The Impact of the U.S. Inflation Reduction Act on Global Clean Energy Supply Chains

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May 1, 2023

For the Bureau of Energy Resources

Executive Summary

On August 16, 2022 the Inflation Reduction Act (IRA) was passed into law, representing the single largest piece of legislation passed by the United States to combat climate change. The IRA contains $370 billion in new spending designed to ensure the U.S. remains the global leader in clean energy technology, manufacturing, and innovation through a series of tax incentives and investment initiatives designed to boost supply and demand for clean energy in alignment with U.S. national security considerations.[1.] The passage of the IRA has already prompted strategic shifts among private actors in the clean energy space as firms mobilize to take advantage of provisions within the legislation. However, U.S. allies and partners in Europe and Asia have criticized the legislation for its emphasis on domestic production and free trade provisions.

This report provides several policy recommendations to the Department of State's (DoS), Bureau of Energy Resources (ENR). The suggestions and the report are produced by student researchers under the supervision of Ambassador Earl Anthony Wayne as part of the State Department's Diplomacy Lab program.

- **Expansion of the Mineral Security Partnership (MSP)**
    - Induction of new member states based on their commitment to MSP principles;
    - Funding multilateral research and development on clean energy technology between member states;
    - Development of a "Battery Passport" to facilitate the trade of ethically-sourced battery components among member states;
    - Creation of a public diplomacy campaign to communicate the accomplishments and the potential of the MSP, and promote understanding and discourse around critical minerals;
    - Establishment of a Strategic Critical Mineral Stockpile among member states;
    - Promotion of further Research and Development Initiatives between MSP member states.
- **Mobilizing Private Sector Investment for Critical Mineral Sourcing and Processing**
    - Formation of country-specific diplomatic and expert task forces composed of seasoned U.S. negotiators with the goal of supporting private firms and entrepreneurs in reaching deals with emerging economies vital to the future of clean energy supply chains;
    - Encouraging the signing of Free Trade Agreements—including bilateral critical mineral agreements—with international partners;
    - Using Private Public Partnerships (PPPs) to mobilize the private sector in projects deemed to be in the U.S. national and international interest.
- **Reaffirming U.S. Leadership in the Clean Energy Space**
    - Education of Foreign Service Economic Officers stationed at U.S. Embassies and Consulates through an Foreign Service Institute Module on critical minerals (and to make similar training available to key officers from other USG agencies involved in the effort mentioned above)
    - Fostering Investment through Business Fora and commercial diplomacy.

Section 1 provides an overview of domestic and international interests of the United States in passing the Inflation Reduction Act.

Section 2 analyzes how specific provisions within the legislation contribute to achieving the objectives of the Inflation Reduction Act.

Section 3 explains the impact of the IRA on specific clean energy technologies, with a particular emphasis on technologies dependent on international supply chains.

Section 4 highlights the role that the IRA has already had in prompting strategic shifts within the private sector, while

Section 5 centers on the longer-term projected impact of the Inflation Reduction Act on clean energy supply chains.

Section 6, examines the international responses to the Inflation Reduction Act from the European Union (EU), China, and other states.

Section 7 includes a set of policy recommendations made to our State Department Clients (ENR) for the USG.

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Introduction

A group of six students from the American University School of International Service produced this report under the supervision of Ambassador Earl Wayne as part of the Department of State's Diplomacy Lab Program. The report examines the impact of the Inflation Reduction Act on global clean energy supply chains and includes a set of policy recommendations made to the Bureau of Energy Resources, based on their research and conversations with experts.

1. Stake of the United States Government

Since the beginning of the new millennium, the United States's manufacturing sector significantly changed, partially due to increasing competition from China. Between 2000 and 2010, one-third of all U.S. manufacturing jobs were lost as the U.S. manufacturing industry adopted new technologies requiring fewer workers.[2.] While output per worker continued to increase, lower skilled U.S. labor decreased as it could not compete against countries which had lower labor costs. The political discontent and increasing sophistication of Chinese manufacturing remains a threat to America's economic competitiveness. The Trump Administration responded with a trade war against China in a bid to force a more favorable set of trade agreements with Beijing. However, this policy did not bear fruit.

Building upon executive orders and priorities that began under the Trump-Pence presidency, the Biden-Harris administration and Congress have made a series of critical investments in restoring America's manufacturing and infrastructure sectors. During the tenure of the 117th Congress, the passage of the Infrastructure Investment and Jobs Act (IIJA), the CHIPS and Science Act, and the Inflation Reduction Act (IRA) represent, roughly, a combined $2 trillion investment into America's Research and Development (R&D), manufacturing, and infrastructure sectors.[3.] This constitutes the largest slate of industrial policy implemented by the U.S. in the 21st century. These investments are aimed at restoring the broad socioeconomic benefits of a vibrant, competitive industrial base which aligns with the geopolitical, environmental, and economic realities of the future including incorporating green technologies to combat climate change. A crucial test for the U.S. is if these policies and their implementation successfully foster resilient, sustainable, job-creating value chains.

In this context, the IRA represents the most significant effort in American history to realign American energy sector supply chains with the clean energy transition. Several goals fueled the passage of the IRA.

- A more U.S.-centered clean energy supply chain is expected to benefit America's job market by incentivizing industries vital to U.S. national security to reshore, nearshore, and "friend-shore" while growing clean energy investments that benefit producers and consumers;
- A supply chain that sources key components from a more diverse set of partners based in allied countries will be more resilient to potential supply shocks;
- IRA provisions incentivize the private sector to reorient the supply chains in closer alignment with U.S. geostrategic interests.

Finally, the Biden-Harris administration's goal to reduce greenhouse gas (GHG) emissions by 50-52% below 2005 carbon emissions levels is well-served by provisions in the IRA.[3.] It mobilizes government agencies and the private sector to develop efficient, resilient, and sustainable clean energy supply chains. Climate models by the REPEAT project indicate that the IRA will push the U.S. to achieve 81-84% of President Biden's emission reduction goal, compared to a scenario without the legislation which would only decarbonize the economy by 52-54%.[5.] These emissions reductions directly contribute to safeguarding American national security, prosperity, and leadership in a world increasingly marked by the effects of climate change.

All of these strategic motivations are behind the Democratic party's consensus to mobilize significant resources and develop resilient global clean energy supply chains through the passage of the Inflation Reduction Act.

2. Relevant IRA Provisions

The IRA includes a diverse array of provisions ranging from corporate tax reform, funding for various government agencies, to lowering healthcare costs. In terms of energy and climate investments, the legislation provides an estimated:

- $161 billion towards funding clean energy tax credits;
- $40 billion towards regulating air pollution, hazardous materials and building transport & infrastructure;
- $37 billion towards Individual Energy Incentives and Clean Manufacturing Tax Credits respectively;
- $36 billion towards Clean Fuel and Vehicle Tax Credits;
- $35 billion towards conservation, rural development, and forestry;
- $27 billion towards developing greater efficiency in electrification and transmission through grants and loans provided by the Department of Energy (DoE);
- and an additional $18 billion in other energy and climate spending.[6.]

Many of these numbers are estimates according to the Congressional Budget Office (CBO) and Joint Committee on Taxation (JCT). Of the IRA's estimated $392 billion price tag, only $121 billion is direct

spending; the rest are tax credits. Because many IRA tax credits are uncapped and/or refundable, the IRA could far exceed the CBO estimate. According to the Electric Power Research Institute, the IRA may disburse $780 billion to $1 trillion as a result of these uncapped tax credits.[7.] These numbers are contingent on several factors including macroeconomic conditions, long-term industry response to the IRA, future government action, permitting reform, and legislation which may dampen or stimulate clean energy investment.

This section analyzes how certain provisions aid in accomplishing the goals of the IRA; specifically, financially supporting direct government action for the clean energy transition, supporting domestic clean technology manufacturing, deployment, and adoption through tax credits, strengthening the U.S.' geostrategic position in the energy sector, and pushing for environmental and social justice.

Financially Supporting Direct Government Action for the Clean Energy Transition

The IRA appropriates funding to various government agencies with the overall objective of reorienting clean energy supply chains. These include $41.5 billion in appropriated funds to support 24 new and existing programs within the *Environmental Protection Agency (EPA)*. For example, $5 billion in new EPA funding will go towards funding Climate Pollution Reduction Grants at the state, local, and tribal level to develop and implement plans to reduce emissions, while an additional $3 billion is appropriated to the EPA to fund Grants to Reduce Air Pollution at Ports, providing necessary funding to to purchase & install zero-emission technology in targeted high-emission zones.

Other agencies like the *Federal Housing Administration* and the *General Services Administration* receive funding to ensure the use of low-carbon materials in federal projects.[8.] The *DoE's National Laboratories* were given over a billion dollars to advance science and technology development, as well as $700 million to the DoE Advanced Nuclear Fuel Availability program to increase the availability of High-Assay Low-Enriched Uranium. The *DoE's Loan Program Office* was given $40 billion for three programs: Title 17 (which provides funding for innovative energy projects), Advanced Vehicles Technology Manufacturing, and the Tribal Energy Loan Guarantee Program.

Supporting Domestic Clean Technology Manufacturing, Deployment, and Adoption through Tax Credits

The IRA extends and modifies sections of the tax code to create *Production Tax Credits (PTC)*. These allow developers of energy facilities to claim a credit off their tax liability on every kilowatt-hour of electricity sold to an unrelated party for a period of 10 years after a facility is placed into service.[9.] PTCs are eligible to be applied to multiple clean energy technologies.[10.] Beginning in

2025, the IRA will create a new but similar technology-neutral PTC that can be applied to all electricity generating facilities with zero or net-negative GHG emissions. Examples of PTCs within the IRA include the *Clean Electricity Production Credit*, *Clean Fuel Production Credit*, and the *Zero-Emission Nuclear Power Production Credit*.

The IRA also makes modifications and additions to the tax to create *Investment Tax Credits (ITC)*. These allow clean electricity and clean energy projects manufacturing to claim tax credits the equivalent of up to 30 percent of the fair market value of eligible projects beginning construction by Dec. 31, 2024. Eligible projects for the ITC may include installation of geothermal heat pumps, microturbines, microgrid controllers, interconnection costs, and stand-alone energy storage systems, among others. Beginning in 2025, the IRA will institute a new technology-neutral ITC similar to what it does for PTCs.[11.]

Companies that manufacture energy components or process critical minerals for use in energy can benefit from different ITCs and PTCs. The ITC is capped at $10 billion and allows eligible entities to claim a 30% tax credit on their investment provided prevailing wage and apprenticeship standards are met, while PTCs provide an uncapped, refundable tax credit. These advanced production and manufacturing tax credits differ from the clean energy tax credits because, with the exception of prevailing wage and apprenticeship requirements for the ITC, there are no bonus credits.

While tax credits for clean tech components will phase out by 2035, they will remain permanent for critical minerals—incentivizing clean tech manufacturers to add and expand production capacity.

