climateworks INDUSTRY

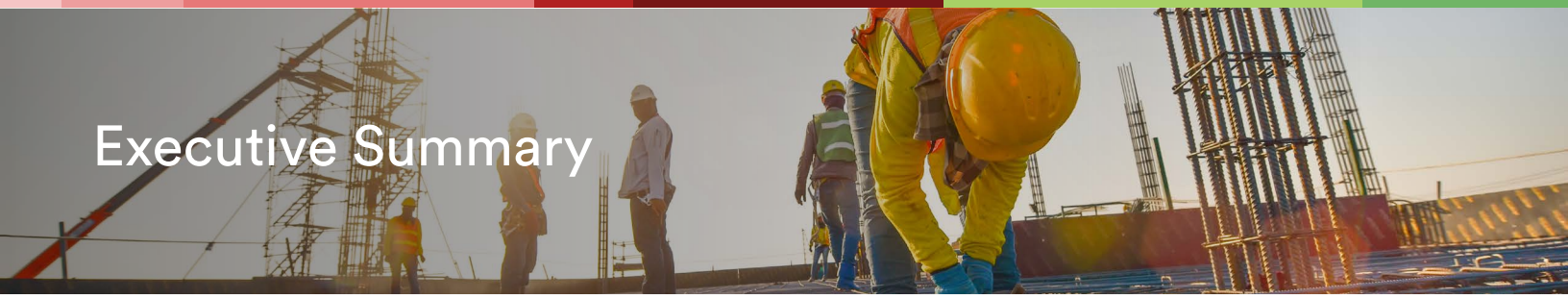
Build Clean:

Industrial Policy for Climate and Justice

By Rebecca Dell

December 2020

Table of Contents



Executive Summary

The material economy is how we provide all the physical stuff we need and want—houses, utility lines, roads and railroads, cars and trucks, consumer products—through manufacturing, construction, mining, and waste processing. Its products provide comfort, convenience, and safety, and making them gives meaningful jobs to more than 20 million Americans. However, the material economy is also the source of an enormous portion of greenhouse gas (GHG) emissions and local pollution.

We cannot reach our climate goal of net-zero GHG emissions by 2050 without getting on a path to net-zero GHG emissions within the industrial sector. We cannot ensure everyone gets the safe, healthy life they deserve without addressing legacy and ongoing pollution from industrial activities.

These goals are achievable. Moreover, meeting them creates enormous opportunities for just and equitable economic development. We can improve health, safeguard the climate, create jobs that are ladders to the middle class, and make U.S. manufacturing stronger and more competitive. To do all of this, we should create markets, support innovation and deployment, invest in and protect people, and strengthen governance and coordination. These are the four pillars of the Build Clean agenda.

We can improve health, safeguard the climate, create jobs that are ladders to the middle class, and make U.S. manufacturing stronger and more competitive.

Create Markets

Create markets and demand for products that are made in a clean way. Using market demand, we can achieve dramatic reductions in GHG emissions and local pollution without significantly raising the cost of finished goods and without offshoring.

- "Buy clean" by using government purchasing to create demand for low-GHG versions of the most climate-damaging products, especially building materials.
- Structure buy-clean policies to support both deployment and innovation, encouraging current best practices and new-and-even-better practices.
- Develop standards that apply to both public and private purchasing and that incentivize or require products to be made through clean manufacturing processes.
- Enforce requirements on products—not manufacturing facilities—to eliminate any loophole or incentive for offshoring.

Support Innovation and Fund Deployment

Invest in technological progress at every stage: from research and development to commercial viability. Then, support widespread deployment and help entrench domestic industry. Make policies and investments in innovation and deployment complementary. Without smart policies and substantial investments, the United States will fall further behind other countries in clean manufacturing leadership.

- Dramatically increase the amount of research and development (R&D) and commercialization spending on clean industrial technologies, processes, and practices from the current level of $850 million per year to $5 billion per year. Ensure these funds are aligned with the broader mission of climate and justice.
- Create new programs specifically designed to commercialize new industrial technologies and processes by demonstrating them at scale.
- Create structures for unions, firms, professional organizations, scholars, and community members who are affected by industrial development to participate in setting research agendas.
- Use a combination of credit supports, tax credits, subsidies, and direct investment to encourage the deployment of clean technologies and business models. When choosing deployment policy instruments, focus on critical industries, processes, or products; complementarity with other policies; and effective implementation.
- Develop supporting infrastructure for low-GHG industry with improvements in the electricity system and in transportation and storage infrastructure for hydrogen and carbon dioxide (CO_2).

Invest in People, Protect People

Make sure that everyone—urban or rural, Black or white, old or young, man or woman, factory worker or engineer—has an opportunity to participate in and benefit from our new industrial policy.

- Invest in people through training and education across skill level and career stage.
- Target investments at every stage—innovation, piloting, and deployment—to vulnerable or overlooked communities.
- Ensure tax dollars are spent to create quality jobs by enforcing and strengthening existing requirements.
- Protect people by enforcing workplace rights, cleaning up legacy pollution from 20th century industry, and funding workforce transitions where needed.

Strengthen Governance and Coordination

Transformative change requires high-level leadership. For any of the above policies to achieve their goals, we must significantly strengthen governance and coordination of action.

- Create a special assistant to the president for clean industrial transformation to direct, convene, and coordinate efforts across all levels of government.
- Create an assistant secretary of energy for industrial transformation to lead R&D, demonstration, technical assistance, analysis, and standards. Appoint people dedicated to industrial transformation at the departments of Labor, Treasury, Transportation, and Commerce, and at the Environmental Protection Agency.
- Create a committee of community stakeholders and experts from government, industry, and labor to identify and oversee large strategic projects.
- Invest in information, enforcement, and technical assistance to make sure that we don't miss opportunities or misapply rules.
- Align our climate diplomacy, trade agreements, and export promotion with our domestic policies for clean industry.

With these policies, we can improve lives for all Americans through a cleaner, safer environment and better employment. We can Build Clean.

Table 1: Summary of Policy Recommendations

	Policy Area	Executive Actions	Appropriations	Statutory Changes
Markets	**Buy Clean**	• Implement buy-clean standards for federally contracted construction, including through GSA and ACE. • Use DOD procurement to create markets for high-quality, low-GHG industrial commodities.	• Encourage states to adopt buy-clean standards through technical assistance, financial incentives, or the siting of innovative projects.	• Implement buy-clean standards for federally funded construction that is contracted at the state and local level.
Markets	**Use Clean Product Standards**	• Develop and certify measurement methodologies and model building codes for states and localities that cover the full life-cycle energy and climate impacts. • Develop methods and databases for emissions characteristics and supply networks of key products.	• Expand methods and databases for emissions characteristics and supply networks to comprehensively cover all key products.	• Implement standards for low-GHG concrete and other products. • Regulate products to improve recyclability and material efficiency. • Make producers responsible for waste disposal costs of their products.
Innovation and Deployment	**Invest in Innovation**	• Improve the alignment of existing innovation investments with climate and justice priorities. • Create structures for workers, community members, and scholars to participate in setting research and innovation agendas. • Integrate manufacturing, construction, and waste processing in innovation programs.	• Increase industrial research and innovation investment from $850 million per year to at least $5 billion per year. • Align innovation investments with climate and justice priorities. • Use innovation investments and strategic projects to encourage states to adopt state-level buy-clean policies.	• Create programs specifically designed to commercialize new industrial technology by demonstrating them at scale.
Innovation and Deployment	**Deploy at Scale**	• Incorporate industrial electrification into power system planning. • Expedite permitting for clean industrial facilities and their enabling infrastructure. • Improve industrial energy efficiency through appliance and equipment standards. • Use the Defense Production Act to invest in clean and competitive manufacturing under $50 million. • Identify opportunities and convene stakeholders to catalyze the development of clean industrial clusters.	• Increase investment and technical assistance for industrial energy efficiency. • Use credit supports, tax credits, and subsidies to deploy clean manufacturing and construction practices and technologies at scale. • Subsidize enabling infrastructure for clean industrial clusters, including electricity, hydrogen, and carbon dioxide. • Use the Defense Production Act to invest in clean and competitive manufacturing over $50 million. • Incentivize the development of clean industrial clusters. • Use deployment incentives and strategic projects to encourage states to adopt state-level policies like Buy Clean.	• Create a new authority for multi-year subsidies and direct federal investment and contracting in clean manufacturing. • Create a financing authority like a national climate bank with a mandate to invest in and finance commercial deployment of clean industrial technology and business models.
People	**Invest in People**	• Assess training needs and develop programs for people across skill level and career stage, including building trades, manufacturing workers, engineers, designers, and executives. • Ensure tax dollars are spent to create quality jobs by enforcing existing requirements like Davis-Bacon and Buy America/American. • Reserve a portion of all innovation and training funds for HBCUs and other minority-serving institutions.	• Make relevant training and education widely available to people across skill level and career stage. • Significantly increase enforcement resources for requirements like Davis-Bacon and Buy America/American. • Target investments to vulnerable or overlooked communities at every stage, including innovation, piloting, and deployment.	• Require that projects receiving deployment incentives deliver quality jobs to the communities hosting them. • Increase the employment standards for federally funded construction projects to include paid leave, overtime, and non-interference with worker organizing. • Prioritize environmental justice communities to host clean pilot and demonstration projects.
People	**Protect People**	• Improve enforcement of existing workplace rights, especially the right to organize. • Increase workplace safety by empowering OSHA and MSHA. • Empower EPA to address legacy pollution and environmental justice.	• Increase enforcement of existing workplace rights, especially the right to organize, by increasing the budget and workforce of NLRB. • Increase workplace safety by increasing the budget and workforce of OSHA and MSHA. • Better address legacy pollution and environmental justice by increasing the budget and workforce of EPA. • Increase funding to existing programs for worker retraining. • Fund cleanup of legacy pollution from 20th century industries, especially fossil fuel industries.	• Strengthen workplace rights, especially the right to organize. • Create and fund new programs for transitions of individual workers and communities through retraining with income replacement, early retirement, and funding social infrastructure like schools and hospitals in affected communities. • Force industries, especially the fossil fuel industries, to take full financial responsibility for future clean-up costs.
Governance	**Strengthen Governance and Coordination**	• Create a special assistant to the president for clean industrial transformation. • Create an assistant secretary of energy for industrial transformation and dedicated positions at Labor, Commerce, DOT, and EPA. • Align our climate diplomacy, trade agreements, and export promotion with our domestic policies for clean industry.	• Invest in information, enforcement, and technical assistance in all above policy areas.	• Create an advisory committee of experts from government, industry, labor, and communities to select and oversee large strategic projects.

Introduction: The Industry and Climate Imperative

The material economy is how we provide all the physical stuff we need and want—houses, utility lines, roads and railroads, cars and trucks, consumer products. It deserves much credit for the comfort, convenience, and safety of our lives. It provides meaningful and profitable work for tens of millions of Americans. However, it is also responsible for an enormous share of climate-changing emissions, local pollution, and environmental injustice.

