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Making a Success of Industrial Policy

Lessons and Insights from the US Experience

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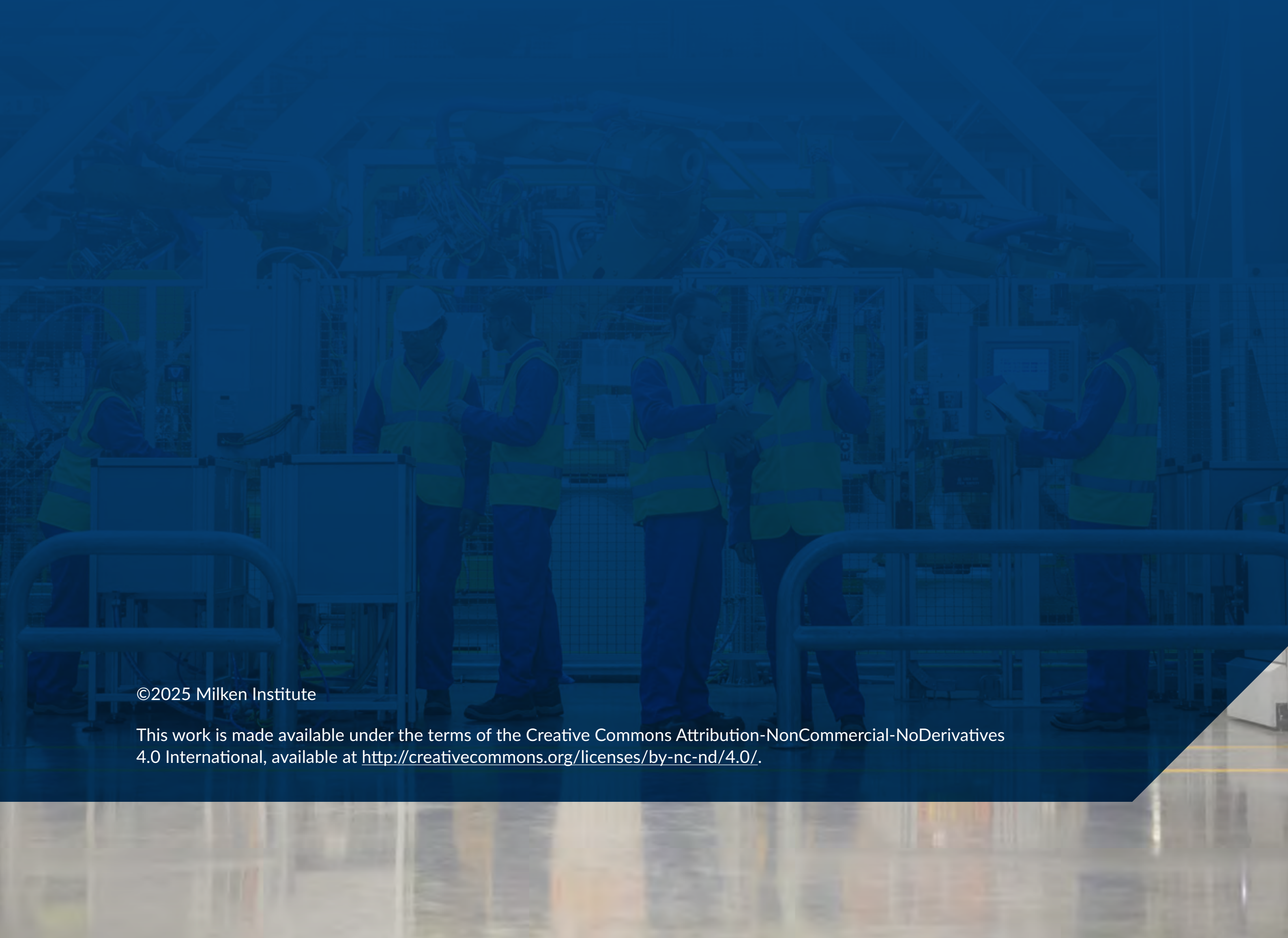
About the European Competitiveness Initiative

This report has been developed through the Institute's European Competitiveness Initiative. This initiative aims to identify actionable steps to catalyse large-scale capital investment to help the EU and UK meet their productivity challenges, as diagnosed in reports by Mario Draghi, Enrico Letta, and Christian Noyer and the 'missions' of the Starmer government. Our work under this initiative focusses on three areas: attracting new investment into infrastructure and decarbonisation, closing the innovation tech gap, and investing in Europe's defence and security priorities.



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EXECUTIVE SUMMARY

Industrial policies, used by governments to address structural economic, societal, and environmental challenges that markets cannot solve on their own, are back in vogue. Once characterised by public ownership and state planning, industrial policies fell out of fashion in the late 1970s in favour of approaches that prioritised the role of free markets to organise economic activity.

Contemporary global challenges, including the COVID-19 pandemic, the climate crisis, and geopolitical and trade tensions, have heightened concerns about economic resilience and the capability of markets to address them.[1] This has led to renewed interest in interventionist policy tools coordinated through industrial strategies. Debates have shifted from *whether* industrial policies should be used to *how* they should be designed and implemented.[2]

The US provides a crucial case study for international audiences on the design and implementation of industrial policies. The federal government used its convening power to progress multiple industrial-policy objectives across different sectors, in collaboration with investors and civil-society actors. The US experience is informative for Europe, including the UK, which is grappling with similar challenges and seeking to increase investment to meet ambitious goals outlined in Mario Draghi's 'industrial strategy for Europe' and *The UK's Modern Industrial Strategy*.[3]

Informed by over 40 stakeholder interviews, existing literature and debates around the application of industrial-policy best practice, this report provides a set of principles and an analytical framework to draw out lessons from the US for effective industrial policymaking. Our approach analyses the *design* and *implementation* processes underpinning recent US policy approaches, rather than assessing individual successes or failures.

We find that whilst significant private investment was mobilised—particularly in proven clean technologies—in several key areas, the previous administration strayed from the essential ingredients for success. This experience offers important lessons for European policymakers and investors, who are the audience for this report. These lessons include:

POLICYMAKERS SHOULD TREAT GOVERNMENT CAPACITY AS SERIOUSLY AS INVESTMENTS THEMSELVES TO ACHIEVE SUCCESSFUL OUTCOMES.

Effective industrial policy requires substantial government capacity—the expertise, administrative resources, and coordination mechanisms necessary to oversee complex market interventions and infrastructure deployment. The US experience reveals both successes and significant capacity constraints. Certain agencies, such as the CHIPS Program Office (CPO), used external expertise to deliver substantial outcomes, whilst other government bodies struggled with insufficient staffing, limited sectoral knowledge, and coordination challenges. Inadequate recognition of the importance of government capacity impeded delivery. Industrial policy requires adequate resources allocated to technical expertise, staffing, and coordination infrastructure, and better recognition of this would have improved recent US policy delivery.

FLEXIBLE, WELL-TARGETED INCENTIVES WITH PROPORTIONATE AND CONTEXT-SPECIFIC CONDITIONS SHOULD BE USED TO SUPPORT PRIVATE INVESTMENT.

Recent US industrial-policy measures spurred significant private-sector investment, particularly in clean tech sectors. Tax credits provided investors with long-term certainty, and reforms such as direct pay and transferability deepened their effectiveness. However, conditions attached to subsidies were not always calibrated to maximise impact: in some cases, they sharpened alignment with policy goals, but in others, they constrained investment and programme delivery. This reflected a lack of coherence in the federal government's strategy and unresolved tensions between competing objectives.

INDUSTRIAL POLICIES CANNOT *SOLELY* RELY ON MEASURES TO STIMULATE PRIVATE-SECTOR ACTIVITY AND MUST ADDRESS DELIVERY BARRIERS TO AVOID PROJECT FAILURE AND WEAKENING PUBLIC SUPPORT.

Building infrastructure or industrial facilities is fraught with risks which contractors, clients, and project sponsors must navigate. Doing so requires strategic collaboration with interest groups and robust accountability between project teams and sponsors. The US struggles with building large, complex projects, and frameworks which govern infrastructure deployment have become more burdensome over time. The federal government undertook initiatives to redress delivery barriers, but in general it overly relied on fiscal stimulus measures to achieve industrial-policy objectives.

A VARIETY OF FLEXIBLE POLICY TOOLS AND PRIORITISING 'PACE OVER PERFECTION' ARE NECESSARY TO HELP MARKETS SCALE IN EMERGING TECHNOLOGIES.

Government interventions are crucial to overcome the financial and technical challenges that early-stage decarbonisation technologies face. Success requires a strategic, portfolio-based approach that embraces risk whilst acknowledging that not all technologies will succeed. The 'lift-off' reports provided valuable roadmaps for the commercialisation of emerging technologies, but the lack of a formalised government strategy or demand-side instruments—which requires careful calibration with supply-side measures to help markets develop—impeded progress for certain technologies.

INDUSTRIAL POLICY IN THE 21ST CENTURY

Industrial strategy—the sum of industrial policies—has a contested history. 'Developmental states' such as South Korea and Singapore used state apparatus with targeted loans, grants, subsidies, and protections to power post-war booms.[4] The US has long practised industrial policymaking, from Franklin Roosevelt's National Industrial Recovery Act of 1933 to Defense Advanced Research Projects Agency-backed research that underpinned Silicon Valley's growth and US tech leadership.[5]

Industrial policy harnessed governments' convening power to direct activity through markets and firms, but from the 1970s its efficacy was questioned. Governments were seen to 'throw good money after bad', propping up uncompetitive industries and distorting markets. Neoliberal orthodoxies then relegated the state to setting fiscal and financial policy, leaving markets to allocate resources.[6] Debates shifted to whether to do industrial planning at all, rather than the essential conditions for its success,[7] exemplified by American economist Gary Becker's assertion in 1985 that 'the best industrial policy is none at all'.[8]

Formal industrial strategies gave way to free-market approaches that reduced state involvement, though elements of industrial policy persisted via monetary, defence, and tax measures. 'Reaganomics' avoided formal industrial policy, but spillover effects from defence spending endured.[9] In the UK, Margaret Thatcher's government backed financial services even whilst scaling down heavy industry.[10]

The COVID-19 pandemic and the climate crisis have heightened concerns about the resilience of supply chains and the capacity of markets to address national security, economic stability, and environmental challenges.[11] These have led governments to experiment with more interventionist policy tools. Geostrategic competition has further driven governments to adopt policies focussed on protecting strategic industries, creating jobs, and shaping global trade patterns in their favour.[12]

In the US, this pivot has been driven by a desire to maintain geopolitical dominance and accelerate industrial renewal.[13] The policies of the US administration under Joe Biden, whilst significant in their scale and ambition, built on interventions under Donald Trump and Barack Obama in using industrial policy to achieve economic security objectives.[14] A further pivot is on climate: even outside the federal government, states have adopted targets to reduce greenhouse gas emissions and encouraged the development of clean-energy projects.[15] The second Trump administration has used different means—tariffs and trade policy—to achieve some of the same industrial-policy aims, such as economic security.