Energy production PTCs and ITCs can be increased by 10%, provided that the project meets the domestic content production requirements of the IRA. These requirements are considered satisfied if (i) 100% of the steel or iron used in a qualifying project is produced within the United States, and (ii) 40% of the manufactured products used in construction are produced in the United States. In order to meet the 40% threshold, at least 40% of total component costs must be attributable to products produced or manufactured within the United States. This 40% threshold will increase at specific intervals over the next decade.

PTCs and ITCs can be increased by 10% if a project is located in an “energy community.” An energy community is defined by the IRA as either (i) a brownfield site, (ii) areas with substantial coal, oil, or natural gas production with an unemployment rate above the national average, or (iii) census tracts which encompass closed coal mines or closed coal-fired electric generating units.[14.]

The IRA adds several new tax credit provisions and extends others:[1]

- ***Advanced Manufacturing Production Credit:*** A new tax credit for the production of certain "eligible components" including key components for solar, wind, inverters, qualified battery components, and critical minerals. The amount varies based on the type of eligible component produced and is calculated on a per unit basis.[15.]
- ***Qualified Plug-In Electric Drive Motor Vehicle Credit*****:** Applies to vehicles that meet certain requirements with respect to minerals and battery components. The credit will become unavailable after December 31, 2023 for vehicles with battery components manufactured by "foreign entities of concern." The vehicles' final assembly must occur in North America to qualify for the credit.
- ***Credit for Qualified Commercial Clean Vehicles*** and ***Credit for Previously Owned Clean Vehicles:*** A new tax credit for taxpayers who have purchased new or used clean vehicles that meet certain mineral and battery requirements over a ten-year span.
- ***Credit for Production of Clean Hydrogen:*** A new tax credit for the production of clean hydrogen produced in the U.S. or possession of the U.S.
- ***Residential Energy Efficient Property Credit****:* Allows taxpayers to claim tax credits for qualified energy efficiency property expenditures. under the IRA, the credit was extended through 2034 and now covers some battery storage technology expenditures.

Strengthening the U.S.' Geostrategic Position in the Energy Sector

Provisions within the IRA boost not only domestic clean energy production and domestic industry, but also address key national security, economic competitiveness, and global leadership concerns of the U.S. Mark R. Kennedy, President Emeritus of the University of Colorado and a Fellow at the Wilson Center, argues that the passage of the IRA represents an improvement to the global standing of democracy amidst an epidemic of democratic backsliding.[16.] As an important achievement for citizens in the U.S. and around the globe, the legislation signals to global audiences that meaningful change can be realized through democratic processes.

The IRA also promotes U.S. leadership on climate issues; the legislation reiterates U.S. commitment to reaching its climate goals while incentivizing the private sector to invest in sustainable green technology supply chains. Consequently, the IRA lends legitimacy to the United States in international fora that it is willing to take the lead on matters related to climate change—a global challenge that will only increase in importance in decades to come.[17.] Kennedy

[1] This is not an exhaustive list of every tax credit provision within the IRA; rather, it is a sample of those likely to impact international clean energy supply chains.

also argues that the forecasted $250-300 billion reduction to the national deficit will help "preserve the primacy of the U.S. dollar as the world's preferred global currency."[18.]

IRA provisions also make frequent reference to "foreign entities of concern" and entities "owned by, controlled by, or subject to the jurisdiction of North Korea, China, Russia, and Iran." In the last two years, the term "foreign entity of concern" appeared in four separate pieces of legislation enacted in the last two years: the 2021 National Defense Authorization Act (NDAA), the IIJA, the CHIPS Act, and the IRA.[19.] Concerns over China's dominance of the critical mineral sector sparked the March 2022 Invocation of the Defense Production Act from the Biden Administration, which invoked Section 303 to direct the Department of Defense (DoD) to strengthen the U.S. industrial base for large-capacity batteries used in "the automotive, e-mobility, and stationary storage sectors."[20.] A significant amount of American defense and clean energy technologies depend on importing minerals from China, posing a risk to national security given that China has a record of ceasing trade in response to political disagreements, as they did to Japan in 2010.[21.]

Under the IRA, clean energy projects are only eligible to receive tax credits if their components are sourced from within the U.S., or with countries that have a Free Trade Agreement (FTA) signed with the U.S. According to the most recent Treasury Department Guidance issued in April, less ambitious agreements—like the critical mineral partnership signed with Japan—will also qualify as FTAs, meaning that Japanese components used in the production of EVs, solar panels, and wind turbines can still qualify for tax benefits.[22.]

Environmental and Social Justice

The IRA supports the Biden Administration's goal to support historically underinvested and underserved communities by implementing policies that advance environmental and social justice. The IRA builds on the Biden Administration's Justice40 Initiative, a commitment to direct 40% of the overall benefits of climate and clean energy investments to disadvantaged communities through specific provisions outlined in the legislation.[23.]

For example, the IRA offers an additional 10% bonus PTC or ITC, provided that the project is implemented in an energy community as defined in the legislation. Furthemore, the IRA also creates a new ITC for up to 1.8 GW of new solar and wind facilities created in low-income communities per year. The ITC adds a bonus 10% to the clean energy ITC to low-income and tribal communities and 20% to some federally subsidized housing programs or if the facility offers at least 50% of the financial benefits of the electricity produced to low-income households.[25.] In addition, billions of dollars in loans and grants will go to low-income communities to help reduce emissions and deploy clean energy.

The IRA represents the "single largest investment in rural electrification since the passage of the Rural Electrification Act in 1936" through a series of loans, grants, and incentives to transform rural power production in a sustainable direction from government agencies like the United States Department of Agriculture's (USDA) Rural Development' Rural Utilities Service and Rural Business and Cooperative Service."[25] The IRA also provides billions in grants to the private sector to facilitate carbon management, community investment, general clean energy financing, and increasing conservation practices in agriculture and forestry; these grants are directed towards low-income and historically marginalized populations.

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3. Overview of Key Clean Energy Technology Supply Chains

To most effectively assess the impact of the IRA on clean energy technology supply chains, it is necessary to narrow the scope of technologies discussed. The IRA includes provisions targeted at a wide range of clean energy technologies, including geothermal, nuclear, hydrogen, liquified natural gas (LNG) and alternative fuels. However, for the purposes of this report, the discussion of technologies will be limited to EVs, Batteries, Solar Photovoltaics, and Wind energy, with a special emphasis on the role of critical minerals in each of their respective supply chains. This decision was made because these technologies are critical to the clean energy transition, have vulnerable, international supply chains, and have supply chains which can be shaped by ENR policy. Other technologies are addressed in Appendix A.

3a. EVs and EV Batteries

International supply chains for electric vehicles (EV) and EV Batteries can be broken down into several phases; raw material, production processes, distribution networks, and end-use applications. In terms of raw materials, China currently dominates the midstream and downstream supply chain of EVs and the batteries that power them. From 2021-2023, the number of EVs sold annually in the country grew from 1.3 million to 6.8 million, making it by-far the world's largest EV market.[27] China processes about 60% of lithium in the world, a mineral crucial to the fabrication of batteries for electric vehicles.[28] While China only mines 23% of all critical minerals used in EV batteries, they function as the global refiner for these minerals—refining 80% of all critical minerals used in EV batteries. Due to the processing and manufacturing supremacy of the PRC in the EV battery sector, former U.S. Trade Negotiator Orit Frenkel argued that EV content requirements outlined in the IRA will be impossible to achieve.[26] However, it should be noted that the U.S. companies are not forced to abide by the content requirements outlined in the IRA; instead, the limitations on Chinese components in EV

batteries is only necessary if a firm wishes to reap the benefits of IRA incentives, such as the aforementioned PTCs and ITCs.

Despite this, a gradual phasing out of China from U.S. EV battery supply chains will increase demand for minerals from other players that could expand production and contribute to greater supply chain diversification; for example, Chile is responsible for producing almost 30% of the global lithium supplies, but sends approximately 90% to China to be processed. Argentina and Bolivia, major lithium producers, recently reached major deals with Chinese firms interested in mining and processing their deposits.[30.] U.S. diplomats and U.S. firms must develop a strategy to compete with China in order to gain market share in emerging economies undergoing lithium-related economic booms.

Mexico has vast proven reserves of the metal, but recent nationalization by the AMLO administration combined with technical problems posed by the country's clay soils in extraction threaten the industry's viability.[31.] Due to the reserves' close proximity to the cross-border U.S.-Mexico automotive industry, there is a large untapped potential for Mexican lithium which is unlikely to bear fruit until at least ten years from now—the minimum time needed to permit and construct a new lithium mine.[32.]

Most U.S. EVs are currently imported from Europe and Mexico.[33.] As the seventh-largest car manufacturer in the world, Mexico has been an attractive destination for investment in the post-IRA world. For example, Ford recently announced its plans to build an EV plant in Mexico and Tesla also shared that they plan to build a new factory in Monterrey.[34.] Under the IRA, Mexico is classified as a nation that shares a FTA with the U.S., allowing it to bypass certain domestic content requirements pertaining to critical minerals.

3b. Solar Photovoltaics

Solar Photovoltaics (PVs) are a clean energy technology that convert light from the sun into usable energy. PVs are recognized by nearly all experts as an integral component of a successful clean energy transition in the U.S.[35.] Technological innovation and a rapidly scaling-up private sector has made them significantly cheaper to produce, more durable, and more efficient in generating electricity.[36.] In 2021, the levelized cost of electricity (LCOE), a statistic that measures the lifetime costs to maintain a generator over the lifetime electrical output of a generator over its cost, indicated that, on average, each kilowatt/hour (kw/h) produced by Solar PVs is cheaper than each kw/h produced by any type of fossil fuel.[37.]

For these reasons, solar energy has been the fastest growing clean technology by newly installed net capacity since 2015—making it the second-largest source of renewable energy within the U.S. Assuming that Solar PV prices continue to decline, further advancements are made in PV efficiency, and

a concerted public/private sector effort is made to reduce carbon emissions, the DoE estimates that solar energy may supply up to 40% of the U.S.'s electricity demand by 2030—up from 3% in 2021.[38.] Currently, the U.S. has the second-largest market demand for solar PVs.[39.] Based on current and projected demand, climate models from the International Energy Agency (IEA) show that the demand for the key minerals, components, and infrastructure which make solar PV deployment possible is expected to increase by several factors by 2030, putting a great strain on the solar supply chain.[40.]

There are two main types of solar PVs available on the market.

- Crystalline Silicon[2] (c-Si): Currently dominates 96% of the global market and 84% of the domestic market;[41.]
- Cadmium-Telluride Thin Film (CdTe): technology used in most other Solar PVs;
- Other PV variants: Perovskite Cells, Copper Indium Gallium Diselenide Solar Cells (CIGS), and others require more research to be produced at-scale.

