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The Roosevelt Project

Iron and Steel Decarbonization by 2050: An Opportunity for Workers and Communities

Executive Summary

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About the Roosevelt Project

The Roosevelt Project takes an interdisciplinary approach to the transitional challenges associated with progress toward a deeply decarbonized economy. The project aims to chart a path forward through the transition that minimizes worker and community dislocations and enables at-risk communities to sustain employment levels by taking advantage of the economic opportunities present for regional economic development. The first phase looked at the history of such transitions in the United States in order to provide a foundation of lessons learned. The second phase examined four places in the United States that are facing uncertainty as the energy system changes. The third phase analyzes large-scale changes that are needed in critical areas of the economy. The project was initiated by former Secretary of Energy, Ernest J. Moniz, and engages a breadth of MIT and Harvard faculty and researchers across academic domains including Economics, Engineering, Sociology, Urban Studies and Planning, and Political Science.

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Note: Participation on the advisory board of this case study does not necessarily imply support for findings or policy recommendations by any advisor or their organization.

Preface

The Roosevelt Project launched in 2017 to address the challenges facing workers and communities as our economy decarbonizes and our energy and industrial systems undergo substantial related change, ideally at a rapid pace compared with past major societal transformations. How do regional economies adjust to the decline of a key industry? What happens to the workers in those industries and those in the surrounding economies? How can regional, state, and federal governments anticipate and adapt to industrial decline and to the invention of new industries? What is the role of civil society, foundations, unions, colleges and universities, national labs, and other institutions in helping "energy communities" gain from the clean energy transition? The American experience offers rich and instructive cases of success and of failure in societal transformation that can help the United States—and others—navigate the changes in our economy that will come with evolving energy systems.

The Roosevelt Project stands on three pillars—economy, environment, and equity. These are exemplified by the namesakes of the Project: Franklin Delano Roosevelt's presidency saved the American economy from collapse during the Great Depression; Theodore Roosevelt's presidency recognized and protected the natural wonders of the American continent; Eleanor Roosevelt was an unwavering champion of social equity and justice. These are the lenses through which the Roosevelt Project has examined the societal implications of the clean energy transition.

The Roosevelt Project has conducted three waves of inquiry into equitable energy and industrial transition. The first phase looked at the history of such transitions in the United States in order to provide a foundation of lessons learned. The second phase examined four places in the United States that are facing uncertainty as the energy system changes. The third phase, of which this report is a part, analyzes large-scale changes that are needed in critical areas of the economy. All Roosevelt Project reports are available at https://ceepr.mit.edu/roosevelt-studies.

This study is one of three investigations into the challenges and opportunities in critical parts of the American energy sector: long-distance electric transmission, strategic metals and minerals, and low-carbon steel. Each presents key infrastructure and industrial challenges that must occur for the United States to take full advantage of the nation's low-carbon energy resources.

- Grid: A significant expansion of long-distance transmission capacity is needed to connect remote wind and solar resources to major urban and industrial users and represents an important part of the solution to meeting major electrification demands of the new economy.
- Minerals: Electrification of transportation, steel, buildings, and other end uses (such as AI-driven data centers) will require expanded access to critical minerals, such as lithium, cobalt, nickel, copper, rare earths and many others. Extraction and processing of these minerals present environmental challenges, including for frontline communities and tribal lands.
- Steel: Decarbonizing steel has proved difficult and slow. Solutions will need integration of community, workforce, competitiveness and trade priorities.

We hope that the Roosevelt Project will continue to inform the debate about simultaneously advancing social equity and the clean energy transition.

Ernest J. Moniz
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13th U.S. Secretary of Energy
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Executive Summary and Recommendations

Steel and the steel industry are critical to societies today due to their central role in manufacturing and infrastructure as well as their long-standing importance for defense. Ensuring a sufficient supply of steel for the U.S. economy while deeply reducing greenhouse gas (GHG) emissions to address climate change will require solutions that integrate community, workforce, competitiveness, trade, and national security priorities. This case study lays out a path for accelerating decarbonization of the iron and steel industry that benefits workers and communities. The recommendations of this study outline a framework for comprehensively supporting the technology and infrastructure required for decarbonization, using revenues from an established policy instrument, Section 232 tariffs.