Europe faces its own challenges: a sense of geopolitical decline and being eclipsed by the Sino-US rivalry, its growth model threatened by competition from high-value Chinese manufacturing, the war in Ukraine and consequent loss of cheap Russian energy, and the threat of the withdrawal of the US security umbrella. Mario Draghi's report on European competitiveness spells out many of these challenges and provides a blueprint of industrial-policy solutions in the climate, defence, and technology spaces to address them.[16] The UK's recent industrial strategy recognises this 'new era', with greater volatility, threats to security and living standards, and a need for a reconfigured relationship between business and government.[17]

The renewed interest in industrial policy and the scale of US interventions make it timely to examine the lessons for policymakers and investors. Too often, international practice is neglected, and policymakers adopt siloed thinking when developing policy. The multiplicity of challenges—growth, climate, economic security, regional policy, geostrategic competition—presents global leaders with a complex policy conundrum when developing industrial strategies. They must align competing objectives and manage trade-offs.

The US case study is informative, as it is a country that has used industrial policies to try to progress multiple objectives simultaneously. Learning from this experience is particularly urgent for Europe as it begins to scale investment to levels not seen since the 1970s to meet the ambitious goals outlined in Draghi's 'industrial strategy for Europe'.[18]

Policymakers must also navigate challenges such as the growing backlash about the cost, social impact, and pace of change of the green transition and inadequate communication of its potential benefits.[19] As the scientific consensus on climate change is overwhelming, it is vital to integrate international learnings into policy design to avoid losing public trust. For investors, a rebirth of industrial policies will yield significant opportunities. Decarbonising the global energy system will save roughly $12 trillion by 2050, helping capital be more productively reallocated.[20]

Predictable, long-term, well-constructed subsidies, fewer regulatory and delivery bottlenecks, and strategic public investment can foster a stronger business environment. However, these benefits come with challenges. Derisking efforts must be carefully aligned with public value and sound risk-return profiles, and investors should use real-world experience with industrial strategy to shape investment decisions and contribute to informed public dialogue.

Informed by the US experience, this report examines how the state and investors can best work together to meet the myriad social, economic, environmental, and security challenges of the 21st century. The Biden administration's policies serve as a rare test case for large-scale interventionist industrial policymaking, an approach few advanced economies have pursued in recent decades, allowing for the construction of practical, evidence-based recommendations.

OUR APPROACH

This report examines the effectiveness of recent US industrial policy, focussing on three legislative acts: the Infrastructure Investment and Jobs Act (IIJA), the Inflation Reduction Act (IRA), and the CHIPS and Science Act. Collectively, this legislation marked a deliberate pivot towards more active state involvement in economic transformation. Rather than simply addressing market failures, the recent administration's 'modern American industrial strategy' sought to actively develop sectors through mission-driven policy, top-down coordination, and strategic capacity building across climate, technology, and infrastructure.

The IIJA primarily allocated funds to states via discretionary and nondiscretionary grants, whilst the CHIPS and Science Act directed funding to semiconductor manufacturing through grants and tax credits (reflecting its more targeted focus on national security), as well as grants via the National Science Foundation. The IRA primarily used tax credits to drive private investment in clean energy.

Across all three laws, a combination of 'carrots' and 'sticks' was employed to promote values-driven policies, supporting the creation of quality jobs and directing investment into economically distressed or 'left behind' regions. Together, these policies intended to 'crowd in' private-sector investment to accelerate growth and, in some cases, create new markets through an approach that was avowedly 'government enabled but private sector led'.[21]

The scale and ambition of these interventions provide a unique petri dish for understanding how advanced economies might deploy industrial policies in the 21st century. Previous work on industrial strategy has tended to examine successes and failures of policy outputs, often narrowing in on examples of government interventions that have had unwanted or unforeseen consequences: failing to achieve the desired effects or having a distortive impact on markets.[22]

Rather than assessing individual policy successes or failures—which may take decades to fully manifest—our approach analyses the design and implementation processes underpinning them. This process-focussed approach aligns with contemporary industrial-policy scholarship that emphasises the importance of learning by doing and adaptation as policies are implemented and new markets develop.[23]

A thoughtfully structured process can foster strategic collaboration between the public and private sectors, enabling them to tackle problems more effectively over time whilst working towards common objectives.[24] We examine the policy approaches undertaken by decision makers and how they engaged with non-state actors, including investors.

METHODOLOGY

The research uses over 40 semi-structured interviews with investors, government officials, and other stakeholders directly involved in, or impacted by, the three pieces of legislation to explore the complexities of industrial-policy design and implementation.[25]

The methodology integrates primary data from stakeholder interviews, secondary data from literature reviews, and quantitative analysis of policy outcomes where data are available. Findings were tested with a panel of experts to ensure their validity. Our analysis excludes assessment of the American Rescue Plan Act of 2021, which focussed primarily on COVID-19 relief measures rather than industrial transformation.

Drawing from the contributions of Rodrik (2004[26], 2019[27], 2022[28]), Mazzucato (2023[29]), Reynolds (2024[30]), and Grubb et al. (2024[31]), we establish a theoretical foundation for industrial-policy best practice, focussing on seven core design principles that the institutional economics literature indicates are critical for the practical success and legitimacy of modern industrial policy.

TABLE 1. SEVEN DESIGN PRINCIPLES FRAMEWORK

Principle	Core Definition	Key Requirements	Purpose
1. CLEAR PURPOSE AND DIRECTIONALITY	Industrial policy should explicitly define a direction and provide objectives aligned with public values and societal goals.	• Objectives should be aligned with collective purposes such as a green transition or economic security. • When multiple objectives are pursued, potential trade-offs between them must be identified and managed early.	Prevent policy diffusion and ineffectiveness, ensure focussed resource allocation, and establish a hierarchy of objectives.
2. PORTFOLIO APPROACH AND RISK MANAGEMENT	Investments should be treated as a portfolio, with attention to the distribution of investment and risk profile across technology stages, sectors, and industries, rather than focussing on picking individual winners.	• Some failures are inevitable and must be managed as part of a larger strategy for experimentation and innovation. • There must be a capacity to 'let losers go' and adjust strategies when projects are not successful.	Enable experimentation and cost discovery and prevent resource misallocation to failing ventures.
3. STRATEGIC COLLABORATION	Industrial policy should foster ongoing interaction and learning between the public and private sectors. The government must maintain independence whilst being deeply informed by the private sector's realities.	• Collaboration should address information asymmetries where governments lack market knowledge. • Trust-building and coalition formation are key to successful collaboration.	Address information asymmetry and facilitate market cocreation.
4. STRONG GOVERNANCE, TRANSPARENCY, AND ACCOUNTABILITY	Effective industrial policy requires government discipline, including monitoring and the ability to adjust when actions are ineffective. Transparency in funding and decision-making is essential for public legitimacy.	• Clear and transparent processes for funding applications and decisions are crucial. • Regular reporting and feedback mechanisms must be in place to assess progress and adjust policies as needed. • Governments need internal capacity to manage complex programmes and adapt as necessary.	Ensure public legitimacy, prevent misappropriation, and enable course correction.
5. FLEXIBILITY AND LEARNING BY DOING	Effective industrial policy requires a flexible set of policy instruments, adaptable to real-time information and learning. The ability to iterate and revise goals and instruments is essential.	• The selection of policy instruments must be flexible to context and market, with consideration for demand and supply-side conditions, sector, and technology stage. • It should allow for learning by doing, where policies are refined over time and through input from external actors.	Navigate uncertainty, respond to unforeseen challenges, enable learning by doing, and evaluate goals and progress for continuous improvement.
6. CONDITIONALITIES	Specific obligations should be attached to public funding to steer private behaviour towards societal goals.	• Conditions should not be overly burdensome but must provide enough leverage to achieve desired outcomes. • Private firms should be incentivised to align their actions with public goals.	Ensure public returns on public investment and align private behaviour with societal objectives.
7. COMPETITION-FRIENDLY DESIGN	Induce greater competition within sectors rather than picking individual winners.	• Use competitive allocation processes. • Market-led deployment should have broad access to incentives for new entrants and innovation. • Competition should be technology-neutral where possible.	Foster innovation through competition, avoid government picking winners, and maximise market efficiency.

Source: Milken Institute (2025)

Drawing from the insights collected through our interviews, we highlight four key themes that guide the structure of the following chapters: (1) government coordination and capacity building, (2) incentives and conditions for crowding-in investment, (3) overcoming barriers to effective delivery, and (4) creating new markets in emerging technologies. We examine each of these themes in light of the seven-principle framework, developing specific recommendations for policymakers and investors.

This study contributes to the growing literature on industrial strategy and innovation policy and provides practical insights for policy transfer and adaptation across different institutional contexts.

1 GOVERNMENT COORDINATION AND CAPACITY BUILDING

Pursuing industrial policies requires using state apparatus to shape markets and organise economic sectors to support socio-economic objectives.[32] It requires effective ‘government capacity’—the ability of governments to achieve policy goals delivered through the administrative, bureaucratic, and legal architecture of the state.[33]

Effective government capacity, being a necessary (if insufficient by itself) precondition for industrial-policy success, cuts across many of our design principles. The technical sophistication required for industrial and infrastructure deployment necessitates flexibility in policy design to adapt instruments as circumstances change (design principle 5). This requires supporting technologies at different levels of maturity whilst adjusting goals and approaches as both public and private sectors learn by doing.[34]

Capacity—in federal, state, and local government—is required to manage processes such as responding to technical dialogue with partners and the permitting of projects. Coordination across government and with nongovernmental actors, and strong governance structures (design principle 4), supports dynamic risk management as events arise, providing the necessary governance, transparency, and accountability for delivery. In light of these principles and our interviews, we focus on three areas: expertise, administrative capacity, and coordination, both federally and at lower tiers of the US government.