The solar PV supply chain for c-Si modules consists of seven key components: Polysilicon, ingots, wafers, cells, modules, mounting modules, and inverters. The process starts upstream with the mining and refining of key minerals and natural resources—the most capital intensive mineral being silica. The silica is refined into metallurgical-grade silicon (MGS) which is then further refined into solar grade polysilicon. Due to the difficulties of refining MGS at current and projected demand levels, the IEA notes that polysilicon will remain a short-term bottleneck despite the abundance of silicon.[42.] Going downstream, the polysilicon is melted and shaped into ingots, sliced into wafers, combined into cells, and assembled into modules with other materials.

CdTe PVs are made through a different process—they require a vertically integrated process in which a CdTe manufacturing facility produces a complete module "under one roof." Refined cadmium and tellurium create the semiconductor which powers the module.[43.]

Both types of modules need professionals to mount them in fields or rooftops, install balance of system components which increase the efficacy of the modules, and connect the module to the grid through an inverter. In both cases, solar PVs function either like a utility in large farms or are distributed on rooftops and sunlight areas on buildings, houses, and other edifices.

Due to cheaper production costs and anti-competitive trade practices, China has substantial market share in nearly every

[2] Technically, there are two types of c-Si modules, monocrystalline (mono-Si) and polycrystalline (poly-Si) silicon modules, but polycrystalline modules have almost completely fallen out of favor to monocrystalline silicon modules and they will be referred to as crystalline silicon (c-Si) modules from here on out.

component of the c-Si Solar PV supply chain. During the past decade, Chinese public/private investment into c-Si R&D has helped reduce the cost per module to produce a watt by 88%. Secondly, Chinese tariffs against foreign polysilicon producers strengthened key weak points in China's solar supply chain while Chinese overproduction of solar PVs and systemic trade dumping practices forced many global solar suppliers out of business.[44.] These policies helped funnel a once diverse solar supply chain into one country. 80% of all refined polysilicon is produced in China. For ingots and wafers, this number is above 95%. The solar supply chain revolves around China, posing a serious potential threat to U.S. access to clean energy components if the supply chain were to be disrupted.

In comparison, the U.S. produces no c-Si ingots, wafers, or cells, and has few factories that produce PV modules. While the U.S. imports most of its solar PV modules from Southeast Asia, many of these facilities are the result of Chinese investments made to avoid U.S. tariffs. Even so, global reliance on China for ingot and wafer production means that U.S. companies who want to buy solar PV modules or components will ultimately still rely on Chinese-made solar components.

Due to higher production costs, a lack of technical know-how, and few operating facilities, the U.S. has economic competitiveness only in downstream production of solar PVs, like in the racking and mounting solar panels, inverters to transfer electricity generated by solar PV's to the electrical grid, and tracking equipment to improve the efficiency of solar panels.[45.] This trend can be seen in U.S. solar employment numbers. While solar manufacturing jobs make up 13% of America's solar workforce and this number is falling, 66% of the workforce is involved in solar installation (which is part of the downstream process mentioned above) and this number is increasing.[46.]

Two non-IRA trade policies instituted by the Biden administration have greatly impacted the solar supply chain: The Uyghur Forced Labor Prevention Act (UFLPA) and an executive order which waives antidumping and countervailing duties (AD/CVD) on solar imports from Southeast Asia for two years.

- ***UFLPA:*** Implemented in June 2022, the legislation restricts U.S. imports of goods made in China's Xinjiang Autonomous Region over concerns of Uyghur forced labor.[47.] Since the region is home to more than a third of current polysilicon production, the UFLPA made it more challenging for American companies to buy solar PVs components, causing major price increases.[48.] Axios has reported that six months after the law was enacted, around $800 million of goods, mostly solar modules, were confiscated by Customs and Border Patrol as a result of this act.[49.]
- **AD/CVD:** In June 2022, President Biden issued a two-year moratorium on AD/CVDs against SE Asian producers

selling Chinese-made solar modules.[50] This decision came after a U.S. solar panel manufacturer, Auxin Solar, alleged that Chinese solar module manufacturers attempted to circumvent U.S. tariffs through SE Asian states, causing the Department of Commerce (DoC) to investigate these claims.[51] If the DoC rules in favor of Auxin, the U.S. would have to implement AD/CVDs against these countries, which would significantly raise solar component costs. President Biden's moratorium signals to solar manufacturers that his administration will not implement these tariffs, but some legislators want to overturn his decision and force him to implement these tariffs if the DoC rules that SE Asian states are allowing Chinese solar PVs to pass through their borders to avoid AD/CVDs.[52]

The implementation of UFLPA and the ensuing fallout caused by its initial implementation contributed to a 16% decrease in solar installation in 2022, compared to the previous year.[53] According to Jeremy Hale, a supply chain director at Earthrise Energy, a solar power plant startup, the UFLPA and ongoing trade policy dispute over AD/CVD against SE Asian c-Si PV producers have influenced American solar manufacturers and power plants to de-risk their solar supply chain by reshoring and nearshoring solar production before the IRA was ever announced.[54]

In direct contrast to c-Si PV manufacturing, the U.S. has a clear advantage in CdTe PV production. The largest CdTe PV producer in the world, First Solar, is located in Ohio.[55] Two more U.S. CdTe facilities are planned which, once completed, will triple domestic production.[56] The company is expanding internationally, and is building their third Asian factory in India.[57] Furthermore, First Solar is far less reliant on China to supply its factories with components and raw materials. Nevertheless, according to Security and Exchange Commission filings, 19% of First Solar's suppliers of 3TGS minerals are from China.[3] Additionally, it is likely that at least some of the 49% of Asian suppliers First Solar has made agreements with the are Chinese.[58]

Moreover, CdTe producers must grapple with bottlenecks in tellurium production. Tellurium is a mineral that is rarer than gold and most production is based in China. While not expensive to mine, its rarity means that production may be effectively capped at only 20 GW_{dc} of annual production capacity. This means that CdTe PV producers will not make up the majority of PV deployments.[59] Although a new Rio Tinto mine in Utah will alleviate some of the short-term concerns of tellurium production, far more mining will be necessary for CdTe to contribute to domestic solar PV deployment targets.[60] Finally, a lack of CdTe PV producers except firms like First Solar and a few smaller CdTe startups means

[3] 3TGS refers to Tantalum, Tungsten, Tin, and Gold. These are labeled as "conflict minerals" by the USGS

that an unexpected shock to supply chains could spell disaster to the domestic CdTe PV manufacturing sector.[61.]

Through reshoring portions of the solar supply chain, the U.S. can create thousands of jobs in the solar sector, reduce the environmental and financial costs of shipping solar PV technologies, and insulate a key sector in the clean energy transition from global supply shocks. The IRA offers a variety of tax credits which should help facilitate this needed change.

3c. Wind Turbines

Horizontal Axis Wind Turbines (HAWT) are the main clean technology used to convert the kinetic energy generated by wind into electricity. Like solar energy, wind energy's LCOE is lower than fossil fuels, and it is viewed by experts as a key clean technology. The DoE estimates that wind energy may provide up to 35% of the U.S.' electrical demand up from 8.3% currently.[62.] Most wind turbines are built onshore, but there has been a recent upsurge in offshore wind. Offshore wind, while more expensive and technically challenging to deploy than onshore wind, is closer to high-energy usage markets and can generate more electricity because wind speeds are faster over water.[63.] The Biden administration hopes to use the IRA to achieve its goal to deploy 30 GW of offshore wind by 2030.

Wind turbines consist of a foundation and tower which support the turbine, a hub which holds three blades which "harness" the wind's kinetic energy, and a nacelle which contains some type of drivetrain that turns the kinetic energy into electrical energy.

The Wind Energy Supply Chain Deep Dive Assessment released by the DoE found that U.S. competitiveness is declining in key wind turbine components. These conditions demand policies that provide strong, stable demand signals to support accelerated investment in the wind supply chain.[64.]

Investment in the development of wind energy in the United States has been hampered by significant price volatility for key materials needed to create turbines. Rising global demand for wind energy combined with pandemic-related supply chain disruptions have meant that the price of steel, copper, aluminum, and other basic commodities have seen prices double or triple within recent years.[65.] According to the International Energy Agency the average offshore wind turbine requires nine times the mineral inputs of a typical gas-fired power plant.

Considering that wind turbines are 40-50% made of steel, aluminum, and copper and that many long-term contracts that companies make with customers contain fixed prices that do not allow adjustments, the potential profitability of investing in wind energy is uncertain. This uncertainty has caused clean energy developers to look to secure access to raw materials at stable prices, increasing the

scale of manufacturing, and enhancing logistics and installation capacity.

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4. Effect of IRA on Clean Energy Supply Chains

The passage of the Inflation Reduction Act has already prompted shifts in certain green energy supply chains as the private sector mobilizes to take advantage of tax incentives outlined in the legislation.

4a. EVs and EV Batteries

Provisions within the IRA are designed to incentivize domestic manufacturing, improve U.S. energy security, and support a transition away from fossil fuels through manufacturing and consumer tax credits applied to EVs.

However, EV tax credits in the IRA only apply if the materials used in the vehicle's production are sourced from the U.S. or a country it has a FTA with. Consequently, these provisions have triggered discontent among European leaders, among others, concerned that the IRA will crowd out investment into the nascent European EV sector. EV supply chains depend heavily on materials sourced from a handful of countries. For example, >70% of global lithium supply comes from Australia and Chile. However, China currently accounts for 60% of global lithium processing capacity. Content requirements which favor the U.S. and its trading allies has caused EV producers to express interest in reshoring their supply chain and market.[67.]

The IRA creates a $3,750 per vehicle tax credit contingent upon vehicle components sourcing requirements and another $3,750 provided the vehicle meets IRA materials requirements. In terms of components, EV battery components must be manufactured or assembled in North America, with 50% beginning in 2023 and increasing by 10% each year up to 100% in 2028. In 2024, vehicles will no longer qualify if battery components were manufactured or assembled by a foreign entity of concern. In terms of materials, 40% of critical minerals used in EV vehicle production must be sourced in North America or from a country that the U.S. has a FTA with, which increases by 10% each year up to 80% in 2026. In 2015, vehicles will not qualify for the tax credit if the battery's critical minerals are sourced from a "foreign entity of concern."[68.]

4b. Solar

The IRA is the single most impactful piece of legislation the U.S. has passed in a decade for the solar industry. Estimates by the Solar Energy Industry Association (SEIA) indicate that the IRA will lead to 69% more growth in the solar industry than compared to a no-IRA scenario.[66.] This translates to an expected creation of 682 GW (of which 222 GW are a result of IRA investment) of total solar capacity by 2032, putting the U.S. on track to meet the DoE's Solar Energy Technologies

Office (SETO) goal of 95% decarbonization by 2035.[69.]