Steel production in the United States has undergone a unique evolution over the past 75 years as the share of electric arc furnace (EAF) production, frequently by new players, has increased dramatically relative to that of the integrated or BF-BOF route—converting iron ore to iron in a blast furnace (BF) and refining it along with scrap into steel in a basic oxygen furnace (BOF). In the United States today, 70% of steel is produced in EAFs and 30% in BOFs, compared to shares of 30% and 70%, respectively, 40 years ago. This transformation has shifted steel production to new regions of the country and involved new workforces and communities. This transition is the principal reason why the emissions intensity of steel in the United States is relatively low, at approximately 1 metric ton (mt) of CO_2 per mt of crude steel (tCO_2/tcs). It is also reflected in the fact that worldwide steel production accounts for 7% of total energy-related CO_2 emissions, while in the United States, its production accounts for only 2%.

Future steel production in the United States, including its decarbonization, will be shaped by a range of conditions and constraints. These include: (1) the availability and cost of inputs, including high-quality scrap, (2) technology readiness and implementation to further reduce GHG emissions from domestic ironmaking and integrated mills, (3) the economics of meeting surface product quality requirements with EAF technologies, (4) the cost of producing ore-based metallics for EAF production with very low CO_2 emissions, (5) the availability of decarbonized electricity to support large industrial loads for all steelmaking facilities, (6) future global and domestic demand for steel, and (7) national security and trade considerations.

Overcoming the Economic Challenge

The challenges in decarbonizing iron and steel production in the United States are mainly economic rather than technical. The ironmaking process is the major source of GHG emissions, although mining, transport, steelmaking, electricity generation, and downstream processing also contribute substantially. Several decarbonization options for current iron and steel production routes are available today.

For illustrative purposes, this analysis provides cost estimates for two options to reduce GHG emissions from both EAF and BF-BOF steelmaking that support a reduction of 70–75% of Scope 1 and 2 GHG emissions relative to 2023 levels. Scope 1 is defined as direct emissions, while Scope 2 is indirect emissions from purchased electricity or heat. Scope 3 is other indirect emissions across the supply chain, both upstream and downstream of iron and steel production. For

BF-BOF plants, this analysis models carbon capture and sequestration (CCS) on BFs as well as direct reduced iron (DRI) produced using natural gas with CCS, plus a melt furnace using existing BOFs. For EAF steelmaking, the model focuses on DRI produced using natural gas with CCS or DRI produced using hydrogen, which is generated via electrolysis with decarbonized electricity.

Relative to the cost of producing steel today, each of these pathways is expensive. The required capital outlays will be approximately $27–41 billion through mid-century; that is, between $1 and $1.6 billion per year, a massive increase in the capital budget of most steel-producing companies. Since there is currently no measurable economic return associated with steel decarbonization investments, companies are unlikely to invest at the rate required to meet national and global climate change mitigation goals, reducing or eliminating GHG emissions. Hence federal policy plays an essential role in providing incentives for decarbonizing investments.

The incremental operating costs of these investments are also substantial. These costs can be partially or fully offset by existing 45Q and 45V Inflation Reduction Act tax credits. However, both tax credits are currently set to expire at the end of 2032, and their implementation should be extended and expanded to provide operating cost relief.

Utilizing Section 232 steel tariff revenues, currently $1.5–2.5 billion annually, to fund decarbonization capital investments (implemented through an effective review process and possibly some cost-sharing requirements) would enable steel companies to pursue decarbonization aggressively and emerge as global technology leaders. These investments would support existing iron and steel industry jobs and benefit communities by improving local air quality.

Benefits to Steelmaking Communities and Workers

For this study, we conducted surveys of communities near iron and steel production sites. In general, survey respondents note several contributions of the steel industry's presence, including high-paying jobs with benefits, public revenue, and other forms of direct economic support. In 2023, employees in EAF and BF-BOF production earned approximately $2,040 per week, 54% above average U.S. wages.

The surveys find that 82% of respondents associate steel plants with positive community impacts related to job creation and to work-related skills development. Respondents generally feel positively toward decarbonization. Economic issues, particularly job and retirement security, are the top concerns for all surveyed communities. Respondents also indicated they would like to see higher wages and greater job creation, retirement benefits, and job training. Respondents are most concerned with the rising cost of living and job loss, including layoffs and outsourcing.