EXPERTISE IN GOVERNMENT

Industrial policymaking is highly complex. Policies should be carefully calibrated to specific market conditions, incorporate competitive principles, and include robust monitoring mechanisms—all requiring sectoral expertise and analytical capabilities.[35]

Whilst recent US industrial policy built on the work of previous administrations, a significant proportion of measures under the IRA and CHIPS and Science Act were novel, reflecting growth in the scale and complexity of interventions. One former White House official noted how the Department of Energy (DoE) had little prior experience of deployment or commercialisation and now had to be restructured and hire commercial expertise to take on new functions.[36]

Implementing these policies required having sufficient expertise in government. Congress provided direct hiring authority to allow agencies to bypass civil service hiring rules; however, agencies varied in their approaches to using this authority, and hiring remained a significant bottleneck for many programmes. The CPO hired staff from the semiconductor supply chain and investor community. The DoE's Loan Program Office (LPO), which provides loan guarantees for 'first of a kind' energyprojects, built links with investors to progress projects at later stages of development, creating a business development team with the technical expertise to lobby firms to take on federal debt and unlock project finance. Both agencies attracted talent with sectoral and analytical expertise due to the high-profile and urgent nature of their work.

Strategic collaboration with the private sector is an essential success factor in industrial policymaking, and the approach of 'government enabled, private-sector led' channelled private expertise to achieve industrial-policy goals.[37] And it yielded significant results, with the LPO distributing loans worth $55 billion by December 2024 and the CPO supporting development of 20 projects worth around $34 billion.[38]

Despite these successes, bringing in expertise eluded some government agencies. The Department of Transportation (DoT) found it difficult to recruit, develop, and retain the workforce necessary to implement IIJA programmes.[39] In particular, our stakeholders identified that smaller and less high-profile agencies struggled to hire staff with the right expertise to deliver effectively.[40]

Under the IIJA, states administered a large volume of funding, with 85 per cent of its funding going directly to state and local government.[41] Lower tiers of government administered funding but could also bid for it from federal agencies. The complexity of new programmes presented a problem for state bureaucracies, which often lacked the expertise necessary to deliver them. The National Electric Vehicle Infrastructure (NEVI) Program has been criticised for its slow deployment of chargers, becoming a well-publicised case study in the weakness of US industrial policy.[42] Whilst there is no single explanation for its delivery challenges, many localities lacked policies for charger installation or the sale of electricity, and state departments of transportation lacked familiarity with the technology.[43]

ADMINISTRATIVE CAPACITY

In addition to expertise, the quantity of programmes necessitated bringing in sufficient 'boots on the ground' to deliver them. For the IIJA alone, over 60 federal bureaus, agencies, and commissions were responsible for allocating funding for 369 new and existing programmes.[44] One stakeholder noted that the Economic Development Administration, 'a $200 million agency for 30 years', had its budget expanded to over $3 billion under the legislation.[45]

Yet it remained challenging to get sufficient staff into posts. This reflected post-pandemic labour market challenges but also the scale of what the government was trying to achieve.[46] The federal workforce in the US is smaller per capita than in European bureaucracies and has fallen in relative terms over time.[47] Certain agencies were chronically understaffed, such as the Bureau of Ocean Energy Management, which was required to permit significantly more offshore wind projects than ever, leading to delays.[48] The same is true of states, with state departments of transportation seeing employment fall by 20 per cent between 1997 and 2020.[49]

The administration sought to grow the size of federal bodies. The DoE, despite hiring thousands of new staff, still faced shortages in certain agencies.[50] And the DoT set out to hire 1,700 staff for IIJA programmes alone.[51] Congress provided some funding to improve administrative capacity, with the IRA providing money to improve permitting in federal agencies.[52] However, funding tended to be inadequately appropriated for programme administration: The $27 billion Greenhouse Gas Reduction Fund (GGRF) had a maximum of around 35 people overseeing the programme, with only $30 million allocated by Congress for administrative costs.[53]

As early as 2021, local capacity was identified as a barrier to programme delivery.[54] In particular, the legislation directed federal funding through mechanisms such as the Distressed Areas Recompete Pilot Program to places that had historically received less. This required support for localities in applying for funds for which they were newly eligible. The DoT provided technical assistance through the Build America Bureau to enable smaller localities to apply and compete for awards and to support recipients in executing on awarded projects.[55]

COORDINATION

The complexity and ambition of the administration's objectives required collaboration among federal, state, and local officials and non-state actors, including businesses and nonprofits. This scale created a coordination challenge which tested the management capability of actors across the US government.[56]

Many policy objectives required the dovetailing of programmes with different objectives. To increase the uptake of electric vehicles (EVs), there was a programme to install chargers on federal highways, tax incentives for consumers to buy vehicles, and credits to build them in the US. This required different agencies of the US government working together to ensure that the overarching objective of vehicle electrification could be delivered.

The US federal structure presents a challenge in implementing state-by-state initiatives across 50 states, each with unique stakeholders and regulations. More complex funding mechanisms, such as competitive grants, required officials to administer approvals and engage with a range of different stakeholders to deliver projects.[57] Funding conditions, such as domestic content requirements, added further complexity.

Recognising this, the federal government instructed large cities and states to appoint infrastructure coordinators to liaise with the federal government and help grant applicants demonstrate that their projects met eligibility criteria.[58] Our stakeholders highlighted that the coordinators, supported by the National Governors Association, were able to unblock delivery challenges through their access to the administration and improve coordination within and outside government.[59] Larger cities such as Detroit improved access to state and federal funds with the help of coordinators, but some smaller cities that lacked the resources to employ them may have missed out on funding opportunities.[60]

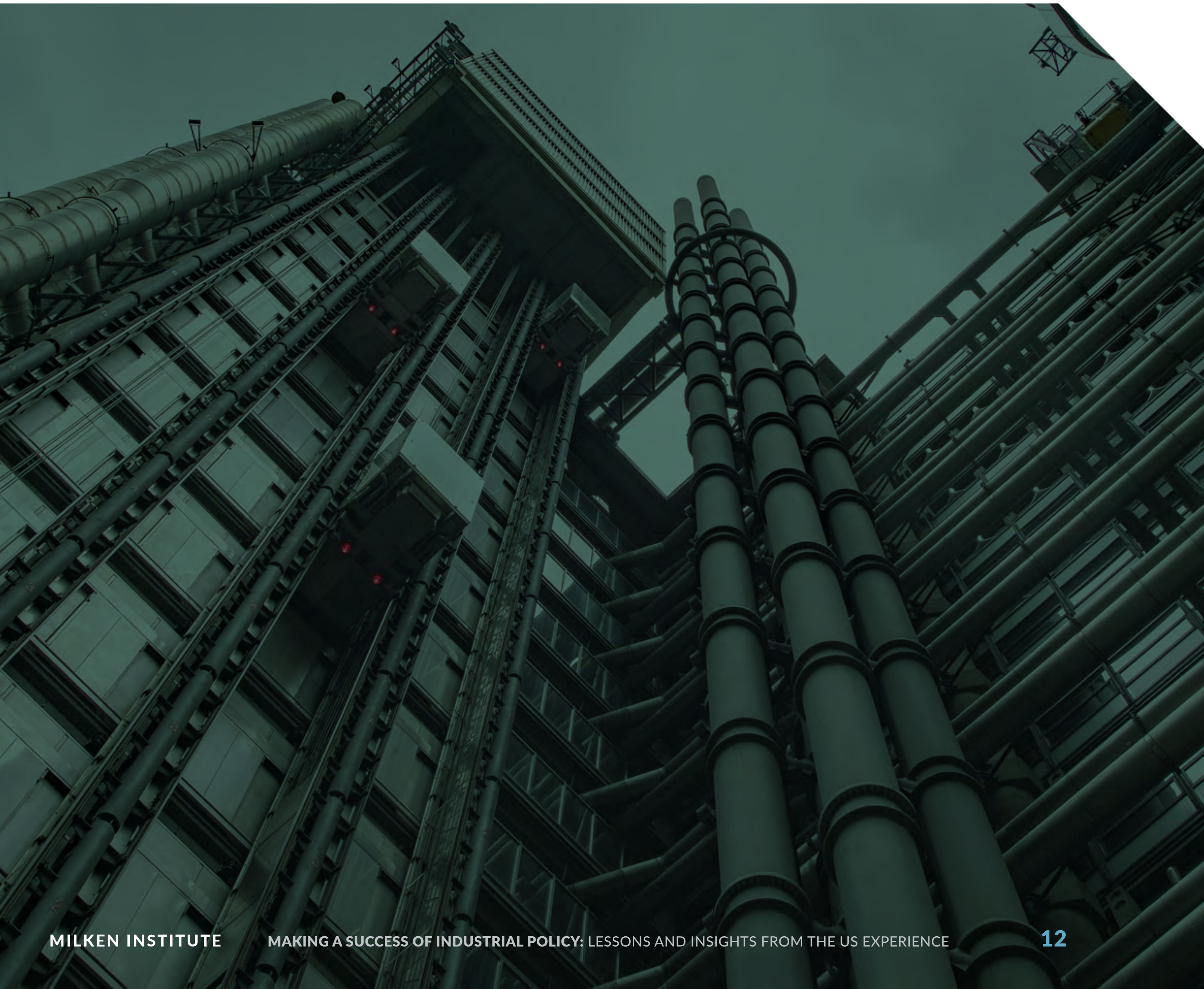
Achieving good outcomes in decentralised political systems is complex and requires significant coordination, especially when so much is being attempted in a short span of time. The scale and ambition of the administration's policies made coordination difficult, although efforts to improve this through the infrastructure coordinators were well received. Nevertheless, efforts to streamline coordination were constrained by the lack of a 'single, unifying touchpoint on industrial policy'.[61]

ADMINISTERING PROGRAMMES

The capacity and coordination challenges faced by the federal government affected delivery. The sheer volume of new programmes—over 160 across the new laws[62]—made delays inevitable. Final wording on the hydrogen tax credit (45V) only appeared in late 2024 due to wrangling over environmental regulations, which led to some projects 'withering on the vine' as producers lacked clarity to estimate supply costs or plan investments.[63]

On the grant side, some stakeholders identified bottlenecks in receiving funds from the CPO and LPO.[64] The LPO in particular faced challenges in administering its expanded loan authority, with the Government Accountability Office identifying that the agency failed to meet targets for the number of application reviews and the time taken to review them.[65]

Nevertheless, a significant volume of funding was administered in a short time. For example, the $27 billion GGRF was fully distributed,[66] and the LPO distributed around a quarter of the $360 billion in new loan authority provided under the legislation, making it the 'largest credit fund in the world'.[67] It will be important for this funding to continue to be monitored *ex post* to maintain public trust in the accountability and governance of such assistance.