IRA tax credits and government grants will support solar energy manufacturing, production, and consumption. Sections 45X and 48C establish PTCs and ITCs for solar manufacturers. The only bonus credit for these tax credits are for prevailing wage and apprenticeship requirements for the ITC and not the PTC. The IRA incentivizes deployment of utility and distributed solar PV projects through PTCs and ITCs created in sections 45/45Y and 48/48E. Though difficult to prove a clear causal link, the domestic content bonus created within these sections will make it more cost effective for solar energy producers to buy from domestic solar component manufacturers. For individuals, Section 25D, a consumer ITC, creates incentives for homeowners to install residential solar onto their rooftops. Finally, a significant chunk of $7 billion in grants from the Greenhouse Gas Reduction Fund will go to the installation of residential solar in low-income communities.[70.]

In addition to these programs, several other policies in the IRA will give grants, tax credits, and loans to the USDA and DoE for solar projects in low-income, rural, tribal, and energy communities. There is also more funding for research into solar technology. These may prove to be transformative for those communities and may increase support and visibility for IRA investments, but they will not individually alter the quantity of domestic solar deployment. However, as a collective these will contribute to further funding into solar manufacturing, deployment, and generation.[71.]

The effects of these provisions have already changed the solar supply chain. There have been a wave of announcements following the IRA's passage. As of mid-April 2023, twenty six new solar facilities or new upgrades to existing solar facilities have been announced.[72.] Per the research team's analysis, 13 of those announcements cited the IRA as an influential factor in their decision to create these facilities.[4] These new factories will collectively produce all major components in the c-Si and CdTe PV supply chain.[73.] One Korean company, Hanwha QCells, announced that it would invest $2.5 billion into building a solar supply chain completely within the United States.[74.] Another company, CubicPV, will build a solar wafer factory.[75.] When these two investments go online, they will produce the first U.S.-made ingots, wafers, and cells in seven years.[76.] Despite industry headwinds due to volatile global and domestic trade policies, the IRA, alongside falling silicon prices in the short-term, will act as a tailwind that will push the solar industry to deploy solar PVs at increased volumes and speeds.

4c. Wind

The IRA promotes the U.S. wind energy sector through provisions like the Advanced Manufacturing PTC, the Renewable Energy

[4] Further analysis can be found in Appendix F

PTC, and the Extension of Energy Investment ITC, which reduce both short and long-term costs associated with the development of new wind energy projects. The IRA makes $100 million available for the development of interregional transmission and optimized integration of energy generated by new offshore wind projects.[77.]

ITCs are especially significant for wind sector projects, which tend to be more capital-intensive up-front, providing more comprehensive benefits when compared to long-term oriented PTCs. The IRA incentivizes deployment of utility and distributed solar PV projects through an ITC for 30% of the project's cost and a PTC of 1.5 cents/kW (adjusted for inflation) provided prevailing wage and apprenticeship requirements are met through 2032, or when the U.S. reduces GHG emission by 25%. The IRA also provides another 10% bonus credit if 100% of the steel and iron and 40% if all manufactured components (which will increase to 55%) are made in the United States.

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5. Future of Clean Energy Supply Chains Under the IRA

Historically, targeted industrial policy towards specific industries of national importance has allowed the U.S. to gain or regain market share in that sector. Industrial policy programs such as DARPA, the Apollo Program, and most recently Operation Warp Speed have led to a variety of technological breakthroughs which benefited American businesses, citizenry, and national security.[78.] From 1991-96, DARPA investment in the semiconductor industry, known as Sematech, restored America's primacy in semiconductors for two decades, which has since been lost to the PRC and other countries in the Indo-Pacific.[79.] Chinese industrial policy towards the Solar PV and EV battery manufacturing sectors have aided in capturing a significant portion of their respective supply chains.[81.]

A Clean Technology Investment Boom?

The IRA is an industrial policy approach that tackles both clean technology deployment (supply) and adoption (demand) through tax credits, grants, and loans to stakeholders along every point of the supply chain. There are several elements within the IRA that explain the market's positive reaction to this legislation.

- First, the IRA creates incentives for first movers, and eventually the rest of the sector, to create facilities and develop investments that augment America's energy sector industrial base.
- Second, the IRA incentivizes consumers to adopt the goods created by the investments it helped spur.
- Third, the IRA demonstrates that the government is committed to supporting clean technology investments because it

is designed to disburse stimulus over a long period of time.

This long-term financial commitment may incentivize investment by convincing investors that the sector is less prone to risk caused by volatile government support. There is some evidence that tax credits spur investment, but their short-term implementation causes "lumpy" investment cycles.[83.] The IRA's predictability may help the clean tech investment pattern to resemble less of a lump and more of an upwards curve.[85.]

Based on the volume of new clean technology projects that have been announced in the aftermath of the IRA's passage, this prediction may come to pass. As of January 2023, 90 new clean energy facilities have been announced. 46 new or expanded utility-scale clean energy manufacturing facilities were announced as of April 2023.[90.] Long-term, a recent report from Bloomberg NEF estimates that the U.S. will deploy a "staggering" 600 GW of "new solar, wind, and energy storage capacity" from 2023-2030 partially due to IRA support.

The IRA as a Provocateur of Global Clean Technology Industrial Policy

The depiction of the IRA across the international media landscape tends to highlight how *their* country needs to develop a cohesive policy response to the IRA— or face being left behind in the clean energy sector. Since its passage, the IRA has "stirred the pot" on climate-based industrial policy. The initial response to the IRA was met with protest internationally. However, this response can be viewed as subtle praise; governments criticize the IRA because they fear that it will spur an investment boom which they will not be able to capitalize on. For this reason, some governments and agencies, in particular parts of the EU commission and some EU member states, may in reality favor the IRA, because it can be used as a tool to kickstart their own cleantech investment programs and initiatives. As Renisch et al. notes, the EU response to the IRA indicates that they see merit in pursuing an industrial policy approach that resembles America's.[86.]

Washington has tried to moderate the protectionist policies within the IRA through diplomatic outreach and treasury guidance, which liberally interprets sections of the IRA to allow more countries to benefit from tax credits. U.S. commercial and political diplomacy is needed to make agreements with our allies to prevent an expensive subsidy war which would undercut the pace of the clean energy transition.

Driving Strategic Decoupling

Domestic content bonus credits, provisions within the IRA specifically targeting China, and additional climate policies such as the Mineral Security Partnership contribute to U.S.-China economic decoupling. This decoupling will, at least in the short to

medium-term, help de-risk and diversify supply chains.

The IRA contributes to the regionalization of clean technology supply chains by picking and choosing which countries can have companies that are eligible for tax credits. This approach will likely produce worse economic outcomes as targeted subsidies distort markets. However, considering the geopolitical context, de-risking supply chains through subsidies may prove to be an effective way of hedging against worst-case outcomes in the form of supply shocks. In this sense, the U.S.' ideal outcome is to shift its clean technology and critical minerals supply chain without sacrificing economic potential or causing politically-motivated supply disruptions from China.

Determinants of IRA Efficacy

The way in which the IRA will shape global green tech supply chains is contingent on several factors. Domestically, permitting reform and additional investment in the electrical grid can speed up the clean energy transition. [89.]

The former is required to reduce lead times for critical mineral mines, clean technology factories and energy generation sites. A streamlined permitting process will increase clean technology investment by reducing the risk that the investment will get bogged down in bureaucracy and require costly changes to be approved for a permit.

Lack of funding into the latter will bottleneck U.S. clean energy production. Electrical grid infrastructure is critical because without it, the electricity generated by clean technology facilities cannot be used. According to Bloomberg, investment into the grid needs to double from an expected $83 billion to $172 billion for the U.S. to meet net-zero targets.[89.] Increased government spending, FDI, and collaboration with foreign partners.

Additionally, the success of the IRA is related to its ability to unlock breakthroughs in key clean technologies. The U.S. lags behind China and the EU in these sectors, but R&D can create new technologies which surpass existing ones and vault the U.S. into pole position. Domestic and international funding of R&D can realize this outcome.

Alongside R&D, the IRA will help spur investment in clean technologies if relevant companies and government agencies are able to increase a globally competitive workforce. In the literature, this effect is referred to as the "learning-by-doing externality." It describes how investment into human capital will generate institutional knowledge that prompts organizational and technological improvements. Ultimately, the concept argues that these improvements result in economic growth. Accordingly, economic modeling by the Brookings Institute argues that for IRA tax credits to work, a learning-by-doing externality needs to be unlocked through public and private sector investments into the climate workforce.[90.]

Presently, the U.S. climate workforce is too small and undertrained to implement a clean energy transition that meets the Biden Administration's climate goals.[92.] However, as the 2023 Global Energy Talent Index notes, the U.S. is home to a healthy and growing climate job market.[94.] This indicates that, under current circumstances, America may benefit from the IRA because it incentivizes companies to invest in domestic human capital so that these companies can build out their domestic supply chains.

The IRA was passed on a tightrope, and several domestic and foreign actors may attempt to reduce its impact. Congress introduced legislation which rolls back some funding for the IRA and IRS which would directly reduce the IRA's efficacy.[81.] There are additional ways legislators can stall IRA spending, including through the legal system.

Moreover, some legislative actions, including a partisan effort to reinstate AD/CVDs on Southeast Asian solar manufacturers, may weaken the impact of the IRA by affecting investment in sectors the IRA is supposed to support.

As a result of domestic politics, the survival of the IRA is tied into future election cycles which may bring in a new Congress and President that are highly supportive or critical of the act. Furthermore, even if the IRA is not altered in the Congress, simply the threat may affect cleantech sectors by chilling investment as investors do not want to risk losing capital as a result of a possible repeal.

Another potential threat to IRA efficacy relates to the international response; some experts warn that the IRA will cause states, including China, to respond with a slate of anti-competitive trade policies to protect their cleantech sector. This could harm international investment in American clean energy. However, U.S. diplomatic efforts, including broadening their definition of FTAs to allow more countries to qualify for IRA credits and the announcement of several new clean tech-related agreements, are efforts that may prove to mitigate the possibility of potential negative outcome.

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6. International Responses

Since the passage of the Inflation Reduction Act, we have seen an array of international responses. Highlighted in this report are the EU, Japanese, and Chinese responses. According to our research, these three are currently at the forefront of the discourse surrounding the IRA's impact on the international stage.

6a. The European Union (EU)

Initial reactions to the IRA from EU leaders were overwhelmingly negative. Despite the content of the bill aligning with fundamental EU attitudes towards climate change and clean energy, the bloc had concerns over the possibility of the IRA crowding out investment in the EU. European leaders

particularly targeted EV tax credits, arguing that its domestic content requirement discriminates against EU businesses. These concerns are being addressed through an EU-U.S. IRA Task Force which resulted in a potential agreement regarding electric vehicle subsidies following a meeting with President Biden and President von der Leyen.[86.]

This preliminary commitment agreed to by the Biden Administration says that the U.S will treat EU-extracted and processed minerals as covered by the IRA's section 30D EV tax credits.[90.] Furthermore, President Biden and von der Leyen also committed to other climate change and security initiatives and left room for further coordination on clean energy policies moving forward. These efforts attempt to ensure that the sources of critical minerals are sustainable, trusted, and ethical, as well as working to diversify our supply chain among trusted allies. This alleviates tensions caused by the IRA's exclusion of EU companies, as they will now benefit from subsidies as well.