Globally, the activities of the material economy—manufacturing, construction, mining, and waste processing—which we collectively refer to as the industrial sector, are responsible for 38% of all GHG emissions.[1] Here in the United States, the material economy generates 37% of GHG emissions, when all sources are considered (Figure 1). Importantly, those emissions sources include all the manufacturing we have offshored and whose products we now import.

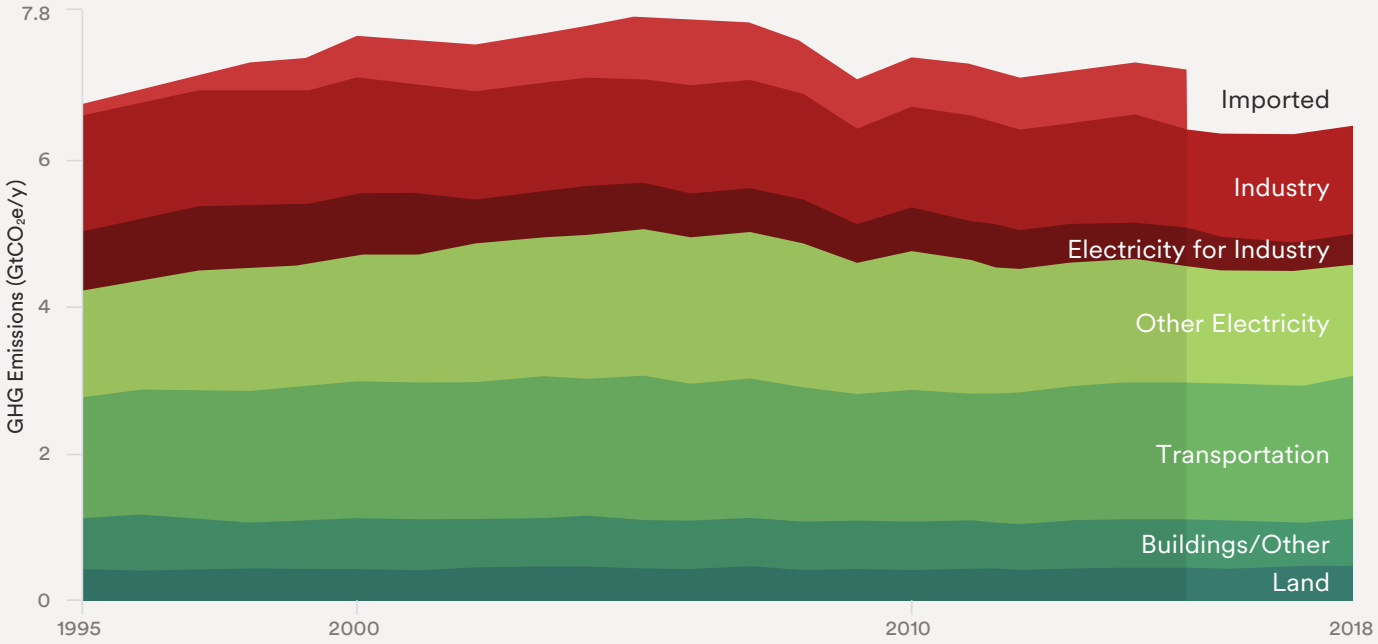
In the U.S., the activities of the material economy—manufacturing, construction, mining, and waste processing—are responsible for 37% of GHG emissions when all sources are considered.

Industrial facilities are also the leading sources of some of the most damaging local air pollution and a range of toxic materials that enter our air, water, and soil (EPA 2019). These local impacts fall disproportionately on vulnerable communities, including Black and other communities of color and low-income people, permanently reducing the life prospects of many Americans. We have seen one of the consequences of this terrible injustice in the disproportionate burden of Covid-19 on these communities.

Covid-19 has also shown us how important a robust manufacturing sector is to our resilience as a society. Americans have been dismayed at our difficulties in providing basic protective equipment like masks since global supply networks seized up in the early months of the pandemic. Fewer Americans noticed the extraordinary agility of U.S. manufacturers that were able to increase production of ventilators tenfold between February and April 2020. Where domestic manufacturing expertise and supply networks were available, they saved lives.

In much the same way, the industrial sector is at the heart of the solution to our broader climate crisis. Building a climate-safe economy will require physically building an enormous amount of stuff: millions of wind turbines, solar panels, and electric vehicles; better insulation for our buildings; better transmission lines and transit. All of these investments will require a similarly enormous amount of basic materials like steel, cement, and plastic. If we don't clean up our industrial sector, that building risks exacerbating the climate and pollution problems. We cannot create the clean and fair economy of the future with the bricks of the past. We need an industrial sector that makes clean things and makes everything in a clean way.

Figure 1 : U.S. GHG Emissions, Including Net Imported Emissions



Industry includes mining, manufacturing, construction, waste processing, and fossil fuel processing. Figure shows carbon dioxide, methane, and nitrous oxide. Non-CO_2 emissions imputed after 2015. Imported emissions not yet available after 2015.

Sources: Crippa et al. (2019); Wiebe and Yamano (2016); Yamano and Guilhoto (2020).

This is a huge opportunity. The United States has a demonstrated history of leadership in technology and business model innovation. We have a skilled workforce, world-leading universities, large and well-regulated domestic markets, and far-sighted public investment. We can solve these problems for ourselves and sell the solutions around the world. In so doing, we can make progress on many of our goals:

- Create manufacturing and construction jobs that are ladders to a secure middle-class life.
- Increase worker power and fight inequality.
- Push back on the financialization of the U.S. economy.
- Fight climate change.
- Improve health and safety, especially for environmental justice communities.

Through smart standards and incentives, we can create markets for products, processes, and business models that allow firms to invest and thrive while protecting the environment and communities. But to realize all these benefits in a full and fair way, we need to invest in Americans to expand the 21st century workforce and protect people from legacy and ongoing pollution. We also need to coordinate effectively across the federal government and with state, local, and tribal governments to make simultaneous progress toward an expanded and modernized industrial sector, a safe climate, and environmental justice. This report lays out a comprehensive agenda, called Build Clean, to address each of these needs: creating markets, supporting innovation and funding deployment, investing in and protecting people, and strengthening governance.

This report gives no particular attention to opportunities for manufacturing clean energy products, a topic discussed in detail elsewhere. Instead, it focuses on the often-overlooked opportunities to make manufacturing and construction themselves align with climate and justice goals.

To achieve our climate goals, we need to provide all Americans with homes, infrastructure, vehicles, and products without net emissions of greenhouse gases, and we need to do it by 2050. This report does not lay out a complete pathway to that goal; nobody knows for certain what that pathway will look like. Instead, it describes what we can do now and what we must do in the next few years to get on a net-zero emissions pathway that creates opportunities and protects jobs and health. We have the power to transform our economy and save our climate—we must be resolved to use it.

A CLEAN FUTURE FOR INDIANA'S STEEL BELT

Consider as a case study how industrial policy could bring economic and environmental benefits to the steel belt of northern Indiana. Along 20 miles of Lake Michigan's shoreline is more than half of the total primary steel production capacity in the United States. These mills directly employ 16,000 people and indirectly support tens of thousands of related jobs. They include storied plants like U.S. Steel's Gary Works and the youngest integrated steel mill in America, at Burns Harbor, and they supply sectors like autos, appliances, and construction.

These mills also generate 40% of all U.S. steel industry GHG emissions, and every single one of the largest mills have been in "high priority" violation of the Clean Air Act in every single quarter of the last three years (EPA 2020a, d). The burden of that conventional and toxic pollution falls most heavily on the cities of East Chicago, Gary, and Portage, three-quarters of whose residents are Black and Hispanic and whose poverty rates range from 50% to 200% above the national average. Despite these demographics, only 30% of the steel industry jobs in these counties are held by Black and Hispanic people.

With thoughtful and forward-looking industrial policy, we can address the steel belt's unsustainable climate impacts and unfairly distributed burden of local pollution while expanding markets for both products and technologies. Northern Indiana has access to high-quality renewable energy resources and geologic CO_2 storage capacity (DOE 2015). It has a skilled and organized workforce, a dense ecosystem of firms in the steel supply chain, and well-developed markets. It would be an obvious place to commercialize clean steel production technologies through joint public and private investment in hydrogen, electrolysis, or carbon capture and storage (CCS), all of which would also dramatically reduce local pollution. However, successfully commercializing these technologies would also require smart standards and incentives to ensure a market for clean steel. Once demonstrated at scale, the technologies would have buyers in the steel industry around the world. With coordinated policy and investment, we can address the injustice of legacy and ongoing environmental pollution in northern Indiana, dramatically reduce GHG emissions here and around the world, and we can create tens of thousands of steel industry jobs.

Indiana Harbor, the largest steel mill in America. Source: CLUI

Create Markets

The first requirement for a manufacturing and construction sector that produces clean products and clean structures is that somebody must be willing to pay for them. Under current market conditions, climate-safe modes of production and business models are generally less profitable than the high-emissions versions. Policy can change that through public purchasing and through smart standards and market creation.

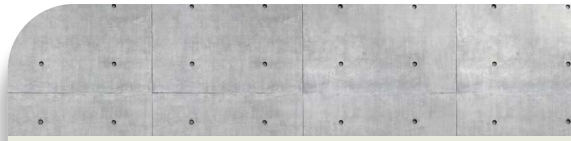
Both approaches rest on the same economic logic: **reductions in both GHG emissions and local pollution can be achieved without significant increases in the cost of finished goods**. Cost increases are limited because the steps in the supply chain that have the greatest environmental impact generally account for a very small portion of the cost of the final product. Often, the most severe environmental damage is from the production of the basic materials: the cement that goes into a bridge, the steel that goes into a car, the precursor chemicals that go into a polyester shirt or a plastic bottle. However, the price of component commodities is a very small share of the price of finished goods made from them—things like labor, design, profits, and overhead are all typically more expensive than materials. This means we can pay for large environmental improvements without making things materially more expensive. For example, cement is typically only about 1% of the cost of public construction and less than 0.5% of the cost of private construction (Dell 2020). The San Francisco-Oakland Bay Bridge—a structure made largely of concrete and completed in 2013—cost more than $6 billion. Of that amount, the cement cost less than $25 million, or about 0.3%.[2]

Because GHG-intensive materials are such a small portion of the cost of finished goods and projects, big emissions reductions do not noticeably increase final costs. A policy that increased cement production cost by 50% would only increase the cost of a typical piece of infrastructure by 0.5%. From the perspective of the final consumer, **big improvements for both the climate and environmental justice are easily affordable**.[3]

A critical role for policy is to ensure that the relatively low costs of these improvements are passed through the supply networks to the final consumer, not borne alone by the material producers. Buy-clean standards and clean product standards could play this role. Respectively, they address public purchasing and private purchasing.

The San Francisco-Oakland Bay Bridge is mostly made of concrete, but cement was only 0.3% of its cost.

Buy Clean



Buy Clean uses government purchasing to create demand for low-GHG versions of the most climate damaging products.