CLOSING REMARKS

The scale of what was attempted under recent US industrial-policy legislation was immense: As one stakeholder put it, 'if a company announced a similar strategic shift, it would take more than 10 years to implement'.[68] The federal government recognised this by applying measures to improve capacity, expertise, and coordination in the US government.

For industrial policy to succeed, our framework underscores the need for technical expertise, institutional capacity at both local and national levels, effective coordination among actors, and governance systems rooted in transparency and accountability. Recent US experience reflects many of these principles in action, yet our research also reveals further lessons to be learned.

Firstly, some agencies received insufficient funding to deliver programmes. Much of the US government was already under-resourced in expertise and staffing, and additional funding should have been allocated to help hire the right people. The example of the GGRF, with $30 million allocated to administrative costs to manage a $27 billion programme, is not untypical. It is too early to identify whether funding was misspent or if a lack of administrative capacity or expertise contributed to high costs and poorer outcomes. But as the UK National Infrastructure Commission has identified, technical expertise in the public sector is essential to delivering timely and cost-effective infrastructure.[69]

Secondly, local government actors needed additional support to deliver the federal government's priorities. US experience demonstrates how insufficient local expertise and capacity undermine delivery. This is most clearly demonstrated by the NEVI programme in electric vehicles, but it was prevalent in areas where lower-tier governments were required to administer funding or had opportunities to bid for it.

Applying these lessons in Europe will be critical to successfully accelerating its industrial transition. A lack of skills has been identified as a particular challenge at lower levels of government, with 69 per cent of municipalities in the EU lacking the requisite skills for environmental and climate assessments.[70]

Policymakers recognise this challenge—with the new UK industrial strategy including funding for additional staff in areas such as planning.[71] But government capacity will have to increase to reflect not only the additional workload from new infrastructure and industrial-related construction but also the heightened technical complexity required by new technology.

Industrial-policy delivery starts with government and requires capable, well-staffed bureaucracies with sufficient expertise to ensure that programmes can be administered properly and robust governance to manage coordination inside and outside government. Applying these lessons is essential for ensuring robust results and popular buy-in for industrial policies in Europe.

RECOMMENDATION

Developing industrial policies is complex, and it is imperative to have the right expertise in government and sufficient capacity at a local level to deliver objectives effectively. To achieve successful outcomes, European governments must ensure civil service hiring rules are flexible enough to bring experts into government where they are needed and all levels of government are resourced to manage and monitor programme delivery.

2

INCENTIVES AND CONDITIONS FOR CROWDING-IN INVESTMENT

Modern industrial strategies aim to stimulate economic activity by mobilising investment from both businesses and consumers, using a mix of incentives to address supply-side constraints (such as high capital costs) and demand-side gaps (including uncertain markets or weak consumer uptake). Governments use ‘vertical’ measures targeting specific firms or sectors, often through loans, grants, and tax credits, and ‘horizontal’ policies focusing on more general capabilities, such as technical standards and competition policy. Incentives can include broad-based tax credits (such as the IRA’s technology-neutral tax credits) and supply-side interventions like easing construction barriers through planning or permitting reform (see Chapter 3).

To maximise impact, these instruments can be designed in strategic partnership with the private sector (principle 3) to ensure they are well targeted and unlock investment that would otherwise be unlikely to occur. Yet incentives alone are rarely sufficient to align private investment with public goals, which is why governments often pair them with conditions to ensure public funds deliver broader social and economic benefits (principle 6).

Government-imposed conditions on financial assistance have a long history across different contexts and have been embedded in US domestic programmes since at least the New Deal era.[72] ‘Conditionality’ can take the form of performance targets (such as job creation or production milestones), compliance requirements (including environmental or safety standards), and accountability mechanisms (like regular reporting or clawback provisions) which help shape the actions of the private sector towards predetermined policy goals.

Under the Biden administration, the conditions placed on government assistance were expanded in both scope and ambition—a shift that has sparked debate over whether such requirements sharpen policy effectiveness or instead impose frictions that slow delivery and diffuse objectives.

Ezra Klein and Derek Thompson, for example, argue that excessively layering goals, standards, and rules onto projects has created administrative bottlenecks that undermine delivery and defeat the very objectives policymakers sought to achieve.[73] This broader critique extends to recent industrial policy, where stakeholders we interviewed provided differing perspectives on the extent to which the conditions attached to private-sector investment under the IRA, the IIJA, and the CHIPS and Science Act either enhanced policy effectiveness or created counterproductive barriers to implementation.

Supporters like Brian Deese (director of Biden's Economic Council) argue that well-designed conditions represent 'capitalism at its finest' by ensuring public funds generate broader social benefits beyond pure market outcomes.[74] Business groups often counter that complex requirements create implementation delays, whilst unions argue the conditions do not go far enough in protecting workers or preventing corporate financialisation. Conditionality design must therefore strike a delicate balance: stringent enough to safeguard public interests and ensure value for money, yet streamlined enough to maintain private-sector participation and project momentum. This requires ongoing assessment of whether each condition's public benefits justify its implementation costs and administrative burden.

INCENTIVES TO CROWD-IN INVESTMENT

By January 2025, the IRA, IIJA, and CHIPS and Science Act had collectively awarded over $777.8 billion in funding.[75] These resources were deployed through a variety of mechanisms designed to catalyse investment in industrial and infrastructure priorities:

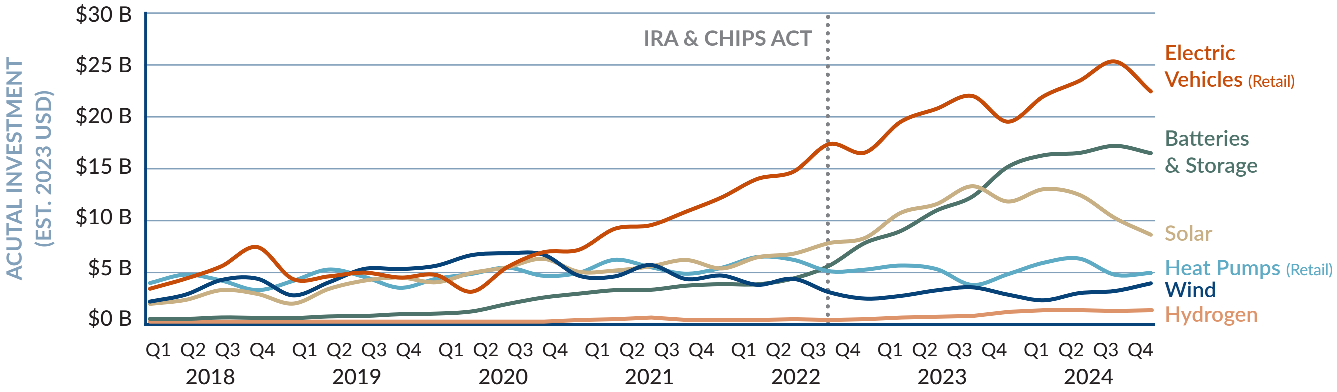
- **IRA:** $108.7 billion, principally via tax credits. For example, supply-side incentives for the domestic manufacturing of clean energy technology components (45X), the production of clean electricity (45Y), and demand-side incentives for commercial vehicles (45W) and consumer EV credits (30D/25E).
- **IIJA:** $595.5 billion, primarily via formula grants (60 per cent), discretionary grants, and cooperative agreements.
- **CHIPS and Science Act:** $73.6 billion awarded for US semiconductor projects in manufacturing tax credits and loans under the CHIPS for America Manufacturing Incentives.

IRA tax credits appear to have been highly catalytic for private investment, and their longevity (most lasting into the 2030s) provided a long-term investment horizon. In the two years following the IRA's passage (mid-2022 to mid-2024), private investment in clean tech increased by 71 per cent, reaching a total of nearly $500 billion.[76] For every $1 of federal government spending (approximately $78 billion in this period), private investment was estimated at five to six times higher.[77] In EVs, the tax credits, in conjunction with $18.6 billion in IIJA grants and loans led to around $88 billion of investment in the sector, creating approximately 60,000 jobs.[78]

The IRA's tax credits significantly reduced the levelised cost of new-build energy generation for utility-scale solar (27–47 per cent reduction) and land-based wind (13–59 per cent reduction).[79] By 2024, over 90 per cent of all generating capacity added to US electricity networks came from renewable-energy sources.[80] However, newer technologies such as hydrogen faced a more complex set of challenges that often constrained private-sector investment (this is discussed in depth in Chapter 4).

Figure 1 illustrates quarterly investment trends across various technology types, with notable growth observed in batteries, retail spending on EVs, and solar production.

FIGURE 1. INVESTMENT IN CLEAN TECHNOLOGY (QUARTERLY, SELECTED CATEGORIES, Q1 2018–Q4 2024)



**Solar covers manufacturing (modules, cells) and production (photovoltaic, concentrating solar power). Wind encompasses manufacturing (blades, towers) and production (onshore/offshore). Batteries & Storage covers cell/module manufacturing and long-duration storage. Hydrogen includes electrolyser manufacturing and production.*

Sources: Rhodium Group (2025), MIT Center for Energy and Environmental Policy Research (2025)

The CHIPS and Science Act has been similarly impactful. Since the passing of the act in August 2022, over 80 projects have been announced, with the Biden administration claiming $449 billion in private-sector semiconductor and electronics investment.[81] The mixture of grants and tax credits has made US semiconductor manufacturing more cost-competitive, with companies such as TMSC announcing new plants on the back of the legislation's passage.[82]

Whilst some IIJA programmes encouraged private-sector investment, most funding was awarded to infrastructure redevelopment, with new market activity limited to match and credit co-investment rules—unlike the IRA and CHIPS Act, which more directly targeted innovation and the development of new markets through tax incentives. Commentators have identified a more limited role for private capital in the IIJA than in other legislation, characterising this as a 'missed opportunity'.[83] The impact of the IIJA on private-sector investment is difficult to assess, with limited evidence available to date.

