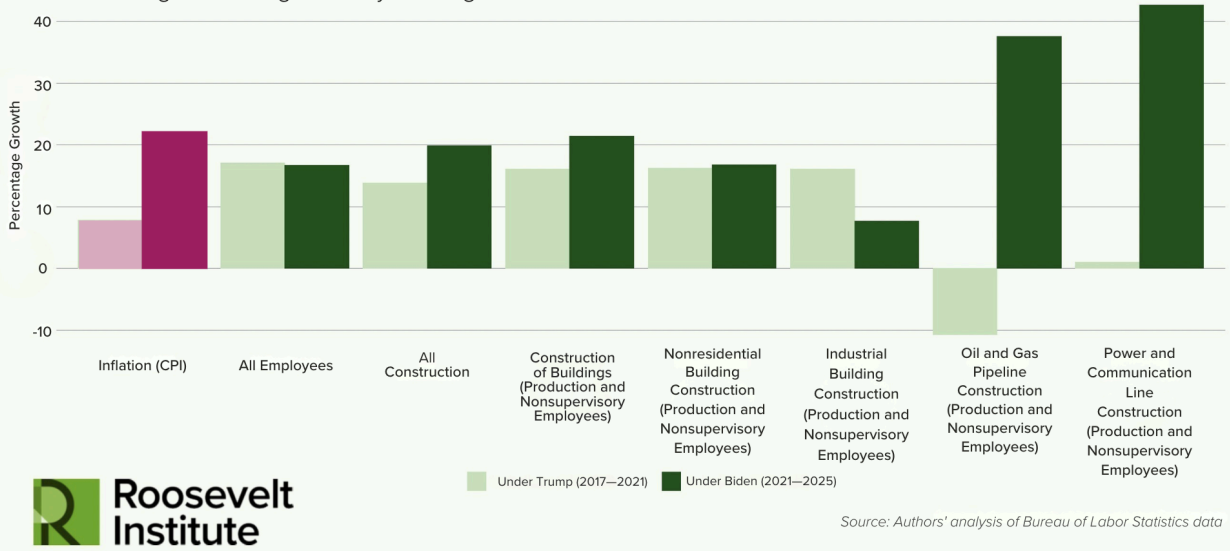
Source: Authors' analysis of Bureau of Labor Statistics data

Under the Biden administration, construction workers' earnings largely kept pace with COVID-induced inflation (see Figure 12). Nonsupervisory workers in construction of some energy-related projects saw earnings growth that far outpaced inflation. Workers in the construction of power and communication lines saw a 43 percent boost to weekly earnings, and oil and gas pipeline workers 38 percent, during the Biden presidency. Both groups suffered low or declining earnings, failing to keep up with inflation, during the first Trump administration.

Wage growth did not outstrip inflation in every construction sector, however. Those working in the construction of nonresidential buildings in general, and industrial buildings in particular, saw their real wages fall over Biden's period in office: The wages of nonresidential building construction workers rose by 17 percent and industrial building construction workers by 8 percent from January 2021 to January 2025, less than the 21 percent growth in prices over the same period. Although prevailing wage tax incentives applied to many clean energy projects and may have increased wages (see Section 3), there were no tax credits or prevailing wage bonuses for clean energy factory construction. For facilities receiving direct grants and loans, prevailing wage law applied, but general private-sector factory construction had no such labor standards or incentives to drive up wages.

Figure 12: Construction Earnings Growth Outpaced Overall Earnings Under Biden, Although Some Sectors Showed Signs of Weakness

Percent change in average weekly earnings



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Source: Authors' analysis of Bureau of Labor Statistics data

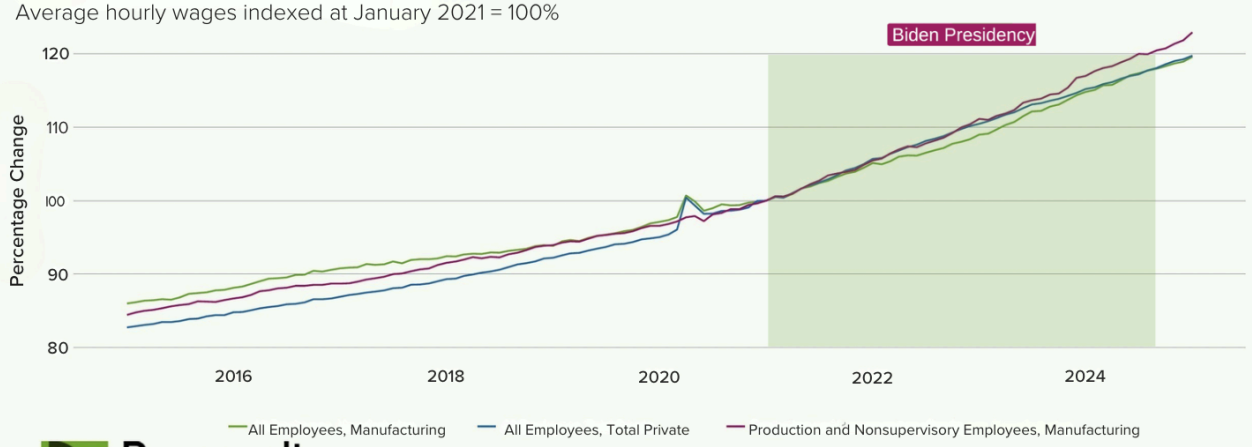
While construction earnings in certain subsectors far outpaced inflation (Figure 12), wages in manufacturing and the economy overall only modestly exceeded price growth (Figure 13). Manufacturing pay under the Biden administration broadly kept pace with, and in some cases slightly exceeded, overall wage growth in the economy. From January 2021 to January 2025, the average manufacturing wage increased from $29.04 to

$34.73—an increase of 19.6 percent. This represented substantially faster nominal wage growth than in the preceding four years (10.0 percent relative to baseline), but it slightly lagged cumulative inflation over the same period (approximately 21 percent).

Nevertheless, gains for production and nonsupervisory workers suggest that the investment cycle was improving job quality at the lower end of the wage distribution. Wage gains were stronger for production and nonsupervisory manufacturing workers, diverging from average manufacturing wage growth in 2023 and through 2024 (Figure 13). For these lower-paid workers, average hourly wages rose from $23.25 in January 2021 to $28.58 in January 2025—a 22.9 percent increase—exceeding inflation and outpacing wage growth for manufacturing workers overall.

Figure 13: Wages for Production and Nonsupervisory Employees in Manufacturing Increased During the Biden Administration

Average hourly wages indexed at January 2021 = 100%



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Source: Authors' analysis of Bureau of Labor Statistics data

Across a wide range of metrics, employment and wages grew considerably for many American workers during the Biden administration. These effects appear concentrated in the industries most immediately impacted by the rapid increases in infrastructure and industrial investments over the same period, but not all categories of workers saw the same level of increases. Wages in industrial facility construction, which includes new factories, failed to keep pace with COVID-era inflation.

While more research will be needed to understand the long-term impact of Biden-era industrial policy on productive capacity in the United States, it is clear that the administration's clean industrial strategy led to strong wage growth, record construction investment and employment, and historically low unemployment. These gains occurred while simultaneously advancing the nation's clean energy transition. Rather than an endpoint, the early results suggest the beginning of a longer-term project to rebuild domestic industry, accelerate decarbonization, and anchor economic growth in job growth, wage increases, and broadly shared prosperity.

Section 3: Tracking Results of Different Labor Policy Levers

The subsidies provided through the Biden administration's industrial strategy did not comprise a package of handouts to private industry investing in clean technologies. Rather, they contained many provisions to improve job quality, job access, investments in training, and community benefits. The Davis–Bacon Act set a wage standard for workers on IIJA-, CHIPS-, and IRA-funded construction projects; the IRA's prevailing wage and apprenticeship (PWA) bonus conditioned the full tax incentive on a wage and training standard; and the Department of Energy's Community Benefits Plan framework allocated 20 percent of the score of proposals for funding to labor and community commitments. These three procurement levers ensured federal investments were creating and distributing public wealth.

The Biden years were a boon for union construction workers and apprentices, and union-affiliated apprenticeship programs continued to train the vast majority of construction apprentices. For example: With project labor agreements (PLAs) on major projects like the Ford BlueOval campuses in Kentucky and Tennessee, the International Association of Sheet Metal, Air, Rail and Transportation Workers (SMART) saw the number of union apprentices in the sheet metal sector increase by 87 percent in Kentucky and 96 percent in Tennessee between 2022 and 2025. States building large battery and electric vehicle plants, particularly when those facilities had PLAs, consistently saw a significant uptick in union apprenticeship growth.[6]

Although factory construction itself did not qualify for any IRA incentives, several large factory projects received DOE loans, with Davis–Bacon Act prevailing wage requirements. In addition to wage standards, DOE strongly encouraged the use of PLAs for large grant- and loan-funded projects. Some other large non-factory energy projects (summarized on pages 31–32 of this report) triggered the IRA prevailing wage and apprenticeship incentives. The sections below detail the different policy levers and their effects on union jobs, training, and wages.

Davis–Bacon Act Increased Wages in Construction

Across IIJA, CHIPS, and IRA, most federally supported construction projects were required to comply with the Davis–Bacon Act, which mandates the payment of locally prevailing wages to laborers and mechanics, as determined by the US Department of Labor. Prevailing wages vary by region, craft, and classification, and in highly unionized labor markets they typically reflect higher union wage rates. In regions with low union density, prevailing wages can be significantly lower—sometimes as low as the federal

[6] Independent analysis by SMART provided to authors on March 19, 2026.

minimum wage of $7.25 per hour.[7] Davis–Bacon does not require the use of union labor; rather, because it establishes a statutory wage floor for federally funded construction projects to avoid a race to the bottom.

In practice, Davis–Bacon shapes labor markets by reducing wage competition on federally supported projects and incentivizing contractors to hire the most skilled workers available at the prevailing wage. Because construction unions invest heavily—approximately $2 billion annually—in apprenticeship and skills training, they are well positioned to compete for federally funded work. Davis–Bacon stabilizes the supply of skilled labor in an industry marked by volatility and temporary, often seasonal work. It facilitates alignment with labor unions without mandating unionization.

At the Department of Energy, the Davis–Bacon Act applied to nearly all CHIPS-, IIJA-, and IRA-funded construction projects, with limited exceptions for small-scale weatherization. Recognizing the compliance burdens associated with prevailing wage enforcement, DOE adopted a centralized approach early in the Biden administration. The department procured a standardized electronic certified payroll reporting system and hired dedicated compliance staff to review weekly payroll submissions across all projects.[8] This represented a significant departure from past practice, improving compliance while reducing administrative burden on both internal project managers and external contractors.

A secondary benefit of this centralized system was unprecedented data transparency. DOE gained real-time visibility into construction activity across its clean energy portfolio, including work hours, compensation, workforce demographics, apprenticeship participation, and geographic distribution of jobs. These data provided an early baseline for assessing job quality, demographics, and other labor market effects well before projects reached full operation. The ability to track these outcomes in real time could also provide feedback on other interventions, such as technical assistance to increase the participation of women in construction or to encourage contractors to create more opportunities for registered apprentices.

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[7] For example, for laborers in certain geographies in Texas, the prevailing wage determination is $7.25 per hour. In San Diego, by contrast, the lowest Davis–Bacon wage is $21.85 plus $7.15 in fringe benefits, and laborers make at least $40.70 plus over $21 per hour in benefits. A lineman earning $41.31 (plus benefits) in Texas must be paid $70.16 plus fringe benefits of $24.71 per hour in San Diego. Executive Order 14026 increased the minimum wage for federal contractors to $15 per hour pegged to inflation. Donald Trump revoked this order, reinstating the Obama-era contractor minimum wage ($13.30 per hour). *Sam.gov* notes, "the minimum wage requirements of Executive Order 14026 are not currently being enforced . . . [in] Texas, Louisiana, or Mississippi."

[8] Dedicating staff positions allows for recruitment and training of individuals with specific payroll compliance expertise, as well as pattern recognition to more easily flag discrepancies usually resulting from misclassification of workers.

As of November 2025, DOE was tracking over 1,000 projects subject to Davis–Bacon requirements, representing more than $8.4 billion in active construction budgets (see Table 1). The fastest IIJA DOE projects to implement were retrofit and weatherization projects. New construction projects had to go through project planning, design, and permitting and were slower to break ground. This is reflected in the more than fourfold increase in work hours in 2025. As a result of Davis–Bacon, average hourly compensation, including fringe benefits, was near $70—a 40 percent premium on average construction compensation in the US.

Demographic data are typically collected by employers through voluntary self-identification to support employer compliance with US Equal Employment Opportunity Commission reporting requirements. As such, race and gender are often included on payroll reports. In January 2025, 83 percent of workers in DOE's Davis–Bacon system reported their race or ethnicity, and by November, this figure had dropped to 62 percent. The Trump administration's aggressive rollback of DEI efforts may have dissuaded workers from reporting this information.[9]

Table 1. Certified Payroll Data for DOE-Funded Projects Subject to Davis–Bacon Act[10]

	January 2025	May 2025	November 2025	Change Since January 2025
Projects Tracked	428	611	1,051	Up 246%
Active Budget	$3.98B	$6.93B	$8.41B	Up 211%
Total Work Hours	235K	487K	1.05M	Up 447%
Total Compensation Paid (with benefits)[11]	$16.17M	$33.87M	$71.42M	Up 442%
Average Hourly Compensation (with benefits)[12]	$68.81	$69.54	$68.02	Down $0.79/hr

[9] Trump rescinded the long-standing Executive Order 11246 and eliminated DEI offices across federal agencies. He also redirected the Equal Employment Opportunity Commission under new leadership to investigate diversity programs as potentially discriminatory and significantly curtailed the enforcement authority of the Office of Federal Contract Compliance Programs.
[10] Data originally compiled for author's presentation "Unlocking Value: Davis-Bacon Reporting to Deliver Benefits Beyond Compliance" at the Ignite 2025 Conference (Long Beach, CA) on May 21, 2025 and from personal communication on LCPtracker.
[11] Davis–Bacon fringe benefits are explicitly specified in the wage determinations published on SAM.gov, along with the base hourly wage. To comply, contractors must provide bona fide fringe benefits (such as health insurance, retirement, training, paid time off, etc.) at the required rate or pay the fringe amount as additional cash wages on top of the basic hourly rate.
[12] The average US private-sector hourly compensation in September 2025 was $45.65 for all occupations and $49.05 for construction occupations, meaning these numbers were 49–52 percent higher than the overall average and 39–42 percent higher than the construction average.