The government is the largest consumer of climate-changing and pollution-producing commodities. In the United States, nearly half of all cement and a fifth of steel is purchased with tax dollars (PCA 2017; AISI 2019). We should use government purchasing to create demand for low-GHG versions of the most climate-damaging products. All levels of government have used green purchasing initiatives for many types of products. Buy-clean standards focus on building materials (Hasanbeigi, Becqué, and Springer 2019). Building materials are purchased in the largest quantities and in large share by the government, so this product category is the one in which the government has the greatest leverage.

The environmental stakes are not small. Without smart buy-clean standards, the infrastructure bill passed through the House of Representatives in June 2020 (H.R.2) could create an additional 200 million tons of CO_2 ($MtCO_2$) emissions. For comparison, between 2011 and 2018 we reduced our national annual GHG emissions by only 170 $MtCO_2$ (EPA 2020c). Our Covid-19 economic recovery should involve a major investment like H.R.2 in rebuilding our deteriorating transportation, water, and communication infrastructures. Such an investment would employ a lot of unemployed people now and to make us more comfortable and productive in the future. Buy-clean standards are how we use those investments to get not just improved infrastructure but also a cleaner and more modern manufacturing sector.

There are three basic approaches to buy-clean standards: a threshold, a cap, and a discount rate. The threshold approach defines a maximum GHG emissions intensity for each category of material, usually in CO_2-equivalent per mass of material. If a material is used in a federally funded project, the emissions associated with its production or life cycle must be below the threshold. This approach is taken by California in its Buy Clean law—the only enacted state-level law of its kind—and the CLEAN Future Act proposed in the House of Representatives in February 2020.[4] The primary advantage of the threshold-based approach is its simplicity. The primary disadvantage of this approach is that it offers no incentive to continue to improve performance once a material qualifies: 1% below and 50% below the threshold are equally eligible. A threshold is effective at encouraging the **uptake of current best practices**, but it does not promote the **commercialization of new practices** that are much cleaner. It's a deployment policy, not an innovation policy.

Ideally, we should structure buy-clean standards to support both deployment and innovation by modifying the threshold-based approach in one of two ways. First, we can use a two-tiered approach: set an eligibility threshold for participation in public projects that requires the use of current best practices and introduce a second, much more stringent, threshold that applies only to a small portion of projects or material quantity. This second threshold would reserve a portion of the public purchasing to commercialize practices that are better than any currently available practices. It would function very much like Renewable Portfolio Standard (RPS) policies did prior to 2010: providing guaranteed, bankable lead markets that could justify significant private-sector investment in at-the-time relatively high-cost technologies. Those lead markets were essential for bringing wind and solar electricity generation to scale, and a two-threshold approach would serve a similar function for genuinely low-emissions building materials like alternative concrete formulations or cement chemistries, cement made with carbon capture and storage, CO_2-sequestering artificial aggregates, and hydrogen- or electrolysis-based steel.

The second approach to modifying the threshold-based approach is the cap approach, creating a tradable compliance instrument. Giving firms the option to sell excess compliance credits when they over-comply provides an incentive to continue to reduce emissions through new practices and processes. As will be discussed in more detail in the next section, the cap approach is taken in the motor fuel market by the California Low-Carbon Fuel Standard (LCFS). Numerous investments—including those with substantial technology risk—have been undertaken by private actors as a result of

the LCFS. One potential disadvantage of the cap is that some facilities may decide not to improve their performance and instead purchase compliance credits. Although this decision may be consistent with climate goals, it could mean that serious local pollution or environmental justice problems go unaddressed.

The third approach for structuring buy-clean standards is the discount rate. This approach is taken in the New York State Low Embodied Carbon Concrete Leadership Act (Assembly Bill A08617), which was proposed in 2019. This bill would create a discount of up to 5% on the total bid price for a public construction project for the contractor using the lowest-climate-impact cement and concrete. Contractors would be incentivized to use higher-cost, lower-emissions cement and concrete, provided the impact on the total project cost was less than 5%. Because the building materials, especially the concrete, are typically such a small portion of the total project cost, this 5% discount is more than sufficient to cover the cost and risk premium of even major investments in new manufacturing equipment.

No matter the approach—threshold, cap, or discount rate—implementation has a great deal in common with requirements routinely applied to today's public construction projects. For example, under the Buy America Act (see the "Invest in People" section below) road and rail projects partially or completely funded by federal grants must preferentially use materials and components manufactured in the United States. Any of the approaches to buy-clean standards would use implementation mechanisms and administrative capacities very similar to those already used for Buy America and similar policies. Buy-clean standards build on existing approaches to make sure we are using our tax dollars to support responsible firms and new technologies and business models that will benefit our climate, our health, and our economy. These standards create opportunities for domestic manufacturers to create new products and new jobs and for building trades workers to increase their skills and wages.

Buy-clean standards could be implemented for federally contracted construction under existing authorities. In fact, in theory they already were implemented by President Obama's Executive Order 13514, "Federal Leadership in Environmental, Energy, and Economic Performance." It ordered all agencies to account for and reduce GHG emissions from the supply chain of purchased goods and services (scope 3 emissions). However, in spite of their importance, building materials were never emphasized in the order's implementation.[5] Moreover, very little *federally funded* construction is *federally contracted*. Instead, federal funds are granted to states and localities, which contract for construction projects. For example, the Federal Highway Administration spends between $45 billion and $55 billion per year on America's highways, but the federal government only contracts for about $1 billion per year of road construction (DOT 2020; U.S. Census n.d.). Over the last decade, federally contracted construction, largely buildings for use by the federal government and the work of the Army Corps of Engineers (ACE), has been between 7% and 11% of total public construction. Buy-clean requirements for federally funded, state and locally contracted construction are essential, but would likely require new statutory authority.

Clean Product Standards

In addition to adopting buy-clean standards, we should **develop standards that apply to both public and private purchasing—standards that incentivize or require products to have cleaner production**. Product standards have given rise to seatbelts, toasters that are unlikely to catch on fire, buildings that are unlikely to fall down, and safe and effective pharmaceuticals. Product standards have been widely used to reduce products' energy use and environmental impact. Successful standards include Corporate Average Fuel Economy (CAFE) standards for vehicles, mandates for pollution control technology such as catalytic converters, and DOE's Appliance and Equipment Standards program to promote energy efficiency.

Product standards can also be used to require GHG emissions reductions in products' production and manufacturing or full life cycle. So far, the most important example of a clean product standard that targets GHG emissions across a supply chain is the above-noted Low-Carbon Fuel Standard. The LCFS requires the carbon intensity of all motor vehicle fuel sold in California to decrease over time. It creates a compliance credit that can be traded for additional flexibility. Although valuable, tradability is not a necessary feature of clean product standards.

Clean product standards are easier to implement when the emissions associated with a product are easier to measure and can be assessed at a well-defined point in the supply chain. In the near term, such a standard is more applicable to bulk commodities than to complicated multi-component products. Under the LCFS, all fuels are compared according to their energy content, and all fuel refiners, importers, and wholesalers are covered. There is a standard metric for all fuels and a manageable number of covered entities.

Cement or concrete would be the best candidate for a clean product standard like the LCFS because the emissions involved are large and the metrics of associated emissions are available. The standard could be implemented through cement kilns and importers or through ready-mix concrete facilities.[6] In the future, metals, petrochemicals, and fertilizers could all potentially have clean product standards. In the long term, they might be effectively applied to more complex products like cars and buildings.

Building codes are one of the most important types of product standard. They should incentivize or require efficient use of building materials and use of low-GHG materials just as they currently promote in-use energy efficiency. Consider that in many parts of the United States as much energy is consumed and CO_2 emitted in the making of materials for a building as in the use of the building over *40 years*.[7] One reason is that many buildings use far more structural material than is needed to comply with engineering and safety requirements (Allwood and Cullen 2015, p. 185). The federal government currently acts as a technical partner, developing, studying, and certifying building energy codes; it should play a similar role for codes and standards covering the energy and environmental performance of building materials.

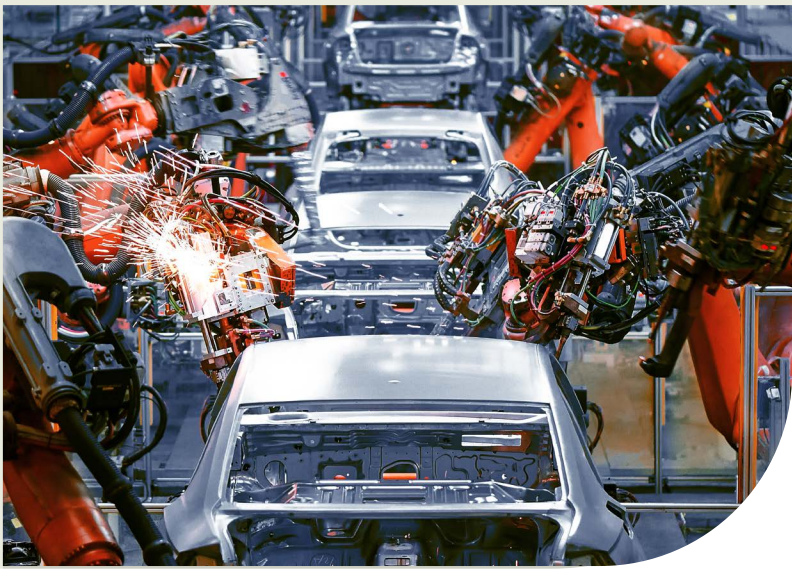
Product standards can be used to promote both efficient use of materials and recyclability of products. For example, limiting the variety of types of plastics used in bottles and packaging could significantly increase the value of the plastic after recycling. It could also reduce both waste in our environment and the local pollution and climate damage that comes from producing and disposing of packaging. Given that a third of all plastic goes into single-use packaging, the benefits of improved recycling could be large (Geyer et al. 2017). We could extend energy efficiency regulations to include recyclability and efficient use of materials. The European Union is already doing so with its Eco-Design regulatory framework. Standards can directly mandate a level of performance, or they can make producers responsible for the recovery, recycling, or disposal costs of their products. This second approach, often called extended producer responsibility (EPR), has been successful with relatively short-lived products that are highly standardized or that have high value added, for example bottle recovery deposits for beverage containers and recovery mandates for personal electronics. EPR efforts with other types of products, like general packaging or building materials, have been less successful; the direct standards approach is probably preferable.

Like buy-clean standards, clean product standards would create a guaranteed market for alternative products or manufacturing processes that reduce GHG emissions. That guaranteed market could be used to justify significant investments in new capacity and capital. LCFS credits are currently worth about $200 per tCO_2, which has allowed the financing of a number of new technologies. Also like buy-clean standards, clean product standards ensure that the costs of improving environmental performance are passed through the supply chain to the final consumer, where they have a very small impact on the cost of finished goods. Creating markets for cleaner alternatives through buy-clean and product standards is the foundation of the Build Clean agenda.