REFORMS TO MAXIMISE IMPACT OF FUNDING

The administration did not start from scratch; instead, it built on pre-existing tax credits and grant structures. For example, in 2006, the George W. Bush administration established tax incentives for 'energy-efficient vehicles' using hybrid technology, and the Obama administration provided a rebate of up to $7,500 specifically for electric vehicles.[84] Under the IIJA, despite the expansion of competitive grants, a significant proportion of funding was 'formula' based in that it relied on existing funding programmes and structures. As formula funding did not require a competitive award process, it should have provided funding for programmes more quickly.[85]

Several reforms were undertaken to maximise the catalytic potential of funding, with the most important being tax system reform to improve liquidity in the market for credits.

The first such innovation was transferability, which allows project owners to monetise tax credits by transferring them to other taxpayers and allowing them to be redeemed for cash. Whilst such mechanisms had existed previously, they typically required investors to hold an equity interest in a project in return for future use of the tax credits.[86] This restricted liquidity, as only banks and large financial firms were sophisticated enough to be tax equity investors. Transferability deepened the market by obviating the requirement for equity, allowing a much larger number of corporates with tax liabilities to become tax credit investors.[87] The new rules allowed 11 types of federal clean-energy tax credits to be sold for cash.[88]

The second innovation was direct pay. Previously, tax-exempt entities such as state or local governments were unable to benefit from tax credits. The new elective, or 'direct pay', regulations allowed these entities to receive cash in lieu of credits. Twelve clean-energy credits could be used for direct pay for technologies including solar panels and battery storage.[89] This allowed organisations such as city councils and school districts to receive the full value of incentives for undertaking clean-energy and electrification projects.[90] By April 2024, there were already more than 1,300 direct-pay projects.[91]

Many tax credits had no upper limit on the number of claims, although the majority were to be phased out in 2029–2032. The exception was credit 48C (advanced energy projects), which was capped at $10 billion in credits.[92] The uncapped nature of credits was an important reform (for example, the consumer EV credit, 30D, replaced a credit that was capped at 200,000 vehicles), but some have criticised it for the potential impact on the US fiscal balance.[93]

Despite these reforms, our stakeholder interviews revealed weaknesses in policy design that constrained access to project finance. A common concern was that fixed-value grants lost real value as construction costs rose with inflation. Other factors, such as supply-chain problems, stricter emissions standards in the energy sector, and extreme weather events, raised baseline spending needs on projects, so even as funding increased, costs increased as well.[94] Stakeholders also emphasised the limited suitability of the policy tools on offer for certain nascent clean-tech sectors, which we discuss in detail in Chapter 4.

CONDITIONALITY IN PRACTICE

Conditionality aims to ensure public subsidies deliver broader economic and social value. Across the IRA, IIJA, and CHIPS and Science Act, conditions steered private capital through measures such as:

- **Domestic content requirements:** 'Buy America' provisions designed to increase the use of US-made materials in construction and supply chains.
- **Labour requirements:** Conditions requiring the use of unionised labour (though in practice court rulings often stopped this) or prioritising hiring from historically disadvantaged or underrepresented groups, including persons of colour.
- **Social provisions:** Requirements for worker-focussed benefits such as on-site childcare in new projects.
- **Regional policy provisions:** Including incentives to direct investment towards 'energy communities'—areas likely to be adversely affected by the energy transition due to previous fossil fuel employment or brownfield sites from former industrial use.[95]

These conditions were applied in several ways. The IRA included a system of bonuses that increased tax credits by 10 to 40 percentage points for projects that met specific objectives. It was still possible to claim a 'base' credit without applying these conditions, but often the large differential in the bonus meant they acted like funding conditions, since not implementing them entailed a significant cost disadvantage.

Elsewhere, meeting the condition was necessary to receive the subsidy. In the CHIPS and Science Act, the Department of Commerce inserted conditions into 'notices of funding opportunity', so that funding was received only if those conditions were met, including limits on share buybacks and improving workforce training.[96] There were also domestic content requirements, with existing 'Buy America' requirements being strengthened, increasing from 55 per cent to 65 per cent of the required value of materials made in America that were used on federal projects.[97]

Conditions were important for delivering on wider objectives but at times impacted programme delivery. The Broadband Equity, Access, and Deployment (BEAD) programme under the IIJA provided $42 billion to expand high-speed internet access in underserved areas. However, limited pre-existing domestic supply chains for network infrastructure equipment meant that the requirement of US-made content was, in effect, impossible to meet. Whilst these requirements were waived, others—for components including fibre optic cabling—remained, which likely increased project costs as local producers were less cost competitive.[98]

Other conditions addressed issues including workforce development, environmental resilience, net neutrality, and consultation with underrepresented groups.[99] By 2024, no BEAD projects had progressed, with the failure of the programme characterised as symbolic of the alleged industrial strategy weaknesses of the administration as a whole.[100] Whilst there is no single explanation for BEAD's failure, it is highly likely that excessive conditionality played a role.[101] Other programmes, such as EV chargers, had their domestic content requirements waived and then phased in to take account of how the stringent requirements on US-made content were constraining the supply of chargers and therefore threatening programme delivery.[102]

Conditionality also applied to tax credits. One construction group argued that apprenticeship and prevailing wage requirements attached to the clean-energy tax credit (45Y) 'needlessly increased costs, delayed clean energy projects, and exacerbated challenges in the construction industry',[103] although the National Renewable Energy Laboratory has disputed that such requirements necessarily led to higher costs.[104]

Anecdotal evidence suggests that simpler tax credits with fewer conditions were more popular amongst manufacturers. The 45X credit—supporting production of solar, wind, and battery components—had no prevailing wage requirements, regional incentives, or bonus credits and, according to one stakeholder, provided a stronger incentive for companies to invest compared to the anticipated uplift in demand from the 30D consumer credit.[105] The latter sought to stimulate consumer demand but had stringent domestic content requirements which increased over time.

CONDITIONALITY AND STRATEGIC COHERENCE

The range of conditions applied under recent US industrial policy reflects both the ambition and the complexity of its design. Whilst the administration advanced several major pieces of legislation—the IIJA, IRA, and CHIPS and Science Act—these were not embedded within a single, overarching strategy document that clearly set out aims, objectives, and success metrics. As one stakeholder observed, this contributed to a perception that policymaking comprised a sequence of bills and initiatives rather than a unified strategy.[106] The absence of a formal framework made it more difficult to prioritise among competing objectives—such as delivering good jobs, accelerating decarbonisation, and strengthening domestic supply chains—which in turn influenced how conditionality was applied.

The impact of conditionality on delivery varied considerably. In some programmes, such as BEAD, multiple and overlapping conditions were seen as contributing to implementation challenges. In others, such as many semiconductor projects supported under the CHIPS and Science Act, delivery proceeded largely as planned despite extensive conditions, possibly aided by the act's more singular focus on economic security.

Adverse effects from conditionality likely had more impact in smaller projects, in programmes with less clearly defined objectives, or where implementation relied heavily on state or local actors for whom meeting multiple requirements was resource intensive. Whilst there is little evidence that conditionality deterred investment outright, the popularity of the relatively condition-free 45X tax credit suggests that its simplicity was attractive to investors.

CLOSING REMARKS

Both the CHIPS and Science Act and the IRA mobilised significant private-sector investment. However, investment was heavily concentrated in sectors that were mature and had proven demand, such as the EV battery supply chain, with far less investment seen in offshore wind, heat pumps, and nascent clean technologies (as discussed in Chapter 4).

As one stakeholder asserted, tax credits were most effective when they were 'clear, transparent, and easy to claim'.[107] The uncapped 45X tax credit, with its straightforward conditions and easy access, was highlighted as particularly impactful for EV battery production. However, the conditions placed on some investments, such as domestic content requirements, slowed delivery, particularly in the cases of the broadband and EV charger programmes.

The overall impact of conditionality on the success of recent US industrial-policy initiatives warrants further study. Evidence to date suggests that well-designed conditions can enhance public value and encourage market participation, whilst overly complex or numerous requirements—particularly in smaller programmes or where the business case is marginal—may slow implementation or complicate delivery. Conditions should be flexible to accommodate sector heterogeneity and adapt to evolving market conditions, for example, in cases where domestic supply chains are less established.

These patterns reflect a broader question of strategic coherence in recent US industrial policy. As our design principles suggest, clarity of purpose and a well-defined hierarchy of objectives are essential for developing and applying conditions, particularly in complex scenarios where trade-offs may arise. For instance, balancing goals like decarbonisation with economic security requires a clear framework to ensure that efforts to achieve one goal do not inadvertently undermine the other. A cohesive overarching strategy, with explicit prioritisation, could have provided a clearer direction and helped to more effectively realise the intended policy outcomes—whether economic growth, job creation, or environmental benefits.

RECOMMENDATION

The US experience shows that when designing incentives to mobilise private investment and meet industrial-policy objectives, governments should ensure that measures are simple, easy to claim, and available long-term. Conditionality should be applied to maximise public value, but policymakers should avoid applying too many conditions, which can dilute objectives and impede delivery, particularly in smaller or more marginal programmes.

3

OVERCOMING BARRIERS TO EFFECTIVE DELIVERY

Building infrastructure and industrial facilities is complex and fraught with risks which contractors, clients, and project sponsors must navigate. Risks exist at the delivery stage but also in obtaining the necessary permits and finance prior to construction.[108]

Achieving successful outcomes requires drawing on industrial-policy best practice. In a democratic society, strategic collaboration with interested parties is necessary to ensure projects have public support and the consents necessary to be built. Robust governance ensures that resources are used efficiently and accountability is maintained between clients and project sponsors. Learning by doing (principle 5) prevents replication of barriers in repeatable projects, reducing costs in multi-project programmes.

Critics have identified how, in the words of Ezra Klein, the federal government 'is extremely good at making building difficult'.[109] This problem has worsened over time as regulatory frameworks have grown in complexity and environmental legislation has increased popular participation in construction decisions.[110] Our interviews identified three sets of related barriers that contribute to this problem:

- **Consenting/permitting:** Obtaining necessary permits for projects is a lengthy process and has slowed over time, with the average time to prepare environmental impact statements increasing from 3.4 years in the 1990s to 4.8 years since the late 2010s.[111]
- **Enabling infrastructure:** For example, for electricity transmission, the US network will need to expand by 2.4 to 3.5 times from its 2020 size by 2050 to meet targets to reduce greenhouse gas emissions.[112]
- **Construction costs:** Construction productivity in the US is 40 per cent lower than it was 50 years ago, with infrastructure construction costs now double the Organisation for Economic Co-operation and Development average.[113]

Many programmes are still being implemented, and it is therefore too early to fairly measure impact. Our interest is in how the federal government *foresaw* and *managed* barriers to delivery by applying industrial-policy approaches in policy design.