Average Hourly Wage (before benefits)[13]	$48.81	$48.65	$47.66	Down $1.15/hr[14]
Nonwhite Work Hours	46% (17% "unspecified")	53% (21% "unspecified)	53% (38% "unspecified")	Up 15% Unspecified up 123%
Total Workers	1,018	2,104	4,647	Up 356%
Percent Apprentices	7.6%	8.4%	9.4%	Up 24%
Percent Women	2.6%	2.0%	1.9%	Down 27%
Percent from Energy Communities[15]	32.7%			

Davis–Bacon illustrates both the strengths and limits of existing US labor standards. While prevailing wage requirements support job quality in federally funded construction, there is no comparable statutory floor for manufacturing jobs supported through federal investment. The Walsh–Healey Act once played a similar role for federal procurement, but its scope has been narrowed through judicial interpretation and regulatory nonenforcement.[16] In a House version of the Build Back Better Act, the Advanced Manufacturing Investment Credit increased by 10 percent if the final assembly of the components was at a facility in the US "which operates under a union-negotiated collective bargaining agreement." This language did not make it into the final version of the IRA.

[13] The average US private-sector hourly wage in September 2025 was $32.07 for all occupations and $34.16 for construction occupations, meaning these numbers were 49–52 percent higher than the overall average and 40–43 percent higher than the construction average.

[14] There are a couple of potential reasons for the small wage decrease. Most likely is the range of crafts represented on DOE projects. Weatherization projects were the first projects implemented under the IIJA and IRA, and that work tends to be more concentrated in the specialty trades (mechanical, electrical, plumbing) for which wages are higher. The second reason is that Biden's Executive Order 14026 set a wage floor of $17.75 for federal contractors, which is considerably higher than Davis–Bacon prevailing wage (or Obama-established minimum) in some regions. Trump's revocation of that executive order may have led to measurable reduction in the average construction wage on DOE-funded projects.

[15] DOE stopped tracking employment in Energy Communities in early 2025.

[16] The Walsh–Healey Act (1936) was passed when federal purchasing power was huge, and reformers in Congress argued that the government should only buy goods from suppliers who met decent labor standards. Like Davis–Bacon, it required the payment of prevailing wages set by the Department of Labor, reflecting union wages in heavily unionized sectors and where union labor dominates the local market. It also banned the use of prison and child labor, set health and safety standards, and required overtime pay. Though Walsh–Healey is still on the books, the courts narrowed its scope through interpretation, deferred to agency nonenforcement, and treated Walsh–Healy as redundant with other laws. The Fair Labor Standards Act (1938) set a national minimum wage and overtime standards that eventually surpassed Walsh–Healy's, and the Occupational Safety and Health Act (1970) replaced its safety enforcement.

Tax Incentives Increased the Number of Construction Apprentices

The Inflation Reduction Act introduced enhanced tax credits for certain clean energy projects that meet prevailing wage and apprenticeship (PWA) requirements. (As noted above, clean energy manufacturing facility construction projects didn't qualify.) By paying prevailing wages and ensuring that registered apprentices perform at least 15 percent of labor hours, projects can claim tax credits up to five times larger than the base rate—typically increasing from 6 percent to 30 percent. Failure to comply (while claiming the credit) triggers financial penalties or loss of bonus eligibility, though in most cases developers can cure violations through back pay and penalties while preserving access to the enhanced credit.[17]

The Department of the Treasury, working closely with the Departments of Labor and Energy, issued detailed guidance clarifying compliance pathways for the clean energy credits. Because the financial value of the PWA bonus far exceeds the incremental cost of compliance, uptake has been widespread.[18] According to tax advisors and developers, PWA compliance has become the default pathway for clean energy projects rather than an optional add-on.

Cost Impacts of Prevailing Wage

A comprehensive review of economic analysis examining the cost impacts of prevailing wage in construction of schools, highways, and assorted municipal buildings finds that, in 90 percent of studies, prevailing wage laws do not increase construction costs. Prevailing wage requirements for affordable housing projects add only an estimated 0–3.3 percent to the costs of affordable housing construction. A firm that evaluates costs on large construction projects found that union labor projects have lower and more predictable costs, due to improved coordination and higher productivity. Such empirical data on renewable energy projects specifically is limited, in part because they are predominantly private-sector projects, and data is harder to attain.

[17] The penalties for noncompliance with the wage requirement are strictly financial and include back pay plus interest and a $5,000 fine per underpaid worker per violation, unless the violation was intentional, in which case the penalty increases to $10,000 per worker per violation. In the case of noncompliance with the apprenticeship standard (or a demonstrated good faith effort to hire apprentices), the taxpayer must pay $50 per labor hour not in compliance, increasing to $100 per hour if the violation was intentional. The Internal Revenue Service (IRS) accepts whistleblower reports of noncompliance, with relevant evidence like payroll records or communications.

[18] According to the authors' personal communication with Baker Tilly in May 2025 and other tax advisors.

Compared to public-sector construction projects, where construction labor accounts for about 23 percent of total project costs, on energy projects this figure is much smaller. Benchmarking studies from the National Renewable Energy Laboratory show that installation labor costs for utility-scale solar projects are less than 5 percent of total project costs. Even if prevailing wage requirements were to increase wages significantly without any offsetting improvements in productivity, total project costs would increase less than 1 percent. The cost impact of the use of registered apprentices is equally inconsequential, as the prevailing wage rates for apprentices are typically 50 to 80 percent of the rate for journey-level workers. The primary cost impact of the PWA incentive is the cost of ensuring compliance and adequate recordkeeping to avoid fines or loss of the bonus, which itself is minimal, particularly with the wide array of recordkeeping tools on the market.

The takeaway is that the IRA PWA incentive provides a 30 percent tax credit in exchange for a wage and training standard that adds minimal additional costs. It's reasonable to assume that all developers of projects that qualify for these IRA bonus credits will seek to comply with the requirements.

The Congressional Budget Office suggests that linking tax credits to other policy objectives—e.g., projects that pay prevailing wages and employ apprentices, are located in certain geographic areas, and use domestically sourced materials—"can encourage investment in projects whose costs per unit of generating capacity are higher than they would otherwise be, thus involving a trade-off between supporting the objectives and stimulating investment in wind and solar power at the lowest possible cost." When it comes to the labor standards, however, the research and data indicate that there is no such trade-off beyond the burden of maintaining compliance records.

While there is no public record of payroll or apprenticeship utilization for tax credit-eligible projects, proxy data suggest meaningful workforce effects.[19] The number

[19] The best source of national data on registered apprenticeships is the Registered Apprenticeship Partners Information Data System (RAPIDS), but these data have many known problems. First, inconsistent reporting across states, different data fields across jurisdictions, and variations in occupation titles and industry classifications produce gaps in the data. Second, sponsors or states may enter data weeks or months after events (registrations, completions, cancellations), and public data releases lag significantly behind real-time activity. We used RAPIDS data, with these caveats, to discern short-term trends. We compared 2023 and 2024 data on new apprentices, which according to the California state apprenticeship office is a more accurate count than "active apprentices." We also rigorously cleaned the data to capture the wide variation in occupational titles, relying on the Institute for Construction Employment Research's apprenticeship report and other apprenticeship experts to identify nuances in the data. Future, more robust apprenticeship analyses may discern different results than those shown here.

of registered construction apprentices increased over six times more in the two years after the IRA's passage than in the preceding two-year period.[20] Given that this increase coincided with record-setting construction activity, can this increase in registered apprentices in construction be attributed to the IRA PWA incentive rather than economy-wide trends?

Investment in PWA-projects would not affect all construction workers equally, so to understand the IRA's effect on apprenticeship growth, we looked at the types of PWA-eligible project investments and the occupational needs of those projects. If PWA was driving apprenticeship growth, we would expect to see a statistical correlation between an increase in apprentices in those occupational categories and PWA-eligible investments.

We analyzed clean energy investment data and parsed the investments that would have qualified for the PWA bonus. The following tax credits (and project types) triggered PWA: 30C (electric vehicle refueling property), 45 / 45Y (production credits), 48 / 48C / 48E (investment credits), 45Q (carbon capture), 45V (clean hydrogen), 45Z (clean fuel production), and 179D deduction (commercial buildings).[21] The sum total of PWA-eligible investment across states between August 2022 and December 2024 was $297 billion.[22] As a rough estimate, assuming 15 percent of approximately 1.2–1.6 jobs per $1 million investment in solar and/or storage, this investment might require 53,000–71,000 apprentices.[23]

By the start of 2025, 46 states had seen construction commence on projects totaling at least $100 million in capital expenditure associated with PWA-eligible projects, and 40 had eligible project investments in excess of $1 billion.[24] Investment was especially concentrated in states with large clean energy pipelines, the highest being Texas, California, Arizona, Georgia, North Carolina, Michigan, Indiana, Kentucky, Nevada, and Ohio (ranked) (Figure 14).

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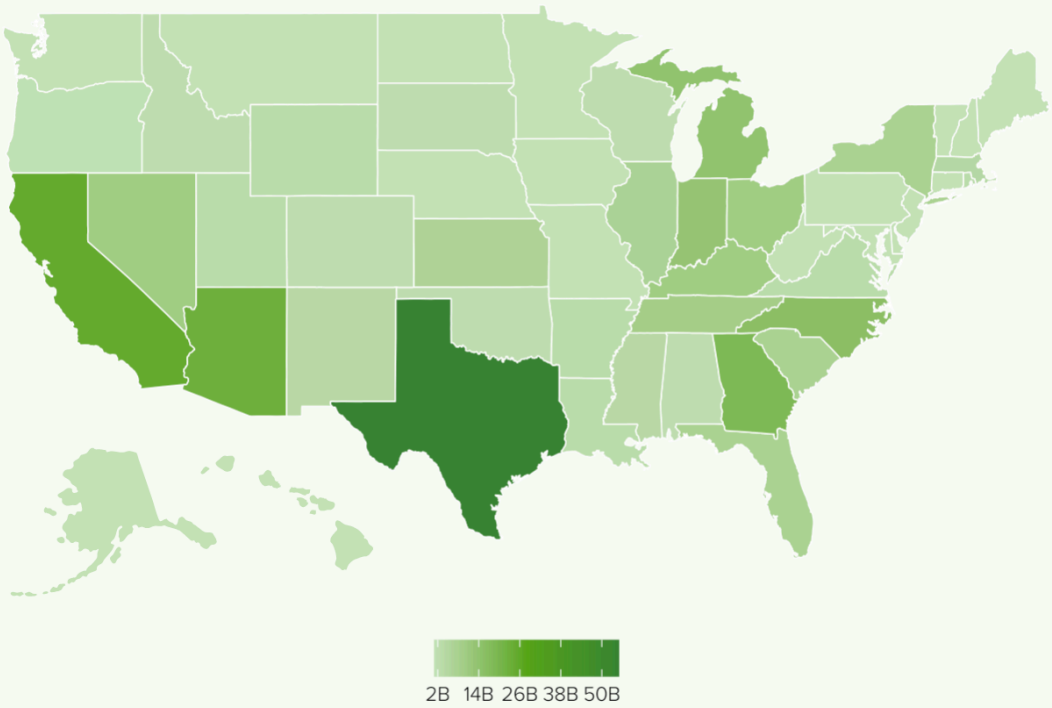
[20] RAPIDS data show a jump in construction apprenticeships following passage of the IRA. Overall construction apprenticeships increased 14.2 percent between 2022 and 2024, far faster than the sector's 2.2 percent growth in the preceding two-year period (between 2020 and 2022).
[21] Only prevailing wage (without apprenticeship) applies to 45L (energy-efficient homes) and 45U (nuclear).
[22] Authors' analysis of Rhodium Group and CEEPR Clean Investment Monitor data.
[23] This assumption is based on National Renewable Energy Laboratory data on solar jobs per MW (2.1–2.9) and Solar Benchmarking model cost per megawatt (MW) of utility solar ($1,806/100 MW(dc)). Both jobs and apprentices are reported in job-years (one job or one apprentice working full time, or around 1800 hours, for one year). Not all construction workers or apprentices work full-time hours, so the actual head count of workers can be significantly higher. Since apprenticeships are multiyear, a smaller number of new apprentices would be needed.
[24] Authors' analysis of Rhodium Group and CEEPR Clean Investment Monitor data by total project capital expenditure and construction start date.