CREATING MARKETS TO AVOID OFFSHORING

Both workers and manufacturers fear that regulations could lead to offshoring of production to places with lower standards. If so, we could potentially lose jobs but not actually improve environmental performance. A market creation approach avoids offshoring because the requirements of both buy-clean standards and clean product standards apply to products, not manufacturing facilities. There is no loophole for offshoring: whoever can demonstrate that their products are the cleanest will get the most favorable access to the markets, regardless of where the goods are produced. Many U.S. industries, like the steel industry, are already cleaner than many international competitors (Hasanbeigi and Springer 2019), and the combination of ready markets and the right innovation and deployment policies will push domestic industry further into the lead. These policies are structured so that no dirty product can evade requirements and undercut cleaner domestic producers.

In the long term, if we were to implement some kind of economy-wide carbon pricing system or a set of regulations that targeted production facilities instead of products, we would need supportive trade policies to prevent offshoring. These policies, which include border carbon adjustments, have returned to prominence as the CO_2 price in the European cap-and-trade system (EU ETS) has risen. However, all of the policies recommended in this report have been designed to function purely domestically without creating incentives to offshore.



Support Innovation and Fund Deployment

The United States has everything needed to lead the world in developing, commercializing, and deploying clean production methods: a varied and innovative economy, entrepreneurial spirit, a great system of public and private universities, a skilled workforce, and a tradition of public investment. But in spite of all of these advantages, we are falling behind. The most important new clean manufacturing technologies are being developed and commercialized in places like Sweden, with hydrogen steelmaking, and Canada, with GHG-free aluminum (HYBRIT Development 2017; Elysis 2018). Other countries do not have better engineers or more innovative societies. They have governments that prioritize and invest in climate-friendly and pollution-reducing technologies. They recognize that these technologies are essential to make their domestic manufacturing and construction safe and productive for their own citizens and that every economy in the world will be looking to buy these technologies in the next two decades.

Clean technologies are essential to make our domestic manufacturing and construction safe and productive, and every economy in the world will be looking to buy them in the next two decades.

To take a leadership role in clean industry, the United States will need to invest in technological progress at every stage. The last section focused on using a range of policies to create markets in which clean and responsible production practices would be rewarded. For those markets to generate the maximum number of new jobs and the greatest environmental improvements, we need technologies and systems that can scale. In some cases, the technologies and systems are already available, but not widely deployed, like heat pumps, construction prefabrication, and many efficiency options. In other cases, the component technologies of a clean production method, like post-combustion CO_2 capture, are available, but they have not been combined or used at scale in the needed industries. And in other cases, we will have to develop new technologies. We need one set of investments and policy tools to bring technologies and business models to initial commercial viability and another set to support widespread deployment and to entrench the domestic industry. These two sets of investments and policy tools should be complementary.

Innovation

The U.S. government supports innovation through a broad spectrum of activities, from basic research at the National Science Foundation (NSF) to early deployment support from the Department of Energy (DOE). We need a dramatic increase in the scale, focus, and ambition of innovation activities in the industrial sector, and in particular we need to create new mechanisms for commercializing large-scale industrial processes with dramatically improved environmental performance.[8]

Currently, our core programs for innovation investments in the industrial sector are the Advanced Manufacturing Office (DOE), the Manufacturing Extension Partnerships through the National Institute of Standards and Technology (NIST), the Advanced Manufacturing and Material Measurement Program (NIST), and the Manufacturing USA Institutes sponsored by DOE, NIST, the Department of Defense (DOD), and the National Institutes of Health (NIH). These four programs

have a combined budget of between $700 million and $750 million per year (Table 2). In addition, there are industry or manufacturing components of basic research programs through NSF and the DOE Office of Science and cross-sectoral programs like the Advanced Research Projects Agency-Energy (ARPA-E) and the DOE Loan Program. These components are limited in some important ways, however. Of 64 funding opportunities that ARPA-E has offered since 2009, only one has focused on manufacturing, and the only loan authority for manufacturing innovations under the DOE Loan Program is restricted to automobile manufacturing.[9] Finally, there are modest industry components of innovation programs at the Department of Transportation (DOT), Environmental Protection Agency (EPA), and Army Corps of Engineers (ACE). All of these programs include dedicated resources for small businesses through the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) programs.

Table 2: Existing Manufacturing Innovation Activities

Program	Department	Type	FY2019 Budget
Advanced Manufacturing Office	DOE	Applied Research	$320m
Manufacturing USA	DOE, NIST, DOD, NIH	Applied Research	$183m
Manufacturing Extension Partnership	NIST	Technical Assistance	$140m
Advanced Manufacturing and Material Measurements	NIST	Applied Research	$148m

The most important manufacturing and materials innovation programs, with FY2019 enacted budgets. The total investment in the above programs is between $700 million and $750 million, given overlap in the listed amounts. Additional modest investments are made as parts of programs like ARPA-E or research programs at the DOT, EPA, and ACE. In addition, there is significant basic research funding through NSF and the DOE Office of Science.

Sources: DOE 2019.; Manufacturing USA n.d.; NIST 2019.

Not included in the above-noted $700 million to $750 million is funding for research that is so theoretical that it has little or no chance of contributing to achieving our 2050 climate goals. If we assume that the DOE Loan Program remains cost-negative, all of the programs mentioned here add up to about **$850 million per year in innovation investment in manufacturing, industry, and construction technology**. This amount is inadequate, as is made clear by three comparisons:

- Manufacturing and construction generate more employment and almost as much GDP as the healthcare sector.[10] The healthcare sector is supported by the research and development activities of the National Institutes of Health, with an annual budget of $42 billion, or 5,000% of what we spend on the industrial sector.
- ARPA-E's current annual budget is $370 million, about 10% of DARPA's budget of $3.6 billion.[11]
- Even though Germany has one-quarter our population and one-fifth our GDP, the German government spends five times more on its Fraunhofer Institutes than we spend on our analogous Manufacturing USA institutes.[12]

We should increase industrial innovation expenditures to at least $5 billion per year, in part by increasing funding to all of the above-noted programs.

In addition to increasing the overall level of funding, we need to **align this funding with our broader mission of climate and justice**, and we need to create mechanisms for funding the essential final stage of the innovation process: **demonstration at scale**.

To better align funding in expanded programs, we should first remove the requirement that energy efficiency be these programs' sole or primary goal.[13] Through both executive and congressional guidance, we should make clear that the priority is reducing GHG emissions and maximizing co-benefits like reducing pollution and environmental injustice and increasing worker safety.

Second, we should create opportunities through advisory committees or other structures for all relevant stakeholders to have ongoing input into the research agenda. Currently, there are many opportunities for partnership and input from manufacturing firms, but many fewer for workers and community members.

Third, we should expand the scope of innovation activities to include construction and waste processing in addition to traditional manufacturing. The construction sector is by far the largest user of energy- and emissions-intensive products, and in the United States it has suffered from *falling* labor productivity in the last 25 years (Economist 2017). As prefabrication becomes more widespread, we will see increasing integration of the construction and manufacturing sectors. Similarly, as we push to increase reuse and recycling of end-of-life products and components, we will need increasing integration of the making and unmaking of things, that is of manufacturing and waste processing.

Fourth, we should specifically target historically Black colleges and universities, tribal colleges, and other minority-serving institutions to participate in and receive funding from these programs.

Finally, we should address the critical missing link in our innovation ecosystem: demonstration at scale. In many emissions-intensive industries like steel or petrochemicals, excellent ideas for reducing or eliminating GHG emissions have languished for decades in laboratories or as prototypes. For example, researchers and metallurgists have been discussing the use of hydrogen to make steel since at least the 1960s, but the first hydrogen steel pilot plant didn't start construction until 2018. After decades of inaction, this project moved forward only when the majority of the $300 million cost was provided by the Swedish government. Across many industries, but especially in low-margin commodity industries, the required investment is large enough and the risk high enough that individual firms are reluctant to fund the needed large-scale innovations. In time, purely business-driven actors would likely find ways to take the risk, but we don't have that time.

We should directly fund demonstrations at scale of technologies capable of bringing key emissions-intensive processes to near-zero GHG emissions. These projects should have significant industry cost-share, but they will likely need to be majority publicly funded. A potential model is the European Union's Important Project of Common European Interest funding structure, which supports disruptive and ambitious innovations with positive spillover effects.[14] Here are just a few of the types of technologies that are ready for large-scale demonstration projects:

- Various approaches for carbon capture and storage in the cement industry.
- CO_2 utilization through artificial aggregates.
- Hydrogen production through electrolysis or methane pyrolysis.
- Inert anodes for aluminum smelting.
- Electrolytic steel production.
- High value-added recycling technologies.

These types of projects will range in price from $20 million to $400 million each, and they could be funded through a dedicated initiative at DOE or through the Defense Production Act (discussed below). In selecting project types and locations, we should consider environmental impacts, the support of the local community, and co-benefits like employment or opportunities for environmental justice. In siting strategic projects, we should also consider supportive state policies, for example, it might make the most sense to put a cement or steel project in a state with strong state-level buy-clean standards that would guarantee a market for the project's products. Other countries are already funding these types of projects, so we will have to move quickly if we wish to remain competitive, and even faster to have a chance of exporting the associated technologies.

All of these activities will have more impact more quickly if they are accompanied by significantly expanded technical assistance resources. Increasing all related program budgets by 5% to fund technical assistance and outreach to relevant firms and state and local governments would dramatically increase the activities' effectiveness.

Deployment

One of the most important accomplishments of the American Recovery and Reinvestment Act (ARRA) was catalyzing the scale-up of the wind and solar industries in the United States. Both industries were on the cusp of widespread deployment in 2009. By guaranteeing technology risk for first-of-a-kind projects, subsidizing retooling manufacturing facilities for clean technologies, and making credits and subsidies more readily available for all wind and solar projects, ARRA dramatically accelerated the takeoff of these critical industries. They now directly employ more than 360,000 Americans (NASEO and EFI 2020), and they contribute to declining GHG emissions and local pollution. Financial support from ARRA in turn made state-level market creation policies like Renewable Portfolio Standards more feasible and affordable.

Similarly, we need deployment policies that complement the already-described market creation and innovation policies to accelerate and entrench climate-safe manufacturing, construction, and waste systems. These policies can help overcome barriers to commercial readiness for new technologies and business models, and they can accelerate the rapid spread of commercially ready innovations. Deployment policies should support industrial activities both directly and with enabling infrastructure. Direct support takes four basic approaches, listed here from least to most aggressive:

- Credit supports.
- Tax credits.
- Subsidies.
- Direct contracting and investment.

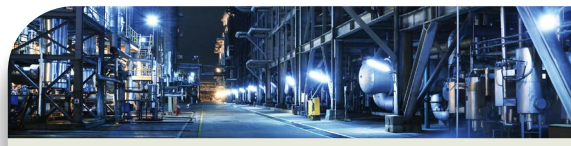
All of these approaches are already in use by the federal government, and all of them could help scale up a clean industrial sector. Given the size and complexity of the industrial sector, deployment policies should focus on complementarity with other policies; critical industries, processes, and products; and effectiveness of implementation.