CONSENTING/PERMITTING

Project development is a multifaceted process that requires engineering design, financing, land acquisition, permitting, construction, and operations.[114] Whilst there are risks at all stages, our interviewees identified how obtaining permissions from local, state, or federal bodies prior to construction is a major barrier to achieving timely results.[115] This problem is most acute in infrastructure but also impacts industrial projects. As an example, two Micron semiconductor plants in New York State were delayed by endangered bat species living in an adjacent site, which needed to be cleared for construction to start.[116]

Obtaining permits is complex due to the proliferation of 'veto powers' across local, state, and federal governments. The National Environmental Policy Act (NEPA) applies when a project crosses federal land, receives federal funding, or is subject to federal regulations, with most large energy and transport projects requiring NEPA approvals.[117] These approvals have become longer over time, from around three years in the late 1990s to nearly five years by 2021, and reviews cost an average of $4.2 million.[118]

States have their own legislation regarding permitting to protect the natural environment and cultural heritage.[119] Local opposition has made the process of achieving these approvals more complex. One survey of wind and solar projects has found that community opposition leads to delays of 11 months for solar and 14 months for wind, with this problem worsening substantially in the past five years.[120]

Delays contribute to project cancellations. This is not a new problem—the Cape Wind project in Nantucket Sound was cancelled in 2017 after taking nearly a decade to receive consents and lawsuits costing the developer $100 million.[121] But delays have become more acute with growth in the volume of construction. Demand from renewables projects has led to significant electricity grid interconnection queues, with 10,000 active requests (representing 2,000GW of projects) at the end of 2022, a 40 per cent increase from 2021.[122]

The permitting bottleneck under the new legislation was widely recognised. An agreement to speed up permitting for energy projects, including a two-year limit for environmental review, was added to the IRA to win support from Sen. Joe Manchin.[123] Staffing in agencies responsible for permitting increased by 14 per cent, and the budget of the Federal Permitting Improvement Steering Council tripled.[124] In the IIJA, a 'permitting action plan' sought to improve coordination between agencies and environmental review of major projects.[125] In the CHIPS and Science Act, large projects were exempted from NEPA review (although not state legislation).[126] One CPO stakeholder highlighted the importance of this exemption for getting projects built quickly.[127]

Permitting times have fallen following these measures,[128] with the average time taken to complete environmental impact statements falling by 28 per cent.[129] However, Manchin's multiple efforts to speed up the process, including through his proposed Energy Permitting Reform Act, failed to pass.[130] Many projects, particularly in the energy space, have foundered due to lengthy delays in receiving the necessary permits.

ENABLING INFRASTRUCTURE

Enabling infrastructure—for example, to transport and store electricity, hydrogen, and CO_2—is critical to industrial activity, including meeting net-zero objectives.[131] One example is the energy transmission network, where investment is needed to support electrification of transport and domestic heating and to balance supply and demand in a system which generates electricity from intermittent and geographically dispersed sources. Meeting these challenges will require a tripling of US grid capacity by 2050.[132]

Like many countries, the US has underinvested in its grid, where 70 per cent of transmission lines and power transformers are over 25 years old.[133] There are systemic weaknesses, too, with shortfalls in inter- and intra-regional capacity and inadequate central planning, with a patchwork of utilities, regional transmission organisations, and independent system operators.[134] The result is insufficient coordination between regions and investment prioritised to local lines over the high-voltage transmission network.[135]

As with permitting, there have been recent attempts to reform this important enabling infrastructure. The Federal Energy Regulatory Commission (FERC) instigated two orders—1920 and 2023—requiring grid operators to undertake 20-year forward plans, improve regional cost sharing for new lines, and reduce interconnection queues.[136] In 2023, the Democrats proposed the Big Wires Act to reduce fragmentation and uncertainty over the allocation of construction costs on projects.[137] However, this and other similar legislation received insufficient bipartisan support to become law.[138]

One challenge lies in the competence of the federal government and its agencies in the face of veto powers from states and localities. The FERC, for example, lacks the power to pre-empt state and local regulations to speed up approval for renewable-energy projects, unlike in certain fossil-fuel projects.[139] Even legislation reforming the grid lacked measures to address the imbalance in decisions held by subnational authorities, which the federal government cannot overrule.[140]

The US government inadequately appreciated the importance of the grid as an enabler for other projects. But enabling infrastructure was lacking in other areas, too—our stakeholders identified affordable housing for workers and childcare provisions as crucial enablers which were largely removed from the IRA during its legislative passage.

CONSTRUCTION COSTS

Permitting challenges and a lack of enabling infrastructure are major contributors to project delays, increasing project costs. The US has some of the highest infrastructure construction costs globally. Since 2010, highways built in the US have been consistently more expensive than highways built in other countries.[141]

Another contributor to high costs is high input prices. The expansion of industrial policies in the US coincided with rising input costs—an index of inputs into highway construction increased by 57 per cent from 2019 to the third quarter of 2023, significantly ahead of the headline inflation rate of 19 per cent, with material costs rising in parallel.[142] These costs have reduced inflation-adjusted spending on infrastructure even with additional funding, so it was lower in 2023 than in 2020, wiping out the benefits of additional money.[143]

Some sectors have witnessed greater impacts from inflation than others. Offshore wind has wrestled with supply-chain-induced shortages from the pandemic and escalating interest rates, increasing financing costs.[144] This has led to cancelled projects, including two in New Jersey, where the developer took an impairment of $5.6 billion.[145] One stakeholder noted how delays from receiving permits made projects unviable as prices rose whilst they were waiting to start construction[146], showing the relationship between construction inflation and permitting in harming the viability of projects.

As noted in Chapter 2, inflexibility of policy tools increased the impact of construction inflation, since grants and tax credits for production were fixed even as inflation eroded their value. High project costs meant that fewer projects could be delivered with the money available, so programmes were unable to deliver on their objectives.

CLOSING REMARKS

We set out to identify lessons from the US in undertaking industrial policy successfully, including whether the administration acted strategically and flexibly enough in identifying and addressing barriers to delivery. The US experience shows that to achieve successful objectives, it is essential to promptly redress barriers that add delays or costs to projects.

This is not a uniquely US problem. Reports in the UK have exposed barriers to delivering infrastructure projects, with permitting identified as a risk to timely and cost-effective delivery.[147] The EU has already initiated measures to minimise the impact of its own environmental legislation on renewable-energy project approvals, such as through regulation 2022/2577.[148] And the Draghi report identifies how permitting onshore wind farms can take three times longer in the slowest member states than in the fastest, recognising that measures to increase the pace of permitting are a prerequisite to achieving results from additional public and private investment.[149]

Every advanced economy will need to enhance infrastructure networks and industrial facilities to meet economic and climate objectives. For this, they must navigate regulatory frameworks conceived decades ago to constrain governmental and private-sector actors' ability to abuse power in ways with social and environmental consequences. However, the current evolutionary state of these frameworks impedes projects with environmental and social value—efforts by New York City to implement congestion charging were stymied by environmental assessments despite their avowed climate objectives.[150]

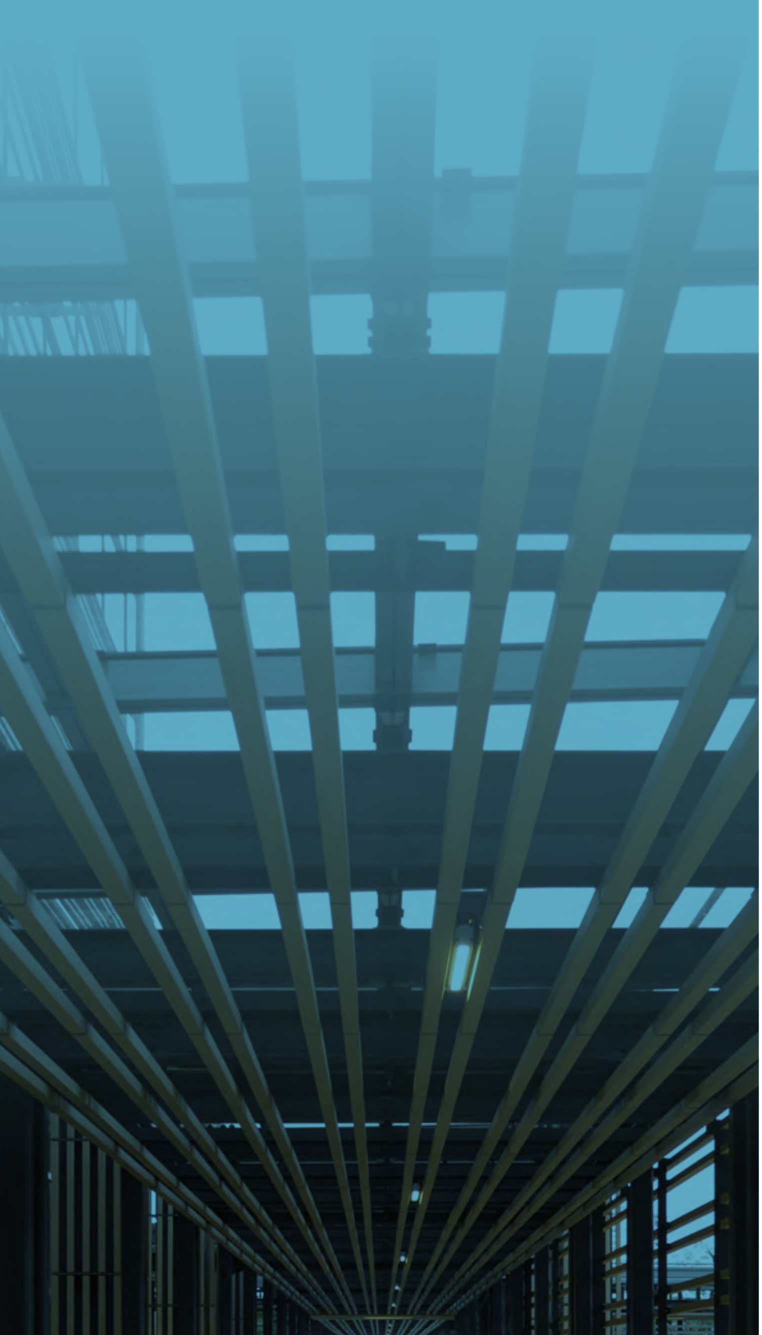
Successful industrial policies cannot rely on measures to stimulate private-sector activity alone. They also require carefully designed initiatives to reduce barriers to construction. Despite Brian Deese identifying this problem,[151] the administration did not pursue difficult measures to remove barriers when they had the political capital to do so. Instead, policymakers have, in the words of one stakeholder, been 'seduced by [their] ability to spend limitless amounts of money'.[152] The systems and frameworks which govern projects—including permitting—need to be revised to ensure they help improve and shape project development, rather than delaying and obstructing it.