Figure 14: Investment in PWA-Eligible Tax Credits

Investments with construction start date between August 2022 and December 2024



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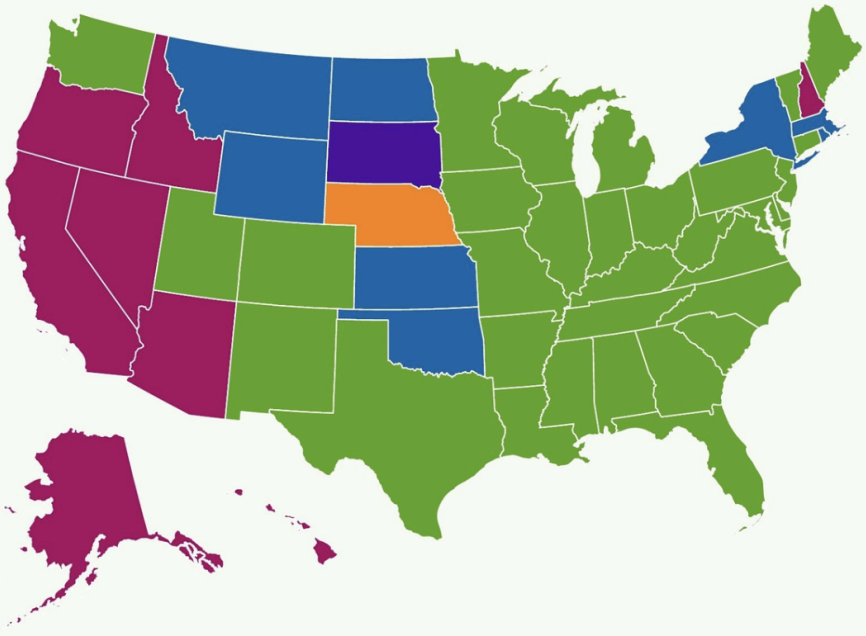
Source: Authors' analysis of MIT - Rhodium Group Clean Investment Monitor data

The vast majority of PWA-eligible projects were in solar and battery storage projects.[25] Figure 15 shows the most prevalent project type by state. In 40 states, solar or storage had the most investments of all the PWA-eligible project types. The most common trades employed on those projects are electrical workers, construction laborers, operating engineers, carpenters, and structural ironworkers, so those are the occupational categories that we used to evaluate potential IRA-triggered apprenticeship growth.

[25] Authors' analysis of Rhodium Group and MIT CEEPR Clean Investment Monitor data by tax credit eligibility.

Figure 15: The Top Technology for PWA-Eligible Investment Varied by State
Projects either under construction or operational between August 2020 and December 2024



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Clean Fuels | Sustainable Aviation Fuel | Solar | Storage | Wind

Source: Authors' analysis of MIT - Rhodium Group Clean Investment Monitor data

Looking at the relationship between PWA-eligible investments and total new apprentices for the five most common occupations in those investments shows a solid but not overwhelming connection between the two: PWA-eligible investments explain about 48 percent of the growth in new apprentices (Figure 16).

There is an important difference between active and new apprentices. Active apprentices represent the total pool of apprentices available to work. Apprenticeships are multiyear training programs, and in any given year some apprentices are graduating (with a journey card, which is like a degree) and some are starting (new apprentices). Figure 16 tracks new apprentices against PWA-eligible investments. Each dot on the graph represents a state, and the line shows the correlation between PWA-eligible investments and new apprentices.

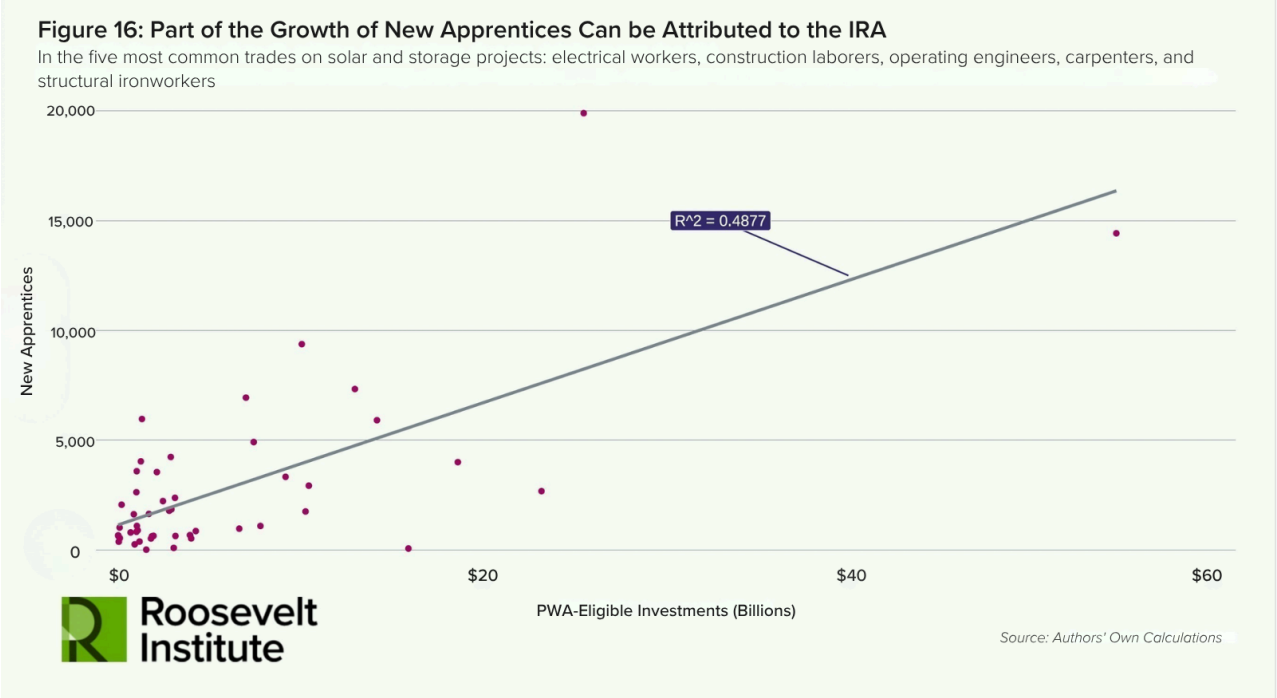


Figure 17 shows active apprentices. Programs with a large pool of active apprentices will not need to bring in as many new apprentices to meet demand. Many programs, particularly union programs, are committed to ensuring that their apprentices have access to the work they need to continue their education and graduate in a reasonable amount of time, as opposed to remaining in training indefinitely. The number of openings for new apprentices, therefore, needs to be carefully calibrated. This is to say that, even if modeling suggests a need for 89,000 apprentices for IRA projects, we wouldn't expect all of those to be *new* apprentices. Using existing apprentices can also be beneficial to project developers because they are more experienced.

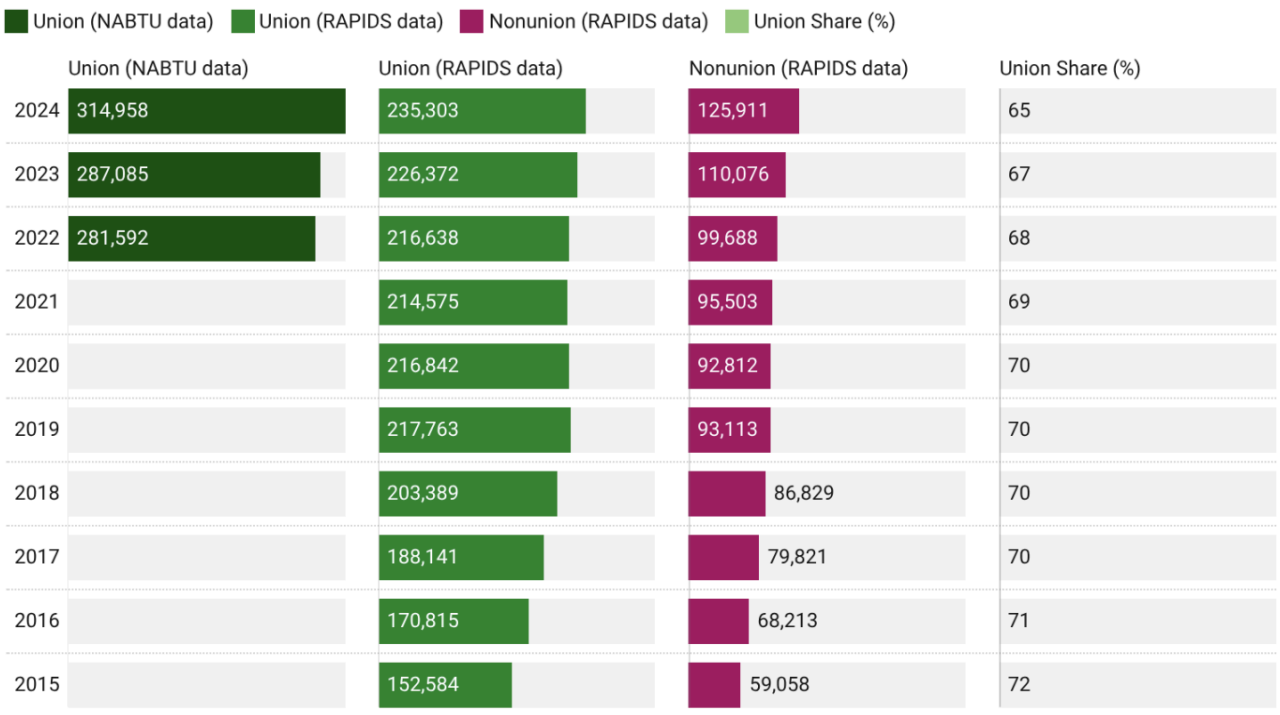
Construction Union Apprenticeships Have More Active Apprentices

After the passage of the IRA, both union and nonunion apprenticeship programs expanded their active apprentices. According to Department of Labor data available in RAPIDS (which does not reflect accurate data for all 50 states),[26] union programs increased active construction apprentices by 18,665 from 2022 to 2024, and nonunion programs increased by 26,223. North America's Building Trades Unions' data collected directly from their members in all 50 states show an increase of 33,366 active apprentices. Both datasets show that the majority of construction apprentices are in union programs. Over the same period, RAPIDS indicates that union programs

[26] States with obvious missing or incomplete data are Connecticut, the District of Columbia, New York, North Carolina, Oregon, Virginia, and Washington.

graduated 61,811 apprentices (77 percent of the total) and nonunion programs only graduated 18,021.

Figure 17: Nationwide, Most Active Apprentices Are in Programs Administered by Unions



	Union (NABTU data)	Union (RAPIDS data)	Nonunion (RAPIDS data)	Union Share (%)
2024	314,958	235,303	125,911	65
2023	287,085	226,372	110,076	67
2022	281,592	216,638	99,688	68
2021		214,575	95,503	69
2020		216,842	92,812	70
2019		217,763	93,113	70
2018		203,389	86,829	70
2017		188,141	79,821	70
2016		170,815	68,213	71
2015		152,584	59,058	72

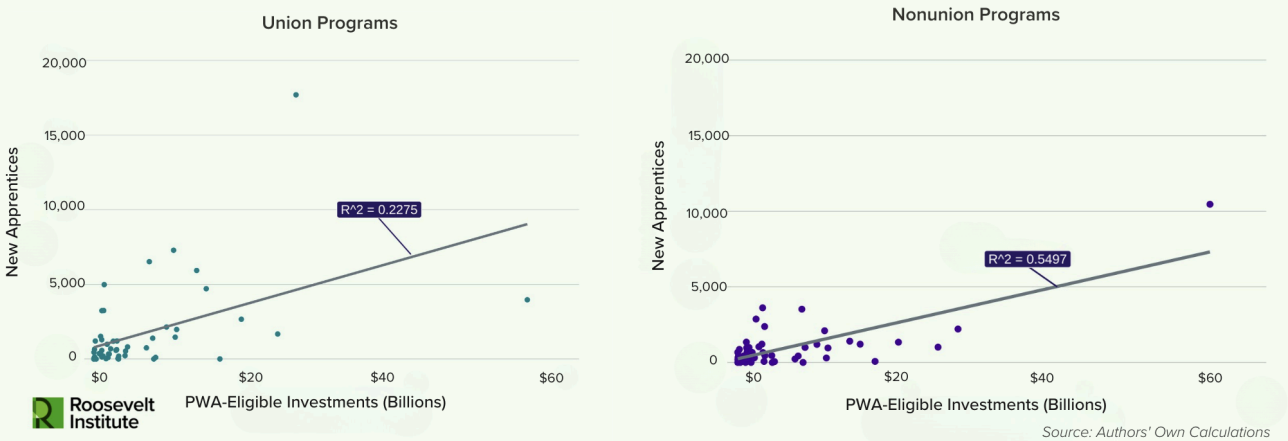
Source: Registered Apprenticeship Partners Information Database Information Database System (RAPIDS) and the North America's Building Trades Unions (NABTU) training data dashboard.

Created with Datawrapper

Growth of New Union Apprentices Exceeded Nonunion Apprentices, but PWA Had a Stronger Effect on Nonunion Program Growth

These same data show that PWA investments did not drive *union* apprenticeship growth as much as nonunion apprenticeship growth. The five trades most likely involved in IRA PWA projects accounted for 83 percent of nonunion apprenticeship growth from 2022 to 2024 and only 35 percent of the union apprenticeship growth in the same period. Figure 18 shows that PWA investment explained 55 percent of the new apprentices in nonunion programs and only 23 percent of the growth of union programs. It appears that union programs were better positioned to address the labor demand driven by an increase in construction activity generally and therefore not as reliant for growth on the specific IRA tax incentives tied to the use of registered apprentices.

Figure 18: Relationship Between New Apprentices and PWA-Eligible Spending by State (2023—2024)
New apprentices in top five trades for solar and storage projects



Source: Authors' Own Calculations

Among the 10 states with the highest investment in PWA-eligible projects,[27] the story is largely the same as it is for the US on the whole. While these states saw 49,455 new union apprentices and 22,255 new nonunion apprentices in the five trades in 2023–24 (making the cohort 69 percent union), this is weaker than the 76 percent of new apprentices in union programs across the same states in 2021–22 (41,236 union vs. 12,978 nonunion). Among these 10 states, only Indiana and Tennessee increased union density among the cohort of new apprentices (Table 2).