Credit supports provide loans, loan guarantees, and insurance. They include the DOE Loan Program and proposals for a national climate or infrastructure bank. Credit supports potentially serve three purposes: to subsidize an investment by as much as the cost of capital; to absorb special kinds of risk, like technology risk; and to demonstrate commercial readiness and reduce transaction costs for future projects. Under the right circumstances, they can aid deployment with very little direct fiscal impact: loans get repaid or loan guarantees are never called in. But credit supports have downsides: the total level of support is capped at the price of the risk being underwritten—typically less than 20% of the project cost—and not all federal credit programs have been managed well (though the DOE Loan Program is generally considered an example of best practices; Grunwald 2015). In addition, many credit programs are designed with a fixed total loan authority, so they cannot use the funds from a repaid loan or guarantee to issue a new loan or guarantee.

Tax credits have been one of the most widely used deployment policies for clean technology. These credits include the solar Investment Tax Credit (ITC), the wind Production Tax Credit (PTC), the CCS 45q tax credit, and the now-expired 48c manufacturing investment tax credit. They can target investment or production, and they can be technology specific or determined solely by emissions characteristics. For example, the 45q tax credit is per ton of carbon dioxide, with the amount of the credit dependent on whether the carbon dioxide is stored or utilized. In the industrial sector, we could create a production tax credit per kilogram of clean hydrogen or per ton of clean cement, or we could target a technology or process with a tax credit for investment in equipment for clean high-temperature process heat. The main advantages of tax credits are that they have been easier to get passed by the U.S. Congress (where they do not require an appropriation) and that they have often been structured so that every eligible project receives the benefit, without additional paperwork or uncertainty.

The disadvantages of tax credits are several. First, tax credits can be difficult to monetize, and they often require an additional financial partner who can realize the tax advantages. This so-called tax equity investor can claim a third or more of the value of the tax credit—the cost to the taxpayer is the same, but the value to the recipient is only two-thirds (Bolinger 2014). Monetizing tax credits is especially a problem for entrepreneurs and innovators because newly founded

firms may not yet owe taxes. That problem can be solved by making a tax credit refundable. Second, the responsible agency for tax credits is the Internal Revenue Service, which has no particular expertise in climate or industrial policy and which does not prioritize such policy, leading to delays and implementation failures. It took more than two years for the IRS to issue the necessary guidance for projects to use 45q.[15] Third, tax credits make it more difficult to include requirements like good labor practices, environmental justice considerations, and coordination with the above-described market creation policies. Fourth, tax credits lack transparency. In most cases, federal grants and contracts are publicly disclosed, but whether a firm claims a tax credit is not, making it difficult to track whether the money is being used effectively. In spite of all of these disadvantages, tax credits cost the government exactly the same amount that subsidies would cost it.



Subsidies—financial incentives in the federal budget instead of in the tax code—can address some of the disadvantages of tax credits. They also can be structured very flexibly. In addition to mirroring the above-described tax credits with a grant for a share of an investment or a per-unit payment for production, the government could provide CO_2-based contracts-for-differences (CCfD). CCfDs guarantee a project owner the equivalent of a certain carbon price for every ton of CO_2 emissions reductions below an agreed-on benchmark emissions intensity. Let's say that making a product typically emits 1 tCO_2 per ton of product. If a project reduces emissions to 0.5 tCO_2 per ton of product, and if the CCfD ensures \$50 per tCO_2, the project owners would receive a \$25 payment for every ton of product they sell. If operational improvements further reduced emissions to 0.4 tCO_2 per ton of product, the owners would get \$30 per ton of product sold. This bankable revenue stream is analogous to a renewable electricity power purchase agreement (PPA), but in non-utility industries, where long-term contracts aren't practical. The advantages of CCfDs are reduced financing cost, efficient use of public money—payments are only made for emissions reductions that actually happen—and the incentive to expand production in the United States. The disadvantage of CCfDs is that they would likely require a new legal structure empowered by Congress, and Congress would have to appropriate the associated funds.[16]

The strongest deployment policies in the federal toolkit are direct contracting and investment. The government specifies industrial activity and pays for it directly, as it has done frequently in the area of defense procurement.

The strongest deployment policies in the federal toolkit are direct contracting and investment. The government specifies industrial activity and pays for it directly, as it has done frequently in the area of defense procurement. The Defense Production Act gives the president a wide array of authorities in the economy at large to "maintain and enhance the domestic industrial base" for purposes of national defense (CRS 2018).[17] During the Great Depression and World War II, the Reconstruction Finance Corporation (RFC, 1932–1957) and the War Production Board (WPB, 1942–1945) used loans, grants, and contracts to make strategic investments, including establishing subsidiaries to build up industries like metals and rubber.[18] Both the Kaiser Steel mill in California and U.S. Steel's mill in Geneva, Utah, were paid for with loans and grants from the RFC and WPB; each received the equivalent in today's dollars of nearly \$2 billion (Herman 2012, ch. 12; Davis 1990, ch. 7). Over the course of World War II, the U.S. government invested nearly \$300 billion in today's dollars in manufacturing facilities and machinery (Hendricks, Gunn-Wright, and Ricketts 2020). The advantages of direct contracting and investment are the opportunities for speed, scale, and coordination—that's why this approach is universally adopted during wartime mobilization. Enterprises with different technologies, in different industries, or at different points in a supply network can work in concert when there is a single investor or contractor (the government) for them all. Direct investment and contracting also makes it easier to require workforce and community protections, as will be discussed in the next section. The disadvantages of direct contracting and investment are the opportunities for waste of public money and the potential for state-owned or -directed enterprises to exert inappropriate influence on regulators or other parts of the government.

Given the scale and speed of the industrial transformation needed to address climate change, we will likely want to use direct contracting and investment in many cases. Without direct contracting and investment, it might be very difficult for the existing building materials industry to make clean cement and concrete available fast enough and in large enough quantities to meet the demand created by a major infrastructure investment with buy-clean requirements in a Covid-recovery package. Clean cement and concrete would require cement kiln construction or retrofits to use carbon capture, CO_2 transportation and storage infrastructure, expanded supply for new and existing supplementary cementitious materials, and possibly new energy generation. Without government intervention, it would take many years to get all of those pieces in place because each would be delayed by uncertainty in the others. Instead of waiving buy-clean requirements, the federal government could use the Defense Production Act or a newly created statutory authority to rapidly direct and fund new or retrofit production capacity and enabling infrastructure.

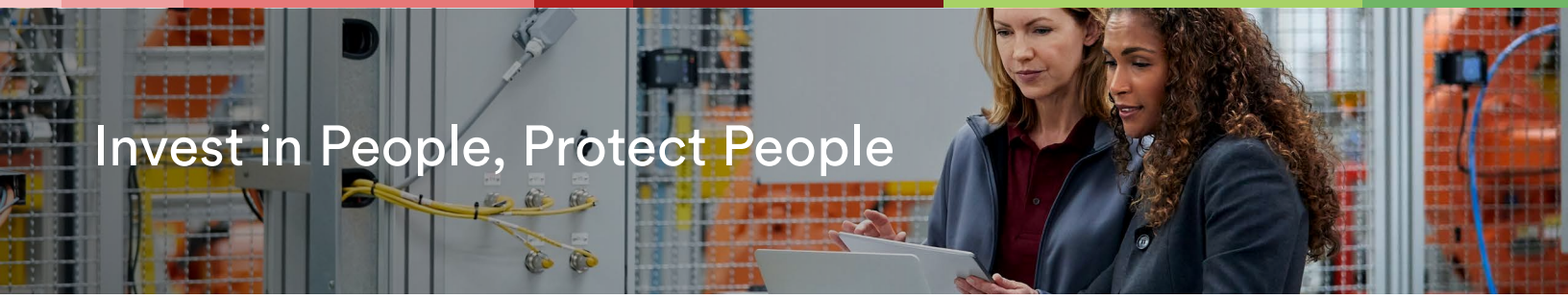
Today, the Defense Production Act primarily functions by requiring private firms to accept public contracts and prioritize their fulfillment, but it has provisions for grants, loans, loan guarantees, advanced market commitments, subsidies, and federal ownership of industrial capital. For example, in 2014, DOD, DOE, and U.S. Department of Agriculture together awarded $210 million in grants to scale up manufacturing capacity for companies making biofuels for military use.[19] If the president determines that there is a "domestic industrial base shortfall," these provisions can be used and up to $50 million spent without Congressional authorization (CRS 2018).

In addition to implementing policies that directly target deployment of clean industries, we need to support the development of enabling infrastructure through improvements in the electricity system and in transportation and storage infrastructure for hydrogen and carbon dioxide. One of the critical decarbonization pathways for industry will be electrifying processes that currently use on-site fuel combustion. This pathway can create very large new electricity demand, especially in energy-intensive industries. For example, fully electrifying just one of the steel mills mentioned in this report's introduction would create at least 3 GW of new electricity demand—the equivalent of three new nuclear power stations. Meeting this new demand with clean electricity is perfectly feasible, but only if we anticipate it and incorporate it in our long-term planning processes for the electricity grid. Similarly, other decarbonization pathways like hydrogen and carbon capture and storage will need enabling transportation and storage infrastructure. The federal government should identify current and potential industrial clusters in which multiple firms and facilities can share the cost of infrastructure. Once infrastructure needs have been assessed across pathways, we can facilitate infrastructure construction through expedited permitting and the most appropriate of the above-described deployment policies.

Innovation and deployment will be the heart of our long-term success in creating new industries and employment opportunities and in reducing our climate and environmental impact. We need to support clean manufacturing, construction, and waste processing at every stage, from research and development through piloting and demonstration to commercial deployment. That support should be well integrated with markets—both markets we create with tools like buy-clean and clean product standards and the market for clean products and processes that will grow around the world in the coming decades.

CATALYZING A CLEAN STEEL INDUSTRY

We can see how these policies fit together in an example from the steel industry. To catalyze a clean steel industry, we need industrial-scale demonstrations of clean production technologies like hydrogen reduction, direct electrolysis, and re-refining of recycled steel. A demonstration plant could be planned and paid for using a combination of research funding, funds authorized under the Defense Production Act, and funds from private-sector partners in the steel and utility industries. It would likely be sited somewhere with existing steel-industry expertise and easy access to clean energy, like Pennsylvania or Michigan. The demonstration plant could act as the anchor of a clean industrial cluster with shared electricity or hydrogen infrastructure—infrastructure that was facilitated by government planning, convening, and potentially funding. Federal procurement and initial customer-partners would provide some long-term demand for the demonstration plant's products—such as steel for naval vessels and for cars. The new Ford-class aircraft carriers require almost 50,000 tons of steel per vessel, and the U.S. Navy is planning to buy eight more of them (Newport News Shipping 2011). Another early customer might come from the automotive industry, with help from a CCfD. The first car to be made with climate-safe steel could be the Chevrolet Bolt, GM's most popular electric vehicle and union-manufactured in Michigan. Only a few demonstration plants would likely require policy support. Once experience reduced technology, product, and market risks, a single deployment incentive like a CCfD or a broad-based product standard would be sufficient to expand the clean steel industry.