RECOMMENDATION

The implementation of industrial policies in the US has encountered numerous delivery barriers, including permitting, environmental regulations, and high costs. Industrial strategies should recognise that removing barriers can be as important to successful delivery as access to finance by containing clear-sighted policies to address barriers quickly and prioritising the development of enabling infrastructure (such as grid capacity).

4

CREATING NEW MARKETS IN EMERGING TECHNOLOGIES



A feature of contemporary industrial policymaking is the need to commercialise new technologies to support decarbonisation in infrastructure—including energy and transport—and 'hard to abate' industrial sectors such as steel and cement. Government action is essential in early-stage clean technology development, which is often hindered by 'valleys of death': critical phases where high capital requirements and significant investor risks impede commercialisation and cost competitiveness against established technologies. Without sufficient early-stage capital, firms in emerging technologies struggle to move from pilot projects to commercial deployment.[153]

Recent US industrial strategy sought to address these problems in a range of nascent sectors, including hydrogen, direct air capture (DAC), advanced batteries, and small modular nuclear reactors (SMRs). In addition, it has used subsidies to develop sectors that are mature internationally but have little footprint in the US, such as offshore wind. The objective is not only decarbonisation, as there are significant 'early mover' advantages from achieving commercial scale in these sectors, as China has demonstrated in technologies such as EVs and batteries.[154]

Achieving commercialisation requires addressing significant challenges, including:

- **Unproven technologies:** As these technologies are grounded in the research and development (R&D) space, there may be uncertainty over their maturity. Examples include nuclear fusion and some nuclear technologies used in SMRs.
- **Unclear or contested use cases:** Certain technologies may face competition from other emerging technologies to replace fossil-fuel use cases. Examples include hydrogen, which has significant commercial potential in chemical feedstocks but faces competition in transport from battery solutions.[155]

- **Lack of public support:** Some technologies face heightened popular opposition to their deployment. Examples include onshore and offshore wind and carbon capture and storage.

Industrial policies can help overcome these challenges. Grants, loans, or credit guarantees reduce real and perceived risk for private investors, helping to ease price volatility. Where demand is uncertain, regulation and price or demand guarantees can be used; in the UK, price guarantees through Contracts for Difference (CfDs) were instrumental in lowering the cost curve for offshore wind projects.[156]

Fiscal measures such as carbon taxes and trade measures like carbon tariffs can further level the playing field. Over time, government support can generate a self-reinforcing cycle: investment lowers unit costs through economies of scale and learning by doing, which boosts market confidence and stimulates demand. As technologies become cost-competitive, subsidies can then be phased out.

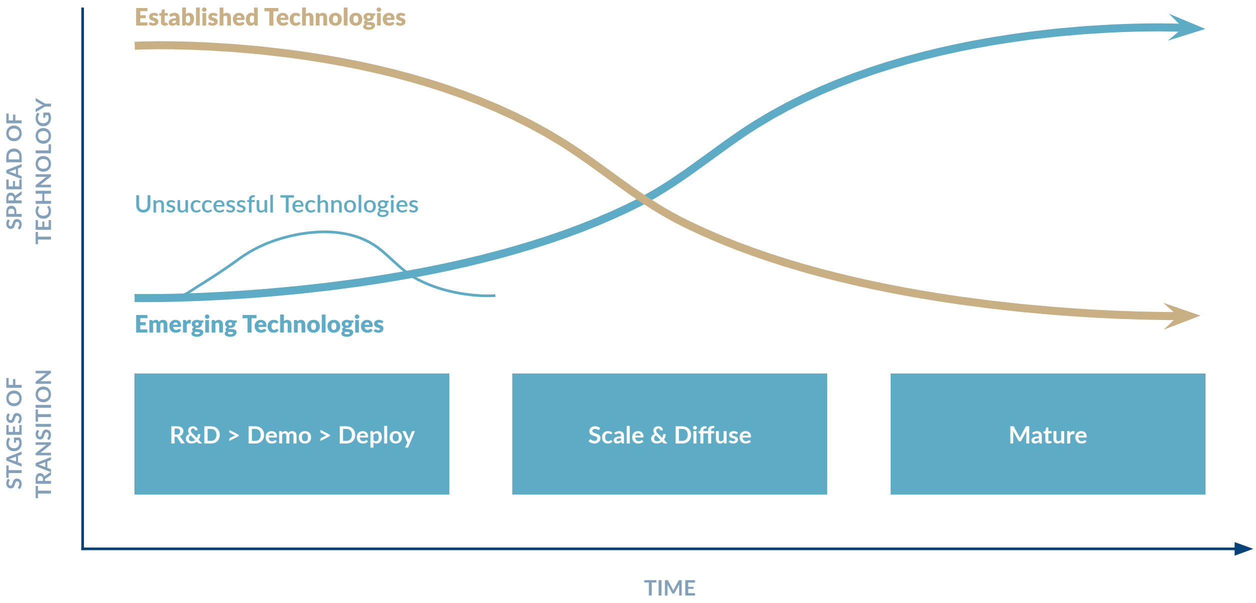
LIFT-OFF REPORTS

Given the complexity in developing new markets for emerging technologies, the Biden administration developed a series of 'lift-off reports' to provide strategic clarity and a roadmap to commercialisation. The reports were produced by the Loan Programs Office at the Department of Energy and published beginning in March 2023. They sought to distil what public- and private-sector partners had learned to date and were codeveloped with industry, reflecting the administration's use of external partnerships (principle 3) and a learning-by-doing strategy for building new sectors.

The reports covered infrastructure (such as for offshore wind), industrial sectors (such as hydrogen), and specific challenges (such as the decarbonisation of hard-to-abate sectors, including chemicals and cement). The reports typically outlined the existing market structure, sector value proposition, a pathway to lift-off, and key dependencies—such as supply chains—together with the principal obstacles to achieving scale.

The cost structure and adoption trajectory of successful new technologies typically follow an S-shaped curve (slow initial uptake, rapid scaling, then maturation; see Figure 2).[157] As technologies move from niche to wide diffusion, they often require additional supporting infrastructure and adjustments to regulatory frameworks. Growth then slows and levels off as the market matures.[158] Policy instruments should therefore be calibrated to a technology's position on the S-curve, reflecting the need for flexibility (principle 5) in policy design. Early-stage R&D support may be essential for nascent fields such as nuclear fusion, whereas demand-side mechanisms—for example, CfDs—are often better suited to scaling technologies like hydrogen or carbon management solutions.

FIGURE 2. S-CURVE DYNAMIC FOR TECHNOLOGY GROWTH AND DISPLACEMENT



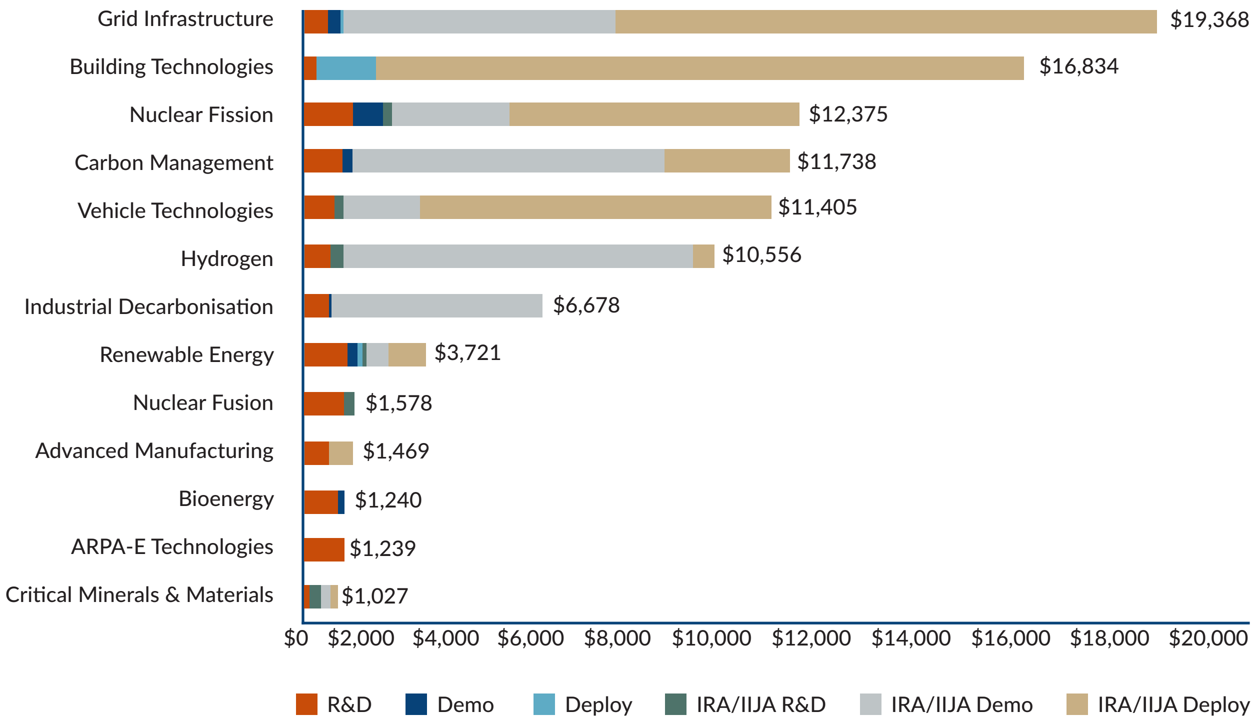
Source: Adapted from IPCCC (2022)

Recognising these dynamics, US policymakers developed a 'portfolio' approach to developing emerging technologies (principle 2). Rather than betting on a single 'winning' technology, the IIJA and IRA funded a wide spectrum of solutions across different stages of maturity. The Office of Clean Energy Demonstrations was established with $21 billion to scale technologies including clean hydrogen and advanced nuclear reactors. The DoE also received a one-time boost of $85 billion to its innovation budget over three years, with funding directed away from its traditional focus on early-stage R&D towards deployment (see Figure 3).[159]