The share of nonunion new apprentices in the five trades increased in 29 states. The share of union new apprentices increased in 13 states of the 44 states for which we have RAPIDS data.[28] The 13 states showing an increase in the share of new union apprentices were: Alaska, Arkansas, Delaware, Hawaii, Idaho, Indiana, Iowa, New Hampshire, Oklahoma, Rhode Island, South Dakota, Tennessee, and Wyoming.

Unions still added the majority of new apprentices in 2023 and 2024 (62 percent) and added more new apprentices than nonunion programs in 30 states; however, their share of new apprentices nationally went down from 69 percent in 2021–22. In addition, in three states (Mississippi, North Dakota, and Maine), the union share went from more than 50 percent to less than 50 percent.

[27] Ranked by PWA-eligible investments: Texas, California, Arizona, Georgia, North Carolina (no apprenticeship data), Michigan, Indiana, Kentucky, Nevada, Ohio, and Tennessee.
[28] RAPIDS data was sorted by occupation. These construction apprentices show up in several different industries in the RAPIDS database, as some states classify apprentices in the Educational Services category.

Table 2. Change in Union Density in New Apprentice Cohort for the Top 10 States by PWA-Eligible Investments

	Percent of New Cohort Union 2023–24	Percent of New Cohort Union 2021–22
Texas	27%	42%
California	89%	91%
Arizona	62%	68%
Georgia	67%	69%
Michigan	80%	83%
Indiana	81%	76%
Kentucky	67%	70%
Nevada	83%	87%
Ohio	78%	79%
Tennessee	64%	60%

The pattern across all 44 states shows that PWA-eligible investment was positively correlated with new apprenticeship numbers in 2023–24 but that higher PWA-eligible investment was more predictive of growth of new nonunion apprentices (Figure 17), whereas overall construction trends were a stronger driver of new union apprentices. While there is no better national source of nonunion data, the unions track their own apprenticeship data, which differs from that reported in RAPIDS. (For more apprenticeship numbers by state, see Appendix B.)

In the Five Trades Most Common on PWA-Eligible Projects, Average Wages for Apprentices Increased 12 to 27 Percent

From 2021 through early 2025, median starting wages for new apprentices in the five trades most common on PWA-eligible projects rose substantially. Median wages increased 27 percent for nonunion apprentices and 12 percent for union apprentices, indicating that IRA requirements increased compensation for apprentices.

By early 2025, the average starting wage for new union apprentices in these trades reached $23.10 per hour, compared to $19.57 for nonunion apprentices, reflecting an average union wage premium of 18 percent. In 2021, starting wages were $20.58 for union apprentices and $15.44 for nonunion apprentices, representing a 33 percent union premium. This means that throughout the Biden administration, nonunion

programs not only significantly expanded their apprentice programs, but workers in their training programs saw significant wage increases, getting much closer to parity with union apprentices, who still start at higher average wages.

Union apprentice wages were highest in Utah, Rhode Island, Wisconsin, New Mexico, and Minnesota, where median starting wages ranged from $28.83 to $33.94 per hour by early 2025. Among nonunion apprentices, the highest median starting wages were observed in Alaska, South Carolina, Maine, Nebraska, and Hawaii, ranging from $23.63 to $26.00 per hour.

These reported average starting wages are for new apprentices only. As apprentices gain skills and experience, their compensation usually increases. Paid on-the-job training confers significant advantages to workers. Not only do they avoid taking on educational debt, but they also don't need to take time away from earning to develop portable, industry-recognized skills. The increase in apprentice wages over the term of the Biden administration—aided by both the Inflation Reduction Act PWA bonus and a healthy construction market overall—means that tens of thousands of workers, many without college degrees, started on the path to stable, family-sustaining careers.

Many Aligned Efforts Expanded Registered Apprenticeship

The Biden administration and building trades unions made concerted efforts to support unionized apprenticeship programs in the US. Several construction unions quickly developed implementation mechanisms that aligned clean energy deployment with union labor standards. The International Brotherhood of Electrical Workers, the International Union of Operating Engineers, and the Laborers' International Union of North America jointly established the National Tri-Trade Solar Agreement (NTTSA), a project labor framework tailored specifically to utility-scale solar construction and designed to facilitate compliance with PWA requirements.

The Treasury Department supported unionization by reducing penalties for certain PWA compliance failures when projects were constructed under project labor agreements, because such agreements provided for self-enforcement. Certain federal funding also supported workforce intermediaries associated with unions. Together, these developments lowered compliance risk, increased predictability for developers and investors, and made union partnerships an attractive pathway for meeting PWA requirements. Many developers and engineering, procurement, and construction firms gravitated toward union agreements—through the NTTSA or other collective bargaining arrangements—not only to ensure compliance but also to capture the cost effectiveness and productivity gains of union labor as well as to benefit from unions' local advocacy in support of clean energy projects.

However, not all efforts aligned with a high-road strategy. Other federally supported efforts operated at cross-purposes with the administration's broader goal of expanding union employment in clean energy. In mid-2023, the Department of Labor awarded a workforce intermediary contract to the Interstate Renewable Energy Council (IREC) to support the development of apprenticeship programs that would meet IRA requirements. While not explicitly anti-union, IREC has an apprenticeship finder that lists only nonunion programs. Through its federally funded technical assistance, IREC supported the registration of 31 new apprenticeship programs and more than 1,100 apprentices—expanding apprenticeship capacity, primarily through nonunion pathways.

Additionally, while there is only one federal framework for Registered Apprenticeship, apprenticeship programs can be approved by either the Department of Labor or a State Apprenticeship Agency that meets or exceeds the federal standard. States vary widely in their speed of approval, prioritization of applications, technical assistance, and enforcement capacity. In states using the Department of Labor system, multiemployer programs common with labor unions are at a disadvantage due to longer approval periods relative to single-employer programs, and state systems of technical assistance often prioritize the needs of new employers over existing programs. State workforce boards can support high-quality programs, such as California's High-Road Training Partnership model, or incentivize quality programs that lead to higher graduation rates. Alternatively, some states like South Carolina and Texas have rapidly grown their apprenticeship system with low barriers, no-cost support for employers, and financial incentives for employers to hire apprentices.

Taken together, these dynamics suggest that, while the IRA incentive was powerful in shaping investment behavior and the PWA increased the number of new apprentices, its effects on union job growth were contingent on the surrounding institutional and policy ecosystems. Where unions were able to coordinate across trades, offer turnkey compliance solutions, and align with Treasury guidance, PWA reinforced union employment. Where federal or state workforce initiatives emphasized apprenticeship expansion without parallel coordination with union systems, PWA compliance could be achieved without strengthening collective bargaining.

DOE's Procurement Policies Resulted in 74 Percent of Major Project Funding Supporting Formal Labor or Community Benefits Agreements

The Department of Energy's Community Benefits Plan (CBP) framework required applicants for large clean energy grants and loans to articulate how their projects would deliver benefits across four dimensions: (1) engagement with labor and community partners, including negotiated agreements; (2) investment in workers

through job quality and worker voice; (3) diverse, equitable, and inclusive access to economic opportunity; and (4) tangible benefits to disadvantaged communities under Justice40. CBPs were required in funding proposals, but the specific commitments in the plans were, by legal necessity, voluntary. DOE competitively scored the strength of the commitments, and stronger, more specific, and better-integrated plans often proved decisive in funding decisions. DOE strongly encouraged—but could not require either legally or practically—negotiated and enforceable Labor or Community Benefits Agreements pre-award.[29]

DOE created a map and project database with CBP summaries, where program offices had made those available. In this database—initially published by the Office of the Undersecretary for Infrastructure, archived by Data for Progress, and recreated by the UC Berkeley Law School—DOE selected over 1,000 projects through competitive solicitations and supported over 4,000 projects through formula funding. The UC Berkeley data reflects a subset of competitively awarded energy and manufacturing projects that had submitted CBPs. This database included 635 projects, representing $110 billion of loans, grants, and tax credits. To this data, our project team added additional loan projects that hadn't been included in the original dataset and limited the dataset to only major projects, defined as receiving $50 million or more in federal funding. This resulted in over $123 billion across 211 awards, with some awards representing multiple projects. Over 60 percent of the awards (52 percent of the funding) went to projects in states not considered union strongholds. Our team also reviewed DOE fact sheets and public information to capture commitments to use negotiated formal agreements that hadn't been accurately described in the original DOE data or in the UC Berkeley data. Most of the previously uncaptured agreements were PLAs and/or other collective bargaining agreements.

Resulting data showed that over half of DOE selections included commitments to negotiate or existing formal labor or community agreements. Such commitments represented 74 percent of total funding (Table 3).[30] Labor agreements were disproportionately concentrated in high-dollar projects, with the greatest potential for shared benefits and also the highest risks of opposition, labor shortages, or other implementation challenges impeding implementation.

[29] Per DOE's CBP FAQ, DOE's goal was to maximize success of IIJA-funded projects, and DOE therefore encouraged the expansive use of negotiated and enforceable Labor and Community Benefits Agreements—legal enforceability being a key tool for accountability. DOE incorporated milestones toward negotiating such agreements or compliance with existing agreements into its funding award terms.

[30] Some selectees agreed to labor agreements for some, but not all, of the work. The amount could not be parsed out in the data available.

Table 3. Binding Labor and Community Agreements in DOE-Funded Projects

Type of Binding Agreement	Percent of Selectees	Percent of Total Funding	Detail
Any legally binding labor or community agreement	52% 110 selectees	74% $91B	• 110 major projects either had in place or committed to negotiate formal agreements. • 32 projects committed to both community and labor agreements. • Average award size with agreements: $824M • Average award size without agreements: $323M
Project Labor / Collective Bargaining Agreements	39% 91 selectees	68% $88B	• Labor agreements were concentrated in high-dollar projects. Average award size: $962M • 55 selectees (over $50B) had in place or committed to labor agreements for construction • 49 selectees (over $40B) had collective bargaining agreements in place for operations or pledged neutrality and/or card check • 17 loan-funded projects and 74 grant-funded (or credit) projects committed to or had labor agreements.
Community / Tribal / Good Neighbor Agreements	24% 51 selectees	8% $10B	• Community, tribal, or good neighbor agreements were more common in grants and smaller-dollar projects. Average award size: $186M

Of the 211 projects receiving at least $50 million in federal support (designated here as "major projects"), 110 either had in place or had committed to negotiate a legally binding labor, tribal, or community agreement.[31] Of these, 91 projects had project labor agreements, other collective bargaining agreements, other neutrality pledges, memoranda of understanding, or other commitments.[32] 51 projects committed to Community Benefits Agreements, Good Neighbor Agreements, or Tribal Agreements. 15 percent of the projects (32 projects) committed to both labor and community agreements. These are remarkable results for a discretionary agency policy.

[31] While false positives are unlikely, tracking agreements is challenging, and the actual number may be higher. Public documents need to be reviewed in more detail to develop an accurate count.
[32] Ascertained via authors' additional research and analysis of projects in the database maintained by CLEE.

Note on Award Cancellations

To understand the impact of announced cancellations, it's useful to understand the funding process. Congress appropriates funding to DOE for specific programs (appropriated funds). Then DOE designs programs, solicits and reviews proposals, and selects and announces awards (awarded or committed funds). Next, DOE negotiates the terms of those awards and enters into formal agreements with awardees (obligated funds). At key milestones, DOE transfers funding to those projects (outlayed funds). USA Spending tracks obligations and outlays.

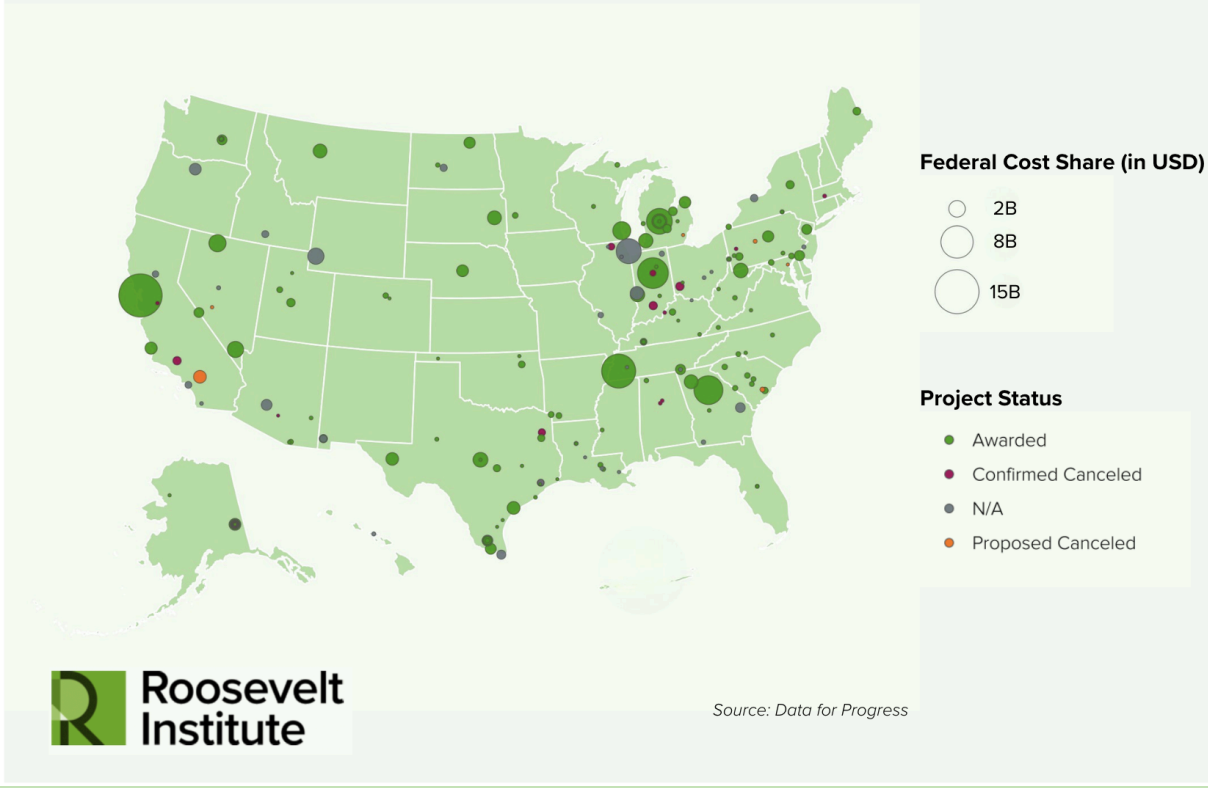
Once DOE announces a cancellation of an obligated award, a project proponent can either accept or challenge the cancellation. If they challenge it, DOE might reinstate the funding, or the company can pursue legal action, during which no rescission is possible.