Invest in People, Protect People

The goal of every policy in this report is to provide better lives for Americans through a cleaner, safer environment and better employment. Those policies can only succeed if we have enough well-trained, committed people to implement them. We need to invest in people through training and education, to target investments to vulnerable or overlooked communities, and to ensure our tax dollars are spent to create quality jobs. At the same time, we need to protect people by enforcing workplace rights, cleaning up legacy pollution from 20th-century industry, and funding workforce transitions where needed.

We need to invest in people through training and education, to target investments to vulnerable or overlooked communities, and to ensure our tax dollars are spent to create quality jobs.

Invest in People

We need to invest in people through training and education at every level. For the manufacturing and construction workforces, we should partner with unions, employers, vocational institutions, and community colleges to train people in clean, energy-efficient manufacturing processes, manufacturing of new product types, the use of clean building materials like mass timber, and material-efficient construction techniques. We should support registered apprenticeships as a mechanism for delivering training. A model for government-supported training in the skilled trades is the Helmets to Hardhats program, which prepares people leaving the military for careers in the construction industry.[20] For practicing architects, designers, and engineers, we should partner with professional associations to provide training in the use of alternative materials, modularity, design for disassembly, process waste reduction, light-weighting, and other practices to reduce the GHG emissions from manufacturing and building materials. We should fund universities to embed these approaches with new generations of architects, designers, and engineers. We should also develop opportunities for outreach and education for business executives and financial services professionals. For years, we have trained executives, investors, and loan officers to offshore production, but not how to develop and manage manufacturing; we will need to retrain them if we wish to revitalize our manufacturing sector.[21]

We need to target components of every investment to vulnerable or overlooked communities by:

- Using project labor agreements or community workforce agreements with deployment policies to ensure that the communities hosting federally funded facilities will receive jobs and benefits from the facilities.
- Maintaining or increasing the portion of innovation investments that are reserved for small businesses, minority-owned businesses, and women-owned businesses.
- Reserving a portion of all research, development, demonstration, and training funds for historically Black colleges and universities, tribal colleges, and other minority-serving institutions.
- Prioritizing environmental justice communities in siting facilities that are receiving public funds to pilot or commercialize clean production processes.

All of these mechanisms ensure that the largest and most diverse group of Americans possible can directly benefit from our transition to clean industry.

Finally, we need to ensure that our tax dollars are spent to create quality jobs. We already have laws to do this: the Davis-Bacon Act (1931) requiring all federal contractors and subcontractors to pay prevailing wages, the Buy American Act (1933) requiring the federal government to prefer American-made goods in all its purchases, and the Buy America Act (1982) creating additional requirements to use American-made building materials in federally funded transportation infrastructure.[22] Unfortunately, these laws are not universally or uniformly enforced. For example, the Buy America Act has no ongoing enforcement—if a contractor illegally uses foreign-sourced building materials, the only recourse would be a lawsuit, typically brought by a domestic supplier whose products were not used. All three of the laws need expanded enforcement with dedicated staff at the relevant agencies to ensure that not just federal projects, but also state and local projects using federal funds, comply with them. Because the largest portion of federal construction spending goes through the Department of Transportation, additional enforcement resources should be directed first to DOT. Enforcement doesn't just support more and better American jobs, it creates incentives for business owners to use more responsible practices. We should increase the Davis-Bacon requirements to include paid leave, fair overtime and scheduling practices, and non-interference with unionizing.

Protect People

In addition to investing in people, we need to protect them from dangerous or unfair circumstances that might be created by industrial activities. The best way to protect people is to give them tools to protect themselves by expanding and enforcing their workplace rights, foremost the right to unionize and collectively bargain. To help workers exercise that right, we need to end abusive practices like misclassification as independent contractors, mandatory arbitration, and employer interference in unionization decisions. We should strengthen the right to unionize, protections against abusive practices, and enforcement of both.[23]

At the same time, we should increase the budget and enforcement staffs of the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA). OSHA's staff has decreased by nearly a quarter in the last 10 years; it now has only 1,808 people to ensure on-the-job health and safety for a workforce of 130 million Americans (DOL 2019). Even including occupational safety and health staff in state governments, the number is inadequate and must be increased.

We also need to protect people from legacy pollution from 20th-century industry, which weighs disproportionately on low-income and minority communities. This pollution causes health and cognitive impairments and depresses the local area economically by preventing land from being put to productive use. Cleaning it up will improve the health, wellbeing, and economic vitality of afflicted communities.

The largest source of legacy pollution is from the fossil fuel industry. Though the Abandoned Mine Land program in the Department of the Interior (DOI) has been working since 1977 to remediate land and water scarred by coal mining, some six million acres remain in need of cleanup, at a likely cost of $10 billion—far more than the $2.2 billion currently in the Abandoned Mine Land Reclamation Fund (Dixon and Bilbrey 2015; DOI 2019).

Similarly, orphaned oil and gas wells—idle wells whose responsible party is unknown or insolvent—are an enormous burden on many rural American communities, where they can leak air, water, and climate pollution. There are 56,600 known orphan wells around the United States and potentially more than 10 times that number of undocumented orphan wells (IOGCC 2019). Based on estimates for California, the cost of plugging and remediating just the known orphan wells could be $5 billion.[24] Cleanup expenditures need to be coupled with significant new bonding requirements for operating wells to prevent operators from foisting their cleanup responsibilities on taxpayers in the future. One recent analysis found that less than 1% of future remediation costs are covered by surety bonds (Schuwerk and Rogers 2020).

In addition to addressing legacy pollution from fossil fuel extraction, we need to remediate hazardous industrial wastes, including lead from leaded gasoline, paint, and pipes; heavy metals from the metals industry, mine tailings, and coal boilers; and toxic organic chemicals from the chemical industry. The primary legal authority for this work is the Comprehensive Environmental Response, Compensation, and Liability Act, better known as Superfund. Under Superfund,

EPA assesses and prioritizes contaminated sites and oversees their remediation. At the current rate of progress, it will take approximately a century to remediate all of the sites on the National Priorities List of Superfund sites.[25] When possible, the responsible party pays for the Superfund cleanup; in the many cases in which that party is unknown or insolvent, the federal government pays. Unfortunately, government funding for cleanups has been decreasing. Since repeal of Superfund's dedicated excise tax 22 years ago, EPA's Superfund enforcement and cleanup budget has dropped by more than half, from over $2 billion to $1 billion (Voltaggio and Adams 2020; EPA 2020b). This reduction in funding has coincided with an increase in the risk associated with more than half of Superfund sites from climate change hazards like sea-level rise and wildfires (GAO 2019). The communities near these sites are significantly more likely than average to be minority, low-income, or otherwise vulnerable.

The costs of remediating legacy pollution are modest compared with the health, economic development, and employment benefits of doing so. Cleanups will open up opportunities for tourism and economic development impossible on degraded land and provide tens of thousands of jobs at a wide range of skill levels in rural and economically distressed areas. Remediating abandoned coal mines will overwhelmingly benefit the most distressed areas of Central Appalachia. Although in the billions of dollars, cleanup expenditures will be made just once, and they are dwarfed by ongoing expenditures we make to benefit comparable numbers of people. For example, we spent $46 billion on farm subsidies in 2020 alone (Rappeport 2020).

Finally, our industrial policy should protect people by funding workforce transitions where needed. Though the energy industry, the chemical industry, the metals industry, and other core manufacturing activities aren't going away, the particular jobs that are required and their locations will change as we move toward cleaner and safer processes. Workers need to be protected if this transition harms their livelihood. We should fund health care and retirement benefits in industries in which there is a federal obligation, like coal. Additionally, we should offer the option of early retirement with a pension for workers nearing retirement and whose particular skills are not well-matched to new types of industry. All workers who lose their jobs in the transition should have access to retraining with income replacement, preferential hiring at any new federally supported facility in their industry, and relocation assistance.

By protecting people and investing in people, we will make sure that everyone—urban or rural, Black or white, old or young, factory worker or engineer—will have an opportunity to participate in and benefit from our new industrial policy. Protecting people and investing in people is a pillar of the Build Clean agenda.

PROTECTING PUBLIC HEALTH THROUGH ENVIRONMENTAL REGULATION

Protecting public health through the vigorous promulgation and enforcement of environmental regulations under existing laws like the Clean Air Act, the Clean Water Act, the Toxic Substances Control Act, and Superfund is an essential part of the Build Clean agenda. We should also continue to use smart standards to promote energy efficiency and electrification under DOE's Appliance and Equipment Standards.

However, in the near term, we should approach direct regulation of GHG emissions from industrial facilities cautiously. Current law bases regulations on the best available control technologies, and for many of the most important industries and processes the best available technologies are only incremental improvements over current typical practice. We would likely achieve more in the long term if we first focused on innovation and market creation approaches, as discussed in the previous sections. Once genuinely low-GHG-emissions technologies are available, we can and should revisit regulatory approaches. In the meantime, the federal government can lay the foundation for that potential future regulation by doing research, building informational infrastructure, and working with state governments as they pursue regulation relevant to their circumstances.

Strengthen Governance and Coordination

For any of the above policies to be implemented effectively and to achieve their goals, we must significantly strengthen governance and coordination across the federal government. Currently, industrial and manufacturing policy is fragmented across multiple agencies and programs and is often administered by mid-level civil servants. It is disturbing to realize that the highest-ranking person in the federal government whose job it is to advance the future of American manufacturing has, at the time of this writing, the rank of acting office director.

Transformative change requires high-level leadership, starting with coordination from the White House and including senior personnel at DOE, DOT, EPA, Labor, Treasury, and Commerce.

Transformative change requires high-level leadership. This leadership should start with coordination from the White House, led by a special assistant to the president for clean industrial transformation. This will provide high-level focus and maintain momentum for this agenda. Given the many agencies that will have to be involved in this transformation—DOE, DOT, Labor, Treasury, Commerce, EPA, NSF, DOT, and others—dedicated staff at the White House will be essential.

Second, we need senior personnel in the relevant agencies. This should include an assistant secretary for industrial transformation at DOE to implement and coordinate research, development, demonstration, and deployment activities; energy efficiency; technical assistance; analysis, standards, and data management; and training.[26] Dedicated appointees at Labor, DOT, Treasury, Commerce, and EPA would also be extremely helpful. With focused leadership from the White House, new positions might not be required at other agencies, though these agencies also have significant roles (Table 3).

Third, we need to create a structure for overseeing and coordinating large-scale strategic investments and demonstration projects. A major demonstration project could involve technology expertise from DOE and NIST, fiscal planning by Treasury, air and water pollution expertise from EPA, purchasing by DOT and DOD, worker safety and training from Labor, and cooperation from state, local, and tribal governments for the jurisdictions hosting the project. It also might involve multiple firms that need to avoid anti-competitive behavior. A model structure for overseeing and coordinating large-scale strategic investments and demonstration projects has been supplied by the European Union. It designates strategic projects as Important Projects of Common European Interest in recognition of the projects' advancement of social goals like competitiveness and sustainability. The projects have access to public monies and use a purpose-built regulatory and administrative framework. We should consider establishing a similar structure, whereby a committee of interagency and external experts, including experts on public health co-benefits and environmental justice, select and oversee projects.