The Biden Administration has made plans to enforce this agreement via executive order. Since the Treasury has released its guidance on new clean vehicle credits, the agreement should not have any legislative hurdles. The guidelines state, "The NPRM (Notice of Proposed Rulemaking) also details a proposed set of principles for identifying the set of countries with which the U.S. has a FTA in effect, since this term is not defined in the statute. This term could include newly negotiated critical minerals agreements".[92.]

In response to the creation of the IRA, Europe has begun to introduce similar acts that reflect the U.S.'s economic and industrial efforts in the clean energy sector. As a part of the European Green Deal, the Commission has introduced the Green Deal Industrial Plan. This plan is divided into four pillars; (1) predictable and simplified regulatory environment, (2) faster access to funding, (3) enhancing skills, and (4) open trade for resilient supply chains. Each pillar works to address employment and growing the clean energy sector in the EU.

6b. Japan

Following the passing of the IRA, the Biden Administration met with Japanese leaders to discuss the future of clean energy in the context of our partner and alliance relationships, creating the Agreement on Strengthening Electric Vehicle Battery Critical Minerals Supply Chains. Some major aspects of this agreement encourage linkages between Japan and the U.S. to maintain high environmental standards and ethical labor practices throughout both nations supply chains. The agreement allows the U.S. and Japan to coordinate their approach towards developing EV battery technology.[95.]

6c. China

U.S. allies have been outspoken in their responses to the IRA; Korea threatened a WTO suit, and EU politicians have been consistent in voicing their concerns about the domestic content requirements included in

the IRA. On the other hand, the countries of concern singled out by the IRA have been for the most part, quiet. While some Chinese newspapers have criticized the act, the most direct statement China has made in regards to the IRA was their Minister of Commerce who stated that they suspect provisions of the IRA violate WTO regulations.[96.]

The lack of reaction by China to the IRA reflects the larger state of Chinese green energy policy. Anders Hove, a Chinese Energy Policy researcher at the Oxford Institute for Energy Studies, describes as undergoing a period of retrenchment—with China pursuing energy security as one of its top priorities, it has been increasingly framed as a coal and power sector issue.[97.] There is concern that the focus on increasing domestic coal supplies may be slowing China's transition to renewables and increasing emissions under the curve of carbon peaking and carbon neutrality.[98.] It is also attributed to their general dominance with the mid and early stages of green energy supply chains that result in China not needing to concern themselves with changing their behavior, at least in the short term, because of the U.S. passage of the IRA.

Additionally, for EVs, Li-on batteries, and solar, China is so far ahead in dominating critical areas of these supply chains that the IRA is not perceived as a threat. China's domestic market for key components mentioned in the IRA is also far larger than the U.S.[99.] China's goal to expand their sale of EVs abroad is comparatively more focused on Europe.[100.]

China has proposed to ban the exportation of certain technologies used to make solar panels. Specifically, the Ministry of Commerce announced that it would restrict the export of solar PV wafer preparation technology.[101.] Such a ban would impact technologies and equipment from intermediate stages of EV production.[102.] According to Anders Hove, this ban is most likely a response of China to the IRA—though this may also be in part due to other sanctions imposed upon China by the U.S.[103.]

However, Chinese companies are currently eligible for benefits under the IRA. Notably, JA Solar, a Chinese owned company, plans to build a manufacturing plant for high efficiency solar modules in the U.S.[104.] Though, if the previously mentioned exportation ban goes into effect, this may derail JA Solar's plans. JA Solar is not alone in taking advantage of IRA tax benefits, Longi Green Energy Technology is planning a 5 GW/year solar panel manufacturing facility in Ohio,[105.] and Jinko Solar already has an operational facility in Florida.[106.] The passage of the IRA has also sparked considerable Chinese investment in Mexico and other countries within the hemisphere that share a FTA with the U.S. in order for firms to qualify for IRA benefits.[107.] However, certain members of the U.S. Congress introduced legislation to prohibit Chinese companies from qualifying for IRA

benefits, but whether such a change will go into effect remains to be seen.[108.]

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7. Policy Recommendations

The Department of State Bureau of Energy Resources (ENR), in conjunction with other government agencies and portions of the State Department, has a clear interest in supporting the private sector, international partners, and non-governmental organizations in fully realizing the goals of the IRA. In the following section, this report provides several recommendations aimed at ensuring the successful implementation of the IRA.

- ***Expansion of the Mineral Security Partnership (MSP)***
  - Recruiting and incorporating new member states based on their commitment to MSP principles;
  - Agreeing on ways to fund multilateral research and development on clean energy technology between member states;
  - Development of a public diplomacy campaign to communicate the accomplishments of the MSP, and promote discourse around critical minerals;
  - Establishment of a strategic critical mineral stockpile program among member states;
  - Development of a "Battery Passport" to facilitate the trade of ethically-sourced battery components among member states;
  - Promoting R&D initiatives between MSP Member States.

- ***Mobilizing Private Sector Investment to Critical Mineral Sourcing and Processing***
  - Formation of country-specific diplomatic task forces composed of seasoned U.S. negotiators, who would responsible for supporting private firms in reaching deals/agreements with emerging economies vital to the future of clean energy supply chains;
  - Encouraging the signing of "Free Trade Agreements"—including bilateral critical mineral agreements—with international partners;
  - Using Private-Public Partnerships (PPPs) to mobilize the private sector in projects deemed to be in the U.S. national and international interest.

- ***Reaffirming U.S. Leadership in the Clean Energy Space***
  - Education of Foreign Service Economic Officers and other agency officers stationed at U.S. Embassies and Consulates through an FSI Module on critical minerals;
  - Fostering Investment through Business Fora and commercial diplomacy activities including delegations sent to key potential partner countries.

7a. Expansion of the Mineral Security Partnership (MSP)

Founded in June 2022, the Mineral Security Partnership is a landmark Department of State Initiative with the potential to transform the procurement of critical minerals among ideologically-aligned states.[109] As of April 2023, the MSP consists of Australia, Canada, Finland, France, Italy, Japan, Norway, Sweden, the Republic of Korea, the United Kingdom, the United States, and the European Union.[110] The MSP encourages "friend-shoring"—the sourcing of components from geopolitical partners—as a basis to reshape and diversify global supply chains.[111]

The success of the MSP is contingent on its ability to balance member states' needs to reduce net import reliance on China, while still ensuring that their respective demand for critical minerals is met in a way that is environmentally and socially responsible.

Since the MSP was launched less than one year ago, relatively little information about its goals and operational structure has been made available to the public. According to keynote remarks made at the Indaba Mining Conference this February by Undersecretary Jose Fernandez, "MSP partners seek to move away from unsustainable development toward a framework that prioritizes transparency, community welfare, and environmental protection" while seeking "greater inclusion of communities affected by potential projects in the decision-making process."[112]

The MSP has already made strides towards increasing critical minerals cooperation between member states; for example:

- ***Critical Minerals and Metals Cooperation Center in East Asia***: designed to promote the sharing of technical expertise;
- ***Private-Public Consortium to Develop a State-of-the-Art Mineral Processing Facility in Latin America***: goal of forming a complete value chain in the region;
- ***Two New Midstreaming Processing Facilities***: located in Africa and Latin America, with the potential to "revolutionize their workforce development;"
- ***MSP Initiative to Create a Closed-Loop Supply Chain for Battery Manufacturing***: includes recycling plants for end-of-life EV batteries.

Recruitment and Inclusion of New MSP Member States

To further build on these successes, this report recommends the establishment of a formal application process for countries interested in joining the MSP, provided they align with the group's founding principles and with the approval of each member state. The MSP should establish a permanently-staffed secretariat to manage internal and external affairs.

Some argue that the induction of additional members to the MSP could transform it into a "metallic NATO," allowing for member states to de-risk their critical mineral and material supply chains from geopolitical supply shocks while maintaining high environmental, social, and governance (ESG) standards.[113.] However, it is far from clear that the MSP will have a collective defense clause similar to that which is at the core of NATO. Nevertheless, membership should not be kept exclusive to countries with already existing proven reserves of critical minerals or processing facilities; as more deposits are uncovered—like the recent discoveries in Sweden—MSP membership would give member states a "first-mover" advantage in developing mining and processing operations.

While the MSP has already engaged with non-member states in Latin America and Africa, regular meetings between MSP members and select states in Asia, the Pacific, and MENA regions should be a priority of the U.S.[114.] The DoS can also use already existing critical mineral alliances, which MSP members are a part of, to create partnerships with non-MSP members.

For example, Australian MSP delegations could involve both India and New Zealand since they hold membership in the Supply Chain Resilience Initiative (SCRI). Similarly, the U.S. and Canada could include Peru and Botswana in its dealings because they are both members of the Energy Resource Governance Initiative (ERGI).[115.] By extending outreach efforts to states with high critical mining potential (Peru, Chile, Bolivia, DRC, Zambia) and high critical mineral refining potential (India, Indonesia, etc.), the MSP can begin supporting projects in these regions to secure and diversify the supply chain of critical minerals.

MSP Public Diplomacy Campaign

MSP member states should commit to establishing and maintaining a joint Public Diplomacy Campaign to communicate significant project milestones and overall institutional objectives. To accomplish this goal, the MSP should:

- ***Interface with the public through expanding MSP online presence***: the establishment of a formal MSP website, as well as MSP social media channels. These channels should be modeled after similar multilateral organizations, like NATO, which boast a considerable following.
- ***Interface with media to bring critical mineral issues to the forefront of the public consciousness:*** the MSP should establish itself as an internationally-recognized authority on policy pertaining to critical minerals. Journalists should have the ability to easily contact the Mineral Security Partnership for comment on stories related to critical mineral supply chains.

MSP Strategic Critical Mineral Stockpile

MSP members must also work to create a bloc-wide Critical Mineral Stockpile Strategy, under which member states agree to contribute a certain amount of critical mineral reserves, relative to their GDP or population. This initiative could significantly help lessen the impacts of supply shocks on the clean energy security of all MSP members. Within the Strategy, MSP member states would need to agree on a list of minerals determined to be of national importance to be contributed to the stockpile. The MSP can learn from best-practices of the IEA, an organization established in 1974 to stockpile fossil fuels when faced with unprecedented supply challenges.[116.]

To accompany a joint strategy that centers around critical minerals, MSP members would agree to designate a list of minerals and materials all parties deem "critical." Considering every MSP signatory has a critical minerals strategy that has a different list of critical minerals, some negotiation is required to achieve a joint list.[117.] The inclusion or exclusion of certain minerals from the list should be determined through considering the following questions:

- Are there viable alternatives to the mineral that can replace it in most applications?
- What is the role of the mineral in the bloc's energy, economic, and national security needs?
- What is the average net-import reliance of the mineral for all MSP members?
- Are there specific minerals in the clean energy supply chain particularly vulnerable to shocks?