Before the end of the Biden administration, DOE had awarded about 99 percent of its appropriated funding for competitive grants under IIJA and IRA, and about a third of that was obligated.

In October 2025, DOE announced cancellation of 321 awards totaling $8 billion in awarded funds, some of which had been already announced as canceled in May. According to analysis by the EFI Foundation, the October cancellations represent 7 percent of the total obligated funds. The majority of the canceled awards affected nonprofits, state governments, and public universities. Less than $3 billion of canceled awards affected private-sector businesses.

For major projects with community benefits plans, the below map, created by Data for Progress, shows the rather limited extent of formal cancellations. Fewer than 8 percent of the awarded projects (comprising less than 3 percent of the awarded funding) have been announced canceled. Another 5 percent of the projects representing 2 percent of the funding were proposed to be canceled in a leaked DOE document in the fall of 2025. That means DOE has not formally canceled 87 percent of the projects; however, capital outlays remain low, and delays in funding and lingering uncertainty can lead to canceled projects anyway.

Figure 19: Map of DOE-Awarded Projects with Community Benefits Plans by Federal Cost Share and Cancellation Status



High-quality CBPs demonstrated partnerships with labor and community organizations, reflected local needs and priorities, and were integrated into project design rather than treated as peripheral obligations. Plans that framed community benefits as part of a project's risk management and implementation strategy scored highest. In practice, this meant embedding workforce pipelines, job quality standards, and community engagement into the core business case for a project, with real plans for accountability to affected workers and communities.

Strong commitments could include financial support for training partnerships to prepare formerly incarcerated workers for registered apprenticeships, wage commitments for manufacturing jobs pegged to the 75th percentile for the relevant industry and occupation, or childcare stipends designed to improve recruitment and retention for workers with caregiving responsibilities. By contrast, proposals that emphasized unrelated charitable gestures or marketing efforts—such as hosting periodic food trucks, funding playground equipment, or sponsoring local sports teams—were viewed as insufficient when they lacked a clear connection to workforce development, job quality, or the equitable sharing of project benefits.

CBPs thus became a mechanism through which DOE used discretionary authority to attach labor and equity standards to federal energy investments—not as aspirational value statements, but as practical tools to mitigate implementation risks. Robust plans reduced the likelihood of workforce shortages, labor disputes, safety incidents, poor workmanship, and community opposition. These benefits are often overlooked in critiques focused narrowly on speed and discounted in standard debates on abundance, but in practice, as the interviewees in Section 4 attest, upfront engagement frequently accelerates deployment, and negotiated agreements reduce friction during construction and long-term operations.

DOE operationalized this framework by recruiting and training specialized reviewers with expertise in labor standards, workforce development, equity and justice, and community engagement. While technical and financial criteria accounted for roughly 80 percent of project scoring, the remaining 20 percent associated with CBPs often differentiated otherwise comparable proposals. Following award, CBP commitments became contractual obligations, with continued funding contingent on progress toward agreed milestones.

Early Results of Biden's Policy Agenda Were Notably Positive for Workers

Though the energy-sector data showing growth in clean energy, manufacturing, and construction appear to be in response to IIJA and IRA, attributing changes in economic data to specific policy agendas or interventions is challenging. For example, while the Biden administration policies undeniably stimulated and accelerated investment in US-based industry, new investment announcements do not immediately translate into jobs created or wages paid. Resulting job and wage growth could materialize during or even after the second Trump administration. At the same time, Trump's trade restrictions and tariffs could amplify or moderate the effects of Biden-era policies. Interviews with company executives emphasize that, regardless of whether a specific policy intervention is helpful or hurtful to a particular industry, the volatility of industrial policy signals has costly impacts and makes already stochastic data even more difficult to interpret.

What is evident in the data is that President Biden oversaw a historically rapid recovery from the COVID pandemic, with record-high job creation and record-low unemployment. While post-COVID inflation was high, wage growth and earnings were solid and in many sectors kept pace with or exceeded inflation. Grants, loans, and incentives for energy infrastructure and supply chains accelerated investments in the US, and clean energy drove job growth in the energy industry, with above-average growth rates in both construction and clean energy manufacturing.

Taken together, these economic indicators suggest that the Biden administration's climate and industrial policies were effective at reshaping near-term investment behavior and labor market dynamics, even before the full realization of manufacturing employment. Construction activity and wage growth point to early-stage capital commitment, sector-specific unionization gains indicate emerging institutional alignment, and sustained clean energy job growth reflects a reorientation of the energy economy toward new technologies. The full employment and wage effects, political economy benefits, and greenhouse gas emission reductions enabled by these investments are likely to unfold over a longer time horizon.

While federal investments do not automatically translate into improved job quality, the statutory, incentives, and discretionary standards adopted in the Biden administration showed real promise. The Davis–Bacon Act increased construction wages, the IRA's prevailing wage and apprenticeship incentive expanded apprenticeships, and the DOE's community benefits plans expanded union partnerships. Each mechanism helped federal subsidies translate into public wealth through better jobs and community benefits.

The above data show that, by the end of the Biden administration, prospects for American workers had improved considerably, buoyed by the alliance of clean investment and worker-friendly policies. Next we turn to how private companies navigated and responded to these standards and incentives—how effectively these mechanisms shifted private-sector investments and practices, and the perceived benefits and durability of those changes.

Section 4: Federal Policy Shifted Corporate Strategy Toward Strong Labor and Community Practices

As noted in the introduction, much of the punditry around the Biden administration's industrial policy record—in particular, whether and how pro-labor and pro-community conditions were fatal to implementation—suffered from weak to nonexistent reporting. By contrast, this section provides an unprecedented and extensive look into the state of play on the ground, four years out from the launch of the policies.

Our project team reached out to over 50 companies that had received DOE grants, loans, or 48C tax credits for interviews, using direct contacts of the authors as well as introductions from other former DOE staff. The goal of the interviews was to understand the companies' experiences with the federal funding opportunities, including friction points, conditions on funding, and the effect of incentives. We also wanted to understand their approaches to workforce needs and how they approached new partnerships with labor unions, workforce partners, and community groups. In

particular, we sought company perspectives on DOE's community benefits plan requirements—and what worked or didn't work about the framework and why.

Specifically, we wanted to address the following unknowns:

- Durability: Are companies continuing to implement community benefits plans (CBPs), and have there been any significant changes to what they proposed?
- Differences: How did labor and workforce commitments in CBPs vary between states, sectors, and size of projects?
- Company perspectives: Were CBPs seen as a risk mitigation or other value-added activity, or were they costly or useless exercises?
- Policy influence: Which policy levers (Davis–Bacon, IRA tax credits, CBPs) led to real changes in how companies thought about working with labor unions and community stakeholders?

The interview sample included 11 executives regarding individual project implementation, 2 industry associations regarding the experience of their members, and 1 venture capital firm involved with several DOE-funded projects. This sample is far from representative, and it reflects the perspectives of companies willing to participate. As a result, findings illuminate patterns and insights rather than quantifiable evidence. The project team also conducted formal interviews with a few stakeholders—labor unions and organizations named as partners in CBPs as well as an individual who had himself interviewed many community stakeholders. We scoured company websites and news stories to garner additional company insights about the above questions, and, in the processes of trying to secure more company interviews, we spoke informally with several project advisors, former DOE senior leaders, and community and labor stakeholders who shared their thoughts on these themes. The below quotes and themes are taken directly from the industry actors.

The introduction of loans, tax credits, and grants under the Biden administration provided clear signals to investors and companies: The government was interested in growing a clean energy economy and would work in lockstep with the private sector to achieve its goals. Investment increased rapidly under Biden (Section 2) in part because the federal government's promise of support encouraged companies to invest in clean sectors. As an executive in **Interview A** emphasized: "*It's absolutely undeniable that it accelerated investment. Would we have done as much investment? Maybe. But we would have wrung our hands for longer.*"

Incentives under the IRA and IIJA mitigated not only financial risk but also strategic exposure to an increasingly volatile global environment, tipping investment decisions toward US production. Incentives and requirements in Biden-era industrial policies

changed how companies navigate project site selection, labor standards, and relationships with community partners. **Interviewee A**[33] explained:

> If I produce it in Mexico and the labor price there is a third of what it is in the United States, but the transportation costs impact me more, then I would do it in the United States. And that's where we ended up coming down—it just makes more sense to build in the United States . . . Thank God . . . between the carrot [of the IRA] and then the Trump administration stick [trade restrictions, import barriers], had we not moved in that direction, we would have been way behind the curve.

These firm-level decisions illustrate how shifting global risk has reshaped corporate incentives. The ability to stack investment tax credits with domestic content and energy-community bonuses created strong financial signals to locate projects in the United States. For firms with international options, programs such as 48C materially shifted the investment calculus. Without them, many projects would likely have been sited abroad. As **interviewee L** stated:

> Those awards were a significant consideration in choosing to do the projects . . . They were compelling factors in the business case for expansions in the US . . . We were looking at projects in the US versus outside the US, and a significant tax benefit really helps make the case.

Federal industrial policy also interacted with local conditions, amplifying advantages where institutional capacity, workforce availability, and infrastructure already existed and exposing constraints where they did not. So, how did firms navigate new investment opportunities provided by the Biden administration's trifecta of industrial bills alongside the requirements and conditionalities contained therein?

Workforce Availability, Natural Resources, and Infrastructure Were the Central Determinants of Site Selection

In selecting sites within the United States, companies weigh a range of factors that vary by sector and by firm. For most, state-level financial incentives are a secondary consideration rather than a primary driver. In critical mineral extraction and processing, geography is largely fixed by the location of the resource base. Further downstream in the value chain, proximity to suppliers and customers offers advantages through coordination, speed, and industrial agglomeration. Where firms already have an operational footprint, expansion can often proceed more quickly than siting entirely new facilities.

[33] As detailed in the methodology, we conducted about two dozen interviews for this project. Except where specifically noted, quotes are not attributed to specific individuals or companies.

In many cases, however, site selection hinges less on regional geography than on the specific attributes of individual sites. Several companies favored brownfield locations, including former coal mines and legacy industrial facilities. Some companies took over former manufacturing facilities, drawing on existing rail access, industrial infrastructure, and a displaced workforce familiar with industrial operations.[34] Lyten expanded by acquiring an existing battery manufacturing facility and its equipment located near its headquarters and R&D centers, where proximity offered operational and organizational advantages.

Across sectors, workforce considerations consistently emerged as a decisive factor in site selection. Several interviewees noted that workforce availability was the deciding factor in site selection—not low wages but the ability to recruit, train, and retain people with the right skills. That capacity varies widely by region. **Interviewee L** chose not to expand at a Midwestern site due to persistent turnover and difficulty staffing additional shifts, despite describing itself as the "*employer of choice*." As one executive in **Interview A** put it, "*If I see one plant with 8–9 percent turnover and another under 3 percent, the lower-turnover site is where I'll invest.*"

Low turnover reflected more than firm-level management practices and employee satisfaction. It often signaled strong community attachment and a local culture that views manufacturing as attractive, stable work. In some long-standing manufacturing regions, executives described growing recruitment challenges tied to population decline and younger workers' reluctance to enter industries perceived as stagnant or declining. "*In some historic manufacturing locations*," the executive in **Interviewee L** noted, "*declining population trends are becoming the biggest challenge.*"

One observer with decades of experience in the automotive industry noted that "*you can't overestimate the effect on workforce morale of decades of disinvestment and increasing stigmatization of manufacturing work.*"[35] Parents who experienced layoffs and instability are less likely to encourage their children to pursue industrial careers. Workforce boards and career counselors often steer students toward sectors perceived as growing or more secure. **Interviewee A** said, "*The local community colleges and the state economic development activity in the South do more to talk about manufacturing as an opportunity, not as dark, dirty, and dangerous work.*"

Community college engagement is valuable not only for training but as an indicator of broader cultural support and institutional alignment. In regions where colleges are confident that manufacturing is here to stay, they work closely with firms to develop

[34] See the examples of Solarcycle and Form Energy.
[35] Interview with an industry stakeholder independent of the executives who participated in semi-structured interviews for this paper.

customized training. But when the perception is of industrial decline, firms see them as reluctant to invest. Speaking about a site in New York, **interviewee A** said,

> Ten years ago . . . we were asking [of a community college in New York], "Could you put new hires through a boot camp—safety, blueprint reading, electricity 101?" And they said, "We don't really know if there's enough demand."

In North Carolina and Louisiana, that hesitation was gone. Interviewee A's company worked with the community college to develop a short-term customized program focused on entry-level manufacturing readiness, and "*hired probably 88–90 percent of the students that went through these programs.*"

State and local support for manufacturing matters. Places with strong community college partnerships rise to the top—not only because the responsiveness to a company's training needs is valuable, but also because such responsiveness indicates broader cultural support for manufacturing. Community college presidents that personally engage to create training programs or customized curricula are a strong indicator of community support. "*The community college was actively engaged . . . The president would literally ask, 'Tell us what you need,' and they built it*," **interviewee A** noted.