Fourth, we need to invest in informational infrastructure. To manage emissions, we need comprehensive and high-quality information about emissions intensities, embodied emissions, and life-cycle effects for covered products as well as information about supply networks for critical industries. This information is the basis for technical and market standards and strategic investments. EPA should develop a national standardized and validated public database of Environmental Product Declarations (EPDs), the most common format for reporting on products' GHG emissions and other environmental performance factors. This database should build on existing methodologies and knowledge from public and non-public

datasets collected by the government, including the Manufacturing Energy Consumption Survey from the Energy Information Administration and the Survey of Manufactures from the Census. We should use these informational resources to expand the use of consumption-based accounting of GHG emissions. In addition, nearly every policy and program described in this report should include a significant budget to support technical assistance. Dedicating 5% of a program budget to technical assistance for firms and state, local, and tribal governments will dramatically increase the policies and programs' overall effectiveness.

Fifth, for both new and existing programs, we need to emphasize smart, aggressive enforcement of the rules. Poor enforcement only benefits businesses that want to cheat. It doesn't benefit businesses that want to behave responsibly. At least four agencies need additional focus and resources to expand enforcement:

- EPA, to undertake additional public health enforcement to address environmental injustice.
- DOT, to investigate and enforce Buy America and Buy American.
- Labor, to increase staffing for and investigation at OSHA and MSHA and to crack down on illegal anti-union practices by employers.
- FTC, to crack down on "greenwashing" to maintain the integrity of markets for clean products.

In most of these cases, the agencies will require additional resources to maintain the integrity of the enforcement system and to achieve the desired environmental and social outcomes.

Finally, we need the domestic agenda outlined here and our foreign and trade policy to be closely aligned. Climate change is a global problem, and goods are traded on global markets. We should explore opportunities to cooperate with other countries in developing clean industrial technologies and in creating shared markets for their products. We can help ensure American firms and innovators benefit from that cooperation with our export promotion capacities, like the Export-Import Bank and development finance institutions. Clean and fair industry should be central to all trade agreements, which should support fair labor standards and the domestic environmental protections of all participating countries.

Photo by Scott Blake on Unsplash

Table 3: Roles for Federal Agencies in Build Clean

Agency	Potential Roles in Build Clean
Executive Office of the President	• Appoint a special assistant to the president for clean industrial transformation. • Set priorities across the government. • Convene and coordinate across the government. • Designate and oversee strategic projects.
Department of Energy	• Appoint an assistant secretary for clean industrial transformation. • Basic and applied research on energy, materials, and methods for manufacturing, construction, and waste processing. • Develop and review technical standards, including building codes. • Manage and oversee major technology demonstrations. • Finance manufacturing technology risk with loans/guarantees. • Coordinate interagency work on multiple technology pathways. • Promote industrial energy efficiency.
Department of Commerce	• Provide technical assistance through NIST's Manufacturing Extension Partnership. • Conduct research and develop technical standards at NIST. • Collect and manage data at Census.
Environmental Protection Agency	• Prioritize and oversee cleanup of legacy pollution. • Measure and validate GHG emissions for both facilities and products. • Develop and promulgate clean product standards. • Act as a technical partner for buy-clean standards.
Department of Transportation	• Develop and promulgate buy-clean standards as regulatory lead. • Implement buy-clean standards for highways and other transportation infrastructure. • Enforce labor and local content requirements in all federally funded transportation projects.
Department of Labor	• Ensure worker safety through OSHA and MSHA. • Ensure fair compensation through Davis-Bacon and other requirements. • Protect the right to organize. • Coordinate interagency workforce development activities.
Department of Treasury	• Implement any deployment policies in the tax code, like tax credits. • Provide macroeconomic analysis to support industrial transformation. • Develop trade policy.
Department of State	• Integrate clean industry into climate diplomacy. • Lead international cooperation on technology and markets. • Promote exports of clean industrial technologies and businesses.
Federal Energy Regulatory Commission	• Incorporate industrial electrification in electricity system planning.
National Science Foundation	• Expand basic R&D on industrial decarbonization and clean manufacturing at universities and research institutes.
General Services Administration	• Implement buy-clean policies for federally contracted construction. • Enforce labor and local content requirements.
Department of Defense	• Use defense procurement to create markets for clean alternatives to critical products and materials. • Implement buy-clean standards for federally contracted construction, especially through the Army Corps of Engineers. • Enforce labor and local content requirements for federally contracted construction, especially through the Army Corps of Engineers. • Use the full powers of the Defense Production Act to develop and deploy essential clean industrial technologies and approaches.
U.S. Department of Agriculture	• Identify opportunities and finance for clean manufacturing in rural areas.
Federal Trade Commission	• Ensure the integrity of markets for low-GHG products and crack down on "greenwashing" and false "made in America" claims.
Small Business Administration	• Funnel innovation investments and procurement opportunities to small, women-owned, and minority-owned businesses.
Government Accountability Office	• Lead oversight, accountability, and government best practices.

Key potential roles for federal agencies to advance an industrial policy for climate and justice. Many parts of the government will have to work together to achieve a fair and clean industrial sector.

Conclusion: Build Clean

For the last few decades, industrial policy has been a dirty word in Washington, DC. The prevailing philosophy from one administration and Congress to the next has been that if the government addresses some externalities (like pollution) and provides some public goods (like basic research), the invisible hand of the market will take care of the rest. The unspoken implication of this philosophy is that our democratic institutions have no business influencing the kind of economy we have: who it is built to benefit, who it is built to harm, what it is built to provide.

This philosophy is quite unusual in the centuries-long history of American government. In his 1791 *Report on the Subject of Manufactures*, Alexander Hamilton, a father of industrial policy, argued for versions of many of the policies described here. He advocated for supporting innovation, subsidizing emerging industries, fostering markets through standards and government purchasing, and protecting strategic industries from overseas competition. He argued, as this report argues, that promoting manufacturing would increase "the total mass of useful and productive labor" and promote "the safety as well as the welfare of the society"—that is, provide better jobs and make us more secure and resilient.

Our recent rejection of industrial policy has not eliminated it, just made it sloppy and disorganized because it is unacknowledged. We have been constantly making decisions about the kind of economy we have, but those decisions have been isolated one from the other, and their consequences have been opaque. As a result, narrow interests have found it much easier to manipulate our de facto industrial policy to their own advantage: using tax loopholes to offshore good jobs, weakening enforcement of workplace protections, and injuring the health and safety of their communities and the Nation by damaging the environment and the climate.

We only need to combine our policies with vision and strategy to achieve what we all want: better lives for everyone through a cleaner, safer environment and more just employment. **This is the moment to choose together the kind of economy we want to build.**

Today we face multiple overlapping and intersecting crises: the Covid-19 pandemic, the economic crisis, the crisis of racial justice, and the climate crisis. This report proposes a set of coordinated policies to make progress on all of these crises together. None of the policies are new or unprecedented, and each we have used successfully before. We only need to combine them with vision and strategy to achieve what we all want: better lives for everyone through a cleaner, safer environment and more just employment. This is the moment to choose together the kind of economy we want to build.

Acknowledgments

My gratitude to Dan Fahey and Paula Swiatkowski for research assistance and to the following people for their valuable feedback on drafts: Matthew Baker, Noah Deich, Elizabeth Dell, Ilmi Granoff, Patty Harper, Trevor Houser, Jonathan Pershing, Abigail Regitsky, and Julia Walsh.

Endnotes

1 Industrial emissions include industrial process emissions (IPCC category 2), waste processing emissions (IPCC category 4), refinery emissions (IPCC category 1.A.1.b), energy used in manufacturing industries and construction (IPCC category 1.A.2), and the portion of electricity and heat production (IPCC category 1.A.1.a) that is used by the industrial sector, taken from Crippa et al. (2019).

2 Author's calculations based on technical specifications of the bridge published in Brown (2007).

3 We saw an example of how increases in commodity prices have extremely muted impacts on the broader economy when President Trump instituted steel and aluminum tariffs in 2018. Though it did lead to a significant increase in steel prices (https://fred.stlouisfed.org/graph/?g=wF98), aside from certain metal-intensive industries, the economy felt little impact.

4 California Buy Clean is currently in the mandatory reporting phase of implementation; the compliance requirement begins in 2021.

5 The implementation guidelines for federal buildings, "Guiding Principles for Sustainable Federal Buildings," mention procuring "construction materials and building supplies that have a lesser or reduced effect on human health and the environment," but they offer no specific metrics, instructions, or information related to GHG content. See https://www.sustainability.gov/pdfs/guiding_principles_for_sustainable_federal_buildings.pdf.

6 USGS estimates that 80-85% of all cement in the United States is sold to ready-mix concrete facilities and concrete product manufacturers (USGS 2020).

7 Author's calculations based on embodied emissions assessments in Smith and Gill (2018). See especially Figure 28.

8 Many of the principles for successful industrial innovation described in this section are already embodied in the Clean Industrial Technologies Act (HR4320), which unanimously passed out of the House Committee on Science, Space and Technology in February 2020.

9 The only manufacturing and materials ARPA-E funding opportunity was the 2013 solicitation for Modern Electro/Thermochemical Advances in Light Metals Systems (METALS).

10 Manufacturing and construction together employ about 20% more people than healthcare and generate about three-quarters of the GDP that healthcare generates. See https://fred.stlouisfed.org/graph/?g=vcsD.

11 See the ARPA-E and DARPA budgets here: https://arpa-e.energy.gov/?q=arpa-e-site-page/arpa-e-budget; https://www.darpa.mil/about-us/budget.

12 See the Fraunhofer budget here: https://www.fraunhofer.de/en/about-fraunhofer/profile-structure/facts-and-figures/finances.html.

13 For example, the Energy Policy Act of 2005 (Pub L No 109-58) establishes "increasing the efficiency of all energy intensive sectors" as a goal of DOE, but it does not establish a goal of reducing GHG emissions or improving other types of environmental performance.

14 See https://ec.europa.eu/competition/state_aid/modernisation/index_en.html.

15 See https://carboncapturecoalition.org/carbon-capture-coalition-welcome-irs-issuance-of-proposed-45q-rule-and-requirements-for-secure-geologic-storage/.

16 A potential policy model for the legal structure that would enter into a CO_2 contract-for-differences might be the Commodity Credit Corporation at the U.S. Department of Agriculture.

17 "National defense" is defined extremely broadly in the statute to include energy production and infrastructure, assistance to foreign nations, and emergency preparedness. See 50 USC §4552(14).

18 The War Production Board also directed production, allocated materials, and rationed commodities.

19 Notably, these were "drop-in" biofuels, identical in their use to conventional fuels but manufactured via a different, more climate-safe process. The DPA can be used to address the climate impacts of the manner of a product's production, provided the president determines that doing so maintains and enhances the domestic manufacturing base. See https://www.renewableenergyworld.com/2014/09/19/us-navy-doe-usda-award-210-million-to-three-companies-for-drop-in-biofuels/.

20 See https://helmetstohardhats.org/.

21 As evidence, the curricula of leading American business schools have many courses in how to manage complex overseas supply networks, but few if any courses in manage production in a factory.