We realize that this proposal would require a complicated negotiation among members and that there are a number of viable options available for creating a stockpile over time. But we see great value in beginning the discussion and negotiating process and to reaching early agreements in moving the MSP in this direction as quickly as possible.

Even while the stockpile discussion is underway, we recommend that an MSP report on the minerals designated as "critical" should be released annually, reflecting changes in supply or demand for minerals given new developments in mining and processing. This would have great benefits for member countries and the private sector.

Development of a "Battery Passport" to Facilitate Trade of Ethically-Sourced Battery Components Among Member States

Taking inspiration from the Kimberley Process Certification Scheme—which developed a diamond oversight system to prevent the infiltration of "blood diamonds" in international supply chains—the U.S. along with its MSP partners should consider the implementation of a "Battery Passport" to prevent battery components from reaching downstream supply chains and consumers that are not sourced in ethically and environmentally responsible ways. The Kimberly Process ensures that members trade

only with companies that include warranty declarations on their invoices and properly report their extraction activities to a governmental authority.

According to the Global Battery Alliance (GBA), a Battery Passport would "establish a digital twin of the physical battery that conveys information about all applicable sustainability and lifecycle requirements based on a comprehensive definition of a sustainable battery." Battery Passports would track data pertaining to its carbon footprint, child labor standards, and human rights scores of the countries whose raw materials went into the battery's production. This regulatory framework would incentivize private firms to invest in sourcing and processing from countries deemed to have adequate ESG standards, and would minimize potential risks placed on firms that source raw materials like Cobalt from the Democratic Republic of Congo.

- The more countries join the MSP, the more likely it is that private firms will look to incorporate their battery manufacturing process within its regulatory framework; not only could they reap the benefits of IRA tax incentives by qualifying as a "free trade" partner, but would also be motivated by the fear of being excluded from the MSP battery trade.
- Private firms could better de-risk their supply chains if data pertaining to extraction conditions were standardized across countries involved in the industry. For example, U.S., Canadian, and Australian mining firms may be more incentivized to expand overseas mining or processing operations provided there is a strong, internationally-recognized regulatory framework in place.

If the battery passport program were to proliferate to the extent that the Kimberley Process (85 member countries), it would become increasingly difficult for nations who operate outside of human rights and labor norms to participate in the global battery economy of the future. Therefore, China's dominance in the critical mineral supply chain will likely weaken, in light of a unified MSP multilateral coalition due to their current low labor standards, emissions requirements, and respect for human rights.

The implementation of such a certification scheme is likely to be a decades-long endeavor, much like the Kimberley Process; it will require member states to gradually phase-out critical mineral components from non-member countries over the span of several years. Members of the MSP Battery Passport Regulatory Framework could receive exclusive access to benefit from MSP initiatives, exclusive deals with regional and global development banks, strategy teams, deal-making teams, and shared strategic mineral stockpiles.

Promoting R&D Initiatives Between MSP Member States

Research and Development Initiatives between MSP members promotes knowledge-sharing and economic cooperation between states.[118.] Recent increases in R&D spending by Australia, Canada, and the U.S.[119.] through the Infrastructure Investment and Jobs Act (IIJA), MSP members can mobilize hundreds of millions of dollars to promote critical minerals research.[120.]

According to a working paper from Daly et al, which tracks mining innovation from 1990-2015, Chinese R&D spending and gross patent totals in the mining and METS sector are approaching parity with MSP governments.[121.] The high number of Chinese patents in rare earths mining strengthen Chinese dominance in the rare earths mining industry.[122.] Going downstream the clean technology supply chain, the patent gap between China and MSP governments is stark: from 2015-2019, 42% of International Patent Families (IPFs) in low carbon emissions technologies were generated by Europe, Japan, South Korea, and the U.S compared to 7% by China.[123.] The MSP should utilize collective resources to improve mining innovation vis-a-vis China while leveraging its strength in clean energy innovation.

Through the MSP, members must develop multilateral critical minerals R&D laboratories for researchers to jointly collaborate on work pertaining to Mining Technology and Services (METS), mineral processing, and mineral recycling. MSP research initiatives should seek to incorporate all sources of R&D, including international partnerships between universities, research centers, and R&D departments researching critical mineral topics. While transatlantic partnership is quite strong, IPFs stemming from international collaboration for metal and minerals processing is relatively high compared to other IPFs.

The MSP can also help improve academic collaboration between South Korea and Japan, which historically have few research partnerships.[128.] Establishing such relationships will improve technology diffusion for critical mineral mining, refining, recycling and clean technologies—benefitting all members.

7b. Mobilizing Private Sector Investment to Critical Mineral Sourcing and Processing

Formation of Country-Specific Diplomatic Task Forces

To mobilize private sector investment to critical mineral sourcing and processing, teams composed of seasoned U.S. negotiators and subject matter experts should be established with the mission of supporting private firms in reaching deals with emerging economies vital to the future of clean energy supply chains. These task forces should be assigned to countries with high concentrations of minerals deemed by the USGS and the MSP to be of vital importance

to work in close coordination with private firms.

Today, for example, the United States is likely to experience a significant increase in demand for both cobalt and lithium—key components for battery technologies. The United States will need six times the amount of critical minerals as it currently imports and/or produces to maintain net-zero by 2050 goals.[132.] Demand for lithium is expected to outpace supply by 55% by 2030.[111] In 2018, the U.S. imported over 80% of its Rare Earth Elements (REE) from China and the EU, Japan, and South Korea, imported over 50% of its supplies. According to Jay Turner, a professor of environmental studies at Wellesley College, the mining industry is characterized by risk due to unstable political situations, unknown future innovations, lengthy development schedules, and many other factors, all of which may disincentivize private sector mobilization in industries vital to U.S. national security.[134.]

Consequently, these new diplomatic Task Forces should form partnerships with U.S. and international firms to advise them during negotiations with host country governments or foreign exporters of critical components. The Task Forces would need to provide convincing arguments to host governments as to why permits should be issued to U.S. firms, instead of state-backed Chinese counterparts. They should also be empowered to use available US tools to encourage agreements. Through expanding MSP benefits to emerging economies made possible by extensive multilateral diplomatic outreach, the U.S. can support both its domestic and international policy objectives.

The Bureau of Energy Resources could play a leading role within the USG. in forming a multilateral diplomatic engagement and cooperation with MSP partners to foster investment into critical supply chains. For example, to secure a hypothetical MSP-backed investment, French officials can use their unique relationship with government officials and local communities in a critical mineral-rich country to help an Australian mining company secure the rights to develop a critical mineral mining operation in that country. The U.S./MSP team would be able to harness existing relationships with their country's firms to facilitate exchanges between the private sector and government agencies involved in the permitting process. Alternatively, French MFA officials, with MSP backing, can offer to share or license critical mineral patents with the company to indicate to the country that they will help develop local production of the most advanced technologies in the sector.

Continue Support for Mineral-Centered "Free Trade Agreements" With International Partners

The United States must continue supporting the formation of "Free Trade Agreements" with foreign governments, including deals specifically pertaining to critical minerals. The January 18th Memorandum of Understanding (MOU) with Zambia and the

DRC to strengthen the EV value chain was a positive step toward reaching this goal.[114] However, the MOU signed was not legally binding and lacked the inclusion of specific changes to trade policy, meaning that Zambia and the DRC do not qualify for IRA benefits. The U.S. must continue to use diplomatic outreach to facilitate the formation of deals that would expand international partnerships for sourcing components vital to international supply chains.

Japan and the U.S. have already reached a bilateral critical minerals agreement that could be emulated with other nations. This would allow more foreign firms to qualify for tax incentives in the IRA, sparking greater investment in clean energy supply chains within the United States.

We realize that forming teams and coordinating negotiations would be a complex process, and that one size would not fit all negotiations. However, we believe the formation of negotiation teams should be a priority effort of the Biden Administration.

Robinson Meyer of *The Atlantic* suggests that it is crucial to form similar partnerships with existing allies,[115.] while Dan Wetzel, Head of Tracking Sustainable Transitions Unit at the IEA, argued that the IRA has given the U.S. considerable leverage over other states that do not have the capacity to secure their own critical mineral supplies.[138.] To take full advantage, the U.S. must guarantee that these opportunities will be robust, mutually beneficial, and long-lasting to help prevent states from shifting towards Chinese-dominated supply chains, if China offers new or more incentives.

Private-Public Partnerships (PPPs) to Mobilize the Private Sector

In projects deemed to be in the U.S. national and international interest, the United States and its allies—either bilaterally, plurilaterally, or through the MSP— should encourage the formation of Private-Public Partnerships in the critical minerals value chain. Axios has reported that the Clean Energy Resources Advisory Committee (CERAC), an ENR initiative which consists of fifteen companies advising DoS about the critical minerals supply chain, will be involved with the MSP.[140.] CERAC members include large automakers and lithium mining companies, among others. The already-existing Public-Private Partnership for Northern Central America could serve as a template for how the U.S. government and private enterprises can collaborate to promote the adoption of clean technologies with support from federal financing through the Export-Import Bank (EXIM) and the Development Finance Corporation (DFC).

7c. Reaffirming U.S. Leadership in the Clean Energy Space

Education of Foreign Service Economic Officers stationed at U.S. Embassies and Consulates and other State and USG agency personnel working on these issues through an FSI Module on critical minerals.

Another attainable action that the Department of State can pursue is the creation of a clean technology supply chain education module. Currently, the Foreign Service Institute does not offer a course that adequately explains the clean technology supply chains in this report. The benefit to such a course would equip officials with up-to-date, accurate information about current clean technologies and their international consequences. There are many aspects of this topic that could be included in such a module: explaining how critical minerals are traded, how clean technologies and their components end up in the developed world, and how these supply chains strain or strengthen foreign relations between nations. This information can be intersected with many different global actors in various geopolitical contexts. Situations may range from the Middle East and the economic consequences of the clean energy transition, to the practicality of mining operations in South America. Such a course may be implemented through an in-person, hybrid, or online format. It is clear that the information about such a topic is crucial for State Department officials to understand, especially if the global transition to clean energy is to become a long-term pillar of United States foreign policy.

These courses and the course materials should be made available to participating civil service employees and those working on the project from other agencies such as USTR and Commerce. More broadly, the USG should coordinate to ensure that personnel receive similar and adequate training to enhance the chances that the US can build success.

Fostering Investment through Business Fora

Whether bilaterally or through the MSP, the State Department can augment its commercial diplomacy efforts in critical mineral and clean technology investment through business fora and through increased regular commercial missions to key international locations.

Relevant bureaus within the State, Commerce, the Development Finance Corporation, and United States Trade and Development Agency and other agencies can create, host, and participate in business fora and targeted commercial missions about fostering critical minerals and clean technology investments and partnerships. Agencies could invite domestic and foreign firms like mining and refining companies, clean technology manufacturers, clean energy distributors, as well as political officials in capital and resource-rich states interested in receiving greater investment. Stakeholders could share new research, enhance networks, and interface with U.S. bureaucrats involved in the clean energy space. By hosting international fora and using targeted missions composed of key actors, the DoS could improve its reputation as a leader in clean energy-related investment.