Military bases are another major asset for industrial site selection. In military-adjacent regions, technical, hands-on work is normalized, and there is perceived value in structured career paths—all of which help destigmatize manufacturing work. In addition, workers leaving military service often seek long-term, stable, place-based employment offered by the manufacturing industry. The concentration of military bases in the Southeast makes that region attractive for new manufacturing.

In addition, while the US lost decades of manufacturing know-how to offshoring during the post-Reagan neoliberal era, military bases partially offset this erosion by continuously training technicians, operators, and logisticians. One company executive in **Interview A** emphasized the importance of the skills workers learn in military service: operational discipline, supply-chain expertise, and systems thinking—all capabilities they see as increasingly scarce in US manufacturing but essential for rebuilding industrial capacity. Military bases illustrate how long-term public commitments can generate institutional alignment—anchoring supply chains, workforce pipelines, and innovation ecosystems over decades. For regions serious about industrial policy and climate-related industry, the lesson is instructive. Credible, long-term public commitments and institutional alignment reduce risks and create conditions under which private investment becomes a rational response.

Transportation links and utility infrastructure were also frequently cited. Access to major interstate corridors, rail, and sufficient electricity and natural gas capacity

emerged as baseline requirements for many projects, particularly those involving heavy equipment or continuous operations. In **Interview B**, one executive highlighted how this lengthy list of considerations limits companies' choice of site:

> We started looking at the key factors that we needed. We need access to rail; we need access to a utility for a lot of electricity; we need access to natural gas. And then we started talking to the locations, and talking to the local governments, and assessing the labor pool. So you start putting all these filters in, and there were like maybe five locations in the US that were suitable.

Interviewee K talked of prioritizing sites that had a ready supply of workers among places with the right natural resources and transport infrastructure:

> Several things drove site selection. One was . . . making land available. They're making fertilizer in a very agricultural, rich region.

Sites with better transportation links, such as interstate corridors, were preferable, as products could be readily transported from the site location. For projects in rural areas, these transportation links also helped offset the workforce problems inherent to sparsely populated rural areas.

Community Benefit Plans Helped Companies Implement Smoothly

Responses to Community Benefits Plan (CBP) requirements varied somewhat, reflecting differences in firms' commercial position and dependence on public funding. The CBP framework appeared most effective in a "*sweet spot*": projects with credible technology, identifiable customers, and a plausible path to long-term viability, but for which labor supply, community acceptance, or local political support posed material implementation risks. In these cases, robust CBPs helped mitigate nonmarket barriers to success without attempting to compensate for weaknesses in technology or business fundamentals. Because of their potential benefits, companies made CBPs an important part of their business strategies. Per **interviewee C**:

> We had a community benefits coordinator with a whole team having bimonthly meetings and talking about what was needed, what the projects and what the concerns are. It was a very intense, hands-on process.

Established high-road incumbents welcomed the framework, viewing it as recognition —and reward—for their existing practices and partnerships and perhaps an opportunity to learn something new. Other executives said they would have developed community and workforce plans even without the requirements, due to business workforce needs

and their desire to create inclusive and collaborative cultures. Many calculated that community engagement, labor engagement, tribal engagement, and workforce development are all necessary to make projects move forward, with or without federal requirements. In that spirit, every company interviewed planned to continue implementing at least part of its CBP even though DOE no longer required it. Several firms had such positive experiences that they adopted CBP practices on other non–federally funded projects.

Regarding labor union engagement, many firms could be described as "labor curious"—willing to suspend prior assumptions, experiment, and assess the potential value of labor partnerships—even as some executives noted they had been discouraged from engaging with unions throughout their education and careers. Local union affiliates and national organizations reported unprecedented outreach from companies and project developers, including firms not pursuing DOE funding and therefore not required to develop CBPs. One union affiliate said that statewide, they had signed 30 new collective bargaining agreements as a result of Biden administration messaging—many of them not even receiving direct federal funding.

Community benefits plans help companies attract talent and streamline project implementation, all while achieving social and equitable ends for local communities. "*At the end of the day, the community is the owner of the resource*," said battery company officials in **Interview E**. The community benefits plan helps the company kill two birds with one stone: uplifting a disadvantaged community while building the next generation of workforce for a critical industry. **Interviewee F** saw the benefits of its CBP in similar terms: "*Our goal is to create opportunities for people to thrive and survive without having to move away. We want to invest in local talent, train people early, and have them stay and grow.*" As the executive in **Interview B** put it:

> The community benefits plan helped us build relationships and to build our presence as a business that is coming to your community. So you need to be cognizant of the fact that you're the newcomer, right? That community exists, there are already predetermined relationships, there was a culture in there, and you're the newcomer and you want to adapt to that. And you want the people in that community to welcome your business.

CBPs helped projects achieve several goals simultaneously. Companies' concerns over social justice—while important—were not the only reason why they were happy to sign up to these agreements. According to one electricity company: "*Workforce development initiatives are simultaneously good for the community while also helping the company retain and retrain people.*"

Across our interviews, workforce concerns proved the central reason why companies looked favorably on their CBP. Several interviewees stated that engagement with the

community opened the door for their community partners to help with recruitment, training, and ultimately workforce retention. In competitive labor markets, these kinds of partnerships help keep workers onside. For one solar panel company in **Interview B**, their community benefits plan was a business necessity: "*We need workers, and we need high-quality workers.*" **Interviewee I** told us the community benefits plan was important because:

> We've got to be better at attracting talent, we've got to be better at hiring, we've got to be better at keeping talent—like, what do we need to do? And the answer can't be, we'll just pay them more . . . we're not making a lot of money right now.

Some companies, such as **interviewee J**, had already established union relationships prior to their award from DOE, so it was easy to include these groups in the CBP of their processing facility project. **Interviewee B** would have had a CBP regardless of whether it was required, due to business workforce needs and their desire to create an inclusive culture. Similarly, others calculated that community engagement, labor engagement, tribal engagement, and workforce development are all necessary to make projects move forward, even without federal requirements. One electricity supply company executive in **Interview H** said that the Biden administration's focus on supporting good jobs, labor unions, and prevailing wages did not change their business strategy. The company was already in consistent discussions with their union to get agreements in place prior to applying. These projects readily leaned in to the Biden administration's emphasis on creating good jobs, which helped them get worker-friendly relationships in place much faster than they otherwise would have:

> Working with the community is much more efficient than forcefully implementing a construction or development or some type of project where they don't see the immediate benefit and they weren't involved in the design and the construction component.

When companies have partnerships with community organizations, they open up avenues to ease the implementation of their projects. CBPs are important mechanisms for companies to establish relationships with the community, which is critical for moving efficiently through permitting and environmental review processes. Even though CBPs take time for projects upfront, they help ease implementation down the road). In **Interview J**, an executive told us:

> Having your social license [through the community benefits plan] is critical for actually moving efficiently through any permitting process or environmental review process. So I think it might take a little more time up front in the early stage of your project to do community engagement, but I think down the road, it is more efficient.

These agreements can also help projects garner political support. Unions, for example, have relationships with the legislatures in their states and with local government leaders. For example, when one interviewee went before the legislature in their state, the union performed the bulk of the lobbying activities, paving the road for the company to get the project up and running and supplying good, union jobs for local workers.

Reputation is important for companies hoping to get projects off the ground, and CBPs can help with just that. One executive in **Interview I** found that community partnerships helped get their name out in the community and establish the company as a good place to work, easing workforce problems:

> Be engaged with your community to make sure that they're supportive of what you're doing as a company. They're supportive of helping you be a major employer [and] communicating how it's a great place to work, right?

The alternative can be damaging to a company's prospects. A lack of community support can lead to rising opposition and ultimately projects getting blocked. As they put it bluntly: "*Lack of community support can destroy a company.*"

Negotiated agreements represented the gold standard for accountability of CBP implementation. Although DOE could not require that organizations successfully negotiate independent contracts, commitments to negotiate binding agreements are strong indicators of funding recipients' willingness to work through contested interests, build institutional alignment, and forge win-win partnerships. Where achieved, these agreements contributed both to stronger project execution and to a more resilient base of political and community support for long-term clean energy deployment, grounded in shared prosperity.

Interviewee J argued that companies would have benefited from having more information about specific case studies or examples of how Community Benefits Agreements might be structured:

> I'm curious to see more of what other companies are doing as well, because community benefits plans, and just community engagement as a whole is, to me, becoming more of the norm and something that companies realize has to be done. It's just part of how you operate. But I still think there's not a lot of information out there about specific case studies and examples.

Another electricity company executive in **Interview H** found that every community had different visions, needs, and priorities. It would have been helpful for companies to have pre-identified partners or formulated groups among which they could negotiate

and build Community Benefits Agreements. In their opinion, having a pre-identified network would have allowed the project to move much faster.

> There's a lot of activity happening by different groups in different areas, and they don't always talk to each other or get along necessarily . . . we would have been able to move a lot faster if there was a pre-identified network, but what we found is that you just go out and ask and you introduce yourself and find out what's happening by being out there.

Workforce Concerns Were Driving Factors Behind Community Benefits Plan Development

When implementing projects, companies cannot go it alone. Our interviewees identified workforce retention as a key problem for projects operating in a tight labor market. The executive in **Interview I** stated that:

> The main challenge is talent. We still have high turnover. And so that's one out of every three people turnover every three to six months. Yeah. So imagine that it's really tough. And a large part of it is that so-and-so will pay 50 cents an hour more down the street.

Workforce building and retention was a considerable problem across our interviews. On their own, companies noted that they struggle to maintain the size of their workforce. As **interviewee H** said:

> We're very much trying to retain a strong local workforce, and we are experiencing some loss by people moving out of the state. They're being approached because of their training and their skills, being approached for jobs and we're very much wanting to keep our local employees within the state.

Interviewee A summarized the cost of this turnover succinctly:

> If your turnover is 30 percent, you're constantly training. You're never going to be able to build on the skills people have acquired. Some of them are trying to make the work even simpler so they don't need to invest in training—but that just makes the jobs less satisfying and more rote.

Unions, community colleges, and workforce development partners can all help companies hire the workers they need. In addition to helping projects win political support and get community groups onside (as discussed above), unions provide multiyear training programs, safety training, and operational capability. **Interviewee C** summed it up thusly:

> [Unions] can guarantee the safety and the operationability of a high-stakes industry that requires multiyear training. So, having [our company] integrated into the union apprenticeship programs is what we needed . . . that's where we were getting the skilled labor from.

For companies working with unions, the benefits are largely the same as those stemming from community benefits plans: They provide a pipeline of skilled workers. However, they can also help companies achieve equity and community goals that they were already keen to pursue. One company was keen to meet the needs of women and underrepresented groups on its projects and cooperated easily with unions that already prioritize inclusion for both.

Across our interviews, no company looked unfavorably on unionized labor. However, some projects took an agnostic view about working with unions, in part because of the lack of existing collective bargaining activity in their project locations. The priority of one of our interviewees is to develop a local workforce. If their workforce organizes or if it does not, the company plans to support them regardless and is in dialogue with union leaders, not least by exploring different kinds of training models. A company official in **Interview C** stated:

> We have looked at opportunities for potential project labor agreements. We're just trying to find what that sweet spot is because it is such a remote location. But I think we'll continue to have that dialogue... In lieu of that, my team's investigating apprenticeship registration... for what we call our progression plans, which really mirror apprenticeship models.

Another, while not addressing the training advantages provided by union partners, acknowledged that it did bring different workforce problems. An executive in **Interview N** stated that even though they committed to union construction, they thought it narrowed the pool of contractors the company could pick from:

> We don't have any regrets, but there are way more open shop contractors out there that are willing to work on our project than there are labor unionized contractors. So we really narrowed our pool of who is going to bid on our project. We were going down that path anyway. We can't turn the dial back . . . I don't know if that's an issue that needs to be fixed . . . it's just a reality.

Interviewee B was open to discussing union agreements if their workforce thinks unions are best for them, but their investments were not in high-union states, so these relationships were not already established. But even states with low union density saw union engagement. A labor representative remarked in an interview, "From our end, we definitely saw a rapid increase in energy technology companies signing MOUs with us.

We did really well in Tennessee, in Alabama, a few across the Southwest . . . some good work in Texas, and quite frankly, we are still proceeding with that."

An official in **Interview K** said that their company joined with the local college to provide scholarships, facility upgrades, capital, and operating costs to train new workers. While they want to go further, they made the decision to invest in electricians first, as their project both needs those workers first and it is the profession with the longest lead time. These workforce initiatives are designed to prioritize opportunities for students from the local community, students with financial need, and underrepresented groups, achieving social and workforce goals simultaneously:

> The majority of our job really is just making sure that we're really supporting those relationships to deliver on our commitments, because we can't do it alone, right? Not in a way that's going to be meaningful to the community. And that's been our approach since we started.

A third company, which partook in **Interview L,** had already been conducting workforce planning, community engagement, and impact analysis at the start of its relationship with DOE. The DOE's focus on workforce partnerships actually reinforced and rewarded its existing strategy, and the interviewee appreciated that DOE and the Treasury acknowledged the centrality of workforce readiness to successful manufacturing projects: "*These were things we were already contemplating . . . workforce partnerships were critical for us, and it was helpful that DOE recognized that.*"

Relationships with unions, community colleges, and workforce development partners are part of a raft of workforce development measures companies pursue to ensure they find workers in the short term and retain workers in the long term. **Interviewee J** is working to ensure its workforce has supporting infrastructure around its project sites, including housing, daycare, and school systems. This wider workforce infrastructure is particularly important in rural areas where the workforce pipelines are limited:

> How do you make sure that the community has what they need, [such as] housing or daycare school systems? Those are kind of the basic foundational things that seem to come along with any conversation about workforce training and development. People think a few more steps ahead from that and say, "Okay, I'm not just worried about the workforce, but also how are we going to keep them here and grow?" At least specifically for our project, being in a rural area.