Trade Policy for Steel Decarbonization

Trade policy is essential to maintaining a healthy steel industry, both in the United States and worldwide, by discouraging unfair trade practices and supporting high-quality jobs and strong environmental performance. Current Section 232 tariffs have not only strengthened national security, their primary purpose, but have also impacted mainly products from countries that have relatively high GHG

emissions from steel production. Trade policy will continue to have consequences for steel decarbonization, since companies and nations that incur the related costs risk losing competitiveness to overseas producers that continue to emit GHGs at current rates. Efforts to address this risk through a carbon-based border adjustment mechanism (CBAM) have been pursued by the European Union and others but to date this approach, despite its theoretical appeal, has not been adopted in the United States. Thus, this case study recommends that existing Section 232 tariffs on direct steel imports should be continued for at least five to eight years and the revenues allocated for the capital expenditures required for steel decarbonization. In the long term, a carbon border adjustment mechanism (CBAM) negotiated between the United States and key trading partners could provide a sustained source of funding based on the GHG emissions intensity of direct and indirect imports, once accounting protocols and verification systems have been agreed upon and established.

Recommendations

This case study generated four key recommendations, laid out below, for a self-funded framework to accelerate deep decarbonization of the iron and steel industry in the United States.

Recommendation 1: Create a national public-private commission to provide leadership and oversight for accelerated iron and steel decarbonization. This commission should be composed of industry, appropriate government agencies, labor, technical experts, and community members. Industry, government, labor, and community representatives should have the opportunity to nominate their own representatives, who would be confirmed by the executive branch. The commission would have broad responsibility to design and review a federal plan for iron and steel decarbonization by 2050. Consistent with federal advisory committee rules and SEC requirements, the commission's key responsibilities would include: (1) developing consensus criteria for net-zero compatible technologies eligible for federal support and overseeing implementation, (2) identifying critical iron and steel decarbonization infrastructure projects, and (3) producing, by December 1, 2025, a roadmap report on iron and steel decarbonization by 2050, which would be used as guidance by implementing federal agencies. The commission should also issue an annual report to the executive and Congress describing the industry's decarbonization program, tracking its progress toward decarbonization goals (based on internationally common or at least interoperable CO_2 emissions accounting boundaries), and identifying gaps in various complementary dimensions of the steel transition.

Recommendation 2: Appropriate Section 232 revenues to fund iron and steel decarbonization by 2050. Section 232 tariffs should be maintained and extended for at least five to eight years or until an agreement on a CBAM is reached with major trade partners. The related Section 232 revenues should be used to fund capital costs for iron and steel decarbonization. A new Office of Steel Decarbonization, administered by the U.S. Department of Energy, should be established to review grant applications and award iron and steel industry decarbonization grants following the guidance supplied by the commission's roadmap report on iron and steel decarbonization and annual reports to the executive and Congress. Once a CBAM is in place to provide funding for decarbonization of iron and steelmaking, Section 232 revenues should revert to the U.S. Department of the Treasury.

Recommendation 3: Extend and augment existing IIJA and IRA programs and tax credits to support iron and steel decarbonization. The funds appropriated for the Industrial Demonstrations Program (IDP), CCS, and the Regional Clean Hydrogen Hubs Program (H2Hubs) will contribute to enabling both early plant-specific investments and deep decarbonization through the provision of infrastructure to access clean electricity and hydrogen. Existing IRA tax credits such as 45Q and 45V will be necessary for iron and steel decarbonization by 2050 and should be adjusted for inflation and extended for the industry beyond their current expiration at the end of 2032. Since multiple federal agencies have a range of authorities and programs that could impact the speed and success of iron and steel industry decarbonization efforts, an interagency working group, including representatives of the DOC, DOE, DOL, USDT, and EPA, should be established to coordinate federal support across federal agencies for iron and steel plants to decarbonize using new and existing programs. This working group should coordinate its activities with the commission and the DOE's Office of Steel Decarbonization and be mandated to address roadblocks to iron and steel industry access to enabling infrastructure, such as decarbonized electricity; carbon capture, transport, and sequestration; and clean hydrogen.

Recommendation 4: Involve community members and workforce representatives early and often in decarbonization planning. Iron and steel companies should proactively engage community members and workforce representatives, including labor unions, to design decarbonization plans with accountability for outcomes. These engagement strategies will need to be site-specific, addressing unique legacies and stakeholder dynamics. Training and upskilling opportunities for affected employees will be an essential component of all decarbonization plans. Companies should ensure that any public health and environmental co-benefits of decarbonization investments are key components of community engagement and part of the design of any Community Benefits Plans (CBPs). Ultimately, Community Benefits Agreements that codify job quality, public health, and environmental targets with accountability provisions are an essential outcome of both community engagement and CBPs and should be required of all federal grant recipients.

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