Conclusion

The policy recommendations in this report include the expansion of the Mineral Security Partnership, mobilization of private sector investment for critical mineral sourcing and processing, and reaffirming U.S. leadership in the clean energy space. These recommendations are informed by experts in the fields of clean energy, global supply chains, and international relations in order to ensure a successful implementation of the Inflation Reduction Act.

List of Policy Recommendations

- **Expansion of the Mineral Security Partnership (MSP)**
    - Induction of new member states based on their commitment to MSP principles;
    - Funding multilateral research and development on clean energy technology between member states;
    - Development of a "Battery Passport" to facilitate the trade of ethically-sourced battery components among member states;
    - Creation of a public diplomacy campaign to communicate the accomplishments and the potential of the MSP, and promote understanding and discourse around critical minerals;
    - Establishment of a Strategic Critical Mineral Stockpile among member states;
    - Promotion of further Research and Development Initiatives between MSP member states.
- **Mobilizing Private Sector Investment for Critical Mineral Sourcing and Processing**
    - Formation of country-specific diplomatic and expert task forces composed of seasoned U.S. negotiators with the goal of supporting private firms and entrepreneurs in reaching deals with emerging economies vital to the future of clean energy supply chains;
    - Encouraging the signing of Free Trade Agreements—including bilateral critical mineral agreements—with international partners;
    - Using Private Public Partnerships (PPPs) to mobilize the private sector in projects deemed to be in the U.S. national and international interest.
- **Reaffirming U.S. Leadership in the Clean Energy Space**
    - Education of Foreign Service Economic Officers stationed at U.S. Embassies and Consulates through an Foreign Service Institute Module on critical minerals (and to make similar training available to key officers from other USG agencies involved in the effort mentioned above)
    - Fostering Investment through Business Fora and commercial diplomacy.

APPENDICES

Appendix A

Additional Green Energy Supply Chains Relevant to the IRA

Green Hydrogen

Hydrogen has been touted as a promising solution to achieving a zero-emission fuel type, in large part because burning hydrogen releases no emissions. However, hydrogen production is currently an emissions heavy process as steam methane reforming is energy intensive and also produces carbon monoxide as a byproduct.[142.] As the world transitions towards greener energy infrastructures, a great deal of research is being invested into methods which allow for the production of completely green hydrogen. Particularly promising is electrolysis, which produces hydrogen by extracting it from water.

Presently, the United States is one of the world's leading hydrogen producers. Particularly in the production of fossil fuels that use hydrogen, a statistical model from the Renewable Energy Agency argues that it will account for 33% of the production of this fossil fuel type by 2030.[143.] However, experts agree that the United States has the resources to become a leader in green hydrogen exportation. The U.S. also controls 10% of the production of hydrogen extraction from ammonia and 3.9% of hydrogen used to produce green steel. The first ammonia plant of this type is planned for Louisiana, which should be operational by 2023.[145.]

The production of green hydrogen depends on the availability of plentiful renewable energy sources, such as solar and wind, together with freshwater availability and enabling infrastructure. The U.S. is well situated in that it has available freshwater to allow for said production. However, U.S.' supply chain dependence on China within the domain of solar energy in the sourcing of materials to produce solar panels may have a limiting effect on its capacity to continue to develop green hydrogen production. Additionally, the United States' current significant stake in the fossil-fuel producing hydrogen will facilitate its capacity to switch and increase its capacity to produce green hydrogen.

LNG

The United States is the world's largest producer of natural gas and it supplies one third of the U.S. 's energy consumption.[145.] The majority of this gas is delivered via pipeline around the country. Liquified natural gas is typical natural gas that has been cooled to a liquid state, at -259 degrees Fahrenheit. This allows for easier storage and transportation, allowing natural gas to be accessible in areas that could not be reached by pipeline. This furthermore extends the natural

gas market outside of the continental United States, as LNG can be shipped overseas. U.S. LNG has been delivered to 40 countries on five continents as of 2021.[146.]

While the Inflation Reduction Act has a goal of reducing greenhouse gas emissions and encouraging the transition to renewable energy sources, it still maintains the usage of fossil fuels as a key component in the long term. A major aspect of the bill rewards natural gas and oil companies that address methane leaks and penalizes those who do not with fines.[147.] Oil and gas drilling leases in the Gulf of Mexico and Alaska's Cook Inlet have also been guaranteed as part of the bill. The federal government must continue to hold regular auctions for oil and gas leases concurrently with new wind or solar projects on federal land. Plants that burn gas or coal will be allowed to remain open so long as they invest in carbon capture technology.[148.]

Nuclear

Nuclear supply chains are extremely complex and require enormous global input. Natural resource mines, power plant construction infrastructure, uranium enrichment, and high-skill maintenance capabilities are just the basic needs for a nuclear power plant. The supply chain starts with mining iron, nickel, and uranium, among other materials. Then the materials, namely uranium, need to be processed and fabricated. Once everything to create a safe nuclear reaction is sources, the sub-components such as the coolant, control rods, and the system to maintain and monitor them. Specialized skill sets and services require a team to assemble the rod and reactors with intense precision.[149.] The U.S. does not have a serious issue sourcing materials. Australia produces 28% and Kazakhstan 15% of the world's Uranium. The U.S. buys 38% of its raw uranium from Kazakhstan.

However, the U.S. nuclear supply chain is extremely vulnerable to disruption. In its current state, the largest risk to the United States is the lack of uranium fabrication and conversion capabilities, which leaves the U.S. dependent on foreign states.[150.] The most glaring possible disruption would come from Russia, which converts the most uranium out of any country globally, amounting to nearly 50% market share. Furthermore, HALEU (High-Assay, Low-Enriched Uranium) is essential for advanced reactors, and Russia has a monopoly on commercial sales. Depending on Russian nuclear energy is not only a U.S. issue: Fifty countries have some sort of nuclear cooperation with Russia, meaning their nuclear infrastructure is set up to run only on Russian technology.

Appendix B

Effect of the IRA on Additional Relevant Green Energy Supply Chains

Green Hydrogen

The IRA offers similar incentives through tax credits as other forms of green energy. The U.S. is well positioned to sustain green hydrogen supply chains due to rapidly expanding green energy capabilities and output. The tax credits for green hydrogen require compliance with the Clean Air Act, that the hydrogen is produced in the U.S., and no more than 4kg of CO2 is produced per kilogram of hydrogen produced.[151.] Once qualified, incentives reward hydrogen producers with lower CO2 to Hydrogen produced ratios (CO2:H). As of March 2023, the simplified equation for the incentives is: *Kg/H x $0.60 x 0.2-1.0* (depending on CO2:H).[152.] This equation incentivizes producers who qualify for tax credits to further decarbonize their processes.

LNG

While LNGs are not the primary target for the IRA's provisions, the industry will still be impacted by the bill to a lesser extent as compared to wind, solar, batteries, and other clean energies. The IRA acknowledges the fact that natural gas will still be a vital component of our energy structure for the foreseeable future, despite its production of GHGs. To attempt to offset some of the negative aspects of LNGs, the IRA tries to hold natural gas and oil companies to a higher standard. Companies that do not address methane leaks will be penalized with fines and those that actively care for them will be rewarded.[153.] It also requires that the federal government continue to hold regular auctions for oil and gas leases alongside any new plans for wind or solar projects on federal land. Natural gas and oil companies investing in carbon capture technologies will also be rewarded with tax credits. Plants that burn gas or coal will be allowed to remain open if they use evolving technology.[154.] Embedded into the IRA is $80 million to expedite the permitting process for energy projects including natural gas infrastructure (Baker). Exports of LNGs are predicted to continue to grow in the U.S. in the short-term and remain relevant in the long-term. LNG exports will average 12.1 Bcf/d in 2023, a 14% increase compared with last year. They will increase by an additional 5% next year as the demand for LNG will rise as it displaces pipeline natural gas exports from Russia to Europe.[148.] Essentially, the IRA looks to ensure eco-conscious infrastructure and labor practices when addressing the continued usage and production of LNGs despite the fact that they cannot be regarded as true "clean" energy.

Nuclear

Due to the dangers of a nuclear supply chain relying heavily on Russia, the IRA makes new investments into Uranium reserves and HALU production. The IRA also provides the DOE with $700M for loans to increase HALU production and development.[156.] The funding structures are complemented by provisions in the CHIPS Act and the Infrastructure Investment and Jobs Act (IIJA). The IRA also provides Megawatt credits to boost nuclear plant construction, but these do not directly affect supply chain issues. New investments into Uranium reserves will increase long-term U.S. energy security, and HALU production and eventual export is vital to cut Russia out of U.S. and allied nuclear supply chains. [157.]

Appendix C

Saudi Arabian Response to the IRA

Dr. Federico Manfredi Firmian of Sciences Po has explained that the response from Saudi Arabia has been generally negative.[158.] As a nation that is economically reliant on fossil fuels, the Kingdom has been dissatisfied with the Biden Administration's global energy policy. As a result, the nation is attempting to undermine this agenda through slowing the transition toward green energy. One example of this was the rhetoric used in the COP summit in Cairo, where this transition was seldom mentioned.[159.] Finally, another avenue they hope to exploit is through diplomatic efforts to ensure reliance on fossil fuels coming out of Saudi Arabia.[160.]

Appendix D

Additional Recommendations

Promote Development of Green Hydrogen supply chains

Unlike many of the supply chains discussed in this report the supply chain for green hydrogen is far less dependent on resources or components from foreign countries. This is because all that is needed for the production of green hydrogen is renewable energy sources, such as solar and wind, together with freshwater availability and enabling infrastructure. The U.S. has access to these resources and is thus in a good position to lead in the developing green hydrogen market.[161.] Thus, one way of sidestepping potential problems caused by sourcing requirements imposed by the IRA is for the relevant USG agencies to promote investment into green hydrogen production so that this becomes a larger part of the U.S. clean energy plan. Part of this effort would need to support the development of the infrastructure needed to transport green hydrogen. Hydrogen gas is very light and highly flammable and is able to escape traditional methods for transporting gasses. However, research is looking promising in this domain with the first ship able to carry liquified hydrogen having been launched in 2022 and work is being done about its transport.[162.]

Expanding DoD critical mineral stockpiles

Critical minerals used to build clean technologies will be ever more needed as more of the U.S. energy supply industrial base relies on these technologies. Furthermore, increasing demand and possible volatility in the supply for these resources will make sourcing more challenging. For these reasons, the U.S. should work to establish critical mineral stockpiles. The Strategic And Critical Materials Stockpiling Act, which is implemented by a DoD agency, provides the U.S. government a congressionally-funded avenue to stockpile critical minerals. However, the scope of a hypothetical American critical minerals stockpiling strategy needs to be expanded to support the clean energy transition. Furthermore, this strategy should encompass a multilateral stockpiling approach to avoid inefficient competition between our strategic partners which would harm our diplomatic relationships and raise the costs of sourcing critical minerals. We realize that new legislation and funding would be required in the US. Partners would also likely need additional funding and authorization. This will likely be a complex and protracted negotiating effort, but the report's team believes this work would be very much worth the effort.