Interviewee N said they were using similar methods to combat the problems of workforce retention in rural areas. One component of this was to construct large accommodation facilities to provide to workers during their transitions into the site:

> You're just remote. So that's a big challenge. Getting the people, and then putting them in homes, because the market out there is not going to put in 20, 30, 40 homes unless they know they're going to have buyers for them, and there's not a huge inventory of homes. So we've mitigated that problem by building a modular building all with individual bathrooms, private rooms, but that's not a place that you can put your family. That's for temporary workers that are coming and going when we need them on the job. But it will provide us a little bit of a cushion if we hire somebody out of [the nearest city], and they've got their family, and they can't find a home. At least the person that we hired . . . while they work on building a home, finding a home, and transitioning over.

Ultimately, unions and community partners can help companies provide the right training opportunities for the employees. As summarized by a company official in **Interview H**:

> I think a lot of it is adapting programs to retain employees, trying to meet employees halfway in terms of what their interests are, making sure that we're talking about the right training opportunities. I think when there is a feeling of stagnation, there's more interest to see what else is out there.

Strong relationships with unions, colleges, and workforce development partners can help companies deliver these benefits for their employees, improve worker retention, and ultimately alleviate their projects' overall costs.

Community Benefits and Labor Standards Weren't Significant Cause of Delays and Were Flexible to Local Conditions

How have collective bargaining agreements, community benefits plans, and labor standards affected project timelines and costs? Our results show that companies have differing opinions on the impact of CBPs and standards on project timelines, though, where delays do appear, the benefits outweigh the costs.

Roughly half of interviewees noted that they experienced no delays to their implementation timeline because of their CBPs. **Interviewee B** and **interviewee E** said that they planned for the negotiation of community agreements in their project design. Although aspects of these designs extended the project timeline at face value, given the time it takes to develop certain social and environmental standards in tandem with community partners, these were offset by advantages to these processes. In particular, **interviewee E** benefited from a fast and transparent FAST-41 permitting process:

> We've been really intentional in our planning. We knew that our approach to what we wanted to do—whether it be from a social perspective, employment, building relationships, things like that, or from an environmental perspective—we knew that it wouldn't always be the fastest path. But we've done things to offset that, and having a transparent process through the FAST-41 program has been helpful.[36]

Interviewee H noted that community engagement helped their project timeline, for similar reasons that CBPs help implementation overall: When community partners come onside, permitting and implementation face limited opposition.

> Community engagement has certainly helped the project timeline. The DOE made this a requirement because they saw in previous projects that working with the community is much more efficient than implementing projects where the community didn't see immediate benefits or wasn't involved in design and construction.

Interviewee N echoed this argument, mentioning the particular struggle they have faced through litigation:

> We're years delayed . . . it's an aggregate of a lot of things, like litigation and raising money. The more consensus you have around a project, the faster you can get through those bigger obstacles, like financing. And so, yeah, you have to make sure all of that moves at the same time, that communities are aligned and on board with the project.

Correspondingly, **interviewee M,** an investor involved in a range of projects, stated that, across the board, the delays (potentially) caused by CBPs and workforce requirements were much smaller than those brought on other factors like National Environmental Policy Act (NEPA) timelines, contracting cycles, and interconnection necessary for electric power transmission: "*It's just overhead until you build this thing . . . NEPA reviews stretching four-plus years were deal-breakers. You get the award, but you can't build for years. What do I tell my board*?"

In part, flexibility of these requirements in certain contexts allowed otherwise-unsuitable projects to proceed without significant delays. An executive in **Interview L** said that local contractor ecosystems vary across the country, making it harder for certain projects to meet apprenticeship requirements. This is especially true in areas without strong union presence or where general contractors lack experience with federal labor standards. However, an executive in **Interview D** proposed that Biden-era

[36] FAST-41 is shorthand for Title 41 of the Fixing America's Surface Transportation Act, a program to make the permitting for certain large, complex infrastructure projects more coordinated, predictable, and transparent.

industrial policy accounts for these differences in its design: Apprenticeship requirements carried a 15-day good-faith effort standard that made compliance straightforward. If no apprentices were available on a project, the waiver was essentially automatic.

Similarly, the availability of registered contractors familiar with PWA requirements differs by region. This meant that compliance was not equal across regions. **Interviewee L** said: "*You can't paint too broad a brush. It really varies by region. Compliance friction is highly place-dependent, not company-dependent.*" However, DOL provided a clear rubric for wage determinations that helped companies to comply with prevailing wage requirements, limiting these differences.

Biden-era industrial policy provided significant financial benefits for companies that abided by labor and apprenticeship standards, further alleviating the trade-offs companies would otherwise make when providing well-paid jobs and training opportunities. While the Davis–Bacon Act required companies to pay prevailing wages, manufacturing tax credits helped offset these expenses. However, **interviewee I** raised their concern about the longevity of these tax incentives.

> If I'm in a high-wage environment, it's challenging, right? Because you don't get incentives for 20 years, right? . . . I mean, you want people to get paid well, these are hard jobs. But I think what companies are challenged with is, these things aren't 20-year incentive programs, right? They're very short term.

More Comprehensive and Coordinated Industrial Policy Would Have Eased Implementation

Most of the investments under the IRA were provided via tax credits. The benefit of this model is that companies can start investing in clean projects without having to agree to a specific contract, as was required for certain grants and loans. In short, companies can invest money quickly. However, companies also require clear guidance from the IRS to glean which tax credits apply to their projects.

Interviewee D highlighted the fact that, after passage of the IRA in August 2022, the wait for IRS guidance on thresholds, documentation, or verification felt interminable for companies:

> IRS has issued virtually no usable guidance on how to document domestic content, so [businesses] are effectively guessing. Although self-attestation is allowed, IRS hasn't defined what counts as "good faith."

Companies considering investing in energy communities, for example, did not know precisely which metropolitan areas or census tracts would make their projects eligible for the energy community tax credit until June 2023. The IRS never provided a definitive list of qualifying brownfield sites, pointing to only the nonbinding list of brownfield sites produced by the EPA.

A common theme across the interviews was that, even where companies had guidance, the occasional lack of consistency across departments and agencies made it hard for companies to navigate requirements. Projects that must comply with Buy America requirements have to abide by three overlapping regimes: IRS, DOE, and the USDA, each of which has different definitions, tests, and waivers. Foreign Entity of Concern (FEOC) restrictions are similarly incredibly complex, and companies struggle to satisfy them, as they often do not have full supply-chain traceability down to components of components. As **interviewee D** highlighted:

> How many suppliers do you have to check? How do you classify component parts versus subcomponents? DOE, USDA, and IRS all have different Buy America/Build America frameworks. We tell members to comply with the most stringent one, but we shouldn't have to play three-dimensional chess with federal agencies.

A lack of clearer and consistent standards can create supply-side problems. The FEOC restrictions, for example, affect sectors like the battery sector more than others, creating supply-chain risks that threaten the economic viability of advanced manufacturing projects. These compound other supply-side issues that the Biden-era industrial policies could have done better to mitigate. **Interviewee M** noted that a lack of steel and aluminum could pose a problem for the efficacy of clean projects in general. Technology-specific incentives cannot combat these upstream supply chain deficits. **Interviewee A** echoed this criticism:

> Policymakers should consider the second- and third-order effects of incentives. [There is] a lack of integrated value-chain thinking—policies that incentivize downstream technologies (EVs, wind) without ensuring upstream material availability (aluminum, steel, copper).

They argued that this oversight spans multiple administrations and reflects a systemic failure to link industrial policy and supply chain strategy. In these conditions, "picking winners" can devolve into a game of whack-a-mole, as programs designed to accelerate one technology encounter friction elsewhere in the industrial ecosystem.

As one executive in **interview A** put it, policymakers often fail to design incentives or trade policies that fully account for how they ripple across upstream and downstream

markets: "*Our policies have not been able to pull that thread very well . . . you've got to understand the whole value chain you're trying to impact.*"

A coherent industrial strategy must support the full value chain of the industries it seeks to bolster: upstream materials (steel, copper, aluminum, critical minerals), supplier networks, predictable permitting pathways, stable and affordable energy, adequate infrastructure, and a sustained system of workforce development. These are the institutional conditions that allow incentives to translate into durable capacity. Where alignment is partial or uneven, generous subsidies lose potency—not because incentives are insufficient, but because the surrounding ecosystem does not yet reinforce them.

Industrial policies are more efficient when they are comprehensive. **Interviewee M** argued that Nevada has captured a relatively high share of investment under the IRA in large part because its planning system allows projects to begin immediately. They suggested that industrial strategy could integrate a permitting agenda and avoid overlaying deployment-style requirements on first-of-a-kind demonstration technologies. A smaller, newer company developing a novel carbon capture solution, for example, should not have to satisfy all of the requirements for a mature plant.

For electrical co-ops, the domestic content rule for elective pay made projects more difficult to deliver. According to an industry leader in **Interview D:**

> A project that could stack 30 percent investment tax credits plus a 10 percent energy community and a 10 percent domestic content suddenly became far more viable. If you can make it pencil at 30 percent, you can really make it pencil at 40 percent.

But the domestic content rules took a wrong turn when Congress applied them to elective pay as a punitive cliff: one year with no penalty, then a 10 percent haircut, then 15 percent, and then total elimination of elective pay if domestic content isn't met. "*That's not an incentive, that's punishment.*" For taxable entities, missing domestic content simply means losing the 10 percent adder. For co-ops relying on elective pay, it could mean losing everything.

Finally, investment policy takes time and consistency to translate into new jobs and stronger industries. In a country like the US, industrial policy needs bipartisan support to last for the long term. **Interviewee D** and **interviewee I** agreed that highlighting the broad range of applicable technologies like nuclear as well as carbon capture, wind, solar, and storage might have helped counter partisan framing that the IRA was primarily a pro-renewables bill. After all, credits are technology-neutral and performance-based.

Last-minute closed-door negotiations produced avoidable errors: For example, the domestic content provision for elective pay became punitive due to last-minute Joe Manchin–Chuck Schumer negotiations. The rushed, behind-the-scenes process that led to the IRA also produced structural design flaws.

Agency Capacity and Funding Processes Were Pain Points, Particularly for Smaller Companies

While agencies including DOE had staffed up considerably and were operating with a sense of urgency, as relayed in the first paper in this series, from the companies' perspectives, the process between award and contract was too slow. **Interviewee C,** who was involved with a hydrogen hub, took over a year to negotiate their cooperative agreement with the Department of Energy. They felt that teams who were involved in the negotiations from the administration often had less knowledge of the projects than the developers and seemed to lack urgency in getting money to those projects:

> After you went for a competitive solicitation, it took 9 to 11 months to get us to contract. And that contract in hindsight was a ridiculous contract, because it was a reimbursement contract instead of one that said, "We'll give you the money for phase one or phase two and then you expense against it."

These delays to the negotiation and approval phases were compounded by the way these projects were funded. Instead of receiving the money upfront, which would both allow the company to move forward where it did not have the requisite funding to hand and get the money out of the door faster, companies had to fund the early stages of the projects themselves and then apply for reimbursement from DOE. This structure stymied projects from the beginning. This further pushed the reimbursement approval process into the Trump administration, which is making it harder for projects to access funds. **Interviewee C** continued:

> Our first experience with reimbursement came with the Trump administration. So they're delayed in paying. Even the meager bills that they're paying, and we don't have enough, we'll go to phase two or three by over 120 days. So yeah, it's really bad.

Even flexible agencies like Advanced Research Projects Agency–Energy take 6 to 9 months to contract, whereas DOE demonstration programs took between 12 and 18 months. For small projects in particular, these contracting timelines make it very hard for projects to get off the ground. Early-stage companies cannot float multiyear uncertainty. As **interviewee M** put it bluntly: "*For start-ups, speed is the entire game.*" The National Environmental Policy Act review process can stretch to over four years,

creating difficult situations where a project can receive an award but then not start building for years.

Policy Volatility Is Costly

From the moment Donald Trump won the 2024 presidential election, companies have had a harder time planning, attracting investment for, and implementing their projects. For those making use of federal contracts or loans, the administration's inclination toward premature cancellation has made it harder for firms to operate. Across the interviews, it was clear that companies feel that they cannot rely on federal contracts as they did under Biden—and the removal of these kinds of partnerships can be unsurvivable, particularly for smaller firms. As an executive in **Interview M** stated clearly:

> The madman theory of Trumpism makes relying on federal contracts fragile . . . There is a need for future progressive policy to lock in intractable obligations that are not just legally durable but practically survivable for small firms.

Uncertainty is bad for business. Since the start of the second Trump administration, investment has slowed across many of the projects we interviewed. For **interviewee K**, the uncertainty over tax credits has made partners weary and slowed implementation. Similarly, other companies have had investors pull out of financing their solar project due to the uncertainty over tax credits since the 2024 election. As one executive in **Interview B** put it: there's "*not a lot of appetite for big investments [in clean industries].*" This has come in spite of their company's rapid and successful growth in the preceding period and had a knock-on effect on their investment timeline (they cannot start training workers for glass manufacturing, for example, until they know the jobs are coming). Ultimately, for **interviewee A**, this uncertainty undermines the effectiveness of industrial policy: "*It creates a ton of waste—additional risk you have to consider when looking at investments. Higher risk is higher cost.*"

The Trump administration has implemented a number of changes across clean industries that exacerbate this uncertainty. For example, the administration removed community benefits spending in new grants. As **interviewee I** responded to these moves:

> Now we got a new administration, it's like, cut everything, no DEI, no community benefits, you're not spending any money on that . . . If you were going to spend $20 million, [because] we were going to give you $10 million, you're not getting anything, you're getting zero. And that's a problem. We always are going to spend on our community, we have to do that to be a good operator there. But at the same time, there's challenges with that, if there's no incentives, and we're paying, you know, 30 percent higher wages versus a nonunion state, let's say.