22 The Davis-Bacon Act has been rightly critiqued by Wilkerson (2010) and others as a tool for excluding Black and minority workers from public construction projects, particularly during the period from its passage in 1931 through the 1970s. However, as the skilled trades have become more racially integrated, Black and minority workers have been able to benefit from Davis-Bacon's protections, and the act is supported by the NAACP and other racial justice organizations.

23 A more comprehensive treatment of needed improvements in union protections is the Protecting the Right to Organize (PRO) Act, passed by the House of Representatives in February 2020. The text of HR2474 is available at https://www.congress.gov/bill/116th-congress/house-bill/2474/text Many of the act's provisions are also found in Senator Merkley's proposed Good Jobs for 21st Century Energy Act: https://www.merkley.senate.gov/.

24 Boomhower, Shybut, and DeCillis (2018) found that remediation of the 5,540 known orphan wells in California could cost the state $500 million in direct fiscal outlays, not counting the health and environmental costs.

25 At the time of writing, 1,327 active sites were on the National Priorities List, and 14 sites had been removed from the list in the previous 12 months. See https://www.epa.gov/superfund/superfund-national-priorities-list-npl; https://www.epa.gov/superfund/deleted-national-priorities-list-npl-sites-deletion-date.

26 Under the DOE Organization Act of 1977, the Secretary of Energy has broad discretion to assign duties and portfolios to eight assistant secretaries (42 U.S. Code § 7133), and so could administratively create an assistant secretary for industrial transformation. Alternatively, Congress could create the position by mandating that it be included among the existing assistant secretaries or by increasing the number of assistant secretaries. The importance of this role was particularly highlighted in the June 2020 majority staff report of the House Select Committee on the Climate Crisis (U.S. House of Representatives 2020, p. 240).

References

- Allwood, J. M., and J. M. Cullen. 2015. *Sustainable Materials without the Hot Air.* UIT Press.
- AISI (American Iron and Steel Institute). 2019. Profile 2019-2020. Technical report. https://www.steel.org/wp-content/uploads/2020/12/2020-AISI-Profile-Book.pdf.
- Bolinger, M. 2014. An analysis of the costs, benefits, and implications of different approaches to capturing the value of renewable energy tax incentives. Technical Report LBNL-6610E, Lawrence Berkeley National Laboratory. https://eta-publications.lbl.gov/sites/default/files/lbnl-6610e.pdf.
- Boomhower, J., M. Shybut, and M. D. DeCillis. 2018. Orphan wells in California: An initial assessment of the state's potential liabilities to plug and decommission orphan oil and gas wells. Technical report, California Council on Science and Technology. https://ccst.us/wp-content/uploads/CCST-Orphan-Wells-in-California-An-Initial-Assessment.pdf.
- Brown, D.C. 2007. "Built to Resist the Big One," *Aspire: The Concrete Bridge Magazine* (Winter 2007): 12–17, http://aspirebridge.com/magazine/2007Winter/SFOBB.pdf .
- Crippa, M., G. Oreggioni, D. Guizzardi, M. Muntean, E. Schaaf, E. Lo Vullo, E. Solazzo, F. Monforti-Ferrario, J. G. J. Olivier, and E. Vignati. 2019. Fossil CO_2 and GHG Emissions of All World Countries—2019 report. Technical Report EUR 29849 EN; JRC117610, Publications Office of the European Union, Luxembourg.
- CRS (Congressional Research Service). 2018. The Defense Production Act of 1950: History, authorities, and considerations for Congress. Technical Report R43767, Congressional Research Service, November. https://fas.org/sgp/crs/natsec/R43767.pdf.
- Davis, M. 1990. *City of Quartz.* Vintage Books.
- Dell, R. W. 2020. "What's at stake with Buy Clean." ClimateWorks Foundation blog, August. https://www.climateworks.org/blog/whats-at-stake-with-buy-clean/.
- Dixon, E., and K. Bilbrey. 2015. Abandoned Mine Land Program: A policy analysis for Central Appalachia and the Nation. Technical report, AML Policy Priorities Group, Appalachian Citizens' Law Center. https://aclc.org/wp-content/uploads/2020/08/aml-policy-paper.pdf.
- DOE (U.S. Department of Energy). 2015. Carbon Storage Atlas, fifth edition. Technical report, National Energy Technology Laboratory. https://www.netl.doe.gov/coal/carbon-storage/strategic-program-support/natcarb-atlas.
- -------. Advanced Manufacturing Office. 2019. FY2020 Budget Justification. https://www.energy.gov/cfo/downloads/fy-2020-budget-justification.
- DOI (U.S. Department of the Interior). 2019. Status of the Abandoned Mine Land Reclamation Fund. Technical report, Office of Surface Mining Reclamation and Enforcement. https://www.osmre.gov/programs/AML.shtm.
- DOL (U.S. Department of Labor). 2019. FY2020 budget in brief. Technical report. https://www.dol.gov/sites/dolgov/files/general/budget/2020/FY2020BIB.pdf.
- *Economist*. 2017. Construction's productivity puzzle. *Economist*, August. https://www.economist.com/graphic-detail/2017/08/25/constructions-productivity-puzzle.
- DOT (U.S. Department of Transportation). 2020. FY2021 Budget Highlights. https://www.transportation.gov/sites/dot.gov/files/2020-02/BudgetHightlightFeb2021.pdf.
- Elysis. 2018. Alcoa and Rio Tinto announce world's first carbon-free aluminum smelting process. May. https://news.alcoa.com/press-releases/press-release-details/2018/Alcoa-and-Rio-Tinto-Announce-Worlds-First-Carbon-Free-Aluminum-Smelting-Process/default.aspx.
- EPA (U.S. Environmental Protection Agency). 2019. Our Nation's Air. Annual report, https://gispub.epa.gov/air/trendsreport/2019/#air_pollution.
- ------. 2020a. Enforcement and Compliance History Online (ECHO). https://echo.epa.gov.
- -------. 2020b. *FY2021 Budget in Brief.* Technical report. https://www.epa.gov/sites/production/files/2020-02/documents/fy-2021-epa-bib.pdf.
- -------. 2020c. *Inventory of U.S. Greenhouse Gas Emissions and Sinks*, 2020. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2018.
- ------. 2020d. *U.S. Greenhouse Gas Reporting Program, 2020.* https://www.epa.gov/ghgreporting/ghg-reporting-program-data-sets.
- GAO (U.S. Government Accountability Office). 2019. Superfund: EPA should take additional actions to manage risks from climate change. Technical report, https://www.gao.gov/assets/710/702158.pdf.
- Geyer, R., J. R. Jambeck, and K. L. Law. 2017. Production, use, and fate of all plastics ever made. *Science Advances* 3 (July). DOI: 10.1126/sciadv.1700782.
- Grunwald, M. 2015. The (Real) Bank of America. *Politico*, January/February. https://www.politico.com/magazine/story/2015/01/federal-loans-bank-of-america-113920.
- Hasanbeigi, A., and C. Springer. 2019. How Clean is the U.S. Steel Industry? Technical report, Global Efficiency Intelligence, November. https://buyclean.org/2019/12/03/report-us-steelmaking-among-cleanest-globally/.
- Hasanbeigi, A. R. Becqué, and C. Springer. 2019. The role of green public procurement. Technical report, Global Efficiency Intelligence. https://buyclean.org/media/2019/09/Green-Public-Procurement-Final-28Aug2019.pdf.
- Hendricks, A., R. Gunn-Wright, and S. Ricketts. 2020. The Greatest Mobilization Since WWII. *Democracy* 56 (Spring). https://democracyjournal.org/magazine/56/the-greatest-mobilization-since-wwii/.
- Herman, A. 2012. *Freedom's Forge.* Random House.
- HYBRIT Development. 2017. Hybrit: Fossil-free steel. Technical report, HYBRIT Development AB. http://www.hybritdevelopment.com/.
- IOGCC (Interstate Oil and Gas Compact Commission). 2019. Idle and orphan oil and gas wells. Technical report. https://iogcc.ok.gov/idle-and-orphan-wells.
- Manufacturing USA. n.d. https://www.manufacturingusa.com/about-us.
- NASEO (National Association of State Energy Offices) and EFI (Energy Futures Initiative). 2020 U.S. energy & employment report. Technical report. https://www.usenergyjobs.org/.
- Newport News Shipping. 2011. Ford Reaches 50% Structural Completion. *Yardlines*, September. http://nns.huntingtoningalls.com/employees/pub/media/yardlines/YL0911.pdf.
- NIST (National Institute for Standards and Technology). 2020. President's FY2020 Budget Request to Congress for the National Institute for Standards and Technology. NIST, U.S. Department of Commerce. https://www.nist.gov/system/files/documents/2019/03/26/fy20_presidential_budget_request.pdf.
- PCA (Portland Cement Association). 2017. U.S. Cement Industry Annual Yearbook. Technical report.
- Rappeport, A. 2020. Trump funnels record subsidies to farmers ahead of election day. *New York Times*, October. https://www.nytimes.com/2020/10/12/us/politics/trump-farmers-subsidies.html.
- Schuwerk, R., and G. Rogers. 2020. Billion Dollar Orphans: Why millions of oil and gas wells could become wards of the state. Technical report, Carbon Tracker Initiative. https://carbontracker.org/reports/billion-dollar-orphans/.
- Smith, A., and G. Gill, editors. 2018. *Residensity.* https://www.residensitybook.com.
- U.S. Census. Construction Spending: Value Put in Place, Annual Federal Totals. https://www.census.gov/construction/c30/historical_data.html.
- USGS (U.S. Geological Survey). 2020. *Mineral Commodity Summaries 2020.* p42. https://www.usgs.gov/centers/nmic/mineral-commodity-summaries.
- U.S. House of Representatives. 2020. Solving the Climate Crisis. Technical report, Select Committee on the Climate Crisis Majority Staff, June. https://climatecrisis.house.gov/sites/climatecrisis.house.gov/files/Climate%20Crisis%20Action%20Plan.pdf.
- Voltaggio, T. C., and J. Adams. 2020. *Superfund: A half century of progress.* Technical report, EPA Alumni Association. https://www.epaalumni.org/hcp/superfund.pdf.
- Wiebe, K.S., and N. Yamano. 2016. Estimating CO_2 emissions embodied in final demand and trade using the OECD ICIO 2015. Science, Technology, and Industry Working Papers 2016-05, OECD. https://doi.org/10.1787/5jlrcm216xkl-en.
- Wilkerson, I. 2010. *The Warmth of Other Suns.* Random House.
- Yamano, N., and J. M. Guilhoto. 2020. CO_2 emissions embodied in international trade and domestic final demand, using the OECD intercountry input-output database. Technical report, OECD. https://www.oecd.org/sti/ind/TECO2_OECD_webdoc2020.pdf.

climateworks FOUNDATION

Contact: Rebecca Dell
Email: rebecca.dell@climateworks.org

Global Headquarters
235 Montgomery St
Suite 1300
San Francisco, CA 94104
Phone: (415) 433-0500
Email: info@climateworks.org
Web: climateworks.org
Twitter: @ClimateWorks