Appendix E

Diagrams of Green Energy Supply Chains

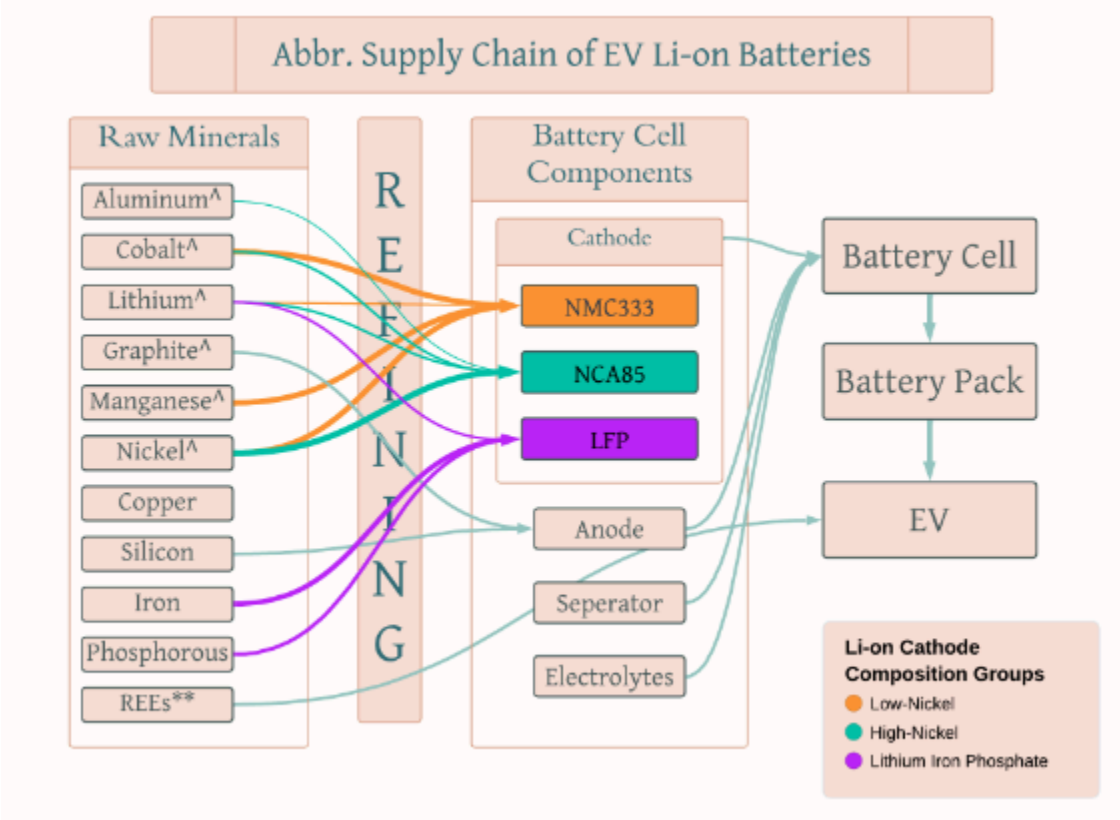

Figure 1: Diagram of EV Batteries Supply Chains

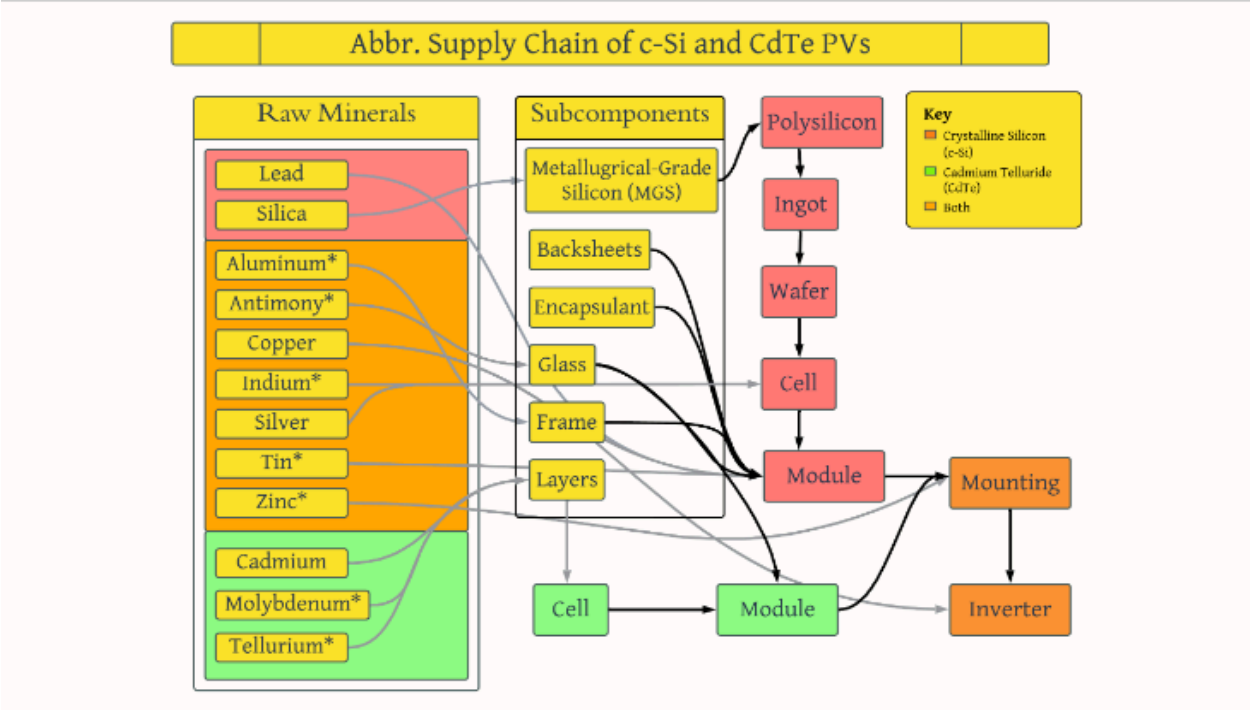

Figure 2: Diagram of Abbr. Solar Supply Chain

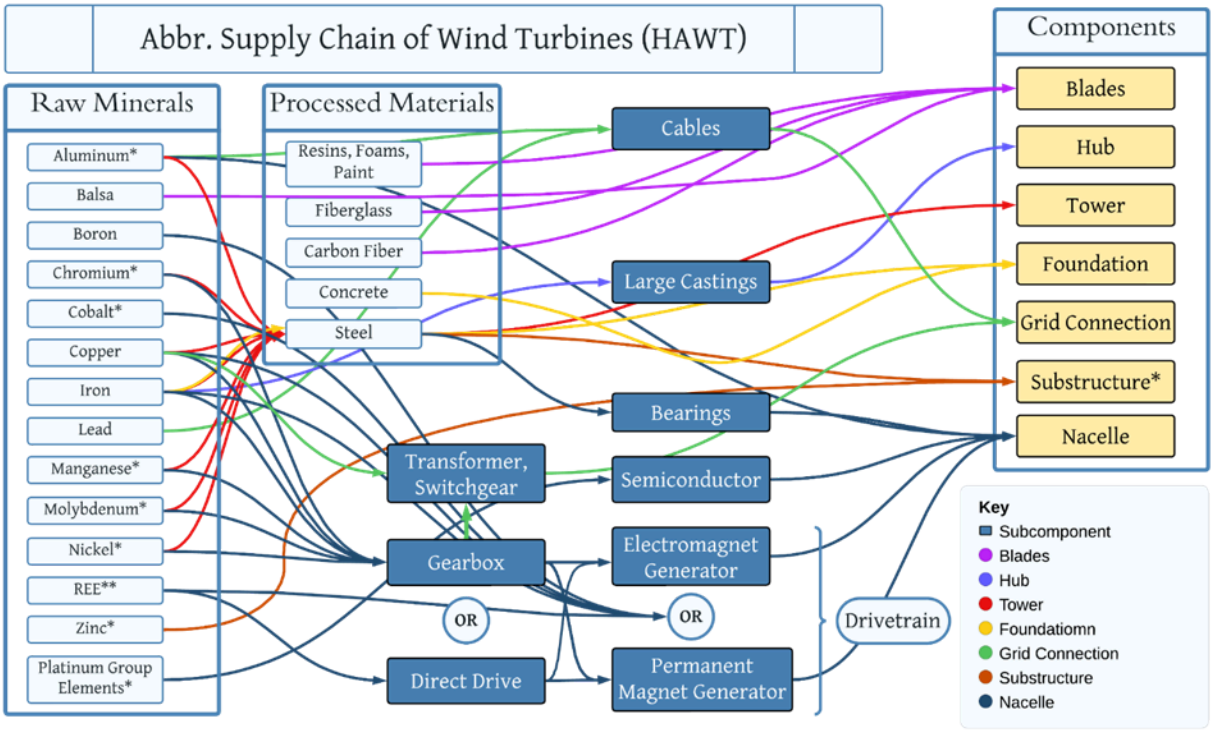

Figure 3: Diagram of Wind Supply Chains

Appendix F

Solar Manufacturer that cited the IRA in the Press Release

Did solar manufacturers cite the Inflation Reduction Act in their press release announcement concerning a new or expanded facility?			
Company	Output	Cite IRA Influence?	State
Adion Solar	500 MW	No	Georgia
Alpha Steel	N/A	No	Texas
Canadian Solar	N/A	No	N/A
CubicPV	10 GW	Yes	N/A
Enel (3Sun)	6 GW	Yes	N/A
Enphase Energy	N/A	No	Multiple
First Solar	3.5 GW	Yes	Alabama
First Solar	3.5 GW	Yes	Ohio
First Solar	0.9 GW	Yes	Ohio
GameChange Solar	24 GW	No	Multiple
Hanwha Advanced Materials GA (HAGA)	N/A	Yes	Georgia
Hanwha Qcells	3.3 GW	Yes	Georgia
Hanwha Qcells	2 GW	Yes	Georgia
Heliene	300 MW	No	Minnesota
Hounen Solar	2 GW	No	South Carolina
Illuminate USA	5 GW	No	Ohio
JA Solar	2 GW	No	Arizona
Linton Crystal Technologies	N/A	Yes	N/A
Meyer Burger	1.5 GW	Yes	Arizona
Mission Solar	800 MW	Yes	Texas
Mitrex	2.5 GW	No	N/A
PV Hardware	N/A	No	Texas
REC Silicon & Mississippi Silicon	N/A	Yes	Washington
SEG Solar	2 GW	No	Texas
Trading Philadelphia		Yes	N/A

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