Multiple interviewees noted that the Department of Energy explicitly told projects not to proceed with community benefits in 2025. As these plans can help companies get the community onside and streamline implementation, not proceeding with CBPs is expected to affect project timelines and companies' bottom lines. Several interviewees noted that these changes compound smaller frictions, such as when a number of companies had their payments temporarily revoked by the so-called Department of Government Efficiency.

While tariffs are purportedly tools to accelerate reshoring conversations and make domestic manufacturing look more attractive, in the current environment, they function less as discrete trade tools than as a source of strategic uncertainty, raising risk premiums. Even more broadly, policy signal volatility driven by extreme political polarization undermines US competitiveness. One executive in **Interview A** noted extreme polarization creates waste:

> It shows up as uncertainty and added risk—and higher risk makes everything more expensive. I would venture to guess that the political risk premium may reduce US GDP by at least 10 percent . . . at some point, the US becomes too unpredictable a place to make long-term investments.

In July 2025, Donald Trump signed a raft of tax and spending policies into law, colloquially called the One Big Beautiful Bill Act. These included, among other things, a faster phaseout of subsidies for solar and wind projects, termination of credits like the electric vehicle consumer, and shorter time frames for other credits like the battery production credit (§ 45X). Projects in receipt of the hydrogen production tax credit in the IRA (§ 45V) now must start construction by January 1, 2028, four years ahead of the previous timeline. Alongside the existing pressures for hydrogen project developers, who must go through the NEPA process, this new rule adds severe time constraints that could make these projects financially unfeasible. **Interviewee K** said of the reduction in timeline in the so-called One Big Beautiful Bill Act:

> [§ 45V] was still in there, but they are going to have to start construction next year. We can't even get through permitting, and now I've got pushed to the first of January 2028, which might not be possible. Because these hubs are federally funded, they're gonna have to get through the NEPA process. And that would not have been a reasonable timeline, but then the DOE changed some of its NEPA guidelines, like last month. There's all these moving parts.

The problem with this level of short-term policy uncertainty is that projects will run for 20 or more years. If tax credits under Biden are revoked or changed considerably after three years, it becomes very hard for companies to make reliable investment decisions.

Changes to Original Projects and CBPs Post Biden

The change in administration commenced a period of significant uncertainty for the clean energy sector. While some of our interviewees, like those in **Interview J**, have not changed their projects and are making considerable progress, many others have had to alter their CBPs and project designs—to lesser and greater extents.

Some projects have reoriented their community plans to limit language that could be interpreted as misaligned with the new administration's priorities. The company in **Interview E**, for example, has reduced mention of diversity, equity, and inclusion language in its plan (which was a focus of the Biden administration but a target of the current presidency). Beyond these superficial changes, however, its original project and community plan remains largely unchanged.

Some companies are reckoning with the loss of Justice40 requirements. Initially, **interviewee K** engaged extensively with local tribes, having tribal representation on its board and involving a local university's tribal relations team in its project development. Without Justice40 requirements, there is a risk that projects will not engage properly with these underserved communities.

There is another consequence of the changing policy environment: stasis. Where many projects have been changed or rolled back, others have been put on hold. The company in **Interview H**, for example, was on the cusp of entering some new agreements just prior to a January 2025 announcement that limited their scope. Even though the company has undertaken the lion's share of planning on those projects, it has asked those partners to stand by until they can get approval. These pauses ultimately create delays, highlighting the risk of policy uncertainty to companies' bottom lines and the wider transition to clean energy.

Conclusion

The economic results of the Biden-era investments were larger and more significant than is commonly appreciated, and firms can and did navigate the requirements and incentives that the administration put in place, often even finding them helpful.

Federal policy succeeded in crowding in private capital, stimulating domestic manufacturing and supply-chain investment, and generating early employment and wage gains—particularly in construction and clean energy manufacturing. These outcomes reflect behavior change: Firms committed capital before full clarity on markets, workers entered expanding sectors, and investors treated federal signals as credible enough to support long-term bets. Construction activity, in particular,

functioned as an early indicator that incentives to build up US productive capacity were working.

Prevailing wage and apprenticeship requirements and Community Benefits Plans embedded job quality, equity, and community considerations into project design and implementation. A labor representative reflected, "The Biden administration focused on the workforce as a core tenet of building of the full energy ecosystem. The breadth was terrific—it provided work for all the different trades. 2024 was our best year of growth since the 50s."

These mechanisms did not eliminate conflict. Instead, they created structured pathways for navigating trade-offs among speed, standards, workforce capacity, and community acceptance—often reducing implementation risk rather than increasing it.

This is important because there is a risk of over-torquing, and it's worth remembering why this approach was favored in the first place: the need to address economic insecurity after decades of offshoring and deunionization; repeated failed efforts to address climate change through sacrifice rather than opportunity; a long legacy of siting energy projects in disadvantaged communities where low-income communities and communities of color bear the costs while the rewards accrue to project owners and their investors; and an opportunity to harness the economic and security benefits of an emerging multitrillion-dollar clean energy economy.

At the same time, the analysis underscores the limits of policy design alone. Not all firms responded similarly; not all regions experienced the same outcomes; and governance gaps, coordination failures, and political volatility constrained results. Community Benefits Plans could not strengthen underlying technologies, generate buyers for new products, or stabilize markets. Prevailing wage and apprenticeship incentives expanded job quality in construction but did not extend equivalent standards to manufacturing. And the durability of many gains remains contingent on policy continuity, institutional capacity, and sustained political support.

A comment from a researcher who had conducted dozens of interviews with community stakeholders sums up the story: "The federal government catalyzed new models, new partnerships, new governance structures, new project ideas, new civic infrastructure. It did move the ball. It worked. It actually worked. It just needed more time."

Appendix A: Interview Template

[Status Check]

1. How is your project going—have there been any major changes to what you initially proposed?

2. What phase is your project in—e.g., preconstruction planning, construction, operations, scaling operations?

[Understanding Their Planning and Early Decision-Making]

3. What were the key factors behind your decision to site your project in [place]?
    a. Did the underlying workforce variables or labor conditions influence that decision?
        i. If so, how did it rank relative to other variables, such as utilities, transportation infrastructure, proximity to customers, state incentives, etc.?

4. [If DOE funded] My understanding is that you needed to develop a CBP for the DOE funding. Recognizing that the new administration has taken a different approach to parts of the CBP, namely Justice40 and DEI, do you mind sharing what the key elements of your CBP initially were?
    a. Are you continuing to implement any parts of it, such as workforce partnerships, community engagement, etc.?
    b. Have there been any significant changes to what you initially proposed?

5. How did you know or decide who to work with in the community?
    a. What would have been helpful in navigating the ecosystem of community partners?

6. In addition to applying for a [grant or loan], are you also pursuing tax credits?
    a. If so, does the prevailing wage and apprenticeship (PWA) enhanced IRA tax credit apply to your project?
    b. How are you making sure you can claim the PWA (prevailing wage and apprenticeship) incentives in the IRA? (consultants, recordkeeping, certified payroll system such as Elation or LCP tracker, etc.)

[Understanding Implementation]

7. What relationships do you have with unions, community colleges, and other workforce development groups in your effort to build and/or operate [project name]? (note to ask specifically about unions)

a. What benefits have you realized or do you envisage for growing and maintaining your workforce or otherwise advancing your project through your relationship with [union or community group]? (e.g., derisking workforce or other supply chain challenges, permitting, support from local electeds)

8. [For DOE-funded projects] If you have already started implementing parts of your CBP, including community engagement or workforce partnerships, how has it helped (or hurt) your project timeline?

9. What strategies have been most effective to ensure you can hire the workers you need for [project name]?

10. What are the challenges you are facing, or think you will face, in developing a workforce for [project name]?

[Reflection]

11. The Biden administration focused a lot on supporting "good jobs" and was very friendly to and supportive of labor unions. This focus resulted in IRA tax incentives that were much higher for prevailing wage projects and DOE conditions on funding that emphasized high wages and the free and fair choice of workers to organize and join a union. Did this change anything about your business strategy as it relates to investing in good jobs and workers? Or project location?

12. How have labor standards (Davis–Bacon, PWA, CBPs) affected project costs and timeline?
    a. Have there been benefits as well as costs, and what's the bottom line?

13. If you worked with labor unions for the first time, was there anything surprising? Was it easier or harder than you thought? Did you find goal alignment?

Appendix B: Union and Nonunion Apprenticeship Growth, 2022–24

New Apprentices by State and Whether They Are Trained Within Union-Administered Programs

State	PWA-Eligible Investment ($)	New Union Apprentices			New Nonunion Apprentices			Share of New Apprentices in Union Program			Modeled Apprentice Demand from IRA	Total New Apprentices
		2024	2023	2022	2024	2023	2022	2024	2023	2022		
Alabama	1,689,445,131	531	454	503	395	264	214	57%	63%	70%	507	1,644
Alaska	89,304,227	339	305	269	194	186	189	64%	62%	59%	27	1,024
Arizona	23,195,046,698	776	895	761	638	374	270	55%	71%	74%	6,959	2,683
Arkansas	2,890,587,566	409	214	183	1,926	1,688	1,459	18%	11%	11%	867	4,237
California	25,506,210,587	8,628	9,056	9,139	1,097	1,114	853	89%	89%	91%	7,652	19,895
Colorado	2,128,845,975	297	381	364	1,500	1,370	926	17%	22%	28%	639	3,548
Connecticut	303,172,829										91	0
Delaware	101,886,973	75	61	58	192	215	273	28%	22%	18%	31	543
DC	14,448,174										4	0
Florida	7,434,278,425	706	684	589	1,852	1,673	1,396	28%	29%	30%	2,230	4,915
Georgia	18,613,107,727	1,479	1,182	1,146	783	557	543	65%	68%	68%	5,584	4,001
Hawaii	867,593,673	860	652	489	64	52	35	93%	93%	93%	260	1,628
Idaho	1,861,019,948	208	125	91	174	120	68	54%	51%	57%	558	627
Illinois	7,007,433,958	3,183	3,330	2,847	295	132	163	92%	96%	95%	2,102	6,940
Indiana	12,976,907,348	3,181	2,744	2,249	780	626	585	80%	81%	79%	3,893	7,331
Iowa	1,006,692,438	636	652	515	686	659	635	48%	50%	45%	302	2,633
Kansas	6,641,869,721	481	263	363	141	88	55	77%	75%	87%	1,993	973
Kentucky	10,451,308,370	975	998	796	413	545	303	70%	65%	72%	3,135	2,931
Louisiana	2,805,640,406	296	281	213	661	551	229	31%	34%	48%	842	1,789
Maine	1,178,205,984	55	134	84	113	85	47	33%	61%	64%	353	387
Maryland	1,035,126,518		134	136	450	514	319		21%	30%	311	1,098

Massachusetts	4,260,380,401	389	419	400	21	34	24	95%	92%	94%	1,278	863
Michigan	14,183,277,387	2,624	2,079	1,964	663	545	397	80%	79%	83%	4,255	5,911
Minnesota	1,025,316,457	1,538	1,696	1,545	216	138	38	88%	92%	98%	308	3,588
Mississippi	3,943,748,963	106	116	100	287	170	40	27%	41%	71%	1,183	679
Missouri	1,313,775,830	2,481	2,496	2,461	576	415	397	81%	86%	86%	394	5,968
Montana	1,081,580,996	109	112	111	354	321	318	24%	26%	26%	324	896
Nebraska	21,581,222	233	214	222	109	79	34	68%	73%	87%	6	635
Nevada	10,271,413,445	589	870	611	189	108	85	76%	89%	88%	3,081	1,756
New Hampshire	42,181,967	34	37	16	164	146	173	17%	20%	8%	13	381
New Jersey	197,644,938	552	649	576	436	426	316	56%	60%	65%	59	2,063
New Mexico	4,007,726,648	239	288	340							1,202	527
New York	7,570,966,074										2,271	0
North Carolina	15,906,560,339		1		39	30	31				4,772	70
North Dakota	693,936,659	196	170	160	345	89	81	36%	66%	66%	208	800
Ohio	10,065,589,455	3,941	3,338	3,602	1,084	1,012	777	78%	77%	82%	3,020	9,375
Oklahoma	1,945,816,408	151	181	124	180	134	117	46%	57%	51%	584	646
Oregon	1,549,919,497	5	13	28							465	18
Pennsylvania	1,251,874,932	1,673	1,568	1,515	438	359	283	79%	81%	84%	376	4,038
Rhode Island	3,147,279,689	91	97	89	243	209	220	27%	32%	29%	944	640
South Carolina	7,802,233,892	80	23	24	454	539	286	15%	4%	8%	2,341	1,096
South Dakota	1,806,858,714	31	68	15	165	258	93	16%	21%	14%	542	522
Tennessee	9,177,046,750	1,118	1,020	738	615	580	499	65%	64%	60%	2,753	3,333
Texas	54,676,235,338	2,186	1,775	1,595	7,231	3,232	2,180	23%	35%	42%	16,403	14,424
Utah	2,929,454,956	706	497	484	371	283	222	66%	64%	69%	879	1,857
Vermont	10,705,489				333	336	145				3	669
Virginia	3,119,885,916				1,268	1,108	877				936	2,376
Washington	915,193,526	138	121	99			2				275	259

West Virginia	1,014,033,245	285	287	265	158	103	89	64%	74%	75%	304	833
Wisconsin	2,462,933,096	197	992	836	547	491					739	2,227
Wyoming	3,052,782,114	16	14	3	29	37	39	36%	27%	7%	916	96
Total	297,246,067,019	42,823	41,686	38,718	28,869	21,995	16,325	60%	65%	70%	89,174	135,373

Source: Authors' analysis of Registered Apprenticeship Partners Information Database System and Rhodium-MIT CEEPR data

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