The portfolio approach was complemented by an understanding that technologies at different development stages require different interventions. Officials emphasised the need for a 'toolkit of solutions' rather than singular approaches, with the lift-off reports designed to identify the optimal mix of tools—grants, technical assistance, and other supports—to foster capital formation and kickstart the private-sector 'flywheel' across different sectors at early stages of technological development.[160]

FIGURE 3. NEW IRA AND IIJA FUNDING BY EMERGING TECHNOLOGY CLASS, VERSUS EXISTING APPROPRIATIONS

Total appropriations (in nominal million USD) by innovation stage and funding source



Source: Rhodium Group, MIT Center for Energy and Environmental Policy Research (2024)

The administration's approach to portfolio development displayed a clear intent to diversify bets across emerging technologies, but in practice, agencies appear to have demonstrated limited appetite for genuine risk-taking. Whilst the LPO provided due diligence and catalysed private-sector capital, interviewees suggested its high repayment rate (greater than 95 per cent) indicated a high level of risk aversion relative to that expected from a risk-taking public green bank.[161]

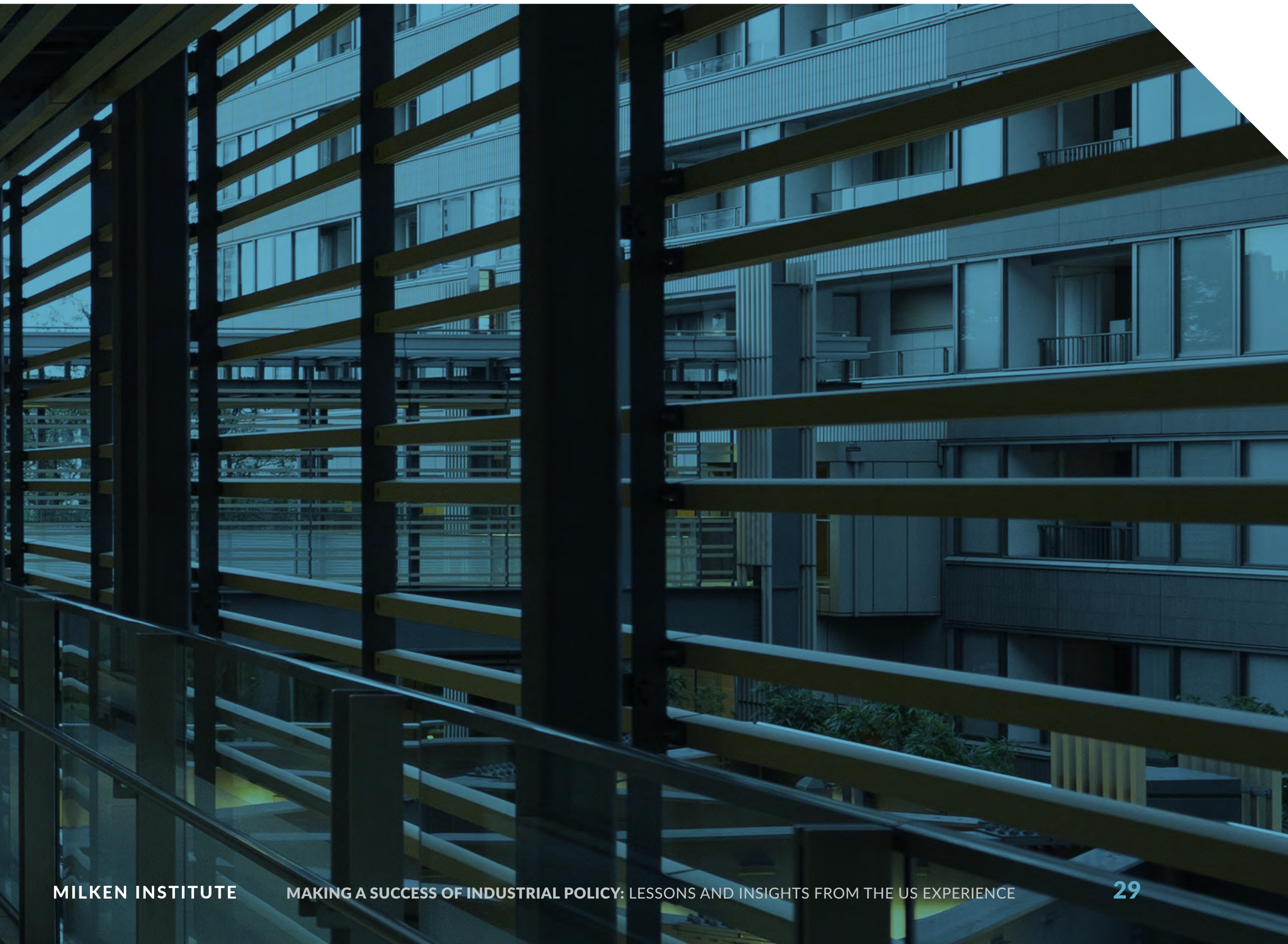
Effective portfolio management requires accepting that some project failures are necessary to pursue breakthrough successes. The LPO's approach to risk-taking was likely impacted by the case of Solyndra, which filed for bankruptcy in 2011 after receiving $535 million in DoE loan guarantees. Whilst an LPO review found that the company's misrepresentation of its financial position, rather than excessive risk-taking by the LPO, was responsible for the loan default, the agency likely continued to suffer from 'Solyndra PTSD'.[162] Further challenges in staffing and governance constrained the LPO's ability to distribute the loan authority authorised by Congress.[163]

Despite the DoE's substantial financial commitment, the commercialisation of emerging technologies faced significant challenges, with some stemming from the newness of the technologies. In hydrogen, industry debates over how to define 'clean' hydrogen led to delays in issuing final guidance for the tax credit 45V. Since this credit was crucial for incentivising production, delays led to stalled investment across hydrogen projects.[164] Whilst the tax credits were generous—for example, 45V offering $3 for every kilogram of hydrogen produced—they were insufficient to catalyse market development. This was despite the lift-off report recognising that without offtake agreements, most project development activity languished in the project development funnel, with comparatively little in the later stages.[165]

Several stakeholders identified how an absence of demand-side tools in the legislation—such as offtake agreements—inhibited market development.[166] Other sectors, such as offshore wind, which had a high cost base and faced competition from renewable as well as fossil-fuel technologies, were also impacted. Furthermore, no mechanism to tax carbon, either domestically or at the border, was included in the legislation, which meant that the true social and environmental costs of fossil-fuel-based technologies continued to be inadequately recognised in policy and priced by the market.

The newness of these technologies meant that other problems that cut across recent US industrial policymaking—such as the inflexibility of tools, barriers to deployment, and adverse impacts of some conditionalities—were amplified in the context of technologies which had not yet achieved commercial scale. Such technologies encountered an array of complex challenges: DAC sites were slowed by permitting and siting constraints and a lack of public support, especially for the CO_2 pipelines necessary for their operation; a lack of demand guarantee remained a key barrier in nuclear given the high cost of projects in that sector; and offshore wind suffered from regulatory problems, including domestic content requirements as well as permitting challenges.[167]

Ultimately, different technologies require distinct toolkits tailored to their use cases, technological maturity, and stage of commercial development. The lift-off reports recognised this. But whilst the reports set out a comprehensively researched pathway, they did not represent a formalised federal government strategy.[168]



CLOSING REMARKS

Achieving successful outcomes in commercialising new technologies requires navigating trade-offs, collaborating with the private sector, and applying tailored toolkits within a risk-tolerant, government-managed portfolio approach. Recent US industrial policy included some, but not all, of these attributes. The lift-off reports provided a strategic blueprint for different sectors but never formed government policy. They required strategic collaboration with the private sector, such as through the relationships built by the DoE. But a lack of consensus among private-sector interest groups led to delays in issuing policy guidance, such as in hydrogen tax credit 45V.

Whilst the toolkit of measures catalysed some additional investment, the lack of a demand-side instrument inhibited market development. The administration adopted a portfolio approach, but uneven execution across sectors slowed progress towards commercialisation.

An important theme from our interviews was how the administration 'spent a lot of time getting things set up perfectly from a legal perspective' and 'feared the risk of getting it wrong'.[169] This can be seen in efforts to create incentives for clean hydrogen, where Congress aimed to jump-start the sector to support decarbonisation of steel, shipping, and aviation (amongst other sectors) by creating a new tax credit, but where implementation of the complex, tiered production-based incentives became a battleground between interest groups over how qualifying emissions should be measured.[170] The stringent criteria acted as a barrier to investment as many potential projects failed to qualify for the credit, whereas the sector advocated that looser initial rules might have given the industry a better chance to establish itself,[171] albeit with a risk of legal challenge from environmental interest groups.

In the commercialisation of new decarbonisation technologies, a more effective approach would be to prioritise 'pace over perfection'[172]—applying incentives to imperfect projects to maximise their chances of success early in the development funnel and tackling negative externalities and market failures through targeted regulation once the industry has established itself. This would better balance urgency with long-term sustainability and help spur market development.

It is also important that past failures, such as Solyndra's, do not instil 'over-learning', where agencies retrench and reduce tolerance for the very portfolio experimentation needed to find transformative winners. When the LPO loaned funding to Solyndra, it was also issuing loans that were responsible for Tesla's survival.[173] This demonstrates how effective policy design for emerging technologies requires active portfolio risk management: staging capital, sizing exposures to portfolio-level return distributions, enforcing mutually agreed-on milestones, and reallocating or cutting losses when projects fail to meet those milestones.

RECOMMENDATION

For governments to create new markets in emerging clean-tech sectors (e.g., hydrogen or direct-air capture) or help pre-existing technologies become cost-competitive (e.g., offshore wind), policymakers should enact both supply- and demand-side tools flexibly as part of a portfolio approach that emphasises 'pace' over 'perfection'.

ENDNOTES

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Aligned Climate Capital

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Blue Green Alliance

Capital Group

CHIPS Program Office

Economic Development Administration

Environmental Protection Agency

Galvanize

Gotion USA

Guggenheim Partners

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Lansing Area Economic Partnership

Loan Programs Office

Michigan Department of Labor and Opportunity

Michigan Infrastructure Office

New York Live Investments

North Carolina Department of Commerce

Office of Clean Energy Innovation and Implementation

Office of the United States Trade Representative

Siemens USA

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UK Department of Business and Trade

University Innovation Alliance

US Department of Commerce

US Department of Energy

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